

**TOWN OF SILT
PLANNING AND ZONING COMMISSION AGENDA
TUESDAY, DECEMBER 5th, 2023 6:30 P.M.
MUNICIPAL COUNCIL CHAMBERS
HYBRID MEETING**

ESTIMATED TIME	ELECTRONIC AGENDA ITEM	PUBLIC HEARING/ ACTION	ELECTRONIC LOCATION AND PRESENTOR
	Agenda		Tab A
6:30 5 min	Call to Order		Chair Williams
	Roll Call		
	Pledge of Allegiance		
6:35 5 min	Public Comments - Each speaker will limit comments to no more than three (3) minutes, with a total time of 30 minutes allotted to public comments, pursuant to Section 2.28.020 of the Silt Municipal Code		
6:40 5 min	Consent agenda – 1. Minutes of the November 8, 2023 Planning & Zoning Commission meeting	Action Item	Tab B Chair Williams
	Conflicts of Interest		
	Agenda Changes		
6:45 20 min	Silt Water Plant – Site Plan Review	Public Notice/ Action Item	Tab C Manager Centeno
7:05 20 min	Marioni Annexation	Public Notice/ Action Item	Tab D Manager Centeno
7:25 25 min	Rislende – Amended Major Subdivision Preliminary Plan	Public Notice/ Action Item	Tab E Planner Chain
7:55 10 min	Planners Report	Info item	Verbal Manager Centeno/Planner Chain
8:05 5 min	Commissioner Comments		
8:10	Adjournment		

The next regularly scheduled meeting of the Silt Planning & Zoning Commission is tentatively set for Tuesday, January 9th 2024, at 6:30 p.m. Items on the agenda are approximate and intended as a guide for the Planning and Zoning Commission. "Estimated Time" is subject to change, as is the order of the agenda. For deadlines and information required to schedule an item on the agenda, please contact the Town of Silt at 876-2353. Please be aware that this agenda is given to the public and to the Commission in electronic form. If you require a hard-copy, please request one before or after the scheduled meeting. Normal Town copying charges may apply. Thank you.

TOWN OF SILT
REGULAR PLANNING AND ZONING COMMISSION MEETING
November 8, 2023 – 6:30 P.M.
HYBRID MEETING

The Silt Planning and Zoning Commission held their regularly scheduled meeting on Tuesday, November 8, 2023. The meeting was called to order at 6:30 PM.

Roll call

Present

Chair Lindsey Williams
Commissioner Robert Doty
Vice Chair Michael Bertaux
Commissioner Jennifer Stepisnik
Alternate Vanessa Westmoreland
Alternate Dana Wood

Absent

Commissioner Eddie Aragon

Also present were Town Planner Mark Chain, Community Development Manager Nicole Centeno, Administrative Assistant Dusti Tornos, Town Administrator Jeff Layman and Town Attorney Mike Sawyer

Pledge of Allegiance

Consent Agenda

1. Minutes of the October 17, 2023 Planning & Zoning Commission meeting.

Commissioner Doty made a motion to approve the consent agenda as presented. Second by Vice Chair Bertaux; the motion carried unanimously.

Conflicts of Interest – There were no conflicts of interest.

Agenda Changes – There were no agenda changes.

The Bank- Site Plan Review Continuation

Manager Centeno explained that the applicant was unable to attend the November meeting, as they stated at the continuation of the October meeting. The applicant requested a continuance to have more time to work on the missing elements of the proposal.

Commissioner Bertaux made a motion to continue and Commissioner Stepisnik seconded the motion. The continuation passed unanimously.

Brew Zone- Special Use Permit

Manager Centeno explained why Brew Zone was back in front of the Planning and Zoning Commission, after being approved for a Site Plan Review the previous month. Mr. Lynch had a whole sale and retail license but due to state regulation, was not able to keep both in his name. He and his business partner are both listed as owners on the two different LLC's, so Mr. Lynch had a choice to remove himself and his partner from the two different LLC's, so they each had only one vested interest, or change his designation to the Silt location from a Brewery, to a Brewpub.

Mr. Lynch chose to change the license from Brewery to Brewpub, Manager Centeno stated. This changing of designation required Mr. Lynch to apply for a Special Use Permit, as a Brewpub designation is not described in the Town Code.

The operating plan changed slightly, mainly because of the differences of liquor licensing. The main difference are:

- Brewery does not require Town Liquor License, but a Brewpub does, so Mr. Lynch has applied for a Town Liquor License
- Brewery does not require that on site premise food be sold (just provided), however, a Brewpub does require that a minimum of 15% of all sales must be from food, annually.
- Brewery is only able to serve the beer that is being brewed and a Brewpub allows for the addition of wine and mixed-drinks. This would allow Mr. Lynch to serve Hard Liquor, only as a mixed drink.

Mr. Lynch is still proposing a fixed food truck, along with allowing guest food trucks and a bring your own option as well. He is not concerned with meeting the minimum requirement of 15% food sales, as he purchased Da' Beef, out of Rifle, and feels as if the food will actually outsell the alcohol at certain times of the year.

The fixed food truck and any guest food trucks will park parallel with Front Street as previously proposed, to ensure a mitigation of noise and nuisance to adjacent property owners.

Live music is still being proposed, not to exceed past 9pm, or the Silt Code noise ordinance.

Manager Centeno recommends approval for the Special Use Permit, with the conditions listed in the Staff Report.

Mr. Lynch was then welcomed to speak to the Commissioners before the Public Hearing was opened. He re-iterated that everything was to remain the same and that he was viewing this as a technicality to meet liquor licensing.

Commissioner Bertaux wanted to clarify what will take place when there is a guest food truck. Mr. Lynch stated that his fixed food truck will be closed when the guest food truck is operational.

Exterior changes was another question that Commissioner Bertaux was wanting clarification on. Lynch stated that there were no changes, but it's possible that he would install his garage doors, with the new ones that he has. Bertaux asked about a sign and Mr. Lynch stated that he was going to work with the Town to install something that complies with Town Codes.

Commissioner Doty confirmed that the hours of operation were going to end at 9pm and Mr. Lynch confirmed that nothing good happens after 9pm, so he's staying with that.

Doty asked about parties and Lynch confirmed that he would be willing to stay open to 10pm, for indoor private parties only.

Commissioner Stepisnik wanted to confirm that there was still a fence proposed and Mr. Lynch confirmed that he was installing it.

Chair Williams inquired a little more about the food requirements and Mr. Lynch assured the Commission that he would meet the requirements.

Commissioner Bertaux would not like to see grass and suggested that maybe Mr. Lynch could install something that isn't going to use water.

Public comment opened at 6:56 pm. No public comments were made and public comment closed at 6:57 pm.

Chair Williams opened the floor to entertain a motion. Commissioner Stepisnik made a motion to approve the Special Use, as presented with the conditions of approval in the staff report and additional conditions added during the meeting. Alternate Wood seconded the motion. The motion passed unanimously.

Manager Centeno requested a new motion and vote, as the Commission had 5 voting members there that night and Alternate Wood was unable to participate in the vote.

Chair Williams re-opened Commissioner Stepisnik's motion and Commissioner Bertaux seconded the motion. It passed unanimously.

Jalisco Food Truck- Site Plan Review and Special Use Permit

Manager Centeno introduced the Jalisco Food Truck application for 125 S. 7th Street. She explained the Mr. Monroy and his mother, Maria Sanchez, purchased the property for the purpose of starting their endeavors of operating a food truck, then eventually opening a restaurant.

Mrs. Sanchez is going to operate from 6:30am to about 7:00pm, which will allow for them to be open for breakfast. The menu will consist of authentic Mexican food and drinks.

The food truck will have power; however, it will not be connected to Town utilities. Since the food truck will not be connected to water and/or sewer, the applicant will be hiring a third party for the following services:

- Trash receptacles will be two 96-gallon bins that will be emptied on a weekly basis. The applicant has also proposed a wooden storage enclosure for the bins to be secured and more aesthetically pleasing.
- Clean, potable water will be delivered to the food truck on a regular basis, as needed.
- Grey water, grease and all other waste will be emptied, without leakage to the property or adjacent properties, but a company that specializes in waste disposal.

Garfield County Public Health approvals and requirements will be met and all preparation and cooking of food will take place on the food truck, not in a commissary kitchen.

The applicant has proposed to build a storage shed, under 200 sq feet, to store dry good that will be needed for the operation of the business. There is also a picnic shelter that the applicant would like to build on the premise, to allow for shade in the summer and weather protection for the winter. They would like to add sides and heaters during the winter months, if possible.

Manager Centeno stated that overall this application and proposal align with the comprehensive plan and expansion of the downtown area.

The picnic shelter, trash enclosure and storage shed will all be built by the same contractor, to allow for a consistency in appearance. The applicant understands that a building permit must be pulled and that a plan review for building code compliance must be met, prior to permitting approval for any of these structures.

The applicant has specified on their site plan, that there will be 3 parking spaces on their property, accessed off of the alley to the north. These parking spaces will be in a gravel area, and assigned by parking signs. After further conversation with the applicant, the angle and location in which those parking spaces are proposed might need to change, in order to ensure the safest and smoothest flow of traffic for their customers. The Town will work with the applicant, to find the best angle and location for those parking spaces/signs. There is also ample street parking at this location, so Town Staff does not see parking as an issue with this application request.

Manager Centeno then welcomed Mrs. Sanchez to speak to the Commissioners, before Public Comment opens. Mrs. Sanchez thanked the Commissioners for their consideration and that this food truck is their life long dream and they are happy to bring their food to Silt.

Commissioner Bertaux made a recommendation to lock the dumpster enclosure.

Public comment opened at 7:12 pm. No public comments were made and public comment closed at 7:13 pm.

Commissioner Doty made a comment to ensure that the structures will be presentable and that Town Staff is working with the applicant to follow proper procedures.

Chair Williams opened the floor to entertain a motion. Commissioner Bertaux made a motion to approve the Special Use, as presented with the conditions of approval in the staff report and additional conditions added during the meeting. Commissioner Stepisnik seconded the motion. The motion passed unanimously.

Laestadian Lutheran Church/Jurmu Annexation

Planner Chain introduced this project. He noted that Logan Jurmu, one of the applicants was present. Chain summarized the annexation and the staff report. He went over the history, noted items about the Annexation Map and Transfer Parcel/Boundary Line adjustment plat and other related items. He noted that there was no development plan for the church at this time and that that issue could be taken care of as part of an Annexation Agreement. He noted that Town

Attorney Sawyer was present and would help with the discussion on the water rights which had a few twists to it. Chain recommended that the Commission recommend approval of the annexation and initial zoning of Rural – Agricultural Zone District to the Board of Trustees.

Chain then introduced the applicant. Michael Sawyer wanted to clarify the water rights. While water rights will come with the project, they are actually part of the federal BLM Project and are allocated to irrigating specific acreages of land. This was not “Silt Water” and cannot legally be transferred to the Town. He noted it was for irrigation only and could not be used for domestic purposes. He said that the applicant could note on the Tract Map the water appurtenant to the acreage would be transferred to the new ownership but was for raw water irrigation only and this water cannot be co-mingle with Town ownership or Town supply.

Sawyer also noted that when there was some type of development proposed in certain items such as water could be evaluated with an agreement.

Logan Jurmu explained the background of the application. His parents own property adjacent to the church and they are willing to sell a portion to the church as the church is dealing with growth issues. Presently, the Church is still looking at options of what to do with the land and its immediate use would probably continue to be irrigated field. He then gave more background information.

Commissioner Doty had a question about churches in general and Attorney Sawyer made some comments regarding legal issues related to churches and religious organizations and land use.

Chair Williams open the public hearing at 7:40 PM. Anthony Zarlingo, 670 N. First Street, said he was in favor of the annexation. He noted how water comes to the property through the canal and he only had a question about use of the head gate. Ryan Nichols, 1757 Belgian Loop, noted that his name was not on the surrounding property owners list but he did receive a copy of the notice. He said he had reviewed the application and had some questions. He noted that there saying there is no change in use, but he thought this was inaccurate and that sometime in the future they would intend to build. He thought that there may be impacts from development such as increased lighting, increase traffic and other related issues. He asked how annexation of the church benefited the town.

Nancy Nichol, 1757 Belgian Loop, briefly spoke. She thought some elements of the application are contradictory and she was wondering if there would be some type of impact. Jennifer Stepisnik, 1744 Belgian Loop, said she has lived on her property since February 2006. She was concerned about any increase in use which would include more light pollution, and use of the road and related issues. She was concerned that annexation of the church would not increase any revenue that would come to the Town and that there would not be a benefit related to the annexation.

The public hearing was closed at 7:49 PM.

Logan said he was glad to hear from nearby property owners. He apologized for any inconsistency in the application. He did note that they were dealing with growth issues but in his mind the use be the same as that has been in the coming years. Commissioner Doty had a couple questions. He asked how many members were in the congregation. Logan said the estimated size of the congregation is 140 members. Commissioner Doty asked about when the major activities occurred with the church. He thought that lighting is supposed to be shutoff at 10 PM. Logan said that on Sundays and sometimes Wednesday evenings all 77 parking spaces are pretty much used and that is one of the reasons why they may want to expand parking in

the future. But at this time, they did not know how they would deal specifically with the growth in the congregation or what extra facilities they may need. Vice chair Bertaux asked the church to remember that they needed to be good neighbors. Alternate Dana Wood thanked the citizens for coming forward with their comments. There was then some discussion about compliance with BLM water, use of the head gate etc. It was noted that Jennifer occasionally has some drainage issues on her property and was not sure the cause. It could be because the town has to flush the hydrant in that area on a regular basis. Whether there was supposed to be some type of drainage improvement or such related item on the church parcel.

There was more discussion on relationship to potential development for the Laestadian Church in the future, potential impacts, existing conflicts and whether the police had been notified, cooperation with the church and the neighborhood and whether there was a benefit to the Town in the application.

Vice Chair Bertaux, made a motion to recommend approval of the annexation and initial zoning but modifying staffs proposed conditions:

- do not include condition 1- which is obtain the Water Rights
- leave in condition 2 – have the Attorney put together an Annexation Agreement but leave out the water rights portion.

Second by Chair Williams, the motion failed by a vote of 2 to 3. Voting yes: Chair Williams and Vice Chair Bertaux. Voting no: commissioners Doty, Westmoreland and Dana Wood.

There was then more discussion on the next steps. There was discussion on whether there should be a recommendation for denial, or continue to get additional information. Planner Chain and Attorney Sawyer outlined some options.

Commissioner Doty made a motion to deny the request for annexation; second by Dana Wood. the motion failed by a vote of 2 to 3.

Voting yes: Commissioners Doty and Dana Wood

Voting no: chair Williams, Vice chair Bertaux, Commissioner Westmoreland.

There was then a motion by Commissioner Bertaux and the second by Westmoreland to continue the discussion of the annexation until the January 9, 2024 Planning Commission meeting.

Commissioner Westmoreland noted that there appeared to be some inconsistencies in the application. Chair Williams advised the church to look at concrete things they can do to help the situation. Commissioner Dana Wood suggested that the church holds some kind of informal gathering.

The motion passed unanimously.

2024 meeting calendar

Meeting dates were briefly discussed. It was noted that the November date may need to change because of the election.

Planner Update

Chain noted that the December meeting would include a review of an amended preliminary plan application for Rislende.

Commissioner Comment

Commissioner Doty noted that it was good to see people attend the meetings and being involved. There was a quick comment about the Fall Fest and the Trick-or-Treat on Main Street.

Adjournment

Commissioner Doty made a motion to adjourn. Second by Vice Chair Bertaux. Meeting adjourned at 8:35 PM.

Respectfully submitted,

Approved by the Planning Commission

Mark Chain
Planner

Lindsey Williams
Chair

TOWN OF SILT
PLANNING COMMISSION STAFF REPORT
Public Hearing Action Item- Site Plan Review
Tuesday, December 5, 2023 6:30 PM

Project:	Town of Silt Water Plant
Location:	500 West River Frontage Road Silt, CO 81652
Applicant:	Town of Silt
Owner:	Town of Silt
Current Zoning:	Public Utility
Proposed Zoning:	No Proposed Change
Present Land Use:	Public Utility
Proposed Land Use:	Water Treatment Plant

Description of Request

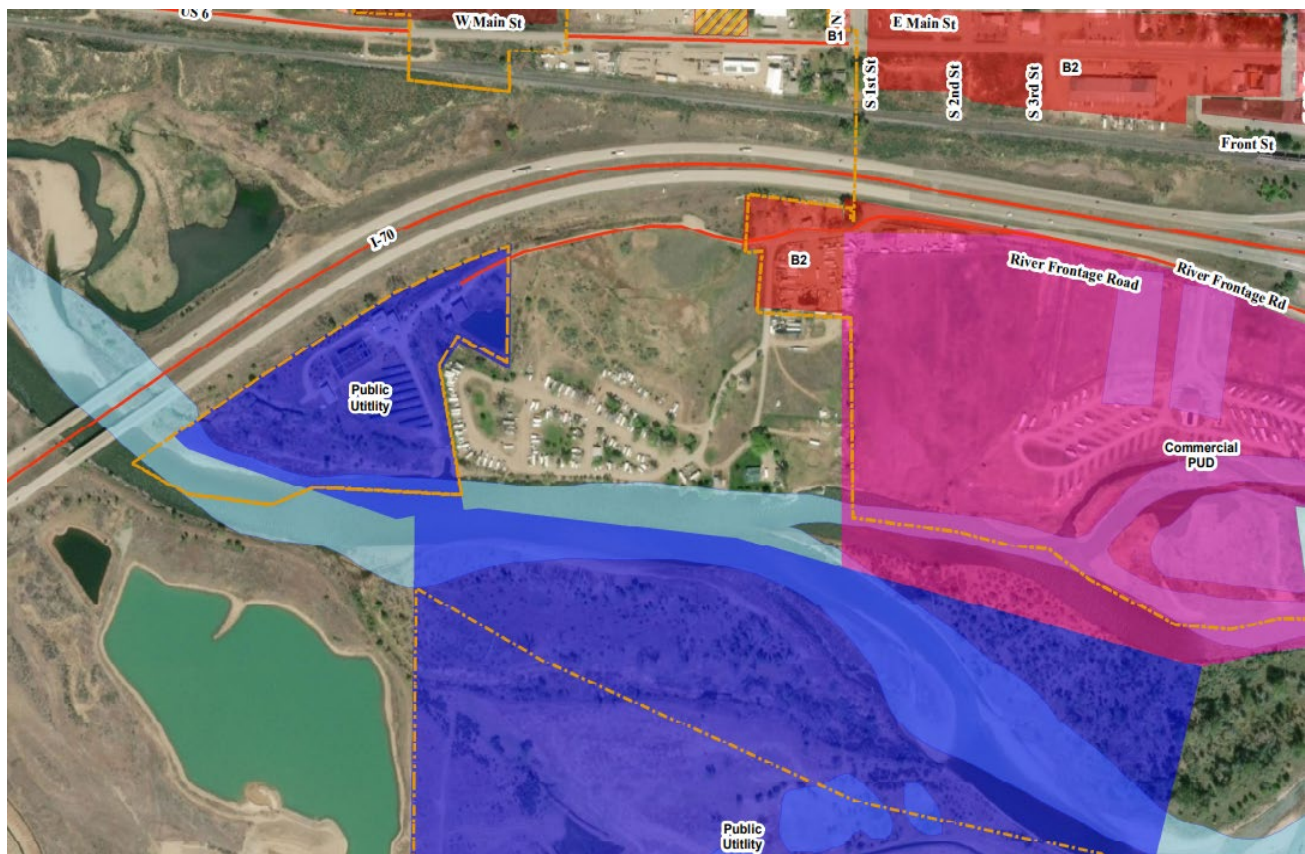
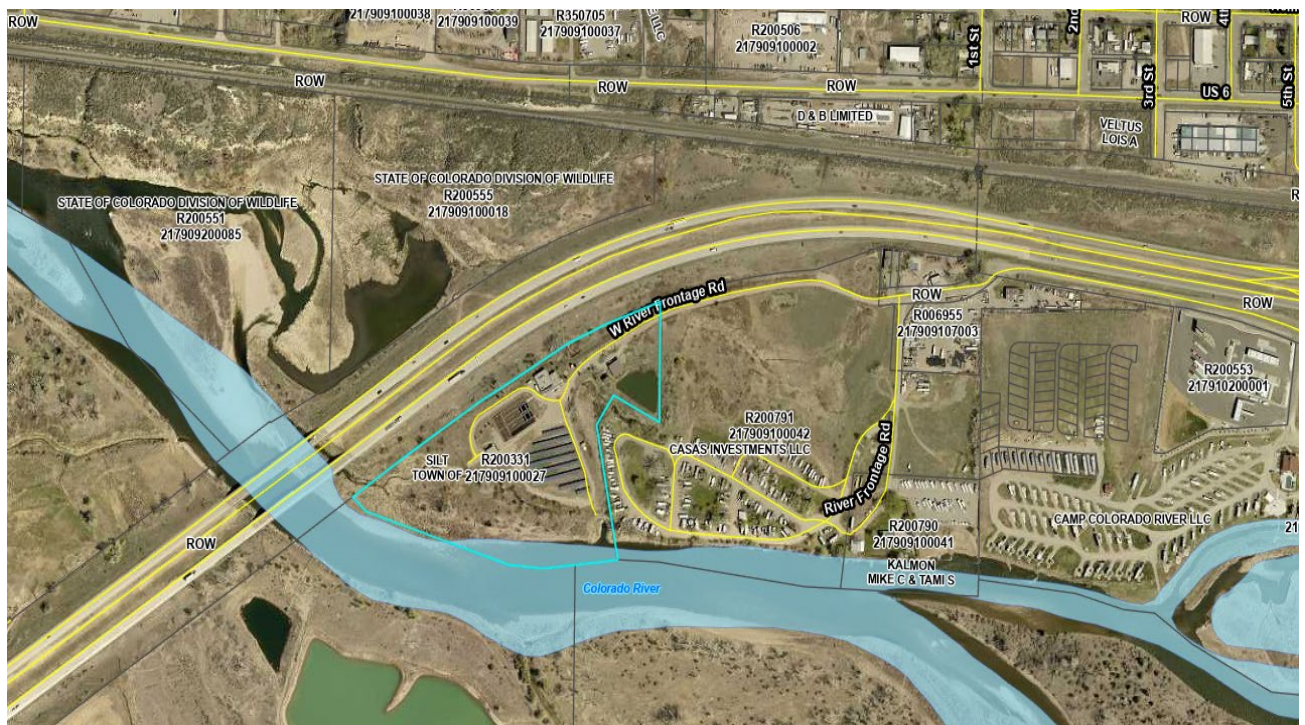
The Town of Silt is replacing the existing Water Treatment Plant (WTP), to meet state requirements and to better serve the community.

The new WTP will incorporate elements of the existing plant, to help lower the overall building costs. Please see Dewberry's memorandum for more details.

After over a year of meetings with the Public and Town Representatives, Town Staff worked with Dewberry, Garney and multiple other entities, to create the most functional and cost-effective proposal available in today's economy.

The Property

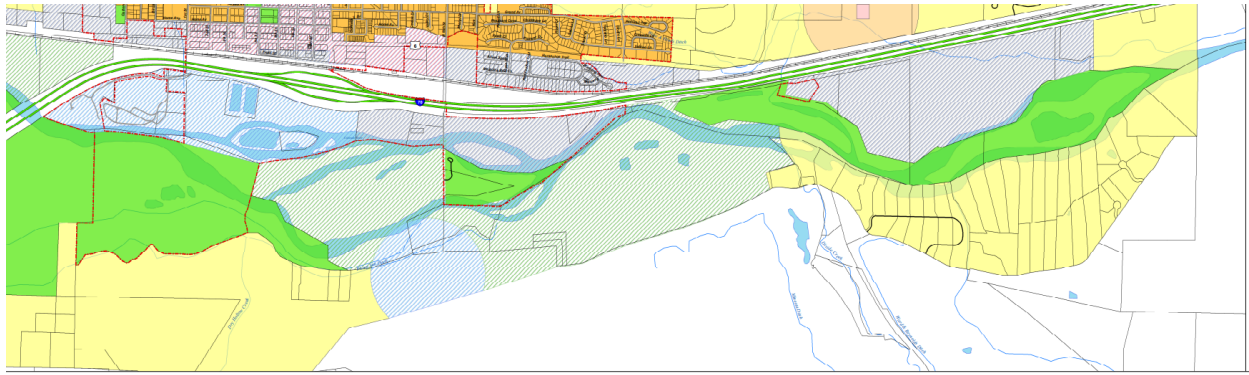
The property is located at the end of West River Frontage Road, on the south side of Interstate 70. The property is 17.25 acres and is zoned as a Public Utility.



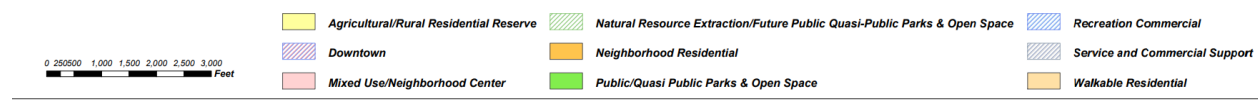
Comprehensive Plan

The Comprehensive Plan, as amended in 2017, designates this parcel as Recreation Commercial. Given that the Water Treatment Plant and Waste Water Treatment Plant are an existing use, the Comprehensive Plan has this designation for the future, just in case the treatment plants were to move location. Overall, this proposal is what aligns with our community needs.

Land Use Designation	Description/Characteristics	Locational Criteria
Recreation Commercial Zone District: PUD	Those properties within the Comprehensive Plan Land Use Designation of “Recreational Commercial” are properties that have large value to the Town in terms of jobs, economic vitality, community interest, aesthetic quality, providing entertaining characteristics, recreational activities, a western theme, historical qualities and cultures. These properties, in their adjacency to the Colorado River, should strive to have high quality building materials in aesthetically pleasing buildings and clusters of buildings with a western theme or natural character. The riparian zone is an especially sensitive area in this region and should be protected from building encroachment, unfettered access to the river during high run-off, and uses that block the view from Interstate-70. The Town or a developer should build a bicycle and pedestrian trail along the Colorado River, in order to entice visitors to the area to stop, relax, enjoy the scenic beauty and then frequent the local commercial establishments. The Town encourages such commercial uses as hotels, convenience stores, truck and automobile fueling establishments, rafting companies, recreational vehicle parks, angler supply shops, and the like, but discourages those uses that do not add to the region in terms of the values stated above, such as those uses not providing jobs, sales tax or a tourism/recreational benefit. Since these properties are located to the north of the Colorado River, good access is crucial to the viability of these types of businesses. The Town should work closely with the landowners and the Colorado Department of Transportation to provide adequate ingress and egress that anticipates appropriate vehicle travel trips and alleviates traffic congestion. The Town should continue to master plan their utilities, with landowner involvement. If upper level residential is proposed, the Town should encourage the density to be commensurate with the space so designated, and might consider growth in the area of eight (8) units to twenty (20) units per acre, if planned appropriately with central water and wastewater facilities, but in no case should the Town consider lower level residential units, due to loss of commercial space, floodplain, and other factors.	Areas along the Colorado River corridor.



sive Plan - Future Land Use 2017: Town of Silt, CO



Staff Findings and Conclusions

Overall, staff finds that this application and proposal are well thought out; diligently creating the most cost-effective product that will meet the state's requirements, as well as increasing the Town's capacity to better serve the needs of the community.

Planner Recommendation

Staff recommends approval of the Site Plan Review for Silt Water Treatment Plant at the proposed location with the following conditions:

- 1) That all statements made by the applicant, both in the application and in any meetings before the Planning and Zoning Commission, be considered conditions of approval, unless modified in any subsequent conditions.
- 2) That the applicant notifies the Town Department of Community Development, with any changes that are being proposed, from the final approved plans and/or original submittal.
- 3) That the applicant provides any additional requested documents and pay any remaining fees, prior to operating business.
- 4) That this approval is not for construction, but rather approval for the use of the land and general Site Plan. Actual licensing and permitting will be a separate process.

Recommended Motion: I move to approve the Site Plan Review for the Silt Water Treatment Plant, with the conditions noted above or verbally added during this meeting.

**TOWN OF SILT
RESOLUTION NO. PZ- 8
SERIES OF 2023**

**A RESOLUTION OF THE PLANNING AND ZONING COMMISSION
APPROVING THE SITE PLAN REVIEW OF THE SILT WATER TREATMENT
PLANT, AT 500 WEST RIVER FRONTAGE ROAD, WITHIN THE TOWN OF
SILT, GARFIELD COUNTY, STATE OF COLORADO**

WHEREAS, The Town of Silt (“Application”) submitted an application for a Site Plan Review on or about October 20, 2023 requesting to build a new water treatment plant at 500 West River Frontage Road; and

WHEREAS, Town Staff processed the application and forwarded the application as well as staff comments about the application and various memoranda to the Town Planning and Zoning Commission (“Commission”); and

WHEREAS, the commission reviewed and discussed the application at its regular meeting on December 5, 2023; and

WHEREAS, upon proper consideration there is a finding that it is reasonable to approve the proposed application, as it aligns with the Town’s Zoning, and it doesn’t appear to have any significant negative impact to adjacent properties.

NOW, THEREFORE BE IT RESOLVED BY THE PLANNING AND ZONING COMMISSION OF THE TOWN OF SILT, COLORADO, THAT: the Site Plan Review for the Silt Water Treatment Plant is hereby granted for 500 West River Frontage Road, within the Town of Silt, Colorado (“Town”) subject to the following conditions:

- 1) That all statements made by the applicant, both in the application and in any meetings before the Planning and Zoning Commission, be considered conditions of approval, unless modified in any subsequent conditions.
- 2) That the applicant notifies the Town Department of Community Development, with any changes that are being proposed, from the final approved plans and/or original submittal.
- 3) That the applicant provides any additional requested documents and pay any remaining fees, prior to operating business.
- 4) That this approval is not for construction, but rather approval for the use of the land and general Site Plan. Actual licensing and permitting will be a separate process.

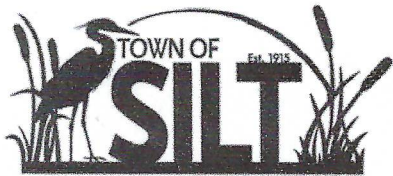
INTRODUCED, READ AND APPROVED at a regular meeting of the Planning and Zoning Commission of the Town of Silt, Colorado held on the 5th day of December, 2023.

ATTEST:

TOWN OF SILT

Chair Lindsey Williams

Community Development Manager, Nicole Centeno



Community Development Department
231 N. 7th Street, Silt, CO 81652
(970) 876-2353 (office) (970) 876-2937 (fax)
www.TownOfSilt.org

Land Use Application Form

<input type="checkbox"/> Amended Plat	<input type="checkbox"/> Boundary Adjustment	<input type="checkbox"/> Subdivision Exemption
<input type="checkbox"/> Annexation	<input type="checkbox"/> Sketch Plan	<input type="checkbox"/> Floodplain Development
<input type="checkbox"/> Final Plan	<input type="checkbox"/> Planned Unit Development	<input type="checkbox"/> Vacation of Right-of-Way
<input type="checkbox"/> Text Amendment	<input checked="" type="checkbox"/> Site Plan Review	<input type="checkbox"/> Metro District or Special District
<input type="checkbox"/> Easement Agreement	<input type="checkbox"/> Zoning or Rezoning	<input type="checkbox"/> Subdivision Improvement Agreement
<input type="checkbox"/> Preliminary Plan	<input type="checkbox"/> Special Use Permit	<input type="checkbox"/> ADA or ADA Amendment
<input type="checkbox"/> Zoning Variance	<input type="checkbox"/> Intergovernmental Agreement	<input type="checkbox"/> Other: _____

Project Name: TOWN OF SILT WATER TREATMENT PLANT

Project Description / Property Information:

Address: 500 West River Frontage Road Parcel ID Number: 21756910027

Legal Description (attach additional sheets if necessary): Sec 9 TS 6 Range 92A TR in Lot 6 Cont 7.09 AC Also a TR of meadowland in same cont 0.16 AC

Access to Property: River Frontage Rd

Acreage or Square Footage: 17.25 Acres Existing Land Use Designation: Public Utility

Proposed Land Use Designation: Public Utility

Existing Zoning: Public Utility Proposed Zoning: same

Proposed Use / Intensity of Use: Water Plant

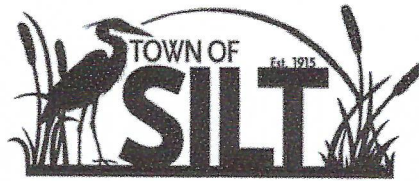
Submittal Requirements:

- A completed original application with original signatures and two copies (2 sets stapled individually) shall be submitted to the department for review. The application shall include two sets of 24" x 36" plans, plats and other appropriate drawings. Application must also be submitted in electronic format (Emailed PDF & Flash Drive).
- In addition to this application, all information on the supplemental checklist must be submitted.
- Incomplete applications will not be accepted and will delay processing.
- When the documents are deemed adequate, additional copies as required by the department shall be submitted ten (10) days before the public hearing.
- All documents submitted for public hearing shall be hole-punched, collated and paper-clipped (no staples). All plans, plats or drawings shall be folded to 8 1/2" x 11" and inserted into the collated application. Each individual application shall be banded together and ready for public distribution.

STAFF USE ONLY

Pre-app conference: _____ (date)	Application received: _____ (date)
Application complete: _____ (date)	File Number: _____
Fees: _____	Referrals Sent: _____ (date)
Deposits: _____	PZC approval: _____ (date)
Paid: _____ (date)	BOT approval: _____ (date)

RECEIVED OCT 20 2023



Billable Party Agreement

Property Owner(s) Name: Town of Silt Phone: 970 876 2353
Company: _____ Fax: 970 876 2937
Address: 231 North 7th St
Authorized Rep.: Name: Frey Fowner Phone: _____
Company: Town of Silt Fax: _____
Address: SAME
Billable Party: Owner YCS Representative _____

The Billable Party, by signing below, hereby agrees to reimburse the Town the actual costs to the Town plus 15% administrative fees for all billable staff time and contract services, including, but not limited to, planning, reviewing, inspecting, engineering, surveying and legal services rendered in connection with the applicant's request. A deposit will be required if deemed necessary by Town Staff. The Billable Party shall also reimburse the Town for the cost of making any corrections or additions to the master copy of the official Town map and for any fees for recording any plats and accompanying documents with the County Clerk and Recorder of Garfield County. The Billable Party agrees that interest shall be imposed at a rate of 5% per month on all balances not paid within thirty (30) days of the date of the statement. In addition to any and all remedies available to the Town and in the event the Town is forced to pursue collection of any amounts due and unpaid, the Town shall be entitled to collect attorney's fees and costs incurred in said collection efforts in addition to the amount due and unpaid.

Name (printed): Town of Silt (Dust Torres Representative)
Address: 231 N 7th St
Phone: 970 876 2353 Email: dtorres@townofsilt.org
h/a [Signature]
Type of Identification Signature

County of _____

State of _____ §

Sworn to and subscribed before me this 30 day of November, 2023
(Day) (Month) (Year)

By Nicole Centeno
(Notary Name)

Witness my hand and official seal

[Signature]
(Notary Signature)

Notary Public

My Commission Expires 2-19-24

(seal)

NICOLE MARIE CENTENO
NOTARY PUBLIC - STATE OF COLORADO
Notary ID #20204007103
My Commission Expires 2/19/2024

RECEIVED OCT 20 2023

TOWN OF SILT, PROOF OF PUBLIC NOTICE AND CERTIFICATE OF MAILING

Project: TOWN of SILT WATER PLANT

I HEREBY AFFIRM THAT Public Notice requirements of the Silt Municipal Code have been met for the Public Hearing before the Silt Planning & Zoning Commission/Board of Trustees to be held on Dec 5, 2023.

In addition, I hereby affirm that on 17 day of November, 2023 I mailed first class, certified return receipt, a true copy of the attached Public Notice by placing the same postage prepaid in the United States Mail at _____, Colorado, addressed to those property owners on the attached list.

Attached are:

1. Certificate(s) of Mailing (green cards and return receipts)
2. Proof of publication from a newspaper of general circulation within the Town showing that prior to the meeting, the Public Notice was advertised as required per Silt Municipal Code.
3. List of names and mailing addresses of all surrounding property owners within 200 feet of subject property.

Dusti Torres
Name of Applicant (printed)

[Signature]
Signature of Applicant Date

County of _____)
State of _____)

ss.

Sworn to and subscribed before me this 30 day of November, 2023.
(fill in day) (fill in month) (fill in year)

By Nicole Centeno
(name printed)

Witness my hand and official seal.

Notary Public

My Commission Expires: 2-19-24



Please don't fill out and return, until the Town gives you the Public Notice to mail, and you have receipt of mailings

Disclosure of Property Ownership

- ☒ If owner is an individual, indicate name exactly as it appears on the deed.
- ☒ If owner is a corporation, partnership, limited partnership or other business entity, name principals on a separate page. Please include articles of organization, partnership agreement, etc., as applicable.
- ☐ If owner is a land trust, name beneficiaries on a separate page.
- ☐ If applicant is a lessee, indicate the owner(s) on a separate page.
- ☐ If applicant is a contract purchaser, attach a copy of the contract and indicate the owner(s) on a separate page.

Please provide the name(s), mailing address(es), street address(es) and phone number(s) for all owners.

Property Owner Affidavit

I/We, Town of Silt, being first duly sworn, depose and state under penalties of perjury that I am (we are) the owner(s) of the property described herein and which is the subject of the application and proposed hearings; that all answers provided to the questions in this application, and all sketches, data and all other supplementary matter attached hereto and made part of this application are honest and true to the best of my (our) knowledge and belief. I (we) understand that this application must be complete and accurate prior to a hearing being scheduled. I (we) authorize Town staff to visit the site as necessary for proper review of this application.

(If there are special conditions such as guard dogs, locked gates, restricted hours, etc., please give the name and phone number of the person(s) who can provide access to the site)

Town of Silt
Name (printed)
Trey Fournier
Address 231 North 7th Silt CO

Phone 970 876 2353

Fax 970 876 2937

Signature [Signature]

Type of Identification _____

County of _____

State of _____

Name (printed) _____

Address _____

Phone _____

Fax _____

Signature _____

SS.

Sworn to and subscribed before me this 20 day of October, 2023
(fill in day) (fill in month) (fill in year)

By Nicole Centeno
(name printed)

Witness my hand and official seal.

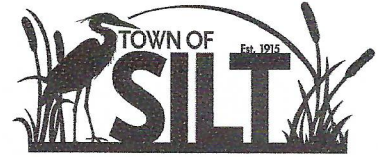
Notary Public

My Commission expires: 2-19-24



Town of Silt Community Development

231 N. 7th Street, Silt Colorado 81652; (970)876-2353 ext. 110



LAND USE ACTIVITY IMPACT STATEMENT

Name of Applicant: Town of Silt Date: 10/20/23

Location of Property: 500 W River Frontage Road

Land Use Request: WATER TREATMENT PLANT

Please answer the following questions to the best of your ability. Attach additional pages as needed.

1. Is your request compatible with the Silt Municipal Code? Yes/No

2. Is your request compatible with the Silt Comprehensive Plan? Yes/No

If not, how is your request useful to the Town of Silt?

WATER TREATMENT PLANT

3. Explain how your request is compatible with the immediate area surrounding the site.

Site of current plant

4. How is your request desirable for the Town of Silt?

New water treatment plant

5. Detail any real or possible environmental, town service, or other impacts your request may have.

None

6. Are there or have there ever been any landfills on any part of the property included in your request? Yes/No No

7. Please mark all the concerns or impacts listed below which apply to your request and give a brief statement about how you have addressed them.

- a. ☐ traffic
- b. ☒ town services (water, sewer, etc.)
- c. ☐ signage
- d. ☐ open space
- e. ☐ schools
- f. ☐ emergency services (police, fire, medical)
- g. ☐ other utilities (electrical, etc.)
- h. ☐ other (pollution, etc.)

Please list any other items or information which you feel would be of help in assessing your application.

b. New treatment plant to produce more water

Garfield County, CO

Summary

Account R200331
Parcel 217909100027
Property 500 W RIVER FRONTAGE RD, SILT, CO 81652
Address
Legal Section: 9 Township: 6 Range: 92 A TR IN LOT 6 CONT 7.09 AC. ALSO,
Description A TR OF MEANDERLAND IN SWNE CONT 8.16 AC. ALSO, A TR OF
MEANDERLAND CONT 2 AC.+/-
Acres 17.25
Land SqFt 0
Tax Area 35
Mill Levy 75.3100
Subdivision

[View Map](#)

Owner

[SILT, TOWN OF](#)
PO BOX 70
SILT CO 81652

Land

Unit Type EXEMPT-POLITICAL SD-LAND - 9149 (EXEMPT PROPERTY)
Square Feet 0

Actual Values

Assessed Year	2023	2022	2021
Land Actual	\$120,000.00	\$120,000.00	\$120,000.00
Improvement Actual	\$0.00	\$0.00	\$0.00
Total Actual	\$120,000.00	\$120,000.00	\$120,000.00

Assessed Values

Assessed Year	2023	2022	2021
Land Assessed	\$33,480.00	\$34,800.00	\$34,800.00
Improvement Assessed	\$0.00	\$0.00	\$0.00
Total Assessed	\$33,480.00	\$34,800.00	\$34,800.00

Tax History

Tax Year	2022	2021	2020	2019
Taxes Billed	\$0.00	\$0.00	\$0.00	\$0.00

[Click here to view the tax information for this parcel on the Garfield County Treasurer's website.](#)

Transfers

Sale Date	Deed Type	Reception Number	Book - Page	Sale Price
12/12/2003	EASEMENT	644232	1552-670	\$0
1/13/2003	ORDINANCE	627043	1468-302	\$0
11/25/2002	ORDINANCE	618201	1424-403	\$0
11/25/2002	ORDINANCE	618199	1424-399	\$0
3/17/2000	QUIT CLAIM DEED	560806	1177-622	\$0
3/17/2000	SPECIAL WARRANTY DEED	560805	1177-620	\$147,500
8/31/1992	WARRANTY DEED	438511	0840-0616	\$440,000
10/15/1991	QUIT CLAIM DEED		0816-0128	\$0
3/15/1991	WARRANTY DEED	421884	0800-0396	\$25,000
8/15/1988	WARRANTY DEED	394534	0739-0325	\$25,000
8/15/1988	QUIT CLAIM DEED		0739-0332	\$0
8/15/1988	QUIT CLAIM DEED		0739-0330	\$0
6/17/1981	RESOLUTION		0574-0562	\$0
5/29/1980	WARRANTY DEED	304259	0549-0278	\$5,400

RECEIVED OCT 20 2023

November 27, 2023

Town of Silt
Community Development Department
231 N. 7th Street
PO Box 70
Silt, CO 81652

RE: Silt Water Treatment Plant Building Permit Application

To Whom it May Concern,

Dewberry Engineers is pleased to submit a Building Permit Application for the Silt Water Treatment Plant (WTP) on behalf of the Town of Silt. The Building Permit Application documents are provided for review and comment.

The General Contractor for the water treatment plant construction will be Garney Construction.

The following documents are included in the submittal package:

1. Building Permit Application
2. Drawings - only drawings pertinent to the building permit were submitted, if any of the omitted drawings are needed please contact Dewberry.
3. Specifications - a hard copy of the specifications was not included as it is over 1,000 pages, if a full hard copy set is needed or hard copies of certain sections are needed please contact Dewberry.
4. Structural Calculations for the WTP
5. Mechanical Compliance Certificate
6. 2018 IECC Mechanical Variance Request
7. Ventilation Code Compliance Summary
8. HVAC Load Calculations
9. Ventilation Calculations
10. Interior Lighting Compliance Certificate
11. 2018 IECC Lighting Compliance Clarifications
12. Interior Lighting Calculations
13. Feeder Voltage Drop Calculations
14. Drainage Letter
15. Existing Building Occupancy and Alteration Memorandum Rev 1

We have included electrical and mechanical clarifications/variances to the 2018 IECC for this project. These clarifications and variances stem from this being a specialized facility that does not fit well within some of the IECC requirements. Please see documents 6 and 11 for more information.

We look forward to receiving your comments and input. Please contact me with any immediate questions or concerns.

Silt Water Treatment Plant
November 27, 2023

Sincerely,



Sam Franzen
Project Engineer
Dewberry Engineers Inc.
303-951-0618

PREPARED FOR: Town of Silt

PREPARED BY: Dewberry Engineers Inc.

DATE: November 27, 2023

SUBJECT: Silt Water Treatment Plant Upgrades – Existing Building Use and Code Evaluation Revision 1

Background Information

The existing Silt Water Treatment Plant (WTP) building, constructed in 2004/2005, currently houses treatment equipment, pumps, chemicals, piping, instrumentation, electrical, and ancillary items. A new WTP is under design and will be located to the east of the existing building. The existing WTP will be reused as part of the new WTP project. The technical memorandum summarizes the proposed plan for the existing building.

Existing Building Use

The existing building will primarily house treatment and electrical equipment as part of the new WTP. The electrical room and restroom on the west side of the building and the compressor and storage rooms on the south side of the building will remain unchanged. The majority of the existing equipment and instrumentation in the process room, comprising the remainder of the building, will be removed. The original building was classified as an F-2 Occupancy under the 2003 IBC. We agree with the Building Official's initial assessment that the storage/compressor area, added after the initial construction, constitutes an S-1 occupancy rating.

Raw water strainers and ultraviolet disinfection equipment and piping will be installed in the process room. The two existing finished water pumps and associated piping and instrumentation in the northeast corner of the building will remain along with some of the house water piping and instrumentation. No chemical will be stored in the existing building. A new chemical storage space will be constructed with the separations and facilities required by its occupancy classification as part of the new WTP building.

Code Review

The existing building use and structure will not be significantly modified, and the hazardous chemicals currently stored in the building will be removed. The building occupancy or use will not be modified. The classification will not be changed from the original F-2 classification.

Per Section 302.3 of the International Building Code, "Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe." To the best of our knowledge the existing building was constructed in compliance with the applicable codes at the time it was built.

The design team has selected the Work Area compliance method for criteria to comply with the International Existing Building Code (IEBC 2015). Below is a code analysis discussing how each applicable portion of the code is being met.

Per Chapter 6 the changes to the existing building we believe the changes are classified as Level 3 Alterations because the work area exceeds 50 percent of the building area.

Chapter 9 of the IEBC presents the requirements for Level 3 Alterations which are summarized below.

Section 901: General – Level 3 Alteration shall comply with the requirements for Level 1 and 2 alterations. These sections (Chapter 7 and 8 of the IEBC) were reviewed and the following requirements in those chapters that are not discussed in Chapter 9 and that will need to be met are summarized below.

Section 705: Accessibility705.2: Alterations affecting an area containing a primary function - This area will no longer be an area of primary function the WTP will be operated from the break/operations room in the new building. Per 1103.2.9 of the 2015 IBC the existing building will be exempt from accessibility requirements under its new use.

Section 807: Structural

807.2: Existing structural elements carrying gravity loads – The equipment installed in the interior of the building is being removed and replaced with new equipment in different locations. The new loads were compared to the existing loads and the existing structural elements were found to be adequate to carry the new loads.

Section 808: Electrical – All new electrical equipment and wiring will comply with NFPA 70.

Section 809: Mechanical – The existing mechanical equipment will not be altered, and the spaces and occupancies will not be changed. This section is not applicable.

Section 8010: Plumbing – Not applicable.

Section 902: Special Use and Occupancy – Not Applicable

Section 903: Building Elements and Materials

903.1: Existing shafts and vertical openings – Not Applicable

903.2: Fire partitions in Group R-3 – Not Applicable

903.3: Interior Finish – All exits serving the work area will comply with section 802.4. Interior finish and trim or walls and ceilings in exits and corridors in any work area will comply with the IBC. The existing cement mortar unit and metal door frames meet the requirements of the IBC.

903.4: Enhanced Classroom Acoustics – Not Applicable

Section 904: Fire Protection

904.1: Automatic Sprinkler Systems – The F-2 work area is not required to be provided with automatic protection. The S-1 area is required to be provided with automatic protection in accordance with the IBC s. Per IBC 903.2.9 for S-1 occupancies fire areas exceeding 12,000 square feet are required to be sprinkled. The area of the entire existing building is approximately 2,500 square feet, so it does not need automatic sprinklers.

904.2 Fire Alarm and Detection Systems – Fire alarm and protection systems are to be provided in accordance with Section 907 of the IBC. Manual fire alarm systems are required for F-2 occupancies that are two stories or have a 500 occupancy load and for S-1 occupancies that are public- or self-storage occupancies that are three stories or greater in height. The existing building will not fall under any of these classifications and does not need a fire alarm and detection system.

Section 905: Means of Egress – The original design meets or exceeds the IBC requirements for means of egress. The building is only one story so the additional illumination and exit sign requirements in 905.2 and 905.3 do not apply. 905.4 does not apply as the building does not have elevator service.

Section 906: Accessibility - See Section 705 above.

Section 907 Structural

907.3: Existing structural elements carrying gravity load - See Section 807.2 above.

907.4: Existing structural elements resisting lateral loads – The building structure will not be substantially altered, so this section does not apply.

Section 908: Energy Conservation – The existing building is not required to comply with the energy requirements of the International Energy Conservation Code (IECC). Alterations are required to conform to the IECC as they relate to new construction only. As the building envelope is not being altered, we do not expect the need for any of the alterations to conform to the IECC.

Conclusions

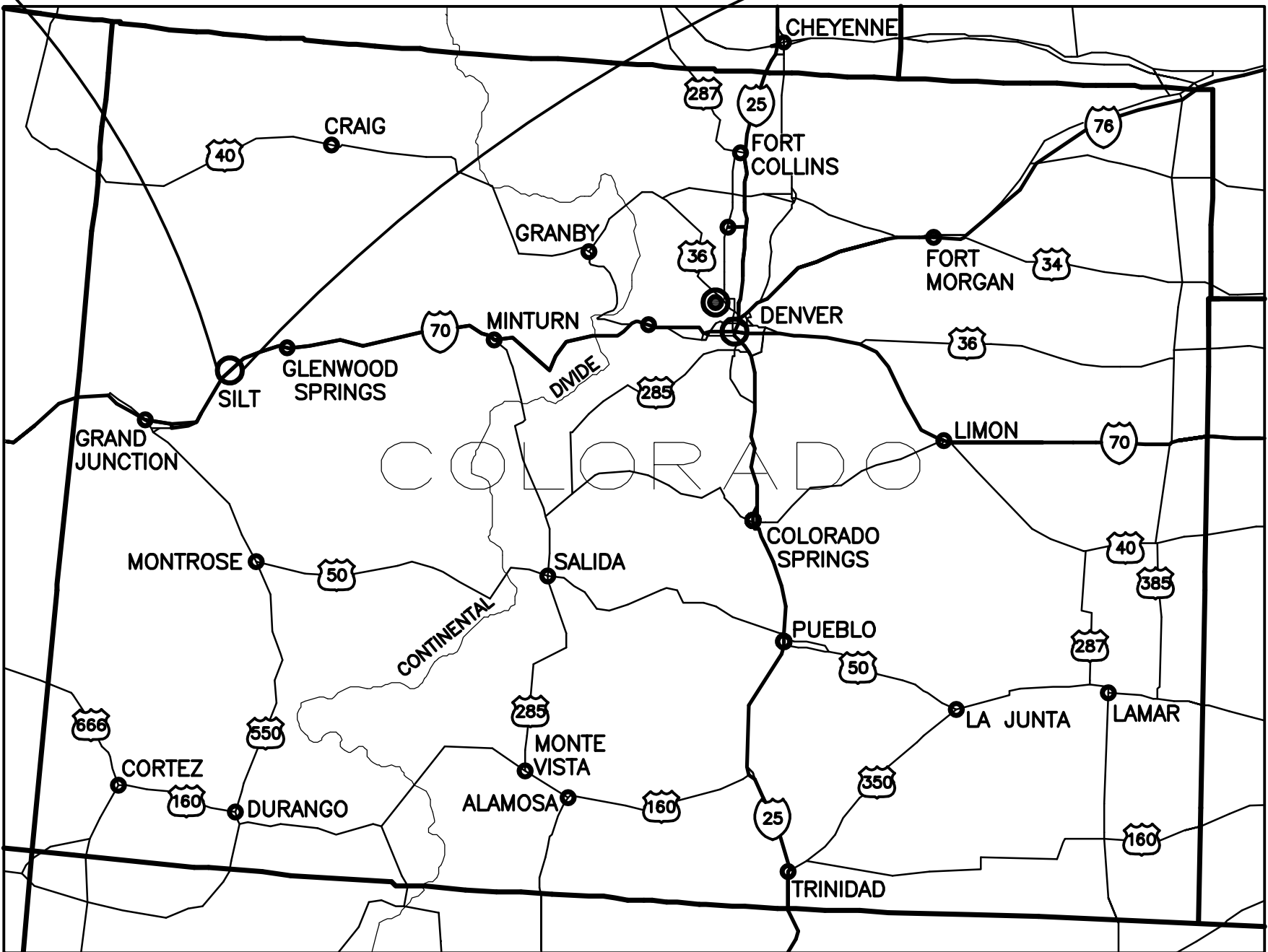
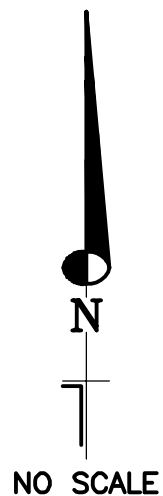
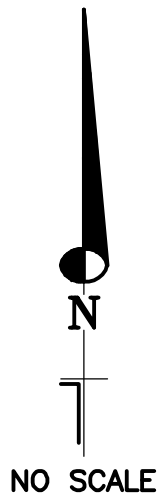
Dewberry is requesting the existing building occupancies (F-2 and S-1) remain unchanged as the use of the space will remain unchanged and that the modifications to the building be classified as Level 3 Alterations. The design of the building alterations will incorporate all code requirements for Level 3 alterations as discussed above.

TOWN OF SILT

WATER TREATMENT PLANT IMPROVEMENTS

GENERAL NOTES

1. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THESE CONTRACT DOCUMENTS, TOWN OF SILT DESIGN STANDARDS AND SPECIFICATIONS, AND BE SUBJECT TO CONSTRUCTION OBSERVATION BY TOWN OF SILT REPRESENTATIVES OR PERSONNEL.
2. THE CONTRACTOR IS RESPONSIBLE FOR THE PROCUREMENT OF ALL PERMITS NECESSARY FOR THE CONSTRUCTION OF THE IMPROVEMENTS SHOWN AND FOR NOTIFYING ALL UTILITY COMPANIES AFFECTED BY THIS CONSTRUCTION.
3. THE CONTRACTOR SHALL VERIFY ELEVATIONS OF EXISTING PIPING AND OTHER UTILITIES AND STRUCTURES PRIOR TO CONSTRUCTION.
4. THE CONTRACTOR SHALL PROTECT ALL EXISTING STRUCTURES, EQUIPMENT AND PIPING. ALL EXISTING PROCESS MECHANICAL AND ELECTRICAL EQUIPMENT THAT IS TO REMAIN OR BE SALVAGED FOR REUSE SHALL BE PROTECTED FROM DAMAGE FROM CONSTRUCTION ACTIVITIES AND WEATHER. ALL EQUIPMENT DAMAGED BY CONSTRUCTION OR WEATHER SHALL BE REPLACED WITH EQUAL OR BETTER AT CONTRACTORS EXPENSE.
5. SITE SURVEY FOR THIS PROJECT WAS PERFORMED BY PRECISION SURVEY & MAPPING INC. JANUARY 2023. FOR PROJECT SURVEY CONTROL INFORMATION SEE DRAWING C-1. COORDINATE WITH ENGINEER IF ELECTRONIC COPY OF THE SURVEY CONTROL IS DESIRED.
6. THIS PROJECT WILL REQUIRE CONNECTION OF NEW PIPING AND EQUIPMENT TO EXISTING PIPING SYSTEMS, AND THE MODIFICATION OF EXISTING PIPING. CONTRACTOR SHALL TAKE FULL RESPONSIBILITY FOR VERIFYING THE QUALITY AND CONDITION OF THE EXISTING PIPING, EQUIPMENT AND RELATED APPURTENANCES USED IN THIS PROJECT. THE ENGINEER MAKES NO REPRESENTATION AS TO THE QUALITY, CONDITION OR SUITABILITY OF EXISTING PIPING, PIPE FITTINGS, APPURTENANCES, SUPPORTS OR OTHER RELATED FACILITIES OR EQUIPMENT IN THE EXISTING BUILDING THAT MAY BE UTILIZED IN THIS PROJECT. THE CONTRACTOR SHALL BRING ANY CONCERNS ABOUT THE CONDITION OF EXISTING PIPING, EQUIPMENT, AND RELATED APPURTENANCES IMMEDIATELY TO THE ATTENTION OF THE OWNER AND THE ENGINEER.
7. THE CONTRACTOR SHALL MAINTAIN ON THE PROJECT SITE A FULL SET OF CONSTRUCTION DRAWINGS, RECORDING ALL INFORMATION PERTAINING TO THE CONSTRUCTION OF THESE FACILITIES. THESE RECORD DRAWINGS SHALL BE PROVIDED TO DEWBERRY ENGINEERS UPON PROJECT COMPLETION.
8. A PRE-CONSTRUCTION MEETING WILL BE HELD AT LEAST 48 HOURS PRIOR TO THE START OF CONSTRUCTION.
9. WORK HOURS SHALL BE BETWEEN 7AM AND 5PM MONDAY THROUGH FRIDAY, UNLESS OTHERWISE DIRECTED BY THE TOWN OF SILT.
10. THE CONTRACTOR SHALL CONTACT UNCC AT 1-800-922-1987 5 DAYS PRIOR TO ANY EXCAVATION TO OBTAIN UTILITY LOCATIONS.
11. ALL PIPING ON THIS PROJECT IS IDENTIFIED BY SERVICE. FOR PIPING SERVICE AND EQUIPMENT ABBREVIATIONS REFER TO DRAWING G-2.



VICINITY AND LOCATION MAPS

BUILDING DEPT REVIEW SUBMITTAL
NOVEMBER 2023

TOWN OF SILT

WATER TREATMENT PLANT IMPROVEMENTS

LIST OF DRAWINGS

Boxed drawings included in building department review submittal. If other drawings are needed, please let us know.

DWG NO.	TITLE
--	COVER SHEET
--	DRAWING INDEX
G-1	SYMBOLS AND LEGEND
G-2	ABBREVIATIONS, GENERAL NOTES AND INSTRUMENTATION LEGENDS
G-3	PROCESS FLOW DIAGRAM
G-4	HYDRAULIC PROFILE
C-1	OVERALL SITE PLAN
C-2	ENLARGED GRADING PLAN
C-3	ENLARGED YARD PIPING PLAN
C-4	HORIZONTAL CONTROL PLAN
C-5	DEMOLITION PLAN
C-20	PROCESS BUILDING TRUCK ACCESS DRIVE PLAN AND PROFILE STA. 10+00 TO STA. 11+17.60
C-21	POND TRUCK ACCESS DRIVE PLAN AND PROFILE STA. 13+00 TO STA. 13+80.84
D-1	STANDARD DETAILS
D-2	STANDARD DETAILS
D-3	STANDARD DETAILS
D-4	CATHODIC PROTECTION DETAILS
D-5	CATHODIC PROTECTION DETAILS
PP-1	16" RAW WATER & 16" FILTERED WATER PLAN AND PROFILE STA. 10+00 TO STA. 11+82.56 & STA. 13+00 TO STA. 14+08.26
PP-2	16" BACKWASH WASTE STA. 16+00 TO STA. 16+13.54
EC-1	GRADING, EROSION, AND SEDIMENT CONTROL PLAN
P-1000	RAW WATER SUPPLY
P-1100	BALLASTED FLOCCULATION TRAIN A
P-1160	BALLASTED FLOCCULATION SOLIDS RESIDUALS HANDLING SYSTEM
P-1200	BALLASTED FLOCCULATION TRAIN B
P-1260	BALLASTED FLOCCULATION SOLIDS RESIDUALS HANDLING SYSTEM
P-3100	MIXED MEDIA FILTER 1
P-3200	MIXED MEDIA FILTER 2
P-3400	BACKWASH SUPPLY PUMP STATION
P-3700	PLANT AIR SYSTEM
P-3800	FILTER AIR SUPPLY BLOWERS
P-4000	CLEARWELL AND POTABLE WATER PUMPS
P-4100	PLANT POTABLE AND NONPOTABLE WATER SUPPLY SYSTEM
P-6000	RESIDUALS POND
P-8200	POLYMER SYSTEM
P-8300	SODIUM HYPOCHLORITE SYSTEM
P-8400	SODIUM HYDROXIDE SYSTEM
P-8500	ALUMINUM CHLOROHYDRATE SYSTEM
P-8600	CHLORINE DIOXIDE SYSTEM
A001	CODE PLAN AND CHEMICAL TABLE
A002	ENERGY CONSERVATION CODE COMPLIANCE
A102	FLOOR PLAN
A103	ROOF PLAN
A201	ENLARGED PLANS
A301	BUILDING SECTIONS 1
A302	BUILDING SECTIONS 2
A401	BUILDING ELEVATIONS 1
A402	BUILDING ELEVATIONS 2
A501	INTERIOR ELEVATIONS
A701	DOOR SCHEDULE, DOOR AND WINDOW ELEVATIONS
A702	DOOR AND WINDOW DETAILS AT CMU
A703	DOOR AND WINDOW DETAILS AT PEMB
A801	ARCHITECTURE DETAILS 1
A802	ARCHITECTURE DETAILS 2
L-01	LANDSCAPE PLAN
L-02	LANDSCAPE DETAILS
L-03	LANDSCAPE DETAILS
S-1	GENERAL NOTES
S-2	STANDARD DETAILS

DWG NO.	TITLE
S-3	STANDARD DETAILS
S-4	STANDARD DETAILS
S-5	STANDARD DETAILS
S-6	STANDARD DETAILS
S-7	STANDARD DETAILS
S-8	STANDARD DETAILS
S-1100	WATER TREATMENT PLANT FOUNDATION PLAN EL 5406.67
S-1101	WATER TREATMENT PLANT FOUNDATION PLAN EL 5409.50
S-1102	WATER TREATMENT PLANT FOUNDATION PLAN EL 5413.00
S-1103	WATER TREATMENT PLANT FLOOR PLAN EL 5416.00
S-1104	WATER TREATMENT PLANT METAL BUILDING FRAMING PLAN
S-1105	WATER TREATMENT PLANT LOW ROOF FRAMING PLAN
S-1106	BACKWASH SUPPLY TANK ENLARGED PLANS AND DETAIL
S-1107	WATER TREATMENT PLANT SECTION
S-1108	WATER TREATMENT PLANT SECTION
S-1109	WATER TREATMENT PLANT SECTION
S-1110	WATER TREATMENT PLANT SECTION
S-1111	WATER TREATMENT PLANT SECTION
S-1112	WATER TREATMENT PLANT SECTIONS AND DETAIL
S-1113	WATER TREATMENT PLANT FOUNDATION SECTIONS AND DETAILS
S-1114	WATER TREATMENT PLANT FOUNDATION SECTIONS AND DETAILS
S-1115	WATER TREATMENT PLANT FOUNDATION SECTIONS AND DETAILS
S-1116	PRE-ENGINEERED METAL BUILDING FOUNDATION SECTIONS AND DETAILS
S-1117	PRE-ENGINEERED METAL BUILDING FOUNDATION SECTIONS AND DETAILS
S-1118	WATER TREATMENT PLANT CMU WALL DETAILS AND SECTIONS
S-1119	FILTER ACCESS PLATFORM DETAILS AND SECTIONS
M-1	STANDARD DETAILS
M-2	STANDARD DETAILS
M-3	STANDARD DETAILS
M-4	STANDARD DETAILS
M-5	STANDARD DETAILS
M-6	STANDARD DETAILS
M-7	STANDARD DETAILS
M-8	STANDARD DETAILS
M-9	STANDARD DETAILS
M-10	STANDARD DETAILS
M-11	STANDARD DETAILS
M-1000	EXISTING WTP BUILDING DEMOLITION PLAN ND DETAIL
M-1001	EXISTING WTP BUILDING GROUND LEVEL PLAN
M-1002	EXISTING WTP BUILDING SECTION
M-1003	EXISTING WTP BUILDING SECTION
M-1004	EXISTING WTP BUILDING SECTION
M-1005	EXISTING WTP BUILDING DETAILS AND SECTIONS
M-1100	WATER TREATMENT PLANT OVERALL GROUND LEVEL PLAN
M-1101	WATER TREATMENT PLANT FOUNDATION LEVEL PLAN
M-1102	WATER TREATMENT PLANT BALLASTED FLOCC AREA ENLARGED PLAN
M-1103	WATER TREATMENT PLANT PROCESS ROOM FILTER AREA ENLARGED PLAN
M-1104	WATER TREATMENT PLANT CHEMICAL ROOM ENLARGED PLAN
M-1105	WATER TREATMENT PLANT SECTION
M-1106	WATER TREATMENT PLANT SECTION
M-1107	WATER TREATMENT PLANT SECTION
M-1108	WATER TREATMENT PLANT SECTION
M-1109	WATER TREATMENT PLANT SECTIONS AND DETAILS
M-1110	WATER TREATMENT PLANT DETAILS
M-1111	WATER TREATMENT PLANT SECTION
M-1112	WATER TREATMENT PLANT DETAILS
M-1113	WATER TREATMENT PLANT DETAILS AND SECTIONS
M-1114	WATER TREATMENT PLANT SECTIONS AND DETAIL
M-1120	WATER TREATMENT PLANT OVERALL PLUMBING PLAN
M-1121	WATER TREATMENT PLANT BALLASTED FLOCC AREA ENLARGED PLAN
M-1122	WATER TREATMENT PLANT FILTER AREA ENLARGED PLAN

DWG NO.	TITLE
M-1123	WATER TREATMENT PLANT CHEMICAL ROOM ENLARGED PLAN
M-1124	WATER TREATMENT PLANT LOW ROOF PLUMBING PLAN
M-1125	WATER TREATMENT PLANT PLUMBING SCHEMATICS AND FIXTURE SCHEDULE
H-1	LEGEND, ABBREVIATIONS AND NOMENCLATURE CONVENTIONS
H-2	EQUIPMENT SCHEDULES
H-3	DETAILS
H-1101	NEW TREATMENT BUILDING GROUND LEVEL PLAN
H-1102	NEW TREATMENT BUILDING LOW ROOF LEVEL PLAN
H-1120	NEW TREATMENT BUILDING SECTIONS
H-1121	NEW TREATMENT BUILDING SECTIONS
H-1122	NEW TREATMENT BUILDING SECTIONS
H-1123	NEW TREATMENT BUILDING SECTIONS
H-1130	NEW TREATMENT BUILDING TEMPERATURE CONTROLS
H-1131	NEW TREATMENT BUILDING TEMPERATURE CONTROLS
E-1	ELECTRICAL SYMBOLS AND LEGENDS SHEET 1
E-2	ELECTRICAL SYMBOLS AND LEGENDS SHEET 2
E-3	ELECTRICAL SYMBOLS AND LEGENDS SHEET 3
E-4	ELECTRICAL DETAILS 1 GENERAL DETAILS
E-5	ELECTRICAL DETAILS 2 SITE AND DUCTBANK
E-6	ELECTRICAL DETAILS 3 EQUIPMENT MOUNTING AND INSTALLATION
E-7	ELECTRICAL DETAILS 4 CONDUIT PENETRATION
E-20	PANELBOARD SCHEDULES
E-21	LIGHT FIXTURE SCHEDULE
E-30	SPECIAL SYSTEM RISER DIAGRAMS
E-100	SITE PLAN
E-101	ENLARGED SITE PLANS 1
E-102	ENLARGED SITE PLANS 2
E-110	DUCTBANK SECTIONS 1
E-111	DUCTBANK SECTIONS 2
E-200	MOTOR CONTROL CENTER MCC9000 ONE-LINE DIAGRAM 1
E-201	MOTOR CONTROL CENTER MCC9000 ONE-LINE DIAGRAM 2
E-202	PRETREATMENT TRAIN 1 ECP1100 ONE-LINE DIAGRAM
E-203	PRETREATMENT TRAIN 2 ECP1200 ONE-LINE DIAGRAM
E-204	DISTRIBUTION PANELBOARD DP9010 ONE-LINE DIAGRAM
E-205	EXISTING LIGHTING PANELBOARD LP9120
E-250	LCP9000 ONE-LINE DIAGRAM
E-251	LCP9000 ONE-LINE DIAGRAM 2
E-252	FILTER 1 LOCAL CONTROL PANEL LCP3100 ONE-LINE DIAGRAM
E-253	FILTER 2 LOCAL CONTROL PANEL LCP3200 ONE-LINE DIAGRAM
E-254	EXISTING LCP9100 CONTROL PANEL ONE-LINE DIAGRAM
E-300	CONTROLS DIAGRAM 1
E-301	CONTROLS DIAGRAM 2
E-302	CONTROLS DIAGRAM 3
E-303	CONTROLS DIAGRAM 4
E-1000	EXISTING WTP BUILDING POWER AND CONTROL PLAN
E-1100	WATER TREATMENT PLANT OVERALL GROUND LEVEL PLAN
E-1101	WATER TREATMENT PLANT BALLASTED FLOCC AREA ENLARGED POWER AND CONTROL PLAN
E-1102	WATER TREATMENT PLANT FILTER AREA ENLARGED POWER AND CONTROL PLAN
E-1103	WATER TREATMENT PLANT CHEMICAL ROOM ENLARGED POWER AND CONTROL PLAN
E-1104	WATER TREATMENT PLANT BREAK ROOM POWER AND CONTROL PLAN
E-1105	WATER TREATMENT PLANT ELECTRICAL ROOM POWER AND CONTROL PLAN
E-1106	WATER TREATMENT PLANT ROOF POWER AND CONTROL PLAN
E-1107	WATER TREATMENT PLANT PRETREATMENT AREA LIGHTING PLAN
E-1108	WATER TREATMENT PLANT FILTER AREA LIGHTING AND RECEPTACLE PLAN
E-1109	WATER TREATMENT PLANT CHEMICAL ROOM LIGHTING AND RECEPTACLE PLAN
E-1110	WATER TREATMENT PLANT ELECTRICAL ROOM AND WORK ROOM LIGHTING
I-1	INSTRUMENT INSTALLATION DETAILS
I-2	INSTRUMENT INSTALLATION DETAILS 2
1-10	LOCAL CONTROL PANEL, LCP 9000, DETAILS PANEL ASSEMBLY DETAILS AND SCHEDULES
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1-12	LOCAL CONTROL PANEL, LCP 9000, DETAILS POWER WIRING DIAGRAM 2
I-20	CONTROL SYSTEM ARCHITECTURE DIAGRAM 1
I-21	CONTROL SYSTEM ARCHITECTURE DIAGRAM 2

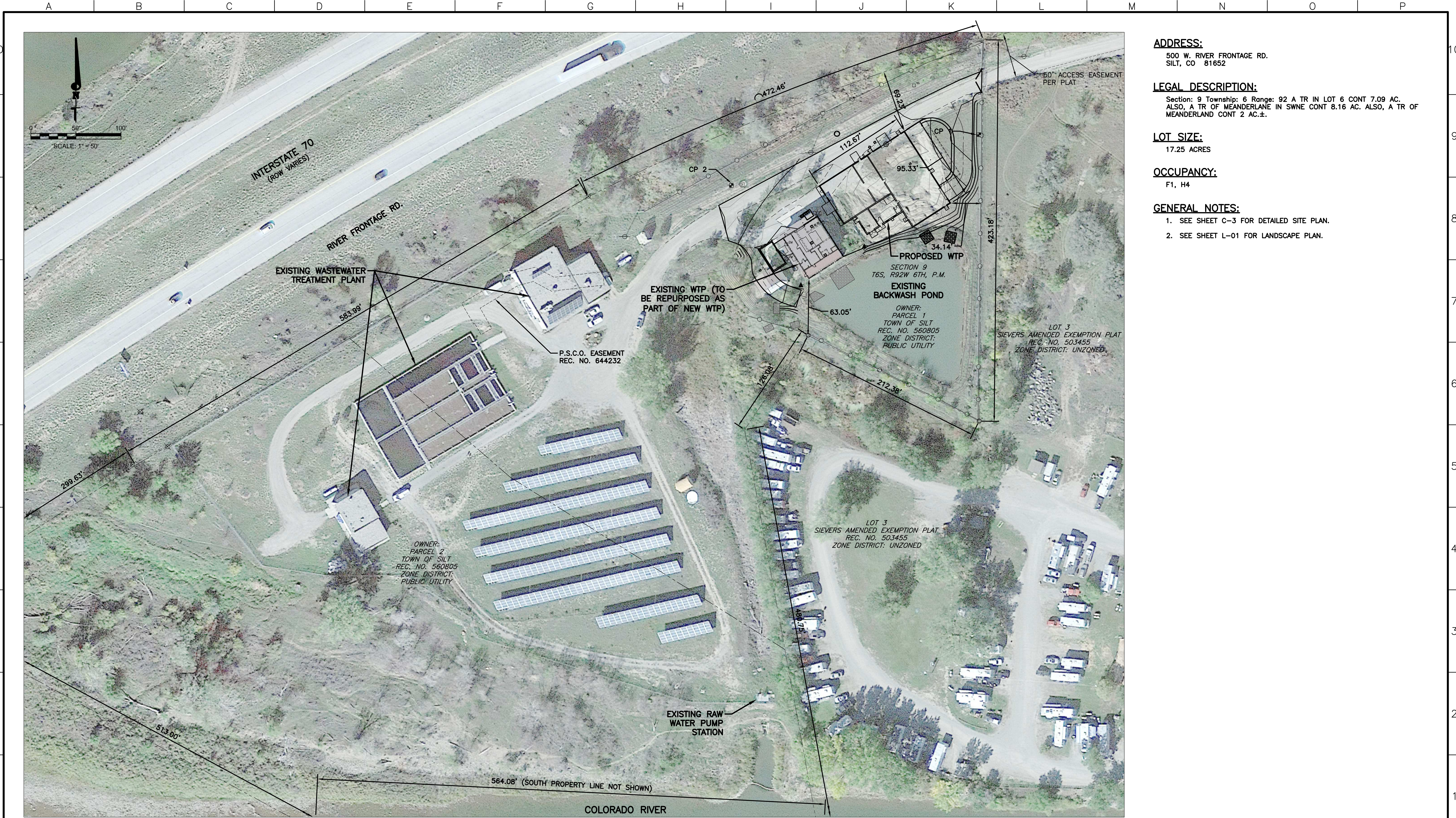
DRAWING INDEX

NOVEMBER 2023



Dewberry[®]
Dewberry Engineers Inc.

990 S. BROADWAY, SUITE 400
Denver, Colorado 80209
(303) 825-1802




ADDRESS:
500 W. RIVER FRONTAGE RD.
SILT, CO 81652

LEGAL DESCRIPTION:
Section: 9 Township: 6 Range: 92 A TR IN LOT 6 CONT 7.09 AC.
ALSO, A TR OF MEANDERLANE IN SWNE CONT 8.16 AC. ALSO, A TR OF MEANDERLAND CONT 2 AC.±.

LOT SIZE:
17.25 ACRES

OCCUPANCY:
F1, H4

GENERAL NOTES:
1. SEE SHEET C-3 FOR DETAILED SITE PLAN.
2. SEE SHEET L-01 FOR LANDSCAPE PLAN.



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Denver, Colorado 80209
(303) 825-1802

LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING CPL59690-1A
DRAWN TWL
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REV. DESCRIPTION BY DATE APP.
A BUILDING DEPT REVIEW SUBMITTAL TWL 10/13/23 SEF

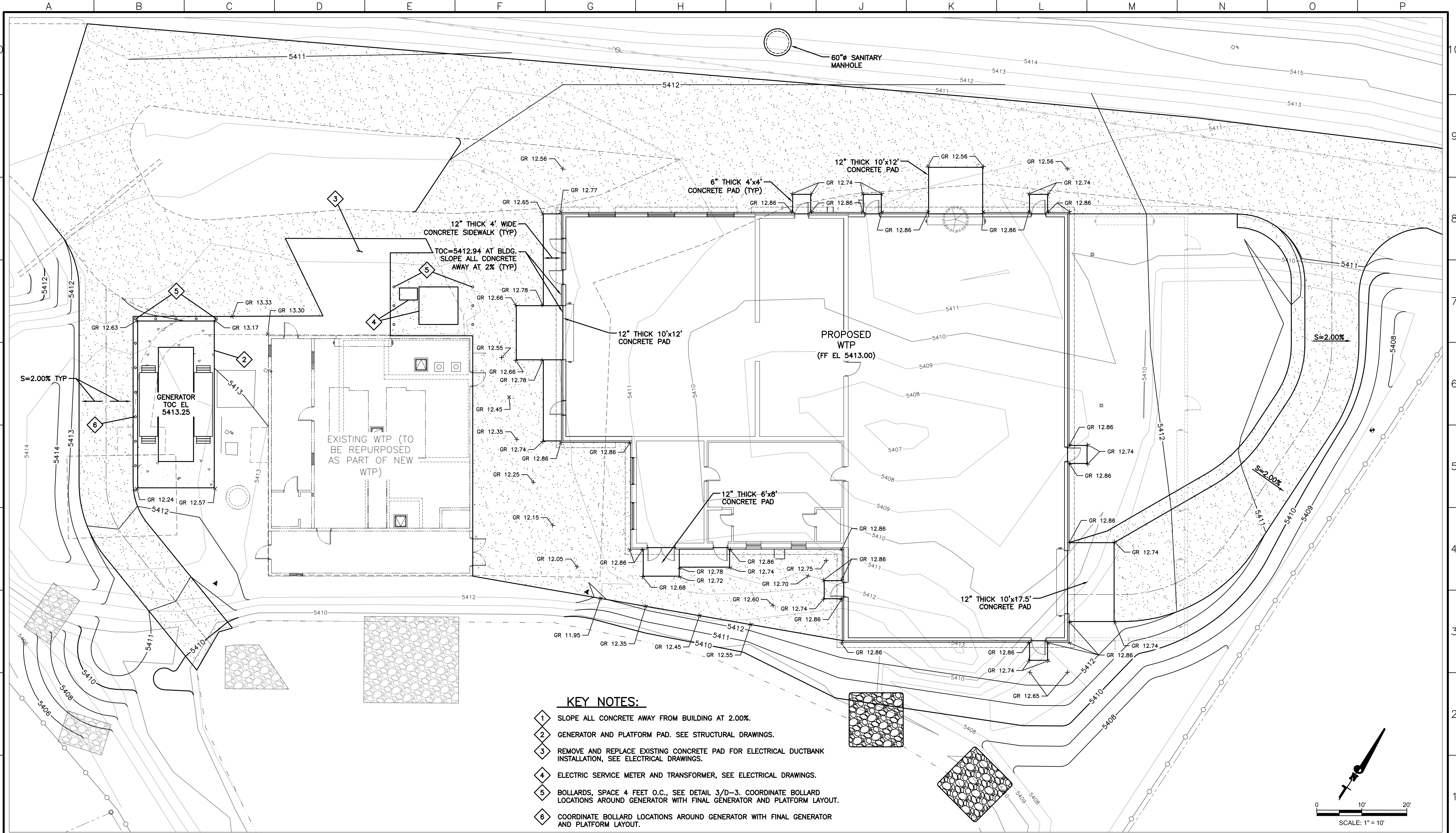
TOWN OF SILT
SILT, COLORADO


WATER TREATMENT PLANT IMPROVEMENTS

CIVIL

OVERALL SITE PLAN

DATE: 10/13/23
PROJECT NUMBER: 50159690
REVISION NO. A
DRAWING NUMBER C-1A
SHEET NUMBER





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LINE IS 2 INCHES
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(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING CPL59690-2

DRAWN TWL

DESIGNED SEF

CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	30% DESIGN REVIEW SUBMITTAL	TWL	05/05/23	SEF
B	60% DESIGN REVIEW SUBMITTAL	TWL	05/25/23	SEF
C	90% DESIGN REVIEW SUBMITTAL	TWL	07/31/23	SEF
D	90% DESIGN ADDENDUM	TWL	08/16/23	SEF
C	CDPHE REVIEW SUBMITTAL	TWL	09/29/23	SEF
D	BUILDING DEPT REVIEW SUBMITTAL	TWL	10/13/23	SEF

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

CIVIL

ENLARGED GRADING PLAN

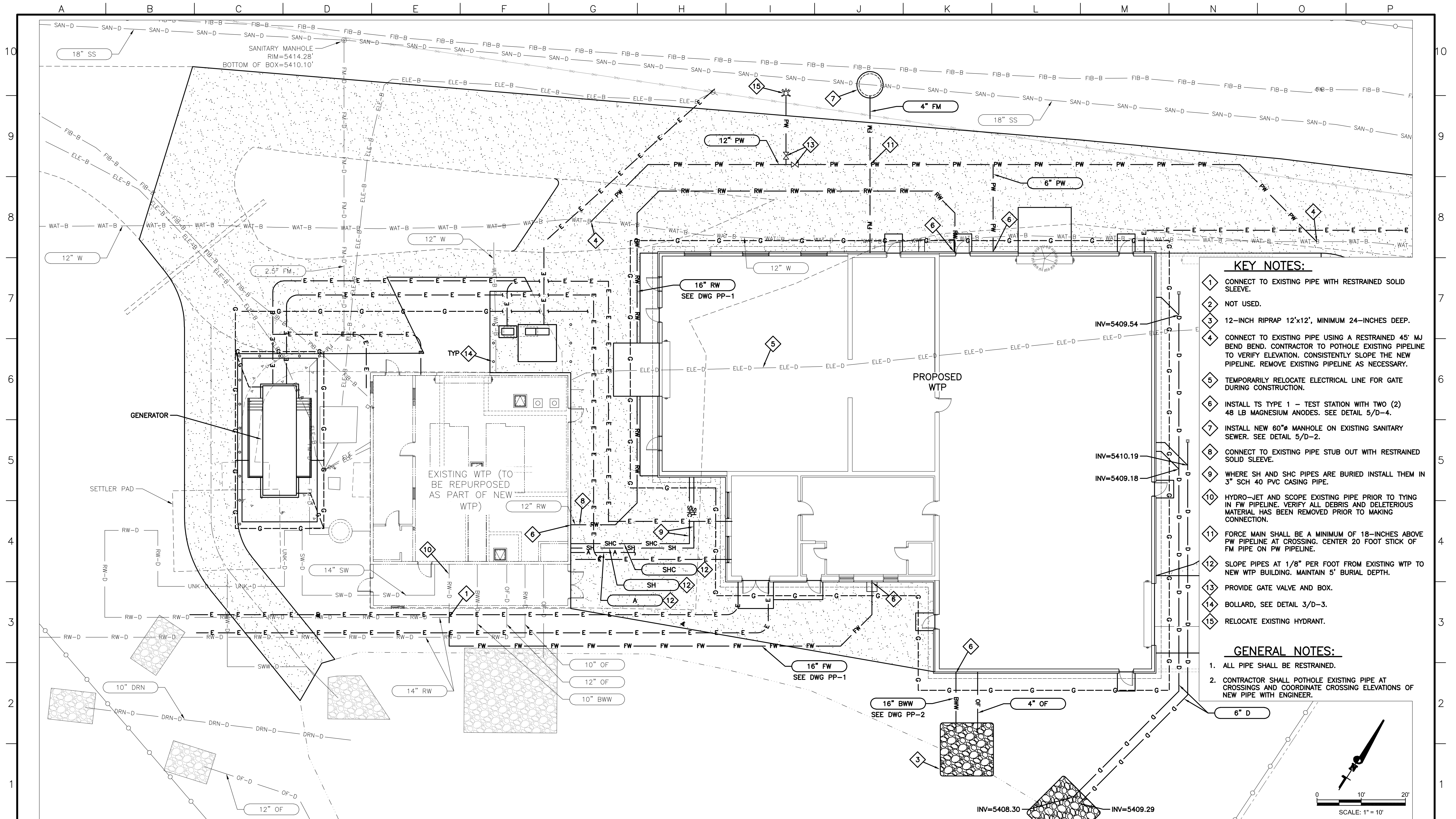
DATE: 05/01/23

PROJECT NUMBER: 50159690

REVISION NO. D

DRAWING NUMBER C-2

SHEET NUMBER



KEY NOTES:

- 1 CONNECT TO EXISTING PIPE WITH RESTRAINED SOLID SLEEVE.
- 2 NOT USED.
- 3 12-INCH RIPRAP 12'x12', MINIMUM 24-INCHES DEEP.
- 4 CONNECT TO EXISTING PIPE USING A RESTRAINED 45' MJ BEND. CONTRACTOR TO POTHOLE EXISTING PIPELINE TO VERIFY ELEVATION. CONSISTENTLY SLOPE THE NEW PIPELINE. REMOVE EXISTING PIPELINE AS NECESSARY.
- 5 TEMPORARILY RELOCATE ELECTRICAL LINE FOR GATE DURING CONSTRUCTION.
- 6 INSTALL TS TYPE 1 - TEST STATION WITH TWO (2) 48 LB MAGNESIUM ANODES. SEE DETAIL 5/D-4.
- 7 INSTALL NEW 60" MANHOLE ON EXISTING SANITARY SEWER. SEE DETAIL 5/D-2.
- 8 CONNECT TO EXISTING PIPE STUB OUT WITH RESTRAINED SOLID SLEEVE.
- 9 WHERE SH AND SHC PIPES ARE BURIED INSTALL THEM IN 3" SCH 40 PVC CASING PIPE.
- 10 HYDRO-JET AND SCOPE EXISTING PIPE PRIOR TO TYING IN FW PIPELINE. VERIFY ALL DEBRIS AND DELETERIOUS MATERIAL HAS BEEN REMOVED PRIOR TO MAKING CONNECTION.
- 11 FORCE MAIN SHALL BE A MINIMUM OF 18-INCHES ABOVE PW PIPELINE AT CROSSING. CENTER 20 FOOT STICK OF FM PIPE ON PW PIPELINE.
- 12 SLOPE PIPES AT 1/8" PER FOOT FROM EXISTING WTP TO NEW WTP BUILDING. MAINTAIN 5' BURIAL DEPTH.
- 13 PROVIDE GATE VALVE AND BOX.
- 14 BOLLARD, SEE DETAIL 3/D-3.
- 15 RELOCATE EXISTING HYDRANT.

GENERAL NOTES:

1. ALL PIPE SHALL BE RESTRAINED.
2. CONTRACTOR SHALL POTHOLE EXISTING PIPE AT CROSSINGS AND COORDINATE CROSSING ELEVATIONS OF NEW PIPE WITH ENGINEER.

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LINE IS 2 INCHES
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(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING CPL59690-3
DRAWN TWL
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	30% DESIGN REVIEW SUBMITTAL	TWL	05/05/23	SEF
B	60% DESIGN REVIEW SUBMITTAL	TWL	05/25/23	SEF
C	90% DESIGN REVIEW SUBMITTAL	TWL	07/31/23	SEF
D	90% DESIGN ADDENDUM	TWL	08/16/23	SEF
C	CDPHE REVIEW SUBMITTAL	TWL	09/29/23	SEF
D	BUILDING DEPT REVIEW SUBMITTAL	TWL	10/13/23	SEF

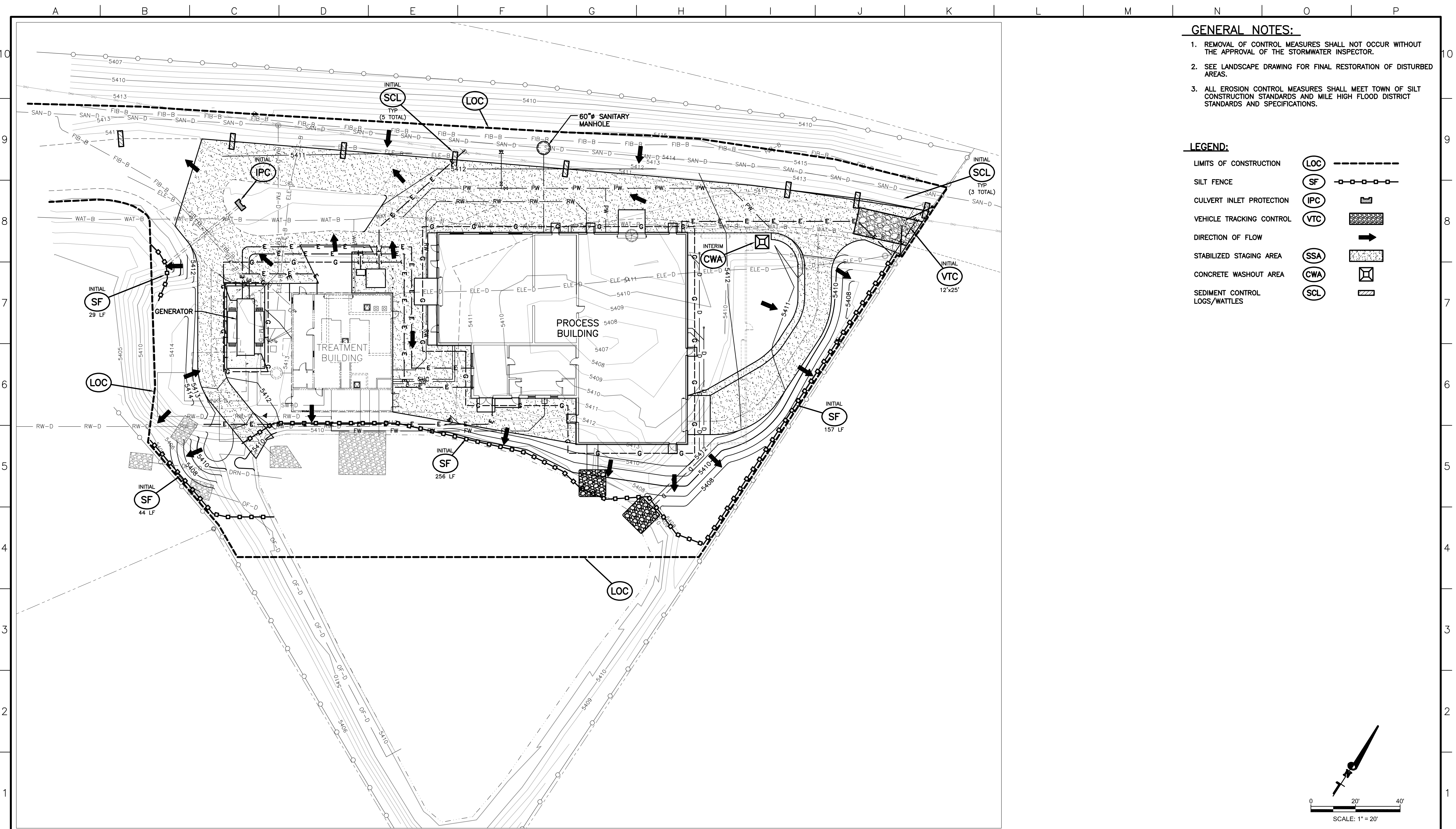
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

CIVIL

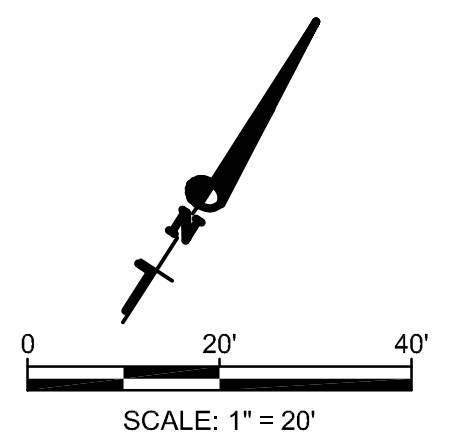
ENLARGED YARD PIPING PLAN

DATE: 05/01/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
C-3
SHEET NUMBER



- GENERAL NOTES:**
1. REMOVAL OF CONTROL MEASURES SHALL NOT OCCUR WITHOUT THE APPROVAL OF THE STORMWATER INSPECTOR.
 2. SEE LANDSCAPE DRAWING FOR FINAL RESTORATION OF DISTURBED AREAS.
 3. ALL EROSION CONTROL MEASURES SHALL MEET TOWN OF SILT CONSTRUCTION STANDARDS AND MILE HIGH FLOOD DISTRICT STANDARDS AND SPECIFICATIONS.

- LEGEND:**
- | | | |
|-------------------------------|-------|-----------|
| LIMITS OF CONSTRUCTION | (LOC) | --- |
| SILT FENCE | (SF) | -o-o-o-o- |
| CULVERT INLET PROTECTION | (IPC) | [Symbol] |
| VEHICLE TRACKING CONTROL | (VTC) | [Symbol] |
| DIRECTION OF FLOW | | → |
| STABILIZED STAGING AREA | (SSA) | [Symbol] |
| CONCRETE WASHOUT AREA | (CWA) | [Symbol] |
| SEDIMENT CONTROL LOGS/WATTLES | (SCL) | [Symbol] |



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LINE IS 2 INCHES
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DRAWING CEC59690-1

DRAWN TWL

DESIGNED SEF

CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	TWL	05/25/23	SEF
B	90% DESIGN REVIEW SUBMITTAL	TWL	07/31/23	SEF
C	90% DESIGN ADDENDUM	TWL	08/16/23	SEF
D	CDPHE REVIEW SUBMITTAL	TWL	09/29/23	SEF
E	BUILDING DEPT REVIEW SUBMITTAL	TWL	10/13/23	SEF

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

CIVIL

GRADING, EROSION, AND
SEDIMENT CONTROL PLAN

DATE: 05/15/23

PROJECT NUMBER: 50159690

REVISION NO. E

DRAWING NUMBER EC-1

SHEET NUMBER

BUILDING CODES:	2018 INTERNATIONAL BUILDING CODE 2015 INTERNATIONAL MECHANICAL CODE 2015 INTERNATIONAL FUEL GAS CODE 2015 INTERNATIONAL PLUMBING CODE 2015 INTERNATIONAL FIRE CODE 2018 INTERNATIONAL ENERGY CONSERVATION CODE NATIONAL ELECTRICAL CODE
CONSTRUCTION TYPE:	TYPE II-B (TABLE 601)
OCCUPANCY:	F-1 - MODERATE-HAZARD FACTORY INDUSTRIAL (306.2) - (NON-SPRINKLERED) H-4 - HIGH HAZARD (307.6) - (SPRINKLERED) HAZARDOUS MATERIALS (TABLE 307.1(2)) CAUSTIC SODA & SODIUM HYPOCHLORITE - CORROSIVE - MORE THAN 2,000 GALLONS TOTAL IN STORAGE/USE-CLOSED SYSTEM (REFER TO CHEMICAL TABLE) RISK CATEGORY (TABLE 1604.5): CATEGORY IV BUSINESS GROUP B (304.1) - (NON-SPRINKLERED)
ALLOWABLE HEIGHTS AND AREAS:	F-1 15,500 SF, 2 STORIES, 55' H-4 70,000 SF, 4 STORIES, 75' B 23,000 SF, 3 STORIES, 55'
ACTUAL HEIGHTS AND AREAS:	F-1 5,175 SF, 1 STORY, 38' - 11" H-4 3,175 SF, 1 STORY, 29' - 9" B 728 SF, 1 STORY, 19' - 4"
MIXED USE AND OCCUPANCY:	SEPARATED OCCUPANCIES (508.4) F-1 / H-4 & B NON-SEPARATED OCCUPANCIES NO SEPARATION REQUIREMENT BETWEEN F-1 AND B OCCUPANCIES (TABLE 508.4) ALLOWABLE BUILDING AREA (508.4.2) (F-1) 5,175 / 15,500 + (H-4) 3,175 / 70,000 + (B) 728 / 23,000 = (F-1) 0.33 + (H-4) 0.05 + (B) 0.03 = 0.41 < 1.0
SEPARATION OF OCCUPANCIES:	PER TABLE 508.4 F-1 (NON-SPRINKLERED) / H-4 (SPRINKLERED): 1 HR FIRE BARRIER B (NON-SPRINKLERED) / H-4 (SPRINKLERED): 1 HR FIRE BARRIER F-1 (NON-SPRINKLERED) / B (NON-SPRINKLERED): NONE

KEY BOXES:

ACCESSIBILITY:

AUTOMATIC SPRINKLER SYSTEMS:

MEANS OF EGRESS:

PLUMBING SYSTEMS

CHAPTER 29:

FIRE ALARM AND DETECTION SYSTEMS (907.2)

AN APPROVED FIRE ALARM SYSTEM IN ACCORDANCE WITH NFPA 72 SHALL BE PROVIDED AND PROVIDE OCCUPANT NOTIFICATION IN ACCORDANCE WITH 907.5. A MINIMUM OF ONE MANUAL FIRE ALARM BOX SHALL BE PROVIDED TO INITIATE A FIRE ALARM SIGNAL FOR FIRE ALARM SYSTEM EMPLOYING AUTOMATIC FIRE DETECTORS.

PORTABLE FIRE EXTINGUISHERS (TABLE 906.3(1))

MAX FLOOR AREA PER EXTINGUISHER = 11,250 SF

MAXIMUM TRAVEL DISTANCE TO EXTINGUISHER: 75 FT

IFC 506.1: KEY BOXES PER UL 1037 IS WILL BE PROVIDED IN LOCATIONS APPROVED BY THE FIRE CODE OFFICIAL

OCCUPANCY GROUP B: COMPLIANT WITH ACCESSIBILITY REQUIREMENTS OF IBC CHAPTER 11 .
OCCUPANCY GROUPS F-1 AND H-4: EXEMPT FROM ACCESSIBILITY REQUIREMENTS PER IBC 1103.2.9

AN AUTOMATIC SPRINKLER SYSTEM IS PROVIDED IN GROUP H OCCUPANCIES PER IBC 903.2.5

OCCUPANT LOAD (TABLE 1004.5):

F-1	MECHANICAL EQPT RM = 300 GSF PER OCCUPANT = 17 OCCUPANTS
H-4	MECHANICAL EQPT RM = 300 GSF PER OCCUPANT = 10 OCCUPANTS
B	BUSINESS = 150 GSF PER OCCUPANT = 4 OCCUPANTS

EXIT ACCESS:

EGRESS THROUGH INTERVENING SPACES (1016.2)

COMMON PATH OF EGRESS TRAVEL (TABLE 1006.2.1):

F	(OCC LOAD <30, NO SPRINKLERS) = 75 FT MAX
H-4	(OCC LOAD 10, SPRINKLERS) = 75 FT MAX
B	(OCC LOAD <30, NO SPRINKLERS) = 100 FT MAX

EXITS:

SPACES WITH ONE EXIT (TABLE 1006.2.1):	
F	MAX OCC LOAD OF 49
H-4	MAX OCC LOAD OF 10
B OCC	MAX OCC LOAD OF 49

EXIT ACCESS TRAVEL DISTANCE (TABLE 1017.2):
F-1 OCC NO SPRINKLERS = 200 FEET MAX
H-4 OCC SPRINKLERS = 175 FEET MAX
B OCC NO SPRINKLERS = 200 FEET MAX

STORIES WITH ONE EXIT (TABLE 1006.3.2): 2 EXITS REQUIRED PER STORY

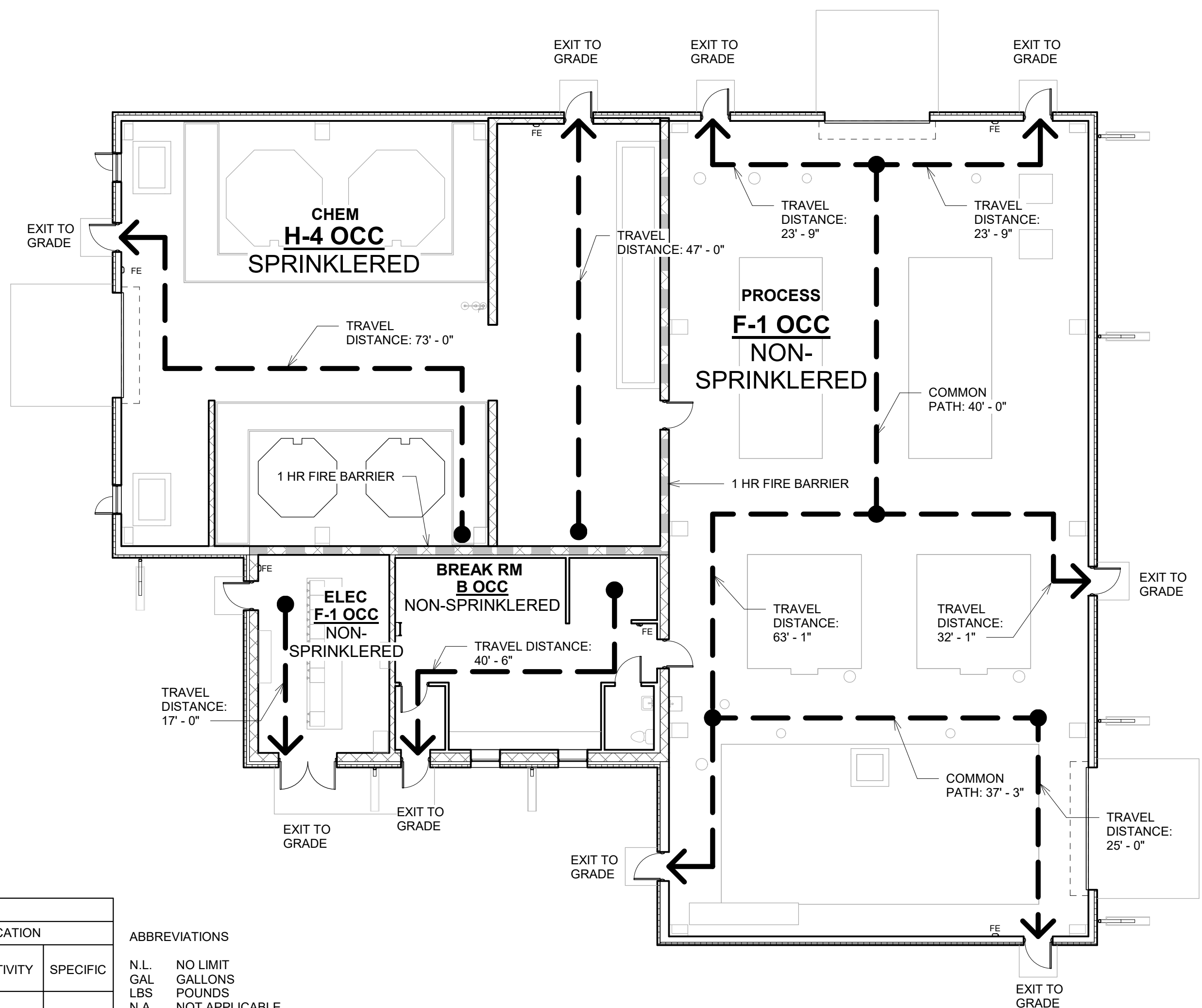
PLUMBING FIXTURES PROVIDED

MALE AND FEMALE: 1 WC PER 100 OCC
MALE AND FEMALE: 1 LAVATORY PER 100 OCC
1 DRINKING FOUNTAIN PER 400 OCC
1 SERVICE SINK

SEPARATE FACILITIES

PER IBC 2902.2, SEPARATE FACILITIES SHALL NOT BE REQUIRED IN STRUCTURES WITH A TOTAL OCCUPANT LOAD LESS THAN 15 OCCUPANTS INCLUDING EMPLOYEES AND CUSTOMERS.

1. UNLESS OTHERWISE NOTED, PLAN DIMENSIONS ARE TO NOMINAL SURFACE OF MASONRY AND CONCRETE.
2. DIMENSIONS OF DOORS, WINDOWS & OTHER ITEMS IN WALLS ARE BASED ON NOMINAL MASONRY COURSING OR ROUGH OPENING DIMENSIONS. FIELD VERIFY AND/OR COORDINATE DIMENSIONS OF ITEMS W/MASONRY &/OR FRMG CONSTRUCTION AS REQUIRED.
3. "FINISH FLOOR" REFERS TO TOP OF CONCRETE SLABS. FOR DEPRESSED FLOOR, PADS AND CURBS, SEE STRUCT DRAWINGS. SEE BUILDING SECTIONS FOR VARYING CONDITIONS.
4. REPETITIVE FEATURES ARE NOT DRAWN IN THEIR ENTIRETY AND SHALL BE COMPLETELY PROVIDED AS IF DRAWN IN FULL.
5. VERIFY ACTUAL SIZES OF ALL EQUIPMENT TO BE PROVIDED IN THIS CONTRACT OR BY OTHERS & COORD ALL ROUGH-IN & SUBSTRATE DIMENSIONS TO DETERMINE ACTUAL REQUIRED SIZES OF & LOCATIONS OF PADS, CURBS, KNOCKOUTS, BLOCKOUTS, ETC.
6. VERIFY AND COORD SIZE AND LOCATION OF ACCESS DOORS, CURBS, PADS, WALL MOUNTED EQUIPMENT AND ACCESSORIES TO PROVIDE ALL OPENINGS THROUGH FLOORS AND WALLS AND/OR ALL BASES, ANCHORS, INSERTS & BLOCKING.
7. NOTES ON DRAWINGS INDICATE SOME OF THE ITEMS TO BE PAINTED. REFER TO SPECIFICATIONS FOR OTHER REQUIREMENTS FOR ITEMS TO BE PAINTED AND PAINT SYSTEMS FOR EACH SUBSTRATE AND/OR MATERIAL.
8. REFER TO PROCESS, ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL AND OTHER CATEGORIES OF DRAWINGS FOR ADDITIONAL NOTES.
9. DO NOT SCALE DRAWINGS. WRITTEN DIMENSIONS SHALL ESTABLISH LOCATION OF ALL PARTITIONS, OPENINGS, EQUIPMENT, ETC.
10. LARGER SCALE DRAWINGS AND DETAILS HAVE PRIORITY OVER SMALLER SCALE DRAWINGS.
11. CONTRACTOR SHALL NOTIFY THE ARCHITECT OF ANY DISCREPANCIES OR CONFLICTS IN THE DRAWINGS AND/OR SPECIFICATIONS TO REQUEST AND RECEIVE AN INTERPRETATION OR CLARIFICATION BEFORE PROCEEDING WITH CONSTRUCTION.
12. CONTRACTOR SHALL VERIFY FIELD CONDITIONS BEFORE PROCEEDING WITH CONSTRUCTION.



ABBREVIATIONS


N.L.	NO LIMIT
GAL	GALLONS
LBS	POUNDS
N.A.	NOT APPLICABLE

CLASSIFICATION ABBREVIATIONS

IRR	IRRITANT
TOX	TOXIC
COR	CORROSIVE
OX	OXIDIZER
OXG	OXIDIZING GAS - LIQUIFIED
OHH	OTHER HEALTH HAZARD
WR	WATER REACTIVE

CHEMICAL TABLE																
CHEMICAL			HAZARD						EXEMPT AMOUNT			OCCUPANCY	NFPA 704 IDENTIFICATION			
NAME	CAS NUMBER	FORMULA	TYPE	CLASSIFICATION	STATE	SOLUTION STRENGTH	ACTUAL AMOUNT	CONTAINER	BASIC	SPRINKLERED BUILDING OR CABINETS	SPRINKLERED BUILDING AND CABINETS	(IF OVER EXEMPT AMOUNT PER 2018 IBC)	HEALTH	FIRE	REACTIVITY	SPECIFIC
ALUMINUM CHLOROHYDRATE	12042-91-0	Al ₂ Cl(OH) ₅	HEALTH	IRR	LIQUID	50%	6,000 GAL	2 TANKS	N.L.	N.A.	N.A.	F-1	2	0	0	
SODIUM CHLORITE SOLUTION (PROPRIETARY)	7758-19-2	NaClO ₂	HEALTH	COR, TOX, OHH	LIQUID	100%	600 GAL	300 GAL TOTES	N.L.	N.A.	N.A.	F-1	3	0	0	OX
			PHYSICAL	OX CLASS 1												
SODIUM HYPOCHLORITE	7681-52-9	NaCl	HEALTH	COR	LIQUID	10-20%	1,200 GAL	300 GAL TOTES	500 GAL	1,000 GAL	2,000 GAL	H-4	3	0	0	
SODIUM HYDROXIDE	1310-73-2	NaOH	HEALTH	COR	LIQUID	50%	15,000 GAL	2 TANKS	500 GAL	1,000 GAL	2,000 GAL	H-4	3	0	0	WR 1
			PHYSICAL	WR 1												

1 CODE PLAN
Scale: 3/32" = 1'-0"

A		B		C		D		E		F		G		H		I		J		K		L		M		N		O		P																																							
 Dewberry® Dewberry Engineers Inc. 990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825-1802				LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" = 1" SCALE, INDICATE)		DRAWING _____ DRAWN _____ CC DESIGNED _____ SBA CHECKED _____ PB		APPROVED _____ PRINCIPAL _____ DATE: _____		REVISIONS						TOWN OF SILT SILT, COLORADO WATER TREATMENT PLANT						CODE PLAN AND CHEMICAL TABLE						DATE: 10/13/23																																									
										<table border="1"> <thead> <tr> <th>REV.</th> <th>DESCRIPTION</th> <th>BY</th> <th>DATE</th> <th>APP.</th> </tr> </thead> <tbody> <tr> <td>C</td> <td>BUILDING DEPT REVIEW SUBMITTAL</td> <td>CC</td> <td>10/13/23</td> <td>PB</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>																		REV.	DESCRIPTION	BY	DATE	APP.	C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB																															PROJECT NUMBER: 50159690	
										REV.	DESCRIPTION	BY	DATE	APP.																																																							
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DRAWING NUMBER																																																																					
A001																																																																					



COMcheck Software Version 4.1.5.1 Envelope Compliance Certificate

Project Information

Energy Code: 2018 IECC
Project Title: Silt WTP
Location: Silt, Colorado
Climate Zone: 5b
Project Type: New Construction
Vertical Glazing / Wall Area: 10%

Construction Site: Silt, CO
Owner/Agent: _____
Designer/Contractor: _____

Additional Efficiency Package(s)

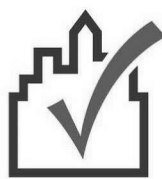
Reduced interior lighting power. Requirements are implicitly enforced within interior lighting allowance calculations.

Building Area	Floor Area
1-Manufacturing Facility : Nonresidential	9114

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor ^(a)
Roof - MTL: Metal Building, Standing Seam, Liner System with Thermal Blocks (d), [Bldg. Use 1 - Manufacturing Facility]	7060	0.0	35.0	0.028	0.035
Roof - Membrane: Insulation Entirely Above Deck, [Bldg. Use 1 - Manufacturing Facility]	1955	---	30.0	0.032	0.032
Floor 1: Slab-On-Grade/Unheated, [Bldg. Use 1 - Manufacturing Facility] (c)	415	---	---	0.730	0.540
NORTH					
North Wall - MTL: Metal Building Wall, Single Layer Mineral Fiber (compressed at girt), [Bldg. Use 1 - Manufacturing Facility]	3078	0.0	32.0	0.030	0.052
Windows: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Window, SHGC 0.38, [Bldg. Use 1 - Manufacturing Facility] (b)	127	---	---	0.320	0.380
Kalwall: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Kalwall, SHGC 0.38, [Bldg. Use 1 - Manufacturing Facility] (b)	300	---	---	0.530	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Manufacturing Facility]	48	---	---	0.380	0.370
OH: Insulated Metal, Garage door 14% glazing, [Bldg. Use 1 - Manufacturing Facility]	192	---	---	0.125	0.310
North Wall - CMU: Concrete Block/8", Solid Grouted, Normal Density, Furring: Metal, [Bldg. Use 1 - Manufacturing Facility]	258	0.0	32.0	0.029	0.090
Window: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Window, SHGC 0.38, [Bldg. Use 1 - Manufacturing Facility] (b)	9	---	---	0.320	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Manufacturing Facility]	25	---	---	0.380	0.370
EAST					
East Wall - MTL - WTP: Metal Building Wall, Single Layer Mineral Fiber (compressed at girt), [Bldg. Use 1 - Manufacturing Facility]	2944	0.0	32.0	0.030	0.052
Kalwall: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Kalwall, SHGC 0.38, [Bldg. Use 1 - Manufacturing Facility] (b)	336	---	---	0.530	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Warehouse]	25	---	---	0.380	0.370
OH: Insulated Metal, Garage door 14% glazing, [Bldg. Use 1 - Warehouse]	196	---	---	0.125	0.310
East Wall - MTL - Chem: Metal Building Wall, Single Layer Mineral Fiber (compressed at girt), [Bldg. Use 1 - Warehouse]	318	0.0	32.0	0.030	0.052
East Wall - CMU - Chem: Concrete Block/12", Solid Grouted, Normal Density, Furring: None, [Bldg. Use 1 - Warehouse]	248	---	32.0	0.029	0.090
SOUTH					
South Wall - MTL: Metal Building Wall, Single Layer Mineral Fiber (compressed at girt), [Bldg. Use 1 - Warehouse]	2150	0.0	32.0	0.030	0.052
Windows: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Window, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	10	---	---	0.320	0.380
Kalwall: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Kalwall, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	180	---	---	0.530	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Warehouse]	24	---	---	0.380	0.370
South Wall - CMU: Concrete Block/12", Solid Grouted, Normal Density, Furring: Metal, [Bldg. Use 1 - Warehouse]	819	0.0	32.0	0.028	0.090
Windows: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Window, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	49	---	---	0.320	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Warehouse]	74	---	---	0.380	0.370
WEST					
West Wall - MTL - WTP: Metal Building Wall, Single Layer Mineral Fiber (compressed at girt), [Bldg. Use 1 - Warehouse]	2267	0.0	32.0	0.030	0.052
Kalwall: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Kalwall, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	336	---	---	0.530	0.380
Windows: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Window, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	9	---	---	0.320	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Warehouse]	25	---	---	0.380	0.370
West Wall - CMU - WTP: Concrete Block/12", Solid Grouted, Normal Density, Furring: None, [Bldg. Use 1 - Warehouse]	360	---	32.0	0.029	0.090
West Wall - MTL - Chem: Metal Building Wall, Single Layer Mineral Fiber (compressed at girt), [Bldg. Use 1 - Warehouse]	1304	0.0	32.0	0.030	0.052
Windows: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Window, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	9	---	---	0.320	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Warehouse]	25	---	---	0.380	0.370
OH: Insulated Metal, Garage door 14% glazing, [Bldg. Use 1 - Warehouse]	192	---	---	0.125	0.310
Chem Feed: Insulated Metal, Swinging, [Bldg. Use 1 - Warehouse]	31	---	---	3.000	0.370
West Wall - MTL - Elec: Concrete Block/12", Solid Grouted, Normal Density, Furring: Metal, [Bldg. Use 1 - Warehouse]	344	0.0	32.0	0.028	0.090
Kalwall: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Kalwall, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	16	---	---	0.530	0.380
Windows: Metal Frame with Thermal Break/Fixed, Perf. Specs.: Product ID Window, SHGC 0.38, [Bldg. Use 1 - Warehouse] (b)	9	---	---	0.320	0.380
HM: Insulated Metal, Swinging, [Bldg. Use 1 - Warehouse]	25	---	---	0.380	0.370

- (a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.
(b) Fenestration product performance must be certified in accordance with NFRC and requires supporting documentation.
(c) Slab-On-Grade proposed and budget U-factors shown in table are F-factors.
(d) Thermal spacer block with minimum R-3.5 must be installed above the purlin/batt, and the roof deck secured to the purlins.



COMcheck Software Version 4.1.5.1 Inspection Checklist

Energy Code: 2018 IECC

Requirements: 0.0% were addressed directly in the COMcheck software

Text in the "Comments/Assumptions" column is provided by the user in the COMcheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

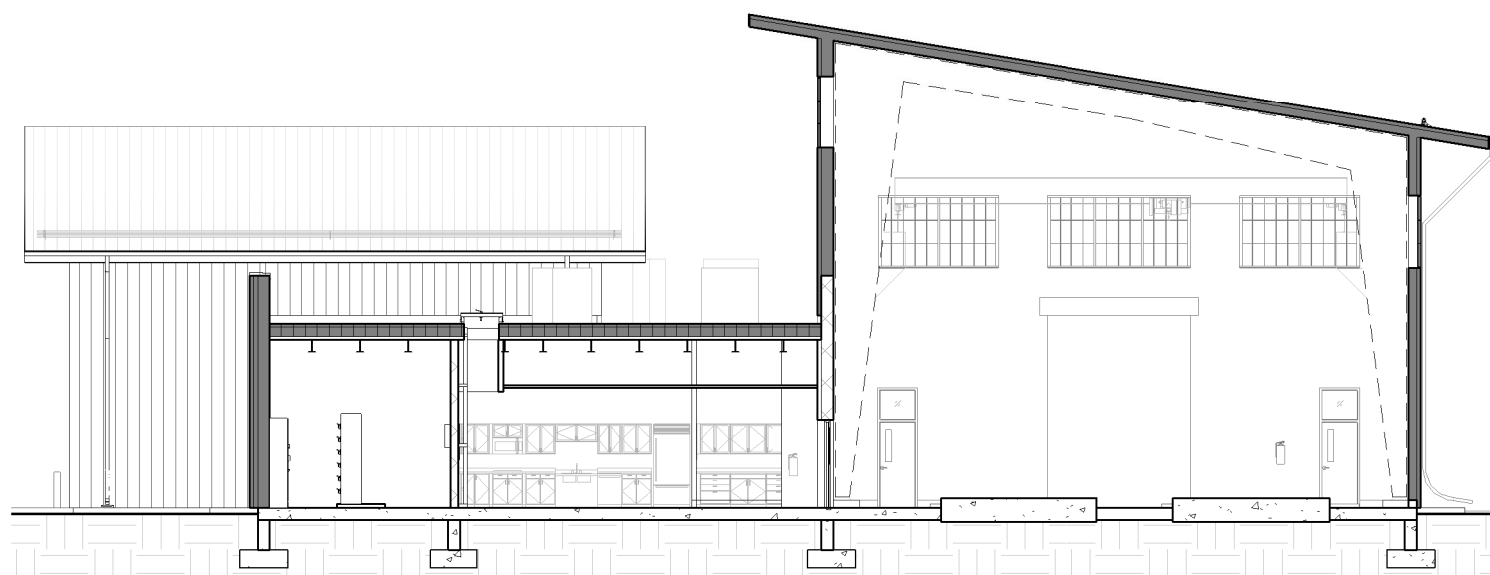
Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
C103.2 [PR1] ¹	Plans and/or specifications provide all information with which compliance can be determined for the building envelope and document where exceptions to the standard are claimed.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See envelope compliance certificate, specs, and drawings.
C402.4.1 [PR10] ¹	The vertical fenestration area <= 30 percent of the gross above-grade wall area.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	The vertical fenestration area is 10% of the gross above-grade wall area.
C402.4.1 [PR11] ¹	The skylight area <= 3 percent of the gross roof area.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No skylights provided.
C402.4.2 [PR14] ¹	In enclosed spaces > 2,500 ft2 directly under a roof with ceiling heights >15 ft. and used as an office, lobby, atrium, concourse, corridor, storage, gymnasium/exercise center, convention center, automotive service, manufacturing, non-refrigerated warehouse, retail store, distribution/sorting area, transportation, or workshop, the following requirements apply: (a) the daylight zone under skylights is >= half the floor area; (b) the skylight area to daylight zone is >= 3 percent with a skylight VT >= 0.40; or a minimum skylight effective aperture >= 1 percent.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	The office portion of the building is less than 2,500 square feet.
C406 [PR9] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the additional energy efficiency package options.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Please see electrical drawings.

C303.2 [FO4] ¹	Slab edge insulation installed per manufacturer's instructions.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No slab edge insulation provided.
C303.2.1 [FO6] ¹	Exterior insulation protected against damage, sunlight, moisture, wind, landscaping and equipment maintenance activities.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No slab edge insulation provided.
C105 [FO3] ¹	Installed slab-on-grade insulation type and R-value consistent with insulation specifications reported in plans and COMcheck reports.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	See the Envelope Assemblies table for values.
C402.2.4 [FO7] ²	Slab edge insulation depth/length. Slab insulation extending away from building is covered by pavement or >= 10 inches of soil.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No slab edge insulation provided.
C402.2.6 [FO12] ³	Radiant heating systems panels insulated to >=R-3.5 on face opposite space being heated.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	See the Envelope Assemblies table for values.

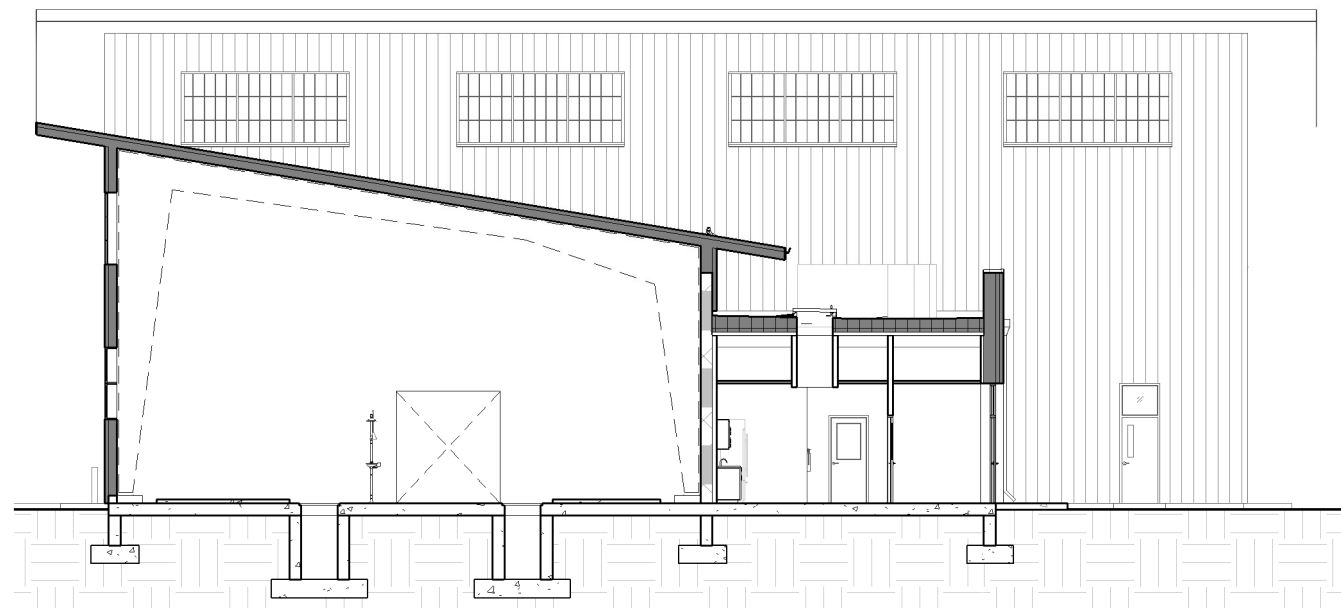
C303.1.3 [FR12] ²	Fenestration products rated in accordance with NFRC.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Please see specs.
C303.1.3 [FR13] ¹	Fenestration products are certified as to performance labels or certificates provided.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Please see specs.
C402.4.3 [FR10] ¹	Vertical fenestration SHGC value.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See the Envelope Assemblies table for values.
C402.4.3, C402.4.3.4 [FR8] ¹	Vertical fenestration U-Factor.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See envelope compliance certificate and specs.
C402.4.4 [FR14] ²	U-factor of opaque doors associated with the building thermal envelope meets requirements.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See the Envelope Assemblies table for values.
C402.5.1.2.1 [FR19] ¹	The building envelope contains a continuous air barrier that is sealed in an approved manner and material permeability <= 0.004 dhm/ft2. Air barrier penetrations are sealed in an approved manner.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See weather barrier and metal building systems spec.
C402.5.2, C402.5.4 [FR18] ³	Factory-built fenestration and doors are labeled as meeting air leakage requirements.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Please see specs.
C402.5.7 [FR17] ¹	Vestibules are installed on all building entrances. Doors have self-closing devices.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	Exception 2: Vestibules are not required where doors not intended to be used by the public or intended solely for employee use.

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C402.5.5, C403.2.4, 3 [ME3] ²	Stair and elevator shaft vents have motorized dampers that automatically close. Reference section C403.7.7 for operational details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No stairs or elevator shafts provided.
C405.6 [EL26] ²	Low-voltage dry-type distribution electric transformers meet the minimum efficiency requirements of Table C405.6.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See electrical drawings and specs.
C405.7 [EL27] ²	Electric motors meet the minimum efficiency requirements of Tables C405.7 (1) through C405.7 (4). Efficiency verified through certification under an approved certification program or the equipment efficiency ratings shall be provided by motor manufacturer (where certification programs do not exist).	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See electrical drawings and specs.
C405.8.2, C405.8.2.1 [EL28] ²	Escalators and moving walks comply with ASME A17.1/CSA B44 and have automatic controls configured to reduce speed to the minimum permitted speed in accordance with ASME A17.1/CSA B44 or applicable local code when not conveying passengers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No escalators or moving walks provided.
C405.9 [EL29] ²	Total voltage drop across the combination of feeders and branch circuits <= 5%.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See electrical drawings and specs.

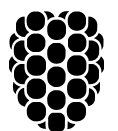
C303.1 [IN3] ¹	Roof insulation installed per manufacturer's instructions. Blown or poured loose-fill insulation is installed only where the roof slope is <=3 in 12.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See metal building systems and EPDM roofing specs.
C402.2.1 [IN20] ¹	Insulation installed on a suspended ceiling having ceiling tiles is not being specified for roof/ceiling assemblies. Continuous insulation board installed in 2 or more layers with edge joints offset between layers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No insulation intalled on suspended ceiling.
C303.1 [IN10] ²	Building envelope insulation is labeled with R-value or insulation certificate providing R-value and other relevant data.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See metal building systems spec.
C303.2 [IN7] ¹	Above-grade wall insulation installed per manufacturer's instructions.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See metal building systems spec.
C303.2.1 [IN14] ²	Exterior insulation is protected from damage with a protective material. Verification for exposed foundation insulation may need to occur during Foundation Inspection.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No slab edge insulation provided.
C105 [IN6] ¹	Installed above-grade wall insulation type and R-value consistent with insulation specifications reported in plans and COMcheck reports.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See the Envelope Assemblies table for values.
C402.2.3 [IN8] ²	Installed floor insulation type and R-value consistent with insulation specifications reported in plans and COMcheck reports.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	See the Envelope Assemblies table for values.
C402.2.6 [IN18] ²	Radiant panels and associated components, designed for heat transfer from the panel surfaces to the occupants or indoor space are insulated with a minimum of R-3.5.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No radiant heating systems provided.
C105 [IN2] ¹	Installed roof insulation type and R-value consistent with insulation specifications reported in plans and COMcheck reports. For some ceiling systems, verification may need to occur during Framing Inspection.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See metal building systems spec.
C402.5.1.1 [IN1] ¹	All sources of air leakage in the building thermal envelope are sealed, caulked, gasketed, weather stripped or wrapped with moisture vapor-permeable wrapping material to minimize air leakage.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See metal building systems, weather barrier, and joint sealants specs.
C402.5.6 [FI37] ²	Weatherseals installed on all loading dock cargo door openings and provide direct contact along the top and sides of vehicles parked in the doorway.	<input type="checkbox"/> Complies <input checked="" type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	No loading dock cargo doors provided.
C402.5.8 [FI28] ²	Recessed luminaires in thermal envelope to limit infiltration and be IC rated and labeled. Seal between interior finish and luminaire housing.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input checked="" type="checkbox"/> Not Applicable	No recessed luminaires provided.
C408.1.1 [FI57] ²	Building operations and maintenance documents will be provided to the owner. Documents will cover manufacturers' information, specifications, programming procedures and means of illustrating to owner how building, equipment and systems are intended to be installed, maintained, and operated.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Building operations and maintenance documents will be provided to the owner.



2 THERMAL ENVELOPE - 2
Scale: 1/16" = 1'-0"



1 THERMAL ENVELOPE - 1
Scale: 1/16" = 1'-0"



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LINE IS 2 INCHES
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DRAWING _____
DRAWN _____ Author
DESIGNED _____ Designer
CHECKED _____ Checker

APPROVED

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB

**TOWN OF SILT
SILT, COLORADO**

WATER TREATMENT PLANT

**ENERGY CONSERVATION CODE
COMPLIANCE**

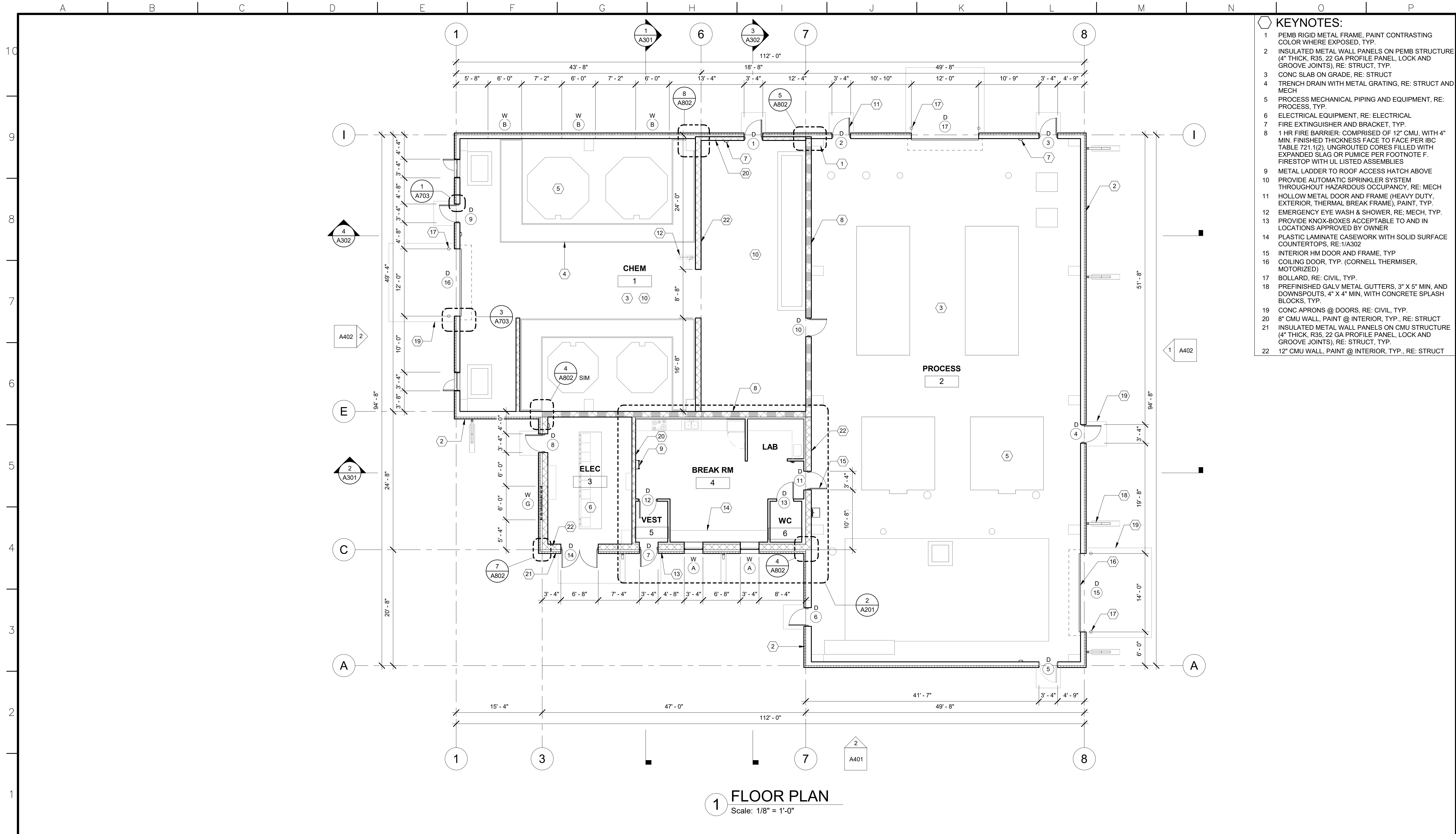
DATE: 10/13/23

PROJECT
NUMBER:50159690

REVISION NO.

DRAWING NUMBER

A002



- KEYNOTES:**
- PEMB RIGID METAL FRAME, PAINT CONTRASTING COLOR WHERE EXPOSED, TYP.
 - INSULATED METAL WALL PANELS ON PEMB STRUCTURE (4" THICK, R35, 22 GA PROFILE PANEL, LOCK AND GROOVE JOINTS), RE: STRUCT, TYP.
 - CONC SLAB ON GRADE, RE: STRUCT
 - TRENCH DRAIN WITH METAL GRATING, RE: STRUCT AND MECH
 - PROCESS MECHANICAL PIPING AND EQUIPMENT, RE: PROCESS, TYP.
 - ELECTRICAL EQUIPMENT, RE: ELECTRICAL
 - FIRE EXTINGUISHER AND BRACKET, TYP.
 - 1 HR FIRE BARRIER: COMPRISED OF 12" CMU, WITH 4" MIN. FINISHED THICKNESS FACE TO FACE PER IBC TABLE 721.1(2), UNGROUTED CORES FILLED WITH EXPANDED SLAG OR PUMICE PER FOOTNOTE F. FIRESTOP WITH UL LISTED ASSEMBLIES
 - METAL LADDER TO ROOF ACCESS HATCH ABOVE
 - PROVIDE AUTOMATIC SPRINKLER SYSTEM THROUGHOUT HAZARDOUS OCCUPANCY, RE: MECH
 - HOLLOW METAL DOOR AND FRAME (HEAVY DUTY, EXTERIOR, THERMAL BREAK FRAME), PAINT, TYP.
 - EMERGENCY EYE WASH & SHOWER, RE: MECH, TYP.
 - PROVIDE KNOX-BOXES ACCEPTABLE TO AND IN LOCATIONS APPROVED BY OWNER
 - PLASTIC LAMINATE CASEWORK WITH SOLID SURFACE COUNTERTOPS, RE:1/A302
 - INTERIOR HM DOOR AND FRAME, TYP
 - COILING DOOR, TYP. (CORNELL THERMISER, MOTORIZED)
 - BOLLARD, RE: CIVIL, TYP.
 - PREFINISHED GALV METAL GUTTERS, 3" X 5" MIN, AND DOWNSPOUTS, 4" X 4" MIN, WITH CONCRETE SPLASH BLOCKS, TYP.
 - CONC APRONS @ DOORS, RE: CIVIL, TYP.
 - 8" CMU WALL, PAINT @ INTERIOR, TYP., RE: STRUCT
 - INSULATED METAL WALL PANELS ON CMU STRUCTURE (4" THICK, R35, 22 GA PROFILE PANEL, LOCK AND GROOVE JOINTS), RE: STRUCT, TYP.
 - 12" CMU WALL, PAINT @ INTERIOR, TYP., RE: STRUCT

1 FLOOR PLAN
Scale: 1/8" = 1'-0"

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LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE, ACCORDINGLY)	
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CHECKED	PB

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PRINCIPAL
DATE:

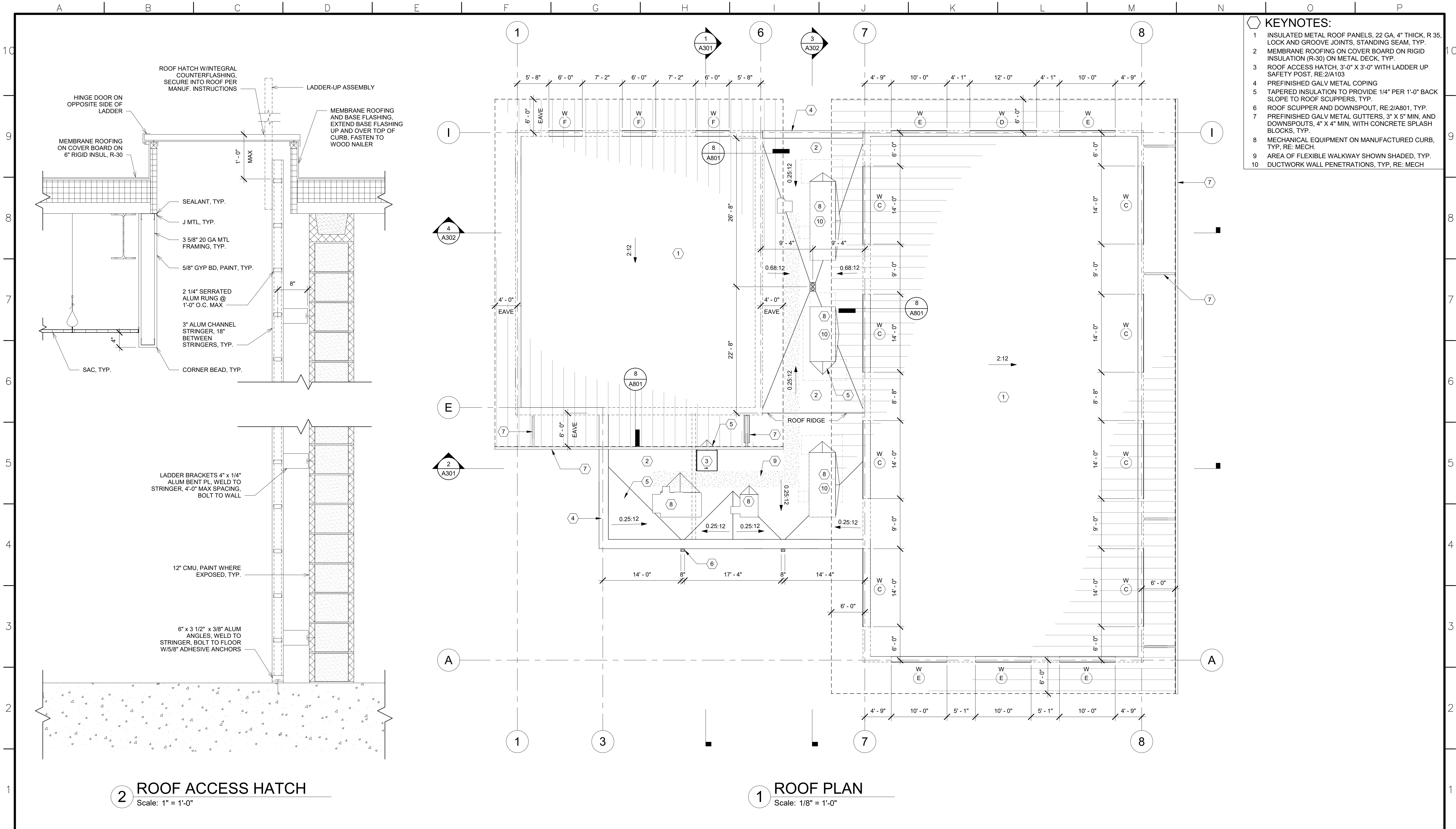
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REV.	DESCRIPTION	BY	DATE	APP.
C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB


**TOWN OF SILT
SILT, COLORADO**

WATER TREATMENT PLANT

FLOOR PLAN

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER A102



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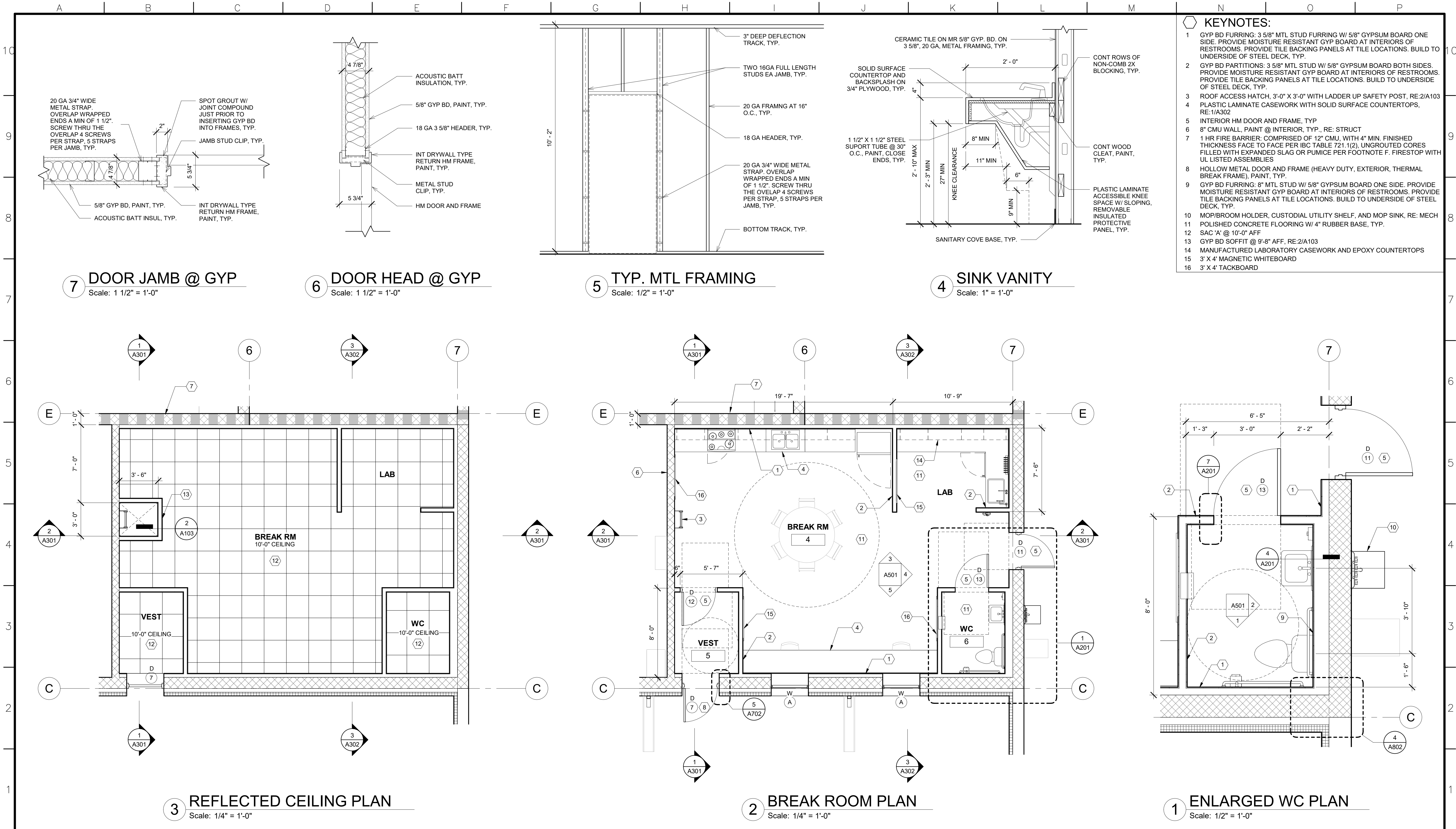
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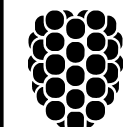
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REV. DESCRIPTION BY DATE APP.
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TOWN OF SILT
SILT, COLORADO
WATER TREATMENT PLANT

ROOF PLAN

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A103



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DATE:

REVISIONS

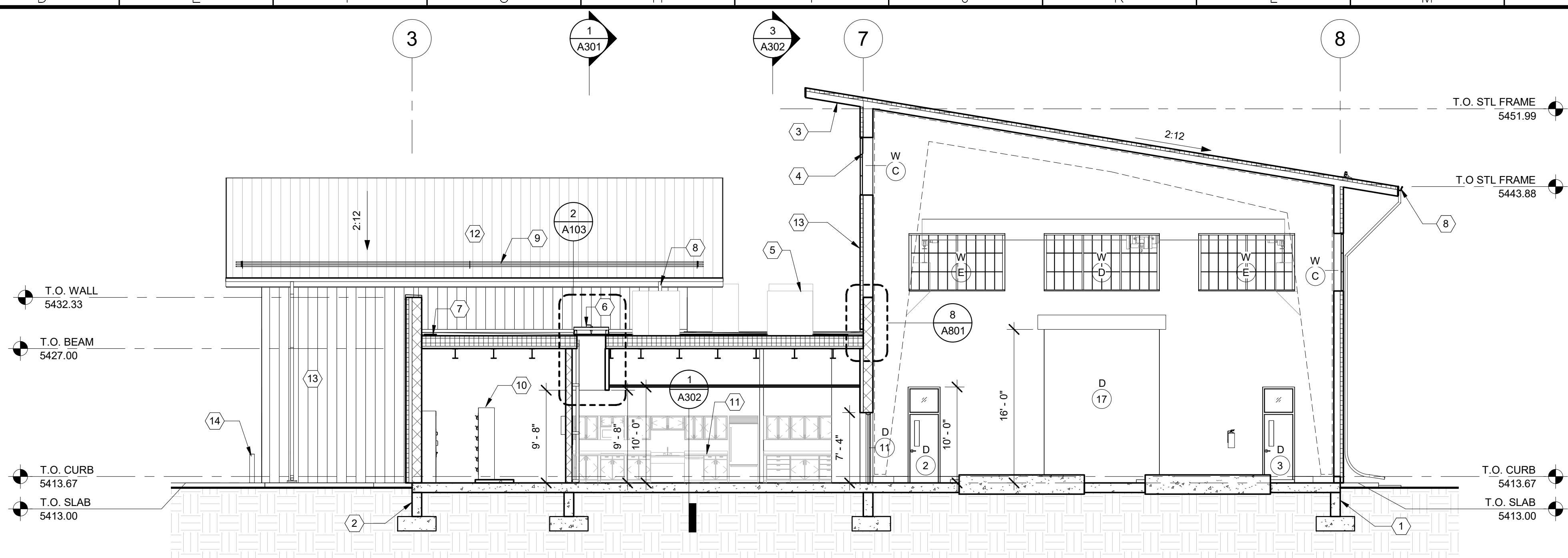
REV.	DESCRIPTION	BY	DATE	APP.
C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB

TOWN OF SILT
SILT, COLORADO

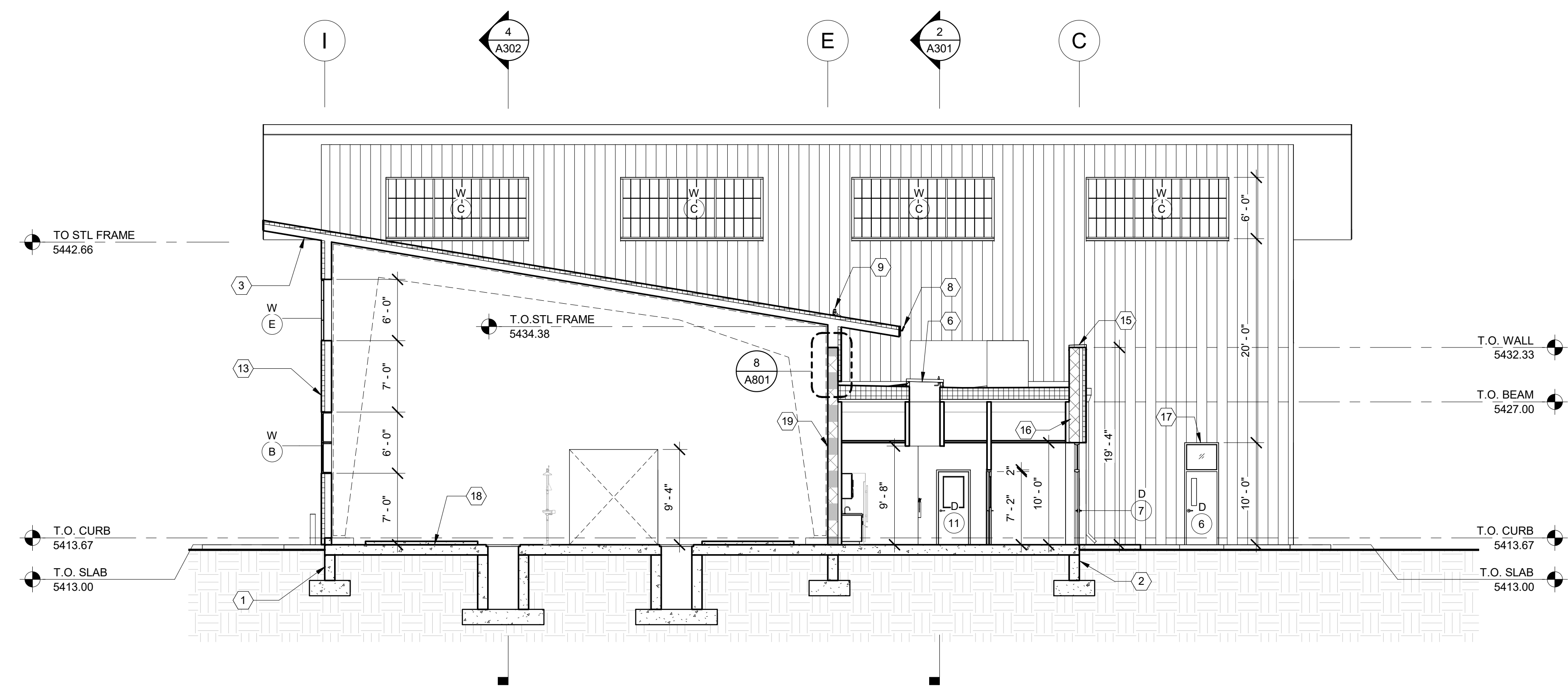
WATER TREATMENT PLANT

ENLARGED PLANS

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A201



SECTION 2
Scale: 1/8" = 1'-0"



SECTION 1
Scale: 1/8" = 1'-0"

- KEYNOTES:**
- 1 CONCRETE FOUNDATION WALL, RE: STRUCT
 - 2 DAMPPROOFING ON CONCRETE WALL WITH PROTECTION COURSE, TYP.
 - 3 PREFINISHED METAL NON-VENTED SOFFIT AND FASCIA PANELS, MATCH ROOFING, TYP.
 - 4 TRANSLUCENT WALL PANEL (KALWALL, 4" W/ AEROGEL)
 - 5 MECHANICAL EQUIPMENT ON MANUFACTURED CURB, TYP, RE: MECH.
 - 6 ROOF ACCESS HATCH, 3'-0" X 3'-0" WITH LADDER UP SAFETY POST, RE:2/A103
 - 7 MEMBRANE ROOFING ON COVER BOARD ON RIGID INSULATION (R-30) ON METAL DECK, TYP.
 - 8 PREFINISHED GALV METAL GUTTERS, 3" X 5" MIN, AND DOWNSPOUTS, 4" X 4" MIN, WITH CONCRETE SPLASH BLOCKS, TYP.
 - 9 SNOW GUARDS
 - 10 ELECTRICAL EQUIPMENT, RE: ELECTRICAL
 - 11 PLASTIC LAMINATE CASEWORK WITH SOLID SURFACE COUNTERTOPS, RE:1/A302
 - 12 INSULATED METAL ROOF PANELS, 22 GA, 4" THICK, R 35, LOCK AND GROOVE JOINTS, STANDING SEAM, TYP.
 - 13 INSULATED METAL WALL PANEL 'A' ON PEMB STRUCTURE, TYP.
 - 14 BOLLARD, RE: CIVIL, TYP.
 - 15 PREFINISHED GALV METAL COPING
 - 16 12" CMU WALL, PAINT @ INTERIOR, TYP., RE: STRUCT
 - 17 HOLLOW METAL DOOR AND FRAME (HEAVY DUTY, EXTERIOR, THERMAL BREAK FRAME), PAINT, TYP.
 - 18 CONC SLAB ON GRADE, RE: STRUCT
 - 19 1 HR FIRE BARRIER: COMPRISED OF 12" CMU, WITH 4" MIN. FINISHED THICKNESS FACE TO FACE PER IBC TABLE 721.1(2), UNGROUTED CORES FILLED WITH EXPANDED SLAG OR PUMICE PER FOOTNOTE F. FIRESTOP WITH UL LISTED ASSEMBLIES

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DRAWN	CC
DESIGNED	SBA
CHECKED	PB

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PRINCIPAL
DATE:

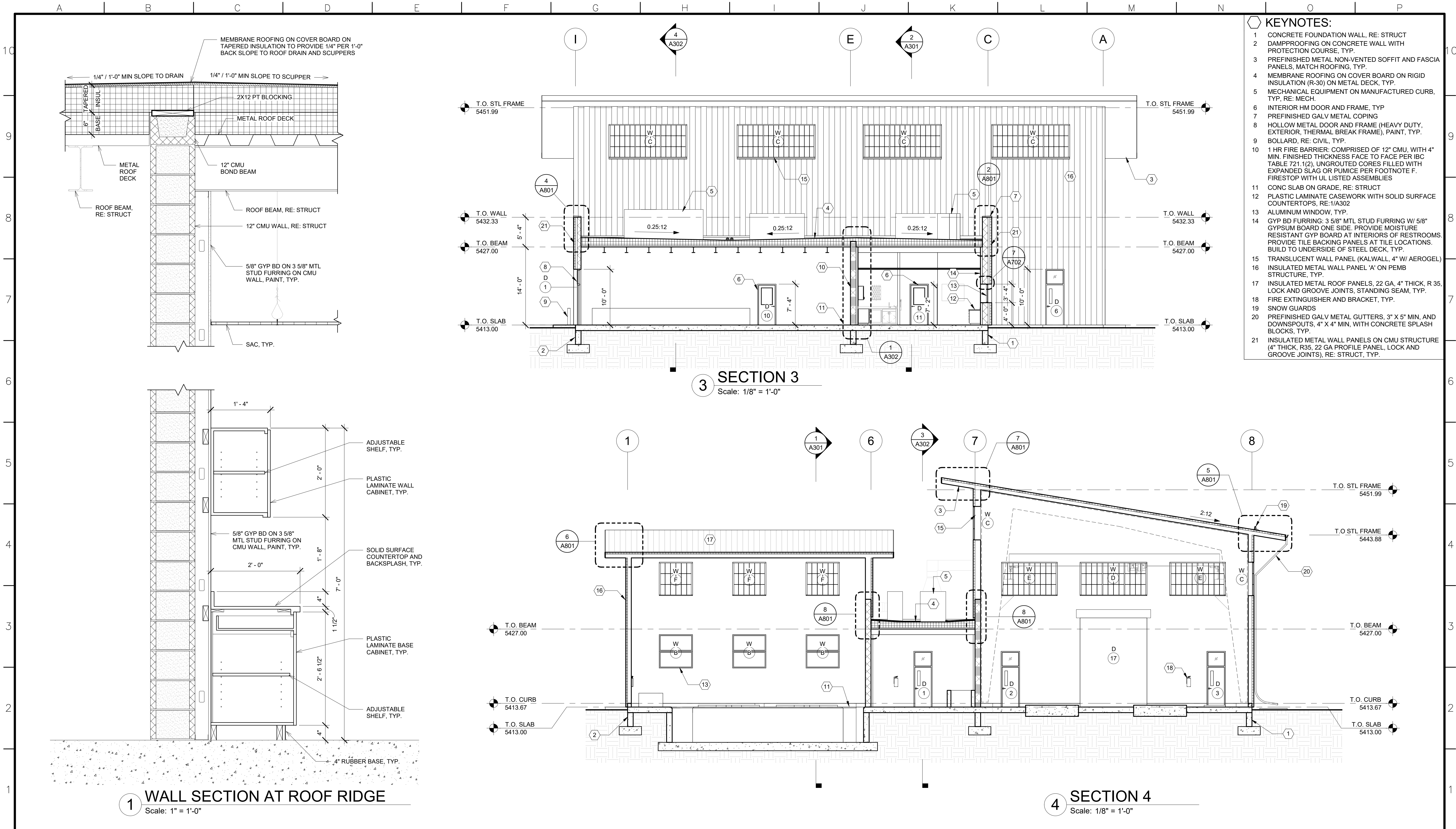
REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB

TOWN OF SILT
SILT, COLORADO

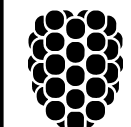
WATER TREATMENT PLANT

BUILDING SECTIONS 1

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A301



- KEYNOTES:**
- 1 CONCRETE FOUNDATION WALL, RE: STRUCT
 - 2 DAMPPROOFING ON CONCRETE WALL WITH PROTECTION COURSE, TYP
 - 3 PREFINISHED METAL NON-VENTED SOFFIT AND FASCIA PANELS, MATCH ROOFING, TYP.
 - 4 MEMBRANE ROOFING ON COVER BOARD ON RIGID INSULATION (R-30) ON METAL DECK, TYP.
 - 5 MECHANICAL EQUIPMENT ON MANUFACTURED CURB, TYP, RE: MECH.
 - 6 INTERIOR HM DOOR AND FRAME, TYP
 - 7 PREFINISHED GALV METAL COPING
 - 8 HOLLOW METAL DOOR AND FRAME (HEAVY DUTY, EXTERIOR, THERMAL BREAK FRAME), PAINT, TYP.
 - 9 BOLLARD, RE: CIVIL, TYP.
 - 10 1 HR FIRE BARRIER: COMPRISED OF 12" CMU, WITH 4" MIN. FINISHED THICKNESS FACE TO FACE PER IBC TABLE 721.1(2), UNGROUTED CORES FILLED WITH EXPANDED SLAG OR PUMICE PER FOOTNOTE F. FIRESTOP WITH UL LISTED ASSEMBLIES
 - 11 CONC SLAB ON GRADE, RE: STRUCT
 - 12 PLASTIC LAMINATE CASEWORK WITH SOLID SURFACE COUNTERTOPS, RE:1/A302
 - 13 ALUMINUM WINDOW, TYP.
 - 14 GYP BD FURRING: 3 5/8" MTL STUD FURRING W/ 5/8" GYPSUM BOARD ONE SIDE. PROVIDE MOISTURE RESISTANT GYP BOARD AT INTERIORS OF RESTROOMS. PROVIDE TILE BACKING PANELS AT TILE LOCATIONS. BUILD TO UNDERSIDE OF STEEL DECK, TYP.
 - 15 TRANSLUCENT WALL PANEL (KALWALL, 4" W/ AEROGEL)
 - 16 INSULATED METAL WALL PANEL 'A' ON PEMB STRUCTURE, TYP.
 - 17 INSULATED METAL ROOF PANELS, 22 GA, 4" THICK, R 35, LOCK AND GROOVE JOINTS, STANDING SEAM, TYP.
 - 18 FIRE EXTINGUISHER AND BRACKET, TYP.
 - 19 SNOW GUARDS
 - 20 PREFINISHED GALV METAL GUTTERS, 3" X 5" MIN. AND DOWNSPOUTS, 4" X 4" MIN, WITH CONCRETE SPLASH BLOCKS, TYP.
 - 21 INSULATED METAL WALL PANELS ON CMU STRUCTURE (4" THICK, R35, 22 GA PROFILE PANEL, LOCK AND GROOVE JOINTS), RE: STRUCT, TYP.

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DRAWN CC
DESIGNED SBA
CHECKED PB

APPROVED

PRINCIPAL

DATE:

REV. DESCRIPTION BY DATE APP.
C BUILDING DEPT REVIEW SUBMITTAL CC 10/13/23 PB

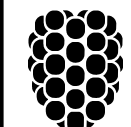
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT

BUILDING SECTIONS 2

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A302



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PRINCIPAL

DATE:

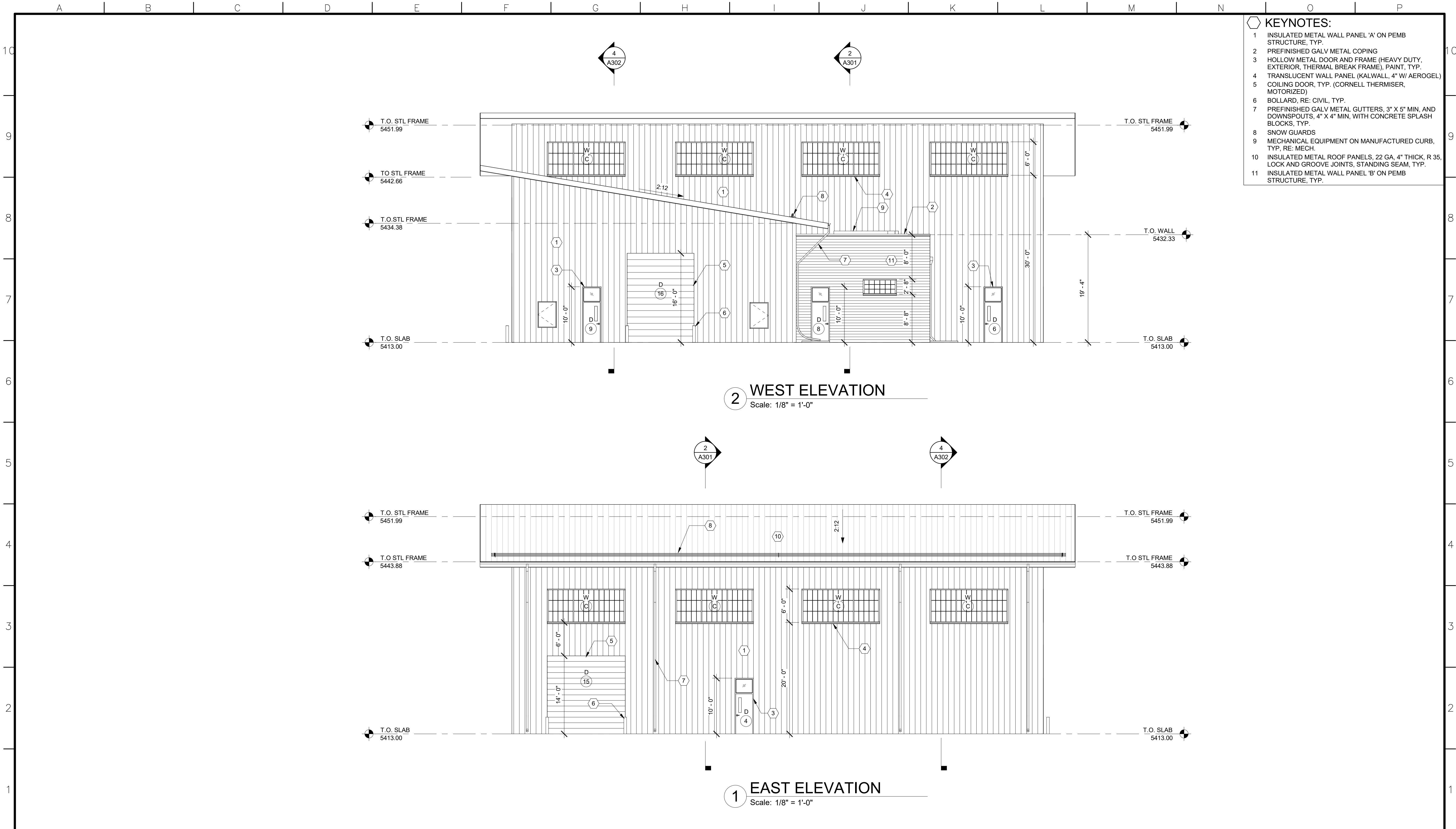
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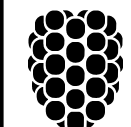
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT

BUILDING ELEVATIONS 1

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A401



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CHECKED PB

APPROVED

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB

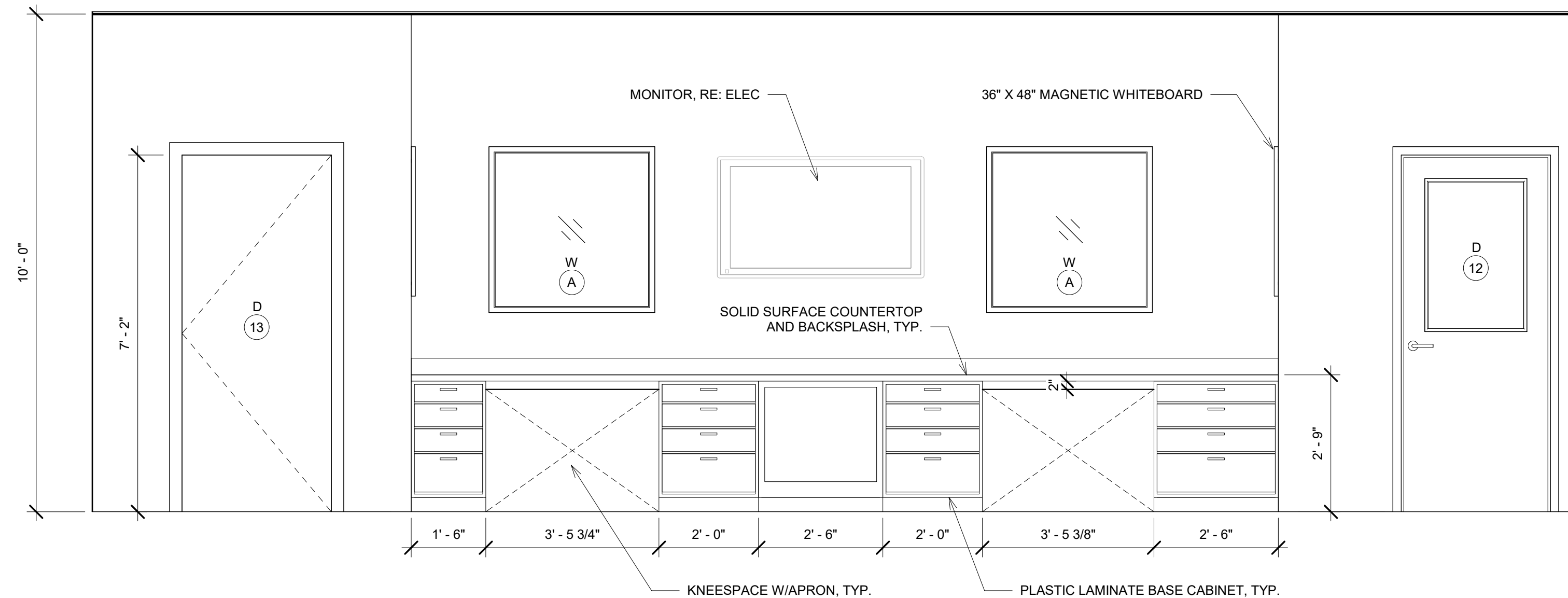
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT

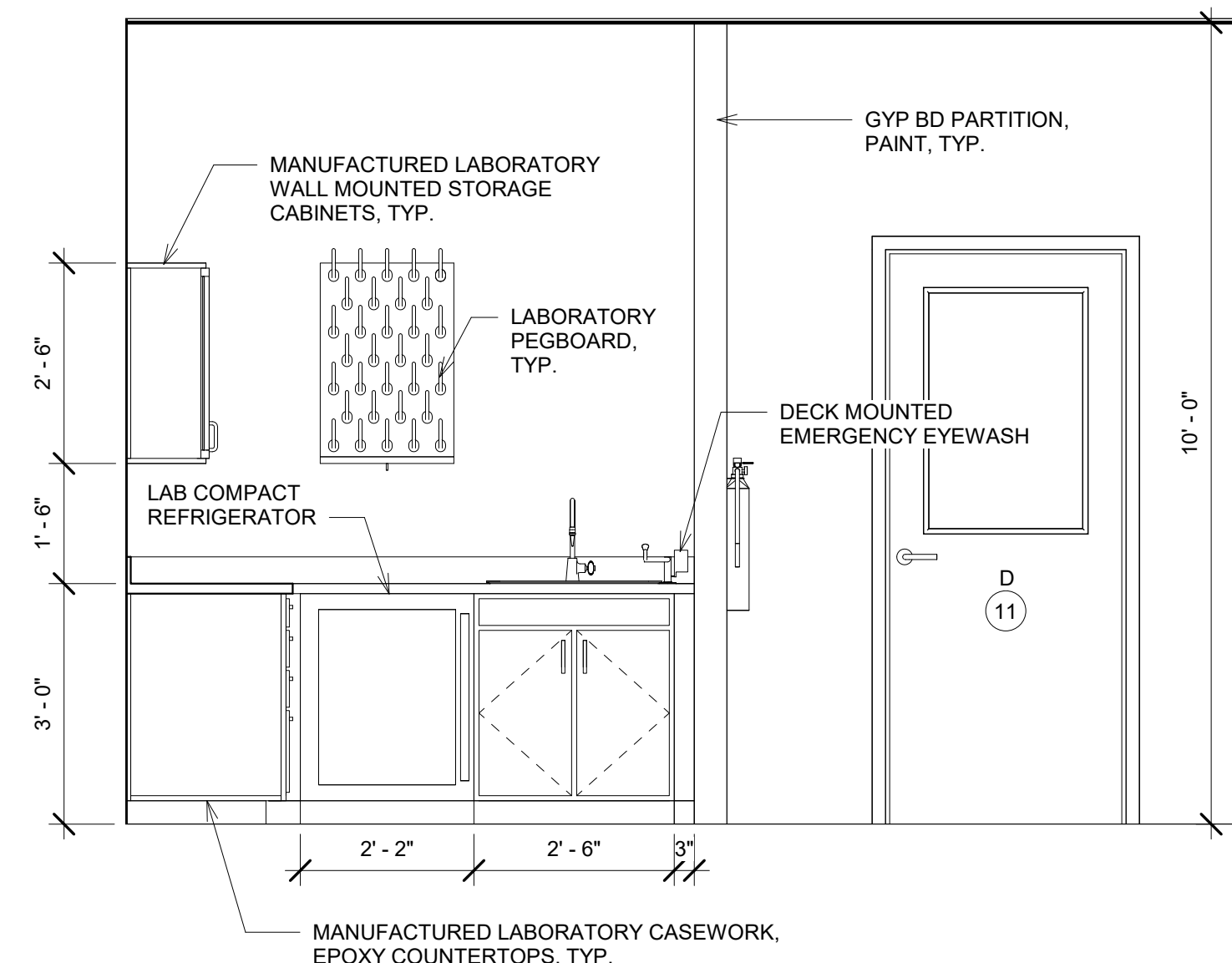
BUILDING ELEVATIONS 2

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A402

FINISH SCHEDULE																
#	NAME	FLOOR MATERIAL	FLOOR FINISH	BASE @ CMU	NORTH WALL		EAST WALL		SOUTH WALL		WEST WALL		CEILING		#	
					MATERIAL	FINISH	MATERIAL	FINISH	MATERIAL	FINISH	MATERIAL	FINISH	MATERIAL	HEIGHT		
1	CHEM	CONC	POL CONC	RUBBER	CMU	PAINT	CMU	PAINT	CMU	PAINT	CMU	PAINT	---	VARIES	1	
2	PROCESS	CONC	POL CONC	RUBBER	---	---	---	---	---	---	CMU	PAINT	---	VARIES	2	
3	ELEC	CONC	POL CONC	RUBBER	CMU	PAINT	CMU	PAINT	CMU	PAINT	CMU	PAINT	---	---	3	
4	BREAK RM	CONC	POL CONC	RUBBER	GYP BD	PAINT	GYP BD	PAINT	GYP BD	PAINT	CMU	PAINT	SAC	10'-0"	4	
5	VEST	CONC	POL CONC	RUBBER	GYP BD	PAINT	GYP BD	PAINT	GYP BD	PAINT	CMU	PAINT	GYP BD	10'-0"	5	
6	WC	CONC	POL CONC	S COVE	CWT	---	CWT	---	CWT	---	CWT	---	GYP BD	10'-0"	6	
7	LAB	CONC	POL CONC	RUBBER	GYP BD	PAINT	GYP BD	PAINT	GYP BD	PAINT	GYP BD	PAINT	SAC	10'-0"	7	



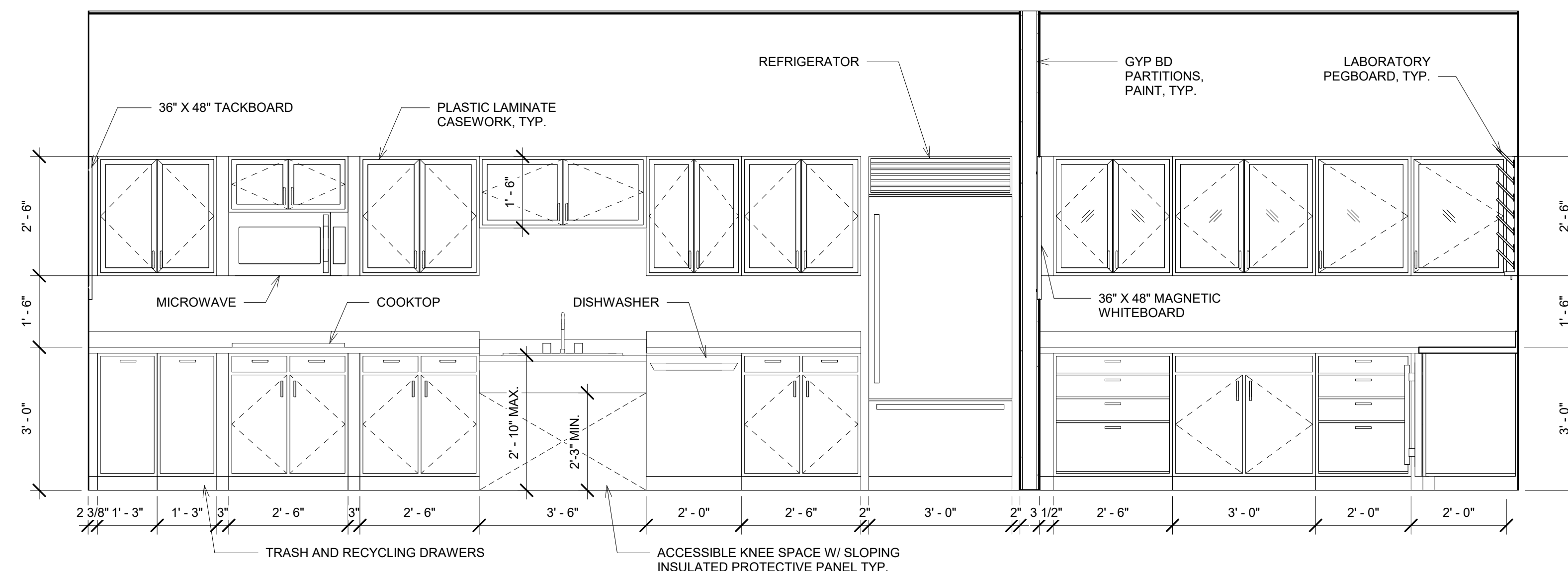
5 SOUTH BREAK ROOM
Scale: 1/2" = 1'-0"



4 EAST LAB
Scale: 1/2" = 1'-0"

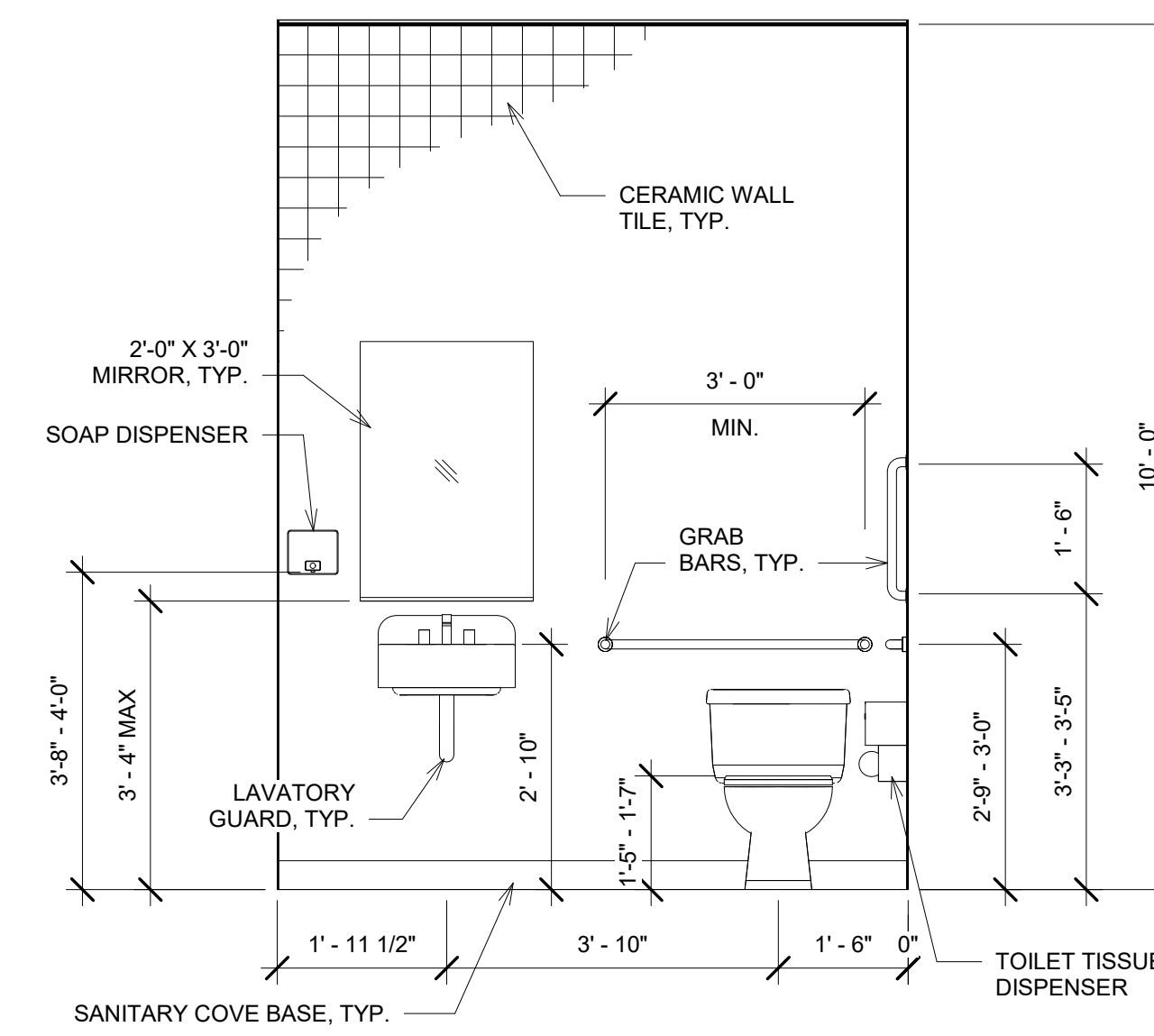
FINISH SCHEDULE ABBREVIATIONS

GYP BD	GYPSUM BOARD
MR GYP BD	MOISTURE RESISTANT GYP BD
CWT	CERAMIC WALL TILE
SAC	SUSPENDED ACOUSTICAL CEILING
POL CONC	POLISHED CONCRETE
S COVE	SANITARY COVE



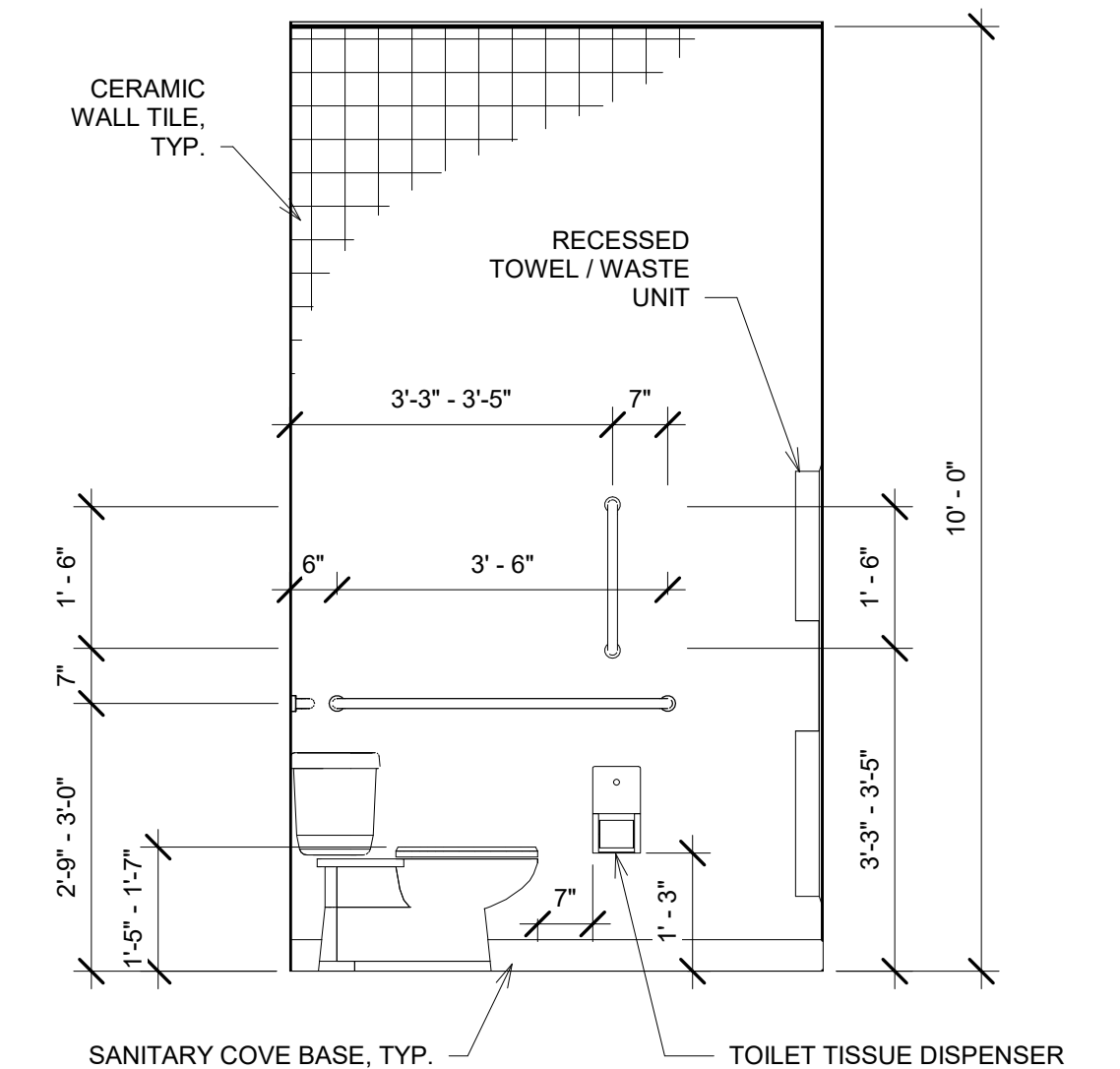
3 NORTH BREAK ROOM & LAB

Scale: 1/2" = 1'-0"




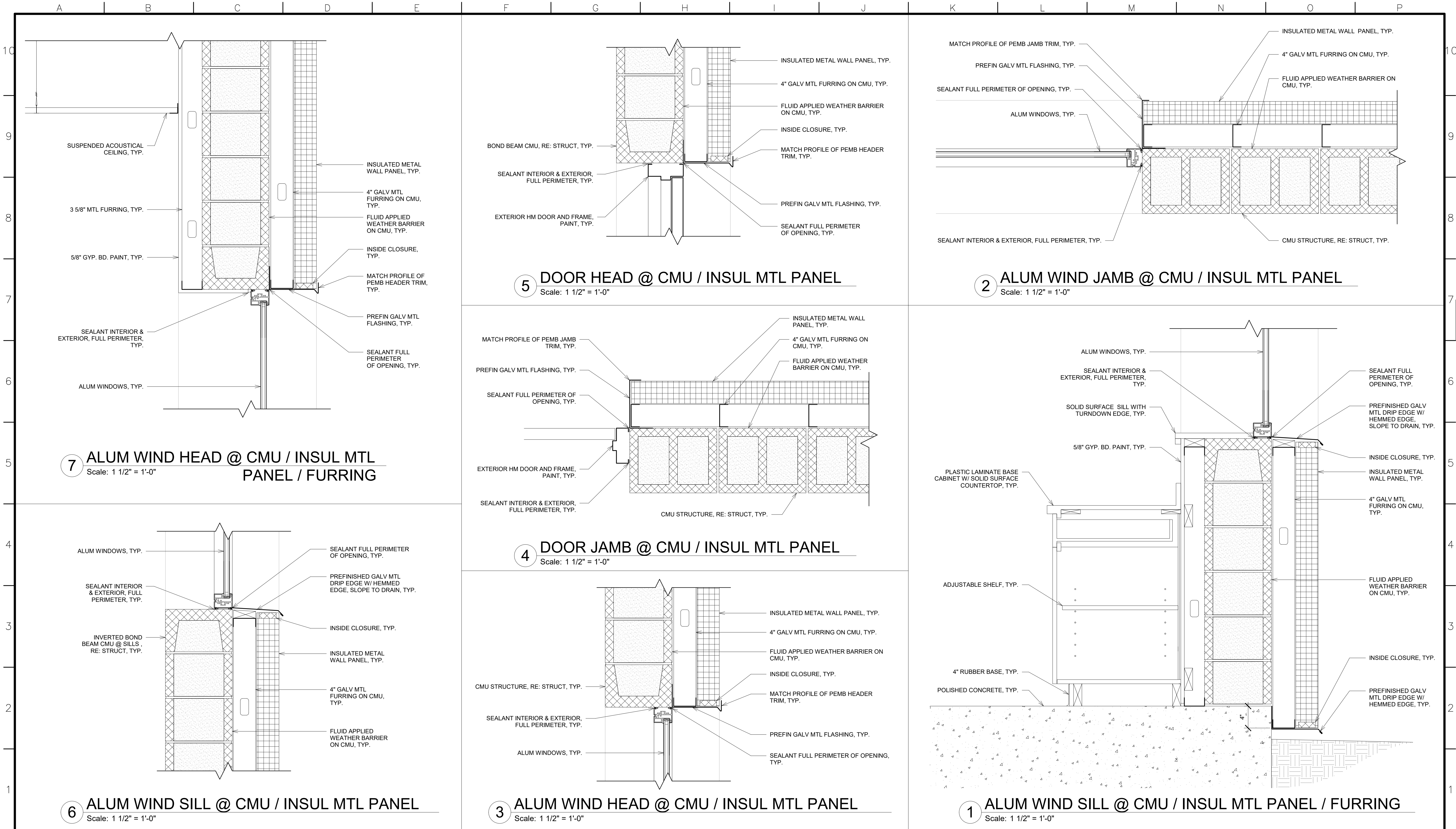
2 EAST WC ELEVATION

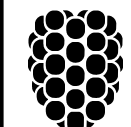
Scale: 1/2" = 1'-0"



1 SOUTH WC ELEVATION

 Dewberry [®] Dewberry Engineers Inc. 990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825-1802	LINE IS 2 INCHES AT FULL SIZE ((IF NOT 2"=SCALE, ACCORDINGLY))	APPROVED _____ PRINCIPAL _____ DATE:	<table border="1"> <thead> <tr> <th colspan="5">REVISIONS</th> </tr> <tr> <th>REV.</th> <th>DESCRIPTION</th> <th>BY</th> <th>DATE</th> <th>APP.</th> </tr> </thead> <tbody> <tr> <td>C</td> <td>BUILDING DEPT REVIEW SUBMITTAL</td> <td>CC</td> <td>10/13/23</td> <td>PB</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>	REVISIONS					REV.	DESCRIPTION	BY	DATE	APP.	C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB																															TOWN OF SILT SILT, COLORADO	INTERIOR ELEVATIONS	DATE: 10/13/23 PROJECT NUMBER: 50159690 REVISION NO. DRAWING NUMBER A501
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C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB																																															
DRAWING _____ DRAWN _____ CC DESIGNED _____ SBA CHECKED _____ PB	WATER TREATMENT PLANT																																																		





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DRAWING

DRAWN Author

DESIGNED Designer

CHECKED Checker

APPROVED

PRINCIPAL

DATE:

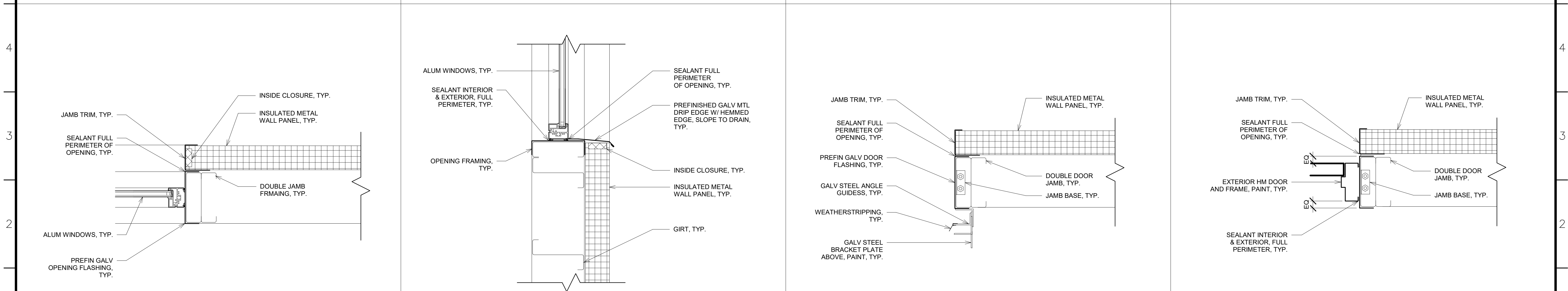
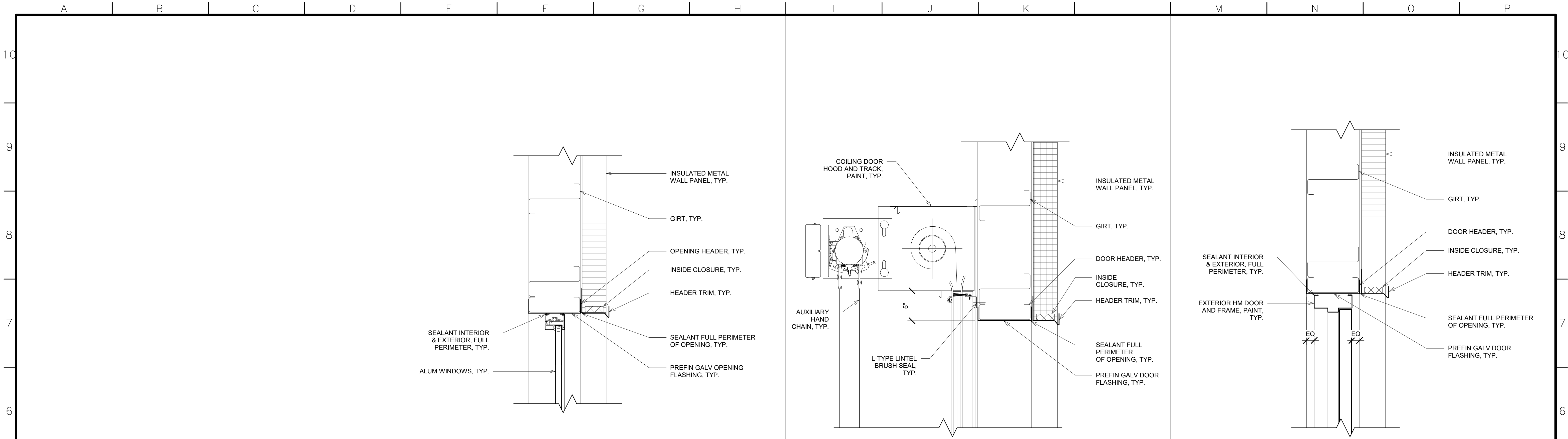
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C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB


TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT

DOOR AND WINDOW DETAILS AT CMU

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A702





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DATE: _____

REVISIONS

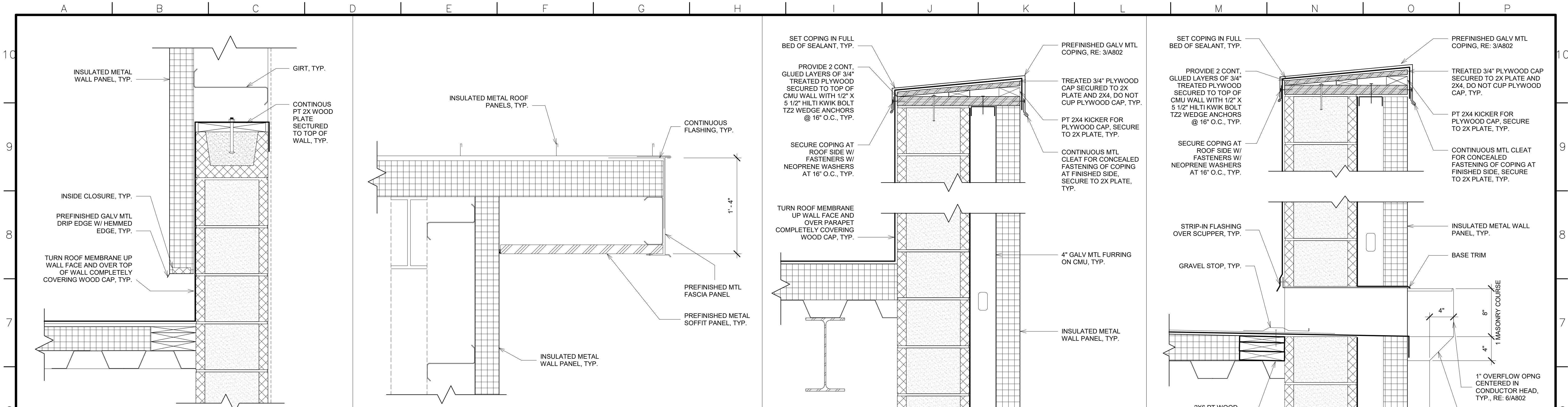
REV.	DESCRIPTION	BY	DATE	APP.
C	BUILDING DEPT REVIEW SUBMITTAL	CC	10/13/23	PB

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT

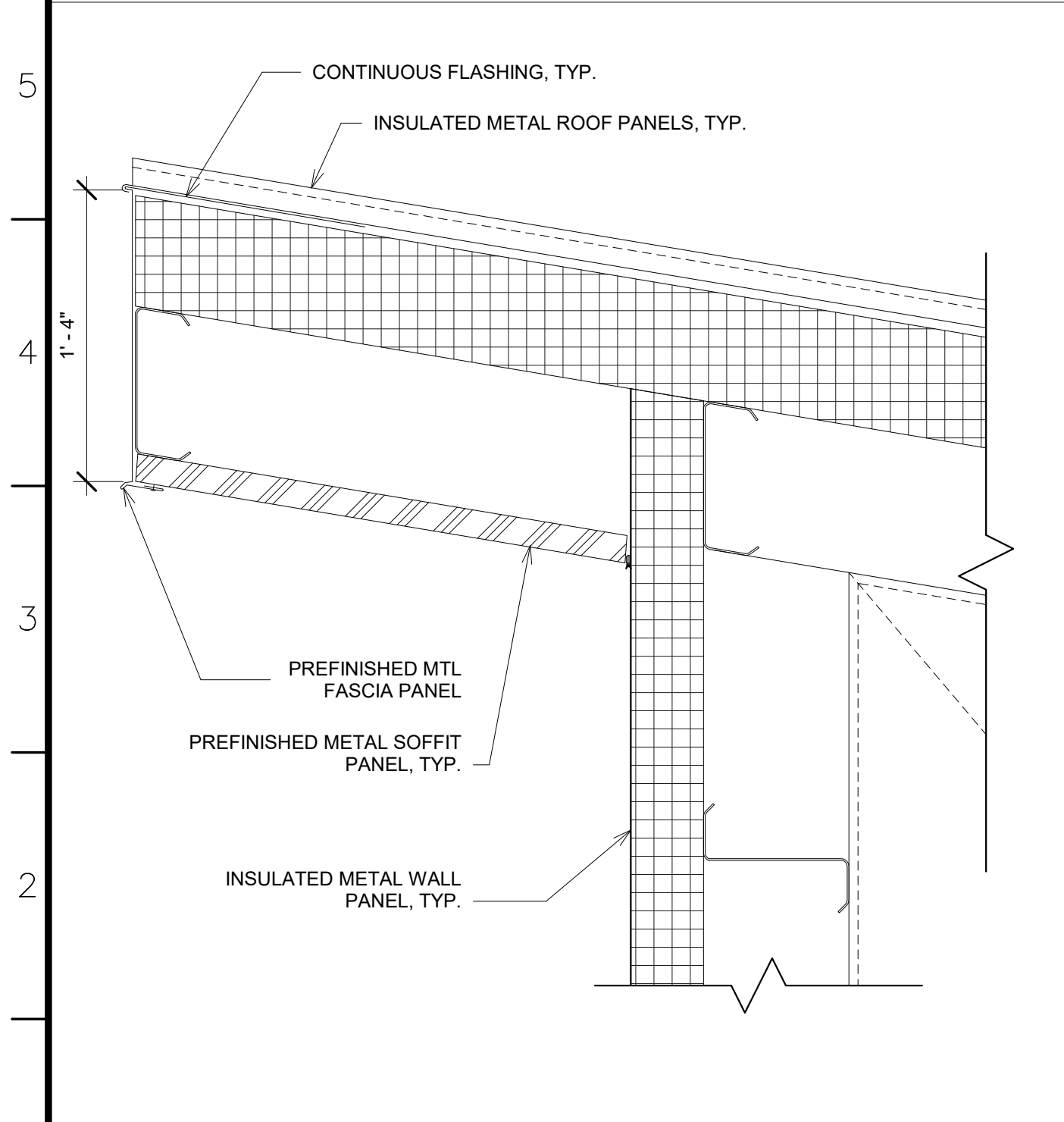
DOOR AND WINDOW DETAILS AT PEMB

DATE: 10/13/23
PROJECT NUMBER:50159690
REVISION NO.
DRAWING NUMBER
A703

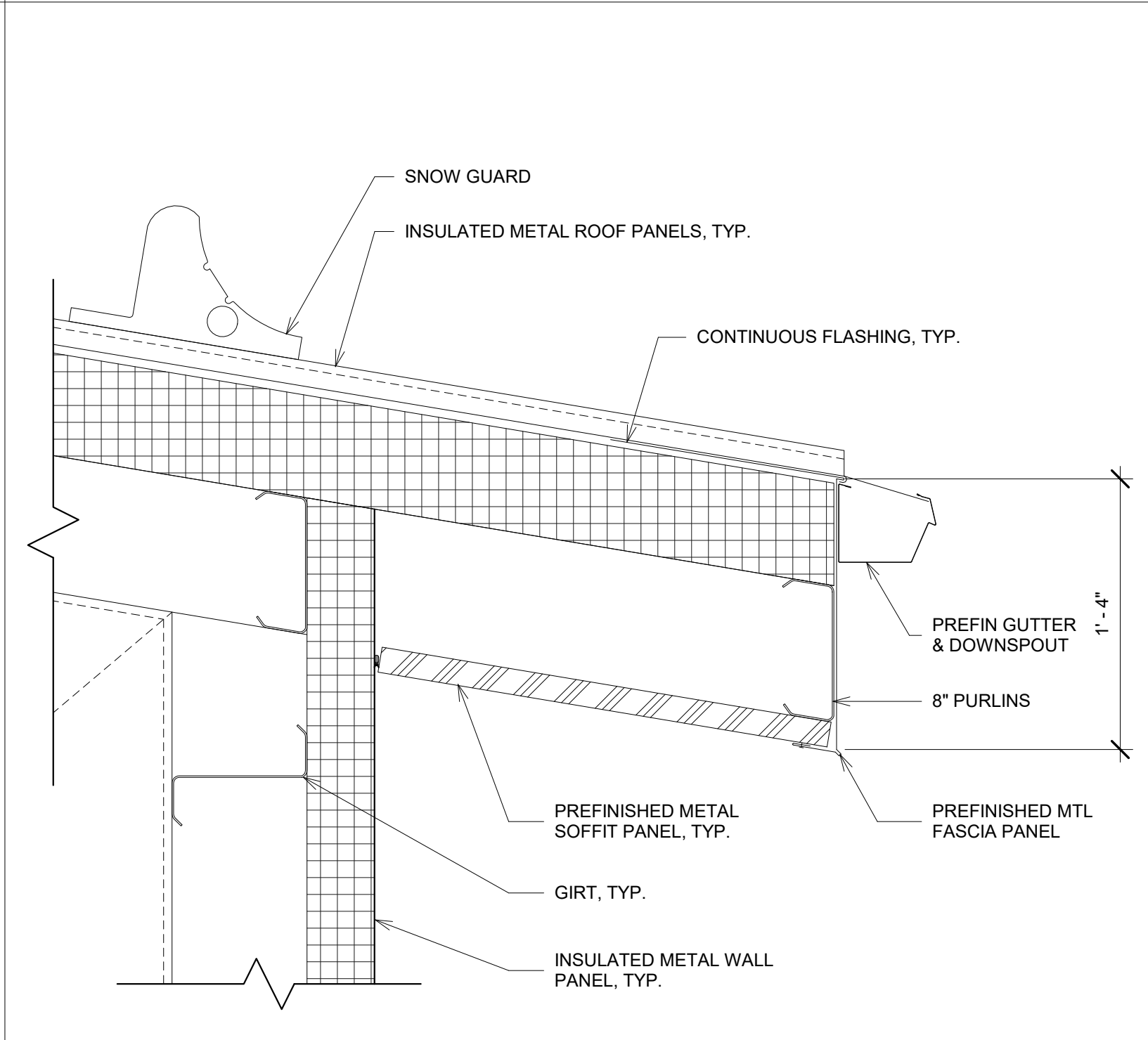


8 PARAPET @ MTL
Scale: 1 1/2" = 1'-0"

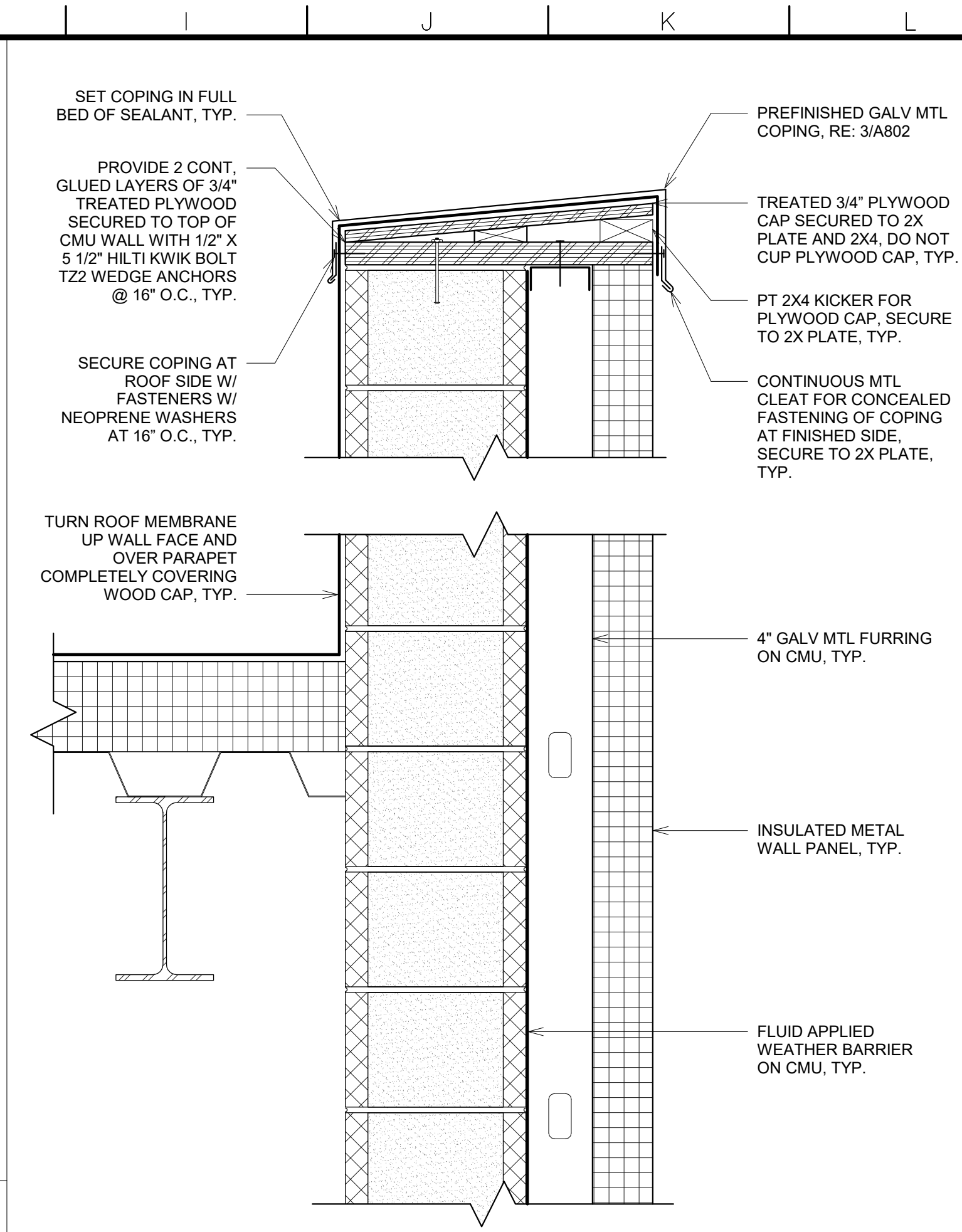
6 ROOF RAKE
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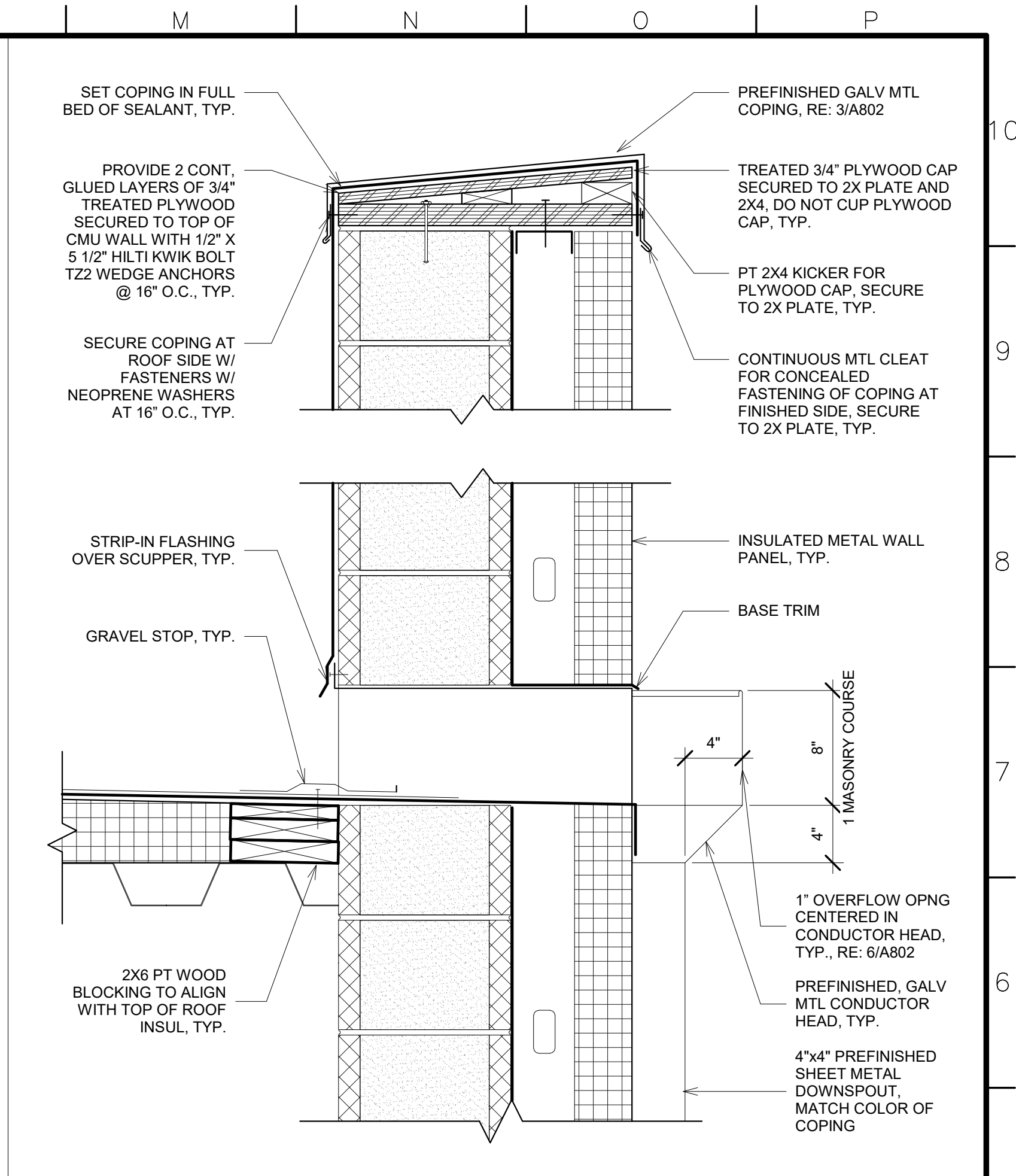
7 HIGH EAVE
Scale: 1 1/2" = 1'-0"



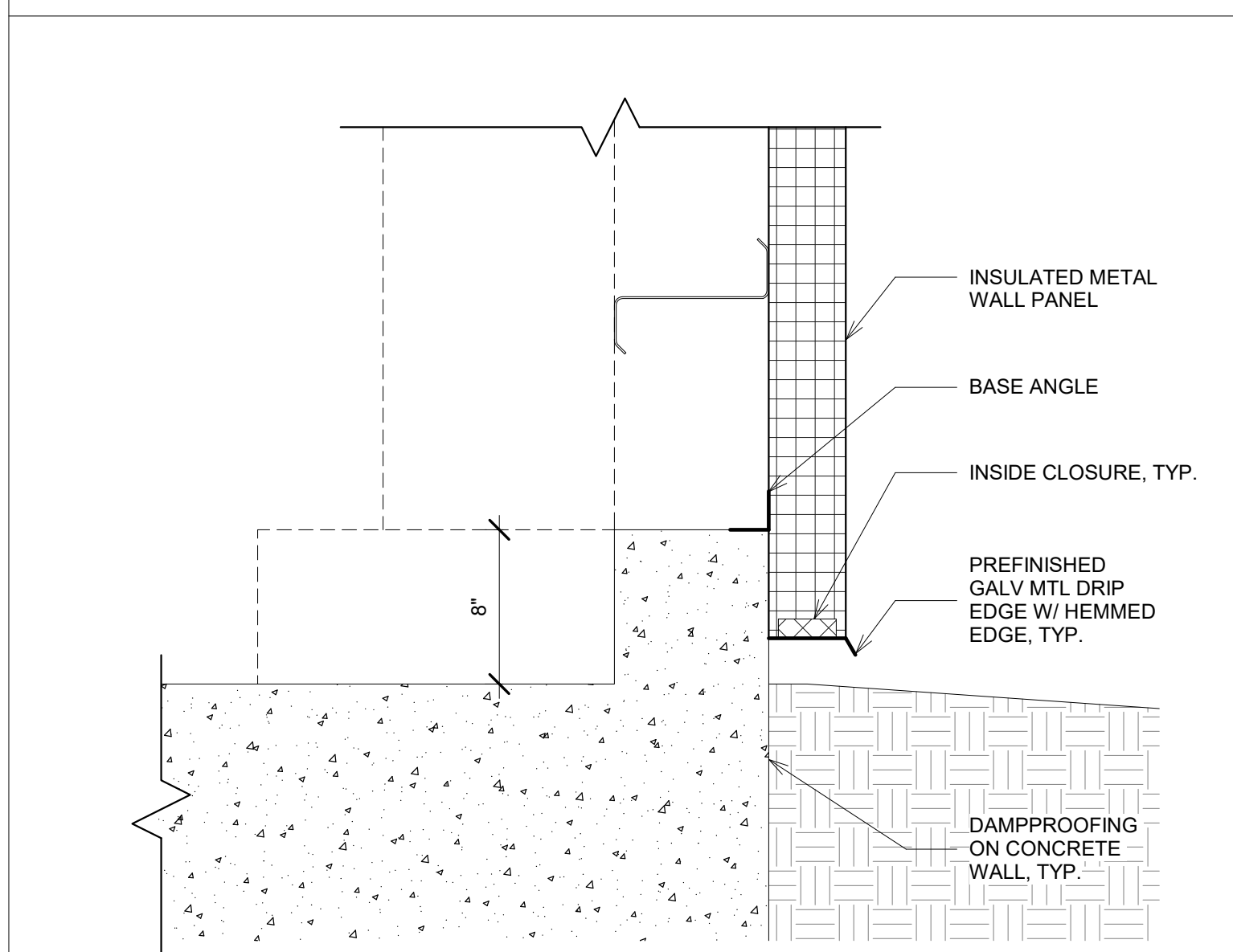
5 LOW EAVE
Scale: 1 1/2" = 1'-0"



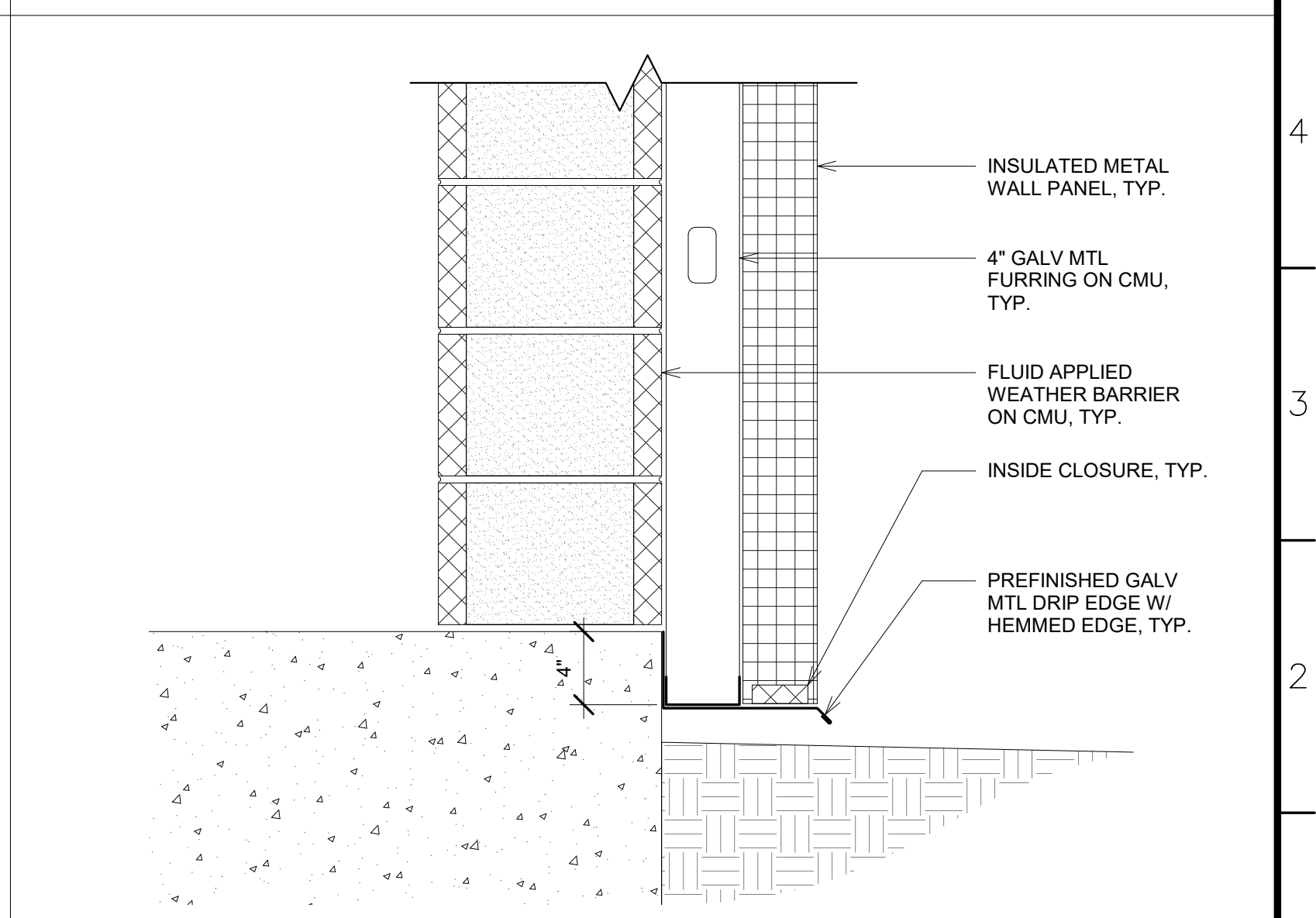
4 PARAPET
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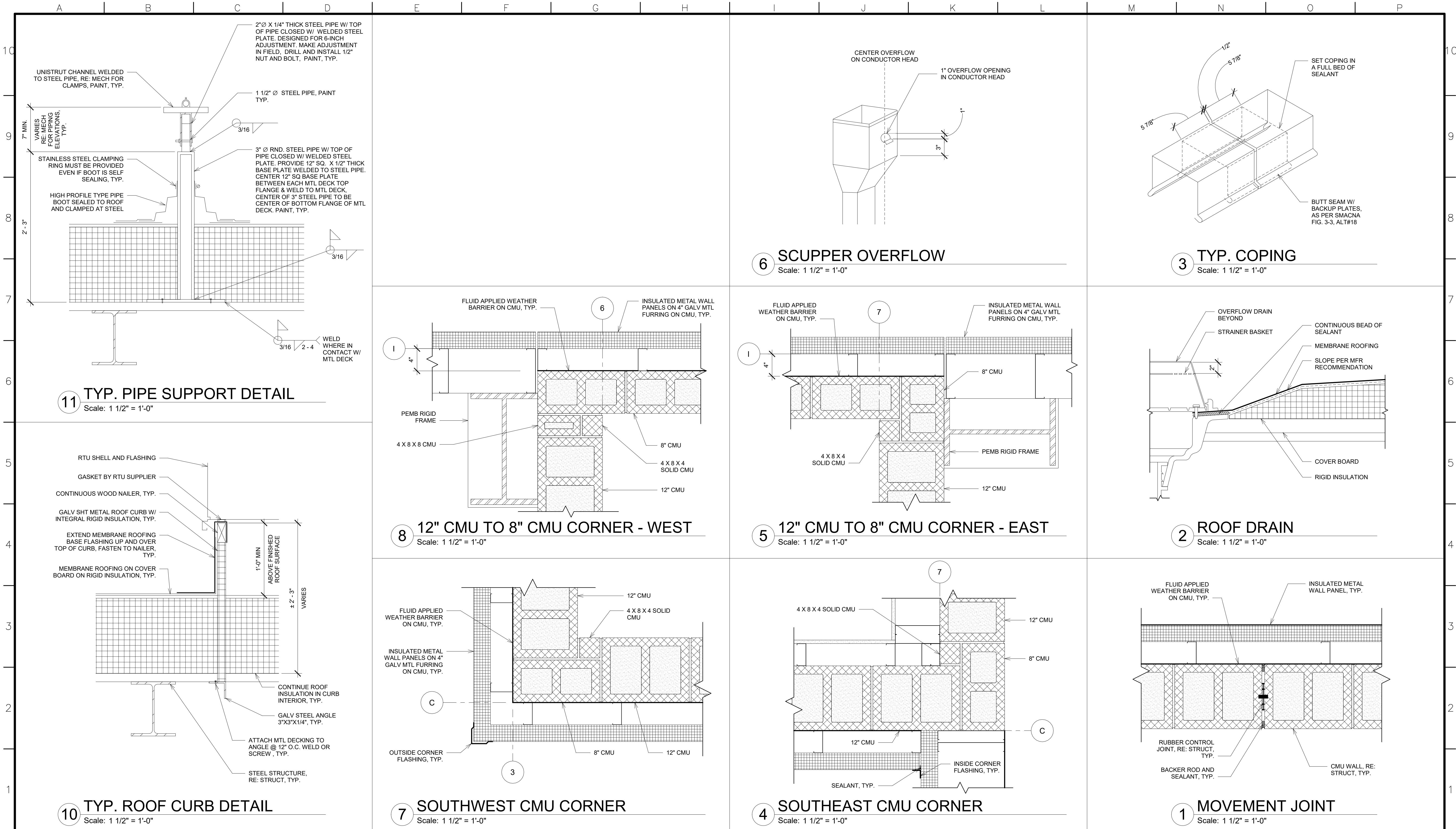
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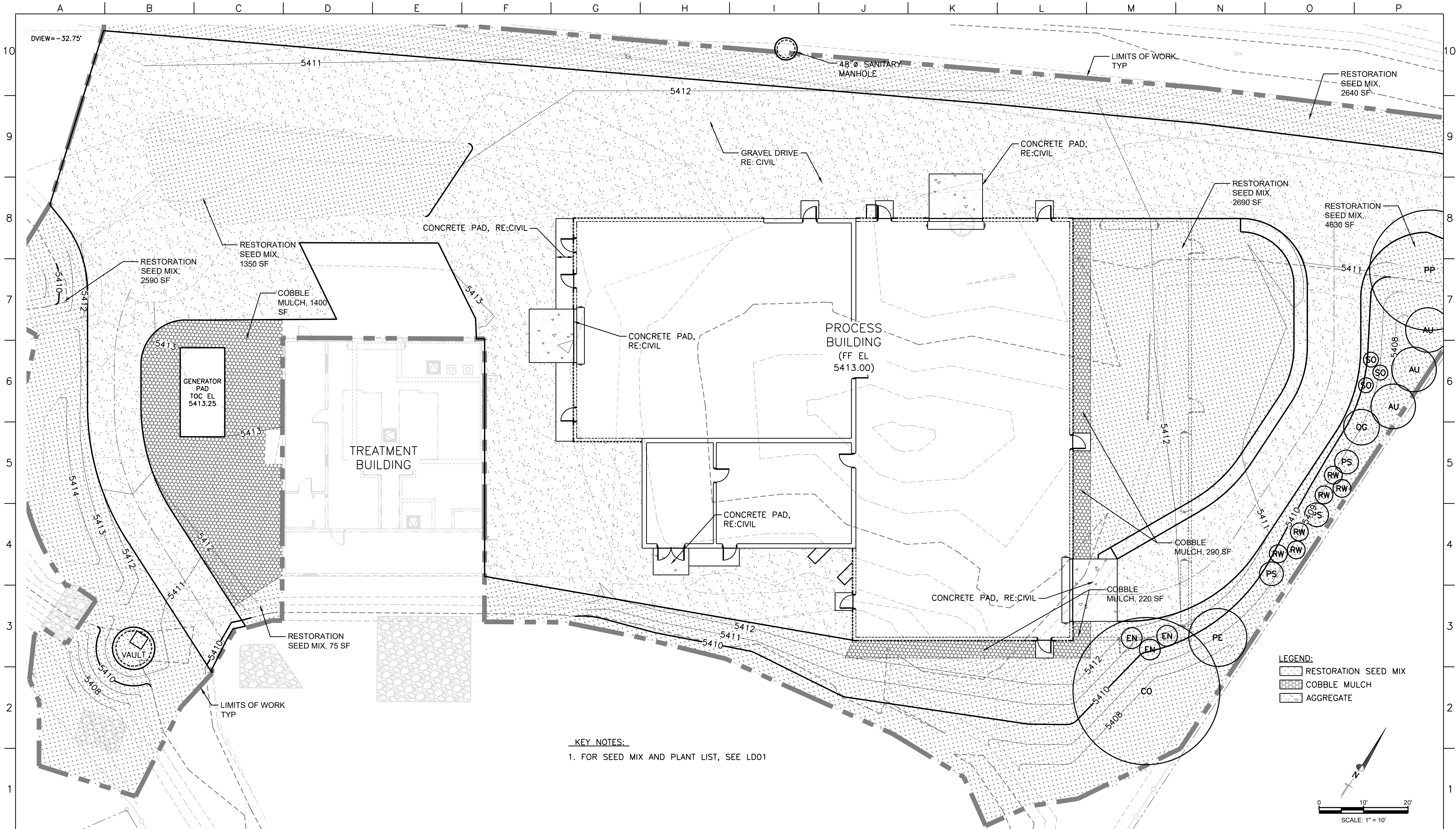


3 PEMB WALL BASE
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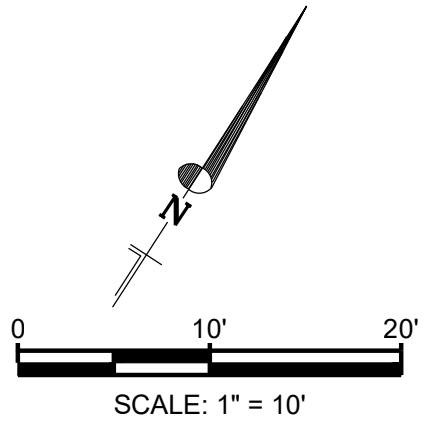
1 CMU WALL BASE
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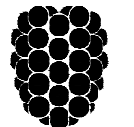




KEY NOTES:
1. FOR SEED MIX AND PLANT LIST, SEE LD01

- LEGEND:
- RESTORATION SEED MIX
 - COBBLE MULCH
 - AGGREGATE





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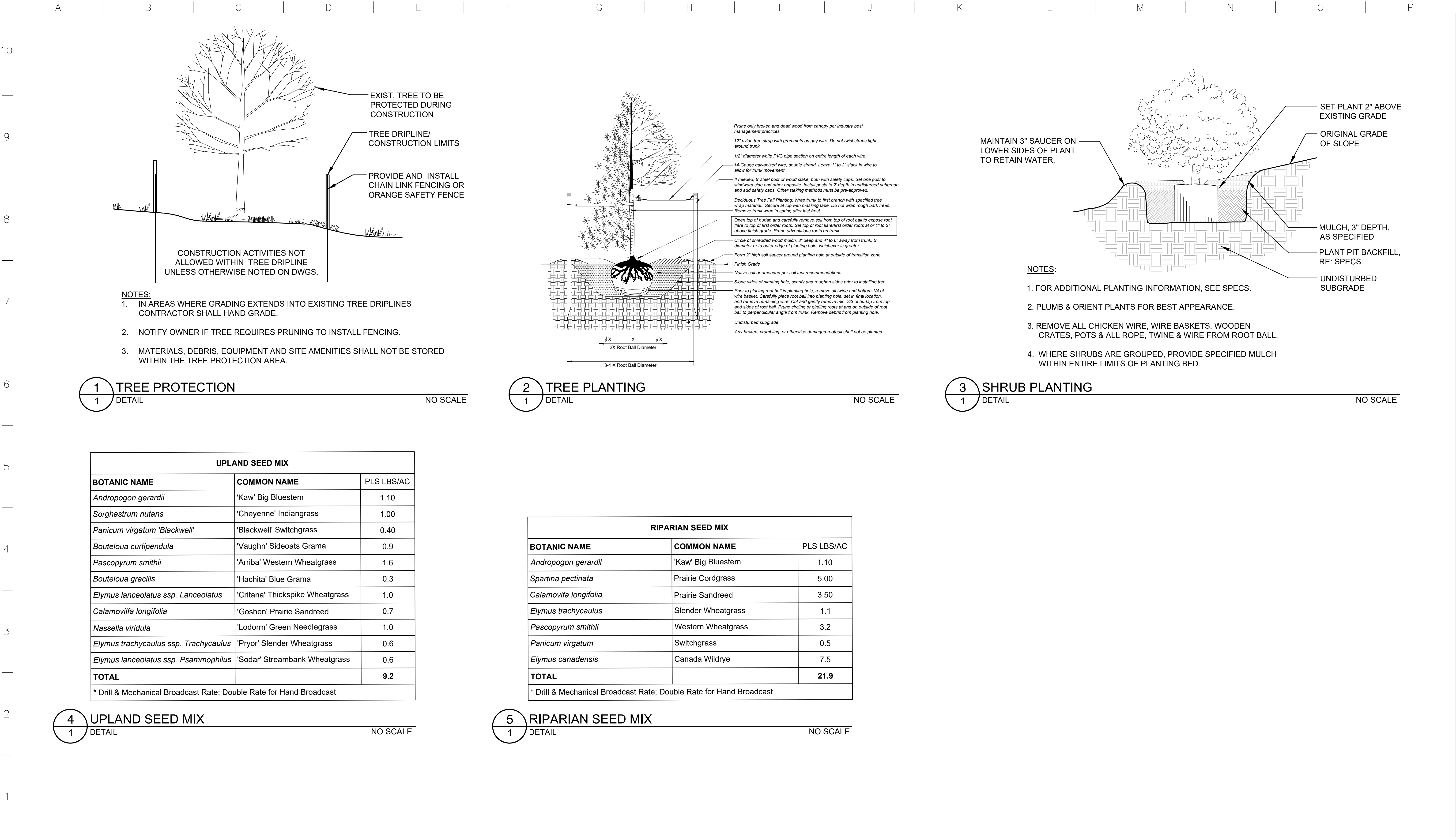
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REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	BP	7/31/23	BG
B	BUILDING DEPT REVIEW SUBMITTAL	BP	10/13/23	BG

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

LANDSCAPE PLAN
LANDSCAPE

DATE: 07/31/2023
PROJECT NUMBER: 50159690
REVISION NO. A
DRAWING NUMBER L-01
SHEET NUMBER



UPLAND SEED MIX		
BOTANIC NAME	COMMON NAME	PLS LBS/AC
<i>Andropogon gerardii</i>	'Kaw' Big Bluestem	1.10
<i>Sorghastrum nutans</i>	'Cheyenne' Indiangrass	1.00
<i>Panicum virgatum 'Blackwell'</i>	'Blackwell' Switchgrass	0.40
<i>Bouteloua curtipendula</i>	'Vaughn' Sideoats Grama	0.9
<i>Pascopyrum smithii</i>	'Arriba' Western Wheatgrass	1.6
<i>Bouteloua gracilis</i>	'Hachita' Blue Grama	0.3
<i>Elymus lanceolatus ssp. Lanceolatus</i>	'Critana' Thickspike Wheatgrass	1.0
<i>Calamoviſa longifolia</i>	'Goshen' Prairie Sandreed	0.7
<i>Nassella viridula</i>	'Lodorm' Green Needlegrass	1.0
<i>Elymus trachycaulus ssp. Trachycaulus</i>	'Pryor' Slender Wheatgrass	0.6
<i>Elymus lanceolatus ssp. Psammophilus</i>	'Sodar' Streambank Wheatgrass	0.6
TOTAL		9.2
* Drill & Mechanical Broadcast Rate; Double Rate for Hand Broadcast		

RIPARIAN SEED MIX		
BOTANIC NAME	COMMON NAME	PLS LBS/AC
<i>Andropogon gerardii</i>	'Kaw' Big Bluestem	1.10
<i>Spartina pectinata</i>	Prairie Cordgrass	5.00
<i>Calamoviſa longifolia</i>	Prairie Sandreed	3.50
<i>Elymus trachycaulus</i>	Slender Wheatgrass	1.1
<i>Pascopyrum smithii</i>	Western Wheatgrass	3.2
<i>Panicum virgatum</i>	Switchgrass	0.5
<i>Elymus canadensis</i>	Canada Wildrye	7.5
TOTAL		21.9
* Drill & Mechanical Broadcast Rate; Double Rate for Hand Broadcast		

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	BP	7/31/23	BG
B	BUILDING DEPT REVIEW SUBMITTAL	BP	10/13/23	BG

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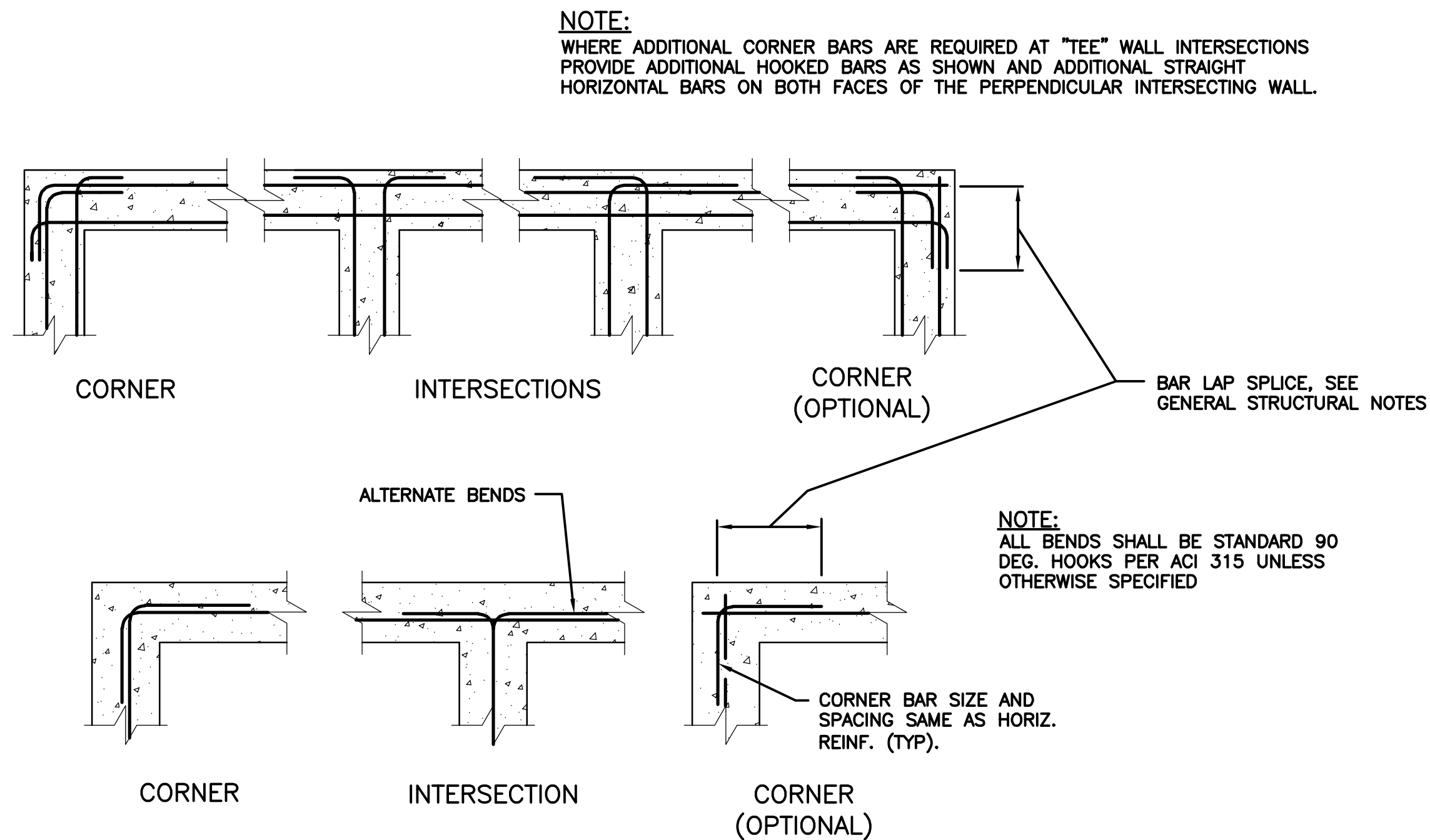
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GENERAL		CONCRETE		MODIFICATION OF EXISTING CONCRETE																																																			
G1.	SCOPE THESE NOTES ARE GENERAL AND APPLY TO THE ENTIRE PROJECT EXCEPT WHERE THERE ARE SPECIFIC INDICATIONS TO THE CONTRARY.	C1.	APPLICABLE CODE CONCRETE CONSTRUCTION SHALL CONFORM TO THE LATEST EDITION OF THE ACI 301 SPECIFICATIONS FOR BUILDINGS, AND ACI 350 ENVIRONMENTAL STRUCTURES.	C11.	SLOPING SLABS MONOLITHIC SLABS WITH TOPS THAT ARE SLOPED SHALL HAVE BOTTOMS SLOPED THE SAME AMOUNT, MAINTAINING A UNIFORM SLAB THICKNESS, UNLESS OTHERWISE SHOWN.	M1.	SCOPE THE FOLLOWING NOTES ON MODIFICATION OF EXISTING CONCRETE ARE GENERAL AND APPLY TO THE ENTIRE PROJECT EXCEPT WHERE THERE ARE SPECIFIC INDICATIONS TO THE CONTRARY.																																																
G2.	APPLICABLE SPECIFICATIONS AND CODES CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE 2012 EDITION OF THE IBC. THE ABOVE SHALL GOVERN EXCEPT WHERE OTHER APPLICABLE CODES OR THE FOLLOWING NOTES ARE MORE RESTRICTIVE.	C2.	REINFORCING STEEL DETAILS ALL DETAILING, FABRICATION, AND ERECTION OF REINFORCING BARS, UNLESS OTHERWISE NOTED SHALL BE IN ACCORDANCE WITH MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES (ACI–315), LATEST EDITION.	C12.	GROUND SUPPORTED SLABS CONCRETE SLABS SUPPORTED BY GROUND, UNLESS OTHERWISE NOTED, SHALL BE 4" THICK REINFORCED WITH 4x4–6/6 WWF AT MID–DEPTH OF SLAB AND DOWELED ALONG THE EDGE OF SLAB TO ALL ADJACENT WALLS, COLUMNS, AND FOUNDATIONS WITH #4 DOWELS X 2’–0" THAT LAP 1’–0" WITH WWF AND EXTEND INTO WALLS, COLUMNS, AND FOUNDATIONS AT LEAST 9". IF SLAB IS DESIGNATED AS "ISOLATED SLAB" ON DRAWINGS, OMIT DOWELS AND SUBSTITUTE 3/8" THICK PREFORMED CLOSED CELL FOAM JOINT FILLER TO ISOLATE THE SLAB FROM CONTACT WITH THE STRUCTURE ALONG ITS PERIMETER. (SEE STRUCTURAL DRAWINGS)	M2.	TIE TO EXISTING STRUCTURE WHERE "TIE TO EXISTING STRUCTURE" IS INDICATED, CON–TRACTOR SHALL STRAIGHTEN AND SANDBLAST DOWELS AND WELD SPLICE WITH NEW REINFORCEMENT AS DETAILED ON THE DRAWINGS OR AS DIRECTED BY THE OWNER, OR SHALL PRO–VIDE DOWELS AS INDICATED ON THE DRAWINGS.																																																
G3.	ALTERNATIVE DESIGNS THE STRUCTURAL SYSTEMS AND DETAILS ON THESE PLANS ARE THE PRIORITY DESIGN. ALTERNATIVE SYSTEMS AND DETAILS MAY BE USED IF THE CONTRACTOR SUBMITS PLANS WITH SUBSTANTIATING CALCULATIONS AND TEST DATA, AND IF THE ALTERNATIVE PLANS ARE ACCEPTED BY THE CONSTRUCTION MANAGER AND OWNER.	C3.	DESIGN STRENGTHS A. CONCRETE, Fc = 4000 PSI ULTIMATE COMPRESSIVE STRESS AT 28 DAYS AND AS OTHERWISE SPECIFIED. B. REINFORCING STEEL, ASTM A615, GR.60, EXCEPT FOR TIES, STIRRUPS, AND BARS NOTED ON DRAWINGS TO BE FIELD BENT, WHICH SHALL BE GRADE 40. BARS TO BE WELDED SHALL BE ASTM A706.	C13.	CHAMFERS EXCEPT AS OTHERWISE REQUIRED, EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE 3/4" CHAMFERS. RE–ENTRANT CORNERS SHALL NOT HAVE FILLETS.	M3.	JOINT PREPARATION EXISTING CONCRETE SURFACES TO BE JOINED WITH NEW CONCRETE SHALL BE THOROUGHLY CLEANED BY SANDBLASTING AND COATED WITH BONDING COMPOUND JUST PRIOR TO PLACEMENT OF NEW CONCRETE.																																																
G4.	DIMENSIONS STRUCTURAL DIMENSIONS CONTROLLED BY OR RELATED TO MECHANICAL OR ELECTRICAL EQUIPMENT SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.	C4.	CONCRETE COVER CONCRETE COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS WITH MINIMUM COVER OF ONE BAR DIAMETER.	C14.	ANCHOR BOLTS USE OF ANCHOR BOLTS SHALL BE IN ACCORDANCE WITH DETAIL 1/S–3.	M4.	JOINT TREATMENT SURFACES EXPOSED TO VIEW SHALL BE NEATLY SAW CUT TO A DEPTH OF 1/2" PRIOR TO REMOVING THE EXISTING CONCRETE UNLESS NOTED OTHERWISE IN THE DRAWINGS. HIDDEN SURFACES SHALL RECEIVE A TOOLED JOINT BETWEEN NEW AND EXISTING CONCRETE.																																																
G5.	PROVISIONS FOR EQUIPMENT DETAILS OF MECHANICAL AND ELECTRICAL EQUIPMENT SUPPORTS, ANCHORAGES, OPENINGS, RECESSES, PIPING, AND EMBEDMENTS NOT SHOWN ON THE STRUCTURAL DRAWINGS BUT REQUIRED BY OTHER CONTRACT DRAWINGS SHALL BE PROVIDED PRIOR TO CASTING CONCRETE.	C5.	MINIMUM REINFORCEMENT CONCRETE CONSTRUCTION SHALL BE REINFORCED CONCRETE EXCEPT WHERE PLAIN CONCRETE IS INDICATED ON THE DRAWINGS. UNLESS OTHERWISE NOTED, MINIMUM TEMPERA–TURE AND SHRINKAGE STEEL SHALL BE PROVIDED IN ACCORDANCE WITH ACI–350, LATEST REVISION.	PRECAST CONCRETE		M5.	DOWELING DOWELS SHALL BE GROUTED BY COATING THE DRILLED HOLES AND DOWELS WITH EPOXY BONDING COMPOUND AND INSERTING THE DOWELS INTO THE HOLES. EPOXY GROUT SHALL BE FORCED INTO HOLES TO FILL THE VOIDS. SEE DETAIL 1/S–3 AND SPECIFICATIONS. HOLES SHALL BE BLOWN OUT PRIOR TO PLACING EPOXY																																																
G6.	CONSTRUCTION LOADS STRUCTURES HAVE BEEN DESIGNED FOR OPERATIONAL LOADS ON COMPLETED STRUCTURES. DURING CONSTRUCTION, STRUCTURES SHALL BE PROTECTED BY BRACING AND SHORING WHEREVER EXCESSIVE LOADS MAY OCCUR.	C6.	ADDED TOP STEEL IN SLABS, EXCEPT AS NOTED ON DRAWINGS WHERE BEAMS OR WALLS ARE PARALLEL TO MAIN REINFORCING IN SLAB, PROVIDE #4 AT 18" TOP OF SLAB NORMAL TO BEAM OR WALL, AND EXTEND BARS 2’–0" BEYOND FACE OF BEAM OR WALL WHEN SLAB IS ON ONE SIDE ONLY, TERMINATE BARS WITH STANDARD HOOK ON SIDE AWAY FROM SLAB.	PC1. DESIGN ALL PRECAST CONCRETE MEMBERS SHALL BE DESIGNED BY THE PRECAST SUPPLIER TO SATISFY THE REQUIREMENTS SHOWN ON THE DRAWINGS, AND LOADS IMPOSED BY TRANSPORT AND PLACEMENT		M6.	WATERSTOPS WHERE WATERSTOP BETWEEN NEW AND EXISTING CONCRETE IS REQUIRED, CONTRACTOR SHALL PREPARE SMOOTH CONCRETE SURFACE AND APPLY PREFORMED HYDROPHILIC WATERSTOP IN ACCORDANCE WITH WATERSTOP MANUFACTURER'S RECOMMENDATIONS.																																																
G7.	DESIGN LIVE LOADS A. FLOOR AREAS: 1. PUMP STATION FLOORS – 250 PSF 2. MCC FLOORS – 200 PSF (PLUS MCC LOADS, OR 350 PSF WHICHEVER IS GREATER) 3. MAIN LEVEL EXTERIOR SLAB ON GRADE AREAS – 250 PSF 4. MECHANICAL EQUIPMENT ROOMS – 250 PSF 5. SIDEWALKS – 250 PSF B. GRATINGS, CHECKER PLATES, AND HATCHES – SAME LOADINGS AS ADJACENT FLOOR AREAS C. STAIRS – 150 PSF D. WALKWAYS – 150 PSF E. ROOFS – 40 PSF SNOW PLUS DRIFT LOADS AND 20 PSF SUPERIMPOSED DEAD LOAD BOTTOM CHORD, 10 PSF TOP CHORD PLUS EQUIPMENT LOADS. F. WIND – 115 MPH. EXPOSURE C WITH 3 SECOND WIND GUST. G. SEISMIC – 2018 I.B.C. CHAPTER 16 1. OCCUPANCY IMPORTANCE FACTOR = 1.50 2. SEISMIC USE GROUP = III 3. GROUND MOTION; Sa = 0.352 G, 0.2 SECOND RESPONSE S1 = 0.078 G, 1.0 SECOND RESPONSE 4. SITE CLASSIFICATION = D 5. DESIGN SPECTRAL ACCELERATION; Sds = 0.305 Sd1 = 0.078 6. SEISMIC DESIGN CATEGORY = C 7. BASIC SEISMIC FORCE RESISTING SYSTEM; ORDINARY REINFORCED MASONRY SHEAR WALLS H. LATERAL EARTH PRESSURE (1) 55 PSF/FT MOIST OR DRY SOIL (2) 115 PCF/FT SATURATED SOIL I. SOIL BEARING PRESSURE: THE MAXIMUM ALLOWABLE SOIL BEARING PRESSURE VARIES. SEE SOILS REPORT.	C7.	EXTRA ACCESSORY BARS IN ADDITION TO NORMAL ACCESSORIES USED TO HOLD REINFORCING STEEL FIRMLY IN POSITION, EXTRA ACCESSORY BARS SHALL BE USED AS FOLLOWS: A. IN SLABS #5 RAISER BARS AT 36" O.C. MAXIMUM TO SUPPORT TOP REINFORCING STEEL. B. IN WALLS WITH TWO CURTAINS #3 U OR Z SHAPE SPACERS AT 6 FEET ON CENTER, EACH WAY C8.	PC2. CONCRETE STRENGTH ALL MEMBERS SHALL HAVE A MINIMUM 28–DAY COMPRESSIVE STRENGTH OF 5000 PSI		M7.	VERIFY EXISTING DIMENSIONS STRUCTURAL DIMENSIONS RELATED TO OR CONTROLLED BY EXISTING STRUCTURES SHALL BE VERIFIED IN FIELD BY THE CONTRACTOR PRIOR TO CONCRETE WORK. (SEE NOTES E AND F THIS SHEET)																																																
		<table><tr><td colspan="10">GRADE 40 OR 60 REINFORCEMENT – LENGTH IN INCHES</td></tr><tr><td>BAR SIZE</td><td>#3</td><td>#4</td><td>#5</td><td>#6</td><td>#7</td><td>#8</td><td>#9</td><td>#10</td><td>#11</td></tr><tr><td>REGULAR BARS</td><td>14</td><td>19</td><td>24</td><td>29</td><td>42</td><td>48</td><td>54</td><td>66</td><td>82</td></tr><tr><td>TOP BARS</td><td>19</td><td>25</td><td>31</td><td>37</td><td>54</td><td>62</td><td>72</td><td>92</td><td>114</td></tr></table>		GRADE 40 OR 60 REINFORCEMENT – LENGTH IN INCHES										BAR SIZE	#3	#4	#5	#6	#7	#8	#9	#10	#11	REGULAR BARS	14	19	24	29	42	48	54	66	82	TOP BARS	19	25	31	37	54	62	72	92	114												
GRADE 40 OR 60 REINFORCEMENT – LENGTH IN INCHES																																																							
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TOP BARS	19	25	31	37	54	62	72	92	114																																														
		TOP BARS ARE HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE CAST IN A SINGLE POUR BELOW THE BAR. ADD 25% TO ALL LAP SPLICES FOR BAR SPACING LESS THAN 6" OR FOR CONCRETE WITH 28–DAY COMPRESSIVE STRENGTH LESS THAN REQUIRED IN NOTE C3.A.																																																					
G8.	SOILS SEE GEOTECHNICAL ENGINEERING STUDY, PROJECT NUMBER 22281, DATED 3/4/2023 PROVIDED BY LITHOS ENGINEERING, DENVER, CO.	C9.	RESTRICTED BAR ANCHORAGE IN CASES WHERE REINFORCING BARS CANNOT BE EXTENDED AS FAR AS REQUIRED DUE TO THE LIMITED EXTENT OF THE ADJACENT CONCRETE STRUCTURE, THE BARS SHALL EXTEND AS FAR AS POSSIBLE AND END IN STANDARD HOOKS.																																																				
G9.	DRAINAGE SURFACES SLOPE DRAINAGE SURFACE UNIFORMLY TO DRAIN. SLOPE SHALL BE 1/8" PER FOOT EXCEPT WHERE NOTED OTHERWISE ON THE PLANS.	C10.	STANDARD HOOKS BARS ENDING IN A RIGHT ANGLE BENDS OR HOOKS SHALL CONFORM TO THE REQUIREMENTS OF TABLE 1 OF ACI–315.																																																				
G10.	FLOOR DRAINS SLOPE FLOOR TO DRAIN AT ELEVATIONS NOTED. SEE MECHANICAL DRAWINGS FOR SIZES AND TYPES.																																																						

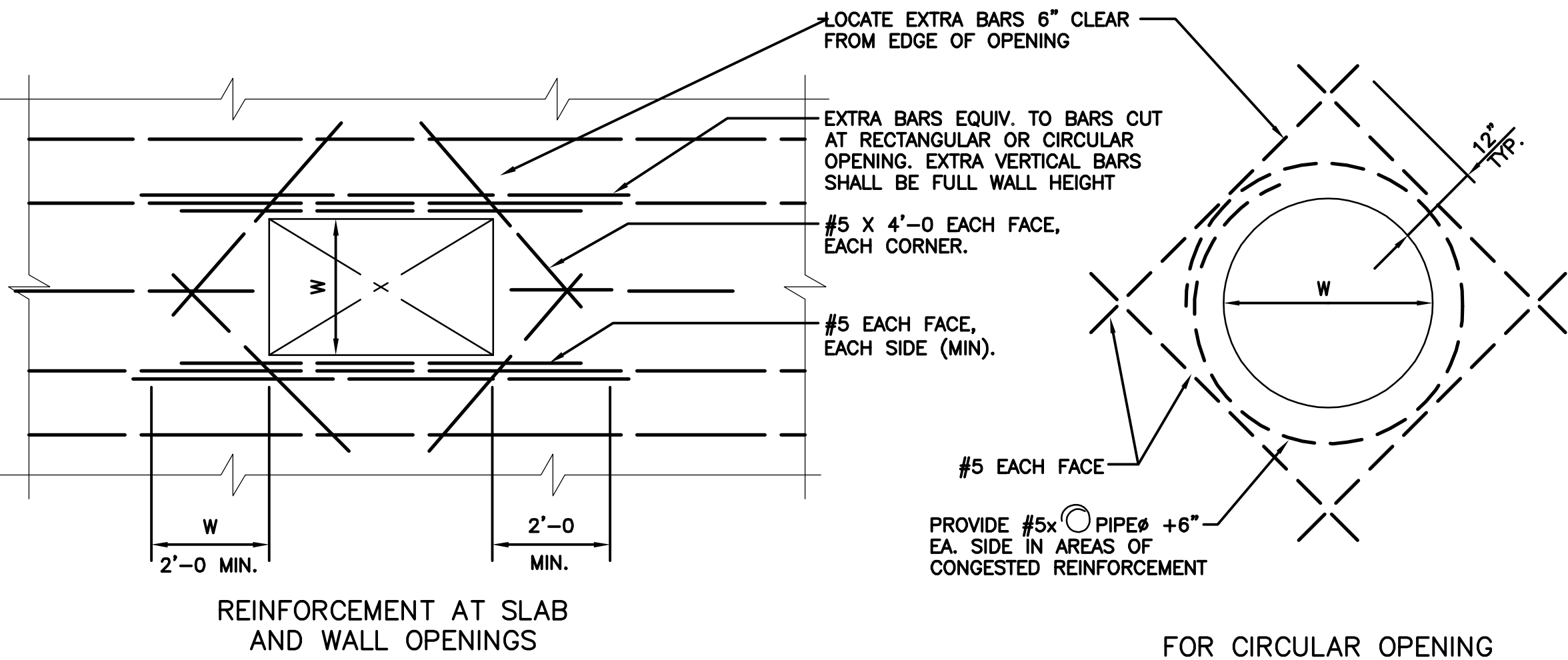
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
<div><div><div><div><div><div></div></div></div><div><div><div></div></div></div><div><div><div></div></div></div></div><div><div><div></div></div></div><div><div><div></div></div></div></div><div>Dewberry</div><div>Dewberry Engineers Inc.</div><div>990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825–1802</div></div>		<div><div>LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY)</div><div>DRAWING SDT59690–1</div><div>DRAWN STD</div><div>DESIGNED STD</div><div>CHECKED MAP</div></div>		<div>APPROVED:</div> <div>PRINCIPAL</div> <div>DATE:</div>											

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	JAJ	05/25/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	KD	07/31/23	MAP
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MAP
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

 TOWN OF SILT SILT, COLORADO WATER TREATMENT PLANT IMPROVEMENTS | | STRUCTURAL GENERAL NOTES | | DATE: 05/03/23 PROJECT NUMBER: 50159690 REVISION NO. D DRAWING NUMBER S–1 | |

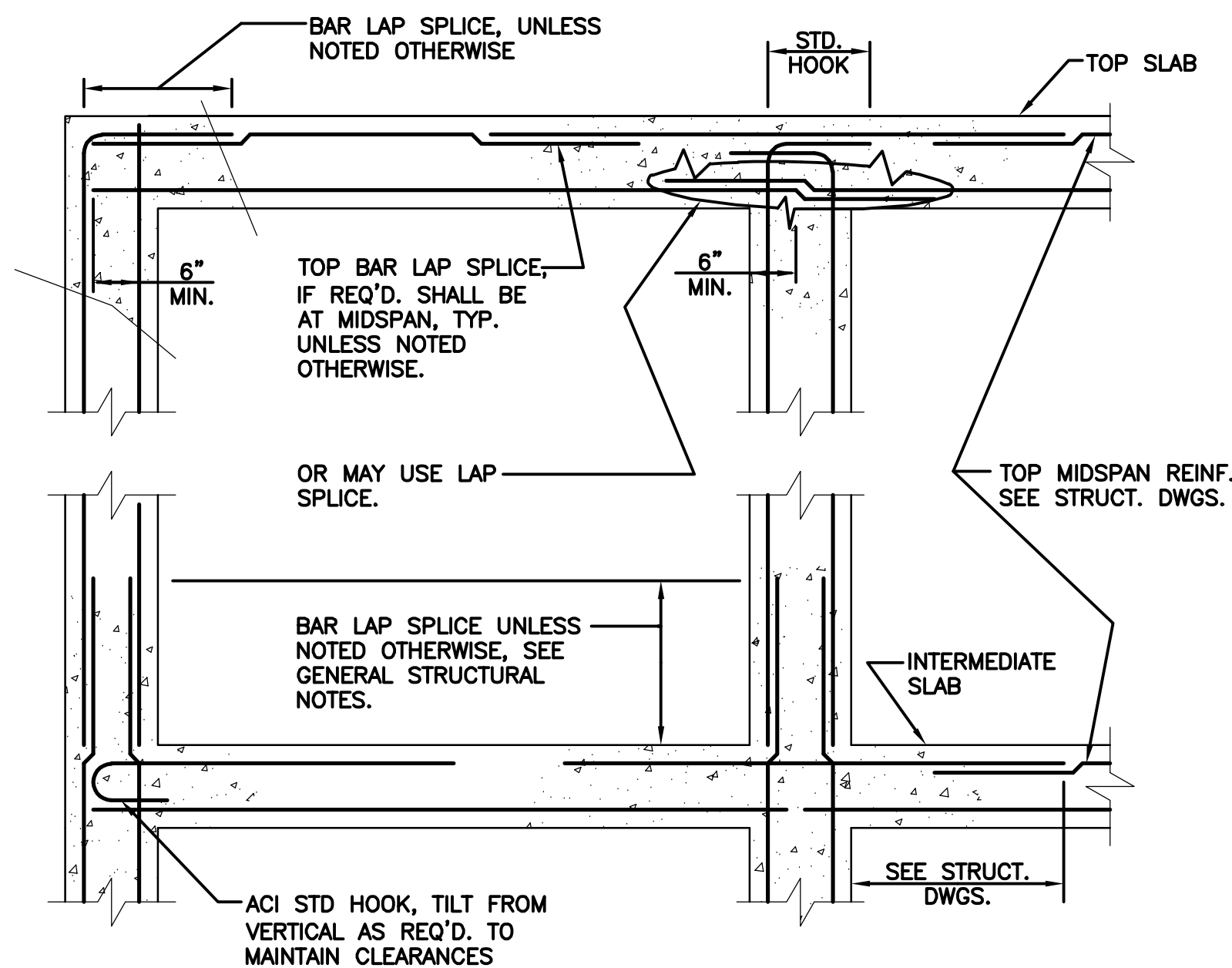


1 DETAIL
REINFORCING STEEL AT WALL INTERSECTIONS
NO SCALE

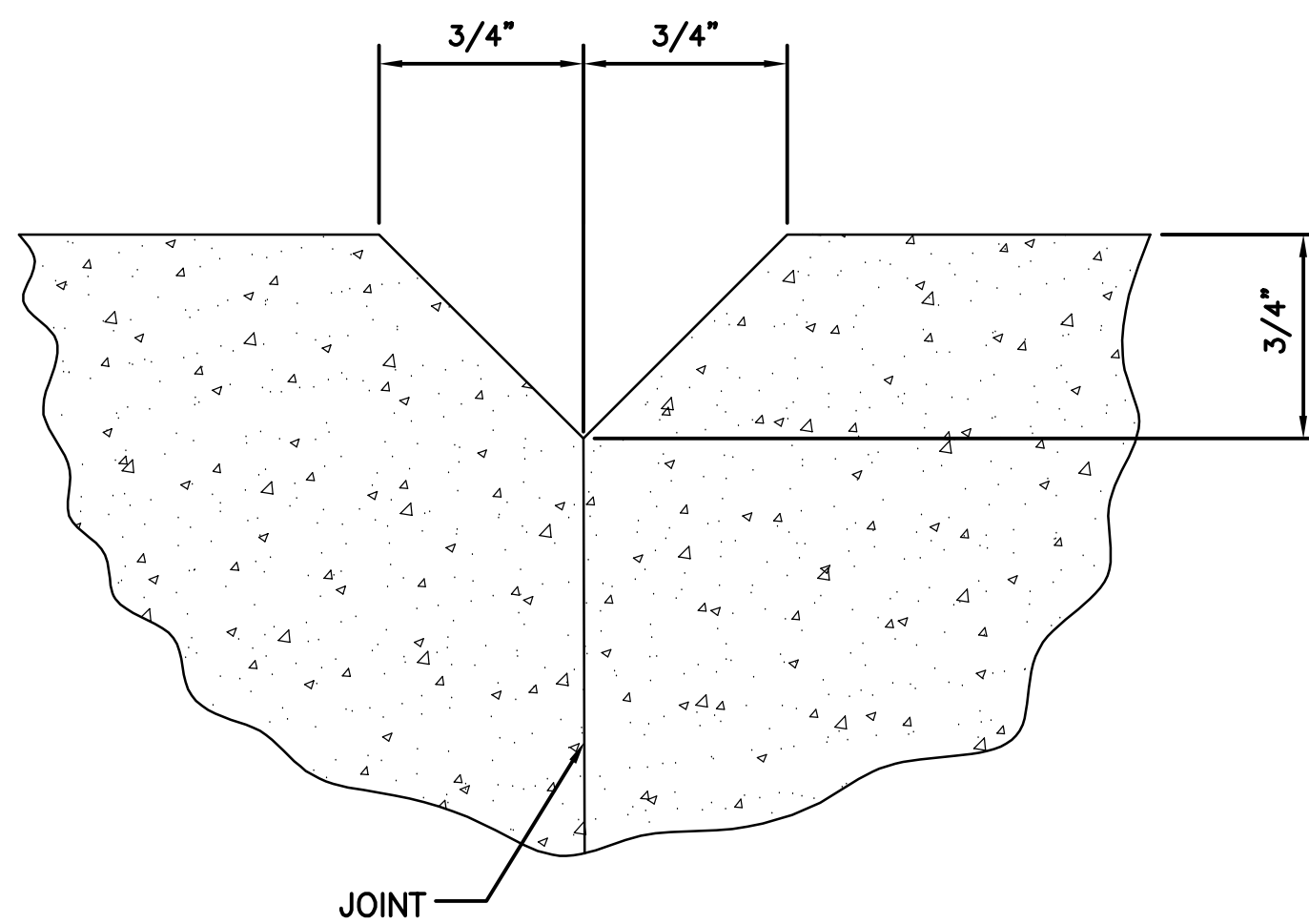


- NOTES:
1. TRANSVERSE REINFORCEMENT NOT SPECIFIED, BUT SHALL BE TREATED IN SAME MANNER AS BARS SHOWN.
 2. W = DIMENSION OF OPENING PERPENDICULAR TO BARS CUT. W = DIAMETER FOR CIRCULAR OPENINGS. BAR PROJECTION BEYOND OPENING SHALL BE NO LESS THAN SPECIFIED LAP LENGTH.
 3. SUPPLEMENTARY REINFORCING MAY BE OMITTED ONLY WHERE OPENING REINFORCING IS NOT CUT.
 4. SUPPLEMENTARY REINFORCING IS NOT REQUIRED WHEN SPECIFIED

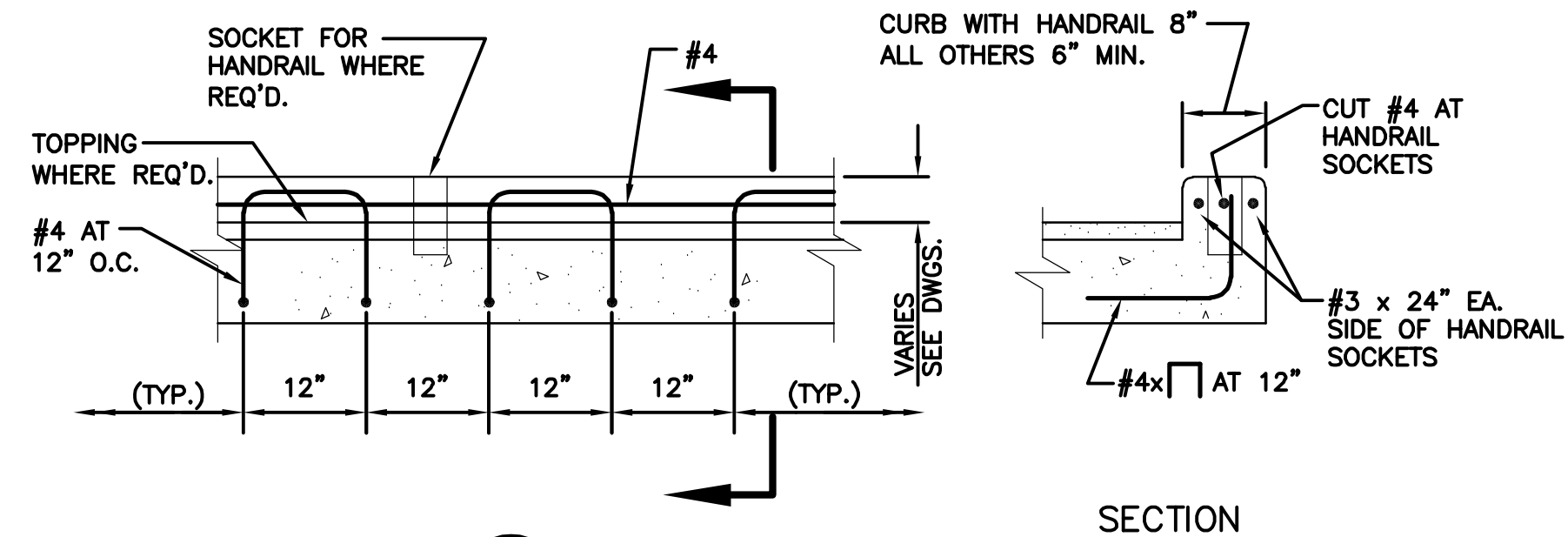
5 DETAIL
REINFORCEMENT AT SLAB AND WALL OPENINGS
NO SCALE



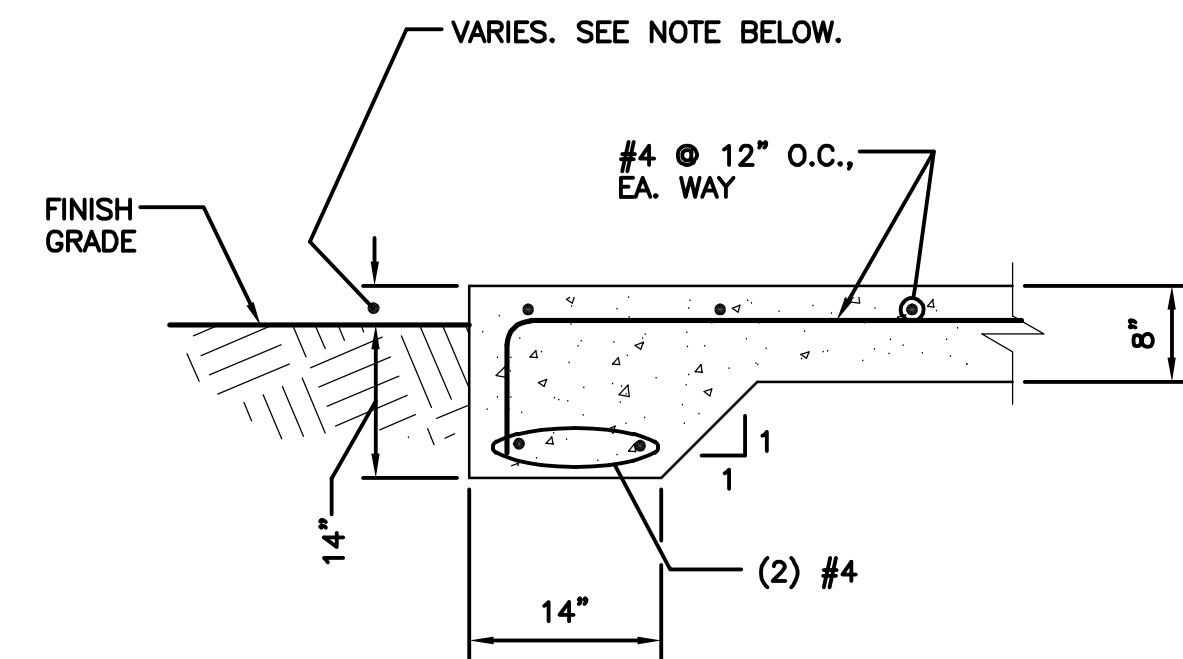
2 DETAIL
REINFORCING STEEL AT
WALL/SLAB INTERSECTIONS
NO SCALE



6 DETAIL
TOOLED CONCRETE JOINT
NO SCALE

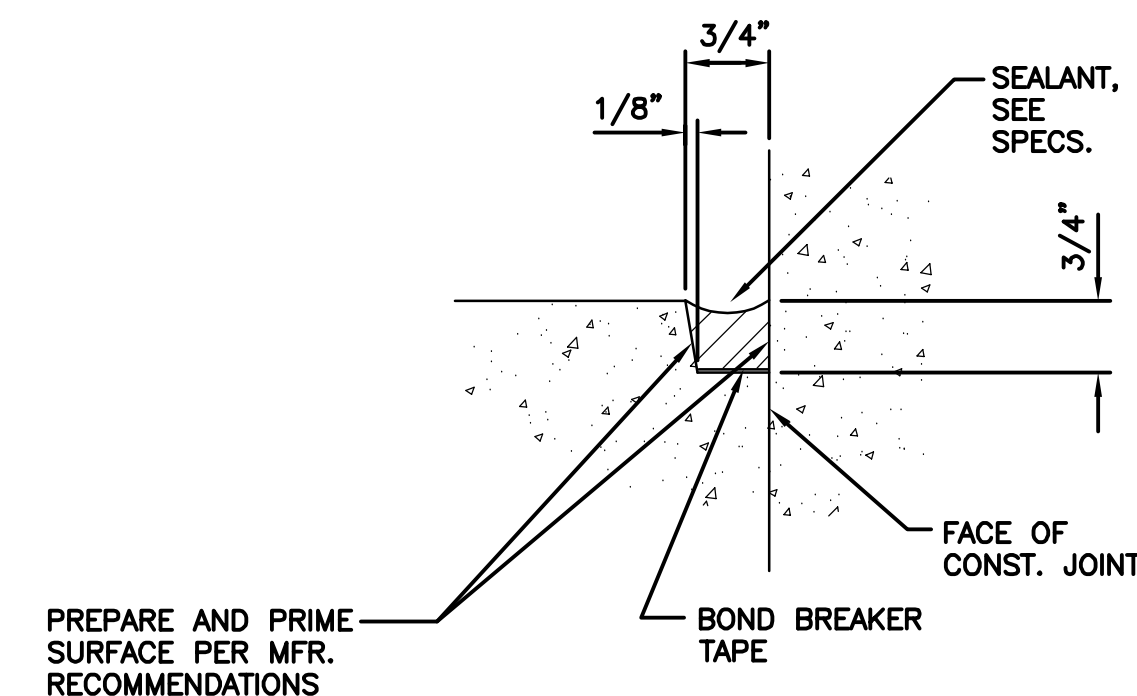


3 DETAIL
TYPICAL CURB
NO SCALE



- NOTES:
1. DIMENSION EQUALS SPECIFIED DEPTH OF ADJACENT PAVING, OR EQUALS 2" FOR SOD APPLICATION, AS REQ'D.
 2. FOR SLAB INTERFACE WITH BUILDING FOUNDATION SEE DETAIL 5/S-4.

4 DETAIL
TYPICAL SLAB EDGE
NO SCALE



7 DETAIL
SEALANT GROOVE
NO SCALE

REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	JAJ	05/25/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MAP
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MAP
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

ADHESIVE ANCHOR SCHEDULE						
BAR OR ROD DIA.	MAXIMUM DRILL SIZE AND MINIMUM HOLE DEPTH 1,2,3,4,7,8				MINIMUM EDGE DISTANCE 5 (X)	MINIMUM TOTAL REINF. BAR LENGTH (L) 6
	REINFORCING BAR		THREADED ROD			
	EPOXY ADHESIVE	ADHESIVE CAPSULE	EPOXY ADHESIVE	ADHESIVE CAPSULE		
3/8"	5/8" x 6"	1/2" x 6"	7/16" or 1/2" x 6"	15/32" x 6"	4 1/2"	18"
1/2"	3/4" x 7"	5/8" x 8"	9/16" or 5/8" x 7"	9/16" x 7"	6"	24"
5/8"	7/8" x 9"	13/16" x 9"	11/16" or 3/4" x 9"	11/16" x 9"	6 3/4"	29"
3/4"	1" x 11"	1" x 12"	13/16" or 7/8" x 11"	7/8" x 10"	9"	36"
7/8"	1 1/8" x 13"	1 1/8" x 14 1/2"	15/16" or 1" x 13"	1" x 11"	11"	45"
1"	1 1/4" x 16"	1 1/4" x 16"	1 1/8" x 16"	1 1/8" x 14"	12"	57"
1 1/8"	1 1/2" x 17"	1 1/2" x 18"	1 1/4" x 17"	1 1/4" x 16"	13 1/2"	70"
1 1/4"	1 3/4" x 19"	1 3/4" x 21"	1 1/2" x 19"	1 1/4" x 19"	15 3/4"	87"

3" MIN.

SEE SCHED.

X

L

HOLE DIAMETER SEE SCHEDULE

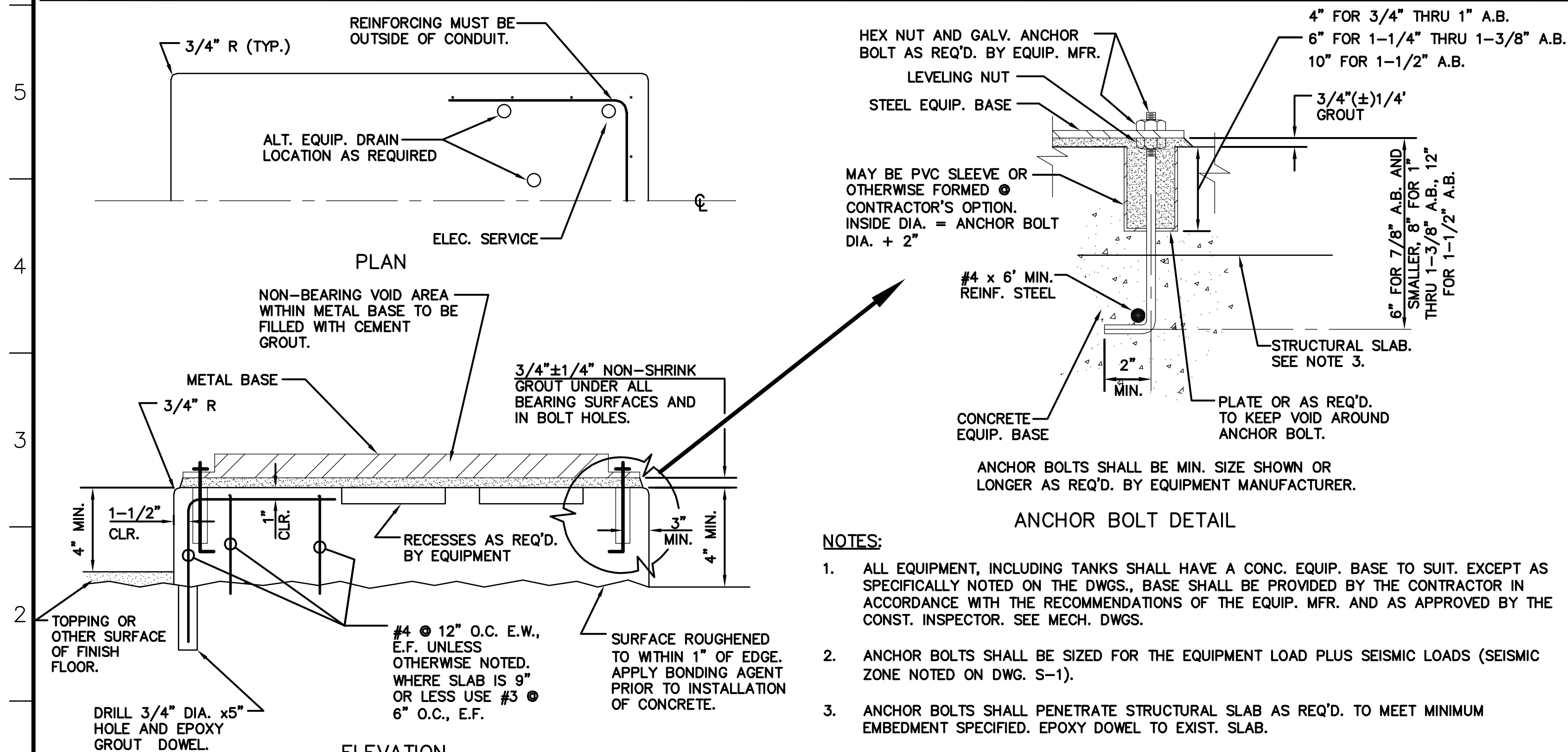
EXISTING CONCRETE

SEE NOTE 8

NOTES:

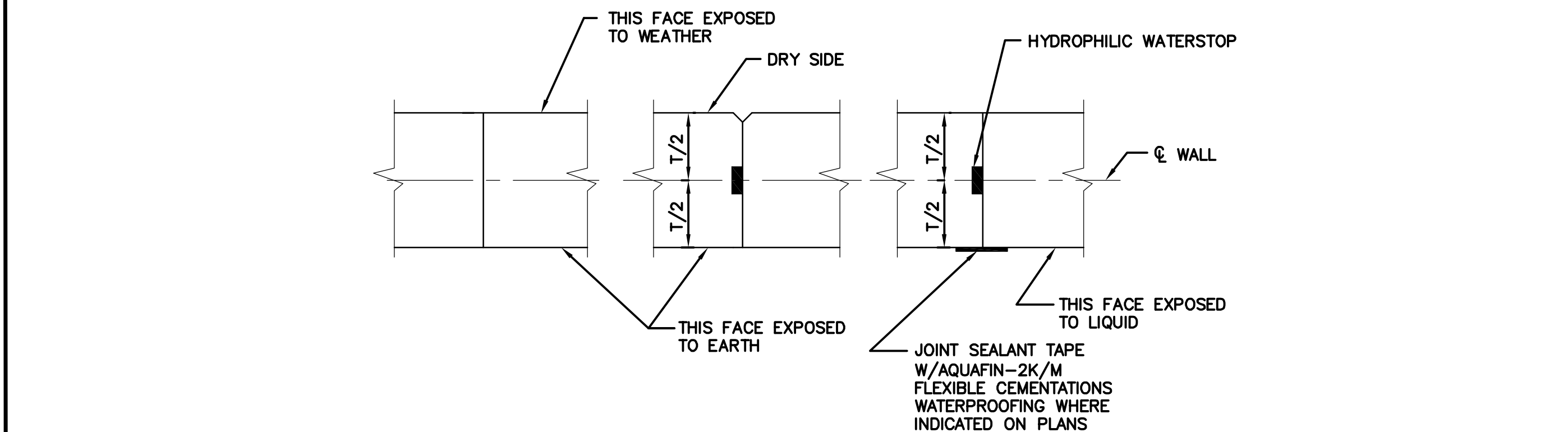
1. DRILL SIZE NOTED FOR BIDDING ONLY. USE ADHESIVE MANUFACTURER'S RECOMMENDED DRILL SIZE. HOLE DEPTH SHALL BE AS SHOWN IN THIS TABLE, EXCEPT WHERE NOTED OTHERWISE ON THE DRAWINGS.
2. VALUES ARE BASED ON CONTINUOUS LOADING AT TEMPERATURES BELOW 110 DEGREES F FOR A307, A36, A304 AND A316 STAINLESS STEEL, OR A615-GR60 STEEL IN 4000 PSI CONCRETE. FOR 3000 PSI CONCRETE, INCREASE HOLE DEPTH 10 PERCENT. FOR HIGH STRENGTH STEEL, INCREASE HOLE DEPTH IN PROPORTION TO TENSILE STRENGTH, BUT USE 25 PERCENT INCREASE MINIMUM.
3. BAR OR ROD TO PENETRATE AND BE COATED WITH ADHESIVE TO FULL DEPTH OF HOLE.
4. SEE SPECIFICATIONS FOR PRODUCT AND INSTALLATION REQUIREMENTS.
5. MINIMUM EDGE DISTANCES FOR FULL WORKING LOAD TO BE EQUAL TO OR GREATER THAN HOLE DEPTH. CONSULT ADHESIVE MANUFACTURER.
6. INDICATES BAR LENGTH REQUIRED TO PROVIDE FULL LAP WITH EQUIVALENT REINFORCING BAR IN NEW CONCRETE.
7. DEPTH OF HOLE NOT TO EXCEED CONCRETE THICKNESS LESS 3". DOWEL DIAMETER TO BE LIMITED ACCORDINGLY.
8. MINIMUM SPACING REQUIRED TO OBTAIN FULL WORKING LOAD = HOLE DEPTH, UNLESS NOTED OTHERWISE BY ADHESIVE MANUFACTURER.

1 **DETAIL**
TYPICAL ADHESIVE ANCHERED BAR OR THREADED ROD
NO SCALE

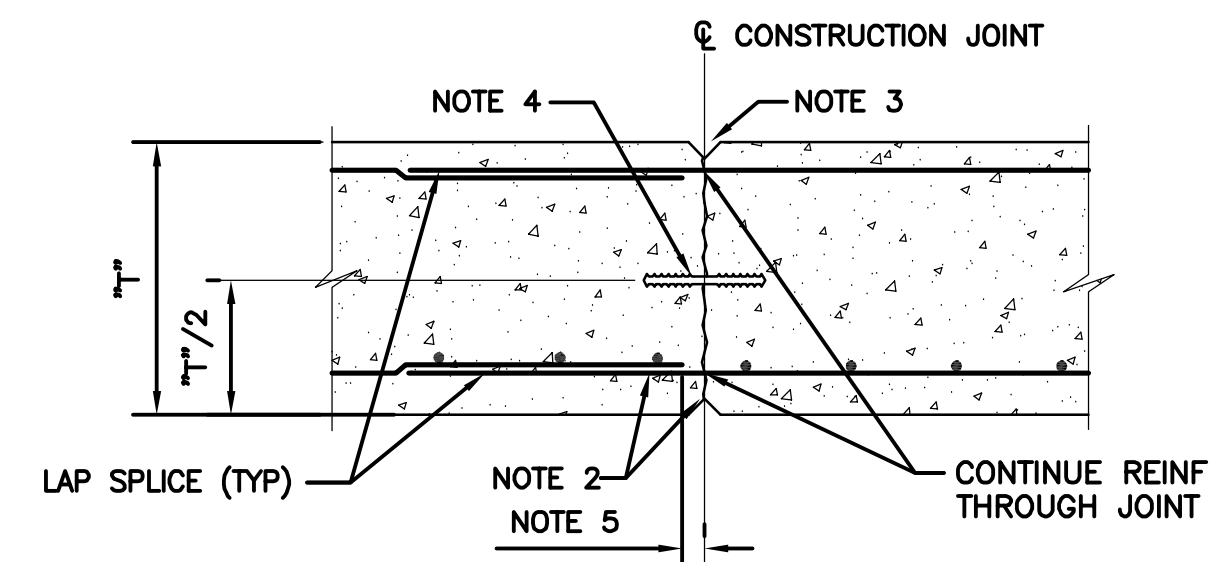
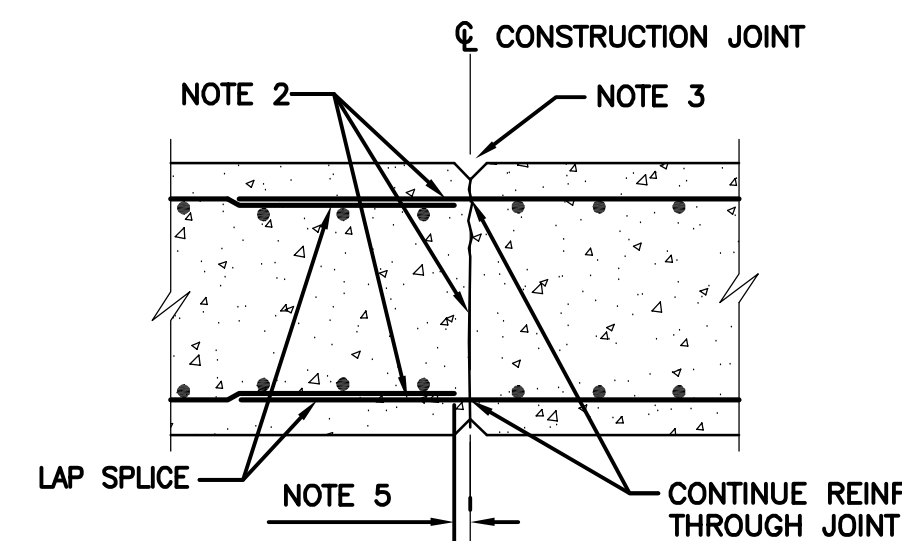
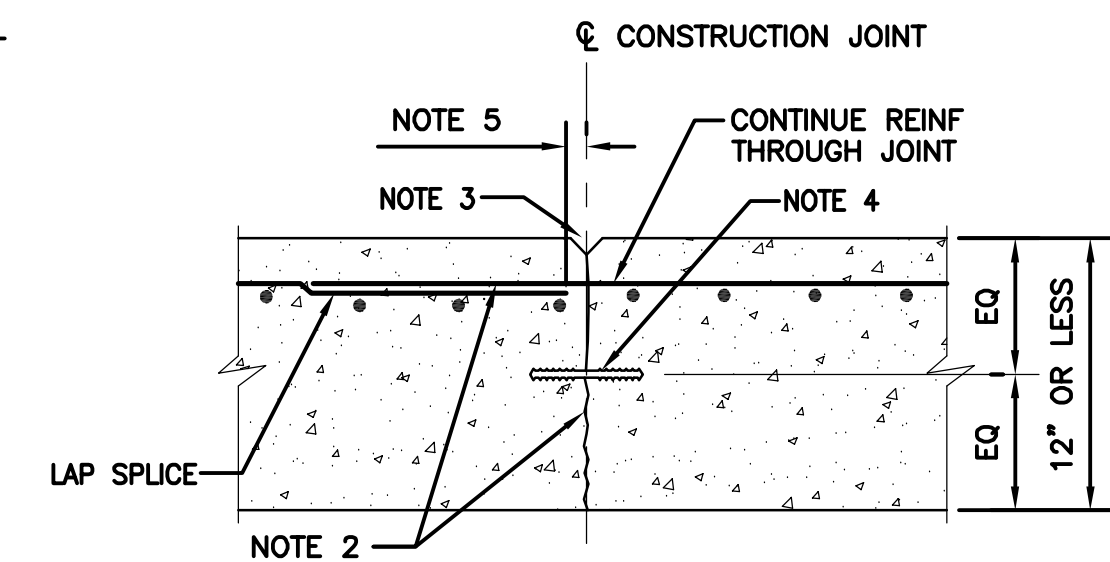
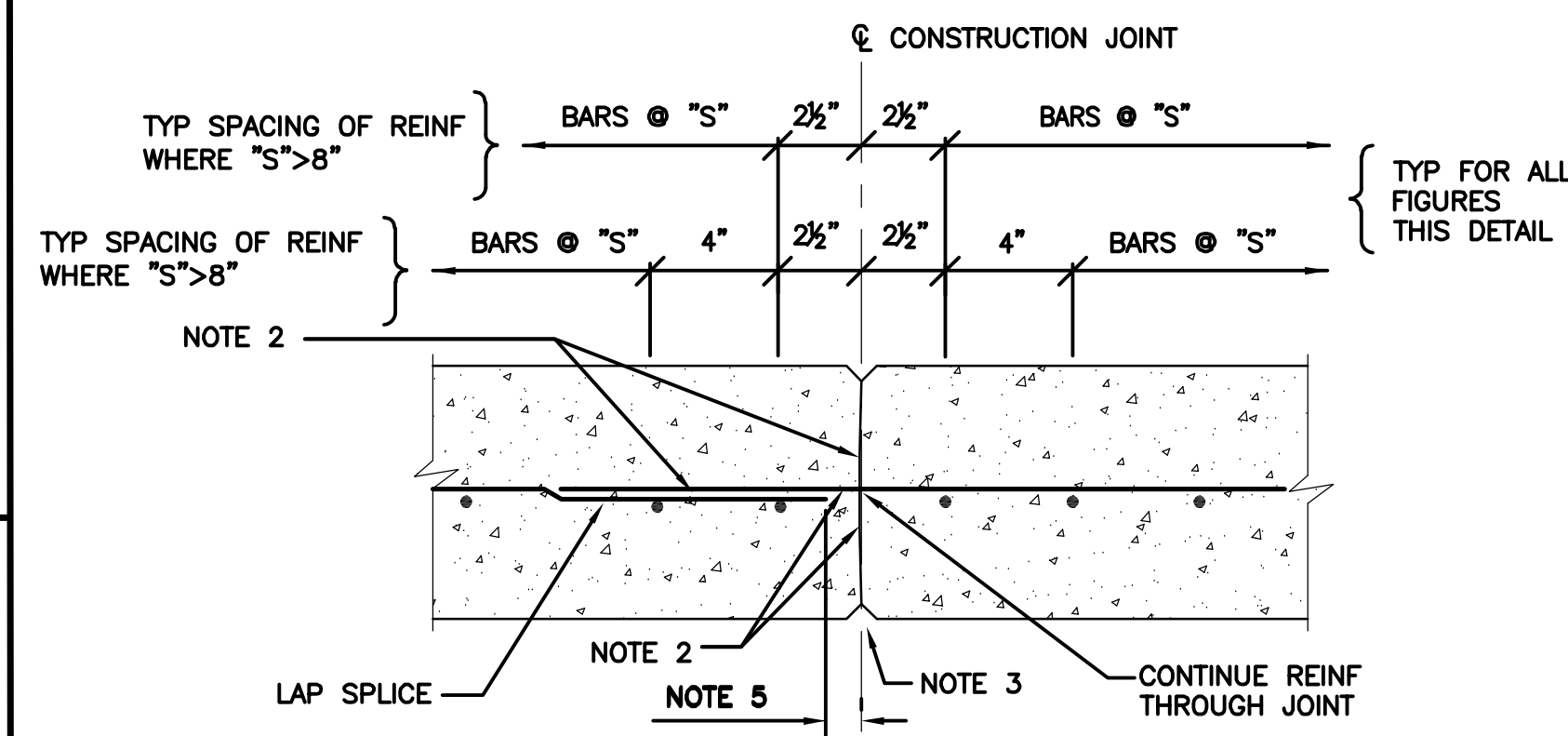


3 **DETAIL**
TYPICAL EQUIPMENT PAD
NO SCALE

- NOTES:




TYPICAL KEY IN VERTICAL WALLS



2 DETAIL
CONSTRUCTION JOINTS
NO SCALE

- NOTES:



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DRAWING SDT59690-3
DRAWN STD
DESIGNED STD
CHECKED MAP

APPROVED:

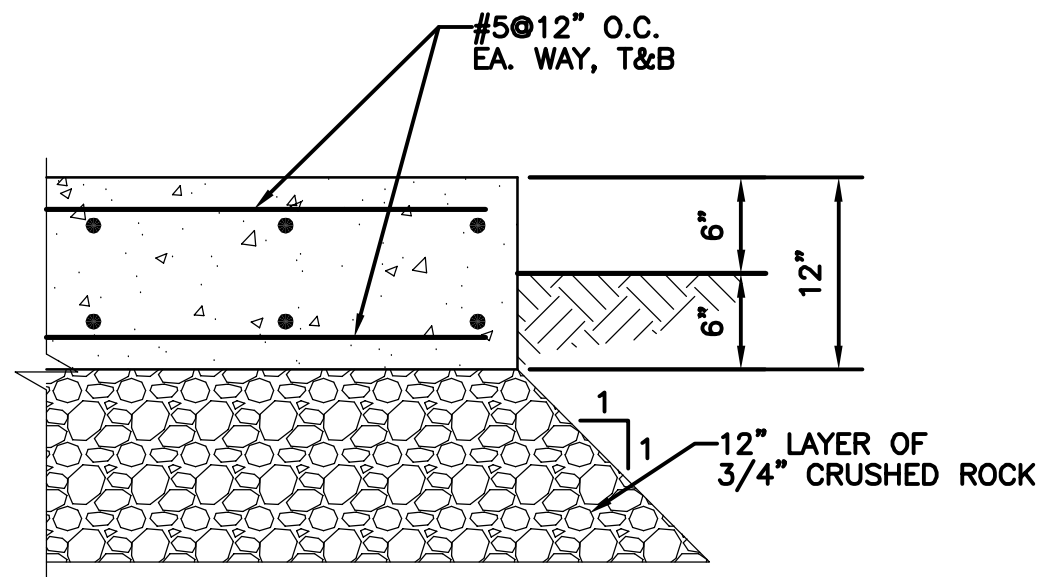
REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP
A	60% DESIGN REVIEW SUBMITTAL	JAJ	05/23/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MAF
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MAF
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAF

**TOWN OF SILT
SILT, COLORADO**

WATER TREATMENT PLANT IMPROVEMENTS

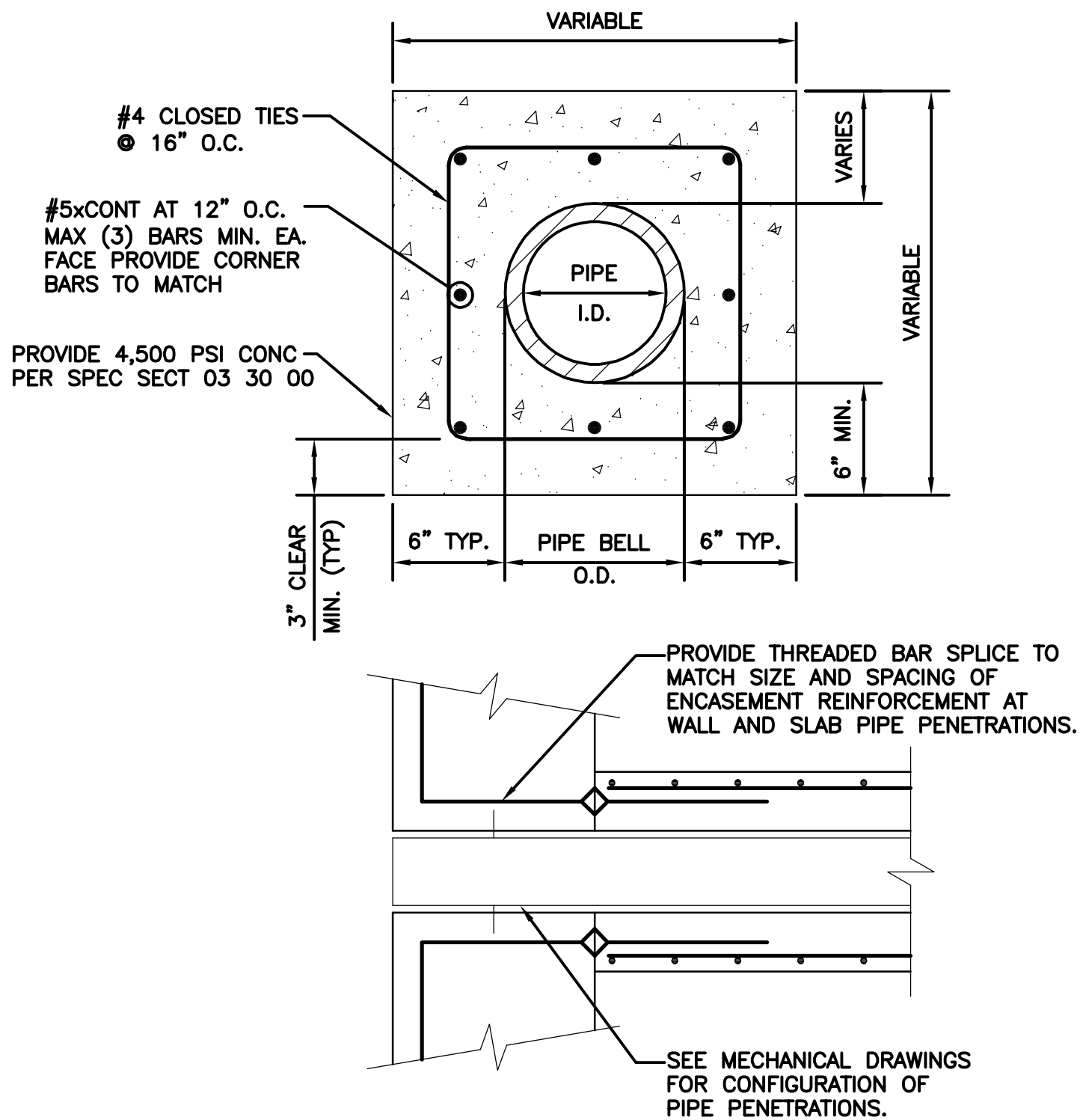
STRUCTURAL

DATE:	05/03/23
PROJECT NUMBER:	50159690
REVISION NO.	D
DRAWING NUMBER	
S-3	

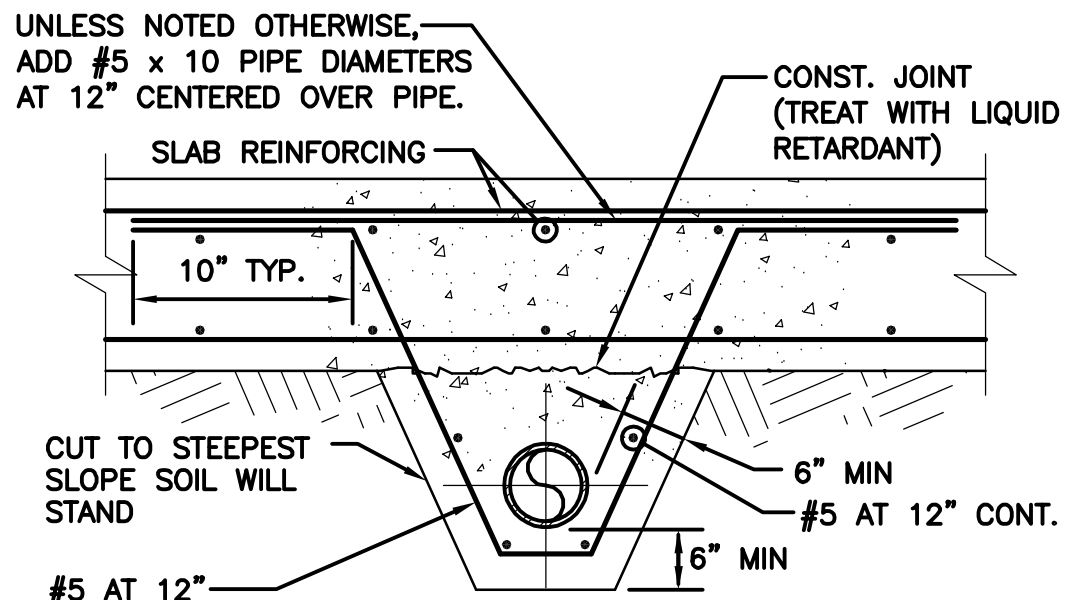


NOTE:
SEE PLAN FOR SLAB DIMENSIONS

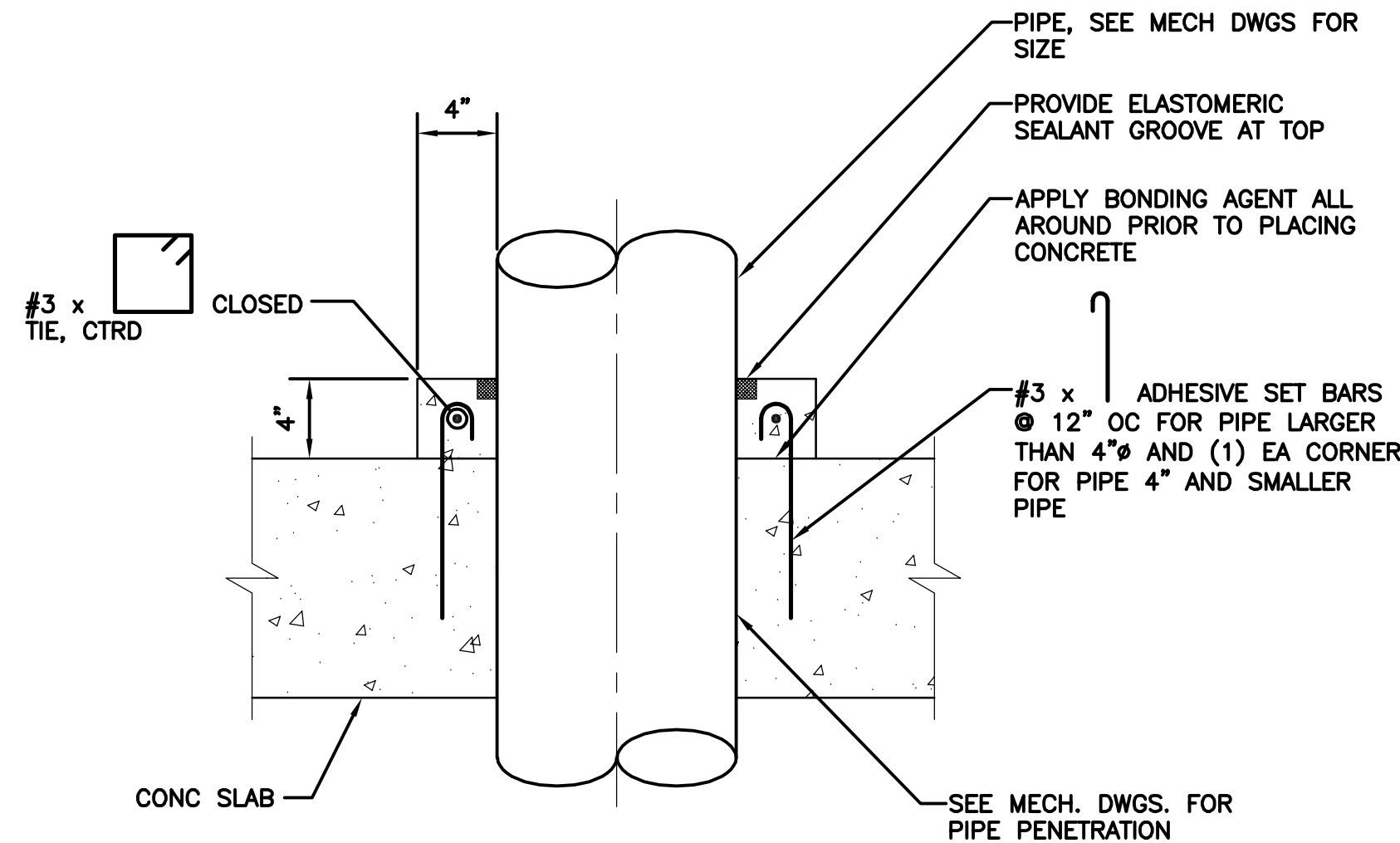
1 **DETAIL**
EQUIPMENT PAD
NO SCALE



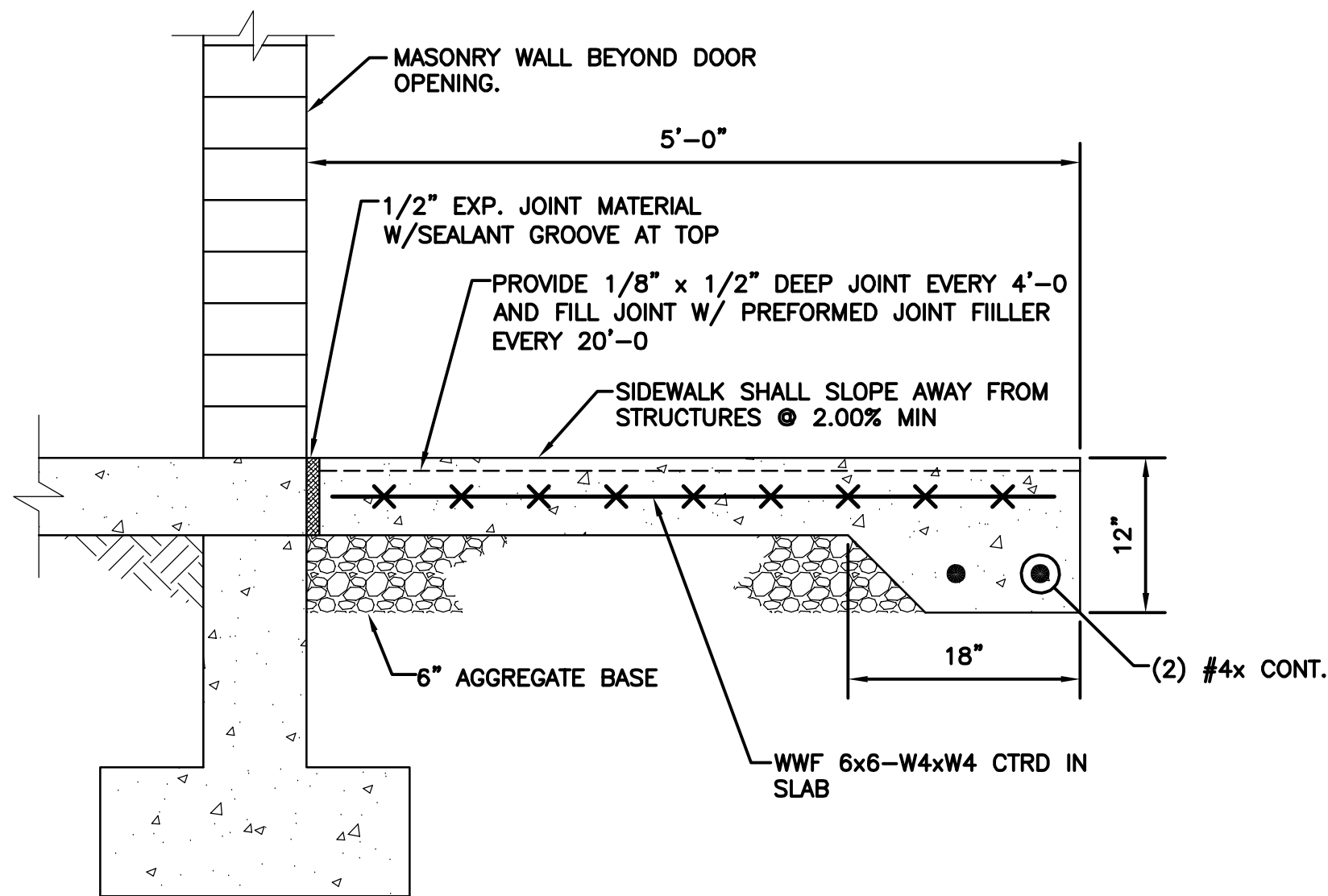
2 **DETAIL**
CONCRETE PIPE ENCASEMENT
NO SCALE



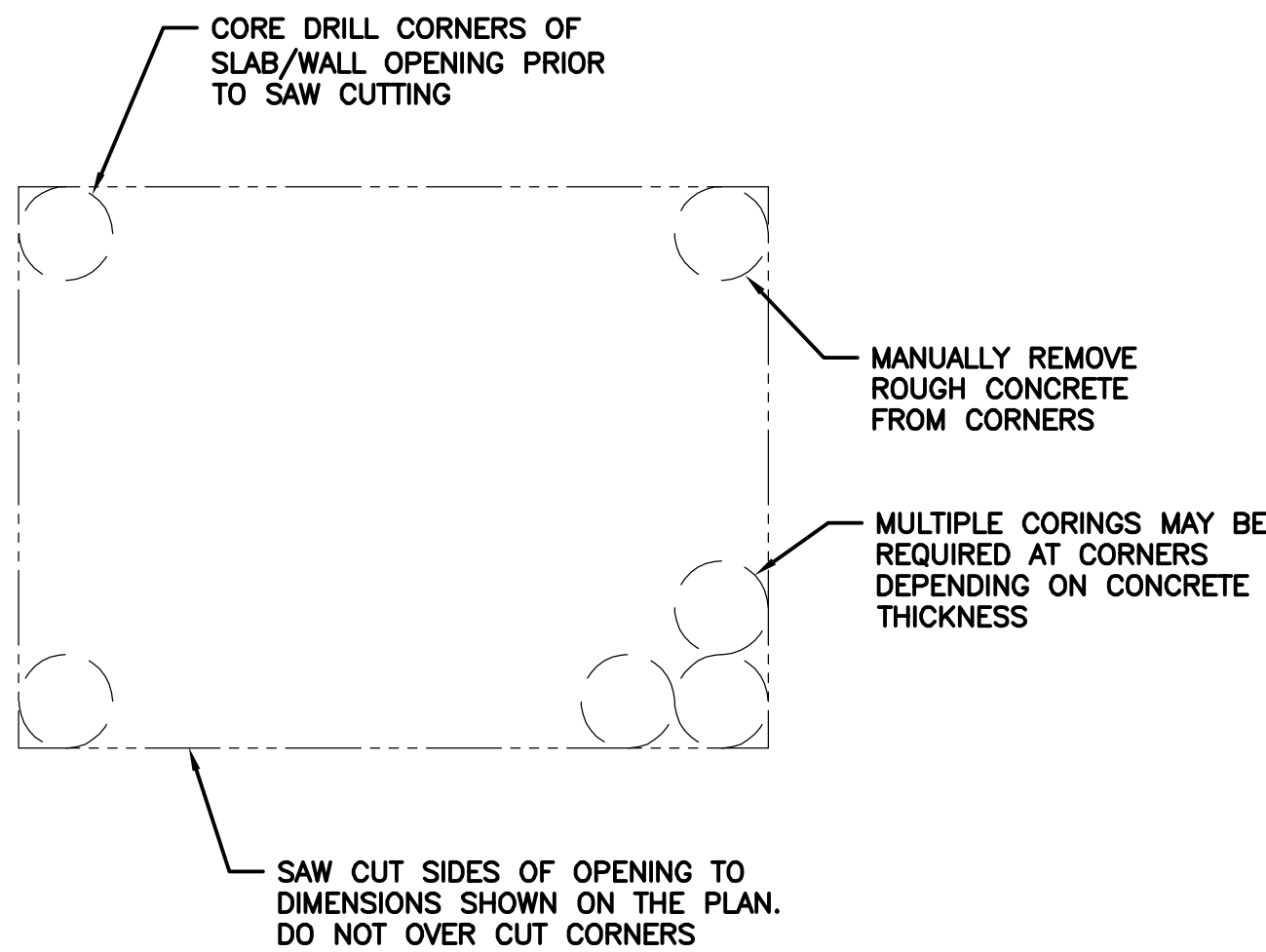
3 **DETAIL**
TYPICAL PIPE ENCASEMENT
UNDER SLAB
NO SCALE



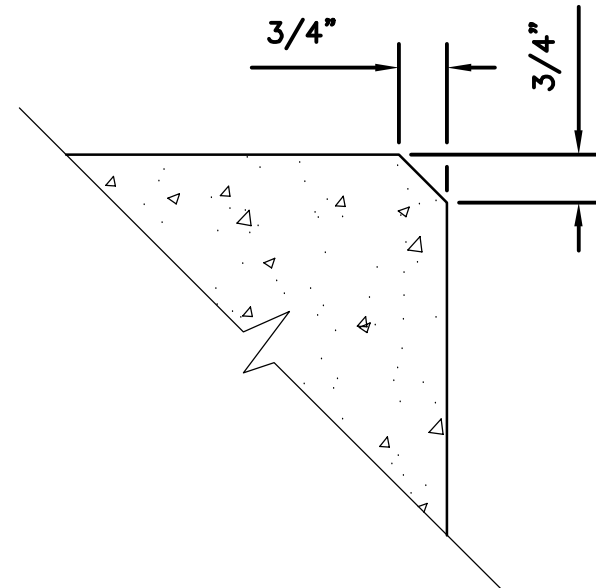
4 **DETAIL**
CONCRETE CURB AT PIPE PENETRATIONS
NO SCALE



5 **DETAIL**
SIDEWALK
SCALE: NONE

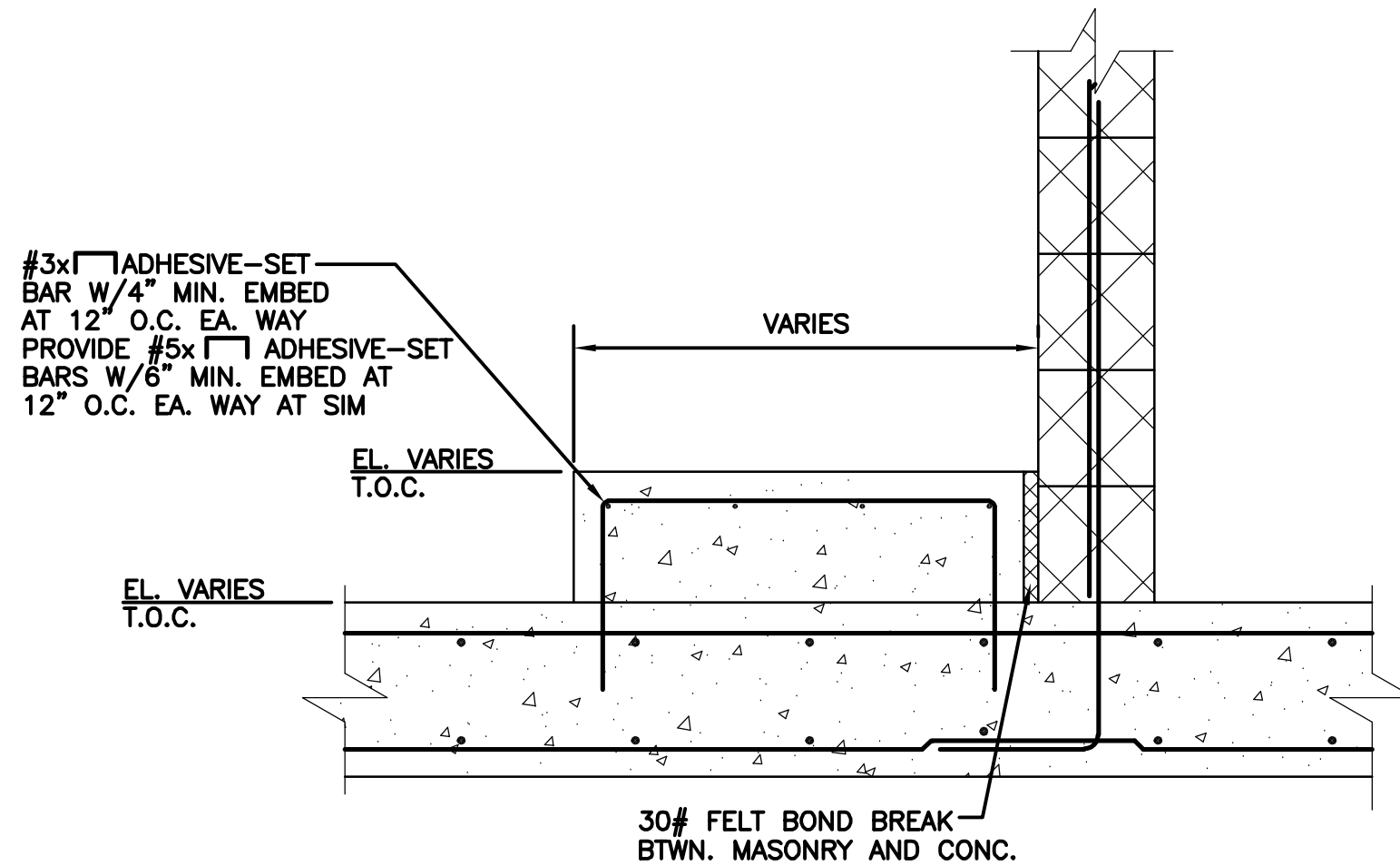


6 **DETAIL**
EXISTING WALL/SLAB PENETRATION
NO SCALE



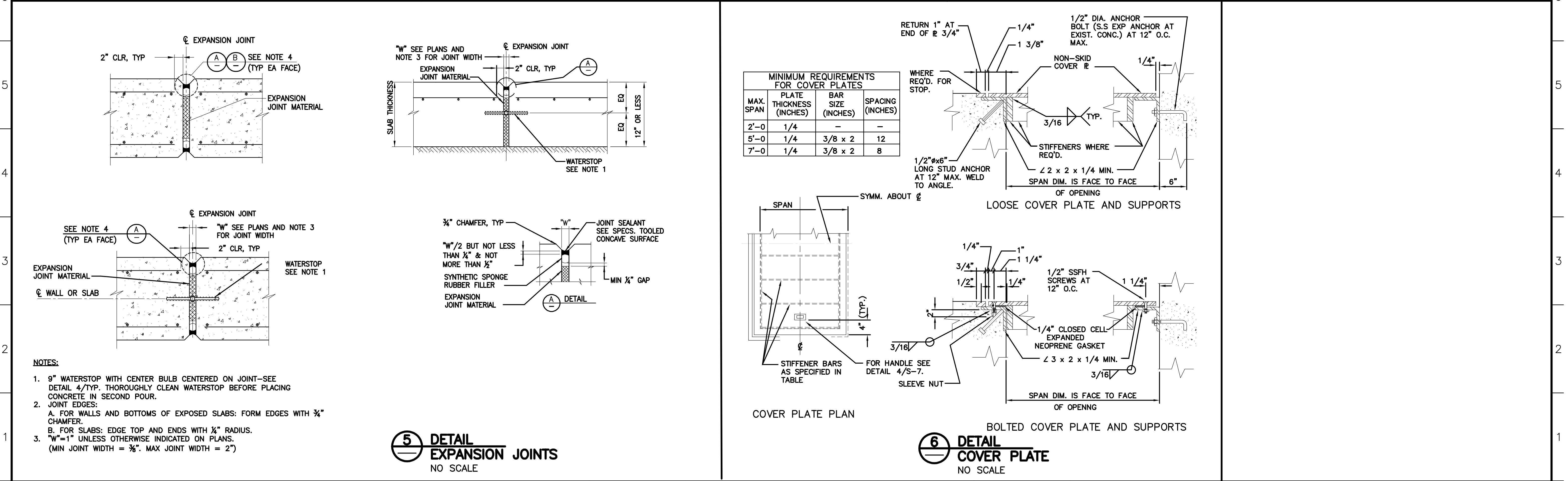
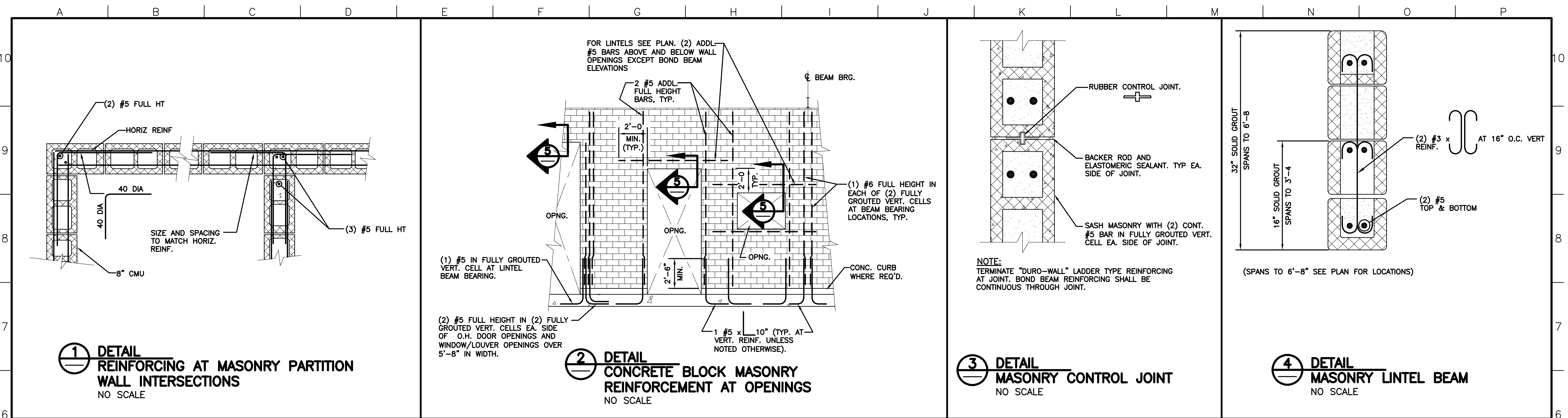
NOTE:
PROVIDE 3/4" FORMED AND FINISHED CHAMFER ON ALL
EXPOSED CAST-IN-PLACE CONCRETE EDGES.

7 **DETAIL**
CAST-IN-PLACE EDGE
NO SCALE



8 **DETAIL**
CONCRETE EQUIPMENT PAD
SCALE: 1"=1'-0"

REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	JA	05/25/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MAP
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MAP
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP



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DRAWN STD
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CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	JAJ	05/25/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MAP
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MAP
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

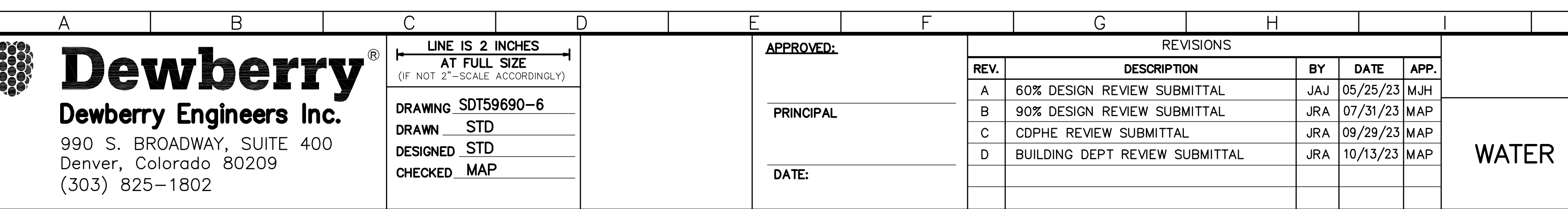
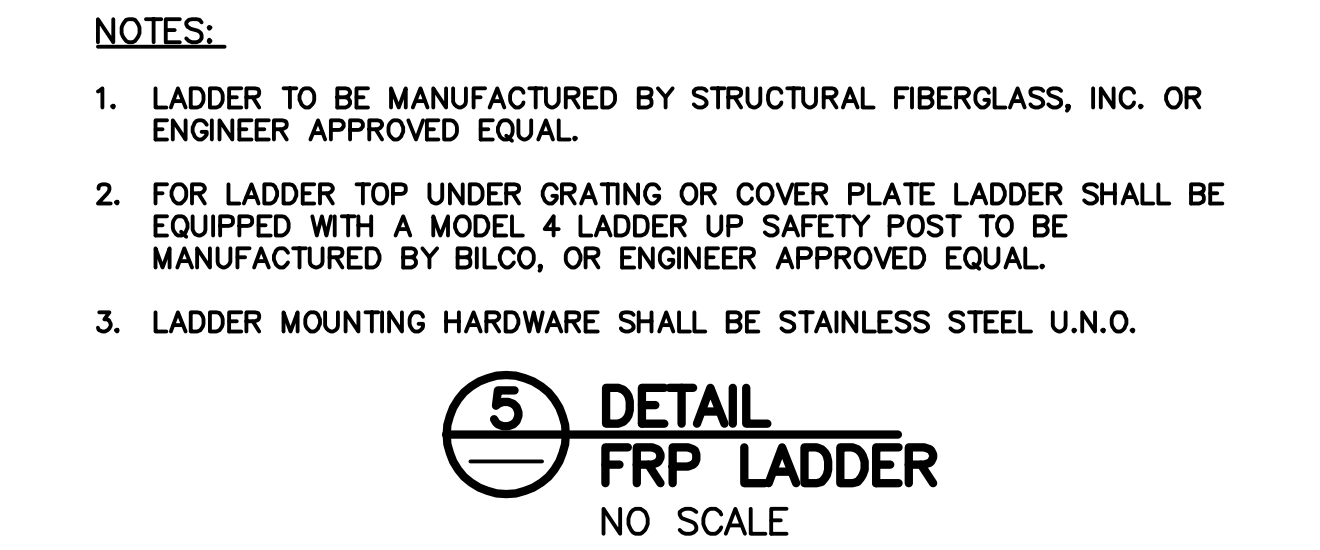
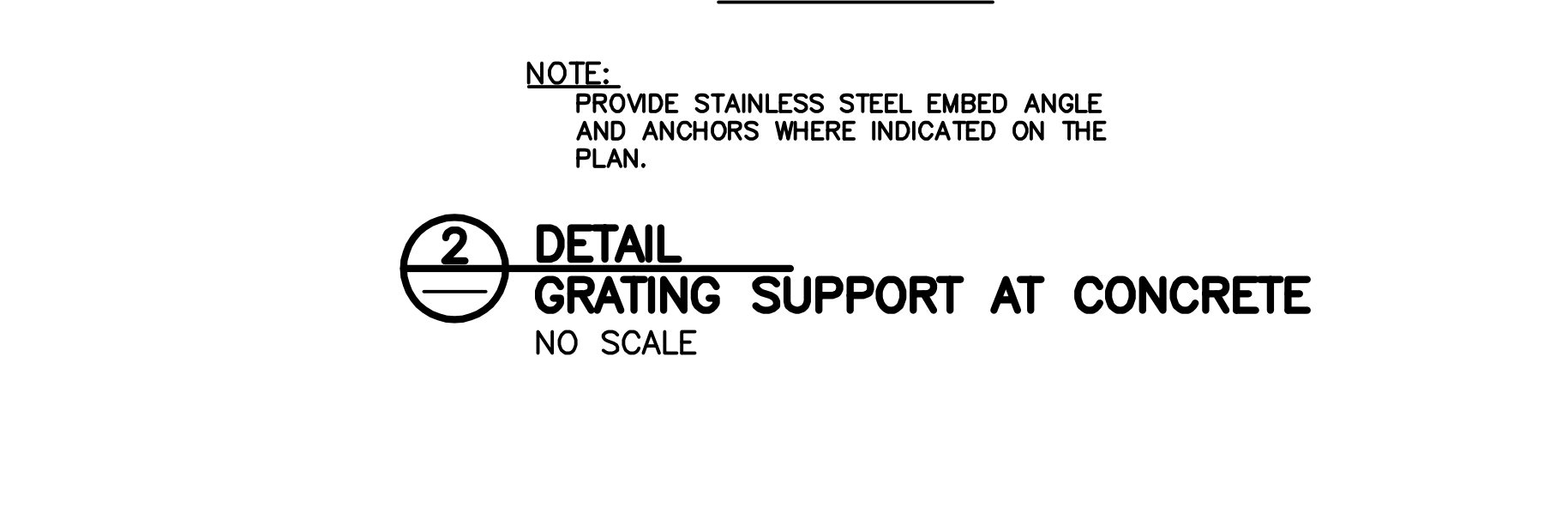
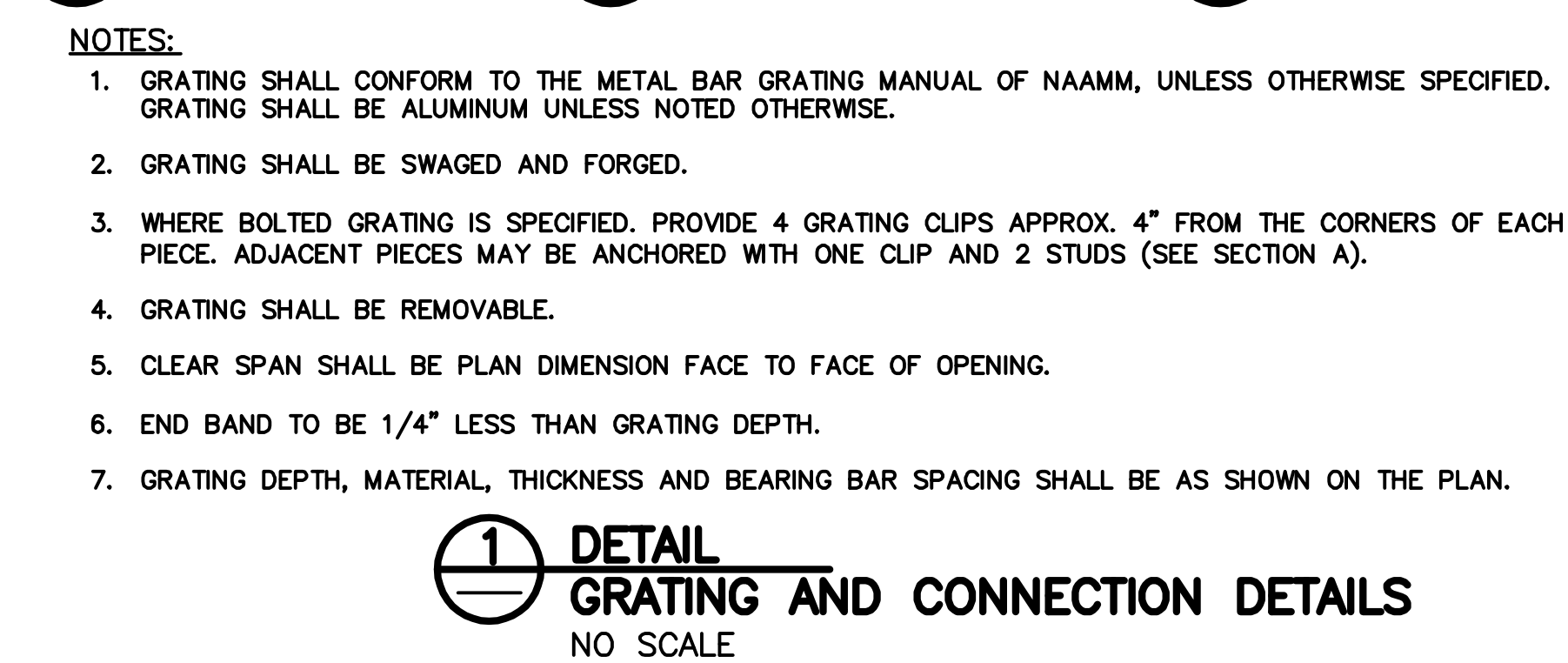
STANDARD DETAILS


DATE: 05/03/23

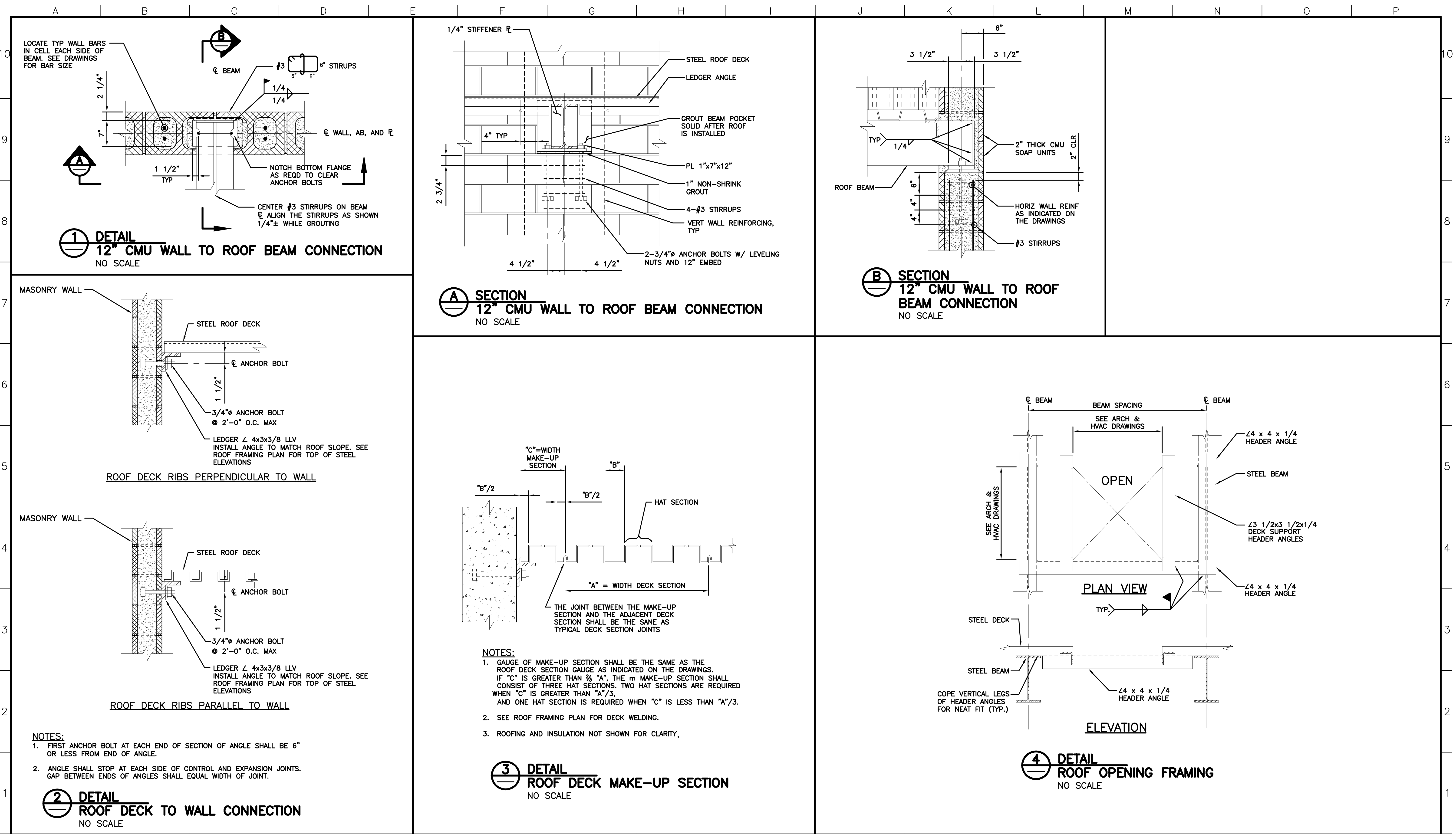
PROJECT NUMBER: 50159690


REVISION NO. D

DRAWING NUMBER S-5



A		B		C		D		E		F		G		H		I		J		K		L		M		N		O		P	
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		DRAWING SDT59690-6				REV.		DESCRIPTION		BY													DATE		APP.		PROJECT NUMBER: 50159690				
		DRAWN STD				A		60% DESIGN REVIEW SUBMITTAL		JAJ													05/25/23		MJH		REVISION NO. D				
		DESIGNED STD				B		90% DESIGN REVIEW SUBMITTAL		JRA													07/31/23		MAP		DRAWING NUMBER				
		CHECKED MAP				C		CDPHE REVIEW SUBMITTAL		JRA													09/29/23		MAP		S-6				
						D		BUILDING DEPT REVIEW SUBMITTAL		JRA													10/13/23		MAP						





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DRAWING SDT59690-7

DRAWN STD

DESIGNED STD

CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	06/22/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	KD	07/31/23	MAP
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MAP
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

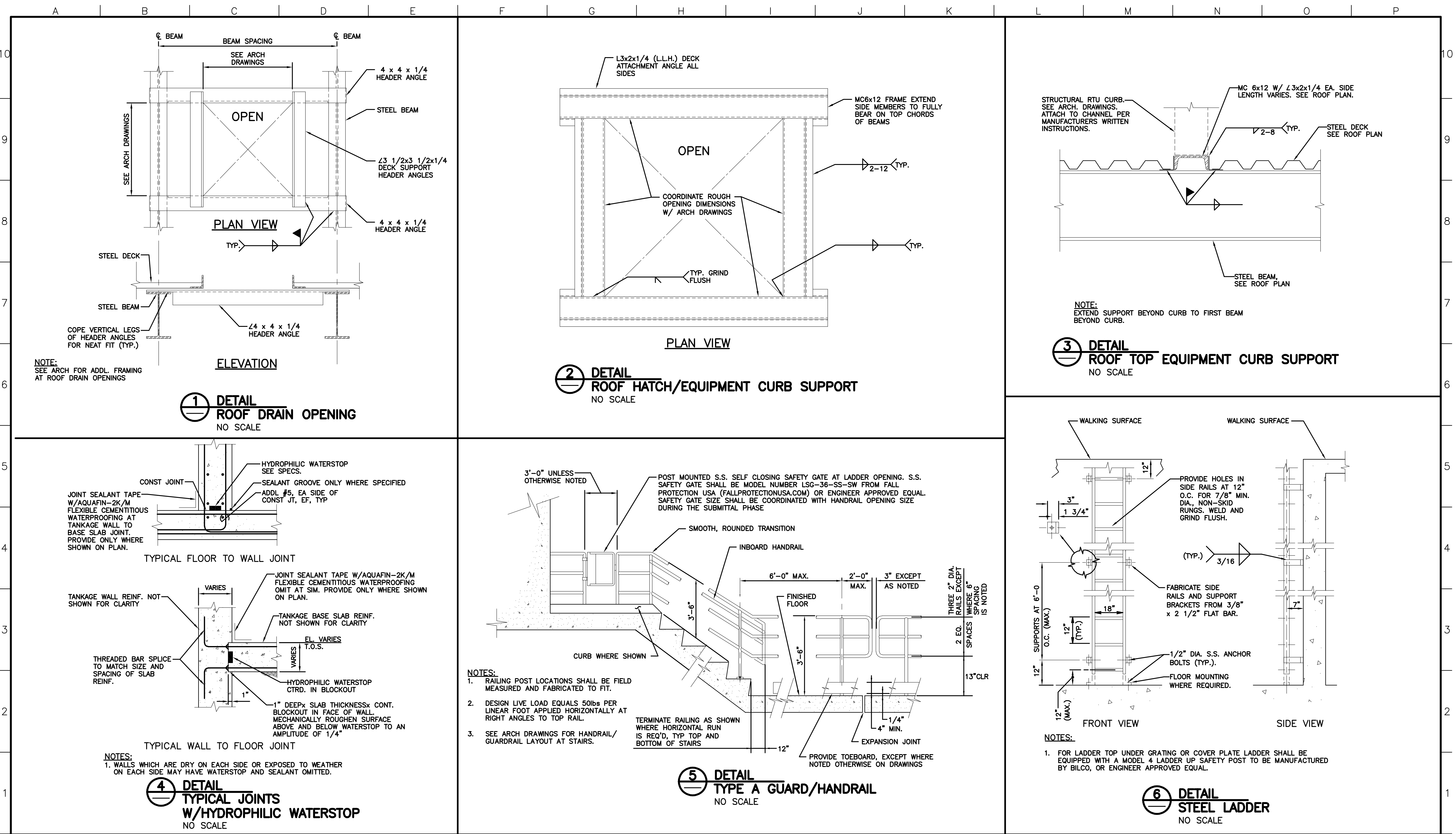
STANDARD DETAILS


DATE: 06/22/23

PROJECT NUMBER: 50159690

REVISION NO. D

DRAWING NUMBER S-7





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990 S. BROADWAY, SUITE 400
Denver, Colorado 80209
(303) 825-1802

LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING SDT59690-8
DRAWN STD
DESIGNED STD
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	06/23/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	KD	07/31/23	MAP
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MAP
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

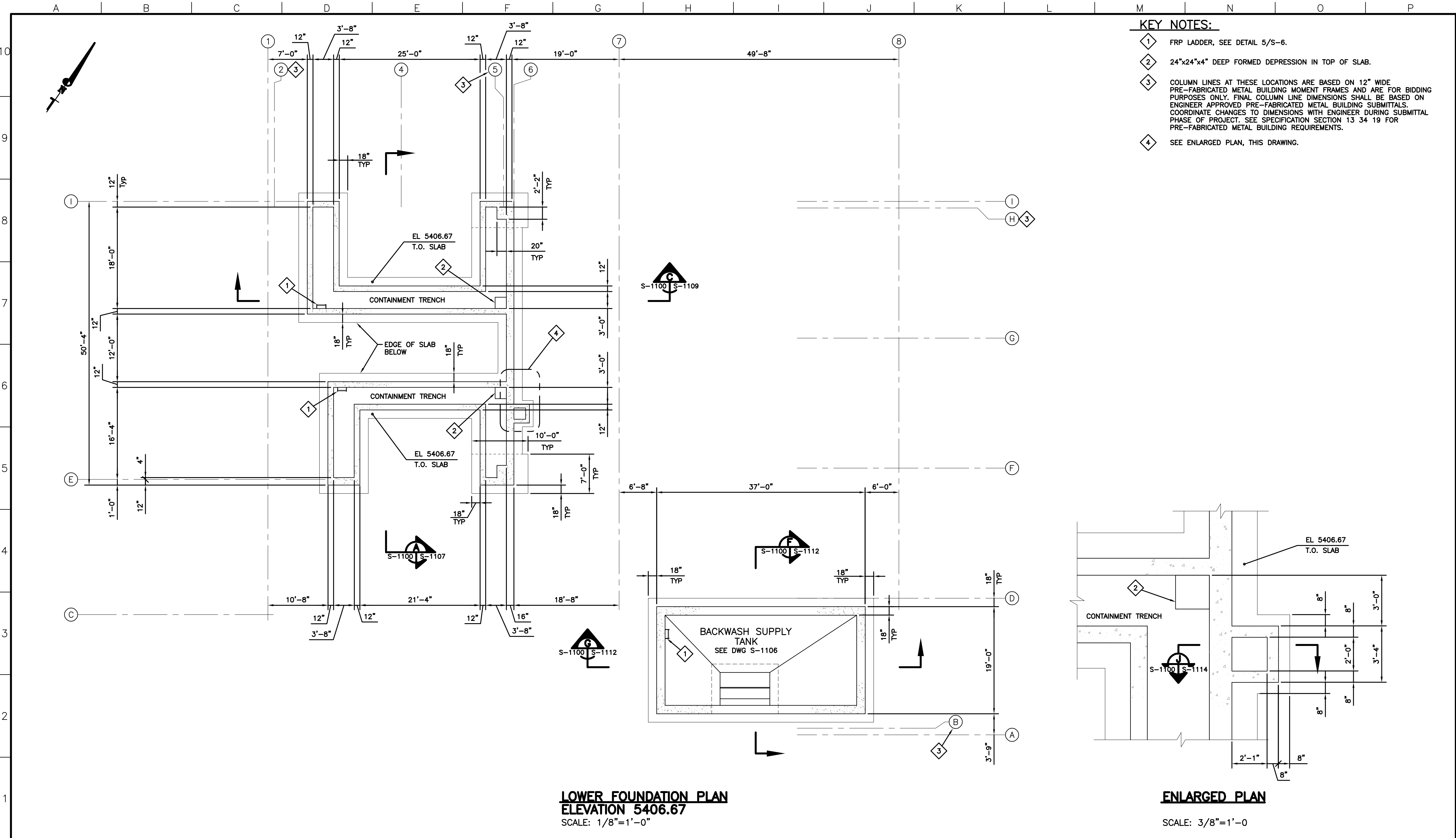
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL


STANDARD DETAILS

DATE: 06/23/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER S-8



LOWER FOUNDATION PLAN
ELEVATION 5406.67
SCALE: 1/8"=1'-0"

ENLARGED PLAN
SCALE: 3/8"=1'-0"

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(303) 825-1802

LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)
DRAWING SPL59690-1100
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
G	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP
B	REVISIONS PER REVIEW	JRA	05/09/23	MJH
C	60% DESIGN REVIEW SUBMITTAL	NJM	05/25/23	MJH
D	REVISIONS PER REVIEW	JRA	06/16/23	MJH
E	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
F	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH

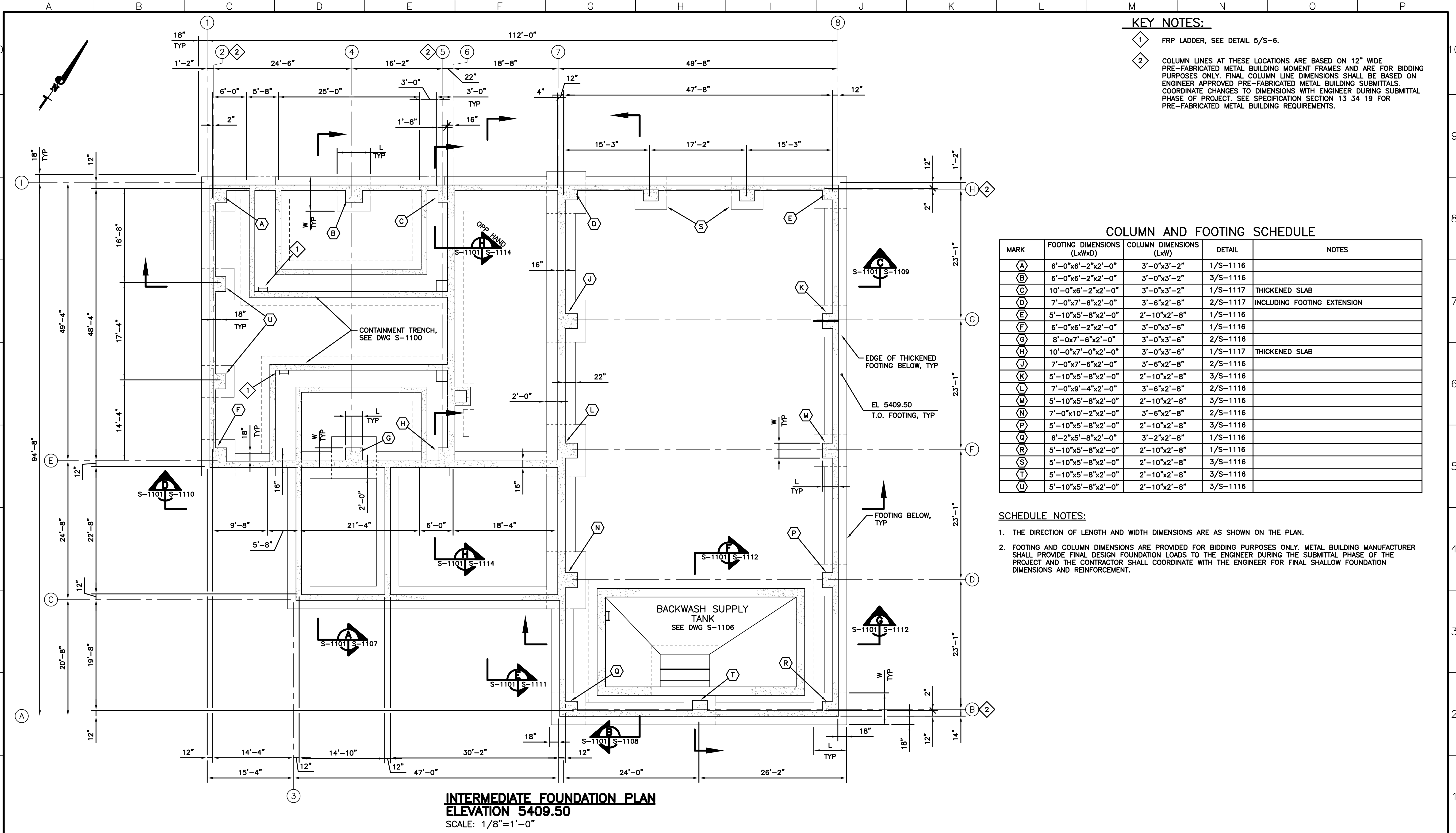
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

WATER TREATMENT PLANT
FOUNDATION PLAN EL 5406.67

DATE: 05/02/23
PROJECT NUMBER: 50159690
REVISION NO. G
DRAWING NUMBER **S-1100**
SHEET NUMBER



KEY NOTES:

- 1 FRP LADDER, SEE DETAIL 5/S-6.
- 2 COLUMN LINES AT THESE LOCATIONS ARE BASED ON 12" WIDE PRE-FABRICATED METAL BUILDING MOMENT FRAMES AND ARE FOR BIDDING PURPOSES ONLY. FINAL COLUMN LINE DIMENSIONS SHALL BE BASED ON ENGINEER APPROVED PRE-FABRICATED METAL BUILDING SUBMITTALS. COORDINATE CHANGES TO DIMENSIONS WITH ENGINEER DURING SUBMITTAL PHASE OF PROJECT. SEE SPECIFICATION SECTION 13 34 19 FOR PRE-FABRICATED METAL BUILDING REQUIREMENTS.


COLUMN AND FOOTING SCHEDULE

MARK	FOOTING DIMENSIONS (LxWxD)	COLUMN DIMENSIONS (LxW)	DETAIL	NOTES
A	6'-0"x6'-2"x2'-0"	3'-0"x3'-2"	1/S-1116	
B	6'-0"x6'-2"x2'-0"	3'-0"x3'-2"	3/S-1116	
C	10'-0"x6'-2"x2'-0"	3'-0"x3'-2"	1/S-1117	THICKENED SLAB
D	7'-0"x7'-6"x2'-0"	3'-6"x2'-8"	2/S-1117	INCLUDING FOOTING EXTENSION
E	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	1/S-1116	
F	6'-0"x6'-2"x2'-0"	3'-0"x3'-6"	1/S-1116	
G	8'-0"x7'-6"x2'-0"	3'-0"x3'-6"	2/S-1116	
H	10'-0"x7'-0"x2'-0"	3'-0"x3'-6"	1/S-1117	THICKENED SLAB
J	7'-0"x7'-6"x2'-0"	3'-6"x2'-8"	2/S-1116	
K	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	3/S-1116	
L	7'-0"x9'-4"x2'-0"	3'-6"x2'-8"	2/S-1116	
M	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	3/S-1116	
N	7'-0"x10'-2"x2'-0"	3'-6"x2'-8"	2/S-1116	
P	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	3/S-1116	
Q	6'-2"x5'-8"x2'-0"	3'-2"x2'-8"	1/S-1116	
R	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	1/S-1116	
S	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	3/S-1116	
T	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	3/S-1116	
U	5'-10"x5'-8"x2'-0"	2'-10"x2'-8"	3/S-1116	

SCHEDULE NOTES:

- THE DIRECTION OF LENGTH AND WIDTH DIMENSIONS ARE AS SHOWN ON THE PLAN.
- FOOTING AND COLUMN DIMENSIONS ARE PROVIDED FOR BIDDING PURPOSES ONLY. METAL BUILDING MANUFACTURER SHALL PROVIDE FINAL DESIGN FOUNDATION LOADS TO THE ENGINEER DURING THE SUBMITTAL PHASE OF THE PROJECT AND THE CONTRACTOR SHALL COORDINATE WITH THE ENGINEER FOR FINAL SHALLOW FOUNDATION DIMENSIONS AND REINFORCEMENT.

INTERMEDIATE FOUNDATION PLAN
ELEVATION 5409.50
SCALE: 1/8"=1'-0"

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LINE IS 2 INCHES
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DRAWING SPL59690-1101
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
G	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP
B	REVISIONS PER REVIEW	JRA	05/10/23	MJH
C	60% DESIGN REVIEW SUBMITTAL	NJM	05/25/23	MJH
D	REVISIONS PER REVIEW	JRA	07/01/23	MJH
E	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
F	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH

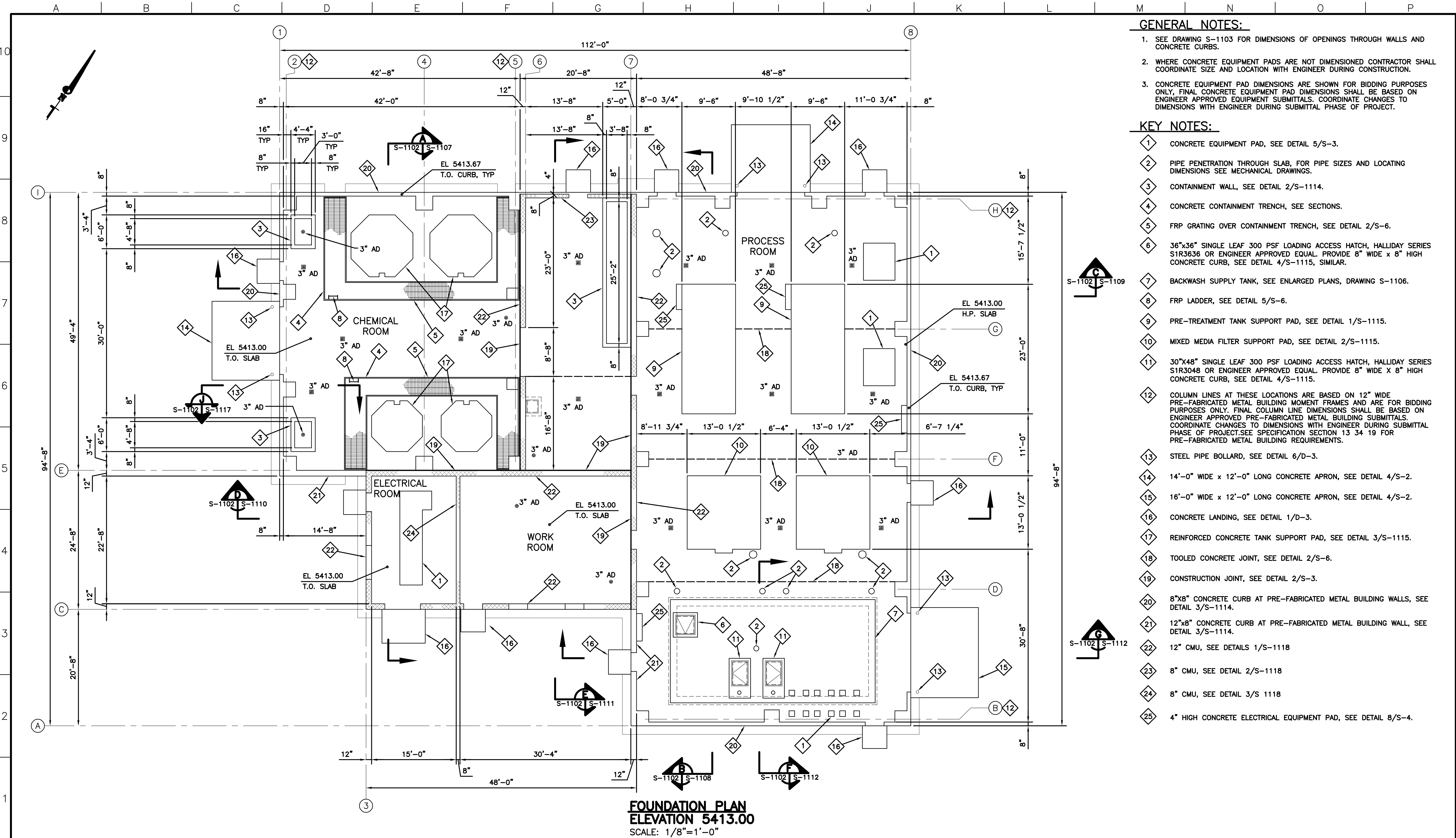
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

WATER TREATMENT PLANT
FOUNDATION PLAN EL 5409.50

DATE: 05/03/23
PROJECT NUMBER: 50159690
REVISION NO. G
DRAWING NUMBER S-1101
SHEET NUMBER




GENERAL NOTES:

1. SEE DRAWING S-1103 FOR DIMENSIONS OF OPENINGS THROUGH WALLS AND CONCRETE CURBS.
2. WHERE CONCRETE EQUIPMENT PADS ARE NOT DIMENSIONED CONTRACTOR SHALL COORDINATE SIZE AND LOCATION WITH ENGINEER DURING CONSTRUCTION.
3. CONCRETE EQUIPMENT PAD DIMENSIONS ARE SHOWN FOR BIDDING PURPOSES ONLY, FINAL CONCRETE EQUIPMENT PAD DIMENSIONS SHALL BE BASED ON ENGINEER APPROVED EQUIPMENT SUBMITTALS. COORDINATE CHANGES TO DIMENSIONS WITH ENGINEER DURING SUBMITTAL PHASE OF PROJECT.

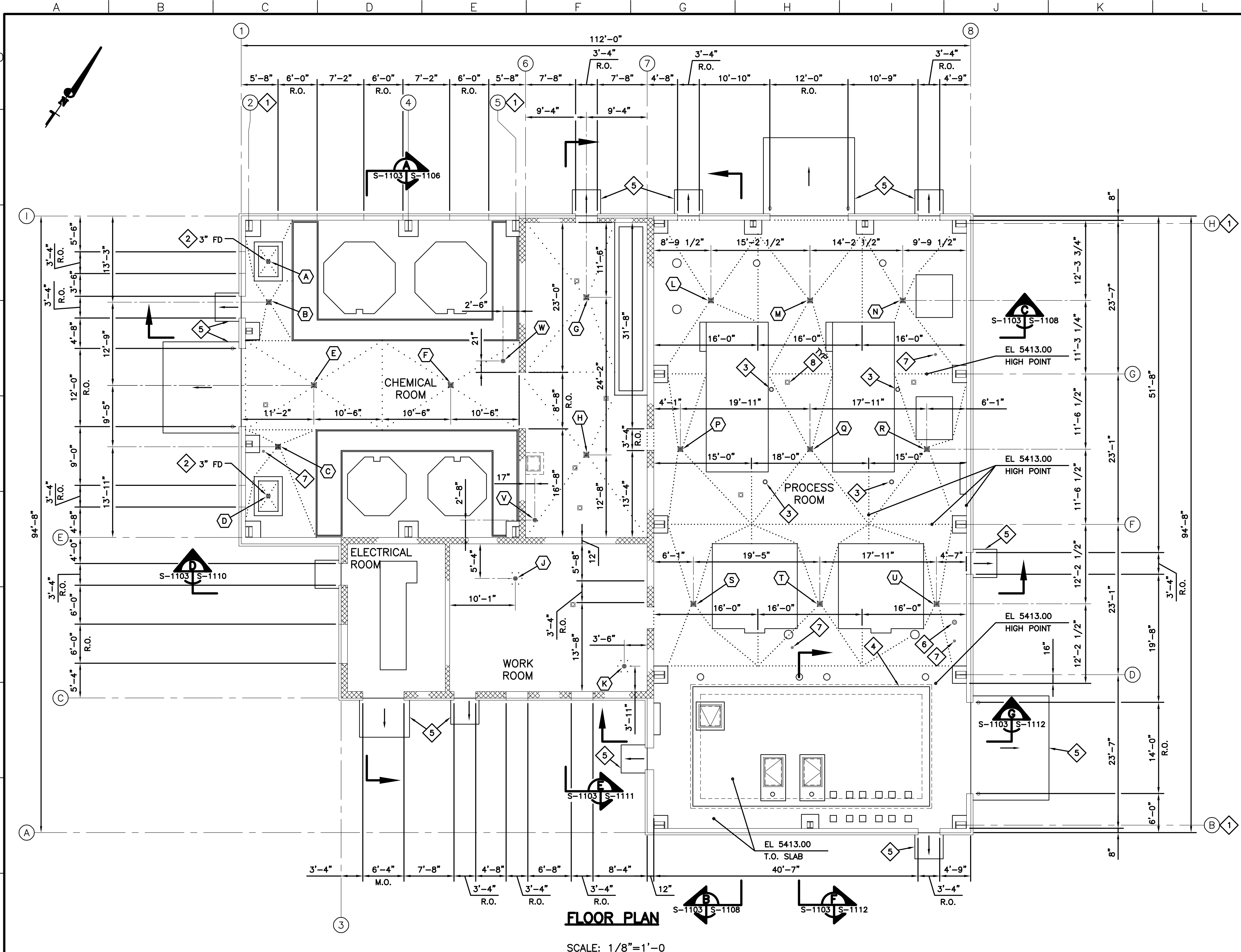
KEY NOTES:

- 1 CONCRETE EQUIPMENT PAD, SEE DETAIL 5/S-3.
- 2 PIPE PENETRATION THROUGH SLAB, FOR PIPE SIZES AND LOCATING DIMENSIONS SEE MECHANICAL DRAWINGS.
- 3 CONTAINMENT WALL, SEE DETAIL 2/S-1114.
- 4 CONCRETE CONTAINMENT TRENCH, SEE SECTIONS.
- 5 FRP GRATING OVER CONTAINMENT TRENCH, SEE DETAIL 2/S-6.
- 6 36"x36" SINGLE LEAF 300 PSF LOADING ACCESS HATCH, HALLIDAY SERIES S1R3636 OR ENGINEER APPROVED EQUAL. PROVIDE 8" WIDE x 8" HIGH CONCRETE CURB, SEE DETAIL 4/S-1115, SIMILAR.
- 7 BACKWASH SUPPLY TANK, SEE ENLARGED PLANS, DRAWING S-1106.
- 8 FRP LADDER, SEE DETAIL 5/S-6.
- 9 PRE-TREATMENT TANK SUPPORT PAD, SEE DETAIL 1/S-1115.
- 10 MIXED MEDIA FILTER SUPPORT PAD, SEE DETAIL 2/S-1115.
- 11 30"x48" SINGLE LEAF 300 PSF LOADING ACCESS HATCH, HALLIDAY SERIES S1R3048 OR ENGINEER APPROVED EQUAL. PROVIDE 8" WIDE x 8" HIGH CONCRETE CURB, SEE DETAIL 4/S-1115.
- 12 COLUMN LINES AT THESE LOCATIONS ARE BASED ON 12" WIDE PRE-FABRICATED METAL BUILDING MOMENT FRAMES AND ARE FOR BIDDING PURPOSES ONLY. FINAL COLUMN LINE DIMENSIONS SHALL BE BASED ON ENGINEER APPROVED PRE-FABRICATED METAL BUILDING SUBMITTALS. COORDINATE CHANGES TO DIMENSIONS WITH ENGINEER DURING SUBMITTAL PHASE OF PROJECT. SEE SPECIFICATION SECTION 13 34 19 FOR PRE-FABRICATED METAL BUILDING REQUIREMENTS.
- 13 STEEL PIPE BOLLARD, SEE DETAIL 6/D-3.
- 14 14'-0" WIDE x 12'-0" LONG CONCRETE APRON, SEE DETAIL 4/S-2.
- 15 16'-0" WIDE x 12'-0" LONG CONCRETE APRON, SEE DETAIL 4/S-2.
- 16 CONCRETE LANDING, SEE DETAIL 1/D-3.
- 17 REINFORCED CONCRETE TANK SUPPORT PAD, SEE DETAIL 3/S-1115.
- 18 TOOLED CONCRETE JOINT, SEE DETAIL 2/S-6.
- 19 CONSTRUCTION JOINT, SEE DETAIL 2/S-3.
- 20 8"x8" CONCRETE CURB AT PRE-FABRICATED METAL BUILDING WALLS, SEE DETAIL 3/S-1114.
- 21 12"x8" CONCRETE CURB AT PRE-FABRICATED METAL BUILDING WALL, SEE DETAIL 3/S-1114.
- 22 12" CMU, SEE DETAILS 1/S-1118
- 23 8" CMU, SEE DETAIL 2/S-1118
- 24 8" CMU, SEE DETAIL 3/S 1118
- 25 4" HIGH CONCRETE ELECTRICAL EQUIPMENT PAD, SEE DETAIL 8/S-4.

**FOUNDATION PLAN
ELEVATION 5413.00
SCALE: 1/8"=1'-0"**

 Dewberry Dewberry Engineers Inc. 990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825-1802	LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY) DRAWING SPL59690-1102 DRAWN JRA DESIGNED MJH CHECKED MAP	APPROVED:	TOWN OF SILT SILT, COLORADO					STRUCTURAL WATER TREATMENT PLANT FOUNDATION PLAN EL 5413.00	DATE: 05/03/23 PROJECT NUMBER: 50159690 REVISION NO. G DRAWING NUMBER S-1102 SHEET NUMBER
		PRINCIPAL	REVISIONS						
		DATE:	REV.	DESCRIPTION	BY	DATE	APP.		
			G	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP		

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---



GENERAL NOTES:

- 1. SEE DRAWING S-1102 FOR DIMENSIONS NOT SHOWN.
- 2. FOR FLOOR DRAIN TYPES, RIM ELEVATIONS AND FLOOR SLOPE INFORMATION SEE PLUMBING DRAWINGS.

KEY NOTES:

- 1. COLUMN LINES AT THESE LOCATIONS ARE BASED ON 12" WIDE PRE-FABRICATED METAL BUILDING MOMENT FRAMES AND ARE FOR BIDDING PURPOSES ONLY. FINAL COLUMN LINE DIMENSIONS SHALL BE BASED ON ENGINEER APPROVED PRE-FABRICATED METAL BUILDING SUBMITTALS. COORDINATE CHANGES TO DIMENSIONS WITH ENGINEER DURING SUBMITTAL PHASE OF PROJECT. SEE SPECIFICATION 13.34.19 FOR PRE-FABRICATED METAL BUILDING REQUIREMENTS.
- 2. FLOOR DRAIN SHALL BE CENTERED EACH WAY WITH CONTAINMENT AREA WALLS.
- 3. 6" INDIRECT WASTE DRAIN, SEE PLUMBING PLANS.
- 4. BACKWASH SUPPLY TANK, SEE ENLARGED PLANS, DRAWING S-1106.
- 5. CONCRETE LANDINGS AND APRONS SHALL SLOPE AWAY FROM THE BUILDING AT 2% MINIMUM.
- 6. 4" INDIRECT WASTE DRAIN, SEE PLUMBING PLANS.
- 7. 2" INDIRECT WASTE DRAIN, SEE PLUMBING PLANS.
- 8. 4" FLOOR CLEANOUT, SEE PLUMBING DRAWINGS.

AREA DRAIN DATA

MARK	RIM ELEV.(±)	GRATE SIZE	NOTES:
A	5412.97	8 INCH	ROUND INLET GRATE
B	5412.86	9 INCH	SQUARE INLET GRATE
C	5412.86	9 INCH	SQUARE INLET GRATE
D	5412.86	8 INCH	ROUND INLET GRATE
E	5412.88	9 INCH	SQUARE INLET GRATE
F	5412.89	9 INCH	SQUARE INLET GRATE
G	5412.88	9 INCH	SQUARE INLET GRATE
H	5412.88	9 INCH	SQUARE INLET GRATE
J	5412.98	8 INCH	ROUND INLET GRATE, 18"ø DISHED FLOOR
K	5412.98	8 INCH	ROUND INLET GRATE, 18"ø DISHED FLOOR
L	5412.87	9 INCH	SQUARE INLET GRATE
M	5412.87	9 INCH	SQUARE INLET GRATE
N	5412.87	9 INCH	SQUARE INLET GRATE
P	5412.87	9 INCH	SQUARE INLET GRATE
Q	5412.87	9 INCH	SQUARE INLET GRATE
R	5412.87	9 INCH	SQUARE INLET GRATE
S	5412.87	9 INCH	SQUARE INLET GRATE
T	5412.87	9 INCH	SQUARE INLET GRATE
U	5412.87	9 INCH	SQUARE INLET GRATE
V	5412.94	8 INCH	ROUND INLET GRATE
W	5412.93	8 INCH	ROUND INLET GRATE

FLOOR PLAN

SCALE: 1/8"=1'-0"

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DRAWING SPL59690-1103
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	06/19/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

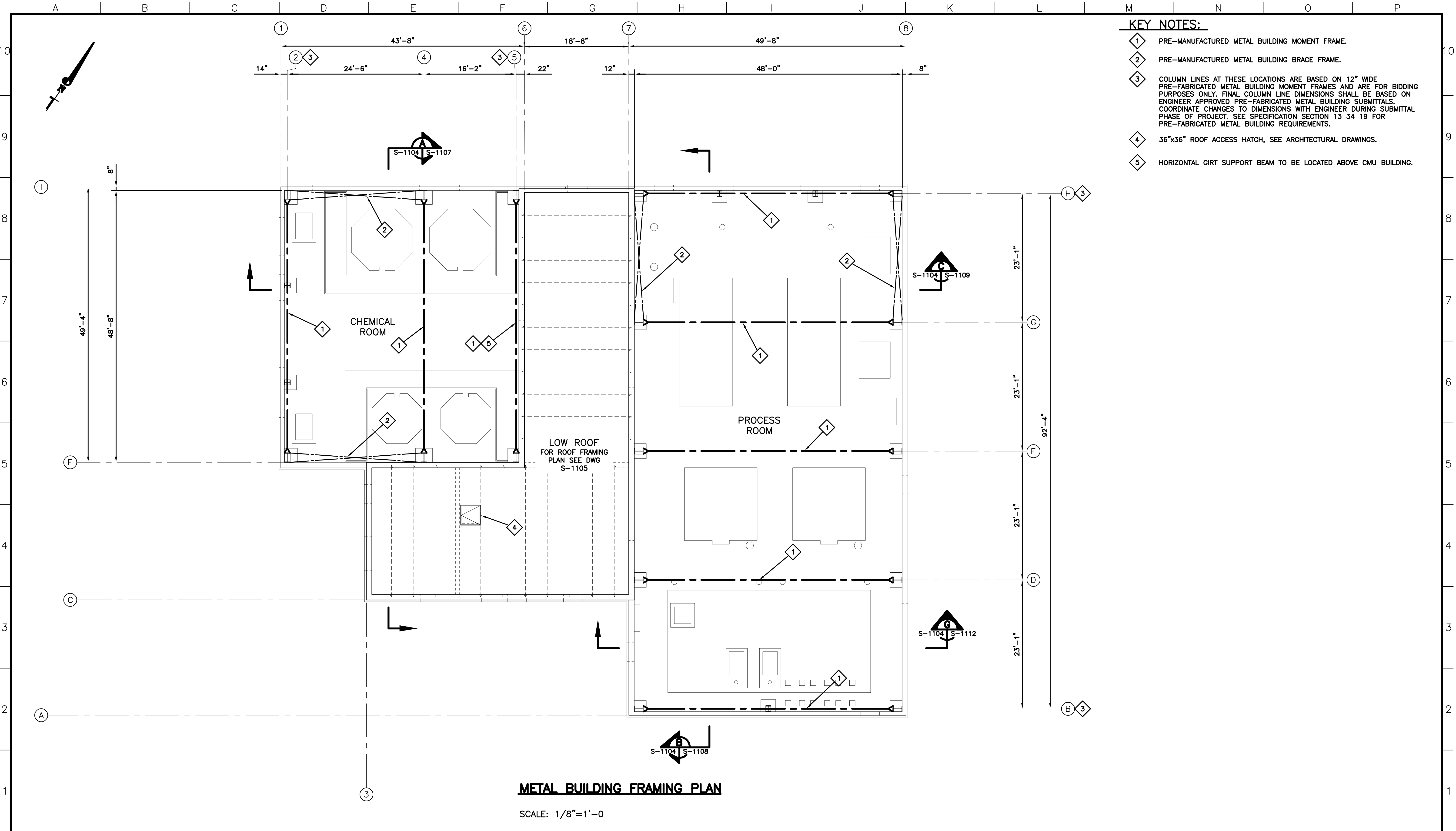
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

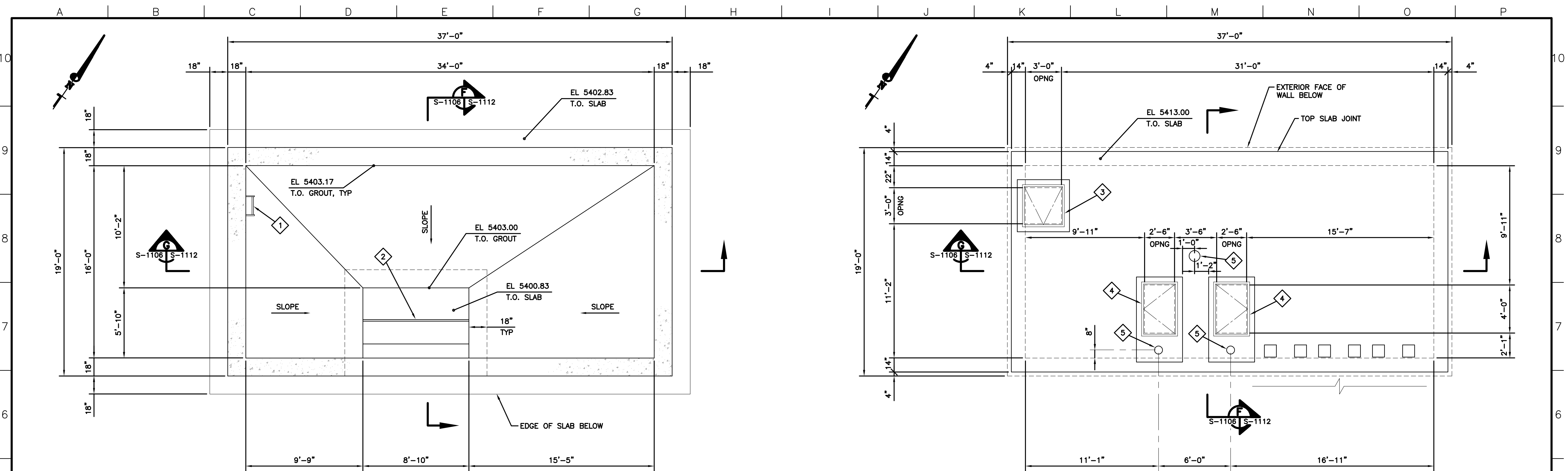
STRUCTURAL

WATER TREATMENT PLANT
FLOOR PLAN EL 5416.00

DATE: 06/19/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
S-1103
SHEET NUMBER



REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	05/25/23	MJH
B	REVISIONS PER REVIEW	JRA	06/21/23	MJH
C	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
D	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
E	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

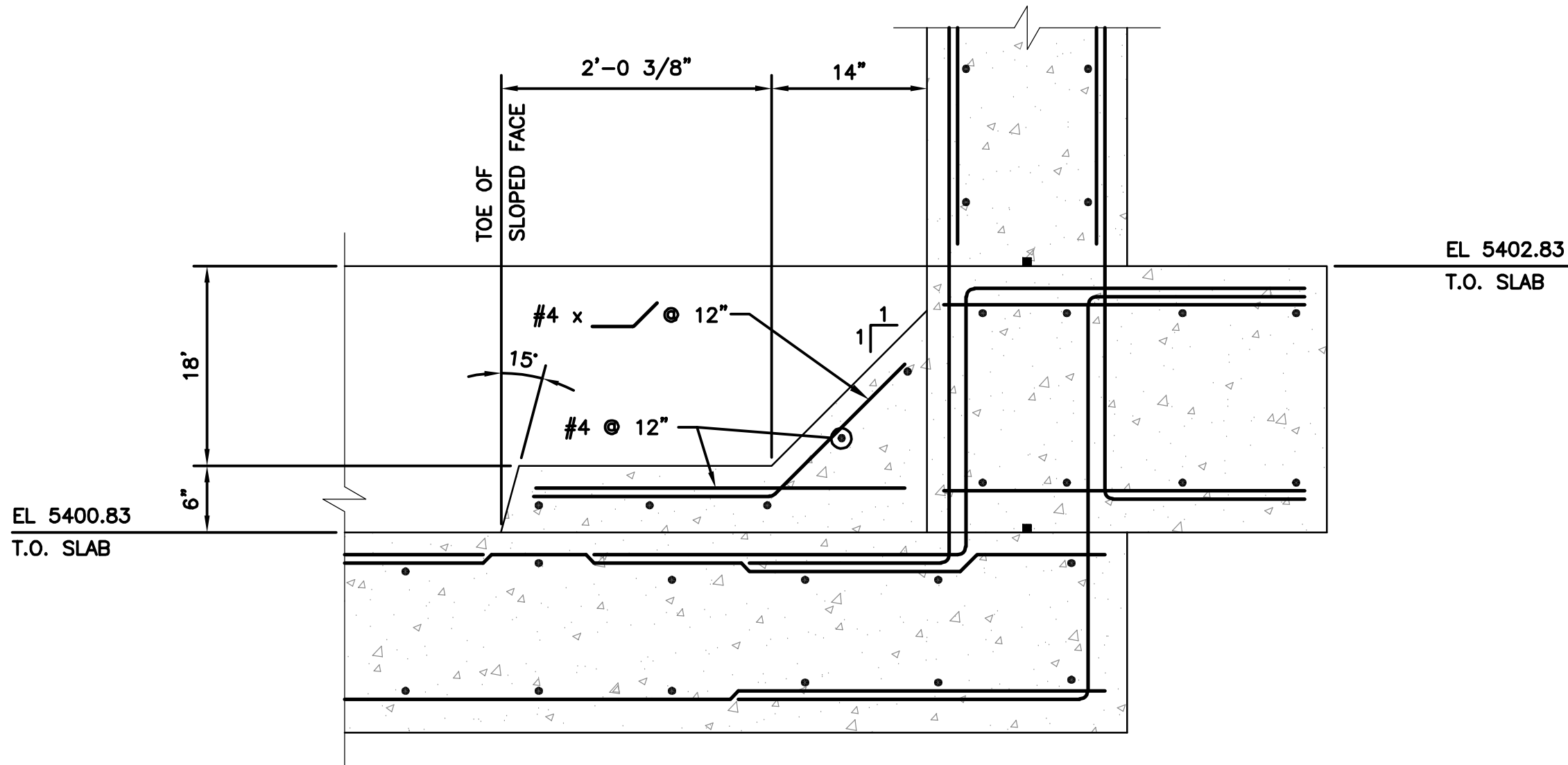


FOUNDATION PLAN

SCALE: 1/4"=1'-0

GROUND LEVEL PLAN


SCALE: 1/4"=1'-0



1 DETAIL
PUMP SUPPORT SHELF
SCALE: 1"=1'-0

KEY NOTES:

- 1 FRP LADDER, SEE DETAIL 5/S-6.
- 2 CONCRETE PUMP SUPPORT SHELF, SEE DETAIL 1/S-1106.
- 3 36"x36" SINGLE LEAF 300 PSF LOADING ACCESS HATCH, HALLIDAY SERIES S1R3636 OR ENGINEER APPROVED EQUAL. PROVIDE 8" WIDE x 8" HIGH CONCRETE CURB, SEE DETAIL 3/S-2, SIMILAR.
- 4 30"x48" SINGLE LEAF 300 PSF LOADING ACCESS HATCH, HALLIDAY SERIES S1R3048 OR ENGINEER APPROVED EQUAL. PROVIDE 8" WIDE x 8" HIGH CONCRETE CURB, SEE DETAIL 3/S-2.
- 5 PIPE PENETRATION THROUGH SLAB, FOR PIPE SIZES SEE MECHANICAL DRAWINGS. SEE DETAIL 5/S-2 FOR REINFORCEMENT REQUIREMENTS.

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LINE IS 2 INCHES
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DRAWING SPL59690-1106
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	06/20/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

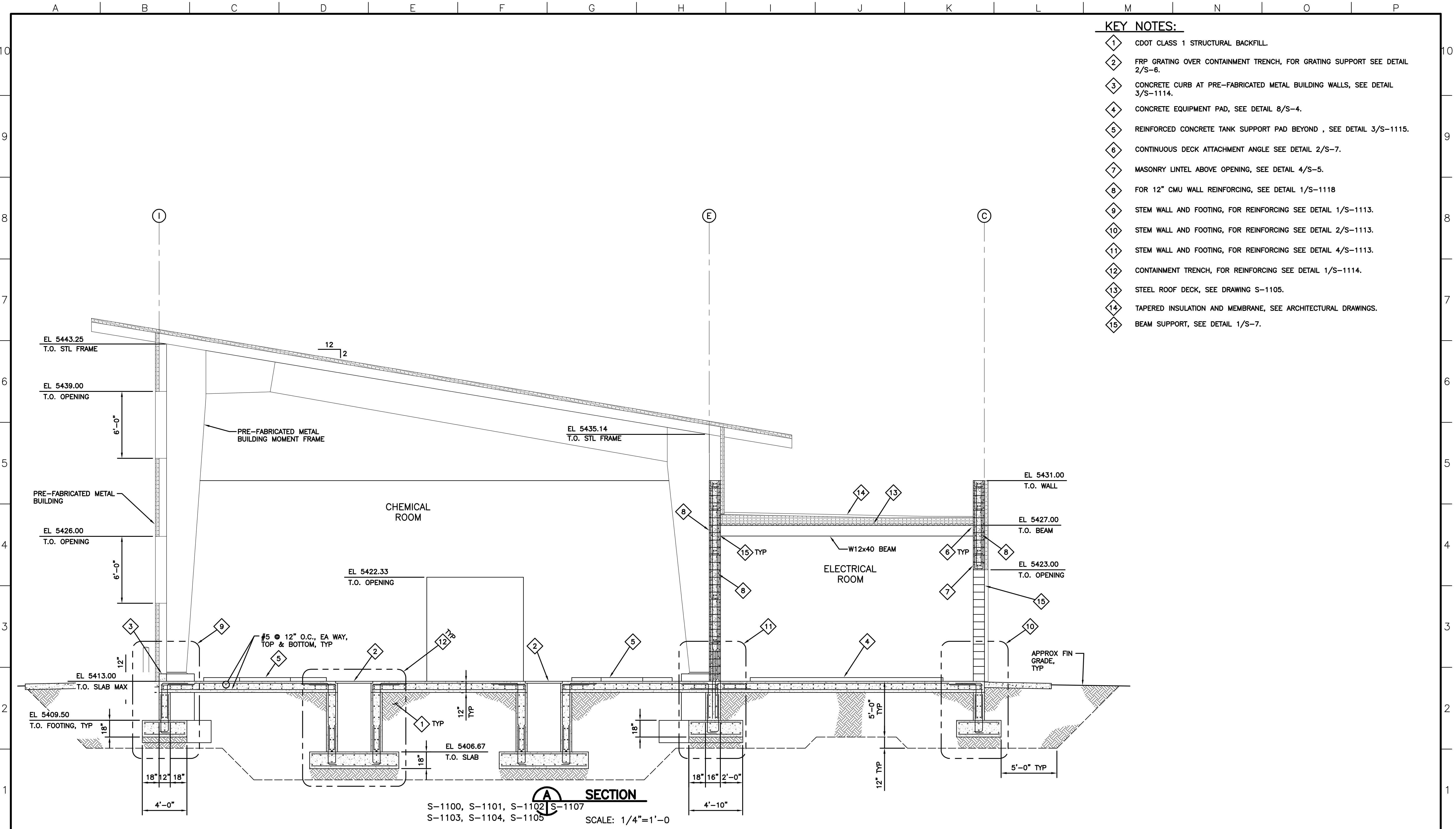
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS


STRUCTURAL

BACKWASH SUPPLY TANK
ENLARGED PLANS AND DETAIL

DATE: 06/20/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
S-1106
SHEET NUMBER



- KEY NOTES:**
- 1 CDOT CLASS 1 STRUCTURAL BACKFILL.
 - 2 FRP GRATING OVER CONTAINMENT TRENCH, FOR GRATING SUPPORT SEE DETAIL 2/S-6.
 - 3 CONCRETE CURB AT PRE-FABRICATED METAL BUILDING WALLS, SEE DETAIL 3/S-1114.
 - 4 CONCRETE EQUIPMENT PAD, SEE DETAIL 8/S-4.
 - 5 REINFORCED CONCRETE TANK SUPPORT PAD BEYOND , SEE DETAIL 3/S-1115.
 - 6 CONTINUOUS DECK ATTACHMENT ANGLE SEE DETAIL 2/S-7.
 - 7 MASONRY LINTEL ABOVE OPENING, SEE DETAIL 4/S-5.
 - 8 FOR 12" CMU WALL REINFORCING, SEE DETAIL 1/S-1118
 - 9 STEM WALL AND FOOTING, FOR REINFORCING SEE DETAIL 1/S-1113.
 - 10 STEM WALL AND FOOTING, FOR REINFORCING SEE DETAIL 2/S-1113.
 - 11 STEM WALL AND FOOTING, FOR REINFORCING SEE DETAIL 4/S-1113.
 - 12 CONTAINMENT TRENCH, FOR REINFORCING SEE DETAIL 1/S-1114.
 - 13 STEEL ROOF DECK, SEE DRAWING S-1105.
 - 14 TAPERED INSULATION AND MEMBRANE, SEE ARCHITECTURAL DRAWINGS.
 - 15 BEAM SUPPORT, SEE DETAIL 1/S-7.

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DRAWING SPL59690-1107
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	05/03/23	MJH
B	REVISIONS PER REVIEW	JRA	05/10/23	MJH
C	60% DESIGN REVIEW SUBMITTAL	NJM	05/25/23	MJH
D	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
E	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
F	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

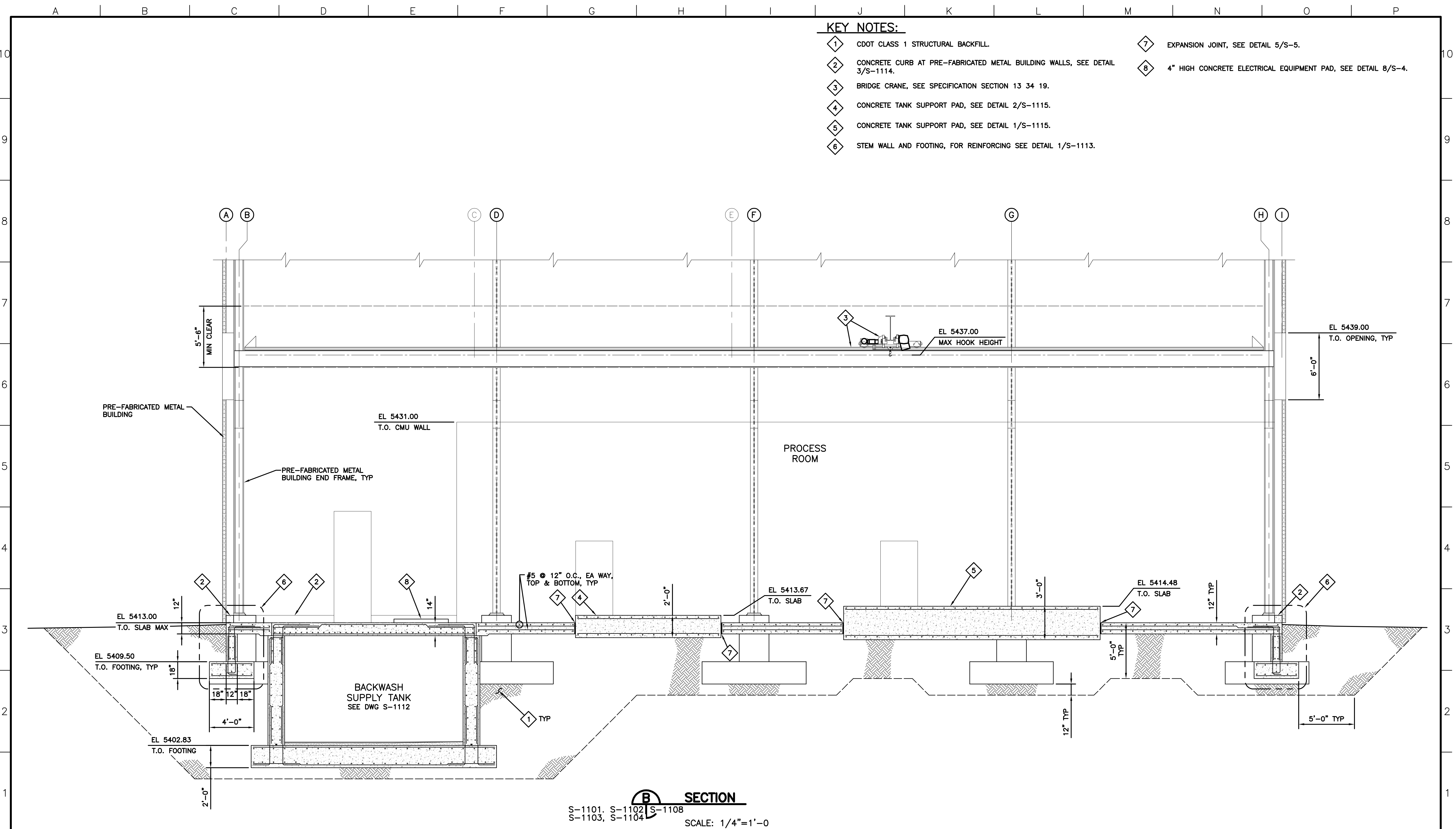
TOWN OF SILT
SILT, COLORADO


WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

WATER TREATMENT PLANT
SECTION

DATE: 05/03/23
PROJECT NUMBER: 50159690
REVISION NO. F
DRAWING NUMBER
S-1107
SHEET NUMBER



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AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)
DRAWING SPL59690-1108
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	05/03/23	MJH
B	REVISIONS PER REVIEW	JRA	05/10/23	MJH
C	60% DESIGN REVIEW SUBMITTAL	NJM	05/25/23	MJH
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E	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
F	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

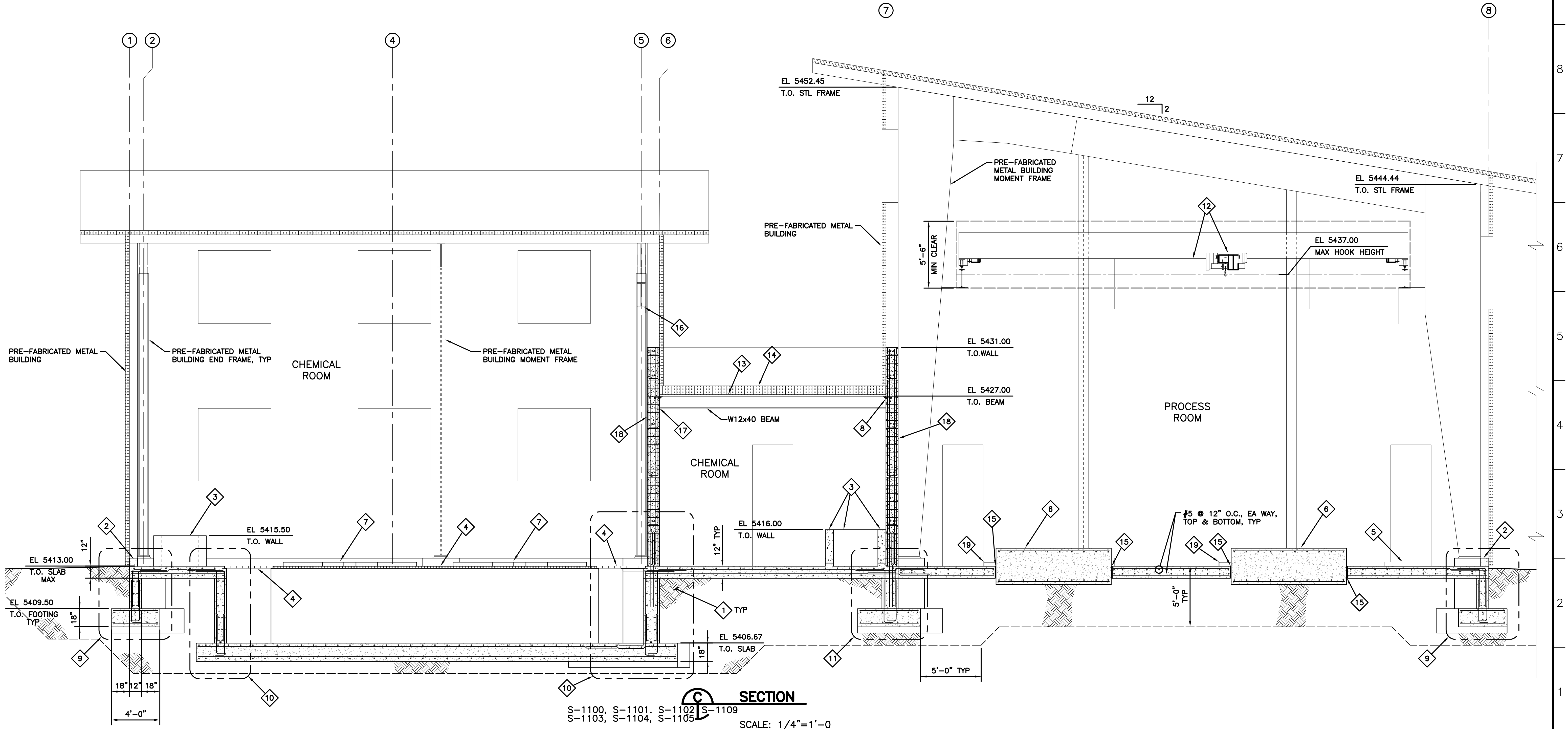
STRUCTURAL

WATER TREATMENT PLANT
SECTION

DATE: 05/03/23
PROJECT NUMBER: 50159690
REVISION NO. F
DRAWING NUMBER
S-1108
SHEET NUMBER

KEY NOTES:

- | | | | | | | | |
|---|--|----|---|----|---|----|--|
| 1 | CDOT CLASS 1 STRUCTURAL BACKFILL. | 7 | REINFORCED CONCRETE TANK SUPPORT PAD BEYOND, SEE DETAIL 3/S-1115. | 12 | BRIDGE CRANE, SEE SPECIFICATION SECTION 13 34 19. | 17 | BEAM SUPPORT, SEE DETAIL 1/S-7. |
| 2 | CONCRETE CURB AT PRE-FABRICATED METAL BUILDING WALLS, SEE DETAIL 3/S-1114. | 8 | CONTINUOUS DECK ATTACHMENT ANGLE SEE DETAIL 2/S-7. | 13 | TAPERED INSULATION AND MEMBRANE, SEE ARCHITECTURAL DRAWINGS. | 18 | 12" CMU, SEE DETAIL 1/S-1118. |
| 3 | CONCRETE CONTAINMENT WALL, SEE DETAIL 2/S-1114. | 9 | STEM WALL AND FOOTING, FOR REINFORCING SEE DETAIL 1/S-1113. | 14 | STEEL ROOF DECK, SEE DRAWING S-1105. | 19 | 4" HIGH CONCRETE ELECTRICAL EQUIPMENT PAD, SEE DETAIL 8/S-4. |
| 4 | 2" FRP GRATING, FOR GRATING SUPPORT SEE DETAIL 2/S-6. | 10 | CONTAINMENT TRENCH, FOR REINFORCING SEE DETAIL 2/S-1114. | 15 | EXPANSION JOINT, SEE DETAIL 5/S-5. | | |
| 5 | CONCRETE EQUIPMENT PAD, SEE DETAIL 8/S-4. | 11 | STEM WALL AND FOOTING, FOR REINFORCING SEE DETAIL 5/S-1113. | 16 | HORIZONTAL GIRT SUPPORT BEAM TO BE LOCATED ABOVE CMU BUILDING. DO NOT ATTACH GIRT'S OR OTHER METAL BUILDING STRUCTURAL MEMBERS TO CMU BUILDING. | | |
| 6 | CONCRETE TANK SUPPORT PAD, SEE DETAIL 1/S-1115. | | | | | | |



SECTION

S-1100, S-1101, S-1102, S-1109
S-1103, S-1104, S-1105

SCALE: 1/4"=1'-0

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LINE IS 2 INCHES
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(IF NOT 2"=SCALE ACCORDINGLY)
DRAWING SPL59690-1109
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	TWL	07/07/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

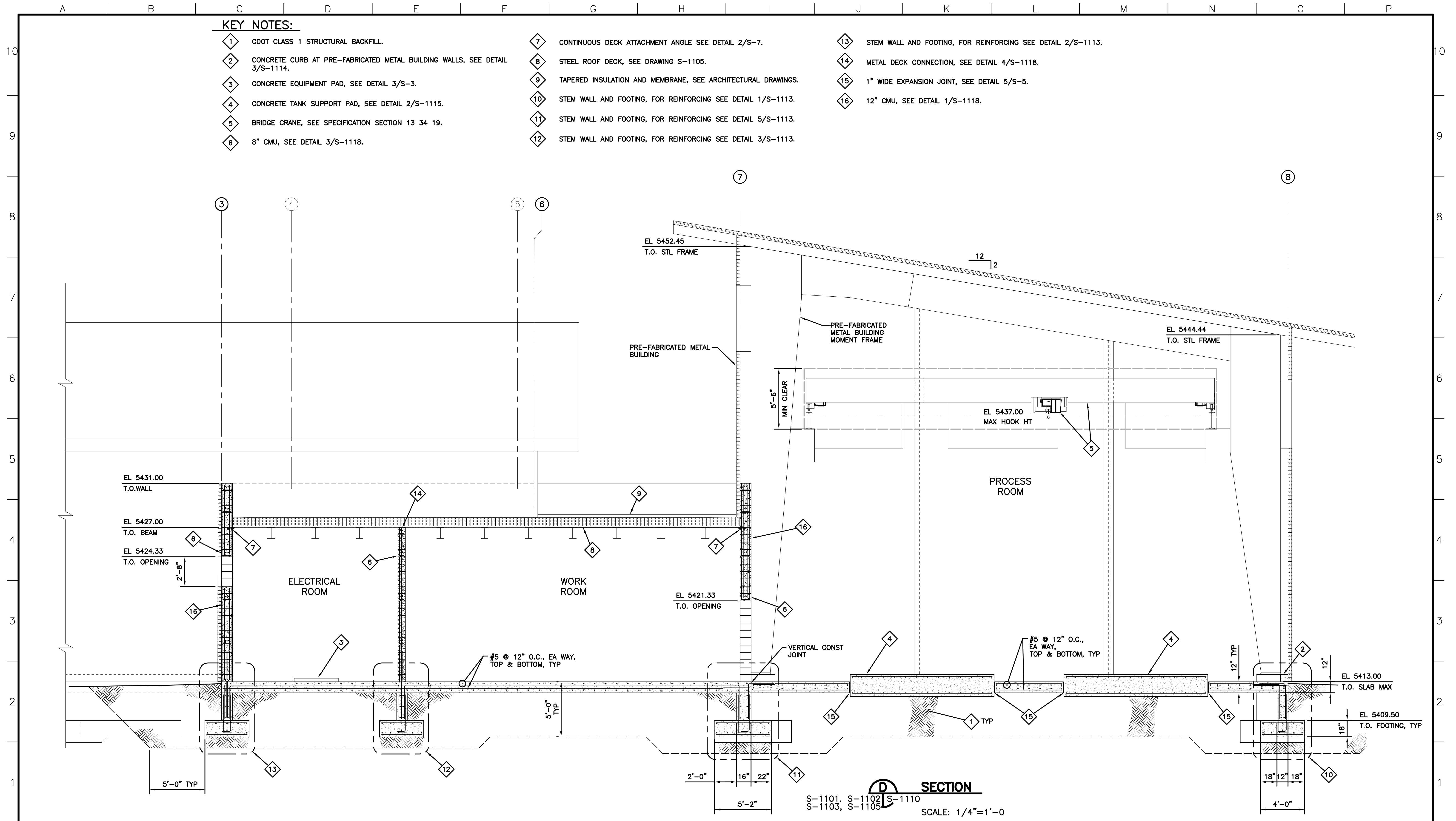
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

WATER TREATMENT PLANT
SECTION

DATE: 07/02/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
S-1109
SHEET NUMBER



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DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	TWL	07/07/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

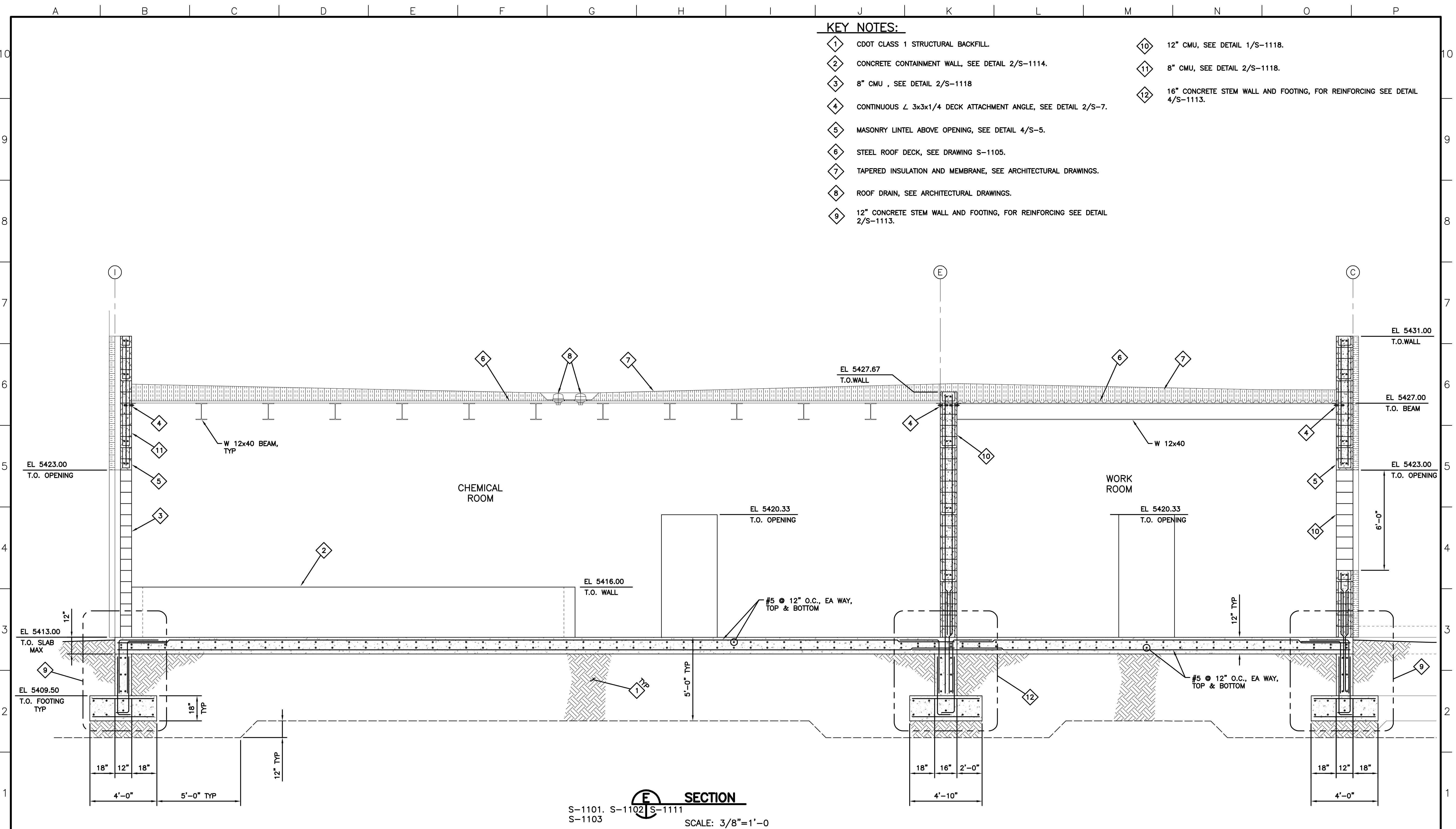
**TOWN OF SILT
SILT, COLORADO**

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

**WATER TREATMENT PLANT
SECTION**

DATE: 07/02/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
S-1110
SHEET NUMBER



- KEY NOTES:**
- 1

CDOT CLASS 1 STRUCTURAL BACKFILL.
- 2

CONCRETE CONTAINMENT WALL, SEE DETAIL 2/S-1114.
- 3

8" CMU , SEE DETAIL 2/S-1118
- 4

CONTINUOUS \angle 3x3x1/4 DECK ATTACHMENT ANGLE, SEE DETAIL 2/S-7.
- 5

MASONRY LINTEL ABOVE OPENING, SEE DETAIL 4/S-5.
- 6

STEEL ROOF DECK, SEE DRAWING S-1105.
- 7

TAPERED INSULATION AND MEMBRANE, SEE ARCHITECTURAL DRAWINGS.
- 8


ROOF DRAIN, SEE ARCHITECTURAL DRAWINGS.
- 9

12" CONCRETE STEM WALL AND FOOTING, FOR REINFORCING SEE DETAIL 2/S-1113.
- 10

12" CMU, SEE DETAIL 1/S-1118.
- 11

8" CMU, SEE DETAIL 2/S-1118.
- 12

16" CONCRETE STEM WALL AND FOOTING, FOR REINFORCING SEE DETAIL 4/S-1113.

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DRAWING SPL59690-1111
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	05/04/23	MJH
B	REVISIONS PER REVIEW	JRA	05/10/23	MJH
C	60% DESIGN REVIEW SUBMITTAL	NJM	05/25/23	MJH
D	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
E	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
F	BUILDING DEPT REVIEW SUBMITTAL	JRA	1-/13/23	MAP

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

WATER TREATMENT PLANT
SECTION

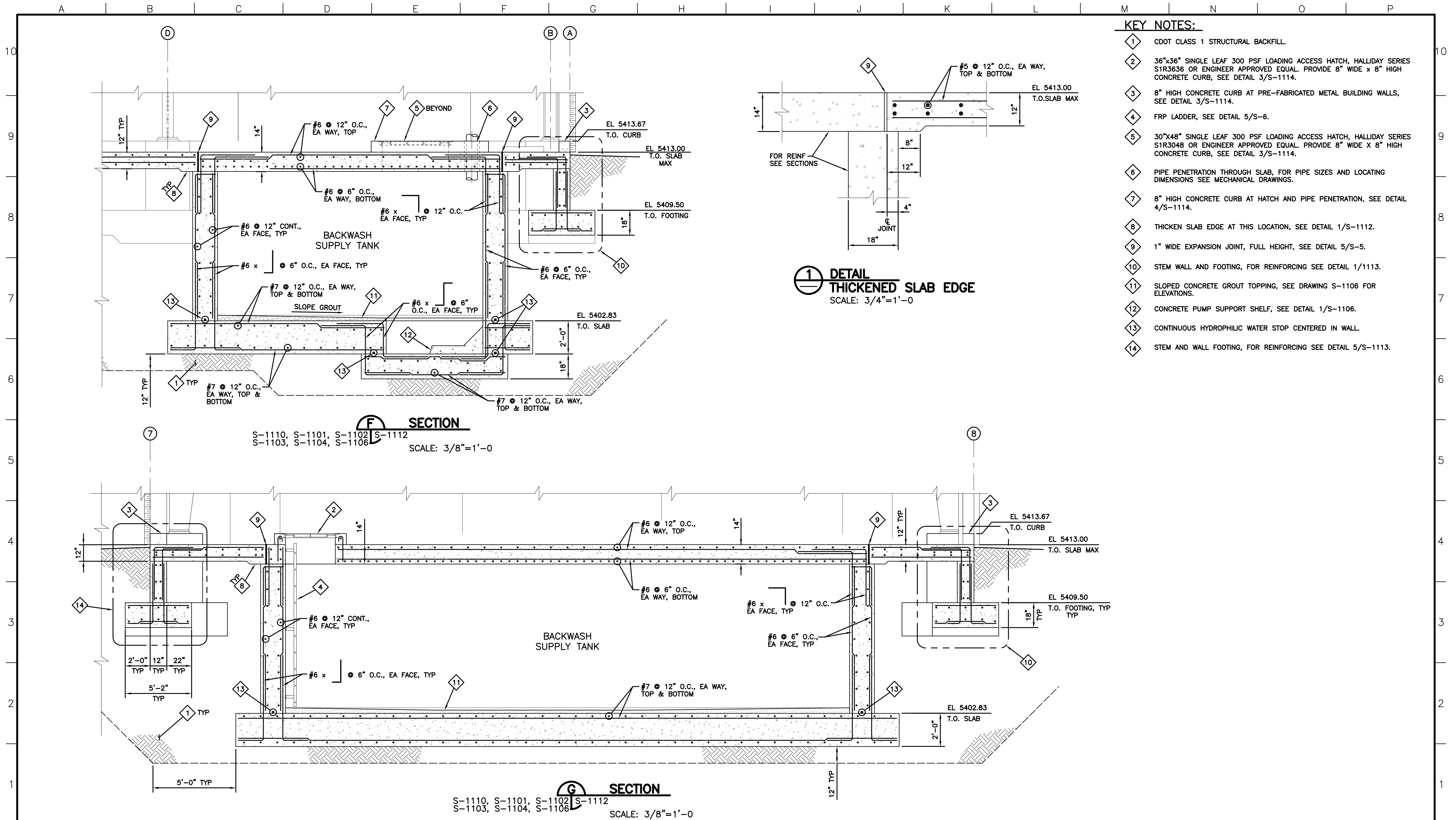
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PROJECT NUMBER: 50159690

REVISION NO. F

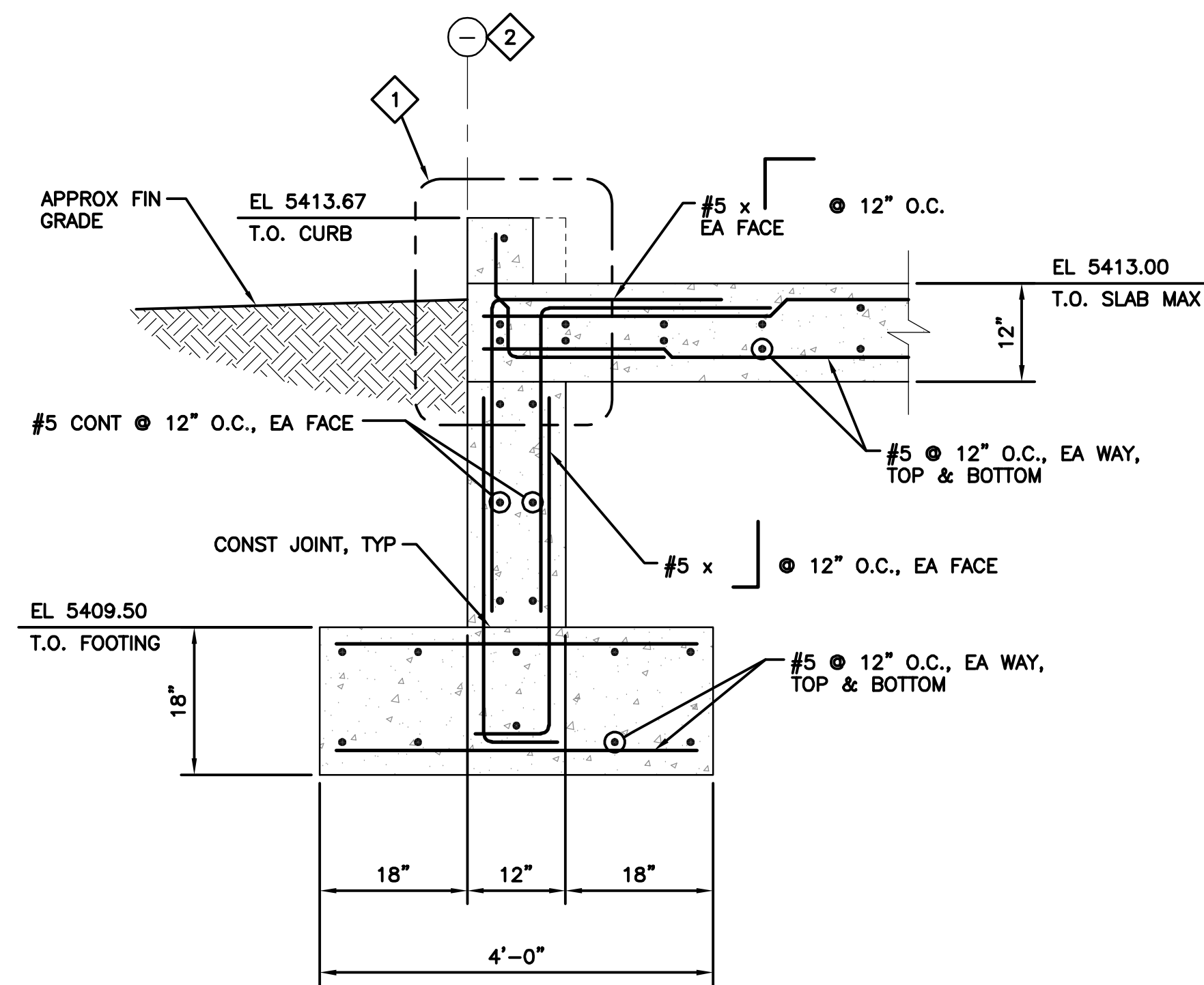
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S-1111

SHEET NUMBER

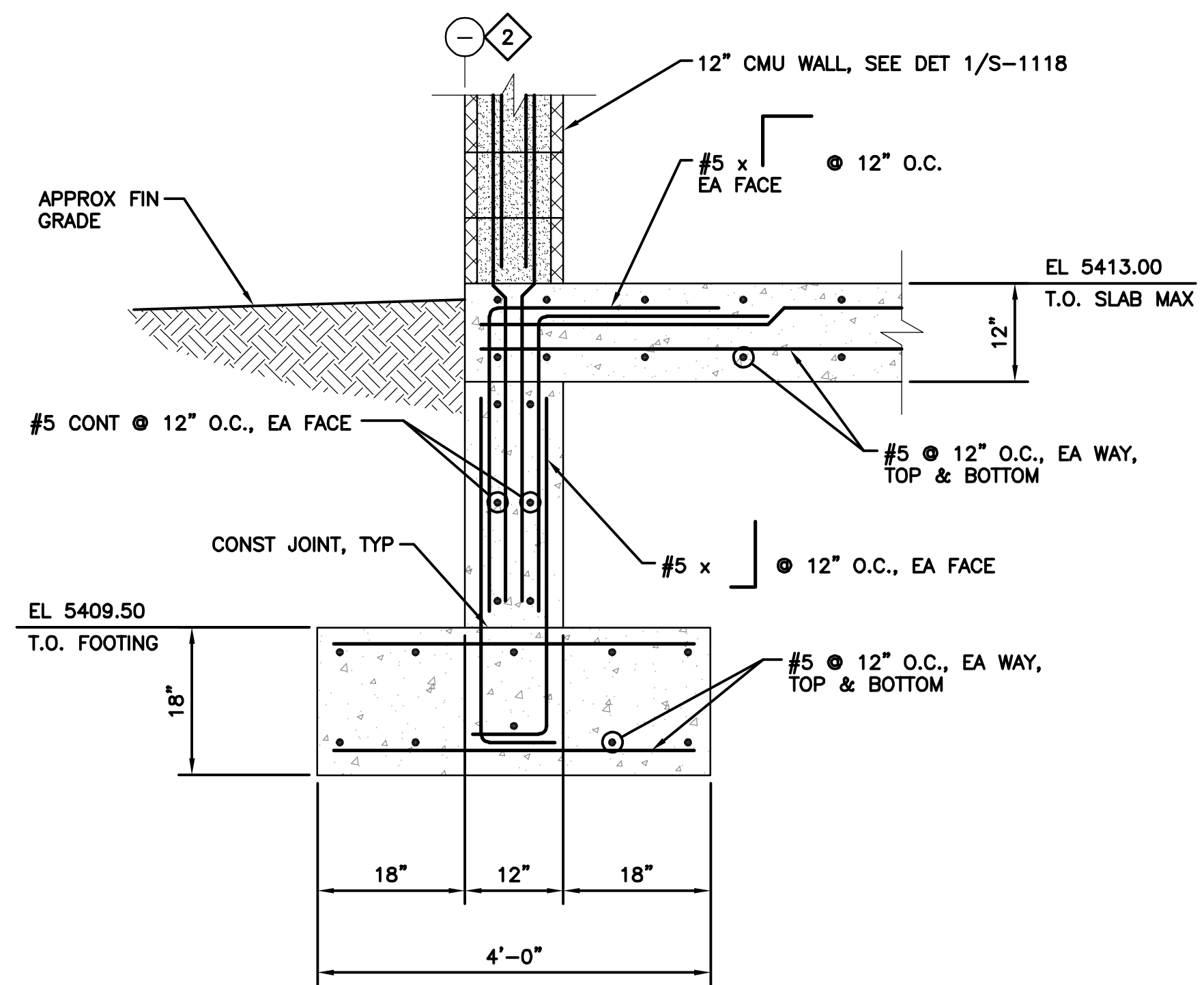


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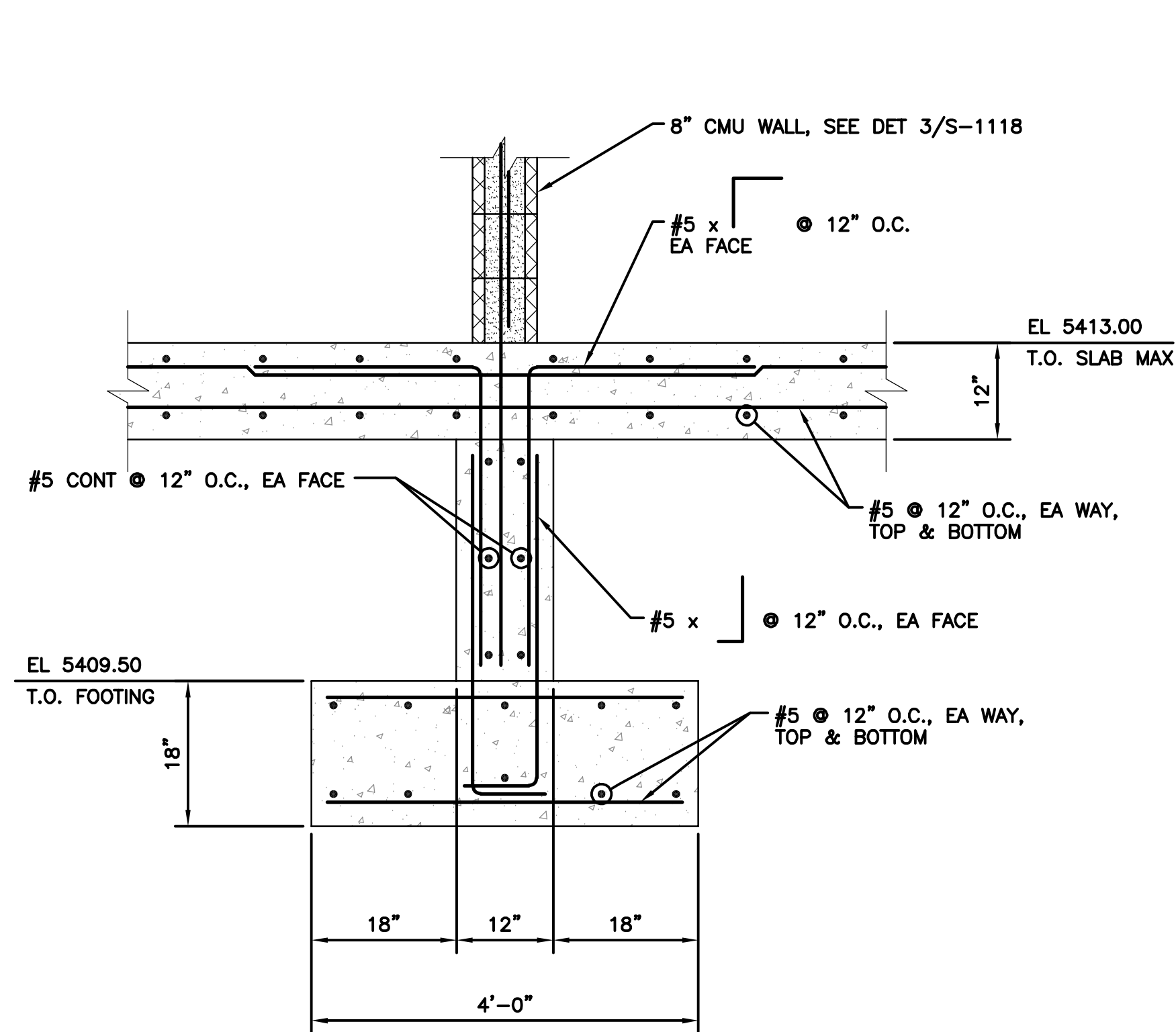
10
9
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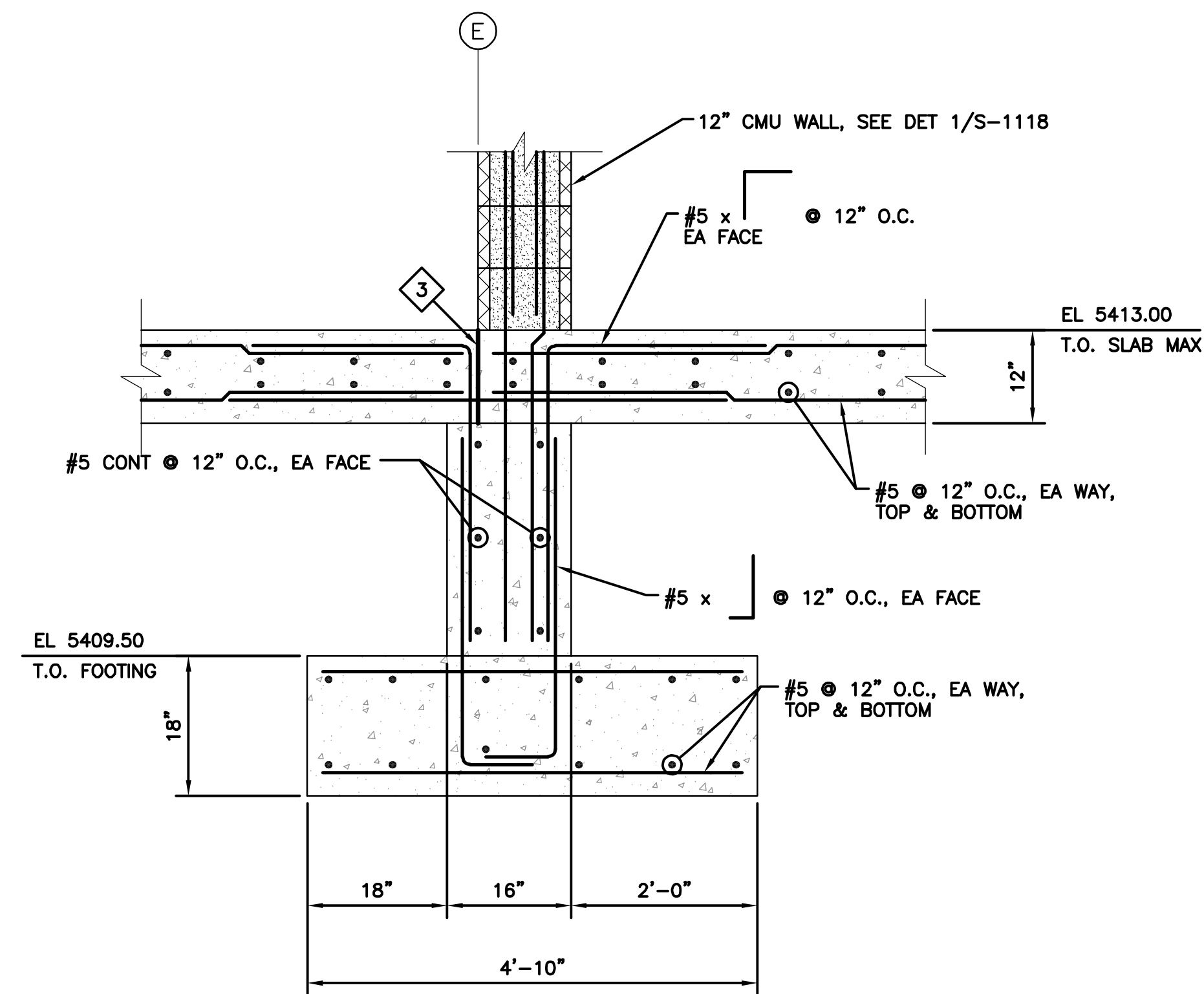
1 DETAIL
PERIMETER FDN AT METAL BUILDING
SCALE: 3/4"=1'-0



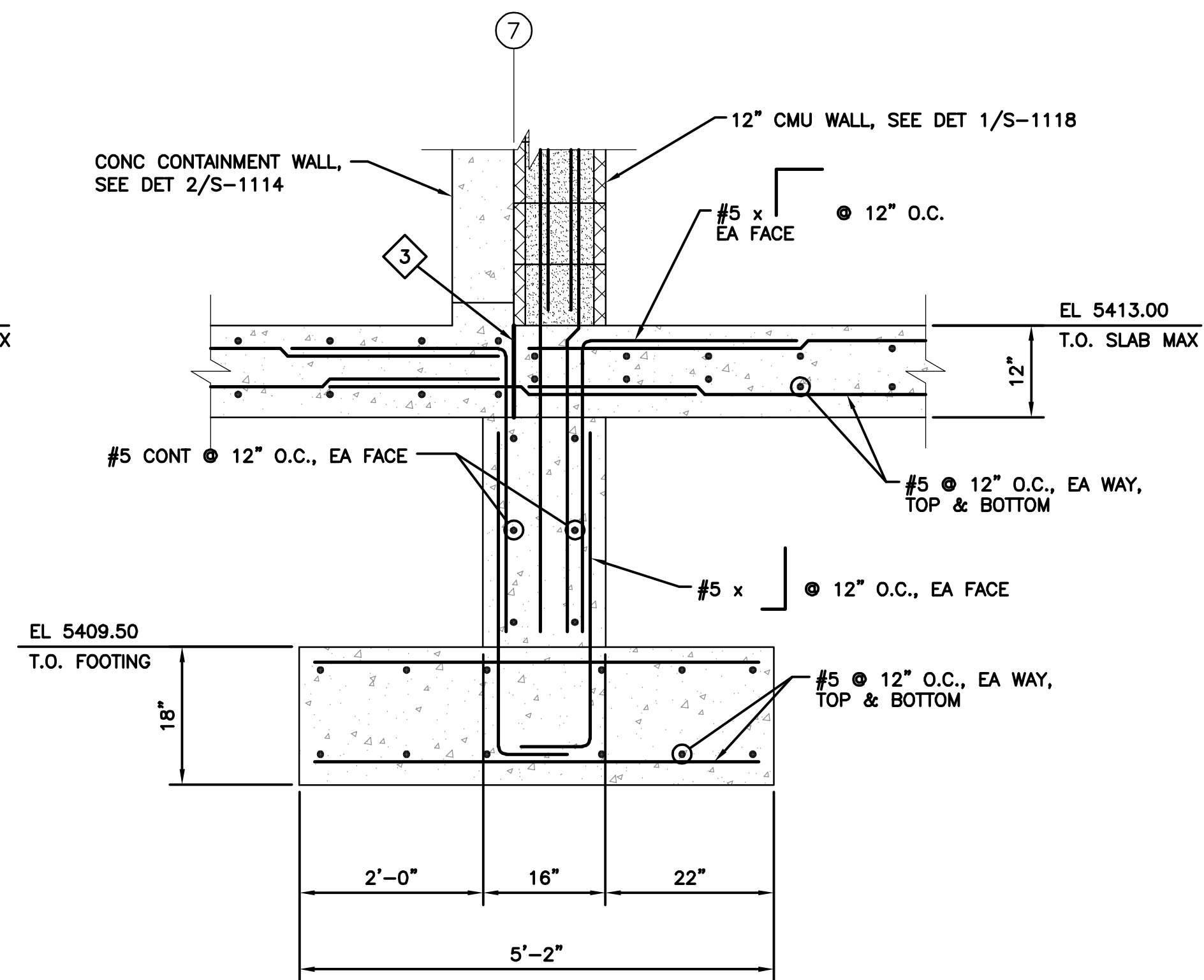
2 DETAIL
PERIMETER FDN AT 12" CMU WALLS
SCALE: 3/4"=1'-0



3 DETAIL
INTERIOR FDN AT 8" CMU WALLS
SCALE: 3/4"=1'-0



4 DETAIL
INTERIOR FDN AT 12" CMU WALLS
SCALE: 3/4"=1'-0



5 DETAIL
INTERIOR FDN AT 12" CMU WALLS
SCALE: 3/4"=1'-0

KEY NOTES:

- 1 8" HIGH CONCRETE CURB AT PRE-FABRICATED METAL BUILDING WALLS, SEE DETAIL 3/S-1114.
- 2 GRID INDEX LOCATION VARIES, SEE STRUCTURAL PLANS AND SECTIONS.
- 3 CONSTRUCTION JOINT, SEE DETAIL 2/S-3.

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DRAWING SPL59690-1113
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

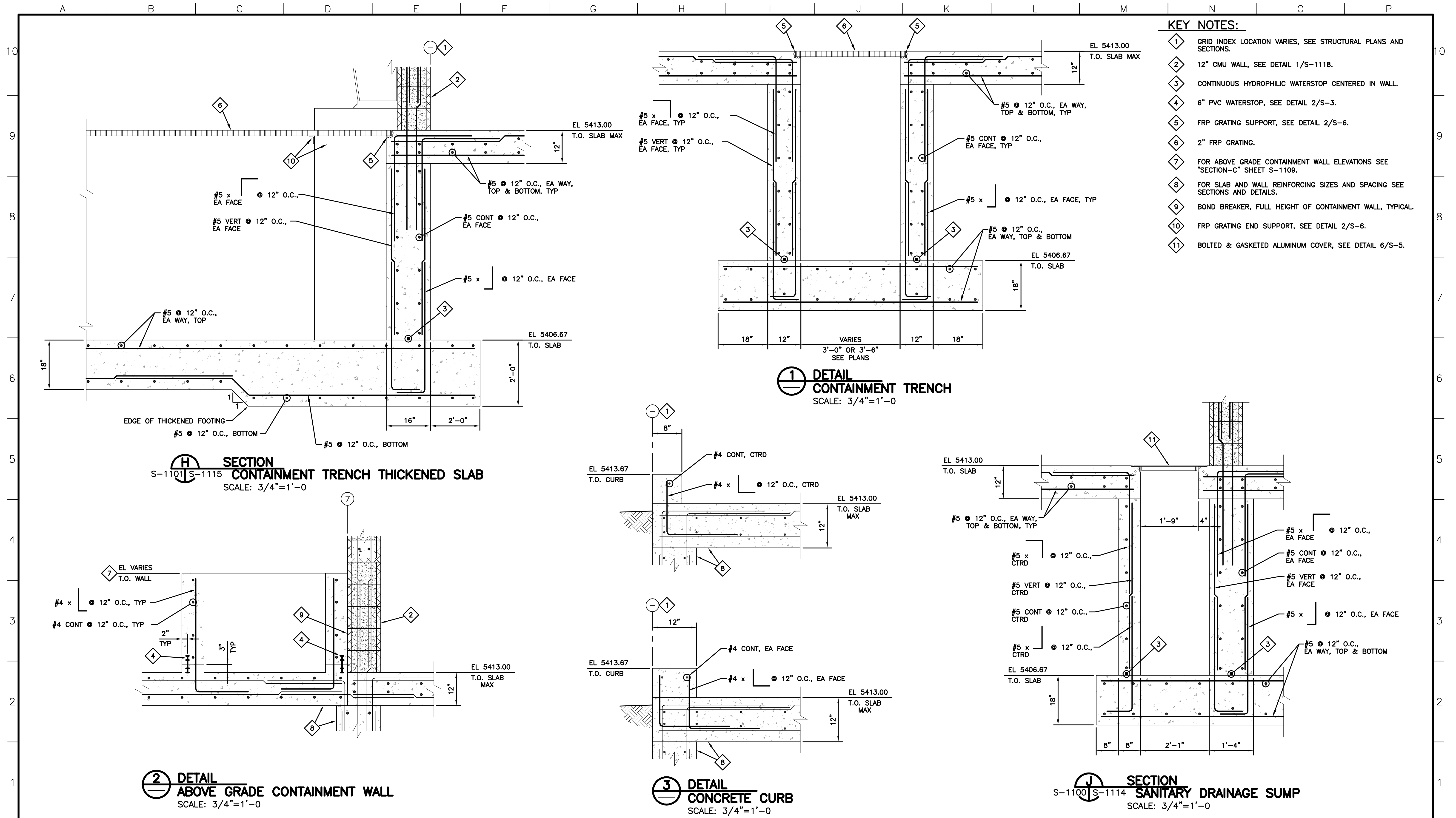
DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
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B	90% DESIGN REVIEW SUBMITTAL	KD	07/31/23	MJH
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

TOWN OF SILT
SILT, COLORADO
WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL
WATER TREATMENT PLANT
FOUNDATION SECTIONS AND DETAILS

DATE: 06/30/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
S-1113
SHEET NUMBER



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DRAWING	SPL59690-1114
DRAWN	JRA/TWL
DESIGNED	MJH
CHECKED	MAP

APPROVED:	
PRINCIPAL	
DATE:	

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	TWL	07/07/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	KD	07/31/23	MJH
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

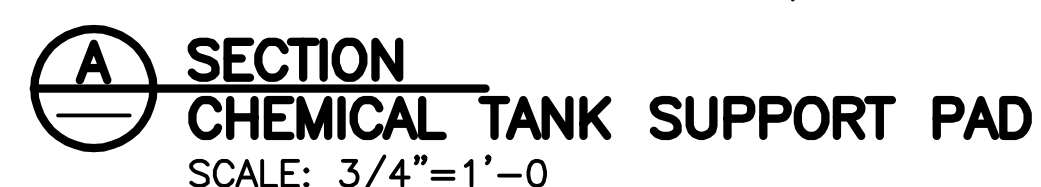
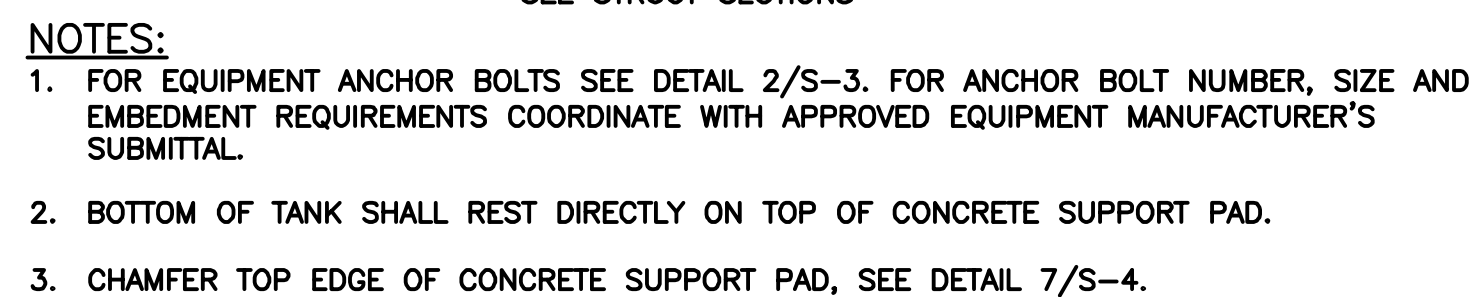
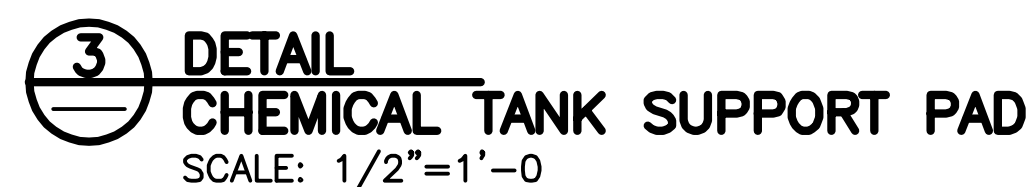
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

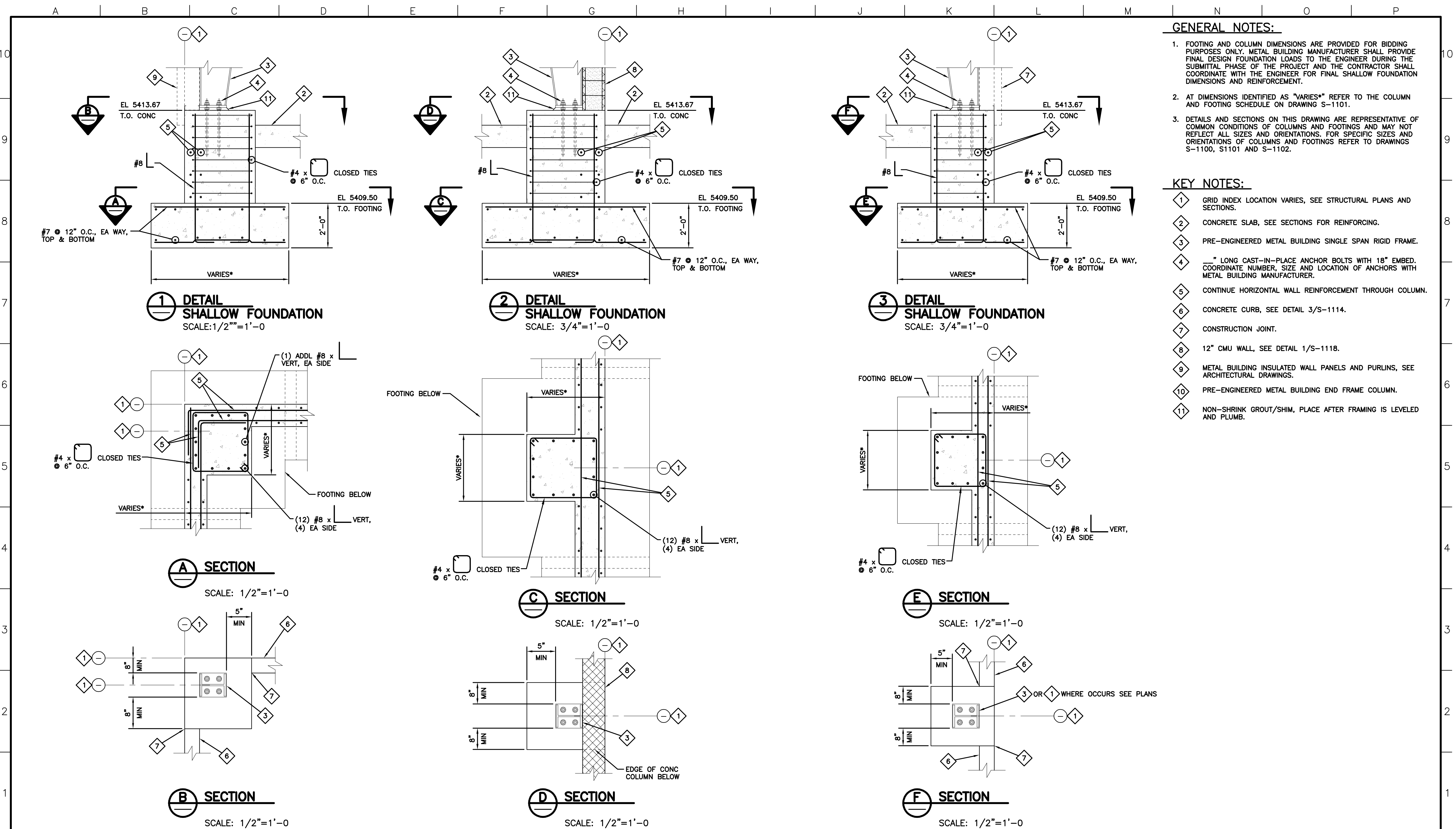
WATER TREATMENT PLANT
FOUNDATION SECTIONS AND DETAILS

DATE:	07/01/23
PROJECT NUMBER:	50159690
REVISION NO.	D
DRAWING NUMBER	S-1114
SHEET NUMBER	



1. FOR SUPPORT PAD DIMENSIONS SEE DRAWING S-1102.
2. COORDINATE ANCHOR BOLT SIZE, NUMBER, SPACING AND EMBED REQUIREMENTS WITH EQUIPMENT VENDOR DURING THE SUBMITTAL PHASE.

1	1" EXPANSION JOINT ALL AROUND, FULL HEIGHT OF FLOOR SLAB, SEE DETAIL 5/S-5. OMIT CHAMFER AT SLAB, TOP & BOTTOM.
2	FOR SLAB REINFORCEMENT SEE SECTIONS.
3	CDOT CLASS 1 STRUCTURAL BACKFILL.



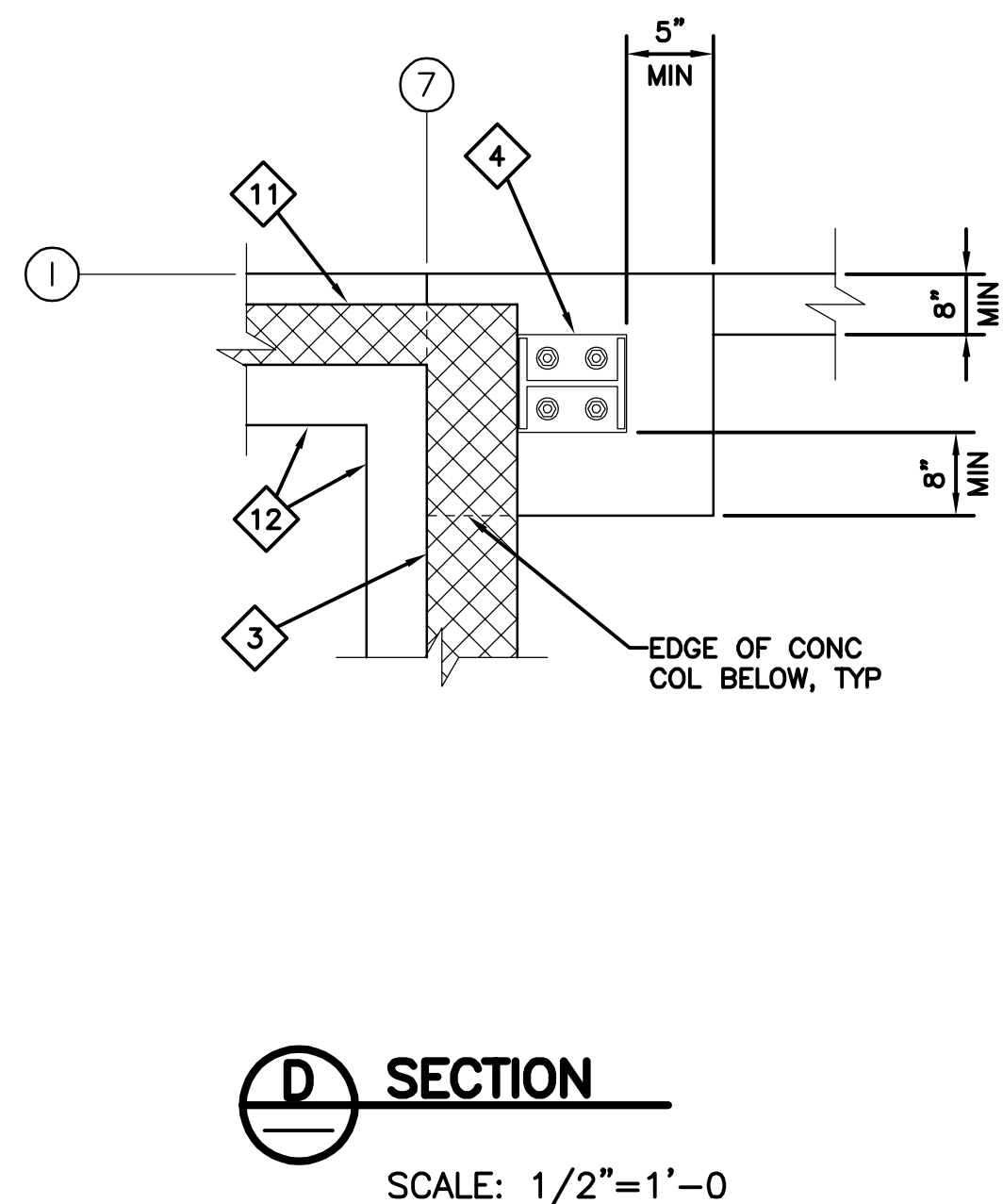
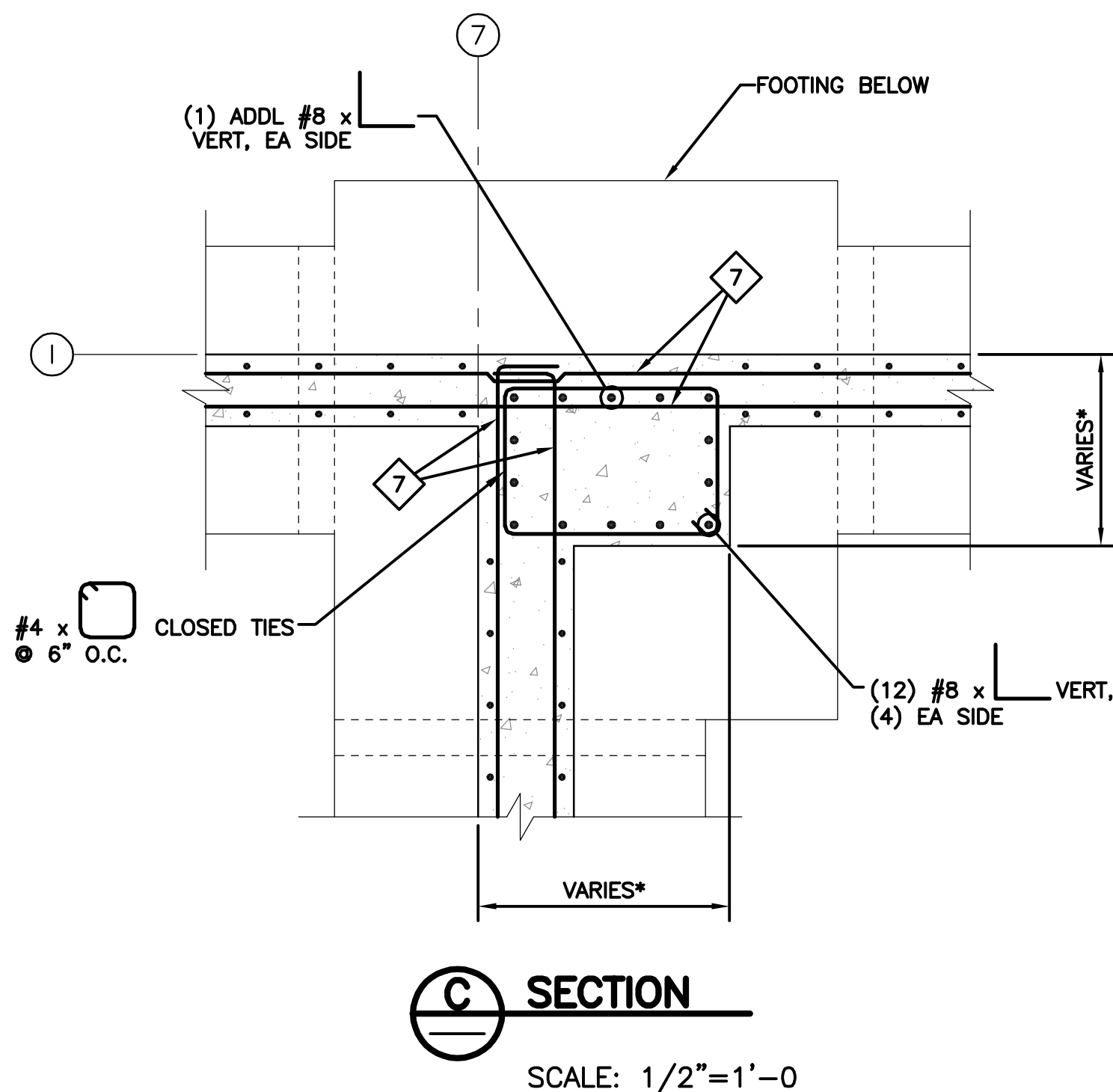
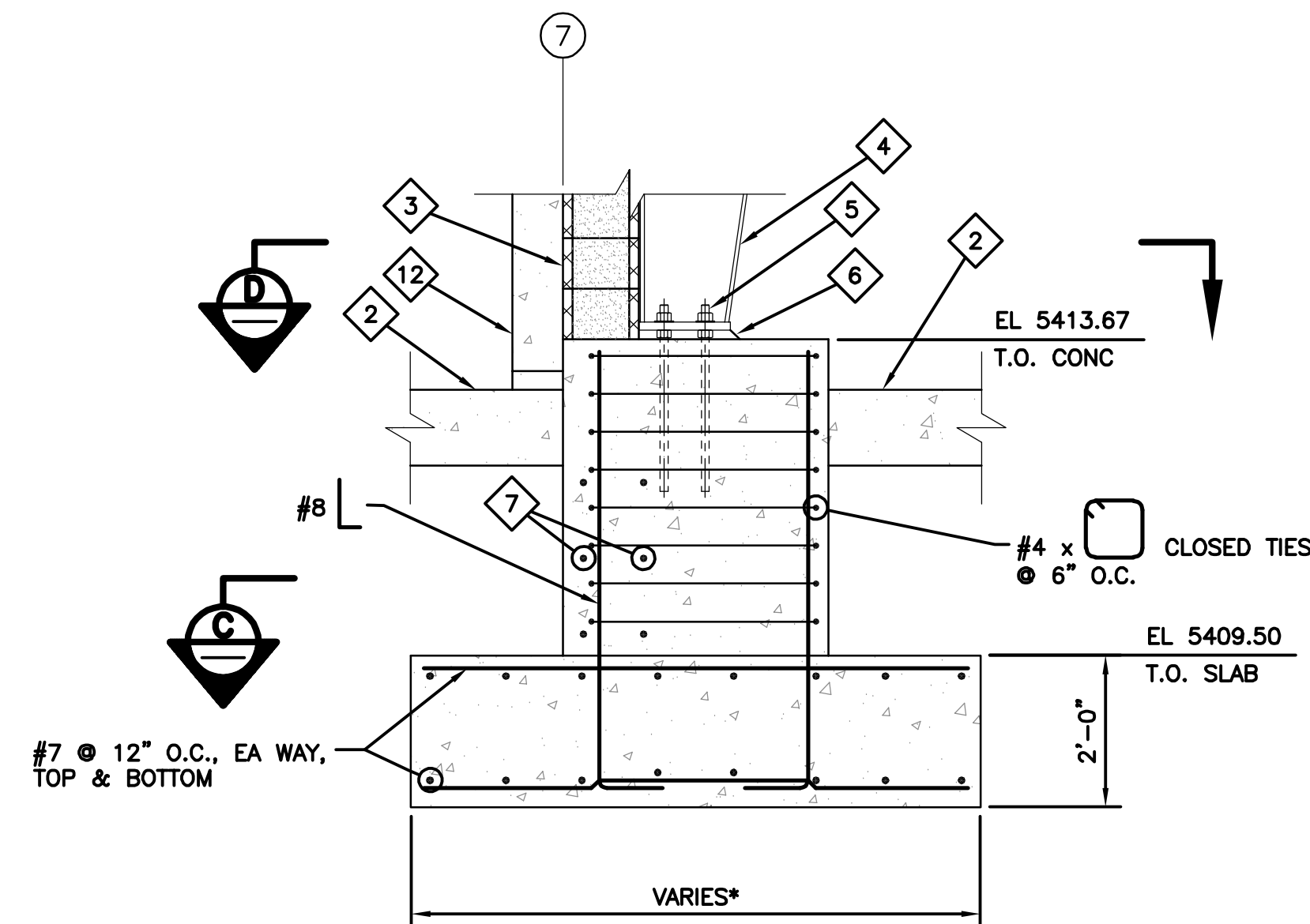
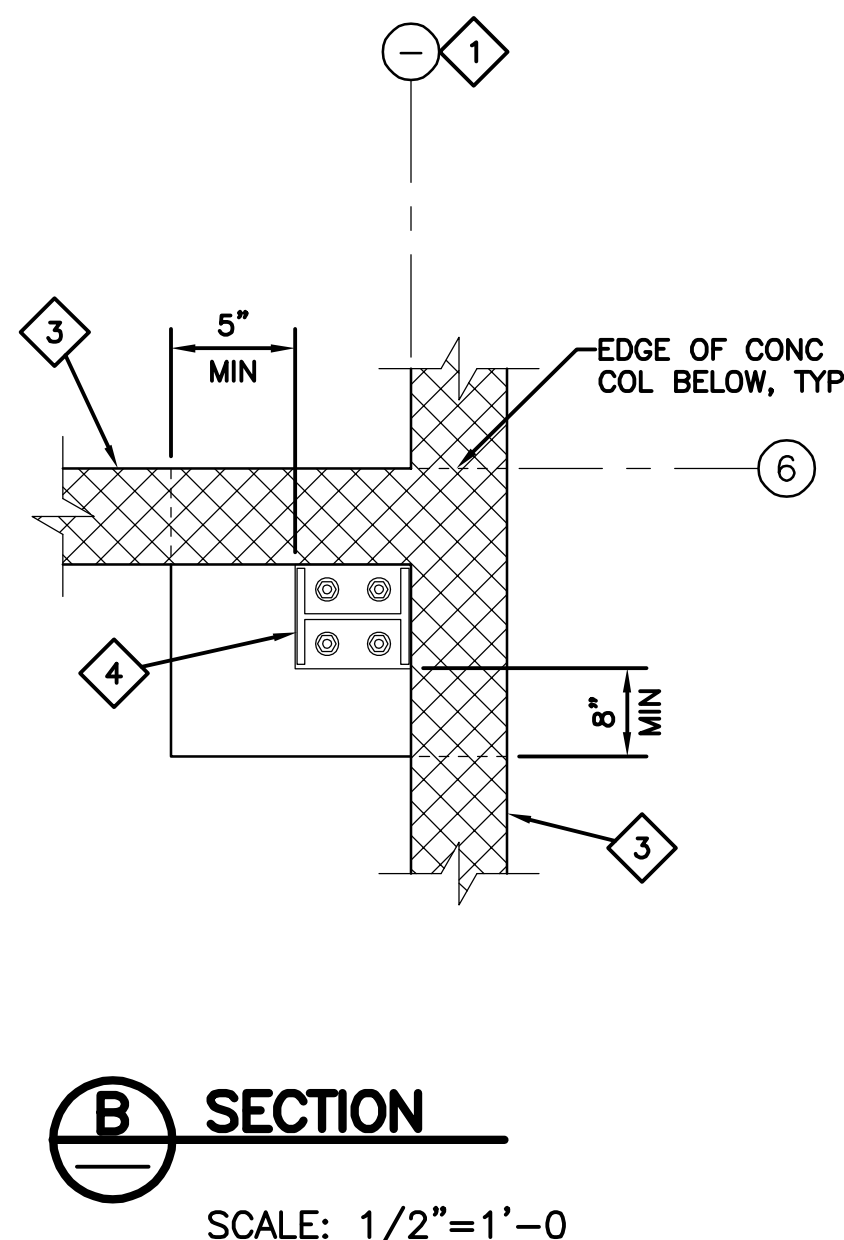
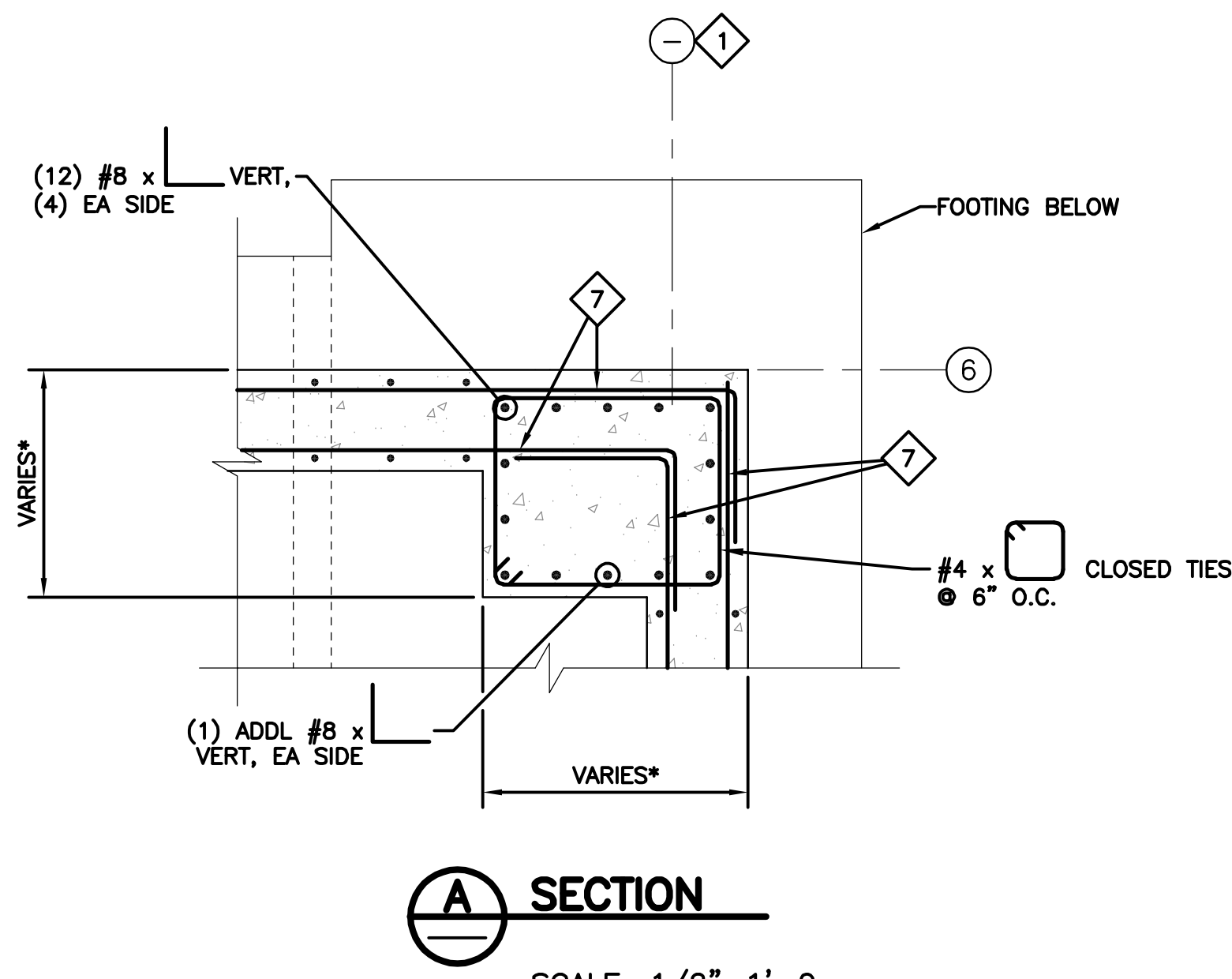
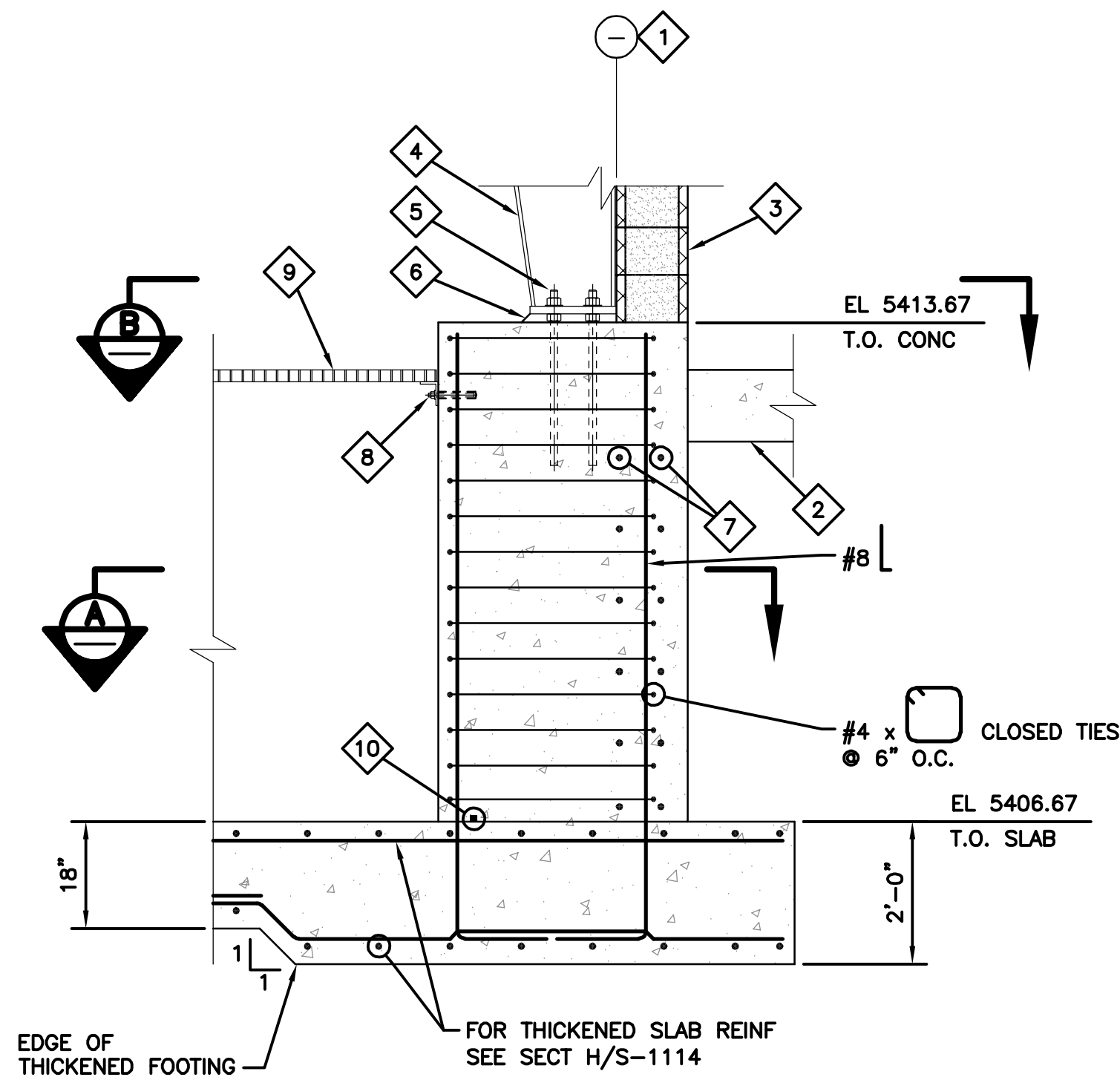
A B C D E F G H I J K L M N O P

GENERAL NOTES:

1. SEE GENERAL NOTES, DRAWING S-1116.

KEY NOTES:

- 1 GRID INDEX LOCATION VARIES, SEE STRUCTURAL PLANS AND SECTIONS.
2 12" CONCRETE SLAB, SEE SECTIONS FOR REINFORCING.
3 12" CMU WALL, SEE DETAIL 1/S-1118.
4 PRE-ENGINEERED METAL BUILDING END FRAME COLUMN.
5 ___" LONG CAST-IN-PLACE ANCHOR BOLTS WITH 18" EMBED. COORDINATE NUMBER, SIZE AND LOCATION OF ANCHORS WITH METAL BUILDING MANUFACTURER.
6 NON-SHRINK GROUT/SIM, PLACE AFTER FRAMING IS LEVELED AND PLUMB.
7 CONTINUE HORIZONTAL WALL REINFORCEMENT THROUGH COLUMN.
8 FRP GRATING END SUPPORT, SEE DETAIL 2/S-6.
9 2" FRP GRATING.
10 HYDROPHILIC WATERSTOP, 6" FROM FACE OF CONCRETE, TYPICAL AT BOTTOM AND SIDES.
11 8" CMU WALL, SEE DETAIL 2/S-1118.
12 CONTAINMENT WALL, SEE DETAIL 2/S-1114.



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DRAWING SPL59690-1117
DRAWN JRA/TWL
DESIGNED MJH
CHECKED MAP

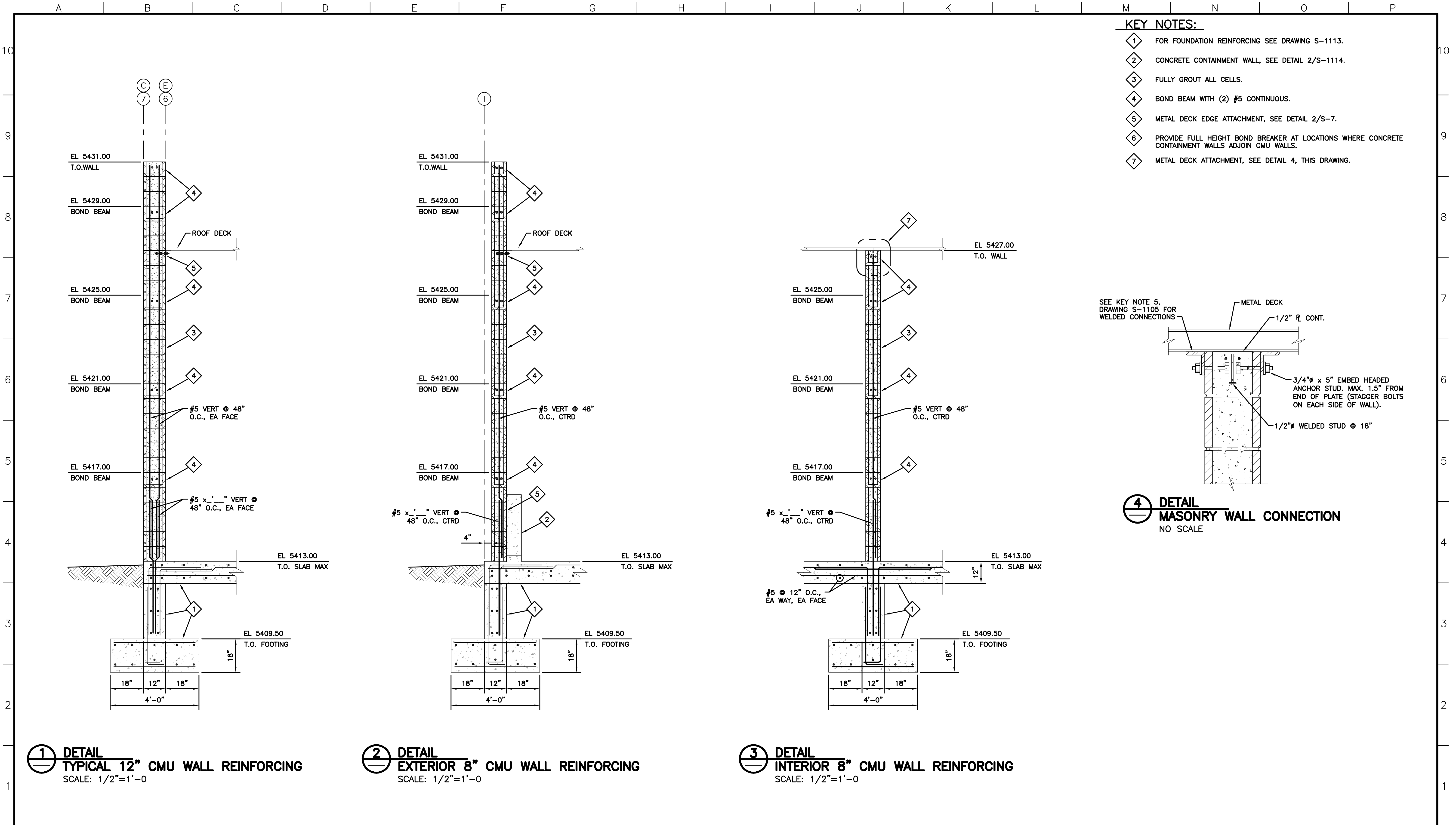
APPROVED:
PRINCIPAL
DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	TWL	07/07/23	MJH
B	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
C	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

TOWN OF SILT
SILT, COLORADO
WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL
PRE-ENGINEERED METAL BUILDING
FOUNDATION SECTIONS AND DETAILS

DATE: 07/02/23
PROJECT NUMBER: 50159690
REVISION NO. C
DRAWING NUMBER S-1117
SHEET NUMBER

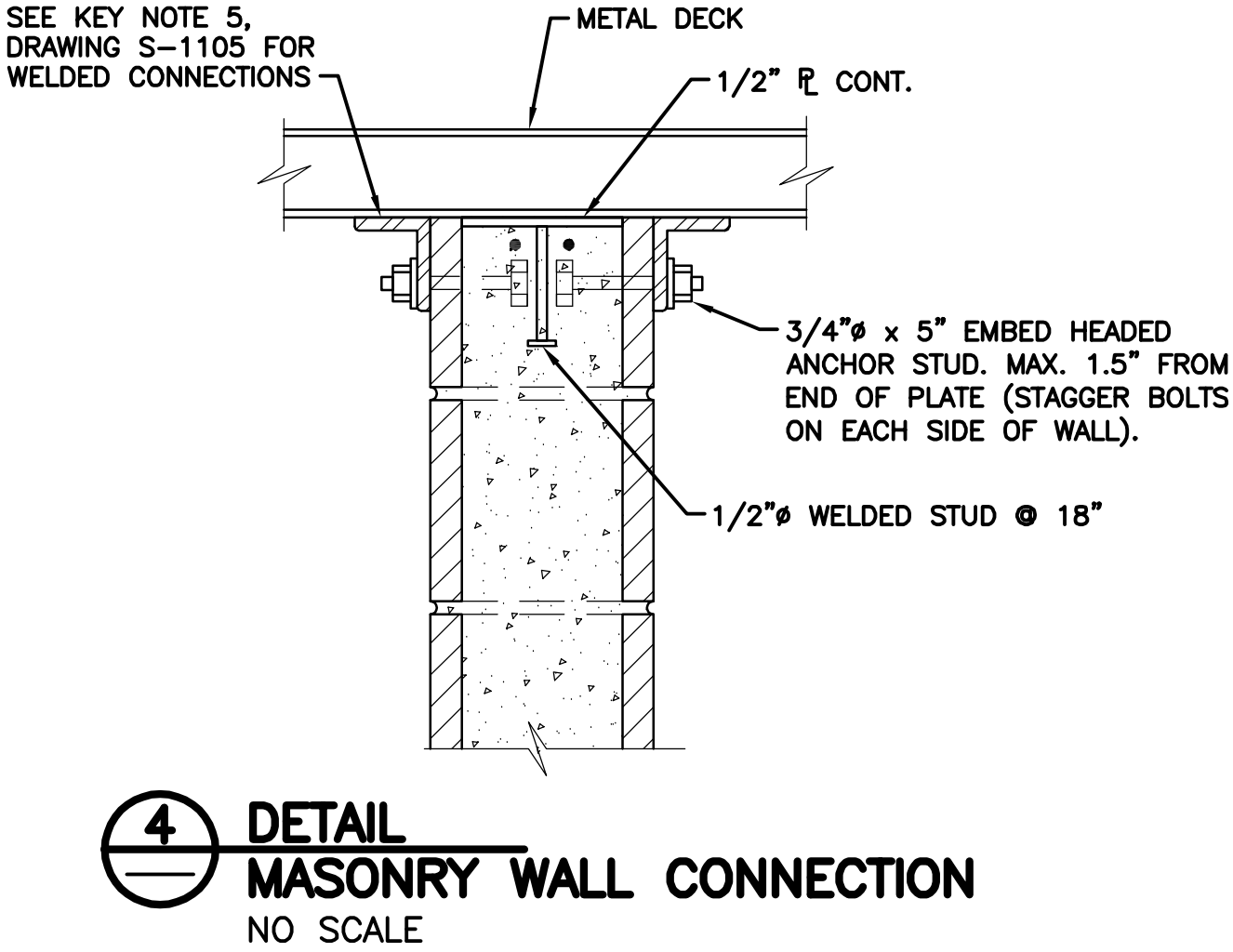


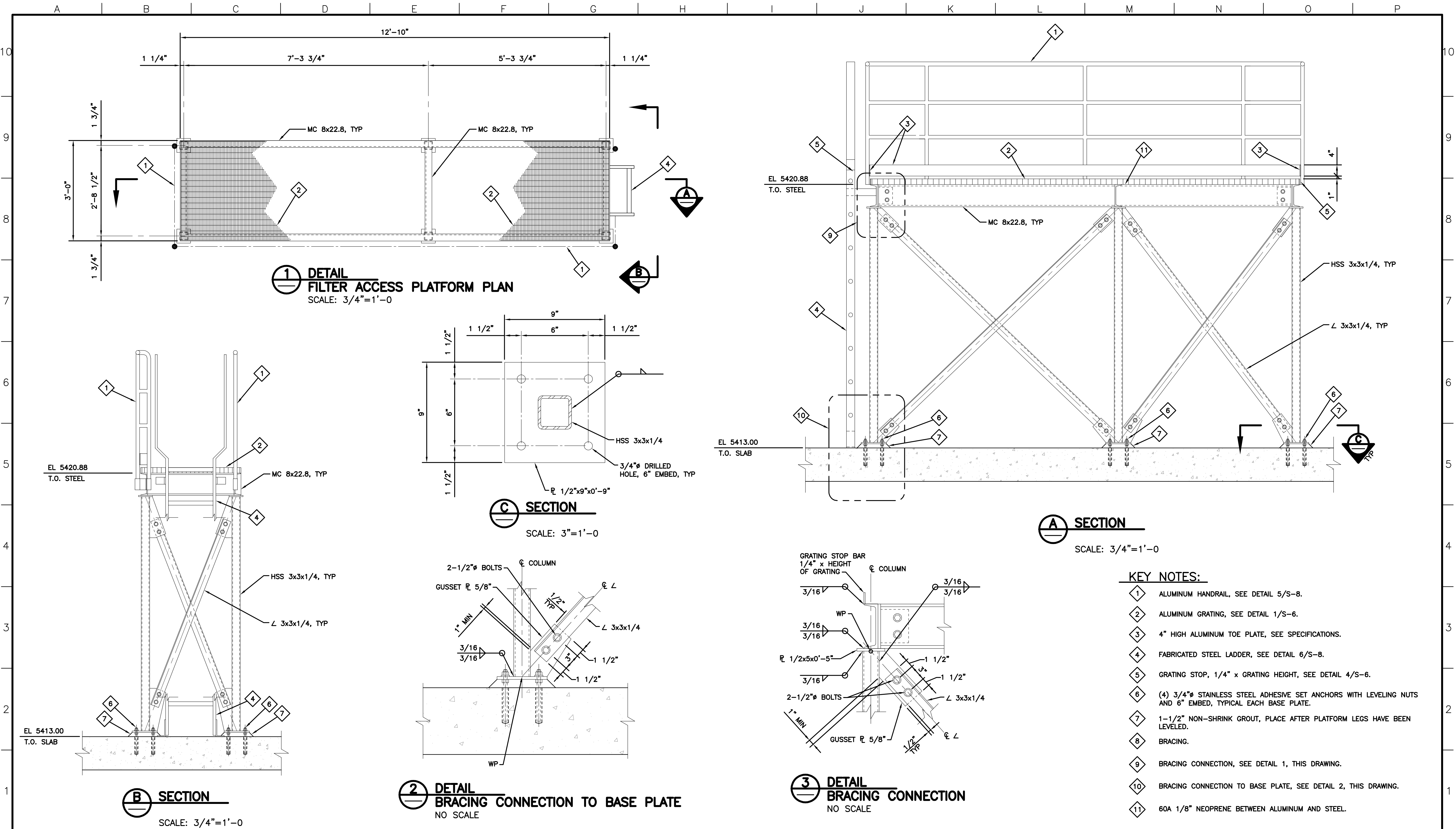
1 DETAIL
TYPICAL 12" CMU WALL REINFORCING
SCALE: 1/2"=1'-0"

2 DETAIL
EXTERIOR 8" CMU WALL REINFORCING
SCALE: 1/2"=1'-0"

3 DETAIL
INTERIOR 8" CMU WALL REINFORCING
SCALE: 1/2"=1'-0"

- KEY NOTES:**
- 1 FOR FOUNDATION REINFORCING SEE DRAWING S-1113.
 - 2 CONCRETE CONTAINMENT WALL, SEE DETAIL 2/S-1114.
 - 3 FULLY GROUT ALL CELLS.
 - 4 BOND BEAM WITH (2) #5 CONTINUOUS.
 - 5 METAL DECK EDGE ATTACHMENT, SEE DETAIL 2/S-7.
 - 6 PROVIDE FULL HEIGHT BOND BREAKER AT LOCATIONS WHERE CONCRETE CONTAINMENT WALLS ADJOIN CMU WALLS.
 - 7 METAL DECK ATTACHMENT, SEE DETAIL 4, THIS DRAWING.





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DRAWING SPL59690-1119
DRAWN JRA
DESIGNED MJH
CHECKED MAP

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	ISSUED FOR REVIEW	JRA	07/24/23	MJH
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	MJH
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	MJH
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	MAP

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

STRUCTURAL

FILTER ACCESS PLATFORM
DETAILS AND SECTIONS

DATE: 07/24/23

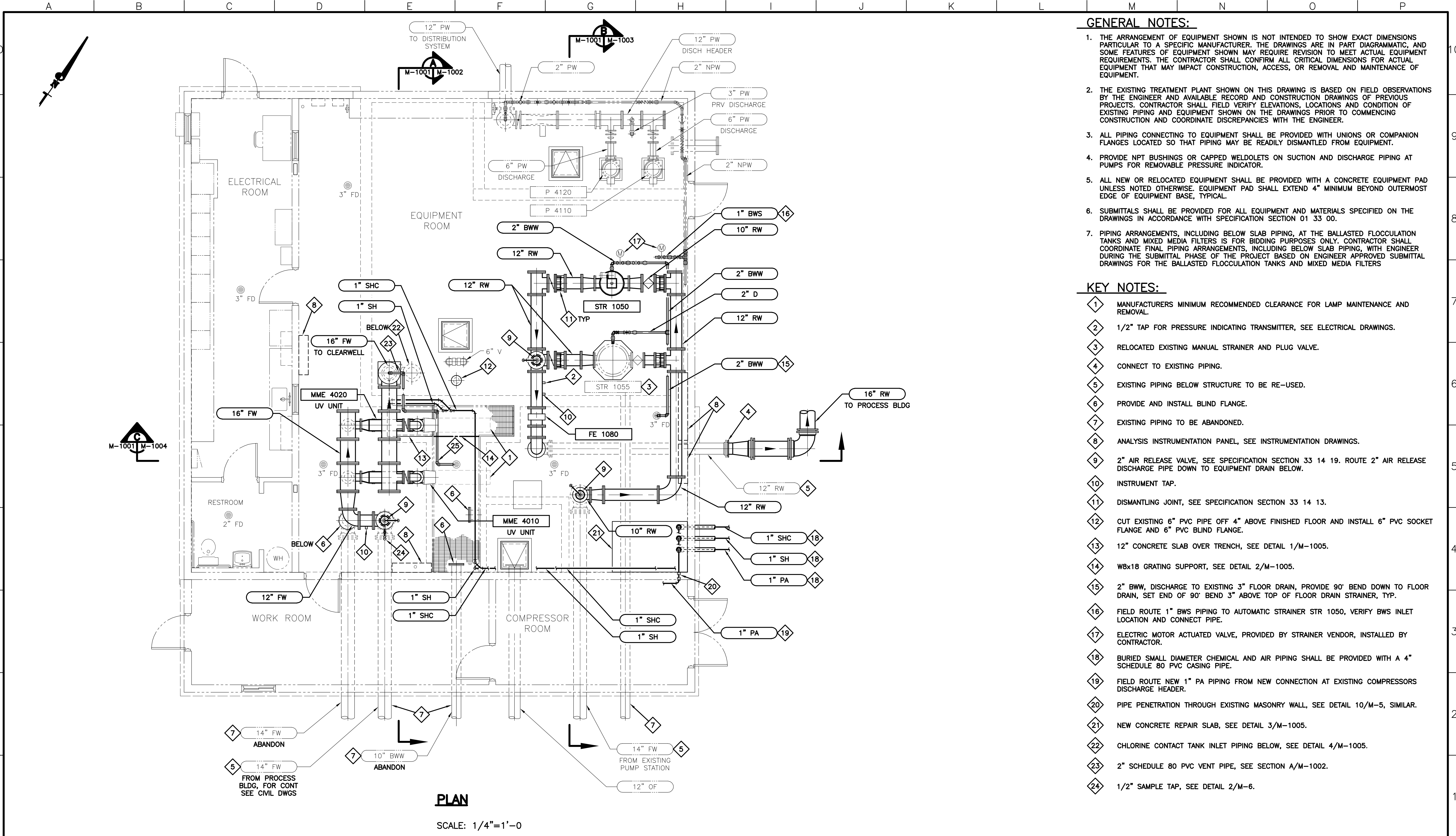
PROJECT
NUMBER: 50159690

REVISION NO. D

DRAWING NUMBER

S-1119

SHEET NUMBER



GENERAL NOTES:

- 1. THE ARRANGEMENT OF EQUIPMENT SHOWN IS NOT INTENDED TO SHOW EXACT DIMENSIONS PARTICULAR TO A SPECIFIC MANUFACTURER. THE DRAWINGS ARE IN PART DIAGRAMMATIC, AND SOME FEATURES OF EQUIPEMENT SHOWN MAY REQUIRE REVISION TO MEET ACTUAL EQUIPMENT REQUIREMENTS. THE CONTRACTOR SHALL CONFIRM ALL CRITICAL DIMENSIONS FOR ACTUAL EQUIPMENT THAT MAY IMPACT CONSTRUCTION, ACCESS, OR REMOVAL AND MAINTENANCE OF EQUIPMENT.
- 2. THE EXISTING TREATMENT PLANT SHOWN ON THIS DRAWING IS BASED ON FIELD OBSERVATIONS BY THE ENGINEER AND AVAILABLE RECORD AND CONSTRUCTION DRAWINGS OF PREVIOUS PROJECTS. CONTRACTOR SHALL FIELD VERIFY ELEVATIONS, LOCATIONS AND CONDITION OF EXISTING PIPING AND EQUIPMENT SHOWN ON THE DRAWINGS PRIOR TO COMMENCING CONSTRUCTION AND COORDINATE DISCREPANCIES WITH THE ENGINEER.
- 3. ALL PIPING CONNECTING TO EQUIPMENT SHALL BE PROVIDED WITH UNIONS OR COMPANION FLANGES LOCATED SO THAT PIPING MAY BE READILY DISMANTLED FROM EQUIPMENT.
- 4. PROVIDE NPT BUSHINGS OR CAPPED WELDOLETS ON SUCTION AND DISCHARGE PIPING AT PUMPS FOR REMOVABLE PRESSURE INDICATOR.
- 5. ALL NEW OR RELOCATED EQUIPMENT SHALL BE PROVIDED WITH A CONCRETE EQUIPMENT PAD UNLESS NOTED OTHERWISE. EQUIPMENT PAD SHALL EXTEND 4" MINIMUM BEYOND OUTERMOST EDGE OF EQUIPMENT BASE, TYPICAL.
- 6. SUBMITTALS SHALL BE PROVIDED FOR ALL EQUIPMENT AND MATERIALS SPECIFIED ON THE DRAWINGS IN ACCORDANCE WITH SPECIFICATION SECTION 01 33 00.
- 7. PIPING ARRANGEMENTS, INCLUDING BELOW SLAB PIPING, AT THE BALLASTED FLOCCULATION TANKS AND MIXED MEDIA FILTERS IS FOR BIDDING PURPOSES ONLY. CONTRACTOR SHALL COORDINATE FINAL PIPING ARRANGEMENTS, INCLUDING BELOW SLAB PIPING, WITH ENGINEER DURING THE SUBMITTAL PHASE OF THE PROJECT BASED ON ENGINEER APPROVED SUBMITTAL DRAWINGS FOR THE BALLASTED FLOCCULATION TANKS AND MIXED MEDIA FILTERS

KEY NOTES:

- 1 MANUFACTURERS MINIMUM RECOMMENDED CLEARANCE FOR LAMP MAINTENANCE AND REMOVAL.
- 2 1/2" TAP FOR PRESSURE INDICATING TRANSMITTER, SEE ELECTRICAL DRAWINGS.
- 3 RELOCATED EXISTING MANUAL STRAINER AND PLUG VALVE.
- 4 CONNECT TO EXISTING PIPING.
- 5 EXISTING PIPING BELOW STRUCTURE TO BE RE-USED.
- 6 PROVIDE AND INSTALL BLIND FLANGE.
- 7 EXISTING PIPING TO BE ABANDONED.
- 8 ANALYSIS INSTRUMENTATION PANEL, SEE INSTRUMENTATION DRAWINGS.
- 9 2" AIR RELEASE VALVE, SEE SPECIFICATION SECTION 33 14 19. ROUTE 2" AIR RELEASE DISCHARGE PIPE DOWN TO EQUIPMENT DRAIN BELOW.
- 10 INSTRUMENT TAP.
- 11 DISMANTLING JOINT, SEE SPECIFICATION SECTION 33 14 13.
- 12 CUT EXISTING 6" PVC PIPE OFF 4" ABOVE FINISHED FLOOR AND INSTALL 6" PVC SOCKET FLANGE AND 6" PVC BLIND FLANGE.
- 13 12" CONCRETE SLAB OVER TRENCH, SEE DETAIL 1/M-1005.
- 14 W8x18 GRATING SUPPORT, SEE DETAIL 2/M-1005.
- 15 2" BWW, DISCHARGE TO EXISTING 3" FLOOR DRAIN, PROVIDE 90' BEND DOWN TO FLOOR DRAIN, SET END OF 90' BEND 3" ABOVE TOP OF FLOOR DRAIN STRAINER, TYP.
- 16 FIELD ROUTE 1" BWS PIPING TO AUTOMATIC STRAINER STR 1050, VERIFY BWS INLET LOCATION AND CONNECT PIPE.
- 17 ELECTRIC MOTOR ACTUATED VALVE, PROVIDED BY STRAINER VENDOR, INSTALLED BY CONTRACTOR.
- 18 BURIED SMALL DIAMETER CHEMICAL AND AIR PIPING SHALL BE PROVIDED WITH A 4" SCHEDULE 80 PVC CASING PIPE.
- 19 FIELD ROUTE NEW 1" PA PIPING FROM NEW CONNECTION AT EXISTING COMPRESSORS DISCHARGE HEADER.
- 20 PIPE PENETRATION THROUGH EXISTING MASONRY WALL, SEE DETAIL 10/M-5, SIMILAR.
- 21 NEW CONCRETE REPAIR SLAB, SEE DETAIL 3/M-1005.
- 22 CHLORINE CONTACT TANK INLET PIPING BELOW, SEE DETAIL 4/M-1005.
- 23 2" SCHEDULE 80 PVC VENT PIPE, SEE SECTION A/M-1002.
- 24 1/2" SAMPLE TAP, SEE DETAIL 2/M-6.

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Denver, Colorado 80209

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DRAWING MPL59690-1001

DRAWN JRA

DESIGNED KEB

CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REV.	DESCRIPTION	BY	DATE	APP.
G	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF
H	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF
C	60% DESIGN REVIEW SUBMITTAL	JRA	05/25/23	SEF
D	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	SEF
E	90% DESIGN ADDENDUM	JRA	08/16/23	SEF
F	REVISIONS PER REVIEW	JRA	08/24/23	SEF

TOWN OF SILT

SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

MECHANICAL

EXISTING WTP BUILDING

GROUND LEVEL PLAN

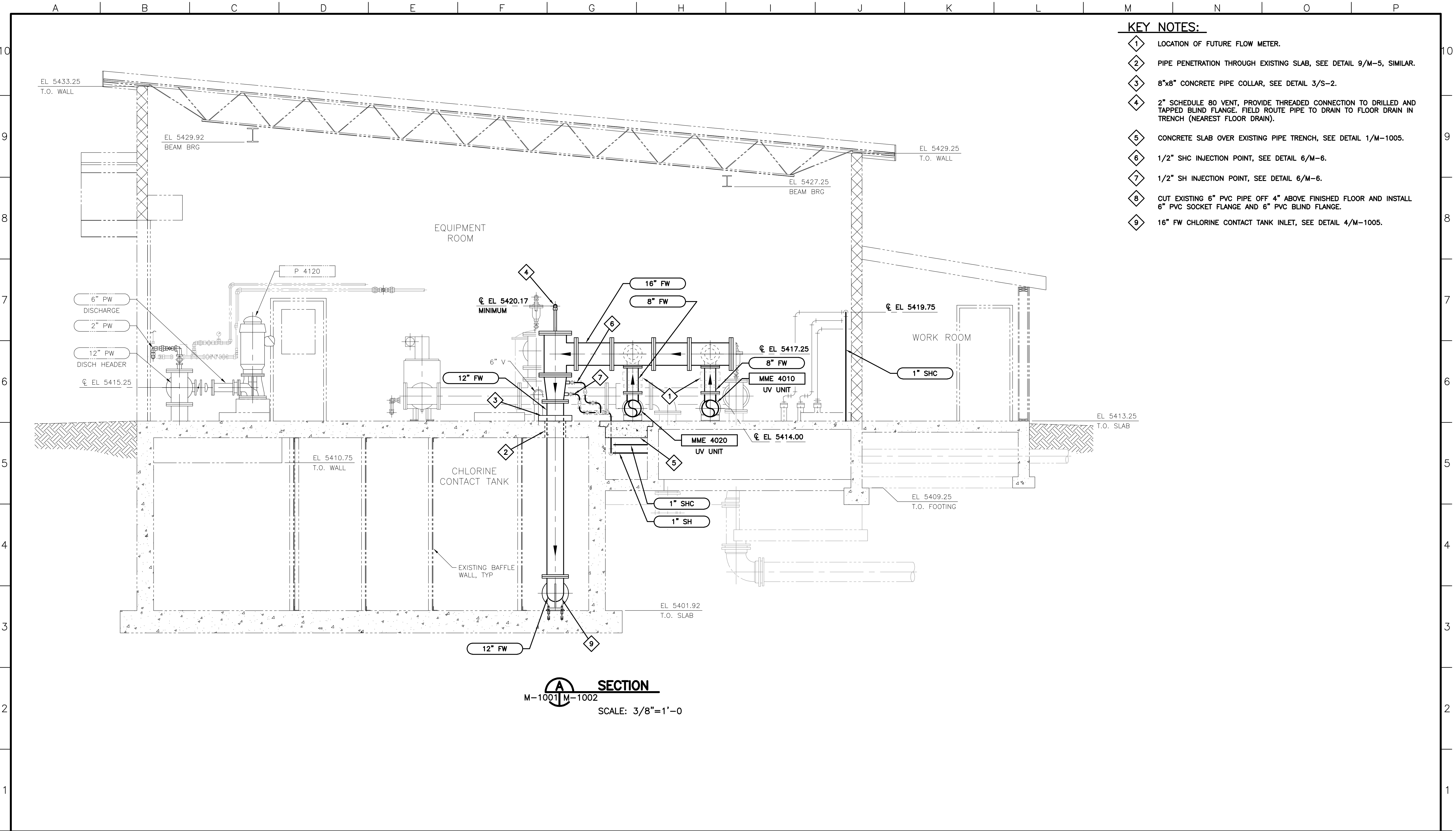
DATE: 04/18/23

PROJECT NUMBER: 50159690

REVISION NO. H

DRAWING NUMBER M-1001


SHEET NUMBER



KEY NOTES:

- 1 LOCATION OF FUTURE FLOW METER.
- 2 PIPE PENETRATION THROUGH EXISTING SLAB, SEE DETAIL 9/M-5, SIMILAR.
- 3 8"x8" CONCRETE PIPE COLLAR, SEE DETAIL 3/S-2.
- 4 2" SCHEDULE 80 VENT, PROVIDE THREADED CONNECTION TO DRILLED AND TAPPED BLIND FLANGE. FIELD ROUTE PIPE TO DRAIN TO FLOOR DRAIN IN TRENCH (NEAREST FLOOR DRAIN).
- 5 CONCRETE SLAB OVER EXISTING PIPE TRENCH, SEE DETAIL 1/M-1005.
- 6 1/2" SHC INJECTION POINT, SEE DETAIL 6/M-6.
- 7 1/2" SH INJECTION POINT, SEE DETAIL 6/M-6.
- 8 CUT EXISTING 6" PVC PIPE OFF 4" ABOVE FINISHED FLOOR AND INSTALL 6" PVC SOCKET FLANGE AND 6" PVC BLIND FLANGE.
- 9 16" FW CHLORINE CONTACT TANK INLET, SEE DETAIL 4/M-1005.

SECTION
M-1001 | M-1002
SCALE: 3/8"=1'-0

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LINE IS 2 INCHES
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(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING MPL59690-1002

DRAWN JRA

DESIGNED KEB/SES

CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	JRA	05/25/23	SEF
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	SEF
C	90% DESIGN ADDENDUM	JRA	08/16/23	SEF
D	REVISIONS PER REVIEW	JRA	08/24/23	SEF
E	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF
F	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

MECHANICAL

EXISTING WTP BUILDING
SECTION

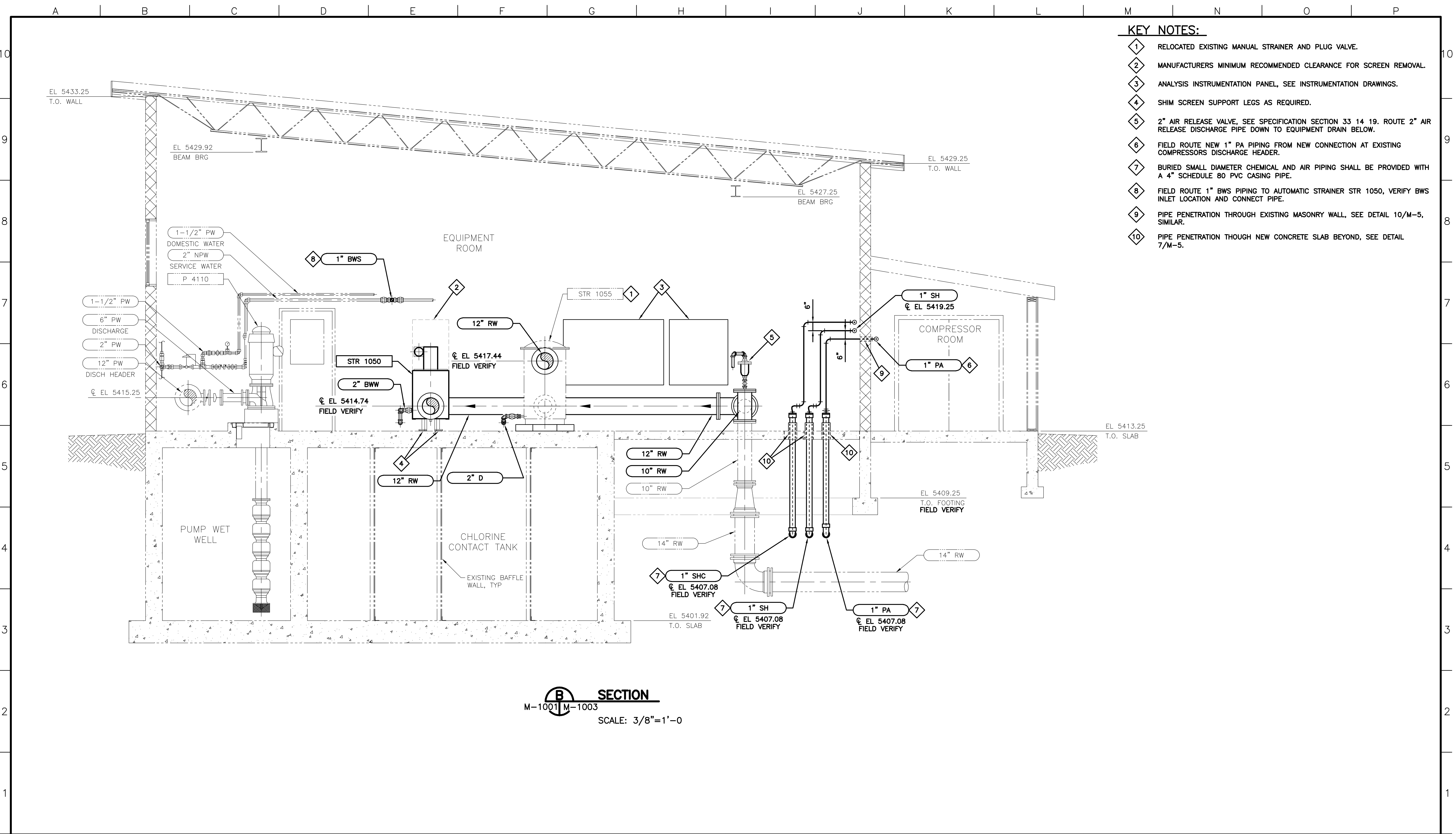
DATE: 05/15/23

PROJECT
NUMBER: 50159690

REVISION NO. F

DRAWING NUMBER
M-1002


SHEET NUMBER



KEY NOTES:

- 1 RELOCATED EXISTING MANUAL STRAINER AND PLUG VALVE.
- 2 MANUFACTURERS MINIMUM RECOMMENDED CLEARANCE FOR SCREEN REMOVAL.
- 3 ANALYSIS INSTRUMENTATION PANEL, SEE INSTRUMENTATION DRAWINGS.
- 4 SHIM SCREEN SUPPORT LEGS AS REQUIRED.
- 5 2" AIR RELEASE VALVE, SEE SPECIFICATION SECTION 33 14 19. ROUTE 2" AIR RELEASE DISCHARGE PIPE DOWN TO EQUIPMENT DRAIN BELOW.
- 6 FIELD ROUTE NEW 1" PA PIPING FROM NEW CONNECTION AT EXISTING COMPRESSORS DISCHARGE HEADER.
- 7 BURIED SMALL DIAMETER CHEMICAL AND AIR PIPING SHALL BE PROVIDED WITH A 4" SCHEDULE 80 PVC CASING PIPE.
- 8 FIELD ROUTE 1" BWS PIPING TO AUTOMATIC STRAINER STR 1050, VERIFY BWS INLET LOCATION AND CONNECT PIPE.
- 9 PIPE PENETRATION THROUGH EXISTING MASONRY WALL, SEE DETAIL 10/M-5, SIMILAR.
- 10 PIPE PENETRATION THOUGH NEW CONCRETE SLAB BEYOND, SEE DETAIL 7/M-5.

B SECTION
M-1001 M-1003
SCALE: 3/8"=1'-0

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DRAWING MPL59690-1003
DRAWN JRA
DESIGNED KEB/SES
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	JRA	05/25/23	SEF
B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	SEF
C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF
D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF

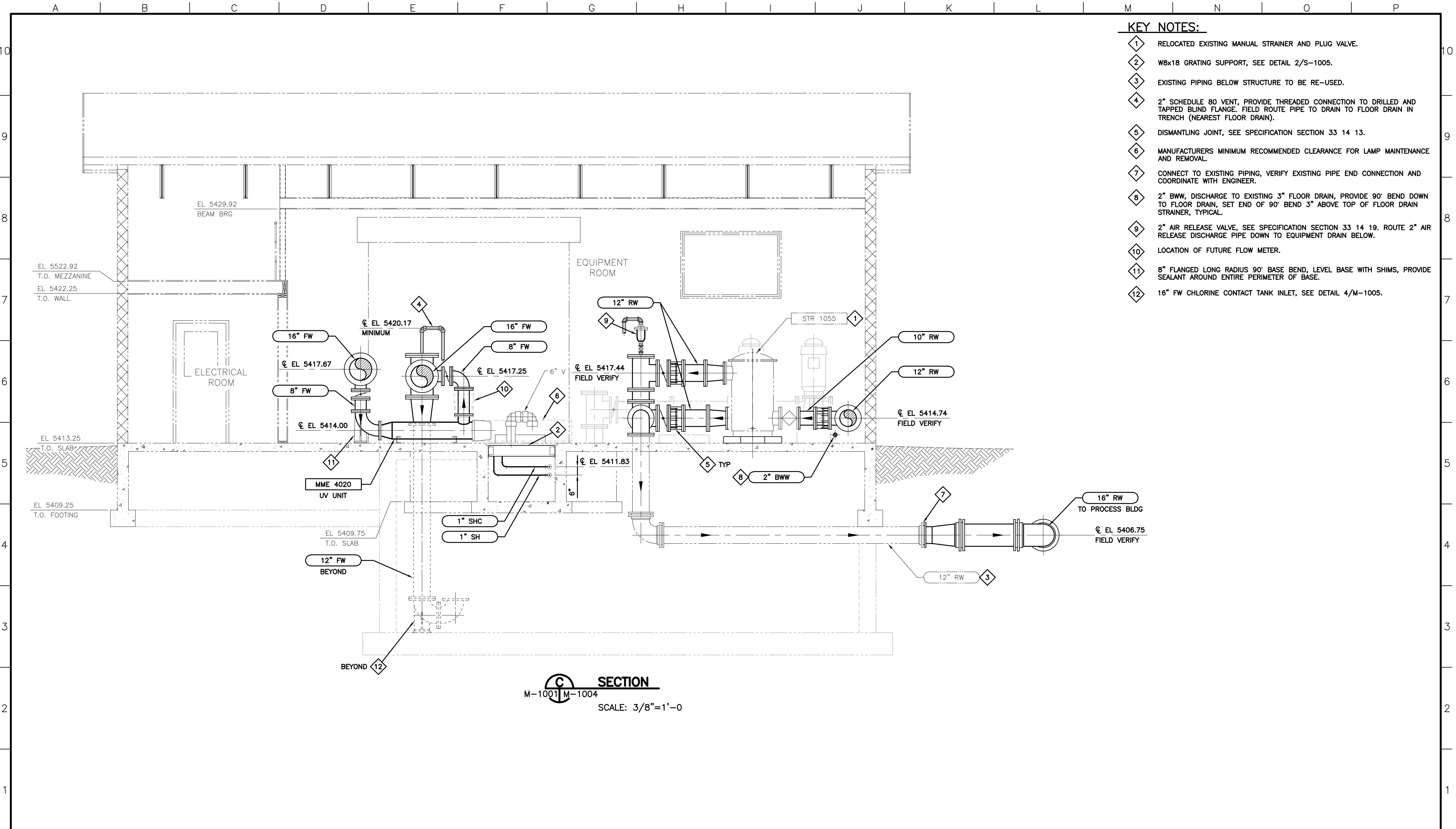
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

MECHANICAL

EXISTING WTP BUILDING
SECTION

DATE: 05/15/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
M-1003
SHEET NUMBER

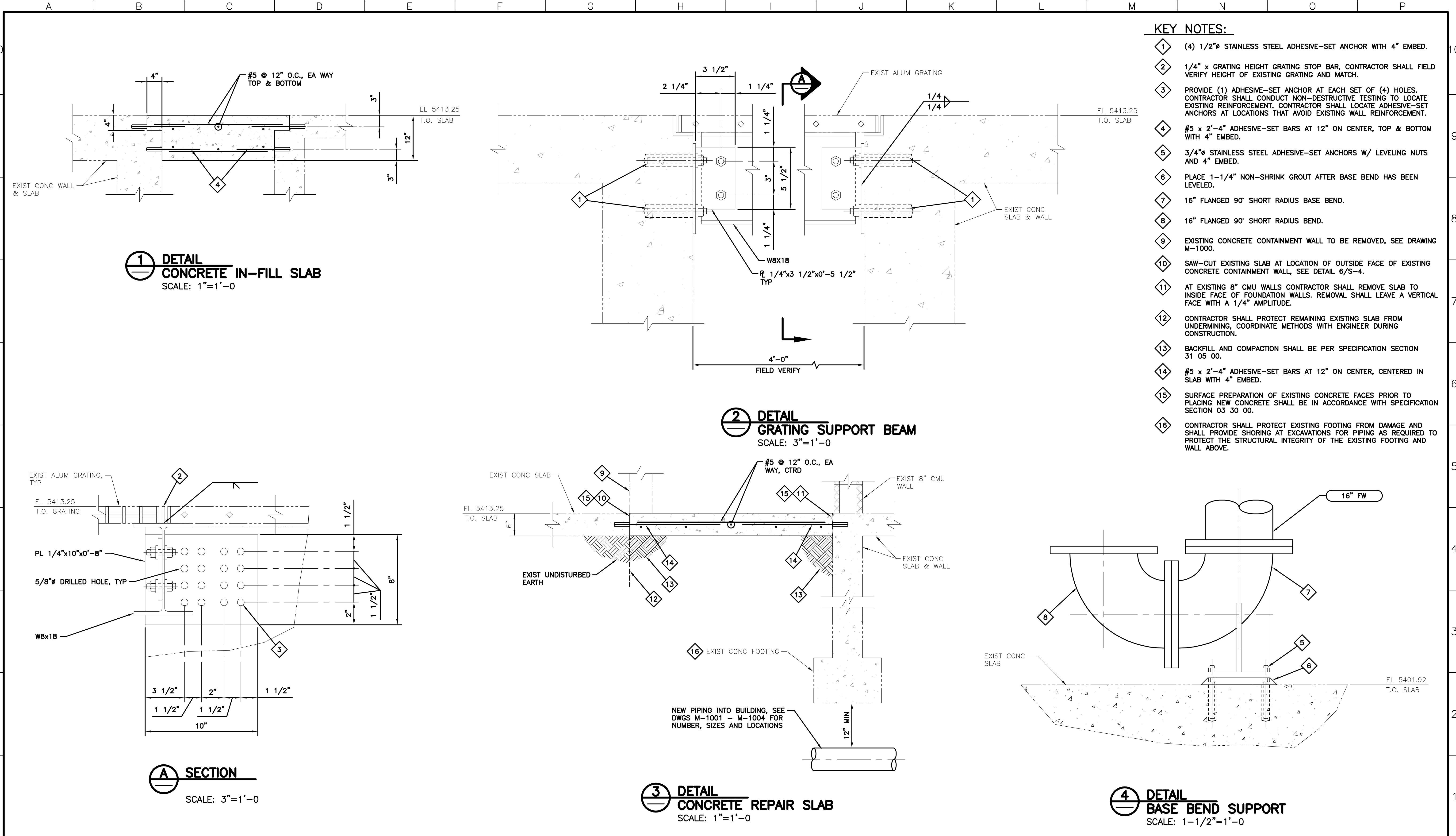


KEY NOTES:

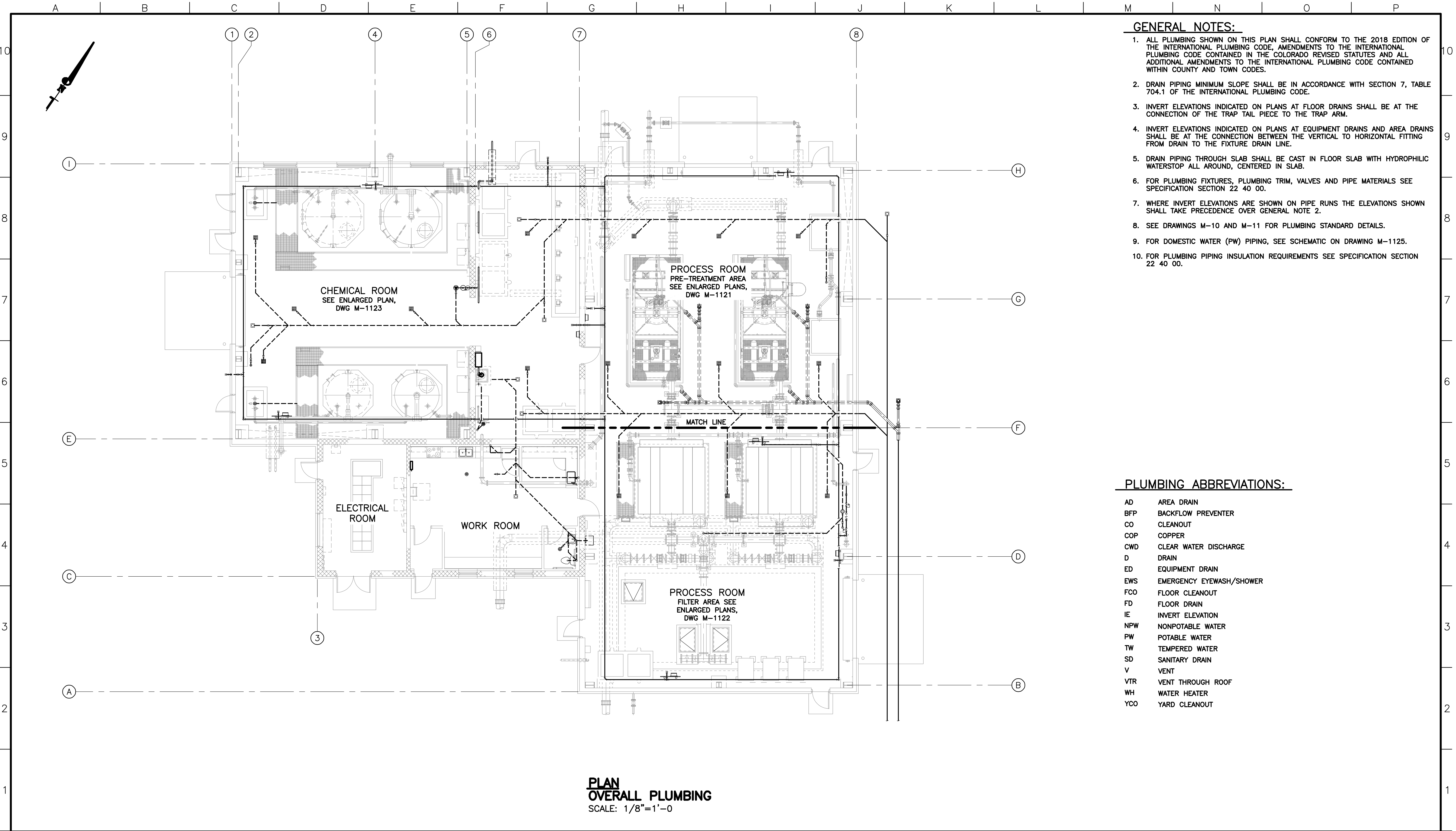
- 1 RELOCATED EXISTING MANUAL STRAINER AND PLUG VALVE.
- 2 W8x18 GRATING SUPPORT, SEE DETAIL 2/S-1005.
- 3 EXISTING PIPING BELOW STRUCTURE TO BE RE-USED.
- 4 2" SCHEDULE 80 VENT, PROVIDE THREADED CONNECTION TO DRILLED AND TAPPED BLIND FLANGE. FIELD ROUTE PIPE TO DRAIN TO FLOOR DRAIN IN TRENCH (NEAREST FLOOR DRAIN).
- 5 DISMANTLING JOINT, SEE SPECIFICATION SECTION 33 14 13.
- 6 MANUFACTURERS MINIMUM RECOMMENDED CLEARANCE FOR LAMP MAINTENANCE AND REMOVAL.
- 7 CONNECT TO EXISTING PIPING, VERIFY EXISTING PIPE END CONNECTION AND COORDINATE WITH ENGINEER.
- 8 2" BWV, DISCHARGE TO EXISTING 3" FLOOR DRAIN, PROVIDE 90° BEND DOWN TO FLOOR DRAIN, SET END OF 90° BEND 3" ABOVE TOP OF FLOOR DRAIN STRAINER, TYPICAL.
- 9 2" AIR RELEASE VALVE, SEE SPECIFICATION SECTION 33 14 19. ROUTE 2" AIR RELEASE DISCHARGE PIPE DOWN TO EQUIPMENT DRAIN BELOW.
- 10 LOCATION OF FUTURE FLOW METER.
- 11 8" FLANGED LONG RADIUS 90° BASE BEND, LEVEL BASE WITH SHIMS, PROVIDE SEALANT AROUND ENTIRE PERIMETER OF BASE.
- 12 16" FW CHLORINE CONTACT TANK INLET, SEE DETAIL 4/M-1005.

SECTION C
M-1001 | M-1004
SCALE: 3/8"=1'-0

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	JRA	05/25/23	SEF
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D	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF
E	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF



A		B		C		D		E		F		G		H		I		J		K		L		M		N		O		P																																				
<div><div><div></div><div>Dewberry</div><div>Dewberry Engineers Inc.</div><div>990 S. BROADWAY, SUITE 400</div><div>Denver, Colorado 80209</div><div>(303) 825-1802</div></div><div><div>LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY)</div><div>DRAWING MPL59690-1005</div><div>DRAWN JRA/TWL</div><div>DESIGNED MJH</div><div>CHECKED MJH</div></div></div>								<div>APPROVED:</div> <div>PRINCIPAL</div> <div>DATE:</div>		<div>REVISIONS</div> <table><tr><th>REV.</th><th>DESCRIPTION</th><th>BY</th><th>DATE</th><th>APP.</th></tr><tr><td>A</td><td>ISSUED FOR REVIEW</td><td>JAJ</td><td>07/17/23</td><td>MJH</td></tr><tr><td>B</td><td>90% DESIGN REVIEW SUBMITTAL</td><td>JRA</td><td>07/31/23</td><td>SEF</td></tr><tr><td>C</td><td>CDPHE REVIEW SUBMITTAL</td><td>JRA</td><td>09/29/23</td><td>SEF</td></tr><tr><td>D</td><td>BUILDING DEPT REVIEW SUBMITTAL</td><td>JRA</td><td>10/13/23</td><td>SEF</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></table>				REV.	DESCRIPTION	BY	DATE	APP.	A	ISSUED FOR REVIEW	JAJ	07/17/23	MJH	B	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	SEF	C	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF	D	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF											<div>TOWN OF SILT SILT, COLORADO</div> <div>WATER TREATMENT PLANT IMPROVEMENTS</div>								<div>MECHANICAL</div> <div>EXISTING WTP BUILDING DETAILS AND SECTIONS</div>								<div>DATE: 07/12/23</div> <div>PROJECT NUMBER: 50159690</div> <div>REVISION NO. D</div> <div>DRAWING NUMBER M-1005</div> <div>SHEET NUMBER</div>	
REV.	DESCRIPTION	BY	DATE	APP.																																																														
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GENERAL NOTES:

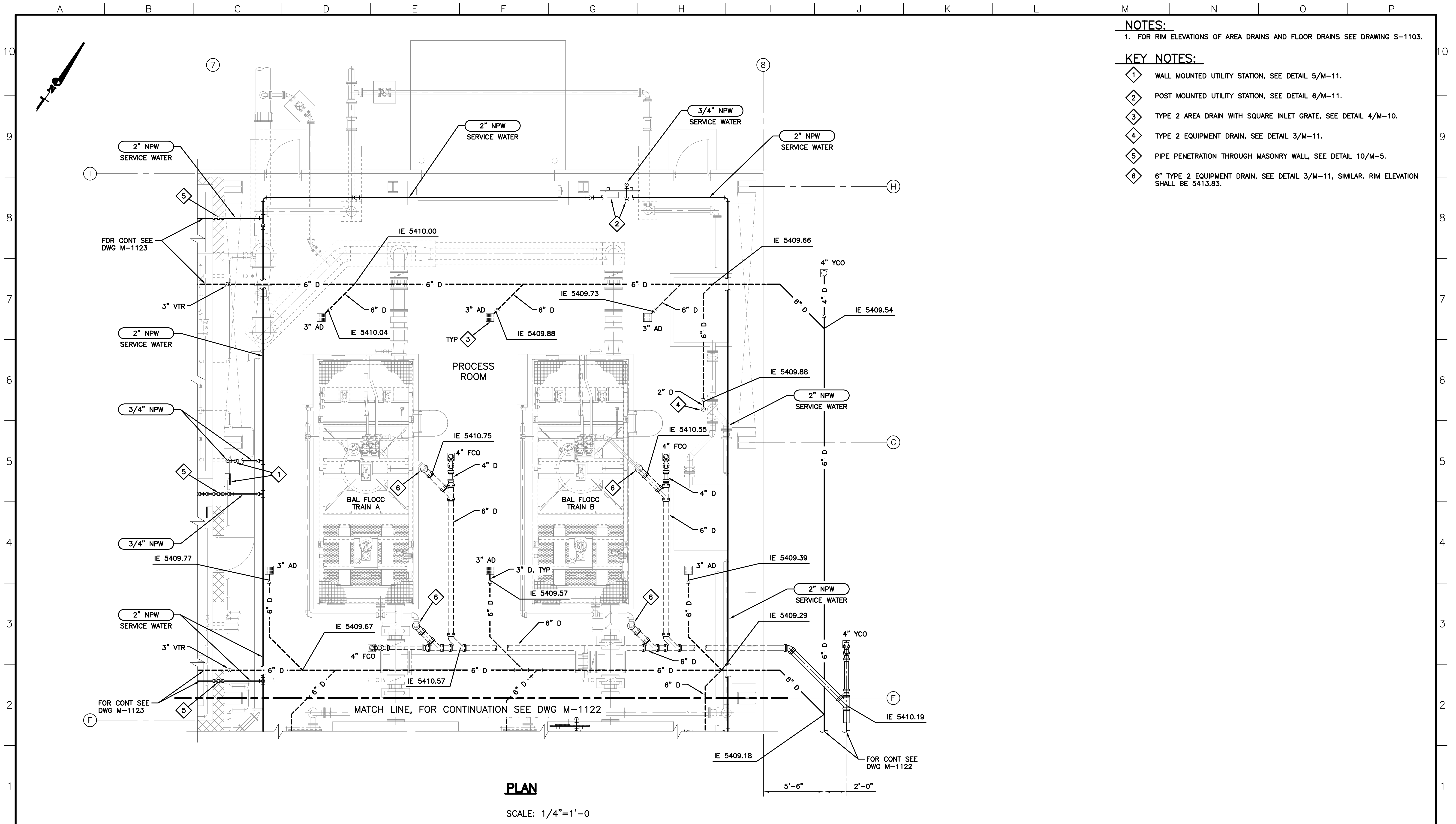
1. ALL PLUMBING SHOWN ON THIS PLAN SHALL CONFORM TO THE 2018 EDITION OF THE INTERNATIONAL PLUMBING CODE, AMENDMENTS TO THE INTERNATIONAL PLUMBING CODE CONTAINED IN THE COLORADO REVISED STATUTES AND ALL ADDITIONAL AMENDMENTS TO THE INTERNATIONAL PLUMBING CODE CONTAINED WITHIN COUNTY AND TOWN CODES.
2. DRAIN PIPING MINIMUM SLOPE SHALL BE IN ACCORDANCE WITH SECTION 7, TABLE 704.1 OF THE INTERNATIONAL PLUMBING CODE.
3. INVERT ELEVATIONS INDICATED ON PLANS AT FLOOR DRAINS SHALL BE AT THE CONNECTION OF THE TRAP TAIL PIECE TO THE TRAP ARM.
4. INVERT ELEVATIONS INDICATED ON PLANS AT EQUIPMENT DRAINS AND AREA DRAINS SHALL BE AT THE CONNECTION BETWEEN THE VERTICAL TO HORIZONTAL FITTING FROM DRAIN TO THE FIXTURE DRAIN LINE.
5. DRAIN PIPING THROUGH SLAB SHALL BE CAST IN FLOOR SLAB WITH HYDROPHILIC WATERSTOP ALL AROUND, CENTERED IN SLAB.
6. FOR PLUMBING FIXTURES, PLUMBING TRIM, VALVES AND PIPE MATERIALS SEE SPECIFICATION SECTION 22 40 00.
7. WHERE INVERT ELEVATIONS ARE SHOWN ON PIPE RUNS THE ELEVATIONS SHOWN SHALL TAKE PRECEDENCE OVER GENERAL NOTE 2.
8. SEE DRAWINGS M-10 AND M-11 FOR PLUMBING STANDARD DETAILS.
9. FOR DOMESTIC WATER (PW) PIPING, SEE SCHEMATIC ON DRAWING M-1125.
10. FOR PLUMBING PIPING INSULATION REQUIREMENTS SEE SPECIFICATION SECTION 22 40 00.

PLUMBING ABBREVIATIONS:

AD	AREA DRAIN
BFP	BACKFLOW PREVENTER
CO	CLEANOUT
COP	COPPER
CWD	CLEAR WATER DISCHARGE
D	DRAIN
ED	EQUIPMENT DRAIN
EWS	EMERGENCY EYEWASH/SHOWER
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
IE	INVERT ELEVATION
NPW	NONPOTABLE WATER
PW	POTABLE WATER
TW	TEMPERED WATER
SD	SANITARY DRAIN
V	VENT
VTR	VENT THROUGH ROOF
WH	WATER HEATER
YCO	YARD CLEANOUT

PLAN
OVERALL PLUMBING
SCALE: 1/8"=1'-0

 Dewberry [®] Dewberry Engineers Inc. 990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825-1802	LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY) DRAWING MPL59690-1120 DRAWN JRA DESIGNED JRA CHECKED SEF	APPROVED:	REVISIONS					TOWN OF SILT SILT, COLORADO				MECHANICAL				DATE: 07/29/23 PROJECT NUMBER: 50159690	
		PRINCIPAL	REV.	DESCRIPTION	BY	DATE	APP.										
		DATE:	A	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	SEF	DRAWING NUMBER									
			B	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF	M-1120									
			C	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF	SHEET NUMBER									
WATER TREATMENT PLANT IMPROVEMENTS								WATER TREATMENT PLANT OVERALL PLUMBING PLAN									



- NOTES:**
1. FOR RIM ELEVATIONS OF AREA DRAINS AND FLOOR DRAINS SEE DRAWING S-1103.
- KEY NOTES:**
- 1 WALL MOUNTED UTILITY STATION, SEE DETAIL 5/M-11.
 - 2 POST MOUNTED UTILITY STATION, SEE DETAIL 6/M-11.
 - 3 TYPE 2 AREA DRAIN WITH SQUARE INLET GRATE, SEE DETAIL 4/M-10.
 - 4 TYPE 2 EQUIPMENT DRAIN, SEE DETAIL 3/M-11.
 - 5 PIPE PENETRATION THROUGH MASONRY WALL, SEE DETAIL 10/M-5.
 - 6 6" TYPE 2 EQUIPMENT DRAIN, SEE DETAIL 3/M-11, SIMILAR. RIM ELEVATION SHALL BE 5413.83.

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DRAWN JRA
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CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	JRA	07/31/23	SEF
B	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF
C	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF

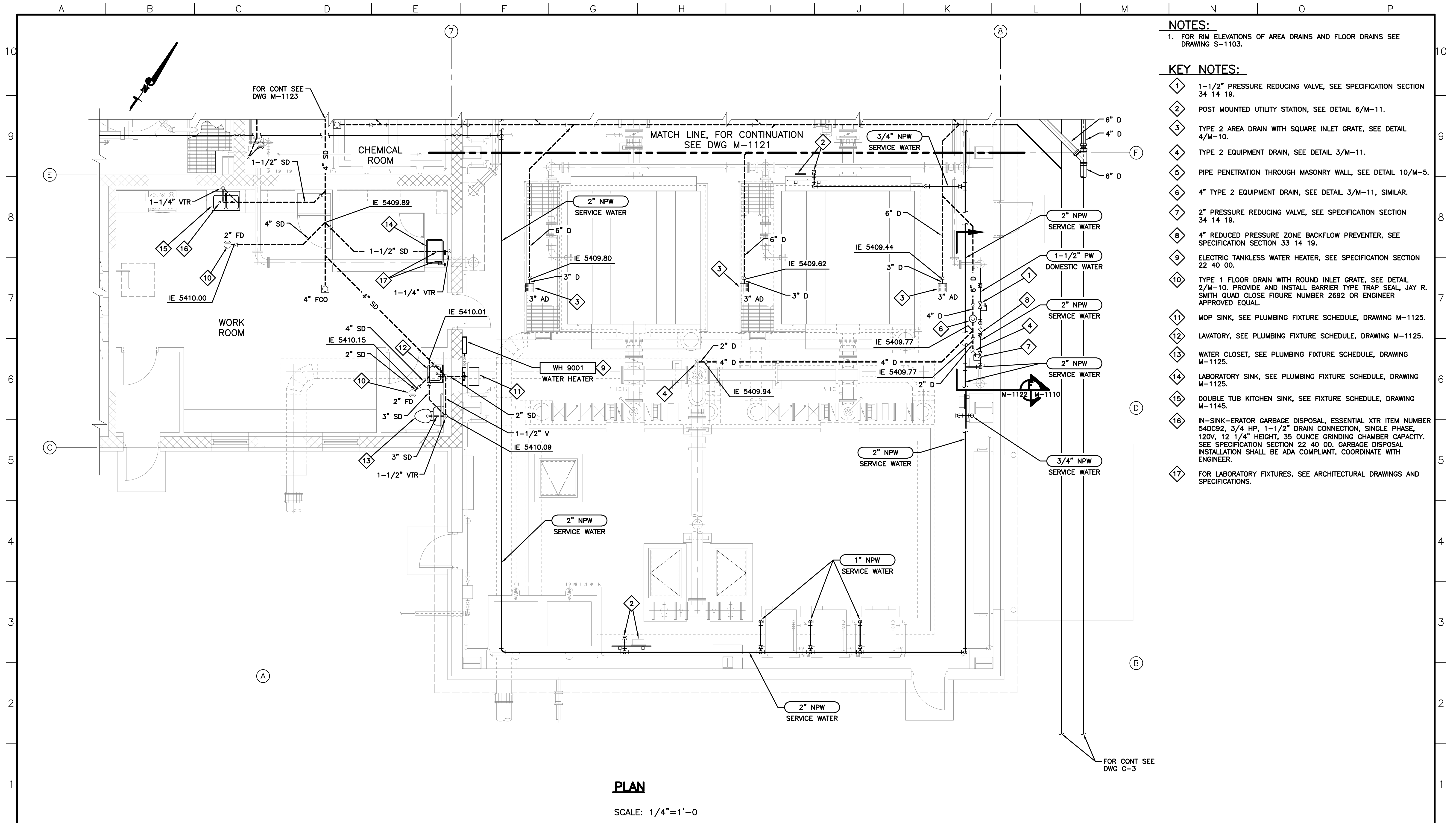
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

MECHANICAL

WATER TREATMENT PLANT
BALLASTED FLOCC AREA
PLUMBING PLAN

DATE: 07/31/23
PROJECT NUMBER: 50159690
REVISION NO. C
DRAWING NUMBER
M-1121
SHEET NUMBER



- NOTES:**
1. FOR RIM ELEVATIONS OF AREA DRAINS AND FLOOR DRAINS SEE DRAWING S-1103.
- KEY NOTES:**
- 1 1-1/2" PRESSURE REDUCING VALVE, SEE SPECIFICATION SECTION 34 14 19.
- 2 POST MOUNTED UTILITY STATION, SEE DETAIL 6/M-11.
- 3 TYPE 2 AREA DRAIN WITH SQUARE INLET GRATE, SEE DETAIL 4/M-10.
- 4 TYPE 2 EQUIPMENT DRAIN, SEE DETAIL 3/M-11.
- 5 PIPE PENETRATION THROUGH MASONRY WALL, SEE DETAIL 10/M-5.
- 6 4" TYPE 2 EQUIPMENT DRAIN, SEE DETAIL 3/M-11, SIMILAR.
- 7 2" PRESSURE REDUCING VALVE, SEE SPECIFICATION SECTION 34 14 19.
- 8 4" REDUCED PRESSURE ZONE BACKFLOW PREVENTER, SEE SPECIFICATION SECTION 33 14 19.
- 9 ELECTRIC TANKLESS WATER HEATER, SEE SPECIFICATION SECTION 22 40 00.
- 10 TYPE 1 FLOOR DRAIN WITH ROUND INLET GRATE, SEE DETAIL 2/M-10. PROVIDE AND INSTALL BARRIER TYPE TRAP SEAL, JAY R. SMITH QUAD CLOSE FIGURE NUMBER 2692 OR ENGINEER APPROVED EQUAL.
- 11 MOP SINK, SEE PLUMBING FIXTURE SCHEDULE, DRAWING M-1125.
- 12 LAVATORY, SEE PLUMBING FIXTURE SCHEDULE, DRAWING M-1125.
- 13 WATER CLOSET, SEE PLUMBING FIXTURE SCHEDULE, DRAWING M-1125.
- 14 LABORATORY SINK, SEE PLUMBING FIXTURE SCHEDULE, DRAWING M-1125.
- 15 DOUBLE TUB KITCHEN SINK, SEE FIXTURE SCHEDULE, DRAWING M-1145.
- 16 IN-SINK-ERATOR GARBAGE DISPOSAL, ESSENTIAL XTR ITEM NUMBER 54DC92, 3/4 HP, 1-1/2" DRAIN CONNECTION, SINGLE PHASE, 120V, 12 1/4" HEIGHT, 35 OUNCE GRINDING CHAMBER CAPACITY. SEE SPECIFICATION SECTION 22 40 00. GARBAGE DISPOSAL INSTALLATION SHALL BE ADA COMPLIANT, COORDINATE WITH ENGINEER.
- 17 FOR LABORATORY FIXTURES, SEE ARCHITECTURAL DRAWINGS AND SPECIFICATIONS.

PLAN

SCALE: 1/4"=1'-0

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DRAWING MPL59690-1122

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DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
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B	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF
C	BUILDING DEPT REVIEW SUBMITTAL	JRA	10/13/23	SEF

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

MECHANICAL

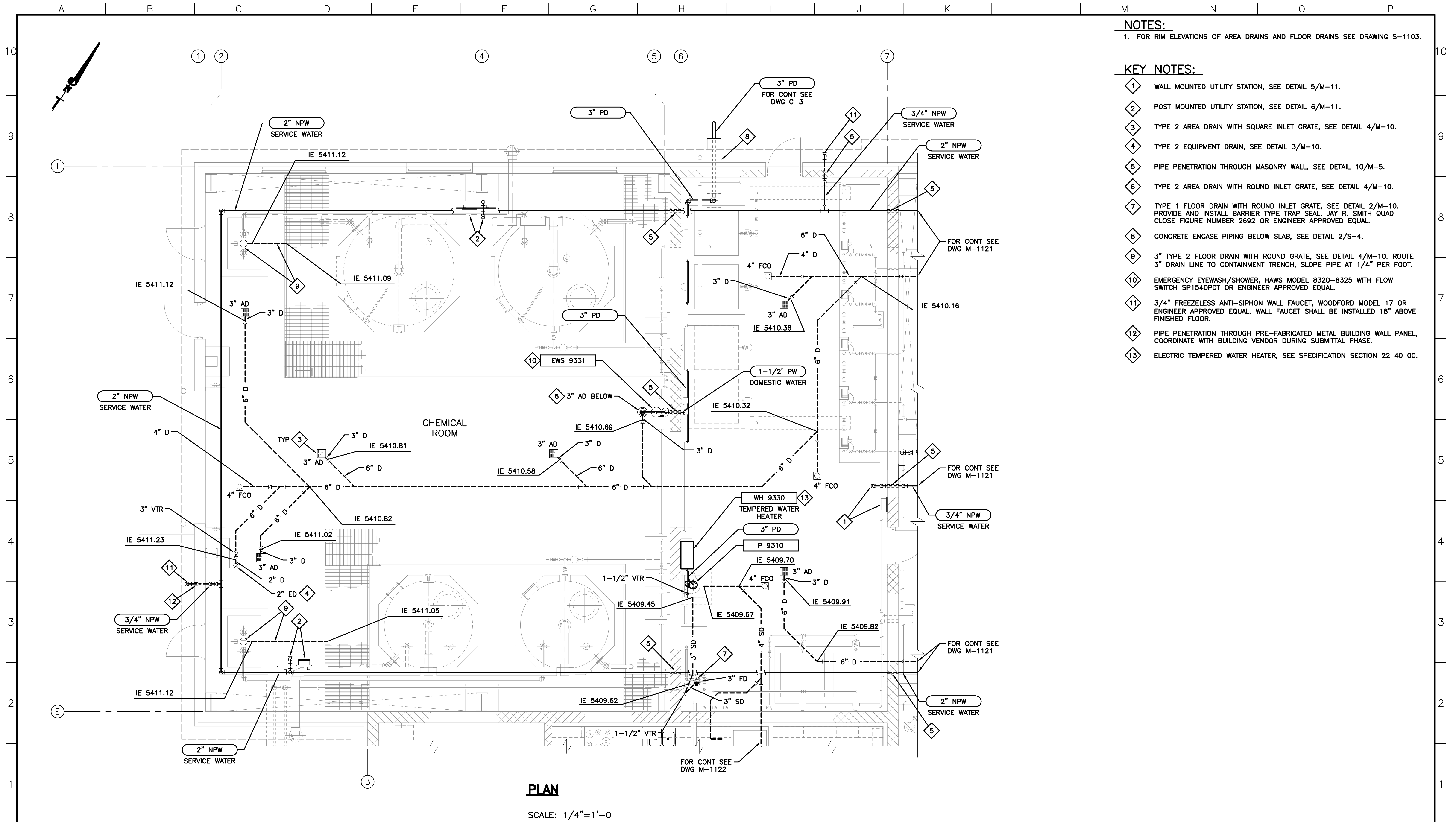
WATER TREATMENT PLANT
FILTER AREA
PLUMBING PLAN

DATE: 07/31/23

PROJECT NUMBER: 50159690

REVISION NO. C

DRAWING NUMBER
M-1122
SHEET NUMBER



NOTES:
1. FOR RIM ELEVATIONS OF AREA DRAINS AND FLOOR DRAINS SEE DRAWING S-1103.

- KEY NOTES:
- 1 WALL MOUNTED UTILITY STATION, SEE DETAIL 5/M-11.
 - 2 POST MOUNTED UTILITY STATION, SEE DETAIL 6/M-11.
 - 3 TYPE 2 AREA DRAIN WITH SQUARE INLET GRATE, SEE DETAIL 4/M-10.
 - 4 TYPE 2 EQUIPMENT DRAIN, SEE DETAIL 3/M-10.
 - 5 PIPE PENETRATION THROUGH MASONRY WALL, SEE DETAIL 10/M-5.
 - 6 TYPE 2 AREA DRAIN WITH ROUND INLET GRATE, SEE DETAIL 4/M-10.
 - 7 TYPE 1 FLOOR DRAIN WITH ROUND INLET GRATE, SEE DETAIL 2/M-10. PROVIDE AND INSTALL BARRIER TYPE TRAP SEAL, JAY R. SMITH QUAD CLOSE FIGURE NUMBER 2692 OR ENGINEER APPROVED EQUAL.
 - 8 CONCRETE ENCASE PIPING BELOW SLAB, SEE DETAIL 2/S-4.
 - 9 3\"/>
 - 10 EMERGENCY EYEWASH/SHOWER, HAWS MODEL 8320-8325 WITH FLOW SWITCH SP154DPDT OR ENGINEER APPROVED EQUAL.
 - 11 3/4\"/>
 - 12 PIPE PENETRATION THROUGH PRE-FABRICATED METAL BUILDING WALL PANEL, COORDINATE WITH BUILDING VENDOR DURING SUBMITTAL PHASE.
 - 13 ELECTRIC TEMPERED WATER HEATER, SEE SPECIFICATION SECTION 22 40 00.

PLAN

SCALE: 1/4"=1'-0

Dewberry
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Denver, Colorado 80209
(303) 825-1802

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DRAWN JRA
DESIGNED JRA
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
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B	CDPHE REVIEW SUBMITTAL	JRA	09/29/23	SEF
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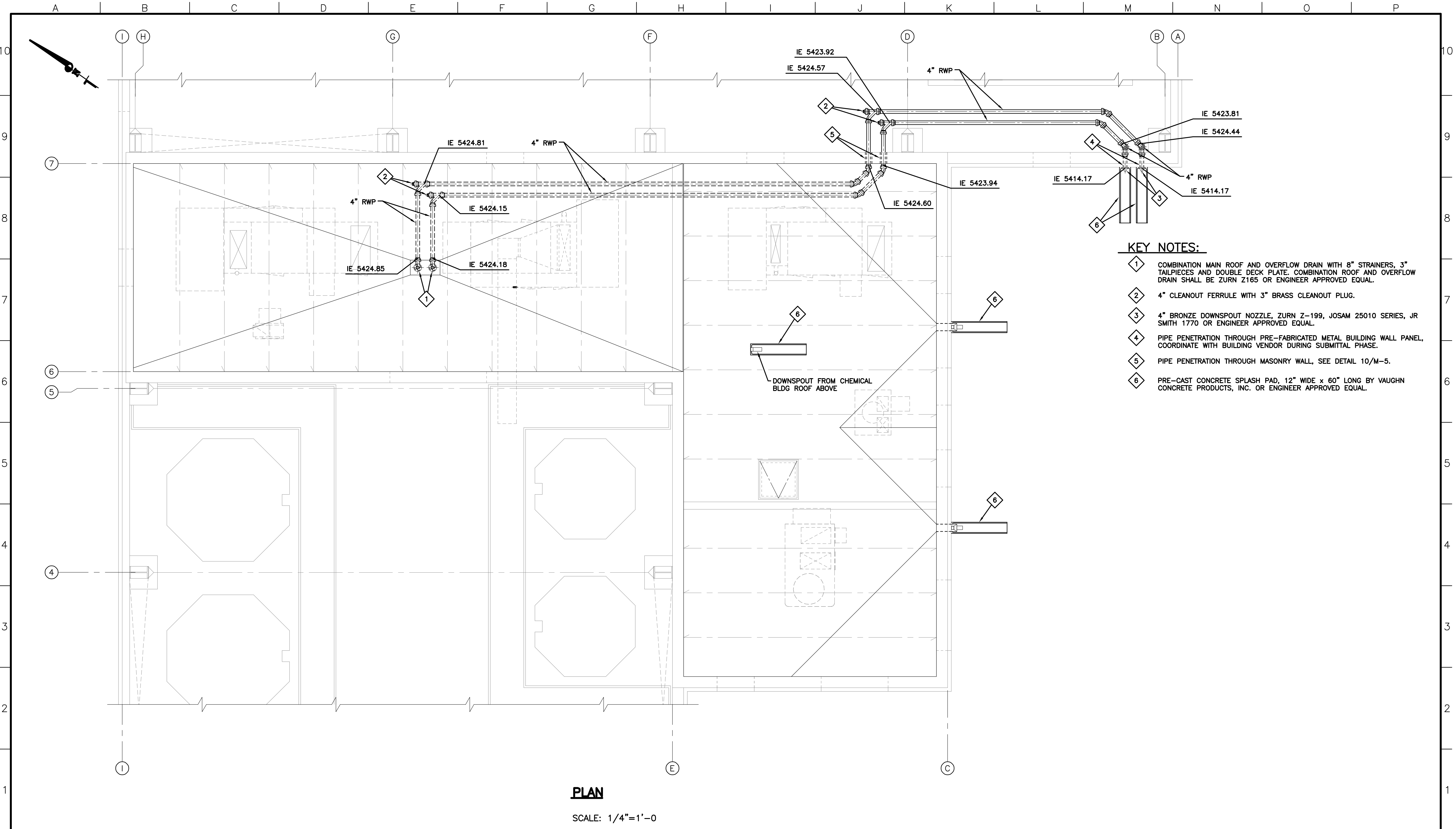
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

MECHANICAL

WATER TREATMENT PLANT
CHEMICAL ROOM PLUMBING PLAN

DATE: 07/31/23
PROJECT NUMBER: 50159690
REVISION NO. C
DRAWING NUMBER
M-1123
SHEET NUMBER




PLAN

SCALE: 1/4"=1'-0

KEY NOTES:

- 1 COMBINATION MAIN ROOF AND OVERFLOW DRAIN WITH 8" STRAINERS, 3" TAILPIECES AND DOUBLE DECK PLATE. COMBINATION ROOF AND OVERFLOW DRAIN SHALL BE ZURN Z165 OR ENGINEER APPROVED EQUAL.
- 2 4" CLEANOUT FERRULE WITH 3" BRASS CLEANOUT PLUG.
- 3 4" BRONZE DOWNSPOUT NOZZLE, ZURN Z-199, JOSAM 25010 SERIES, JR SMITH 1770 OR ENGINEER APPROVED EQUAL.
- 4 PIPE PENETRATION THROUGH PRE-FABRICATED METAL BUILDING WALL PANEL, COORDINATE WITH BUILDING VENDOR DURING SUBMITTAL PHASE.
- 5 PIPE PENETRATION THROUGH MASONRY WALL, SEE DETAIL 10/M-5.
- 6 PRE-CAST CONCRETE SPLASH PAD, 12" WIDE x 60" LONG BY VAUGHN CONCRETE PRODUCTS, INC. OR ENGINEER APPROVED EQUAL.



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DRAWN JRA
DESIGNED JRA
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REV. DESCRIPTION BY DATE APP.
A ISSUED FOR REVIEW JRA 08/10/23 SEF
B CDPHE REVIEW SUBMITTAL JRA 09/29/23 SEF
C BUILDING DEPT REVIEW SUBMITTAL JRA 10/13/23 SEF

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

MECHANICAL

WATER TREATMENT PLANT
LOW ROOF
PLUMBING PLAN

DATE: 08/11/23
PROJECT NUMBER: 50159690
REVISION NO. C
DRAWING NUMBER
M-1124
SHEET NUMBER

HVAC DRAWING NUMBERING CONVENTION

H-1001

EXAMPLE DWG NO.

FIRST CHARACTER: INDICATES DISCIPLINE OF WORK AS FOLLOWS:
H = HVAC

SECOND & THIRD CHARACTERS: INDICATE BUILDING AS FOLLOWS:
00 = ALL BUILDINGS WHERE APPLICABLE (OMITTED)
10 = EXISTING TREATMENT BUILDING
11 = NEW TREATMENT BUILDING

FOURTH CHARACTER INDICATES DRAWING CONTENT AS FOLLOWS:
0 = NORMAL SCALE PLANS (OMITTED WHEN 2ND & 3RD CHARACTERS = 0).
1 = ENLARGED SCALE PLANS
2 = SECTIONS
3 = TEMPERATURE CONTROLS
4 = DEMOLITION PLANS

FIFTH CHARACTER IS CONSECUTIVE NUMBERING FOR DRAWINGS WITH THE SAME FOURTH CHARACTER. FOR NORMAL SCALE PLANS, THIS CHARACTER ALSO REPRESENTS THE LEVEL OF THE PLAN, AS FOLLOWS:
0 = BASEMENT LEVEL
1 = GROUND LEVEL
2 = SECOND LEVEL (ROOF FOR SINGLE LEVEL BUILDINGS)
3 = THIRD LEVEL (ROOF FOR 2-LEVEL BUILDINGS)

HVAC EQUIPMENT TAGGING CONVENTION

MAU 1001

EXAMPLE EQUIPMENT TAG

FIRST FIELD (ONE TO FOUR CHARACTERS): INDICATES TYPE OF EQUIPMENT. RE: ABBREVIATIONS, THIS SHEET.

SECOND & THIRD CHARACTERS: INDICATE BUILDING WHERE EQUIPMENT IS LOCATED AS FOLLOWS:
10 = EXISTING TREATMENT BUILDING
11 = NEW TREATMENT BUILDING

FOURTH AND FIFTH CHARACTERS INDICATE TYPE OF EQUIPMENT, AS FOLLOWS:

RANGE	EQUIPMENT TYPE
00-09	= MAKE-UP AIR UNITS
10-19	= DX/ELEC ROOFTOP AIR CONDITIONING UNITS
20-29	= DX/GAS ROOFTOP AIR CONDITIONING UNITS
30-39	= SPLIT SYSTEM AIR CONDITIONING UNITS
40-44	= ELECTRIC UNIT HEATERS
45-49	= ELECTRIC BASEBOARD HEATERS
50-54	= GAS-FIRED UNIT HEATERS
55-59	= GAS-FIRED RADIANT HEATERS
60-69	= AUTOMATIC CONTROL DAMPERS
70-79	= EXHAUST FANS
80-99	= MISCELLANEOUS

HVAC LEGEND

DRAWING NOTATION

CONNECTION TO EXISTING

NEW WORK

EXISTING ITEMS

EXISTING ITEMS TO BE DEMOLISHED

NORTH ARROW

SECTION NO.

DIRECTION OF SECTION

SHEET WHERE SHOWN

DETAIL NOTE REFERENCE

REVISION NUMBER

MISCELANEOUS PIPING SERVICES

ED — EQUIPMENT DRAIN

F — FIRE LINE

G — NATURAL GAS

RL — REFRIGERANT LIQUID

RS — REFRIGERANT SUCTION

PIPING SYSTEM COMPONENTS

ELBOW DOWN

ELBOW UP

FLEXIBLE CONNECTION

FLOW ARROW

HOSE END FITTING

PUMP

MANUAL AIR VENT

METER

P&T TAP

PIPE BREAK

REDUCER (CONCENTRIC)

REDUCER (ECCENTRIC)

TEE

TEE DOWN

TEE UP

UNION

VALVES

BALL VALVE

CHECK VALVE

FLOW MEASURING AND BALANCING VL

BALL VLV W/ HOSE END CONN.

GATE VALVE

GATE VALVE W/ HOSE END CONNECTION

VALVE IN RISER

INST AND CONTROL

ACTUATED BALL VALVE

DIFFERENTIAL PRESSURE SENSOR

DIFFERENTIAL PRESSURE SWITCH

FLOW SENSOR

FLOW SWITCH

FREEZE STAT

GAUGE

HUMIDISTAT

OCCUPANCY SENSOR

PRESSURE SENSOR

PRESSURE SWITCH

DUCT SMOKE DETECTOR

SOLENOID VALVE, TWO-WAY

SOLENOID VALVE, THREE-WAY

TEMPERATURE SENSOR

TEMPERATURE SWITCH

THERMOMETER

SPACE TEMPERATURE SENSOR

AIR SYSTEM COMPONENTS

DUCT SIZE INDICATES INSIDE CLEAR DIMENSIONS. FIRST NUMBER IS SIZE OF SURFACE SHOWN.

18x12 RECTANGULAR DUCT

12"Ø ROUND DUCT

12/12 FLAT OVAL DUCT

TEE WITH TURNING VANES

SQUARE ELBOW WITH TURNING VANES

MANUAL DAMPER

AIR SYST COMP. CONT'D

MOTORIZED DAMPER

FIRE / SMOKE DAMPER

FIRE DAMPER

SMOKE DAMPER

FLEX CONNECTION

RECT. SUPPLY DUCT UP

RECT. SUPPLY DUCT DOWN

RECT. RETURN DUCT UP

RECT. RETURN DUCT DOWN

CIRCULAR DUCT UP

CIRCULAR DUCT DOWN

12x12 / 18x12 CONCENTRIC REDUCER

16x12 / 18x12 ECCENTRIC REDUCER

DN DUCT SLOPE

SUPPLY DIFFUSER/RETURN GRILLE

SUPPLY DIFFUSER SHOWING 3-WAY PATTERN (MAY BE USED FOR 1, 2, 3, 4 WAY)

RETURN GRILLE W/ SOUND BOOT

UNIT HEATER

RETURN/EXHAUST/TRANSFER AIR FLOW ARROW

FAN

TAG SIZE (#) CFM FLOW # OF SIMILAR DEVICES DIFFUSER CALLOUT

ABBREVIATIONS			
AAV	AUTOMATIC AIR VENT	HPEF	HIGH PLUME EXHAUST FAN
ACU	AIR CONDITIONING UNIT	HR	HUMIDITY RATIO
ADJ	ADJUSTABLE	HVAC	HEATING, VENTILATING AND
AI	ANALOG INPUT		AIR CONDITIONING
AO	ANALOG OUTPUT	HZ	HERTZ
AS	AIR SEPARATOR		
		IN	INCHES
BHP	BRAKE HORSEPOWER	IN WC	INCHES OF WATER COLUMN
BI	BACKWARD INCLINED		
BTUH	BRITISH THERMAL UNITS/HR	KW	KILOWATTS
		KWH	KILOWATT-HOURS
CFH	CUBIC FEET PER HOUR		
CFM	CUBIC FEET PER MINUTE	LAT	LEAVING AIR TEMPERATURE
		LBS	POUNDS
DB	DRY-BULB	LWT	LEAVING WATER TEMPERATURE
DBA	DECIBELS, A-SCALE		
DDC	DIRECT DIGITAL CONTROL	MANUF	MANUFACTURER
DEG F	DEGREES FAHRENHEIT	MAU	MAKE-UP AIR UNIT
DI	DIGITAL INPUT	MBH	ONE THOUSAND BTUH
DN	DOWN	MCA	MINIMUM CIRCUIT AMPACITY
DO	DIGITAL OUTPUT	MOCP	MAXIMUM OVER-CURRENT
DP	DEW POINT		PROTECTION
DX	DIRECT EXPANSION		
		NC	NOISE CRITERIA
EA	EACH	NO	NUMBER
EAT	ENTERING AIR TEMPERATURE		
EBB	ELECTRIC BASEBOARD HEATER	OA/OSA	OUTSIDE AIR
EER	ENERGY EFFICIENCY RATIO	OBD	OPPOSED BLADE DAMPER
EF	EXHAUST FAN		
EPO	EMERGENCY POWER OFF	PG	PROPYLENE GLYCOL
ET	EXPANSION TANK	PH	PHASE
EUH	ELECTRIC UNIT HEATER		
EWT	ENTERING WATER TEMPERATURE	RH	RELATIVE HUMIDITY
EX	EXISTING	RLA	RUNNING LOAD AMPS
		RPM	REVOLUTIONS PER MINUTE
FAF	FRESH AIR FAN	RTU	ROOFTOP AIR CONDITIONING UNIT
FCU	FAN COIL UNIT		
FLA	FULL LOAD AMPS	SA	SUPPLY AIR
FPI	FINS PER INCH	SAV	SUPPLY AIR VALVE
FPM	FEET PER MINUTE	SEER	SEASONAL ENERGY EFFICIENCY
FT	FEET		RATIO
		SSIU	SPLIT SYSTEM INDOOR UNIT
GA	GAUGE	SSOU	SPLIT SYSTEM OUTDOOR UNIT
GBD	GRAVITY BACKDRAFT DAMPER	STS	SPACE TEMPERATURE SENSOR
GEV	GENERAL EXHAUST VALVE		
GF	GLYCOL FEEDER	TYP	TYPICAL
GIH	GRAVITY INTAKE HOOD		
GMU	GLYCOL MAKE-UP UNIT	V	VOLTS
GPM	GALLONS PER MINUTE	VA	VOLT-AMPERES
GRD	GRILLES, REGISTERS, DIFFUSERS	VAC	VOLTS - ALTERNATING CURRENT
GRH	GAS-FIRED RADIANT HEATER	VAV	VARIABLE AIR VOLUME
GUH	GAS-FIRED UNIT HEATER	VFD	VARIABLE FREQUENCY DRIVE
HEV	HOOD EXHAUST VALVE	W	WATTS
HP	HORSEPOWER	WB	WET-BULB

Dewberry Engineers Inc.

990 S. BROADWAY, SUITE 400
Denver, Colorado 80209
(303) 825-1802

LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"-SCALE ACCORDINGLY)

DRAWING
DRAWN BGT
DESIGNED BGT
CHECKED BGT

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN DELIVERABLE	ESI	08/11/23	BGT
B	90% DESIGN ADDENDUM	ESI	08/16/23	BGT
C	BUILDING DEPT REVIEW SUBMITTAL	ESI	10/13/23	BGT

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

HVAC

LEGEND, ABBREVIATIONS
AND NOMENCLATURE CONVENTIONS

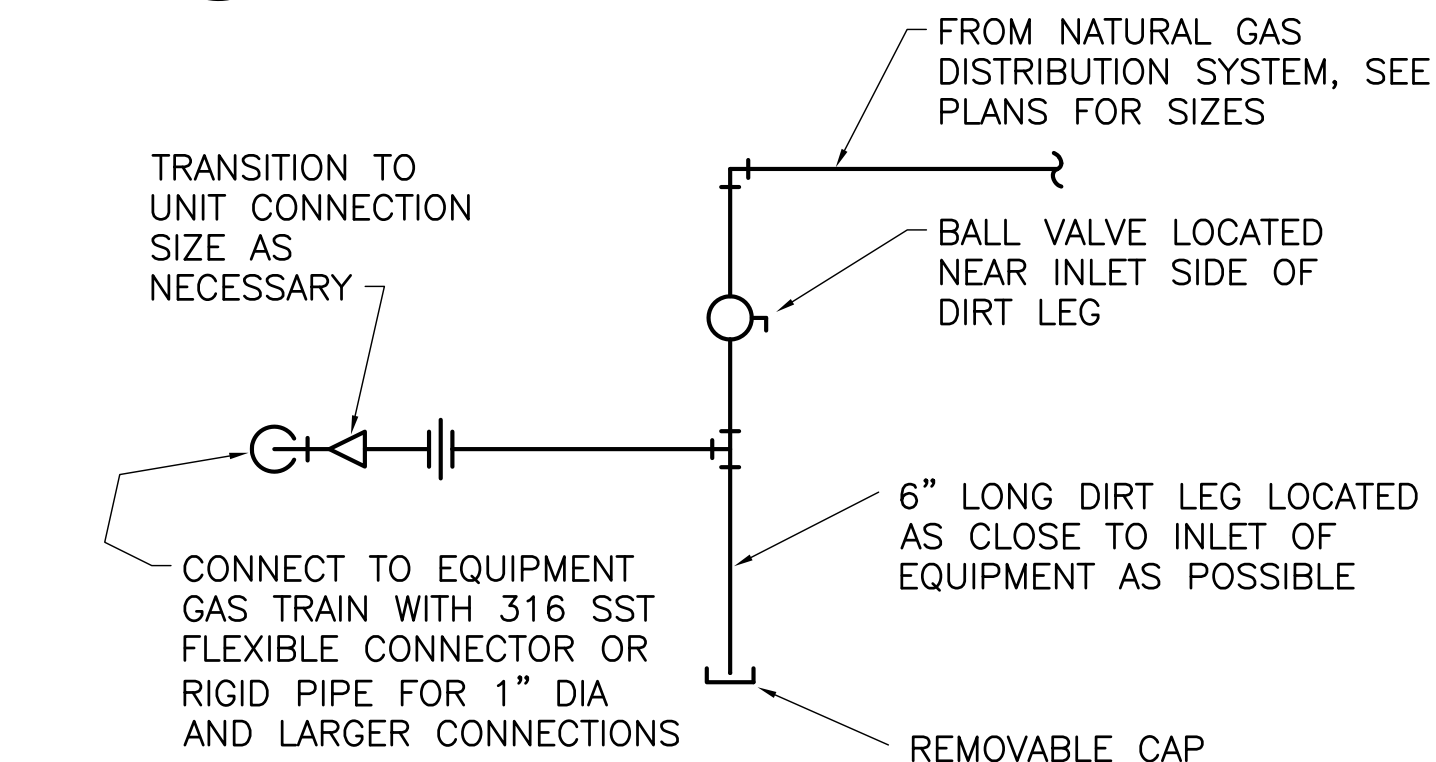
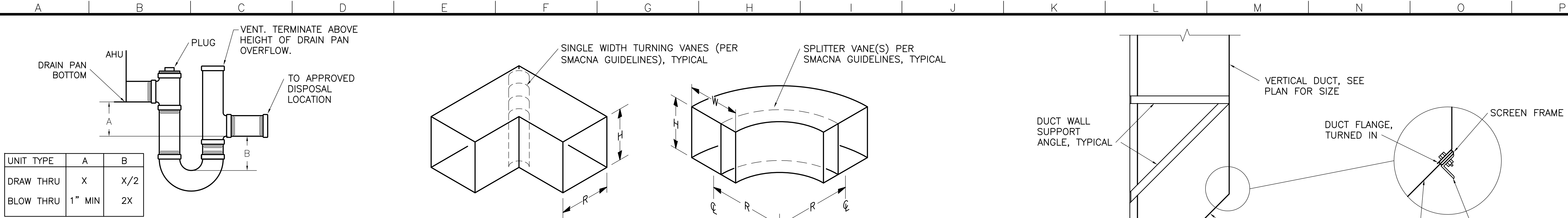
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NUMBER:

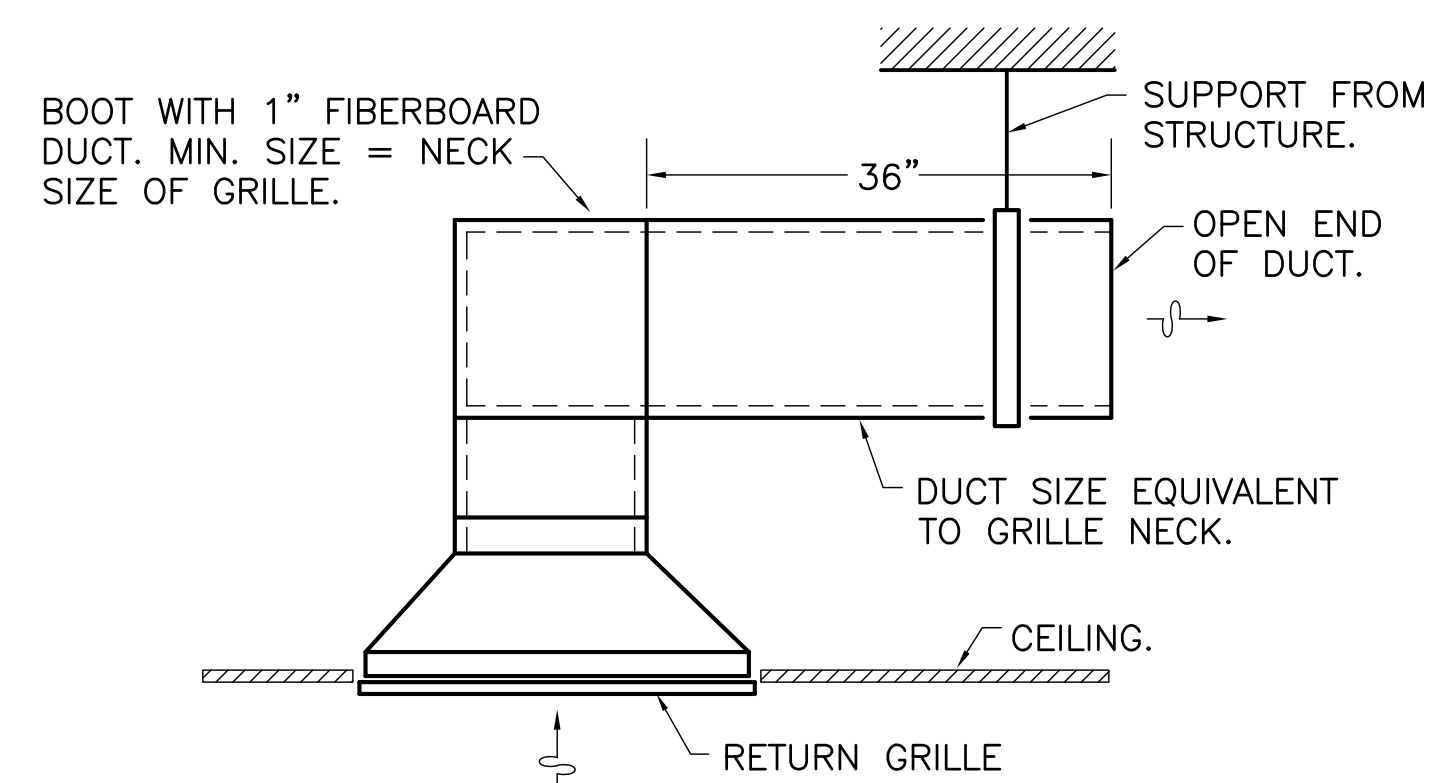
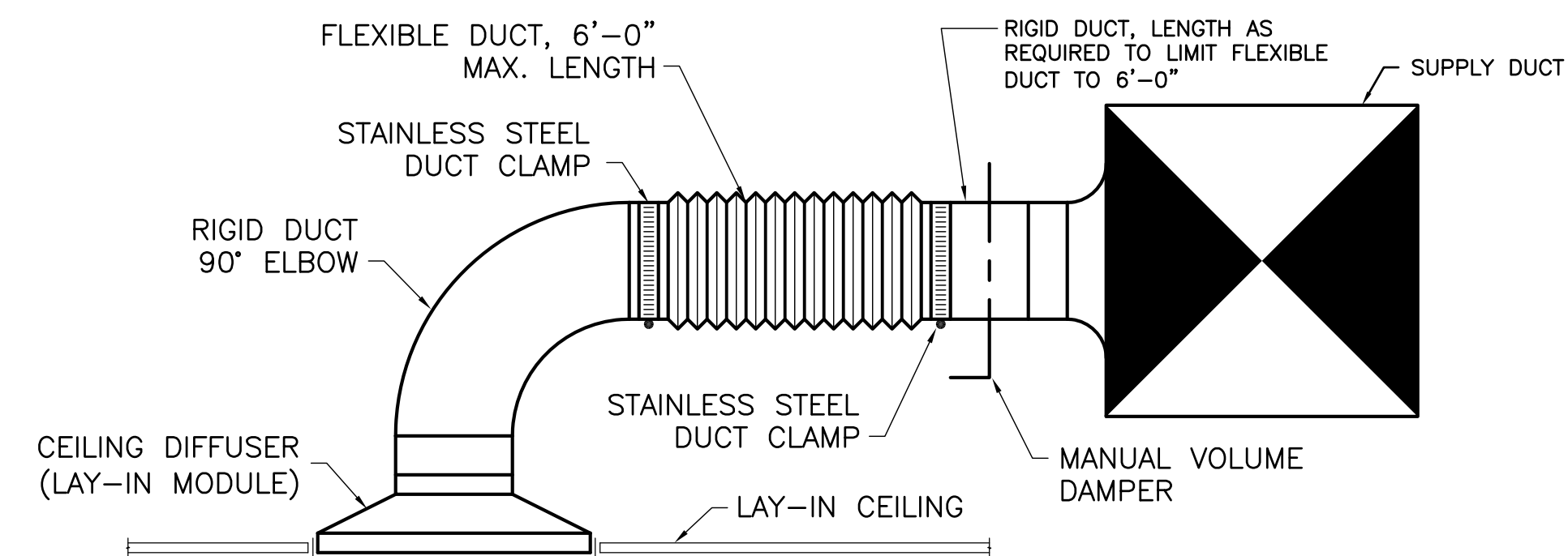
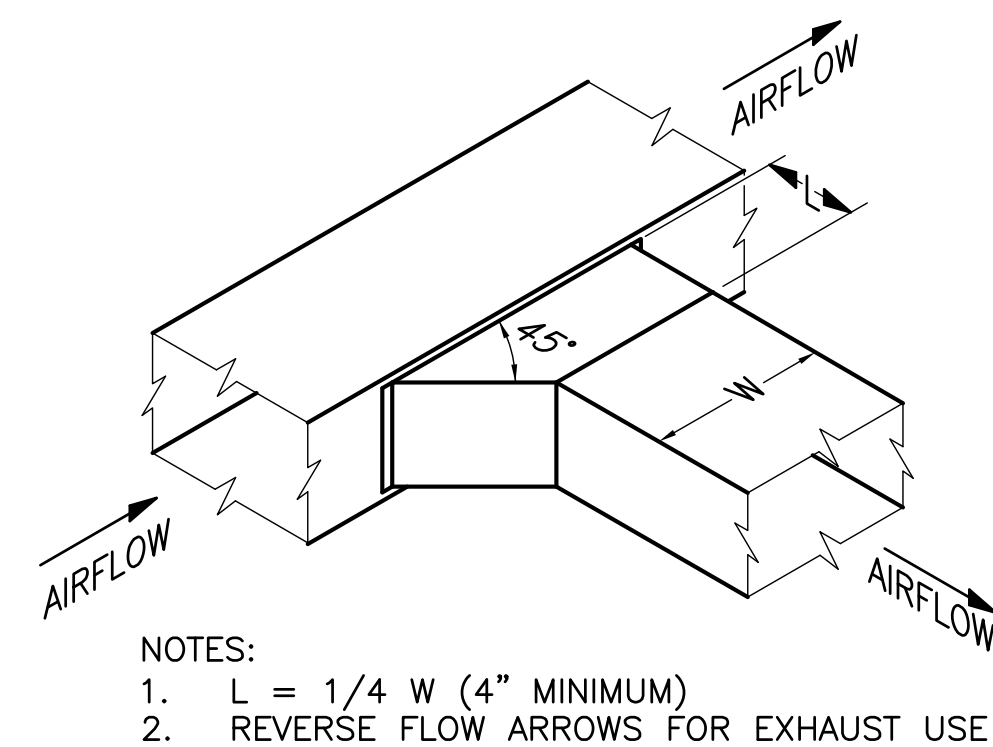
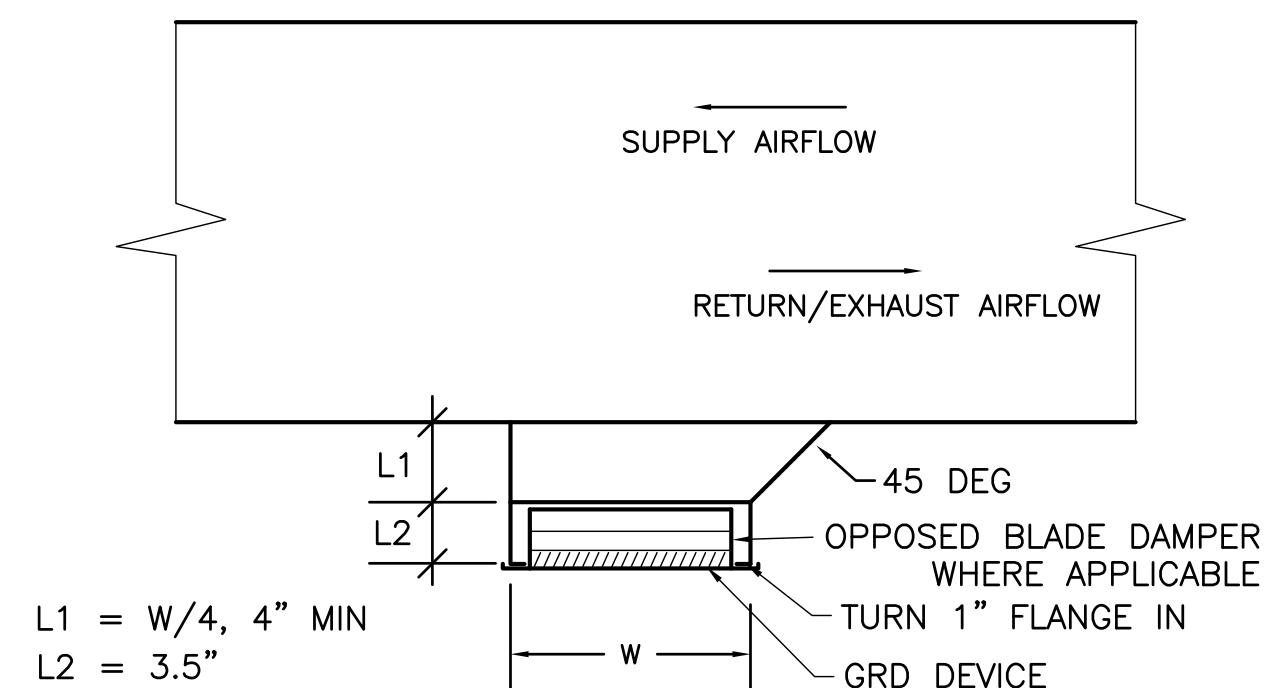
REVISION NO. C
DRAWING NUMBER
H-1
SHEET NUMBER

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N/A	0.76	0.78	DX COIL	FAN SPEED (RPM)	N/A	983	812	MOTOR BRAKE HORSEPOWER	N/A	1.19	1.32	MOTOR NAMEPLATE HORSEPOWER	N/A	1.50	1.50	EDB (DEG F)	77.2	95.0	95.0	EWB (DEG F)	58.1	60.5	60.5	LDB (DEG F)	53.6	53.0	52.5	AMBIENT TEMPERATURE (DEG F)	99.6	99.6	99.6	DESIGN SPACE COOLING SETPOINT	73.0	95.0	95.0	TOTAL COOLING (MBH)	24.0	126.7	150.6	SENSIBLE COOLING (MBH)	24.0	126.7	150.6	REFRIGERANT	R-410A	R-410A	R-410A	AIR PRESSURE DROP (IN. WC.)	NOTE 2	NOTE 2	NOTE 2	HEATING	FUEL	NAT GAS	NAT GAS	NAT GAS	INLET PRESSURE (IN WC)	7-14	7-14	7-14	HEATING EFFICIENCY (%)	80.0	80.0	80.0	HEATING SA FLOW RATE (CFM)	880	3,320	3,900	HEATING INPUT (MBH)	48.0	90.1	90.1	HEATING OUTPUT (MBH)	38.0	72.1	72.1	TURNDOWN RATIO	2-STAGE	15:1 MODULATING	15:1 MODULATING	DESIGN AMBIENT TEMPERATURE (DEG F)	-8.90	-8.9	-8.90	FURNACE EAT (DEG F)	57.70	55.0	55.00	TEMPERATURE RISE (DEG F)	26.10	24.6	20.9	DESIGN LAT (DEG F)	83.80	79.6	75.9	FURNACE APD (IN WC)	NOTE 2	NOTE 2	NOTE 2	ELEC POWER	VOLTS	208	460	460	PHASES	1	3	3	MIN CIRCUIT AMPACITY (MCA)	19.5	30.5	36.7	MAX OVERCURRENT PROTECTION (MOCP)	30.0	35.0	40.0	FULL LOAD CURRENT (FLA)				FLTR	FILTER DEPTH (IN)	2	2	2	FILTER RATING (MERV)	8	8	8	MID-LIFE AIR PRESSURE DROP (IN. WC.)	NOTE 2	NOTE 2	NOTE 2	LENGTH (IN)	50.59	176.00	217.00	WIDTH (IN)	43.06	88.00	89.00	PHYSICAL	HEIGHT, UNIT/CURB (IN)	35.38/24	49/28	50/28	WEIGHT (LBS)	370.00	4200.00	4600.00	DISCHARGE DIRECTION (H, V/UP, V/DN)	V/DN	V/UP	V/UP	ECONOMIZER (%)	100	100	100	RELIEF (POWERED/BAROMETRIC)	BAROMETRIC	BAROMETRIC	POWERED	SPE- CIAL	PACKAGED CONTROLS	NOTE 4	NOTE 4	NOTE 4	NOTES:				1.	Scheduled performance at an elevation of 5,522 ft ASL.			2.	Internal APD shall be sufficiently low to accommodate design cfm at scheduled ESP with a fan BHP ≤ the scheduled BHP.			3.	Fan motor nameplate HP shall be not larger than the first available size that meets the following: 1.5 x BHP (for fans < 6 BHP); or, 1.3 x BHP (for fans ≥ 6 BHP).			4.	Refer to controls drawing for sequence of control.			5.	Equipment Roof Curb provided under Architectural Scope. Coordinate height and approved unit requirements.			
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WC.)</td><td>NOTE 2</td></tr><tr><td rowspan="5">ELEC HEATING COIL</td><td>DESIGN AIR FLOW RATE (CFM)</td><td>2,000</td></tr><tr><td>MINIMUM AIR FLOW RATE (CFM)</td><td>2,000</td></tr><tr><td>EDB (DEG F)</td><td>55</td></tr><tr><td>LDB (DEG F)</td><td>64.43</td></tr><tr><td>HEATING CAPACITY (KW)</td><td>6</td></tr><tr><td rowspan="5">ELEC POWER</td><td>AIR PRESSURE DROP (IN. WC.)</td><td>NOTE 2</td></tr><tr><td>VOLTS</td><td>460</td></tr><tr><td>PHASES</td><td>3</td></tr><tr><td>MIN CIRCUIT AMPACITY (MCA)</td><td>16.0</td></tr><tr><td>MAX OVERCURRENT PROTECTION (MOCP)</td><td>20.0</td></tr><tr><td rowspan="5">FLTR</td><td>FULL LOAD CURRENT (FLA)</td><td></td></tr><tr><td>FILTER DEPTH (IN)</td><td>2</td></tr><tr><td>FILTER RATING (MERV)</td><td>8</td></tr><tr><td>MID-LIFE AIR PRESSURE DROP (IN. 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NOTE 2	ELEC HEATING COIL	DESIGN AIR FLOW RATE (CFM)	2,000	MINIMUM AIR FLOW RATE (CFM)	2,000	EDB (DEG F)	55	LDB (DEG F)	64.43	HEATING CAPACITY (KW)	6	ELEC POWER	AIR PRESSURE DROP (IN. WC.)	NOTE 2	VOLTS	460	PHASES	3	MIN CIRCUIT AMPACITY (MCA)	16.0	MAX OVERCURRENT PROTECTION (MOCP)	20.0	FLTR	FULL LOAD CURRENT (FLA)		FILTER DEPTH (IN)	2	FILTER RATING (MERV)	8	MID-LIFE AIR PRESSURE DROP (IN. WC.)	NOTE 2	LENGTH (IN)	88.68	PHYSICAL	WIDTH (IN)	53.28	HEIGHT, UNIT/CURB (IN)	40.92/24	WEIGHT (LBS)	942.00	DISCHARGE DIRECTION (H, V/UP, V/DN)	V/DN	ECONOMIZER (%)	100	SPE- CIAL	RELIEF (POWERED/BAROMETRIC)	BAROMETRIC	PACKAGED CONTROLS	NOTES 4 AND 6	NOTES:		1.	Scheduled performance at an elevation of 5,522 ft ASL.		2.	Internal APD shall be sufficiently low to accommodate design cfm at scheduled ESP with a fan BHP ≤ the scheduled BHP.		3.	Fan motor nameplate HP shall be not larger than the first available size that meets the following: 1.5 x BHP (for fans < 6 BHP); or, 1.3 x BHP (for fans ≥ 6 BHP).		4.	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	FREQUENCY (HZ)	60	60																																																																																																																																																																																																																																																																																														
DIM'S	RPM	1,725	985																																																																																																																																																																																																																																																																																														
	FRAME SIZE																																																																																																																																																																																																																																																																																																
	WIDTH (IN)	32.625	12																																																																																																																																																																																																																																																																																														
	HEIGHT, UNIT/CURB (IN)	31.5/28	14/NA																																																																																																																																																																																																																																																																																														
	DEPTH (IN)	32.75	8.375																																																																																																																																																																																																																																																																																														
DUCT CONNECTION SIZE (IN)	18	6																																																																																																																																																																																																																																																																																															
WEIGHT, (LBS)	285	16																																																																																																																																																																																																																																																																																															
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1.	Scheduled performance at an elevation of 5,522 ft ASL.																																																																																																																																																																																																																																																																																																
2.	For EF 1171, include occupancy sensor option. To be installed by Electrical.																																																																																																																																																																																																																																																																																																
3.	Equipment Roof Curb provided under Architectural Scope. Coordinate height and approved unit requirements.																																																																																																																																																																																																																																																																																																
4.	For EF 1170, include motorized backdraft damper with 120V actuator. Wiring and control by electrical. (Re: H1130).																																																																																																																																																																																																																																																																																																
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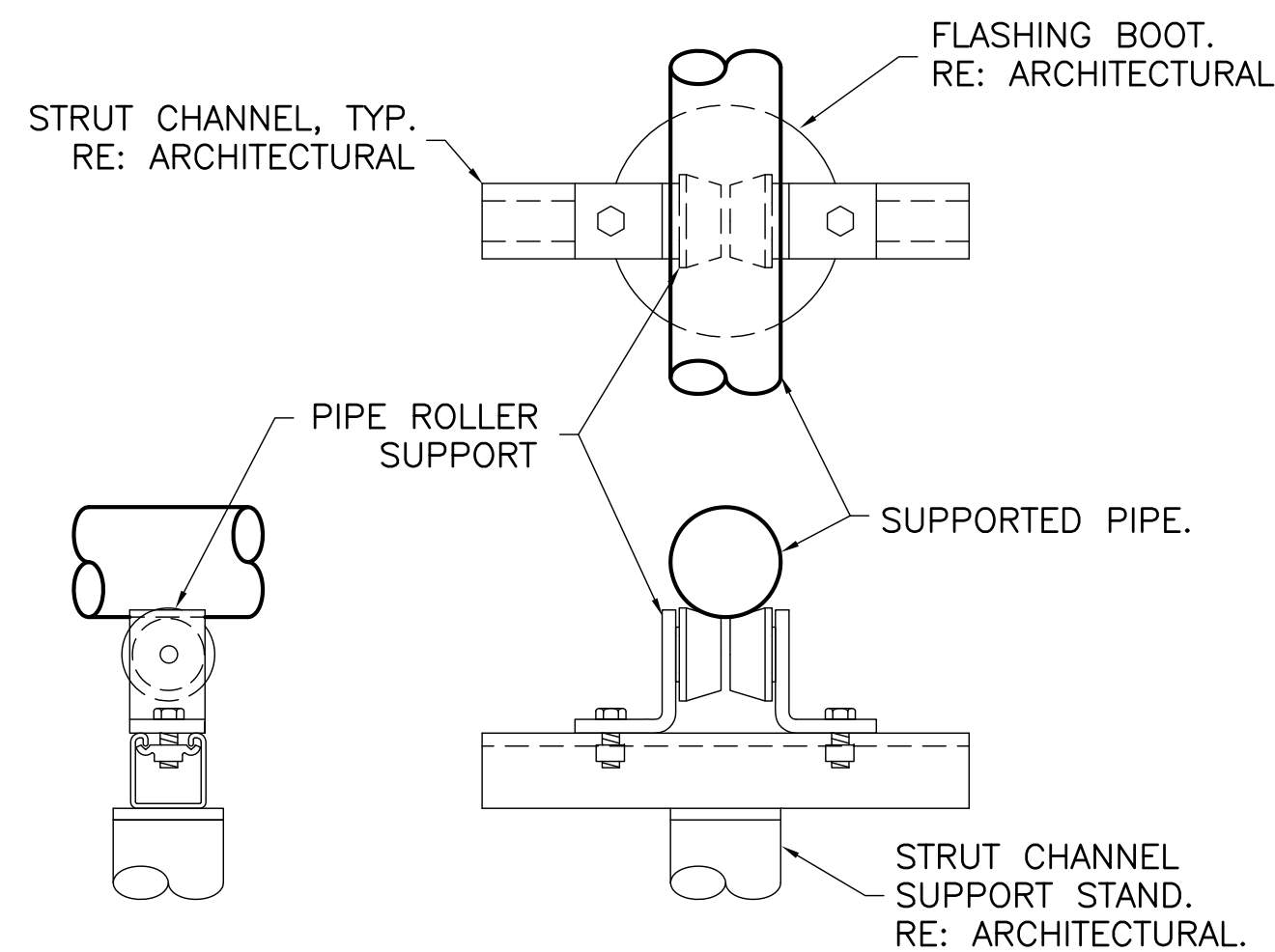
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<div><div><div></div></div><div><div>Dewberry®</div><div>Dewberry Engineers Inc.</div><div>990 S. BROADWAY, SUITE 400</div><div>Denver, Colorado 80209</div><div>(303) 825-1802</div></div></div>				<div>LINE IS 2 INCHES</div> <div>AT FULL SIZE</div> <div>(IF NOT 2"=SCALE ACCORDINGLY)</div> <div><div>DRAWING</div><div>DRAWN <u>BGT</u></div><div>DESIGNED <u>BGT</u></div><div>CHECKED <u>BGT</u></div></div>				<div>APPROVED:</div> <div>PRINCIPAL</div> <div>DATE:</div>				<div>REVISIONS</div> <table><thead><tr><th>REV.</th><th>DESCRIPTION</th><th>BY</th><th>DATE</th><th>APP.</th></tr></thead><tbody><tr><td>A</td><td>90% DESIGN DELIVERABLE</td><td>ESI</td><td>08/11/23</td><td>BGT</td></tr><tr><td>B</td><td>90% DESIGN ADDENDUM</td><td>ESI</td><td>08/16/23</td><td>BGT</td></tr><tr><td>C</td><td>BUILDING DEPT REVIEW SUBMITTAL</td><td>ESI</td><td>10/13/23</td><td>BGT</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></tbody></table>				REV.	DESCRIPTION	BY	DATE	APP.	A	90% DESIGN DELIVERABLE	ESI	08/11/23	BGT	B	90% DESIGN ADDENDUM	ESI	08/16/23	BGT	C	BUILDING DEPT REVIEW SUBMITTAL	ESI	10/13/23	BGT																<div>TOWN OF SILT</div> <div>SILT, COLORADO</div> <div>WATER TREATMENT PLANT IMPROVEMENTS</div>				<div>HVAC</div> <div>EQUIPMENT SCHEDULES</div>				<div>DATE:</div> <div>PROJECT NUMBER:</div> <div>REVISION NO. C</div> <div>DRAWING NUMBER</div> <div>H-2</div> <div>SHEET NUMBER</div>			
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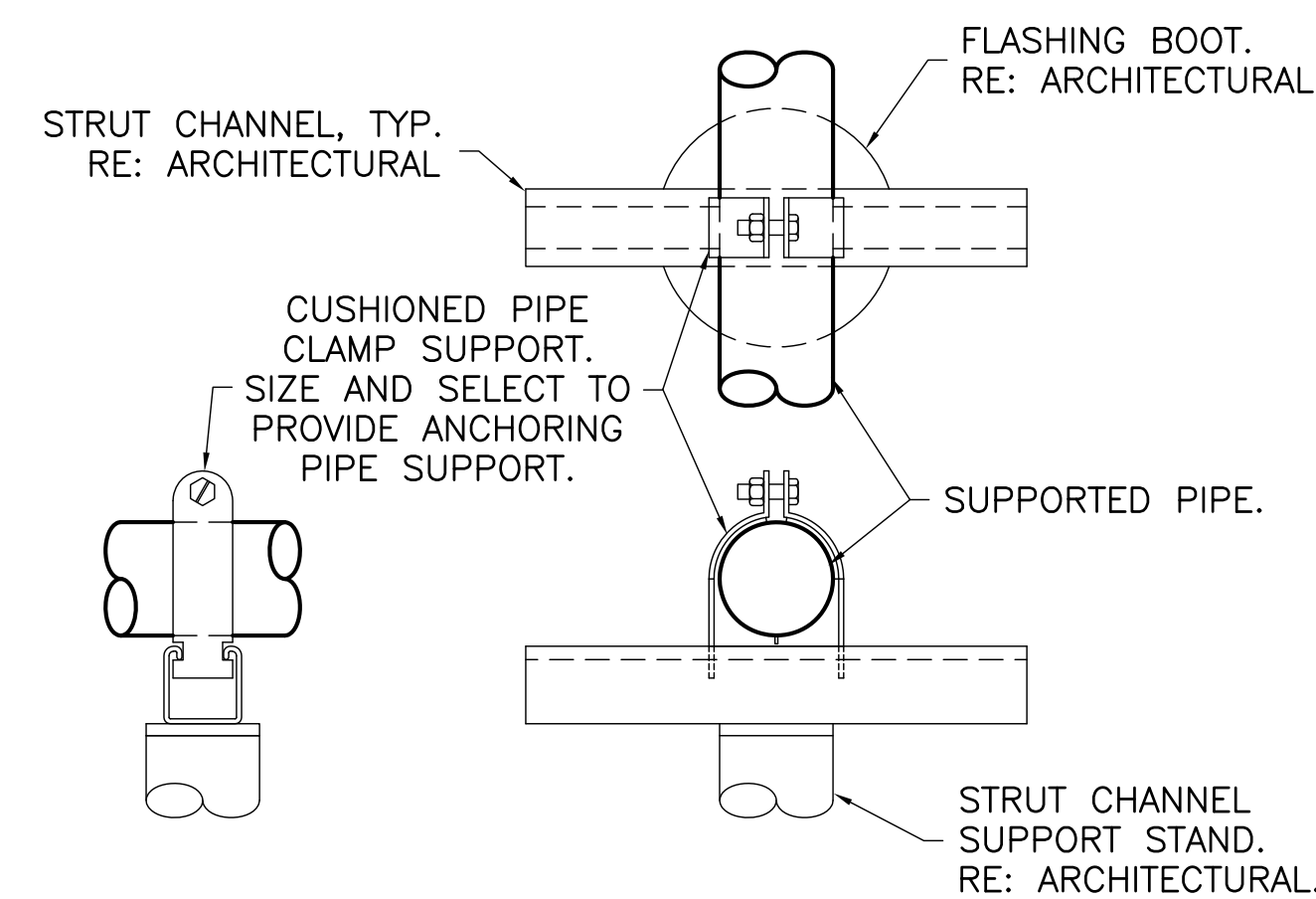
- NOTES:
1. PROVIDE GAS PRESSURE REGULATOR FOR INDIVIDUAL EQUIPMENT AS NECESSARY TO MEET PRESSURE REQUIREMENTS.

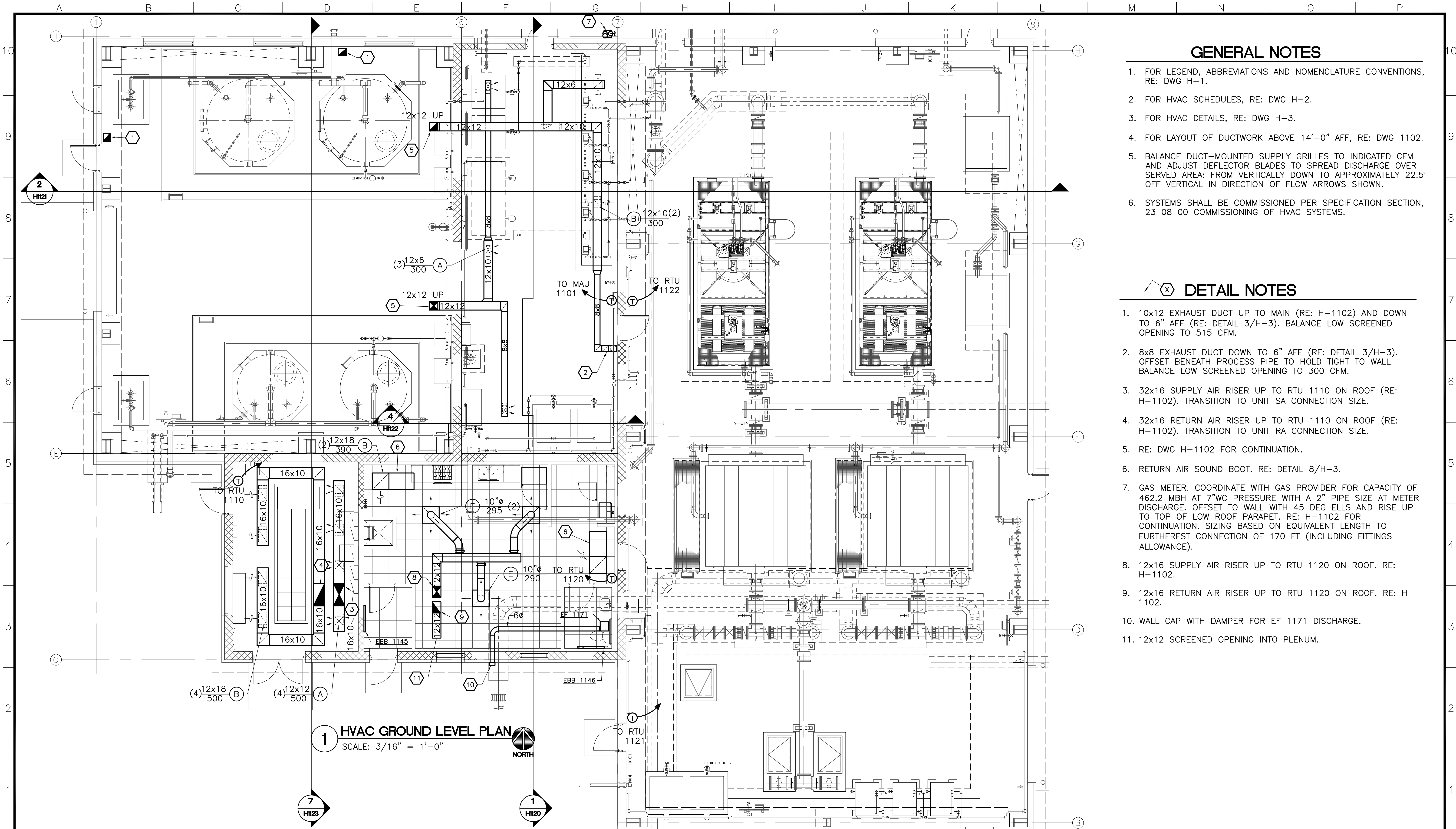


- NOTES:
1. 36" DIMENSION CAN BE VERTICAL OR HORIZONTAL. CONTRACTOR TO COORDINATE IN FIELD.
 2. INSTALL DUCT PARALLEL TO BUILDING LINES AND SUPPORT FROM STRUCTURE.



- PIPE SUPPORT DETAILS NOTES:
1. COORDINATE GAS PIPE SUPPORT LOCATIONS WITH ARCHITECTURAL. (RE: H-1102)
 2. PIPE SUPPORT STANDS (INCLUDING AND BELOW STRUT CHANNEL) PROVIDED UNDER ARCHITECTURAL SCOPE.
 3. HVAC CONTRACTOR TO PROVIDE ROLLER OR CLAMP TYPE SUPPORT (RE: NOTES ON DRAWING H-1102) AND ATTACHMENT TO STRUT CHANNEL, AND ADJUST SUPPORT STAND HEIGHT TO MAINTAIN UNIFORM PIPE CENTERLINE HEIGHT ABOVE ROOF DECK OF 38", EXCEPT WHERE OTHERWISE NOTED.
 4. PIPE SIZE SHOWN IN DETAILS IS NOM 2". SIZES REQUIRING SUPPORT VARY FROM 3/4" - 2".






1 HVAC GROUND LEVEL PLAN
SCALE: 3/16" = 1'-0"

GENERAL NOTES

1. FOR LEGEND, ABBREVIATIONS AND NOMENCLATURE CONVENTIONS, RE: DWG H-1.
2. FOR HVAC SCHEDULES, RE: DWG H-2.
3. FOR HVAC DETAILS, RE: DWG H-3.
4. FOR LAYOUT OF DUCTWORK ABOVE 14'-0" AFF, RE: DWG 1102.
5. BALANCE DUCT-MOUNTED SUPPLY GRILLES TO INDICATED CFM AND ADJUST DEFLECTOR BLADES TO SPREAD DISCHARGE OVER SERVED AREA: FROM VERTICALLY DOWN TO APPROXIMATELY 22.5' OFF VERTICAL IN DIRECTION OF FLOW ARROWS SHOWN.
6. SYSTEMS SHALL BE COMMISSIONED PER SPECIFICATION SECTION, 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

DETAIL NOTES

1. 10x12 EXHAUST DUCT UP TO MAIN (RE: H-1102) AND DOWN TO 6" AFF (RE: DETAIL 3/H-3). BALANCE LOW SCREENED OPENING TO 515 CFM.
2. 8x8 EXHAUST DUCT DOWN TO 6" AFF (RE: DETAIL 3/H-3). OFFSET BENEATH PROCESS PIPE TO HOLD TIGHT TO WALL. BALANCE LOW SCREENED OPENING TO 300 CFM.
3. 32x16 SUPPLY AIR RISER UP TO RTU 1110 ON ROOF (RE: H-1102). TRANSITION TO UNIT SA CONNECTION SIZE.
4. 32x16 RETURN AIR RISER UP TO RTU 1110 ON ROOF (RE: H-1102). TRANSITION TO UNIT RA CONNECTION SIZE.
5. RE: DWG H-1102 FOR CONTINUATION.
6. RETURN AIR SOUND BOOT. RE: DETAIL 8/H-3.
7. GAS METER. COORDINATE WITH GAS PROVIDER FOR CAPACITY OF 462.2 MBH AT 7"WC PRESSURE WITH A 2" PIPE SIZE AT METER DISCHARGE. OFFSET TO WALL WITH 45 DEG ELLS AND RISE UP TO TOP OF LOW ROOF PARAPET. RE: H-1102 FOR CONTINUATION. SIZING BASED ON EQUIVALENT LENGTH TO FURTHEREST CONNECTION OF 170 FT (INCLUDING FITTINGS ALLOWANCE).
8. 12x16 SUPPLY AIR RISER UP TO RTU 1120 ON ROOF. RE: H-1102.
9. 12x16 RETURN AIR RISER UP TO RTU 1120 ON ROOF. RE: H-1102.
10. WALL CAP WITH DAMPER FOR EF 1171 DISCHARGE.
11. 12x12 SCREENED OPENING INTO PLENUM.

**Dewberry**
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Denver, Colorado 80209
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LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING
DRAWN BGT
DESIGNED BGT
CHECKED BGT

APPROVED:

PRINCIPAL

DATE:

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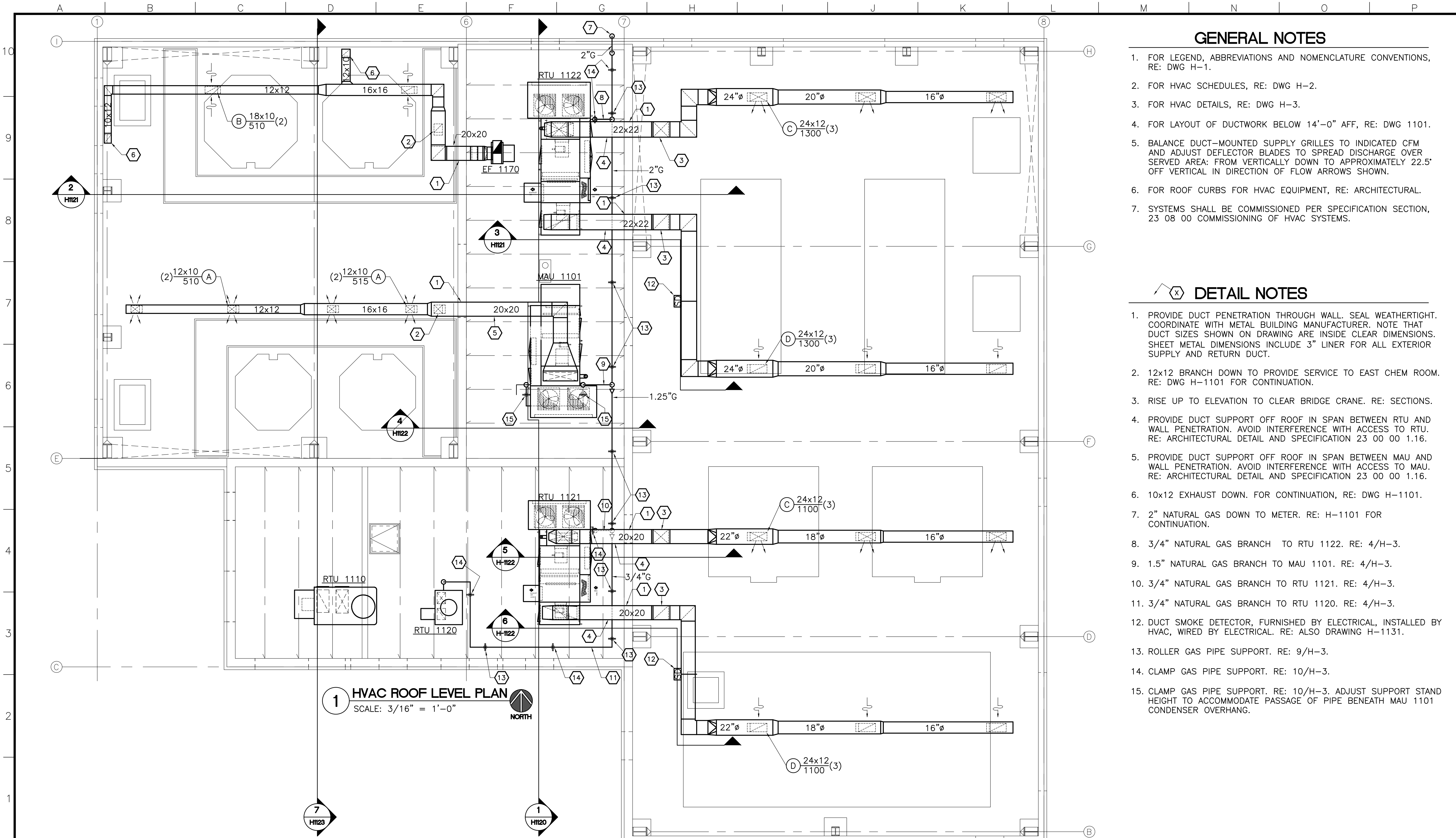
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

HVAC

NEW TREATMENT BUILDING
GROUND LEVEL PLAN

DATE:
PROJECT NUMBER:
REVISION NO. C
DRAWING NUMBER
H-1101
SHEET NUMBER



1 HVAC ROOF LEVEL PLAN
SCALE: 3/16" = 1'-0"

GENERAL NOTES

1. FOR LEGEND, ABBREVIATIONS AND NOMENCLATURE CONVENTIONS, RE: DWG H-1.
2. FOR HVAC SCHEDULES, RE: DWG H-2.
3. FOR HVAC DETAILS, RE: DWG H-3.
4. FOR LAYOUT OF DUCTWORK BELOW 14'-0" AFF, RE: DWG 1101.
5. BALANCE DUCT-MOUNTED SUPPLY GRILLES TO INDICATED CFM AND ADJUST DEFLECTOR BLADES TO SPREAD DISCHARGE OVER SERVED AREA: FROM VERTICALLY DOWN TO APPROXIMATELY 22.5' OFF VERTICAL IN DIRECTION OF FLOW ARROWS SHOWN.
6. FOR ROOF CURBS FOR HVAC EQUIPMENT, RE: ARCHITECTURAL.
7. SYSTEMS SHALL BE COMMISSIONED PER SPECIFICATION SECTION, 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

DETAIL NOTES

1. PROVIDE DUCT PENETRATION THROUGH WALL. SEAL WEATHERTIGHT. COORDINATE WITH METAL BUILDING MANUFACTURER. NOTE THAT DUCT SIZES SHOWN ON DRAWING ARE INSIDE CLEAR DIMENSIONS. SHEET METAL DIMENSIONS INCLUDE 3" LINER FOR ALL EXTERIOR SUPPLY AND RETURN DUCT.
2. 12x12 BRANCH DOWN TO PROVIDE SERVICE TO EAST CHEM ROOM. RE: DWG H-1101 FOR CONTINUATION.
3. RISE UP TO ELEVATION TO CLEAR BRIDGE CRANE. RE: SECTIONS.
4. PROVIDE DUCT SUPPORT OFF ROOF IN SPAN BETWEEN RTU AND WALL PENETRATION. AVOID INTERFERENCE WITH ACCESS TO RTU. RE: ARCHITECTURAL DETAIL AND SPECIFICATION 23 00 00 1.16.
5. PROVIDE DUCT SUPPORT OFF ROOF IN SPAN BETWEEN MAU AND WALL PENETRATION. AVOID INTERFERENCE WITH ACCESS TO MAU. RE: ARCHITECTURAL DETAIL AND SPECIFICATION 23 00 00 1.16.
6. 10x12 EXHAUST DOWN. FOR CONTINUATION, RE: DWG H-1101.
7. 2" NATURAL GAS DOWN TO METER. RE: H-1101 FOR CONTINUATION.
8. 3/4" NATURAL GAS BRANCH TO RTU 1122. RE: 4/H-3.
9. 1.5" NATURAL GAS BRANCH TO MAU 1101. RE: 4/H-3.
10. 3/4" NATURAL GAS BRANCH TO RTU 1121. RE: 4/H-3.
11. 3/4" NATURAL GAS BRANCH TO RTU 1120. RE: 4/H-3.
12. DUCT SMOKE DETECTOR, FURNISHED BY ELECTRICAL, INSTALLED BY HVAC, WIRED BY ELECTRICAL. RE: ALSO DRAWING H-1131.
13. ROLLER GAS PIPE SUPPORT. RE: 9/H-3.
14. CLAMP GAS PIPE SUPPORT. RE: 10/H-3.
15. CLAMP GAS PIPE SUPPORT. RE: 10/H-3. ADJUST SUPPORT STAND HEIGHT TO ACCOMMODATE PASSAGE OF PIPE BENEATH MAU 1101 CONDENSER OVERHANG.

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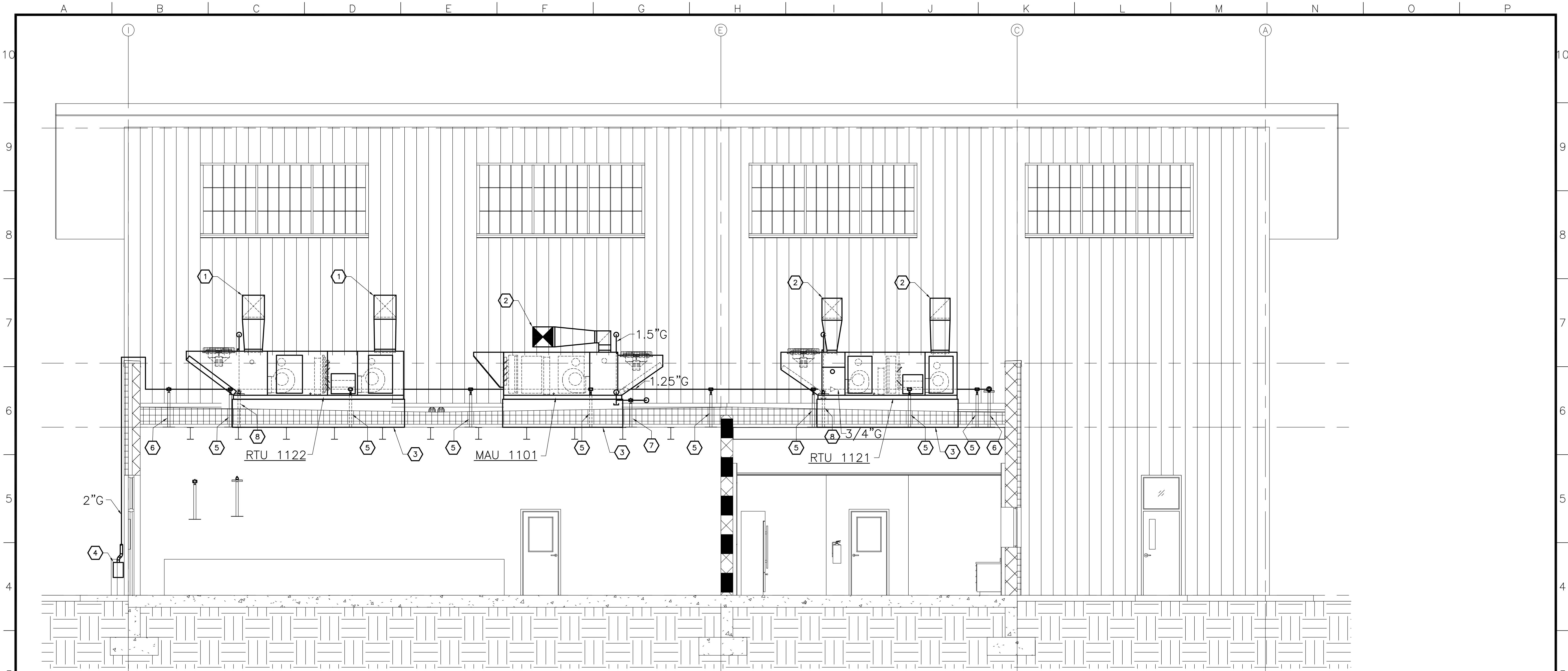
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

HVAC

NEW TREATMENT BUILDING
LOW ROOF LEVEL PLAN

DATE:
PROJECT NUMBER:
REVISION NO. C
DRAWING NUMBER
H-1102
SHEET NUMBER



DETAIL NOTES

- 22x22 DUCT PENETRATION INTO BUILDING. RE: DETAIL NOTE 1/H-1121.
- 20x20 DUCT PENETRATION INTO BUILDING.
- EQUIPMENT ROOF CURB. RE: EQUIPMENT SCHEDULE FOR CURB HEIGHT AND ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL INFORMATION. CURB FURNISHED AND INSTALLED UNDER ARCHITECTURAL SCOPE.
- GAS METER. RE: DWG H-1101.
- ROLLER GAS PIPE SUPPORT. RE: 9/H-3.
- CLAMP GAS PIPE SUPPORT. RE: 10/H-3.

DETAIL NOTES CONT'D

- CLAMP GAS PIPE SUPPORT. RE: 10/H-3. ADJUST SUPPORT STAND HEIGHT TO ACCOMMODATE PASSAGE OF PIPE BENEATH MAU 1101 CONDENSER OVERHANG.
- CLAMP GAS PIPE SUPPORT. RE: 10/H-3. ADJUST SUPPORT STAND HEIGHT TO ACCOMMODATE GAS CONNECTION HEIGHT ON RTU.

1 HVAC SECTION LOOKING EAST
SCALE: 1/4" = 1'-0"

GENERAL NOTES

- FOR LEGEND, ABBREVIATIONS AND NOMENCLATURE CONVENTIONS, RE: DWG H-1.
- FOR HVAC SCHEDULES, RE: DWG H-2.
- FOR HVAC DETAILS, RE: DWG H-3.

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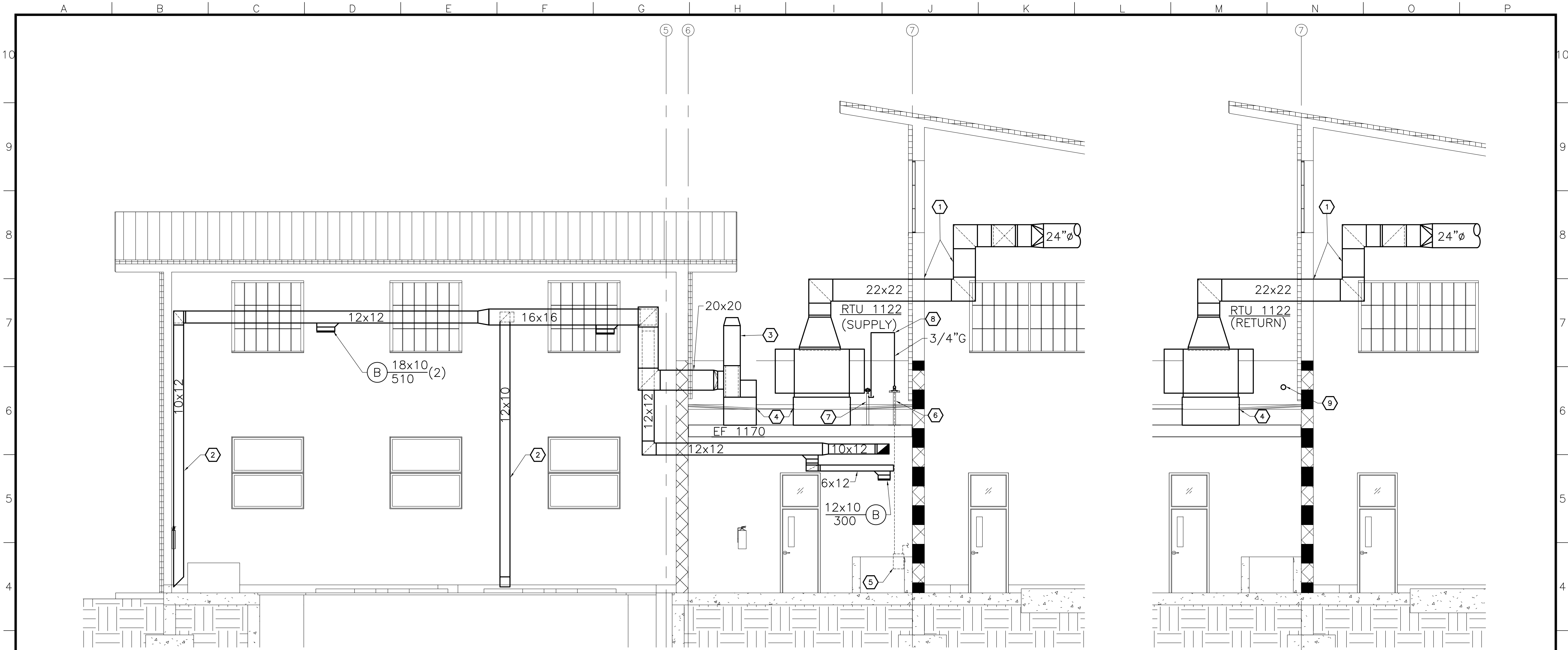
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

HVAC

NEW TREATMENT BUILDING
SECTIONS

DATE:
PROJECT
NUMBER:
REVISION NO. C
DRAWING NUMBER
H-1120
SHEET NUMBER



2 HVAC SECTION LOOKING NORTH
SCALE: 1/4" = 1'-0"

3 HVAC SECTION LOOKING NORTH
SCALE: 1/4" = 1'-0"

DETAIL NOTES

- ADJUST ELEVATION OF WALL PENETRATION AND DUCT RISE INSIDE BUILDING TO AVOID INTERFERENCE WITH BUILDING STRUCTURAL CROSS BRACING AND STILL REACH DUCT MAIN ELEVATION ABOVE BRIDGE CRANE.
- EXTEND 12x10 EXHAUST DUCT DOWN TO 6" AFF (RE: DETAIL 3/H-3). BALANCE LOW SCREENED OPENING TO 515 CFM.
- 4' STACK EXTENSION WITH 12"x12" NOZZLE AT DISCHARGE END.
- EQUIPMENT ROOF CURB. RE: EQUIPMENT SCHEDULE FOR CURB HEIGHT AND ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL INFORMATION. CURB FURNISHED AND INSTALLED UNDER ARCHITECTURAL SCOPE.

DETAIL NOTES CONT'D

- GAS METER BEYOND ON N WALL EXTERIOR. RE: DWG H-1101.
- ROLLER GAS PIPE SUPPORT. RE: 9/H-3.
- CLAMP GAS PIPE SUPPORT. RE: 10/H-3. ADJUST SUPPORT STAND HEIGHT TO ACCOMMODATE GAS CONNECTION HEIGHT ON RTU.
- RISE UP TO PROVIDE APPROXIMATELY 6' CLEARANCE ABOVE ROOF SURFACE.
- 2" NG PIPE CONTINUATION TO MAU 1101. RE: H-1102.

GENERAL NOTES

- FOR LEGEND, ABBREVIATIONS AND NOMENCLATURE CONVENTIONS, RE: DWG H-1.
- FOR HVAC SCHEDULES, RE: DWG H-2.
- FOR HVAC DETAILS, RE: DWG H-3.

GENERAL NOTES CONT'D

Dewberry
Dewberry Engineers Inc.
990 S. BROADWAY, SUITE 400
Denver, Colorado 80209
(303) 825-1802

LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING _____
DRAWN BGT
DESIGNED BGT
CHECKED BGT

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN DELIVERABLE	ESI	08/11/23	BGT
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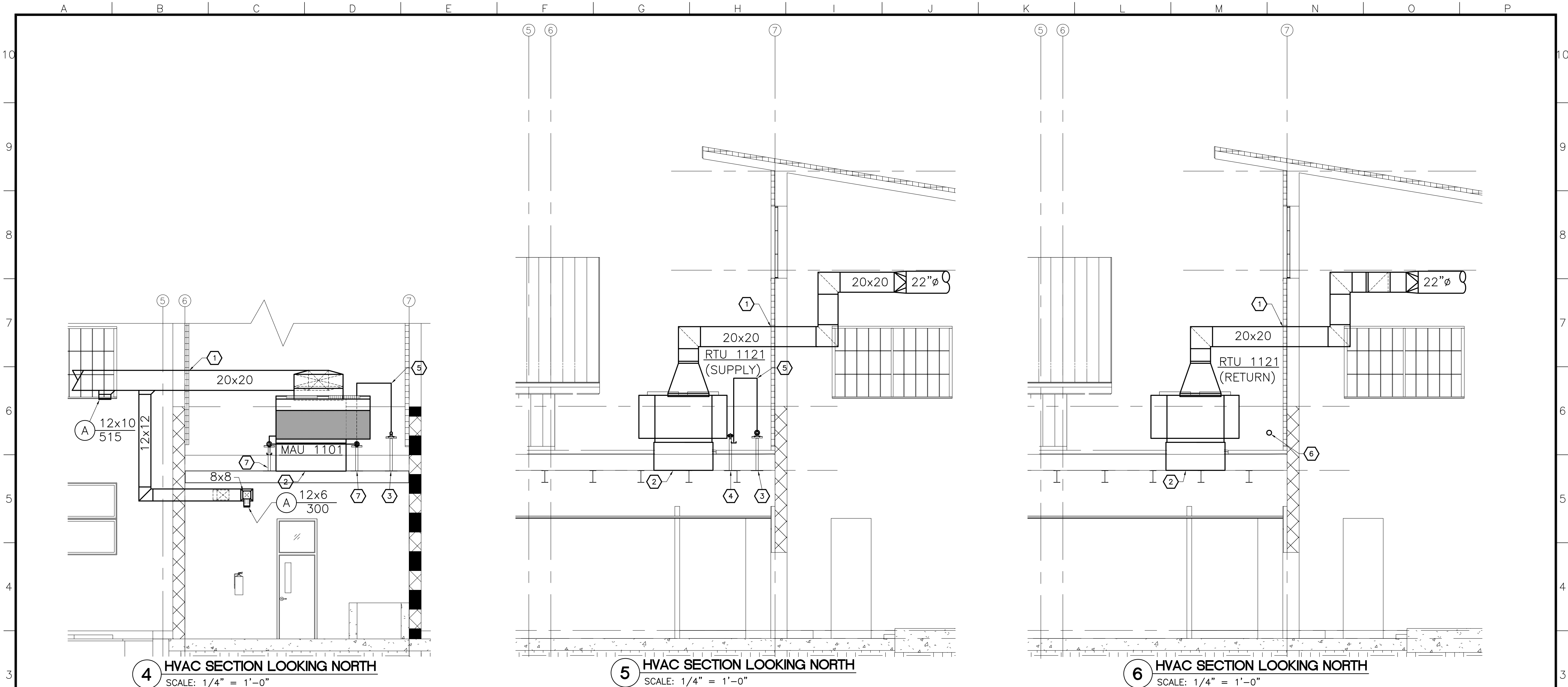
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

HVAC

NEW TREATMENT BUILDING
SECTIONS

DATE:
PROJECT
NUMBER:
REVISION NO. C
DRAWING NUMBER
H-1121
SHEET NUMBER



4 HVAC SECTION LOOKING NORTH
SCALE: 1/4" = 1'-0"

5 HVAC SECTION LOOKING NORTH
SCALE: 1/4" = 1'-0"

6 HVAC SECTION LOOKING NORTH
SCALE: 1/4" = 1'-0"

DETAIL NOTES

- 20x20 DUCT PENETRATION INTO BUILDING.
- EQUIPMENT ROOF CURB. RE: EQUIPMENT SCHEDULE FOR CURB HEIGHT AND ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL INFORMATION. CURB FURNISHED AND INSTALLED UNDER ARCHITECTURAL SCOPE.
- ROLLER GAS PIPE SUPPORT. RE: 9/H-3.
- CLAMP GAS PIPE SUPPORT. RE: 10/H-3.
- RISE UP TO PROVIDE APPROXIMATELY 6' CLEARANCE ABOVE ROOF SURFACE.
- 3/4" NG PIPE CONTINUATION TO RTU 1120. RE: H-1102.

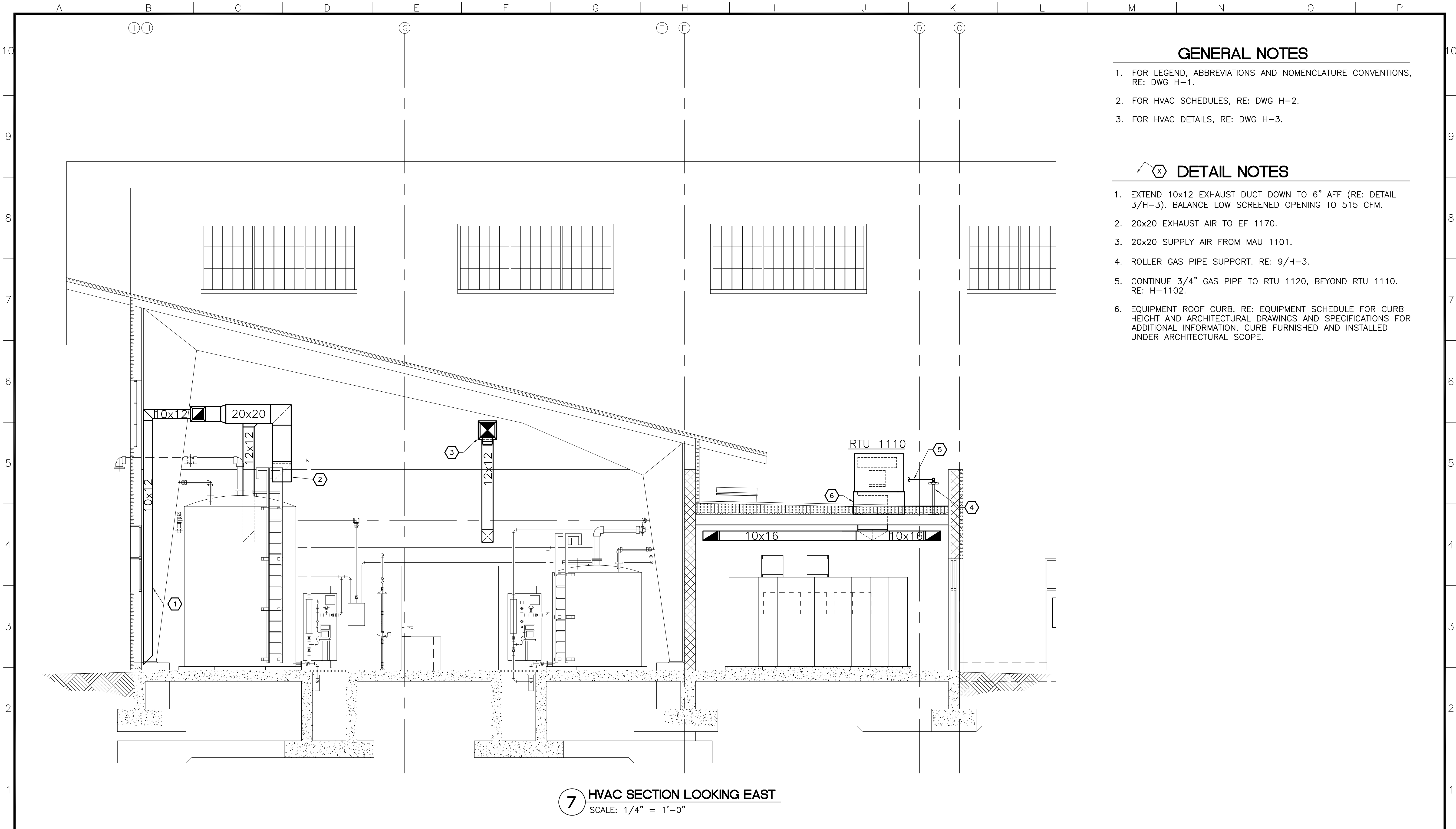
DETAIL NOTES CONT'D

- CLAMP GAS PIPE SUPPORT. RE: 10/H-3. ADJUST SUPPORT STAND HEIGHT TO ACCOMMODATE PASSAGE OF PIPE BENEATH MAU 1101 CONDENSER OVERHANG.

GENERAL NOTES

- FOR LEGEND, ABBREVIATIONS AND NOMENCLATURE CONVENTIONS, RE: DWG H-1.
- FOR HVAC SCHEDULES, RE: DWG H-2.
- FOR HVAC DETAILS, RE: DWG H-3.

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GENERAL NOTES

- FOR LEGEND, ABBREVIATIONS AND NOMENCLATURE CONVENTIONS, RE: DWG H-1.
- FOR HVAC SCHEDULES, RE: DWG H-2.
- FOR HVAC DETAILS, RE: DWG H-3.

DETAIL NOTES

- EXTEND 10x12 EXHAUST DUCT DOWN TO 6" AFF (RE: DETAIL 3/H-3). BALANCE LOW SCREENED OPENING TO 515 CFM.
- 20x20 EXHAUST AIR TO EF 1170.
- 20x20 SUPPLY AIR FROM MAU 1101.
- ROLLER GAS PIPE SUPPORT. RE: 9/H-3.
- CONTINUE 3/4" GAS PIPE TO RTU 1120, BEYOND RTU 1110. RE: H-1102.
- EQUIPMENT ROOF CURB. RE: EQUIPMENT SCHEDULE FOR CURB HEIGHT AND ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL INFORMATION. CURB FURNISHED AND INSTALLED UNDER ARCHITECTURAL SCOPE.

7 HVAC SECTION LOOKING EAST
SCALE: 1/4" = 1'-0"

Dewberry
Dewberry Engineers Inc.
990 S. BROADWAY, SUITE 400
Denver, Colorado 80209
(303) 825-1802

LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING
DRAWN BGT
DESIGNED BGT
CHECKED BGT

APPROVED:

PRINCIPAL

DATE:

REVISIONS

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TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

HVAC

NEW TREATMENT BUILDING
SECTIONS

DATE:

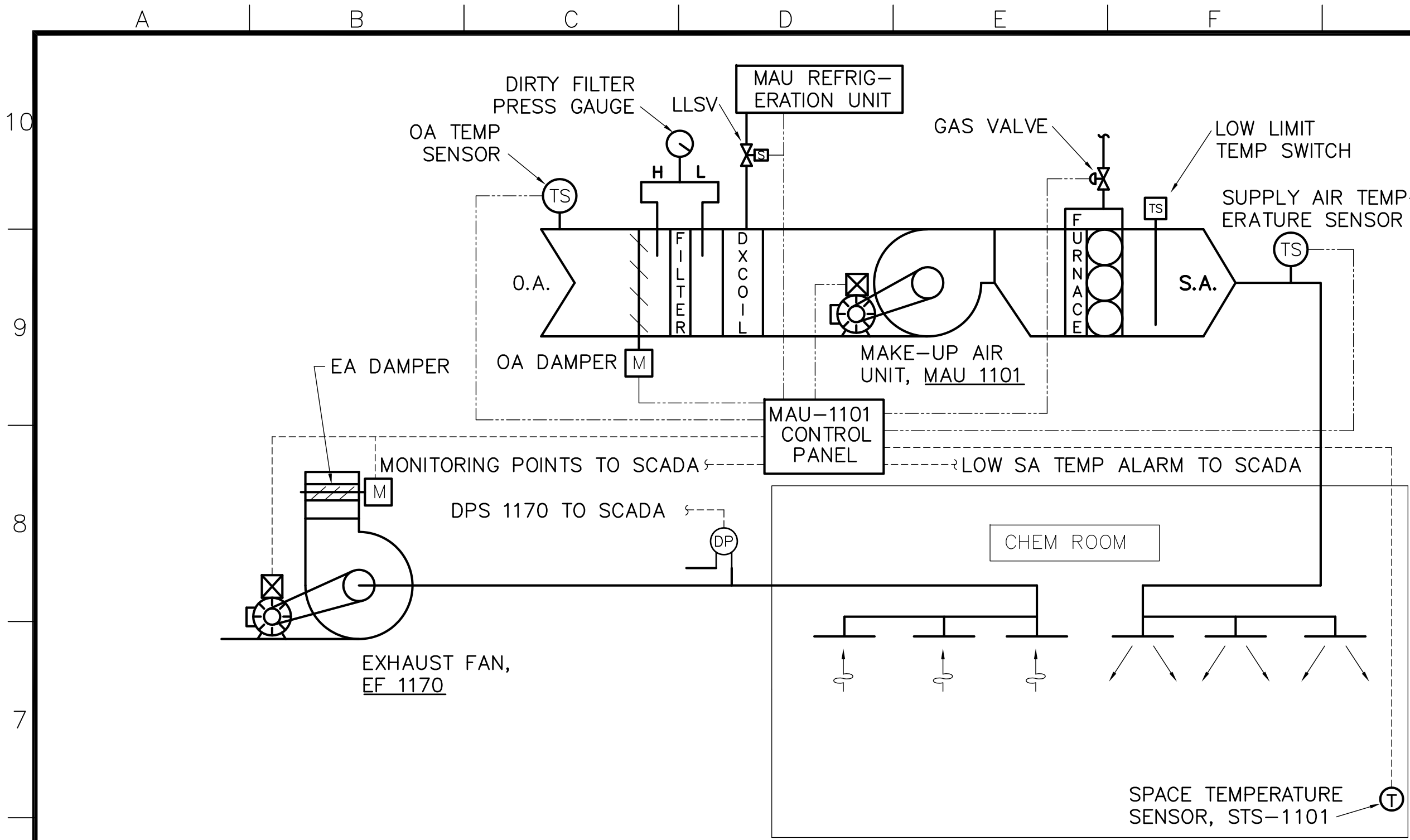
PROJECT
NUMBER:

REVISION NO. C

DRAWING NUMBER

H-1123

SHEET NUMBER



1 CHEMICAL ROOM HVAC SYSTEM CNTL DIAG
SCALE: NTS

SEQUENCE OF CONTROL - CHEMICAL ROOM HVAC SYSTEM

MAKE-UP AIR UNIT, MAU-1101

A. SUPPLY FAN:

1. THE UNIT SUPPLY FAN SHALL BE STARTED AND STOPPED VIA THE FACTORY PROVIDED INTERNAL CONTACTORS, ENERGIZED THROUGH THE "ON/OFF" SWITCH IN THE UNIT CONTROL PANEL.
2. NORMALLY THE UNIT SHALL RUN CONTINUOUSLY.
3. THE SUPPLY FAN RUN STATUS AND UNIT GENERAL ALARM SHALL BE MONITORED TO PROVIDE CONTACT CLOSURE SIGNALS TO THE SCADA SYSTEM.
4. THE UNIT SHALL INCLUDE AN ADJUSTABLE SET POINT LOW LIMIT THERMOSTAT FOR FREEZE PROTECTION TO STOP EQUIPMENT OPERATION IN THE EVENT OF LOW DISCHARGE AIR TEMPERATURE. IF THE DISCHARGE AIR TEMPERATURE FALLS BELOW 35 DEG F (ADJUSTABLE), THE SUPPLY FAN SHALL SHUTDOWN, THE OUTSIDE AIR DAMPERS SHALL CLOSE, AND AN ALARM CONTACT SHALL CLOSE TO SEND AN ALARM TO THE SCADA SYSTEM. A LOW LIMIT BYPASS TIMER SHALL PREVENT NUISANCE LOW LIMIT ALARMS DURING COLD WEATHER STARTUP.

B. TEMPERATURE CONTROL:

1. THE UNIT SHALL OPERATE IN HEATING, VENTILATING, OR COOLING MODE TO MAINTAIN SPACE TEMPERATURE, AS SENSED BY SPACE TEMPERATURE SENSOR, STS-1101, BETWEEN THE HEATING SETPOINT OF 55°F AND THE COOLING SETPOINT OF 90°F.
2. WHEN THE SPACE TEMPERATURE FALLS BELOW THE HEATING SETPOINT OF 55° F, THE MAU SHALL OPERATE IN HEATING MODE AS FOLLOWS:
 - a. THE MAU BURNER SHALL FIRE AT A RATE CONTROLLED BY THE PACKAGED BURNER CONTROLS, FURNISHED WITH THE UNIT, TO MAINTAIN THE SUPPLY AIR TEMPERATURE, AS SENSED BY THE SUPPLY AIR TEMPERATURE SENSOR, AT SETPOINT (SEE BELOW).

3. WHEN THE SPACE TEMPERATURE IS BETWEEN THE HEATING AND COOLING SETPOINTS, THE MAU SHALL OPERATE IN VENTILATING MODE WITHOUT EITHER HEATING OR COOLING.
4. WHEN THE SPACE TEMPERATURE RISES ABOVE THE COOLING SETPOINT OF 90°F THE MAU SHALL OPERATE IN COOLING MODE AS FOLLOWS:
 - a. THE MAU REFRIGERATION SYSTEM SHALL CYCLE/STAGE ITS COMPRESSORS UNDER THE COOLING CONTROLS FURNISHED WITH THE UNIT, TO MAINTAIN THE SUPPLY AIR TEMPERATURE, AS SENSED BY THE SUPPLY AIR TEMPERATURE SENSOR, AT SETPOINT. (SEE BELOW.)
5. THE SUPPLY AIR TEMPERATURE SETPOINT SHALL HAVE A BASE VALUE OF 65°, BUT SHALL BE CONTINUOUSLY RESET, VIA A MODULATING ROOM RESET CONTROL, BETWEEN 55°F AND 85°F, BY SPACE TEMPERATURE SENSOR, STS-1101, TO RETURN THE SPACE TEMPERATURE TO THE HEATING OR COOLING SETPOINT RESPECTIVELY, IN HEATING OR COOLING MODE. IN VENTILATION MODE, THE SUPPLY AIR TEMPERATURE SHALL FLOAT WITH HEATING AND COOLING OFF.

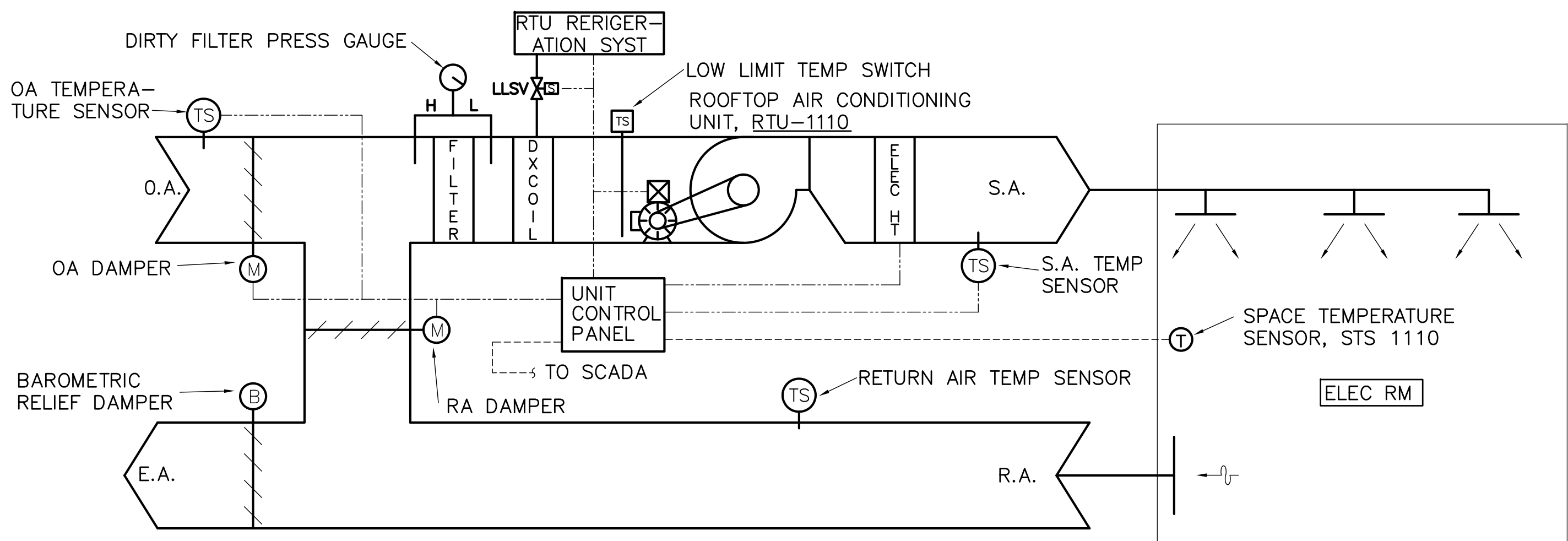
EXHAUST FAN, EF-1170:

A. FAN:

1. THE EXHAUST FAN SHALL BE STARTED AND STOPPED VIA THE HOA ON ITS STARTER. IN THE AUTO POSITION, THE FAN SHALL BE INTERLOCKED WITH THE MAU-1101 SUPPLY FAN TO RUN WHENEVER THE MAU-1101 SUPPLY FAN RUNS. THIS CONTROL BY ELECTRICAL.
2. THE EXHAUST FAN STATUS SHALL BE MONITORED BY FAN STATUS DIFFERENTIAL PRESSURE SWITCH, DPS-1170, AND REPORTED TO THE SCADA SYSTEM WITH A CONTACT CLOSURE.

B. EXHAUST AIR DAMPER:

1. THE EXHAUST FAN EA DAMPER SHALL OPEN WHENEVER THE FAN IS ON, AND CLOSE WHENEVER THE FAN IS OFF. THIS CONTROL BY ELECTRICAL.



2 ELECTRICAL ROOM HVAC SYSTEM CONTROL DIAGRAM
SCALE: NTS

SEQUENCE OF CONTROL - ELECTRICAL ROOM HVAC SYSTEM

ROOFTOP AIR CONDITIONING UNIT, RTU 1110

A. SUPPLY FAN:

1. UNIT SUPPLY FAN SHALL BE STARTED AND STOPPED VIA THE "ON/OFF" SWITCH ON THE UNIT CONTROL PANEL. WHEN IN THE "ON" POSITION, THE UNIT SUPPLY FAN SHALL RUN CONTINUOUSLY.
2. FAN RUN STATUS SHALL BE MONITORED TO PROVIDE A CONTACT CLOSURE SIGNAL TO THE SCADA SYSTEM.
3. THE UNIT SHALL INCLUDE AN ADJUSTABLE SET POINT LOW LIMIT THERMOSTAT FOR FREEZE PROTECTION TO STOP EQUIPMENT OPERATION IN THE EVENT OF LOW DISCHARGE AIR TEMPERATURE. IF THE DISCHARGE AIR TEMPERATURE FALLS BELOW 35 DEG F (ADJUSTABLE), THE SUPPLY FAN SHALL SHUTDOWN, THE OUTSIDE AIR DAMPERS CLOSE, AND AN ALARM CONTACT SHALL CLOSE TO SEND AN ALARM TO THE SCADA SYSTEM. A LOW LIMIT BYPASS TIMER SHALL PREVENT NUISANCE LOW LIMIT ALARMS DURING COLD WEATHER STARTUP.

B. TEMPERATURE CONTROL:

1. THE UNIT SHALL AUTOMATICALLY SWITCH BETWEEN HEATING, ECONOMIZER, AND MECHANICAL COOLING MODES TO MAINTAIN SPACE TEMPERATURE, AS SENSED BY THE ROOM THERMOSTAT, WITHIN A TEMPERATURE RANGE OF 55°F AND 90°F (ADJUSTABLE), AS FOLLOWS.
 - a. HEATING MODE SHALL OCCUR WHENEVER THE SPACE TEMPERATURE FALLS BELOW THE HEATING SETPOINT OF 55 DEG F.
 - b. IN THIS MODE, THE ELECTRIC HEATING COIL SHALL BE STAGED/CYCLED AS REQUIRED TO RETURN THE SPACE TEMPERATURE TO THE HEATING SETPOINT.
 - c. IN THIS MODE, THE OA DAMPERS SHALL BE AT MINIMUM OPEN POSITION, AND THE RA DAMPERS AT MAXIMUM OPEN POSITION. THE BAROMETRIC RELIEF DAMPER SHALL BE CLOSED.
2. HEATING MODE:

- d. HEATING SHALL BE LOCKED OUT UNTIL AIR FLOW IS PROVED BY THE FAN PROOF SWITCH.

3. ECONOMIZER MODE:

- a. ECONOMIZER MODE SHALL OCCUR WHENEVER THE SPACE TEMPERATURE RISES ABOVE THE COOLING SETPOINT OF 90°F, PROVIDED THE OA TEMPERATURE, AS SENSED BY THE OA TEMPERATURE SENSOR, IS BELOW THE RETURN AIR TEMPERATURE AS SENSED BY THE RETURN AIR TEMPERATURE SENSOR.

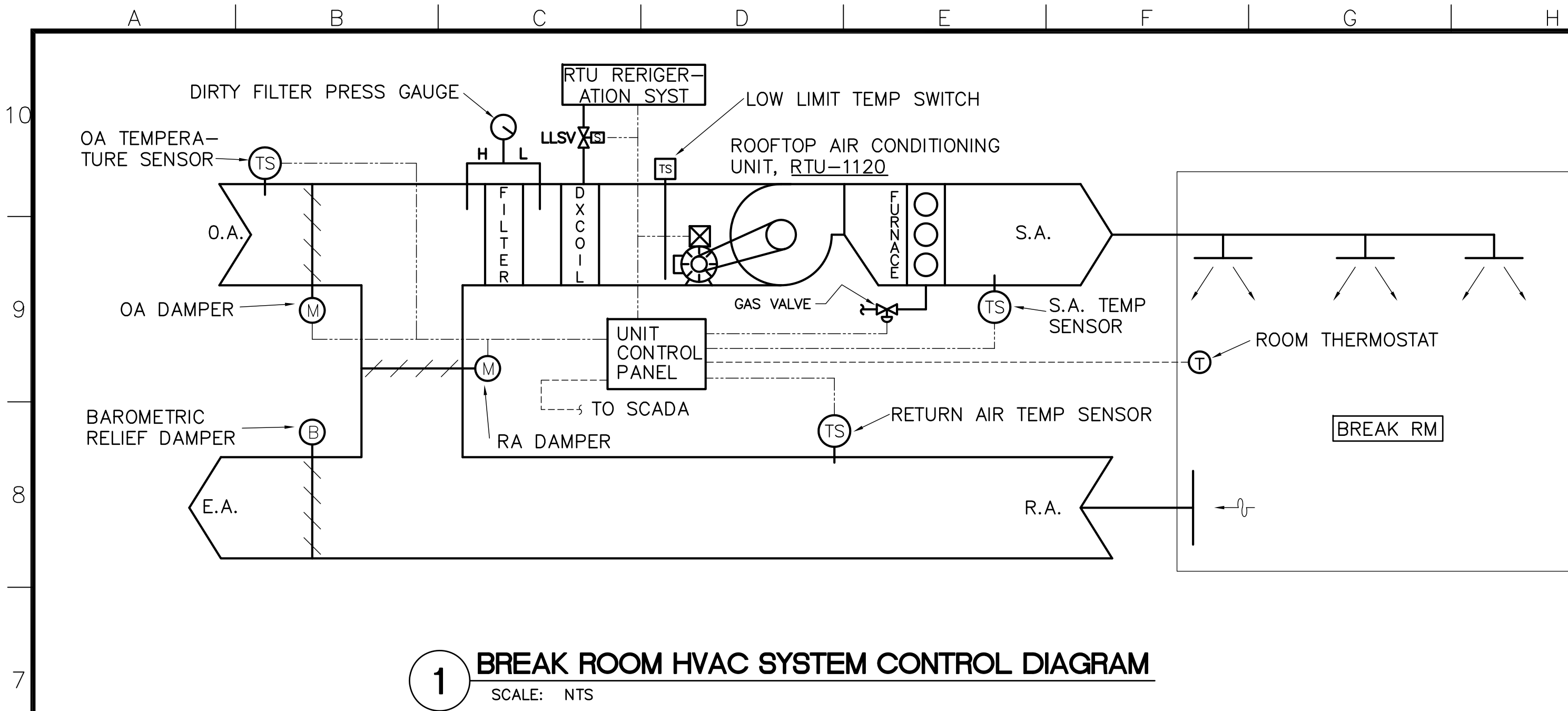
- b. IN ECONOMIZER MODE, THE OUTSIDE AIR (OA) DAMPER SHALL MODULATE OPEN, AND THE RETURN AIR (RA) DAMPER SHALL MODULATE CLOSED AS REQUIRED TO RETURN SPACE TEMPERATURE TO THE COOLING SETPOINT. IN ECONOMIZER MODE, THE BAROMETRIC RELIEF DAMPER SHALL RELIEVE SPACE PRESSURIZATION TO NOT EXCEED 0.10" WC ABOVE AMBIENT.

4. MECHANICAL COOLING:

- a. WHEN SPACE TEMPERATURE RISES ABOVE THE COOLING SETPOINT, AND ECONOMIZER OPERATION IS INADEQUATE TO RETURN THE SPACE TEMPERATURE TO THE COOLING SETPOINT, THE UNIT SHALL OPERATE IN MECHANICAL COOLING MODE AS FOLLOWS.
- b. UNIT COMPRESSOR(S) SHALL BE STAGED/CYCLED UNDER THE CONTROL OF THE PACKAGED REFRIGERATION CONTROLS FURNISHED WITH THE UNIT TO RETURN THE SPACE TEMPERATURE TO THE COOLING SETPOINT.
- c. IN MECHANICAL COOLING MODE, THE OUTSIDE AIR AND RETURN AIR DAMPERS SHALL REMAIN UNDER ECONOMIZER CONTROL (I.E., OA DAMPER 100% OPEN, RETURN AIR DAMPER CLOSED) AS LONG AS THE OA TEMPERATURE IS BELOW THE RA TEMPERATURE. IF THE OA TEMPERATURE RISES ABOVE THE RA TEMPERATURE, THE OA DAMPER SHALL CLOSE TO MINIMUM OPEN POSITION AND THE RA DAMPER SHALL OPEN TO MAX OPEN POSITION.

WIRING LEGEND

FACTORY WIRED - - - - -
FIELD WIRED - - - - -



SEQUENCE OF CONTROL - BREAK ROOM HVAC SYSTEM

ROOFTOP AIR CONDITIONING UNIT, RTU 1120

A. SUPPLY FAN:

- UNIT SUPPLY FAN SHALL BE STARTED AND STOPPED VIA THE "ON/OFF" SWITCH ON THE UNIT CONTROL PANEL. WHEN IN THE "ON" POSITION, THE UNIT SUPPLY FAN SHALL RUN CONTINUOUSLY.
- FAN RUN STATUS SHALL BE MONITORED TO PROVIDE A CONTACT CLOSURE SIGNAL TO THE SCADA SYSTEM.
- THE UNIT SHALL INCLUDE AN ADJUSTABLE SET POINT LOW LIMIT THERMOSTAT FOR FREEZE PROTECTION TO STOP EQUIPMENT OPERATION IN THE EVENT OF LOW DISCHARGE AIR TEMPERATURE. IF THE DISCHARGE AIR TEMPERATURE FALLS BELOW 35 DEG F (ADJUSTABLE), THE SUPPLY FAN SHALL SHUTDOWN, THE OUTSIDE AIR DAMPERS CLOSE, AND AN ALARM CONTACT SHALL CLOSE TO SEND AN ALARM TO THE SCADA SYSTEM. A LOW LIMIT BYPASS TIMER SHALL PREVENT NUISANCE LOW LIMIT ALARMS DURING COLD WEATHER STARTUP.

B. TEMPERATURE CONTROL:

- THE UNIT SHALL AUTOMATICALLY SWITCH BETWEEN HEATING, ECONOMIZER, AND MECHANICAL COOLING MODES TO MAINTAIN SPACE TEMPERATURE, AS SENSED BY THE ROOM SPACE TEMPERATURE SENSOR, WITHIN A TEMPERATURE RANGE OF 68°F AND 73°F (ADJUSTABLE), IN OCCUPIED PERIOD AND 55° - 90° DURING UNOCCUPIED PERIOD.
- HEATING MODE:
 - HEATING MODE SHALL OCCUR WHENEVER THE SPACE TEMPERATURE FALLS BELOW THE HEATING SETPOINT.
 - IN THIS MODE, THE GAS BURNER SHALL BE STAGED/CYCLED AS REQUIRED TO RETURN THE SPACE TEMPERATURE TO THE HEATING SETPOINT.
 - IN THIS MODE, THE OA DAMPERS SHALL BE AT MINIMUM OPEN

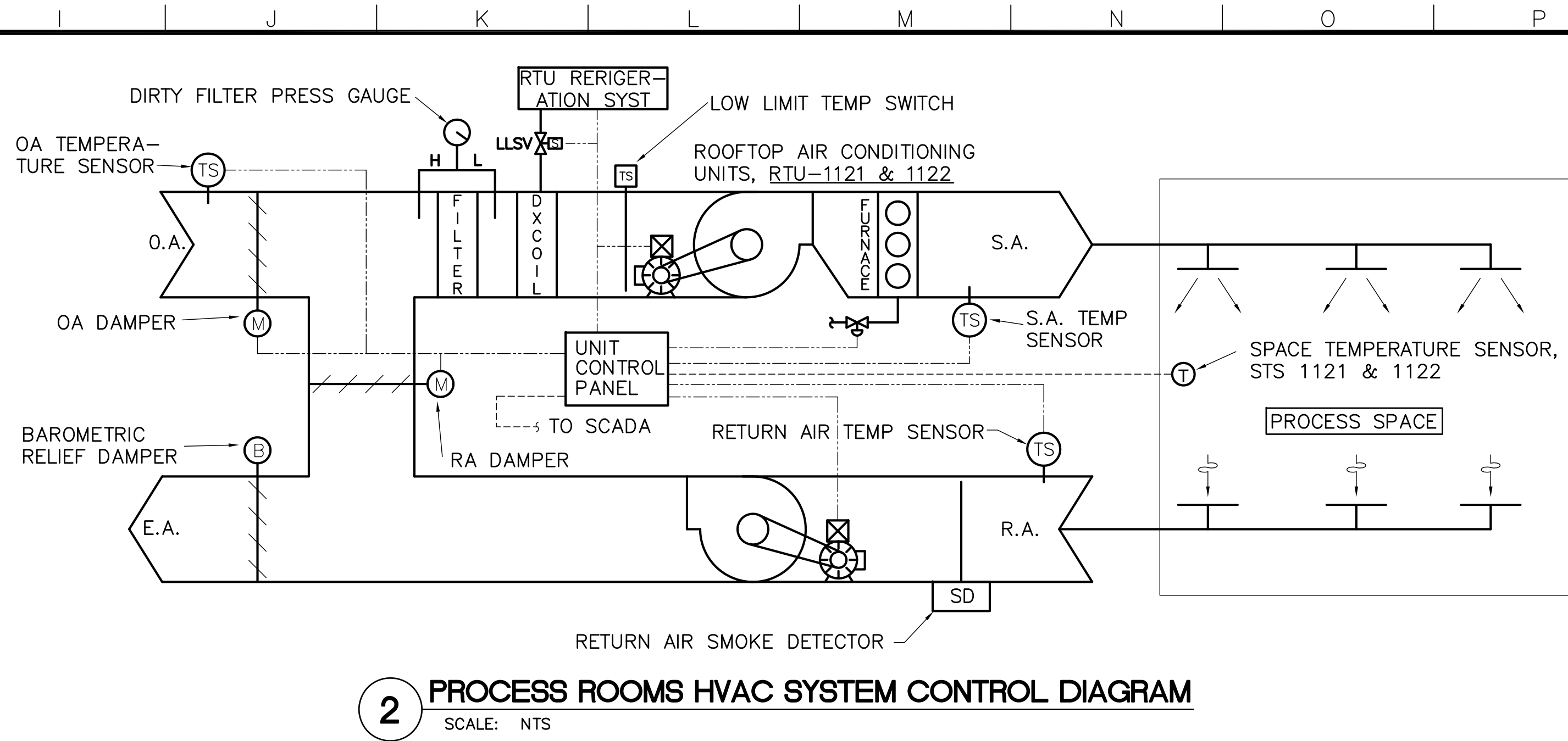
POSITION, AND THE RA DAMPERS AT MAXIMUM OPEN POSITION. THE BAROMETRIC RELIEF DAMPER SHALL BE CLOSED.

- HEATING SHALL BE LOCKED OUT UNTIL AIR FLOW IS PROVED BY THE FAN PROOF SWITCH.
- ECONOMIZER MODE:

- ECONOMIZER MODE SHALL OCCUR WHENEVER THE SPACE TEMPERATURE RISES ABOVE THE COOLING SETPOINT, PROVIDED THE OA TEMPERATURE, AS SENSED BY THE OA TEMPERATURE SENSOR, IS BELOW THE RETURN AIR TEMPERATURE AS SENSED BY THE RETURN AIR TEMPERATURE SENSOR.
- IN ECONOMIZER MODE, THE OUTSIDE AIR (OA) DAMPER SHALL MODULATE OPEN, AND THE RETURN AIR (RA) DAMPER SHALL MODULATE CLOSED AS REQUIRED TO RETURN SPACE TEMPERATURE TO THE COOLING SETPOINT. IN ECONOMIZER MODE, THE BAROMETRIC RELIEF DAMPER SHALL RELIEVE SPACE PRESSURIZATION TO NOT EXCEED 0.10" WC ABOVE AMBIENT.

4. MECHANICAL COOLING:

- WHEN SPACE TEMPERATURE RISES ABOVE THE COOLING SETPOINT, AND ECONOMIZER OPERATION IS INADEQUATE TO RETURN THE SPACE TEMPERATURE TO THE COOLING SETPOINT, THE UNIT SHALL OPERATE IN MECHANICAL COOLING MODE AS FOLLOWS.
- UNIT COMPRESSOR(S) SHALL BE STAGED/CYCLED UNDER THE CONTROL OF THE PACKAGED REFRIGERATION CONTROLS FURNISHED WITH THE UNIT TO RETURN THE SPACE TEMPERATURE TO THE COOLING SETPOINT.
- IN MECHANICAL COOLING MODE, THE OUTSIDE AIR AND RETURN AIR DAMPERS SHALL REMAIN UNDER ECONOMIZER CONTROL (I.E., OA DAMPER 100% OPEN, RETURN AIR DAMPER CLOSED) AS LONG AS THE OA TEMPERATURE IS BELOW THE RA TEMPERATURE. IF THE OA TEMPERATURE RISES ABOVE THE RA TEMPERATURE, THE OA DAMPER SHALL CLOSE TO MINIMUM OPEN POSITION AND THE RA DAMPER SHALL OPEN TO MAX OPEN POSITION.



SEQUENCE OF CONTROL - PROCESS ROOMS HVAC SYSTEMS

ROOFTOP AIR CONDITIONING UNITS, RTU 1121 & 1122

d. A. SUPPLY FAN:

- UNIT SUPPLY FAN SHALL BE STARTED AND STOPPED VIA THE "ON/OFF" SWITCH ON THE UNIT CONTROL PANEL. WHEN IN THE "ON" POSITION, THE UNIT SUPPLY FAN SHALL RUN CONTINUOUSLY, SUBJECT TO THE SAFETIES DESCRIBED BELOW.
- FAN RUN STATUS AND UNIT GENERAL ALARM SHALL BE MONITORED TO PROVIDE CONTACT CLOSURE SIGNALS TO THE SCADA SYSTEM.
- THE UNIT SHALL INCLUDE AN ADJUSTABLE SET POINT LOW LIMIT THERMOSTAT FOR FREEZE PROTECTION TO STOP EQUIPMENT OPERATION IN THE EVENT OF LOW DISCHARGE AIR TEMPERATURE. IF THE DISCHARGE AIR TEMPERATURE FALLS BELOW 35 DEG F (ADJUSTABLE), THE SUPPLY FAN SHALL SHUTDOWN, THE OUTSIDE AIR DAMPERS CLOSE, AND AN ALARM CONTACT SHALL CLOSE TO SEND AN ALARM TO THE SCADA SYSTEM. A LOW LIMIT BYPASS TIMER SHALL PREVENT NUISANCE LOW LIMIT ALARMS DURING COLD WEATHER STARTUP.
- THE UNIT SHALL INCLUDE A SMOKE DETECTOR (FURNISHED UNDER ELECTRICAL DIVISION) IN THE RETURN AIR TO SHUT THE UNIT DOWN UPON DETECTION OF SMOKE.

B. RETURN FAN:

- THE RETURN FAN SHALL BE INTERLOCKED WITH THE SUPPLY FAN TO RUN WHENEVER THE SUPPLY FAN RUNS. WHENEVER THE SUPPLY FAN IS OFF, THE RETURN FAN SHALL ALSO BE OFF, AND THE OUTSIDE AND RELIEF AIR DAMPERS SHALL BE CLOSED.

C. TEMPERATURE CONTROL:

- THE UNIT SHALL AUTOMATICALLY SWITCH BETWEEN HEATING, ECONOMIZER, AND MECHANICAL COOLING MODES TO MAINTAIN SPACE TEMPERATURE, AS SENSED BY THE ROOM THERMOSTAT, WITHIN A TEMPERATURE RANGE OF 55°F AND 90°F (ADJUSTABLE), AS FOLLOWS.
- HEATING MODE:
 - HEATING MODE SHALL OCCUR WHENEVER THE SPACE TEMPERATURE FALLS BELOW THE HEATING SETPOINT OF 55 DEG F.
 - IN THIS MODE, THE GAS BURNER SHALL BE STAGED/CYCLED AS

REQUIRED TO RETURN THE SPACE TEMPERATURE TO THE HEATING SETPOINT.

- IN THIS MODE, THE OA DAMPERS SHALL BE AT MINIMUM OPEN POSITION, AND THE RA DAMPERS AT MAXIMUM OPEN POSITION. THE BAROMETRIC RELIEF DAMPER SHALL BE CLOSED.

- HEATING SHALL BE LOCKED OUT UNTIL AIR FLOW IS PROVED BY THE FAN PROOF SWITCH.

3. ECONOMIZER MODE:

- ECONOMIZER MODE SHALL OCCUR WHENEVER THE SPACE TEMPERATURE RISES ABOVE THE COOLING SETPOINT OF 90°F, PROVIDED THE OA TEMPERATURE, AS SENSED BY THE OA TEMPERATURE SENSOR, IS BELOW THE RETURN AIR TEMPERATURE AS SENSED BY THE RETURN AIR TEMPERATURE SENSOR.

- IN ECONOMIZER MODE, THE OUTSIDE AIR (OA) DAMPER SHALL MODULATE OPEN, AND THE RETURN AIR (RA) DAMPER SHALL MODULATE CLOSED AS REQUIRED TO RETURN SPACE TEMPERATURE TO THE COOLING SETPOINT. IN ECONOMIZER MODE, THE BAROMETRIC RELIEF DAMPER SHALL RELIEVE SPACE PRESSURIZATION TO NOT EXCEED 0.10" WC ABOVE AMBIENT.

4. MECHANICAL COOLING:

- WHEN SPACE TEMPERATURE RISES ABOVE THE COOLING SETPOINT, AND ECONOMIZER OPERATION IS INADEQUATE TO RETURN THE SPACE TEMPERATURE TO THE COOLING SETPOINT, THE UNIT SHALL OPERATE IN MECHANICAL COOLING MODE AS FOLLOWS.

- UNIT COMPRESSOR(S) SHALL BE STAGED/CYCLED UNDER THE CONTROL OF THE PACKAGED REFRIGERATION CONTROLS FURNISHED WITH THE UNIT TO RETURN THE SPACE TEMPERATURE TO THE COOLING SETPOINT.

- IN MECHANICAL COOLING MODE, THE OUTSIDE AIR AND RETURN AIR DAMPERS SHALL REMAIN UNDER ECONOMIZER CONTROL (I.E., OA DAMPER 100% OPEN, RETURN AIR DAMPER CLOSED) AS LONG AS THE OA TEMPERATURE IS BELOW THE RA TEMPERATURE. IF THE OA TEMPERATURE RISES ABOVE THE RA TEMPERATURE, THE OA DAMPER SHALL CLOSE TO MINIMUM OPEN POSITION AND THE RA DAMPER SHALL OPEN TO MAX OPEN POSITION.

WIRING LEGEND

FACTORY WIRED -----
FIELD WIRED - - - - -

APPROVED:

PRINCIPAL

DATE:

REVISIONS

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TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

HVAC

NEW TREATMENT BUILDING
TEMPERATURE CONTROLS

PLAN DRAWINGS:

GENERAL LINEWORK:

- NEW WORK
- EXISTING TO REMAIN
- EXISTING TO BE REMOVED
- NEW EQUIPMENT OR PACKAGE BOUNDARY
- KEY NOTE DESIGNATOR. REFERENCE CORRESPONDING KEY NOTE ON THE DRAWING

RACEWAY SYMBOLS:

- RACEWAY OR WIRING SYSTEM ABOVE FLOOR LEVEL BELOW CEILING, EXPOSED UON.
- RACEWAY OR WIRING SYSTEM IN OR UNDER FLOOR, OR CONCEALED IN OR BEHIND STRUCTURE OR EQUIPMENT, OR CONCEALED IN WALL OR ABOVE CEILING OR CONDUIT ROUTED BELOW GRADE IN CONCRETE ENCASEMENT, UON.
- RACEWAY OR WIRING SYSTEM TURNED TOWARD THE VIEWER (UP ON PLAN DRAWINGS)
- RACEWAY OR WIRING SYSTEM TURNED AWAY FROM THE VIEWER (DOWN ON PLAN DRAWINGS)
- CONDUIT STUB AND CAP
- TB 1035
- TERMINAL BOX WITH OPTIONAL IDENTIFIER
EXAMPLE: TERMINAL BOX #1035
- JUNCTION BOX

HOMERUN CIRCUIT SYMBOLS

- HOMERUN CIRCUIT DESIGNATIONS REFERENCE A ONE-LINE DIAGRAM OR PANELBOARD SCHEDULE. REFER TO THE REFERENCED DIAGRAM OR SCHEDULE FOR WIRE AND RACEWAY REQUIREMENTS.
- MCC 1301-2 HOMERUN CIRCUIT IN EXPOSED RACEWAY
 - LP 1310-2 HOMERUN CIRCUIT IN CONCEALED RACEWAY.

GROUNDING SYMBOLS:

- GROUND ROD, 3/4" x 10'-0", COPPERCLAD (UNLESS OTHERWISE NOTED)
- GROUND ROD AND WELL
- GROUND CONNECTION
- GROUNDING CONDUCTOR
- GROUND PLATE

MOTOR AND EQUIPMENT SYMBOLS:

- MOTOR
- MOTOR STARTER, INDIVIDUAL--NOT LOCATED IN AN MCC OR SIMILAR GROUP ASSEMBLY
- COMBINATION MOTOR STARTER--NOT LOCATED IN AN MCC OR SIMILAR GROUP ASSEMBLY
- DISCONNECT, NON-FUSED, 30A, 3 POLE UON. 100A, 3P RATING INDICATED
- FUSED DISCONNECT: 30A, 3 POLE, CLASS R FUSES UON.
- ENCLOSED CIRCUIT BREAKER
- FIELD INSTRUMENT
- CONTROL STATION. CONFIGURATION ACCORDING TO CONTROL DIAGRAMS.
- EQUIPMENT DESIGNATOR
- TRANSFORMER

LIGHTING SYMBOLS AND FIXTURES:

- NOTE: LIGHTING FIXTURE SHAPES AND SCALE ARE REPRESENTED WHERE POSSIBLE. THE EXAMPLES SHOWN BELOW ARE TYPICAL APPLICATIONS.
- 10'-0" AFF
FIXTURE TYPE IDENTIFIER. TYPE APPLIES TO FIXTURES OF THE SAME SHAPE WITHIN A ROOM OR AN AREA. U.O.N. REFER TO LIGHTING FIXTURE SCHEDULE
 - MOUNTING HEIGHT, DIMENSION TO BOTTOM OF FIXTURE
 - RECESSED, SURFACE OR PENDANT FIXTURE
 - WALL MOUNTED FIXTURE
 - POLE-MOUNTED AREA LIGHT. ONE POLE AND TWO FIXTURES SHOWN.
 - EMERGENCY LIGHTING UNIT, SELF-CONTAINED
 - BOLLARD LIGHT FIXTURE
 - IN-GRADE UP LIGHT
 - RECESSED FIXTURE
 - SURFACE MOUNTED FIXTURE
 - SUSPENDED/PENDANT MOUNTED FIXTURE
 - WALL MOUNTED FIXTURE
 - LIGHTING CIRCUIT IDENTIFIER: INDICATES CIRCUIT NUMBER AND ASSOCIATED SWITCH. FOR EXAMPLE, 3a INDICATES A FIXTURE POWERED FROM CIRCUIT 3 AND SWITCHED BY SWITCH a. N SIGNIFIES AN UNSWITCHED POWER SOURCE. 'E' PRECEEDING THE CIRCUIT NUMBER INDICATES AN EMERGENCY CIRCUIT.
 - INDIVIDUAL FIXTURE TYPE IDENTIFIER.

EXIT SIGNS

- DARK QUADRANTS INDICATE FACES ILLUMINATED:
- EXIT SIGN, SURFACE MOUNTED ON CEILING
 - EXIT SIGN, WALL MOUNTED. DIRECTIONAL ARROW SHOWN.

WIRING DEVICE SYMBOLS:

- SWITCHES
- GENERAL: UNLESS OTHERWISE NOTED WIRING DEVICES SHALL BE WALL MOUNTED. FOR MOUNTING HEIGHT SEE SPECS.
- SINGLE POLE SWITCH.
 - GANGED SWITCHES--IN COMMON BOX, WITH COMMON WALL PLATE
 - CIRCUIT SUPERSCRPT MODIFIER. LOWER CASE LETTER. INDICATES CIRCUIT CONTROLLED--a,b,c,etc. COMBINED WITH CIRCUIT NUMBER. EXAMPLE: 1a, 4b, etc.
 - SWITCH SUBSCRIPT MODIFIER. UPPER CASE LETTER OR NUMBER:
 - 2 = DOUBLE POLE
 - 3 = THREE WAY
 - 4 = FOUR WAY
 - OS = OCCUPANCY SENSOR, DUAL TECHNOLOGY, LEGRAND WATTSTOPPER LMDW-100 SERIES.
 - DS = DIMMING SWITCH, LOW VOLTAGE, LEGRAND WATTSTOPPER LMDM-101 OR EQUAL
 - MS = MANUAL (MOTOR) STARTER OR SWITCH
 - R = RHEOSTAT (DIMMER, SPEED CONTROL)
 - L = LOCKABLE
 - LV = LOW VOLTAGE
 - AS = ASTRONOMICAL
 - IT = INTERVAL TIMER
 - MD = MOTION DETECTOR

LIGHTING CONTROLS

- CEILING MOUNTED OCCUPANCY SENSOR
- POWER RELAY MODULE
- DIMMING CONTROL WALL MODULE
- TYPE 1 WALL SWITCH SENSOR MODULE
- TYPE 2 WALL SWITCH SENSOR MODULE

RECEPTACLES:

- 20 AMP RECEPTACLE; SINGLE STROKE - SINGLE DOUBLE STROKE - DUPLEX.
- RECEPTACLE MODIFIERS:
 - 3 = CIRCUIT NUMBER
 - C = CLOCK HANGER
 - GF = GROUND FAULT CIRCUIT INTERRUPTER
 - IG = ISOLATED GROUND
 - F = FOURPLEX
- SPECIAL RECEPTACLE. RATING OR NEMA CONFIGURATION AS SHOWN. EXAMPLE: NEMA 10-50R, 125/250V, 3 POLE, 3 WIRE, 50 AMP, NON-GROUNDING TYPE.
- RECESSED FLOOR RECEPTACLE
- TOMBSTONE RECEPTACLE. DARKENED AREA INDICATES SIDE PROVIDED WITH RECEPTACLE. DUPLEX RECEPTACLE IS STANDARD.
 - F = FOURPLEX
 - D = DATA
 - T = TELEPHONE
- SURFACE RACEWAY, 42" AFF U.O.N. NUMBER OF RECEPTACLES INDICATED LENGTH OF RACEWAY AS DRAWN

FIRE ALARM AND DETECTION

- SMOKE DETECTOR
- DUCT SMOKE DETECTOR
- HEAT DETECTOR
- FLOW SWITCH
- PRESSURE SWITCH
- TAMPER SWITCH
- MANUAL PULL STATION
- INTELLIGENT INPUT MODULE
- INTELLIGENT RELAY MODULE
- KEYED TEST STATION
- HORN/STROBE
- STROBE ONLY
- END OF LINE TERMINATOR
- AUXILIARY POWER SUPPLY
- FIRE ALARM ANNUNCIATOR PANEL
- FIRE ALARM CONTROL PANEL
- SIGNALING LINE CIRCUIT
- NOTIFICATION APPLIANCE CIRCUIT

ACCESS CONTROL SYSTEM SYMBOLS

- SECURITY SYSTEM JUNCTION BOX
- SECURITY SYSTEM WIREWAY

SITE

- ELECTRICAL DUCT BANK
- TELEPHONE UTILITY DUCT BANK
- PRIMARY ELECTRIC UTILITY SERVICE DUCT BANK
- DUCT BANK SECTION REFERENCE. REFER TO ASSOCIATED SCHEDULE ON DRAWINGS FOR CIRCUITS CONTAINED
- SIGNAL(S), LOW VOLTAGE (L), OR MEDIUM VOLTAGE (M) HANDHOLE (HH) OR MANHOLE (MH) WITH DESIGNATION. EXAMPLE: LOW VOLTAGE MANHOLE 1 (LMH1)

DISTRIBUTION EQUIPMENT SYMBOLS:

- GENERAL: APPROXIMATE SHAPE AND SCALE REPRESENTED WHERE POSSIBLE. HOWEVER EXACT SIZE AND NUMBER OF SECTIONS IS ESTIMATED
- FLOOR-STANDING DISTRIBUTION ASSEMBLY, SUCH AS A SWITCHBOARD, TRANSFORMER, OR MOTOR CONTROL CENTER
 - EQUIPMENT NUMBER (EXAMPLE)
 - WALL-MOUNTED DISTRIBUTION ASSEMBLY, SUCH AS PANELBOARD, MOTOR STARTER PANEL, OR TERMINAL CABINET
 - EQUIPMENT NUMBER (EXAMPLE)

COMMUNICATIONS SYMBOLS:

- PHONE AND DATA OUTLET
- PHONE OUTLET
- DATA OUTLET (INCLUDING VOIP)
- RECESSED FLOOR OUTLET
- INDUSTRIAL DATA OUTLET
- CATV OUTLET
- WIRELESS ACCESS POINT. PROVISIONS FOR WIRELESS ACCESS POINT INCLUDING CONDUIT, ETHERNET CABLE AND DEVICE BOX AT THE LOCATION SHOWN FOR THE WIRELESS ACCESS POINT. WIRELESS ACCESS POINT HARDWARE SHALL BE PROVIDED AND INSTALLED BY OTHERS, NOT WORK OF THIS CONTRACT.

MISCELLANEOUS SYMBOLS:

- AREA DESIGNATION. ALL ELECTRICAL WORK WITHIN THIS AREA SHALL CONFORM TO THE REQUIREMENTS OF THE SPECIFICATIONS FOR THE DESIGNATION INDICATED.
- THERMOSTAT
- PROFIBUS JUNCTION BOX
- PROFIBUS PA SEGMENT PROTECTOR
- COMBINATION COMBUSTIBLE GAS/VENTILATION FAILURE HORN AND BEACON
- CAMERA

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

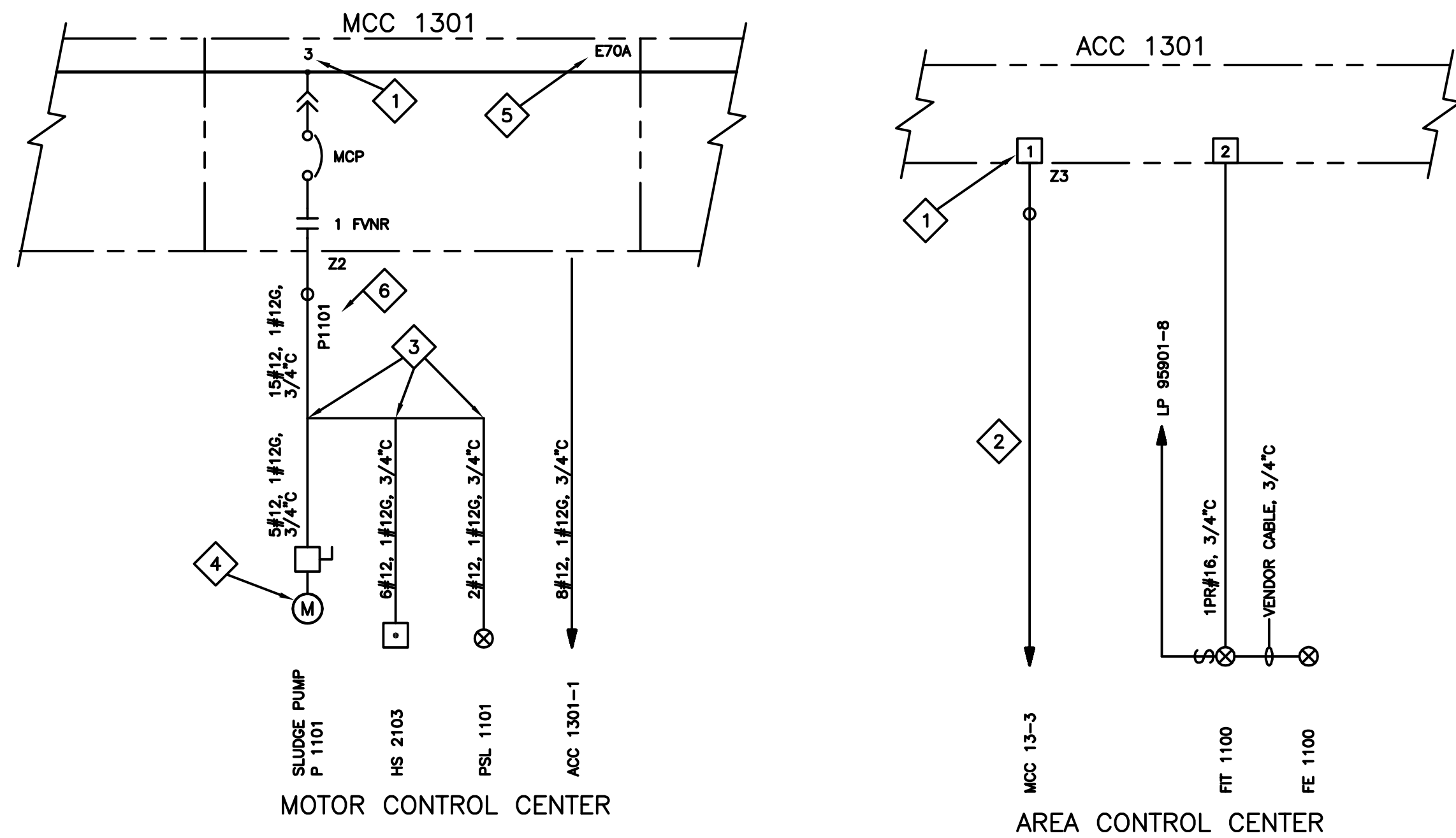
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

ELECTRICAL SYMBOLS AND
LEGENDS SHEET 1

ONE LINE DIAGRAM PRESENTATION



KEY NOTES:

- 1 SEQUENTIAL CIRCUIT DESIGNATOR.
- 2 CIRCUIT REQUIREMENTS INDICATED ON REFERENCED ONE LINE DIAGRAM.
- 3 DIAGRAMMATIC REPRESENTATION OF RACEWAY REQUIREMENTS. DRAWINGS DO NOT NECESSARILY DEPICT PHYSICAL RELATIONSHIPS OR INTERFACES WITH OTHER EQUIPMENT OR TRADES. PROVIDE ALL OFFSETS, TRANSITIONS, FITTINGS AND ACCESSORIES WHICH MAY BE REQUIRED TO FORM A COMPLETE RACEWAY SYSTEM.
- 4 CIRCUIT REQUIREMENTS UNCHANGED FROM UPSTREAM CIRCUIT REQUIREMENTS.
- 5 CONTROL DIAGRAM APPLICABLE TO EQUIPMENT SERVED FROM THIS LOCATION.
- 6 DUCTBANK SCHEDULE REFERENCE

NOTE:

1. EQUIPMENT ENCLOSURES SHALL NOT BE USED AS RACEWAY FOR CONDUCTORS THAT DO NOT TERMINATE IN THE ENCLOSURE.

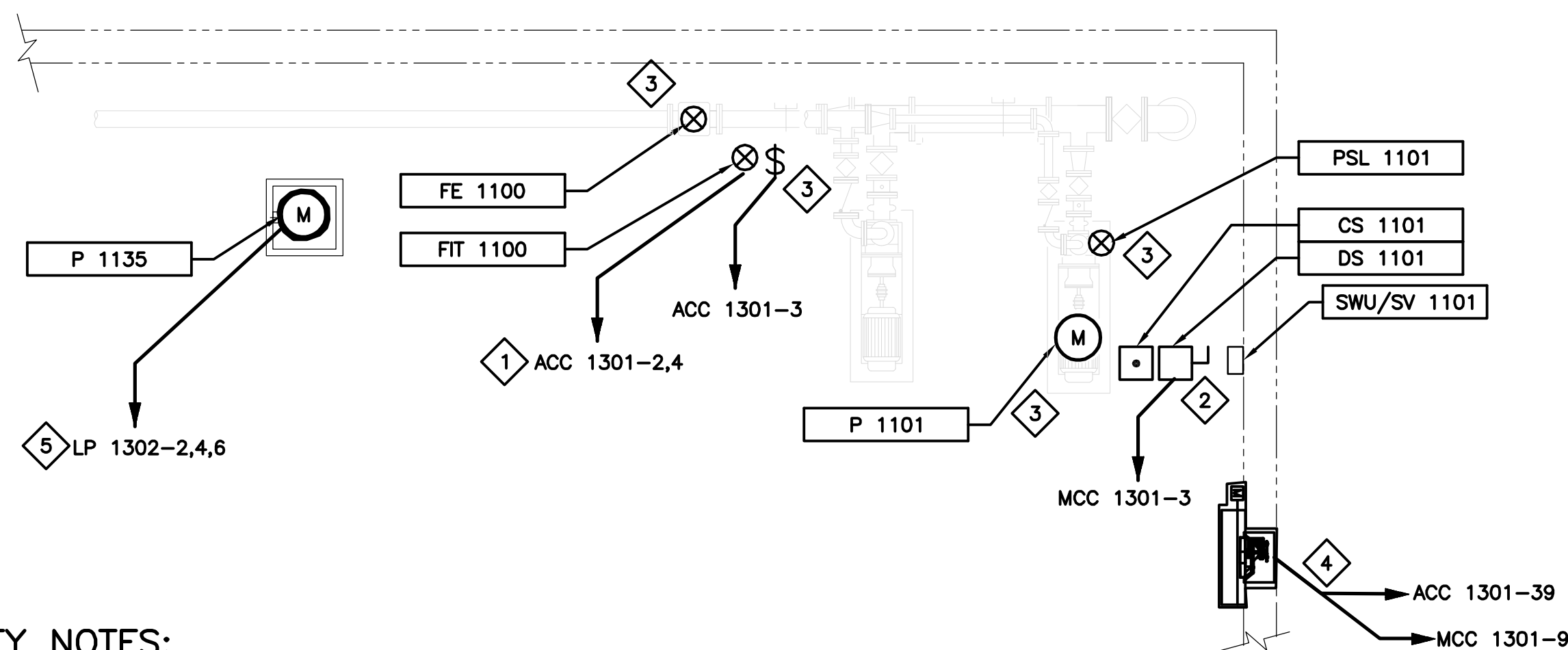
GENERAL ABBREVIATIONS

NOTES:

1. REFER TO INSTRUMENT IDENTIFICATION TABLE ON DRAWING G-2 FOR INSTRUMENT IDENTIFICATION.
2. FOR EQUIPMENT ABBREVIATIONS USED PROJECT WIDE AND NOT DEFINED HERE, REFER TO DRAWING G-2

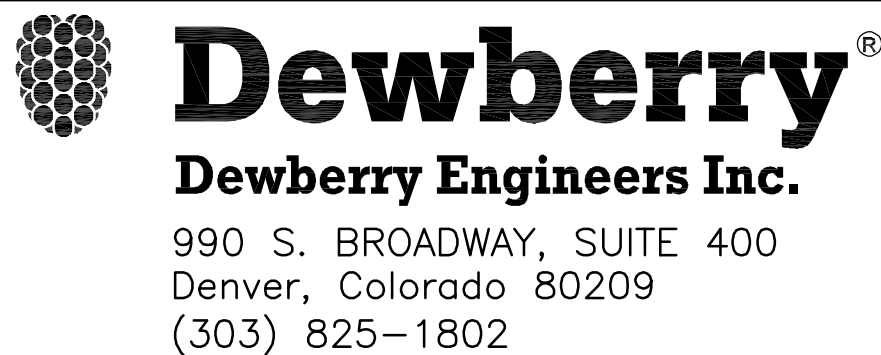
A, AMP	AMP(S), AMPERE(S)	H	HIGH	PJB	POWER JUNCTION BOX
AC	ALTERNATING CURRENT	HC	HUMIDITY CONTROLLER	PLC	PROGRAMMABLE LOGIC CONTROLLER
ACC	AREA CONTROL CENTER	HGT	HEIGHT	PMM	POWER METERING MODULE
ACP	ACCESS CONTROL PANEL	HH	HANDHOLE	PNL	PANEL
ACU	AIR CONDITIONING UNIT	HIM	HUMAN INTERFACE MODULE	PP	POWER PANEL
AFF	ABOVE FINISHED FLOOR	HP	HORSEPOWER	PPA	PROFIBUS PA NETWORK CABLE
AFS	ABOVE FINISHED GRADE	HTR	HEATER	PR	PAIR
AHB	ALARMING HORN AND BEACON	HVAC	HEATING, VENTILATION, AND AIR	PRI	PRIMARY
	COMBINATION		CONDITIONING	PRMC	PLASTIC COATED GALVANIZED RIGID
AI	ANALOG INPUT	HZ	HERTZ		STEEL CONDUIT
AIC	AMPS INTERRUPTING CAPACITY, SYMM.	IC	ISOLATION CONTACTOR	PSM	POWER SUPPLY MODULE
		ICOM	INTERCOM	PT	POTENTIAL TRANSFORMER
AIU	AIR IONIZATION UNIT	IFF	INTERFACE PANEL	PVC	POLYVINYL CHLORIDE
AL	ALUMINUM	IG	ISOLATED GROUND	PWR	POWER
AO	ANALOG OUTPUT	IMC	INTERMEDIATE METAL CONDUIT	RCPT	RECEPTACLE
ARCH	ARCHITECT (URAL)	INST	INSTANTANEOUS	RE, REF	REFERENCE
ARM	ARC FLASH REDUCTION MAINTENANCE	I/O	INPUT -OUTPUT	REQD	REQUIRED
ARV	AUTOTRANSFORMER REDUCED VOLTAGE	JB	JUNCTION BOX	RE STL	REINFORCING STEEL
	STARTER	KB	KNOX BOX		REMOTE INPUT/OUTPUT
ASYM	ASYMMETRICAL	KCMIL	1000 CIRCULAR MIL	RIO	RIGHT OF WAY SQUARE
ATO	AUTOMATIC THROW OVER	KV	KILOVOLT	RTD	RESISTANCE TEMPERATURE DETECTOR
ATS	AUTOMATIC TRANSFER SWITCH	KVA	KILOVOLT - AMPERE	RTU	REMOTE TERMINAL UNIT
AUTO	AUTOMATIC	KVAR	KILOVOLT - AMPERE REACTIVE	RVSS	REDUCED VOLTAGE SOLID STATE
AUX	AUXILIARY	KW	KILOWATT		STARTER
AWG	AMERICA WIRE GAUGE	KWH	KILOWATT-HOUR	SCH	SCHEDULE
BC	BARE COPPER	L	LONG	SCHD	SMOKE DETECTOR
BLDG	BUILDING	LCP	LOCAL CONTROL PANEL	SE	SERVICE ENTRANCE
	CONDUCTOR, CONDUIT	LFMC	LIQUID TIGHT FLEX, METAL CONDUIT	SEC	SECONDARY
CB	CIRCUIT BREAKER	LHH	LOW VOLTAGE HANDHOLE	SHH	SIGNAL HANDHOLE
CER	COMMUNICATION EQUIPMENT RACK	LP	LIGHTING PANEL OR LEGEND PLATE	SJB	SIGNAL JUNCTION BOX
CIB	CONTROL INTERFACE BOX	LS	LEVEL SWITCH	SMP	SAMPLER
CKT	CIRCUIT	LSHH	LEVEL SWITCH HIGH HIGH	SPT	SEGMENT PROTECTOR MODULE
CLG	CEILING	LTG	LIGHTING	SPD	SURGE PROTECTION DEVICE
C.O.	CUTTING ONLY, SPARE	LTB	LIGHTING TERMINAL BOX	SPEC	SPECIFICATION
CONC	CONCRETE	LV	LOW VOLTAGE	SPKR	SPEAKER
CJB	CONTROL JUNCTION BOX	LVRC	LIGHTING RELAY CONTROLLER	SS	STAINLESS STEEL
CPT	CONTROL POWER TRANSFORMER	MA	MILLIAMPERE	SSM	SOLID STATE METERING
CS	CONTROL SIGNAL, CONTROL STATION	MBS	MANUAL BYPASS SWITCH	STK	STROKER POSITION
CT	CURRENT TRANSFORMER	MCC	MOTOR CONTROL CENTER	STR	STRAND
DB	DUCT BANK, DIRECT BURIAL	MCP	MOTOR CIRCUIT PROTECTOR	SUB	SUBSTATION
DC	DIRECT CURRENT, DATA CABLE	MD	MOTORIZED DAMPER	SV	SOLENOID VALVE
DDC	DIRECT DIGITAL CONTROL	MFR	MANUFACTURER	SW	SWITCH
DI	DIGITAL INPUT	MH	MANHOLE	SWBD	SWITCHBOARD
DIAG.	DIAGNOSTIC	MIC-A	MULTI CONDUCTOR INSTRUMENTATION	SWGR	SWITCHGEAR
DISC	DISCONNECT		CABLE TYPE A	T	TRANSFORMER
DMSS	DOUGLASS MINI SPLIT SYSTEM	MME	MISCELLANEOUS MECHANICAL	TB	TERMINAL BOX
DO	DIGITAL OUTPUT		EQUIPMENT	TEL	TELEPHONE
DP	DISTRIBUTION PANEL, PROFIBUS DP (DECENTRALIZED PERIPHERAL)	MP	METERING PUMP	TFR	TRANSFORMER
		MS	MOTOR STARTER	TLP	TRANSFORMER/LIGHTING PANEL
DS	DISCONNECT SWITCH	MTS	MANUAL TRANSFER SWITCH		COMBINATION POWER CENTER
DWG	DRAWING	MV	MILLIVOLT, MEDIUM VOLTAGE	TPTS	TWO PAIR TWISTED SHIELDED
EA	EACH	MVHH	MEDIUM VOLTAGE HANDHOLE	TSP	TWISTED SHIELDED PAIR
ECB	ENCLOSED CIRCUIT BREAKER	N/A	NOT APPLICABLE	TST	TWISTED SHIELDED TRIAD
ECP	EQUIPMENT CONTROL PANEL	N.C.	NORMALLY CLOSED	TV	TELESCOPING VALVE
EL	ELEVATION	NEUT, N	NEUTRAL	TYP	TYPICAL
EMER	EMERGENCY	NF	NON-FUSED	UCP	UNIT CONTROL PANEL
ENCL	ENCLOSURE/ENCLOSED	NIC	NOT IN CONTRACT	U/G	UNDERGROUND
ENET	ETHERNET NETWORK CABLE	N.O.	NORMALLY OPEN	UNSW	UNSWITCHED
EPI	EMERGENCY POWER INTERLOCK	NO.	NUMBER	UON	UNLESS OTHERWISE NOTED
ES	EMERGENCY STOP	NP	NUMERATE	UPP	UTP PATCH PANEL
ETP	ELECTRONIC TRAP PRIMER	NTS	NOT TO SCALE	UPS	UNINTERRUPTIBLE POWER SUPPLY
FACP	FIRE ALARM CONTROL PANEL	OC	ON CENTER	UTP	UNSHIELDED TWISTED PAIR
FAS	FIRE ALARM SYSTEM	OCP	OVERCURRENT PROTECTION	*V	VENDOR SUPPLIED EQUIPMENT
F.C.	FAIL CLOSE	OH	OVERHEAD	V	VOLT
FLA	FULL LOAD AMPS	OHD	OVERHEAD DOOR	VA	VOLTAMPERE
F.O.	FAIR OPEN	OIS	OPERATOR INTERFACE STATION	VAR	VOLTAMPERE REACTIVE
F.O.	FIBER OPTIC	OLR	OVERLOAD RELAY	VC	VACUUM CONTACTOR
FPF	FIBER OPTIC PATH	OWS	OPERATOR WORKSTATION	VFD	VARIABLE FREQUENCY DRIVE
FUT	FUTURE	P	POLE, PHASE	XFMR	TRANSFORMER
FVNR	FULL VOLTAGE NON REVERSING	PAC	PROGRAMMABLE AUTOMATION	XMTX	TRANSMITTER
FVR	FULL VOLTAGE REVERSING		CONTROLLER	W	WATT, WIRE, WIDE
GC	GROUND CONDUCTOR	PASP	PROFIBUS PA SEGMENT PROTECTOR	W/	WITH
GEC	GROUND ELECTRODE CONDUCTOR	PB	PUSHBUTTON, PULLBOX	W/O	WITHOUT
GF	GROUND FAULT	PCP	PROCESS CONTROL PANEL	WAP	WIRELESS ACCESS POINT
GFIC	GROUND FAULT INTERRUPTER	PDP	PROFIBUS DP NETWORK CABLE	WP	WATERPROOF
GND, G	GROUND	PF	POWER FACTOR	WW	WIREFEED
GNG	GO/NO GO PANEL	PH	PHASE	XP	EXPLOSIONPROOF
GRS	GALVANIZED, RIGID STEEL	PHH	POWER HANDHOLE	Z	IMPEDANCE
				ZSS	ZERO SPEED SWITCH

TYPICAL PLAN PRESENTATION



KEY NOTES:

- 1 HOMERUN CIRCUIT DESIGNATION, MULTIPLE CIRCUITS IN SINGLE CONDUIT. REFER TO REFERENCED ONE LINE DIAGRAM FOR CABLE AND RACEWAY REQUIREMENTS.
- 2 REFER TO MOTOR FEED INSTALLATION DETAILS FOR SUPPORT SYSTEM REQUIREMENTS.
- 3 PLAN DRAWING DEPICTS APPROXIMATE SPATIAL RELATIONSHIP OF ASSOCIATED EQUIPMENT AND DEVICES. REFER TO ONE LINE DIAGRAMS FOR INTERCONNECTING CIRCUIT REQUIREMENTS. REFER TO TYPICAL ONE LINE DIAGRAM PRESENTATION ON DRAWING E-3.
- 4 HOMERUN CIRCUIT DESIGNATION, PROVIDE SEPARATE CONDUIT FOR EACH CIRCUIT.
- 5 HOMERUN CIRCUIT DESIGNATION, MULTIPLE CIRCUITS FEEDING ONE PIECE OF EQUIPMENT.



LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"—SCALE ACCORDINGLY)

DRAWING EDG59690-003
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE: _____

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	SEF
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

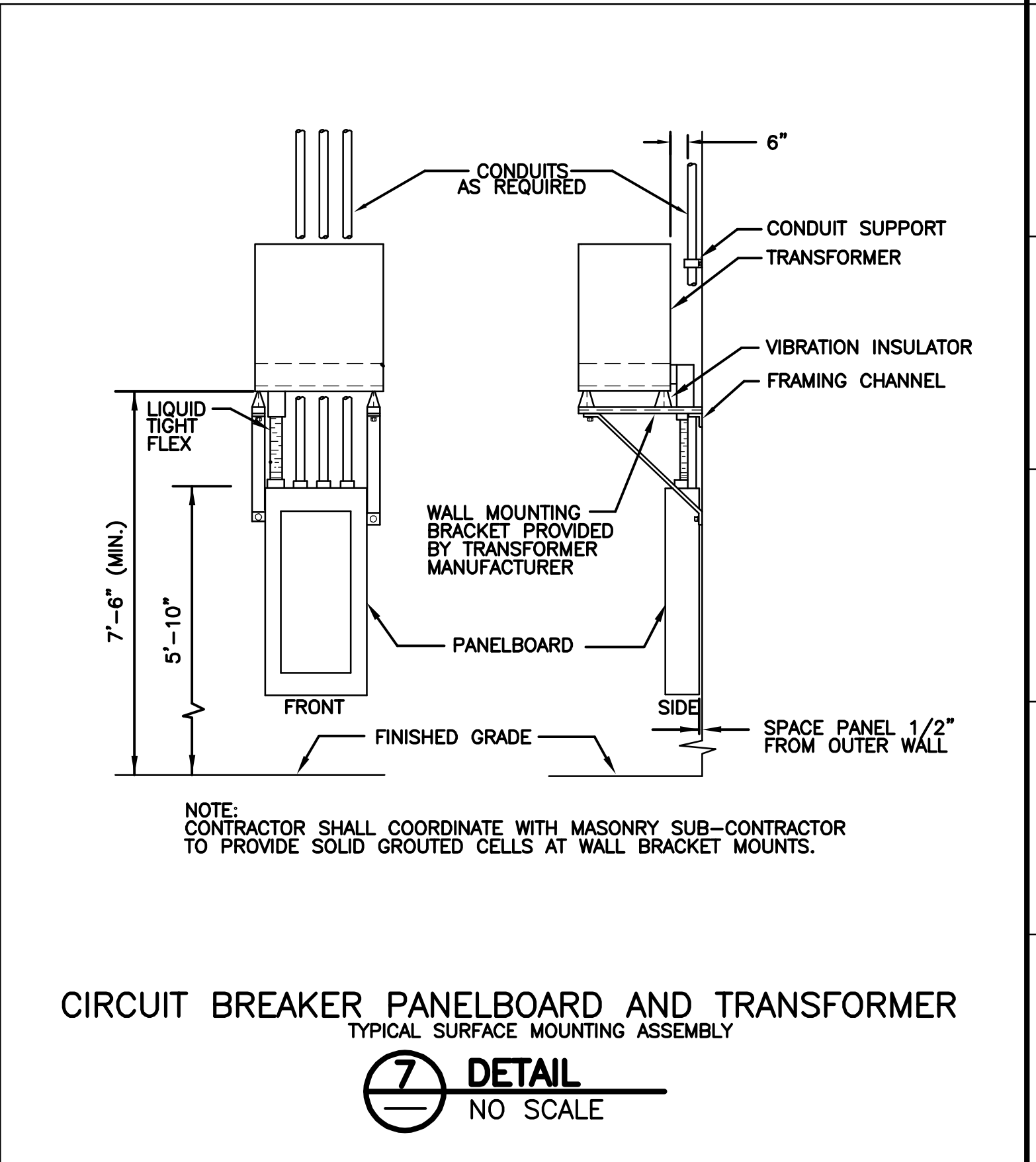
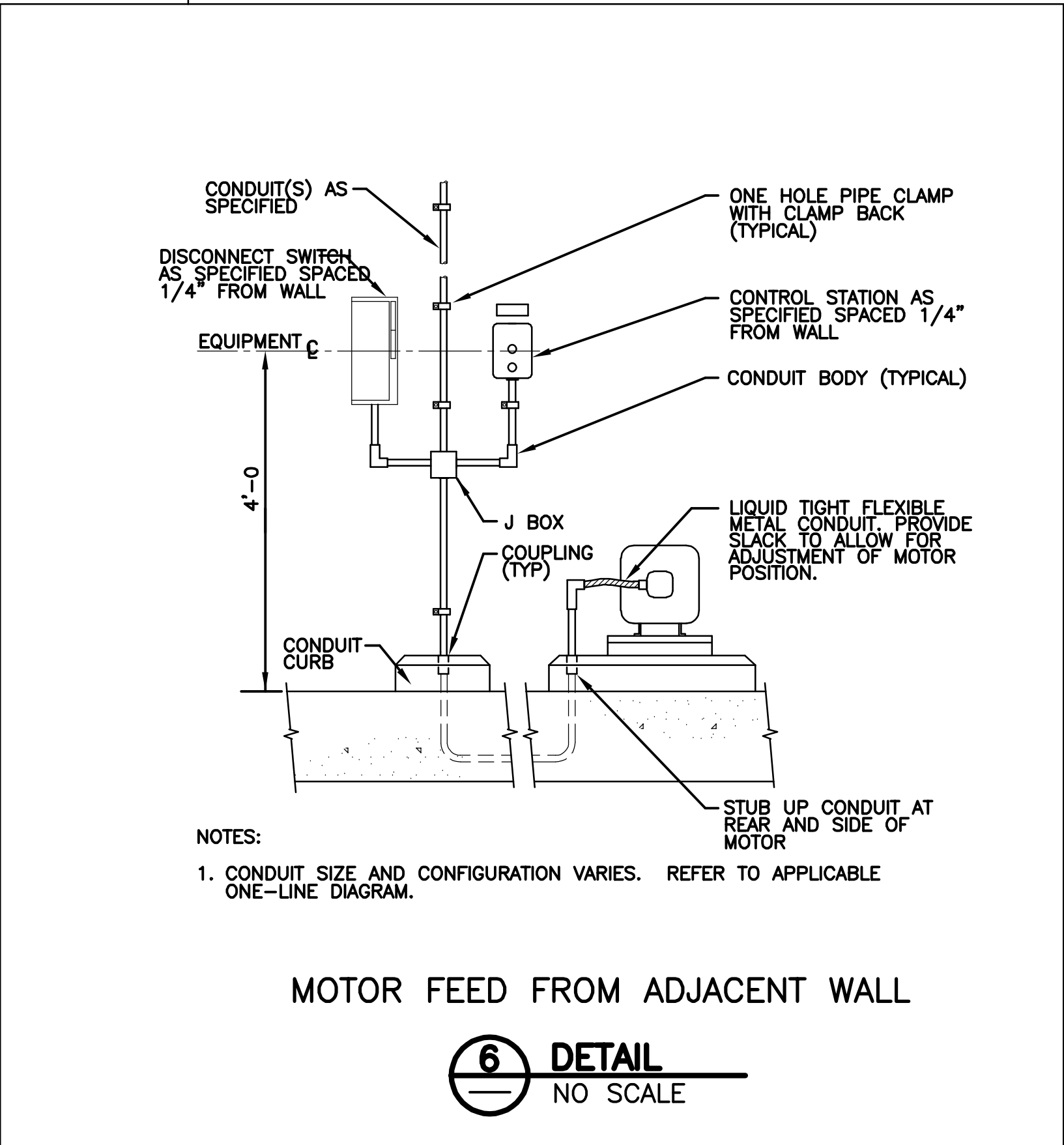
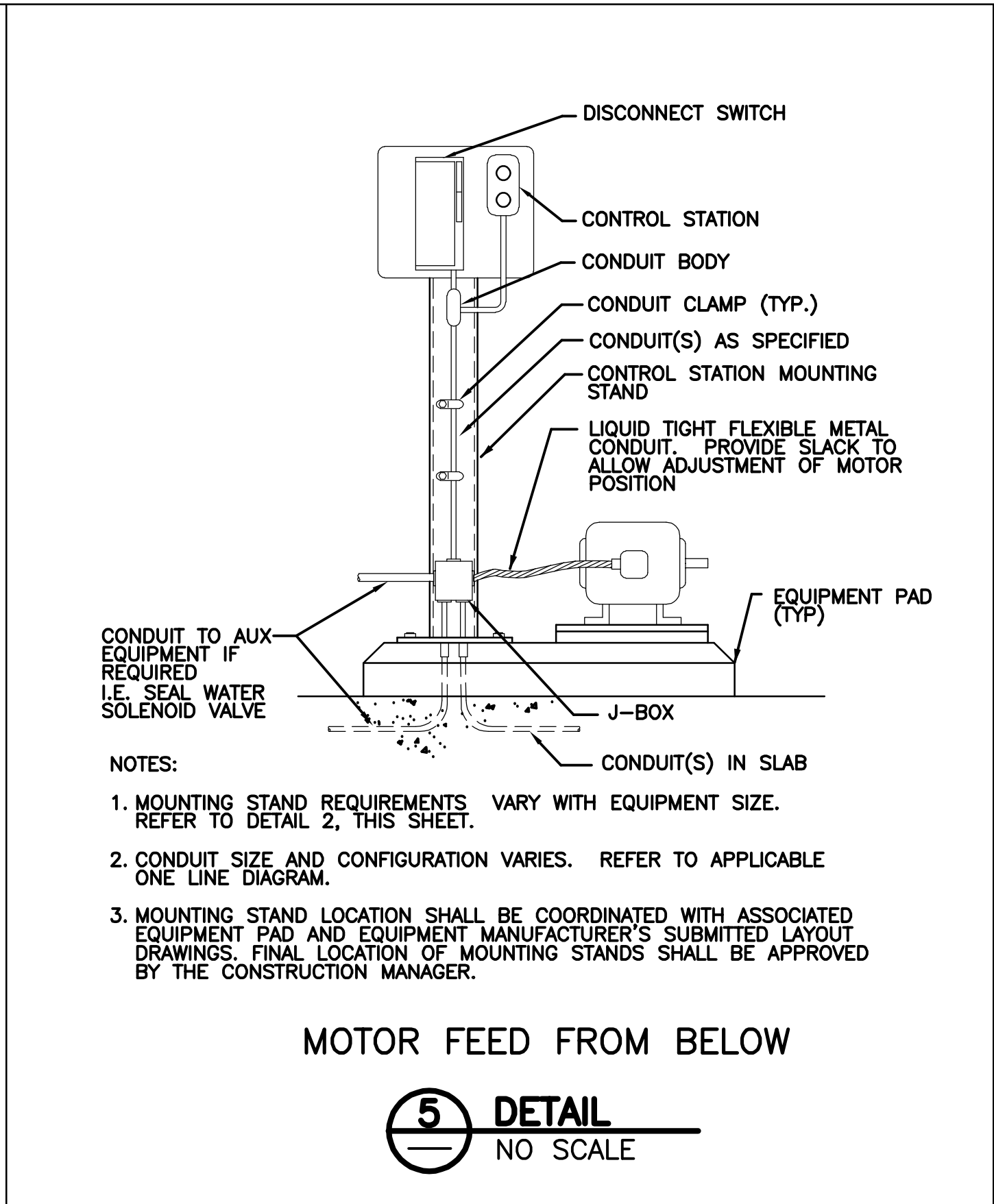
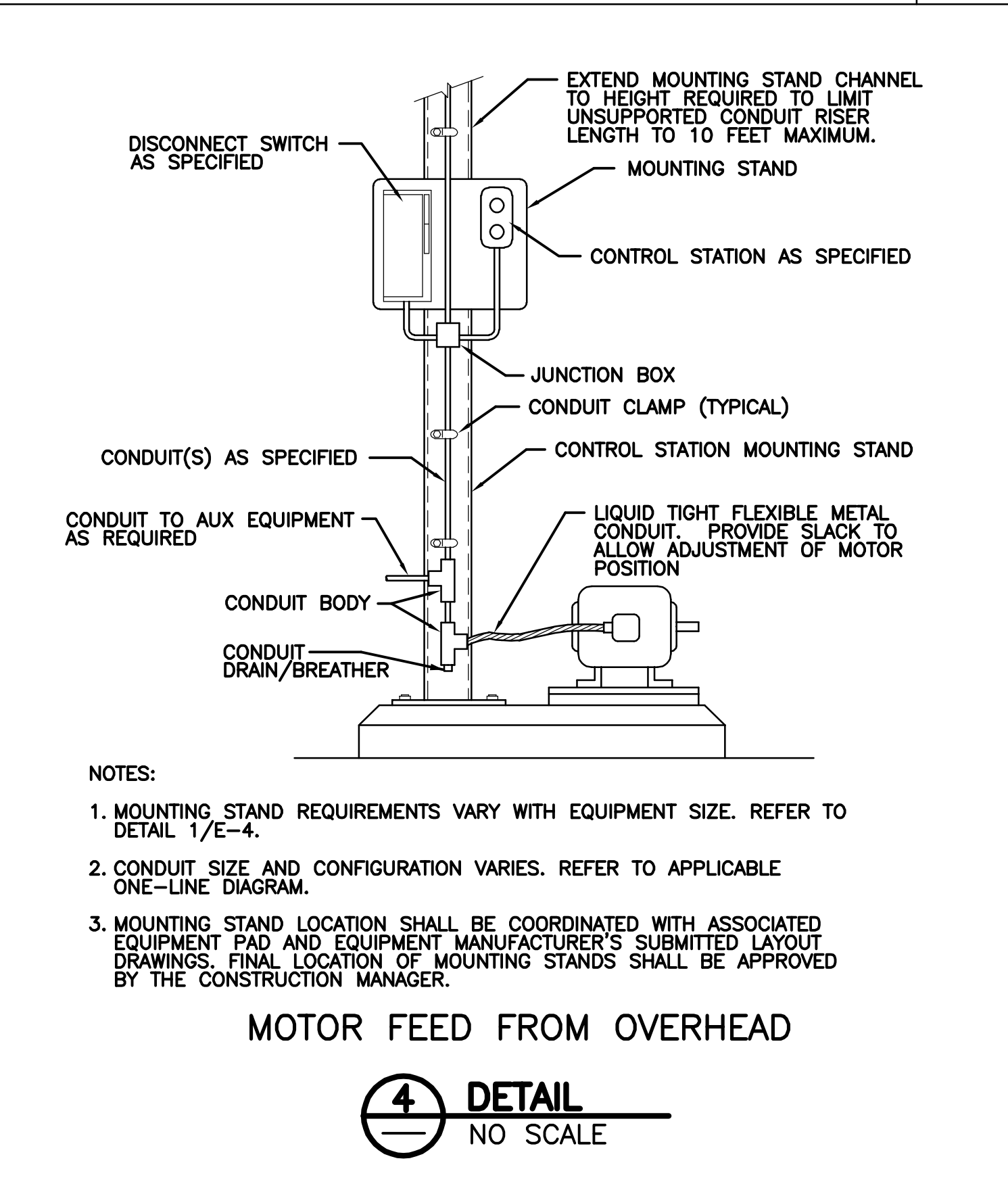
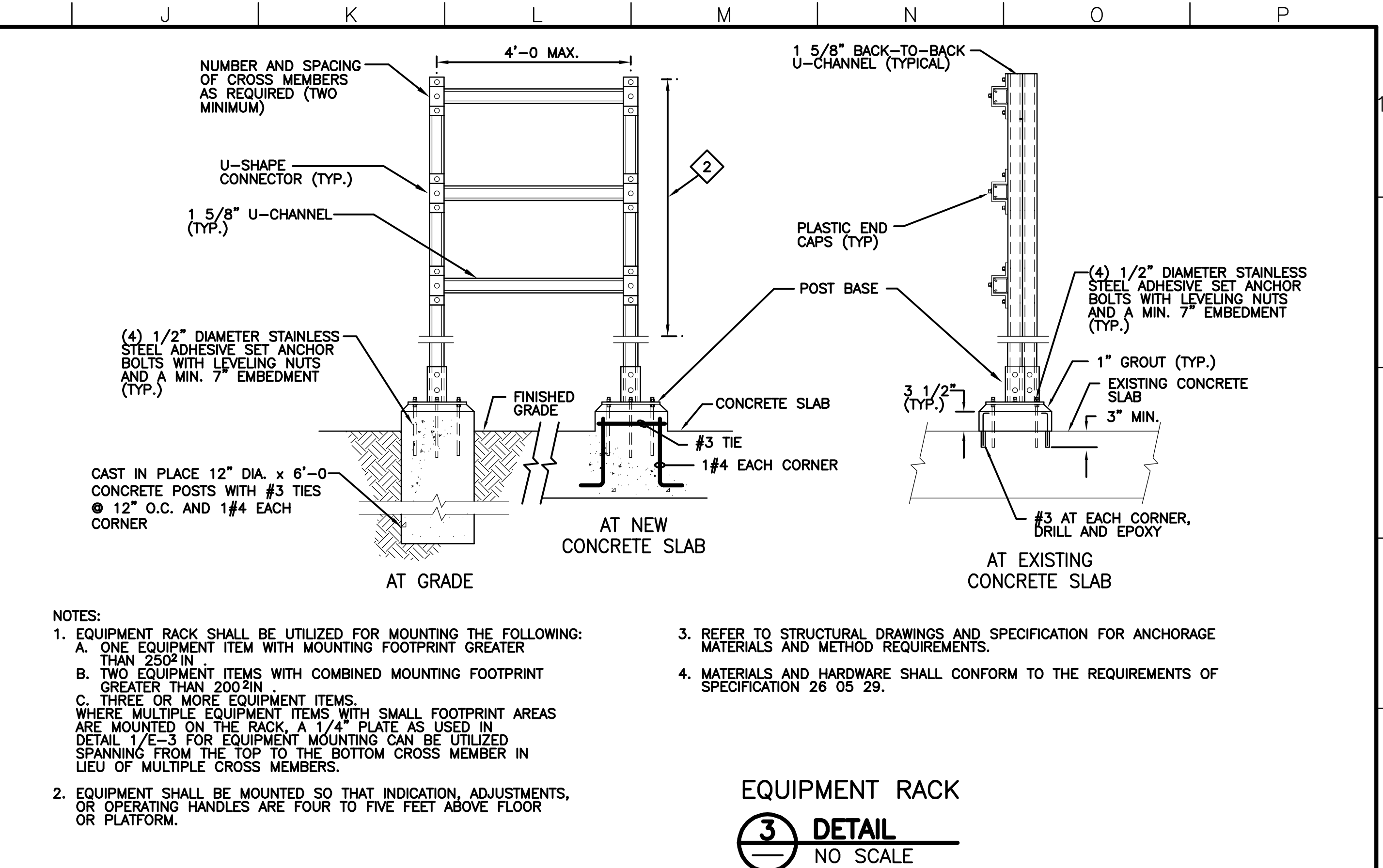
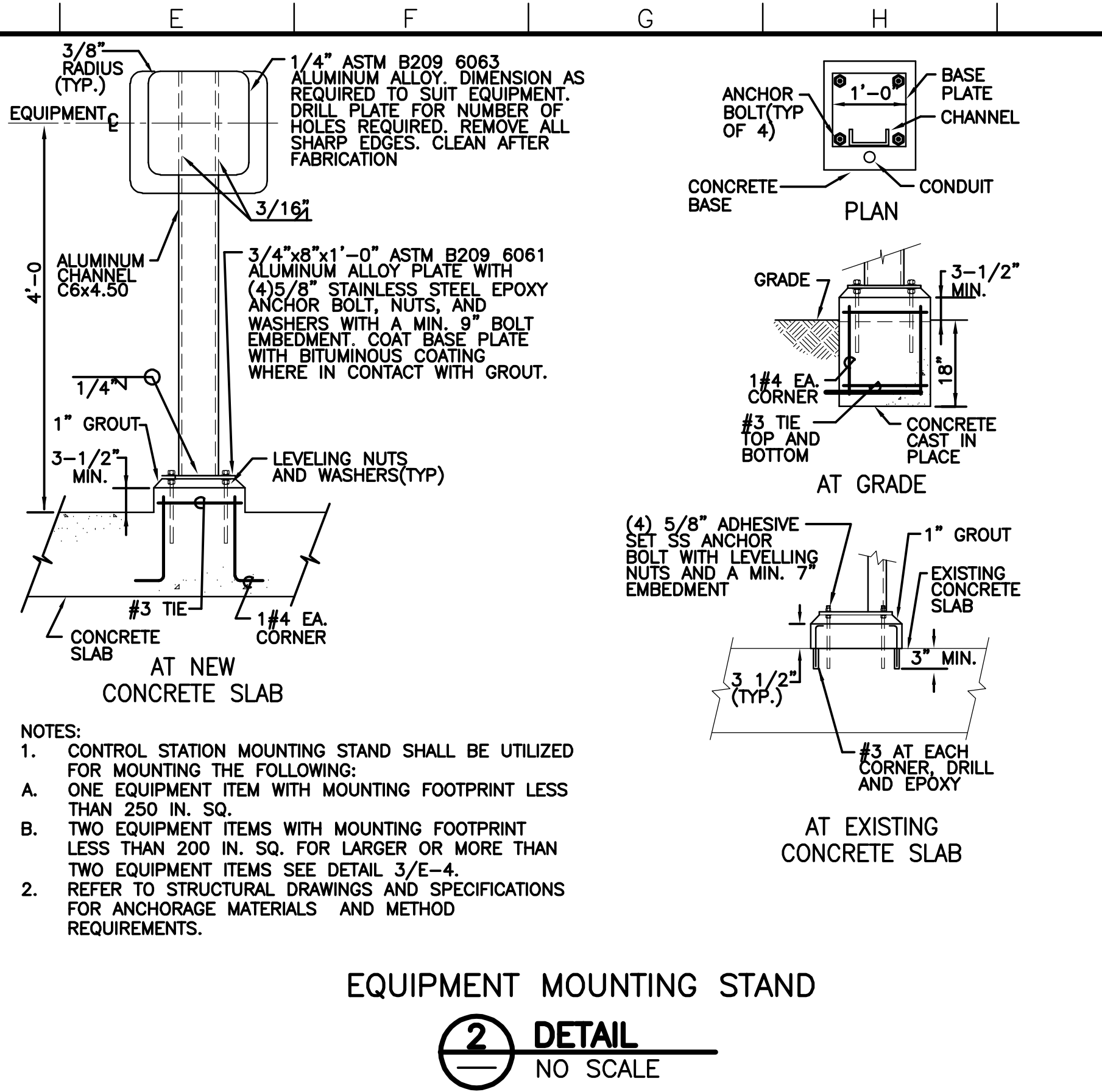
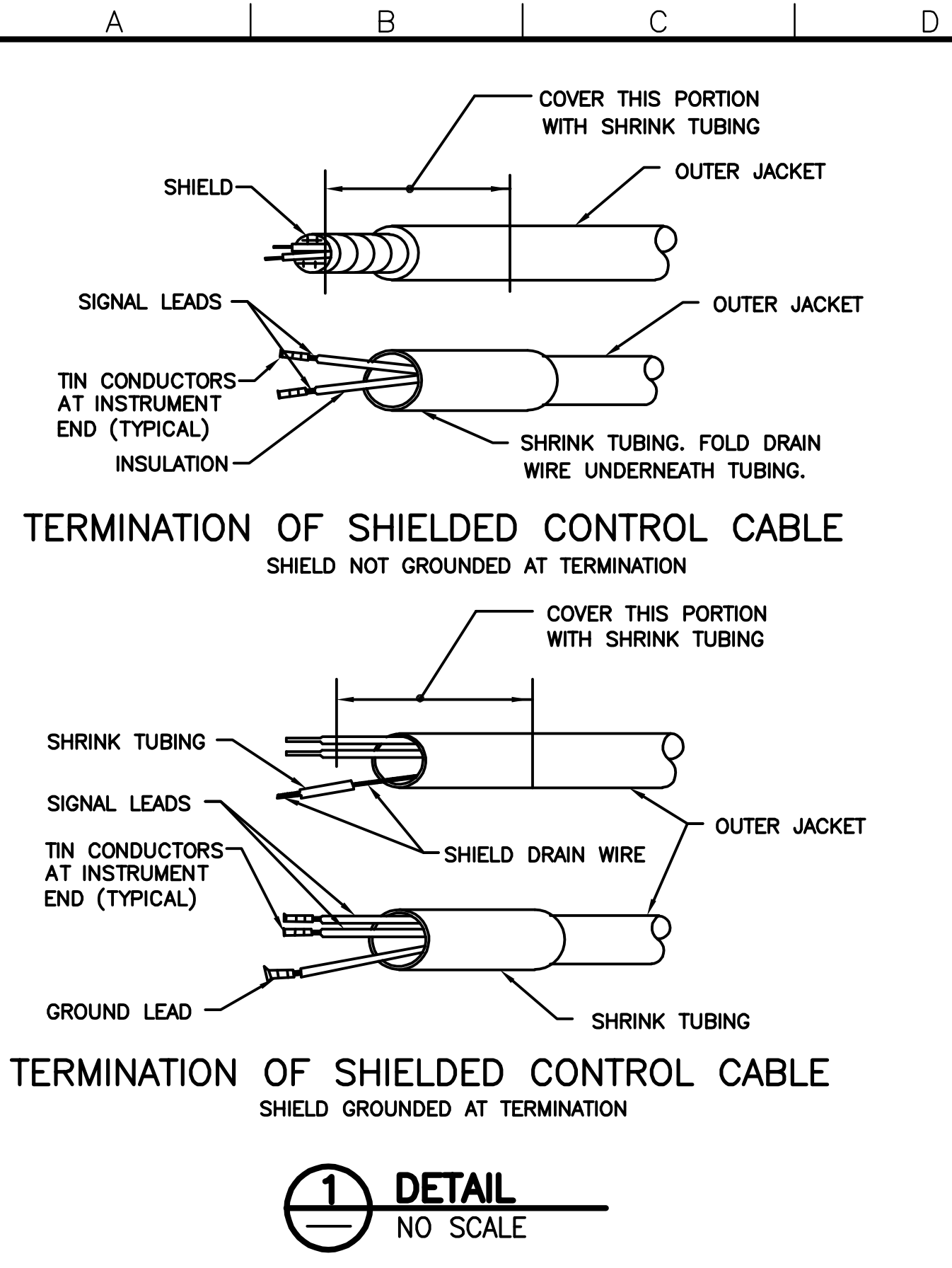
ELECTRICAL SYMBOLS AND LEGENDS SHEET 3

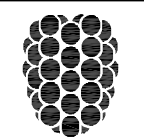
DATE: 05/15/23

PROJECT NUMBER: 50159690

REVISION NO. D

DRAWING NUMBER
F-3



**Dewberry**
Dewberry Engineers Inc.
990 S. BROADWAY, SUITE 400
Denver, Colorado 80209
(303) 825-1802

LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING EDG59690-004
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:		REVISIONS			
PRINCIPAL		REV.	DESCRIPTION	BY	DATE
		A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23
		B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23
		C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23
DATE:		D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23

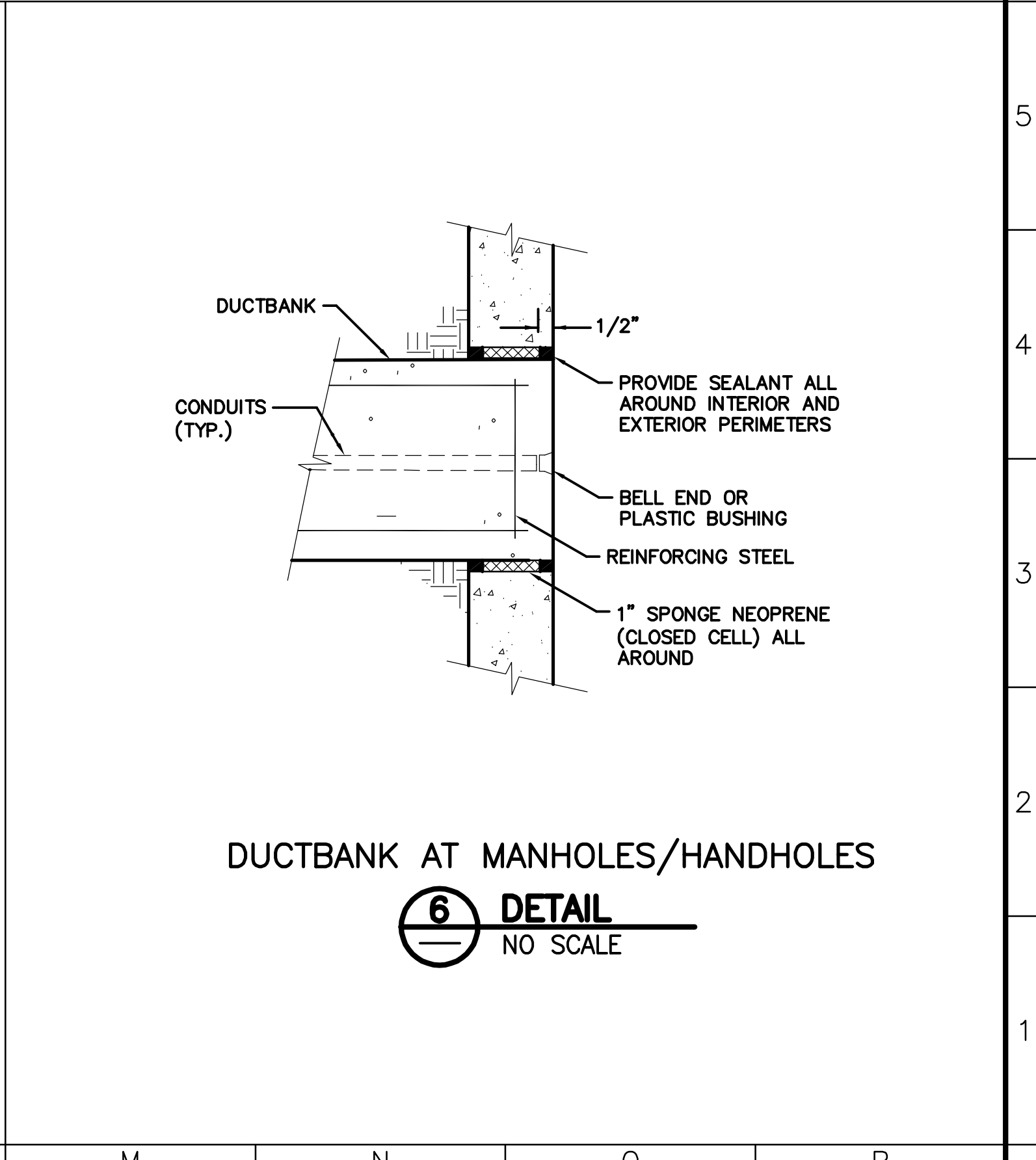
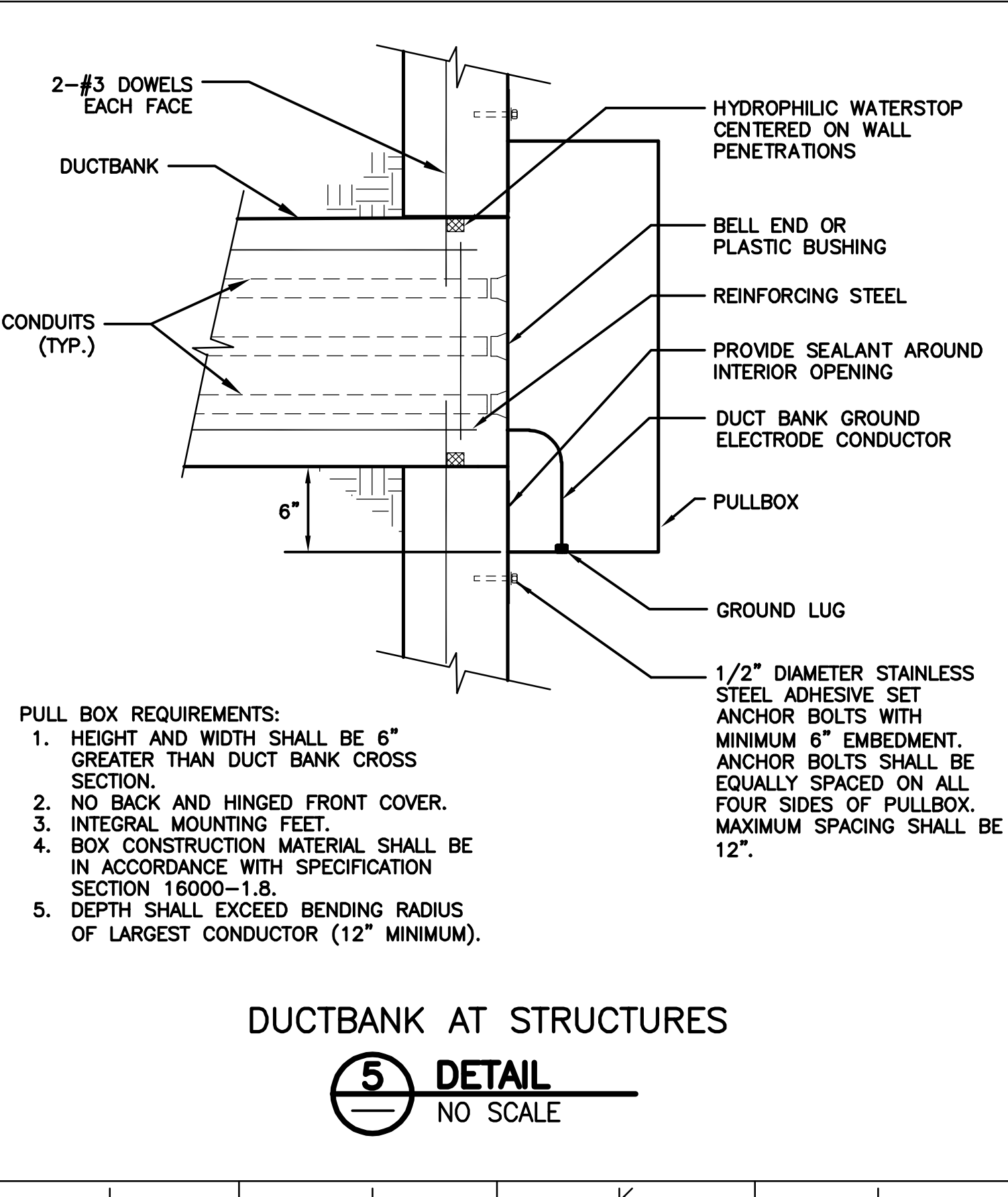
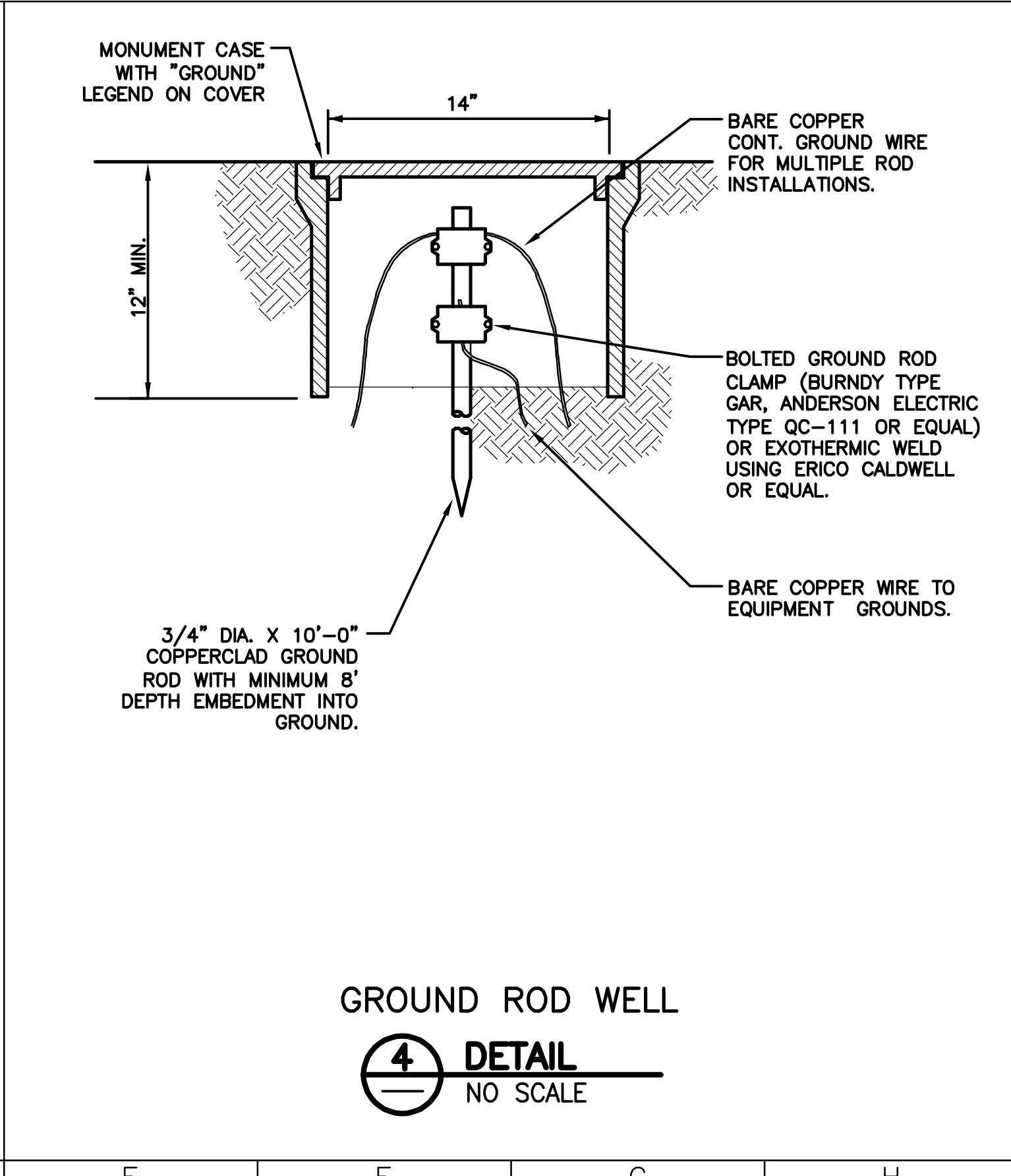
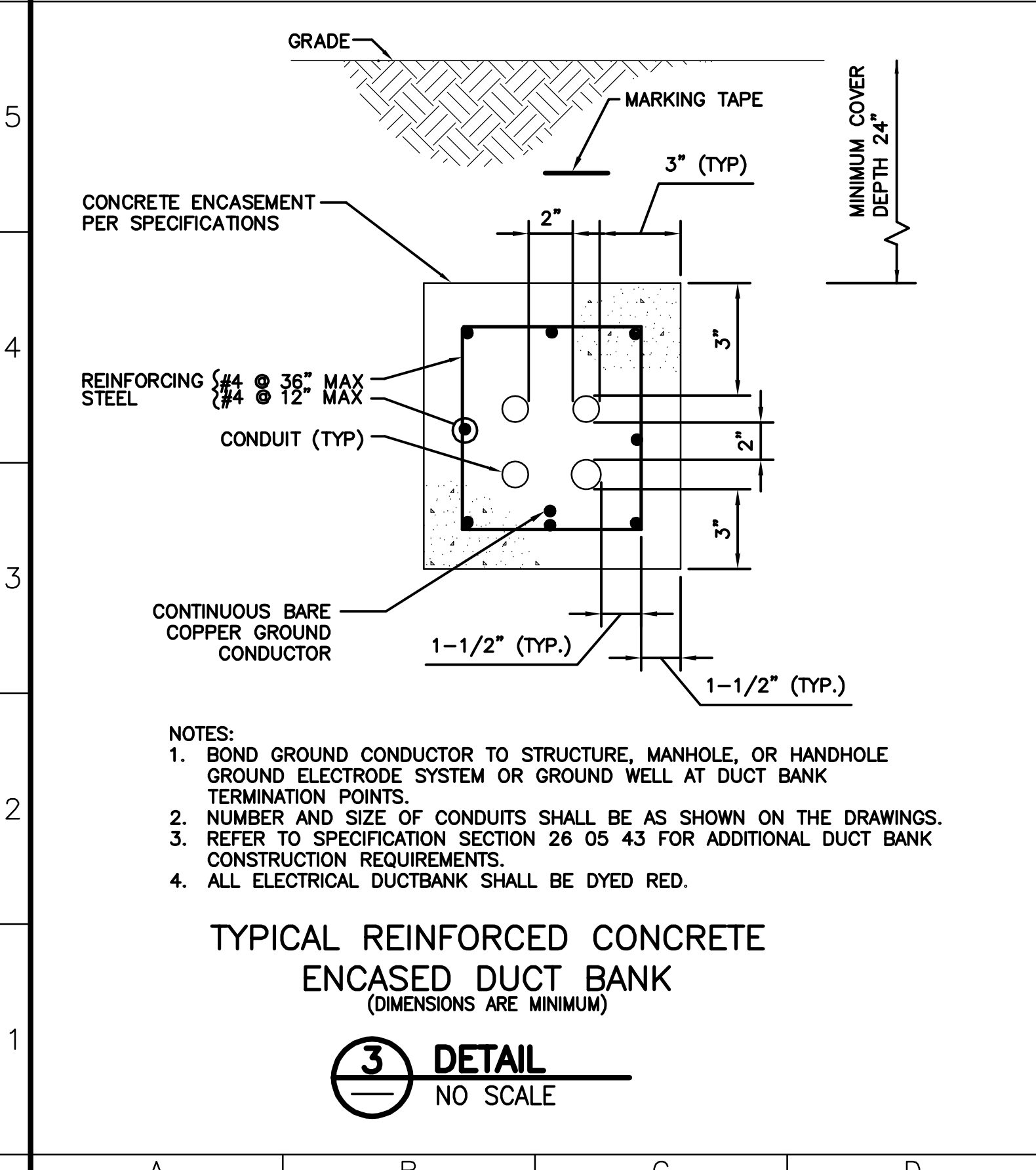
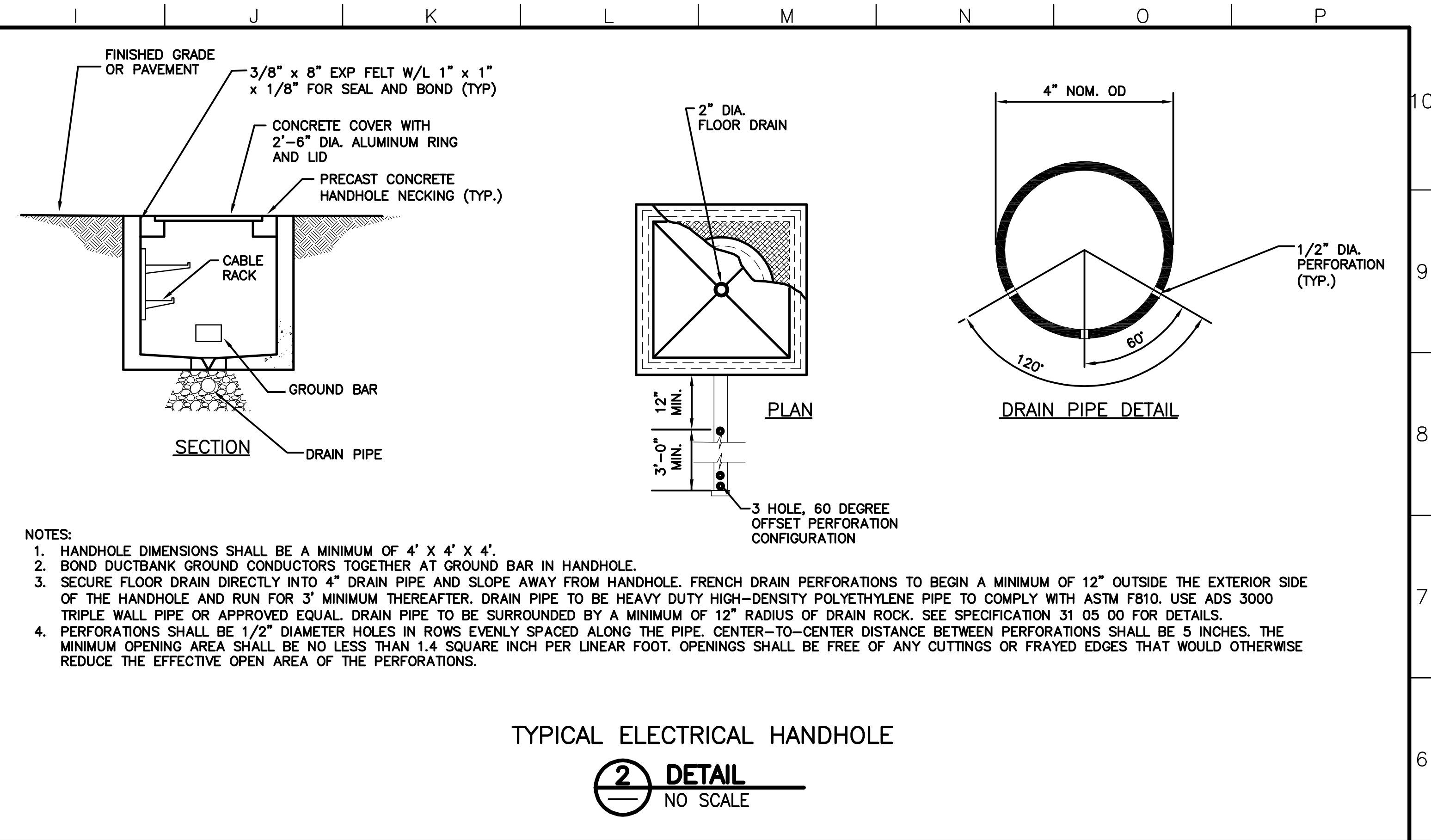
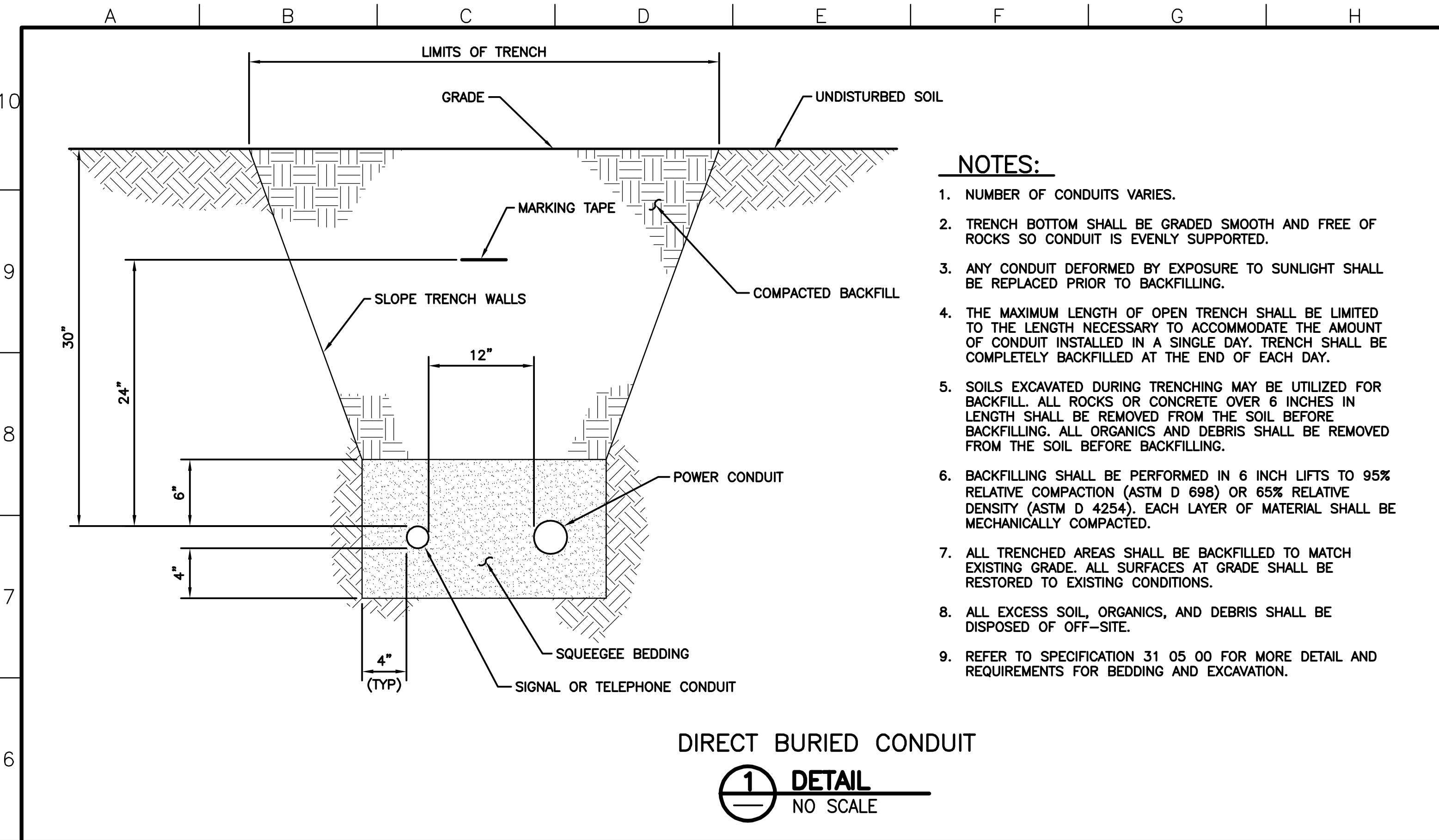
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

ELECTRICAL DETAILS 1
GENERAL DETAILS

DATE: 05/15/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER E-4



Dewberry
Dewberry Engineers Inc.
990 S. BROADWAY, SUITE 400
Denver, Colorado 80209
(303) 825-1802

LINE IS 2 INCHES AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING EDG59690-005
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	SEF
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

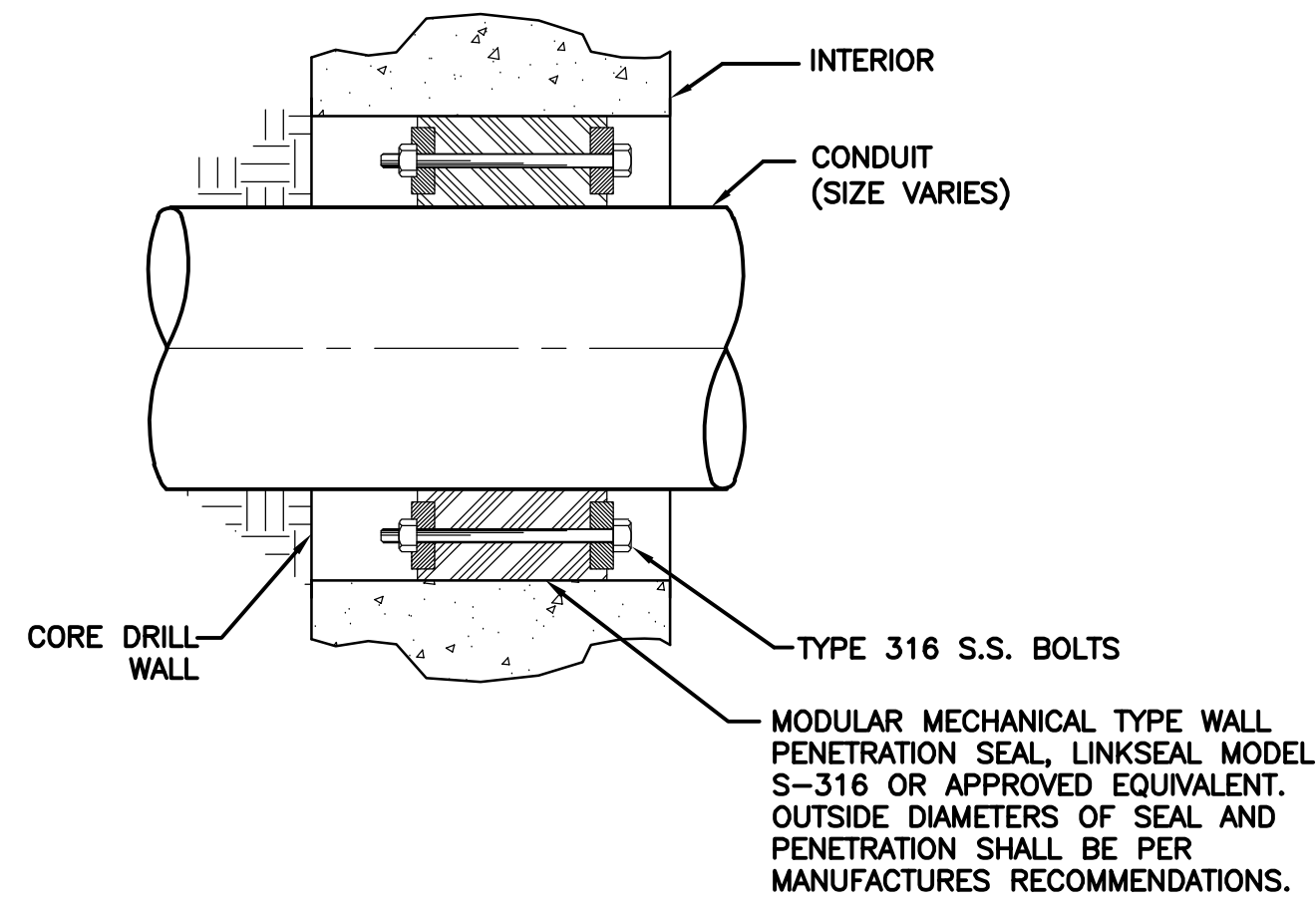
ELECTRICAL DETAILS 2
SITE AND DUCTBANK

DATE: 05/15/23

PROJECT NUMBER: 50159690

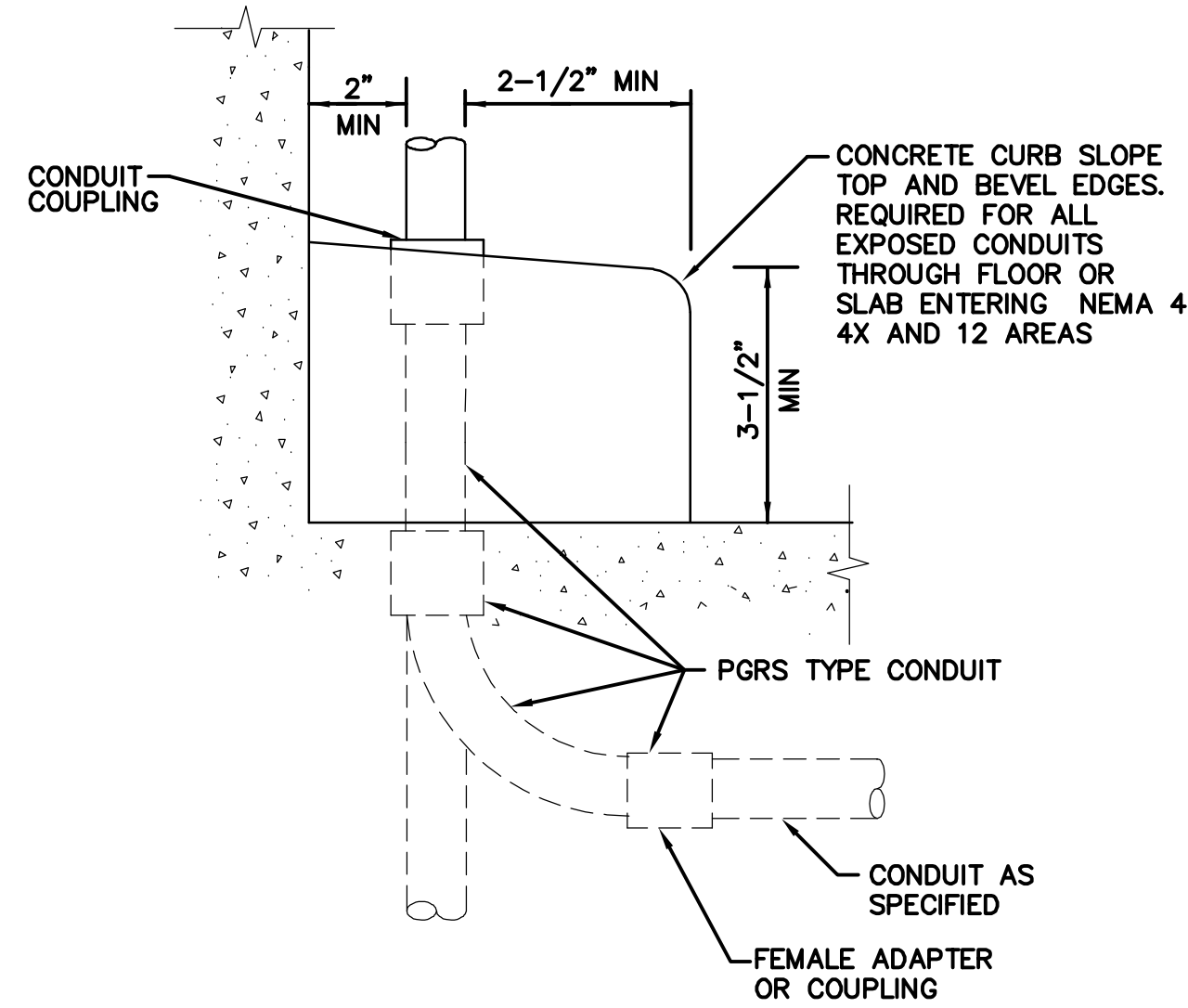
REVISION NO. D

DRAWING NUMBER **E-5**



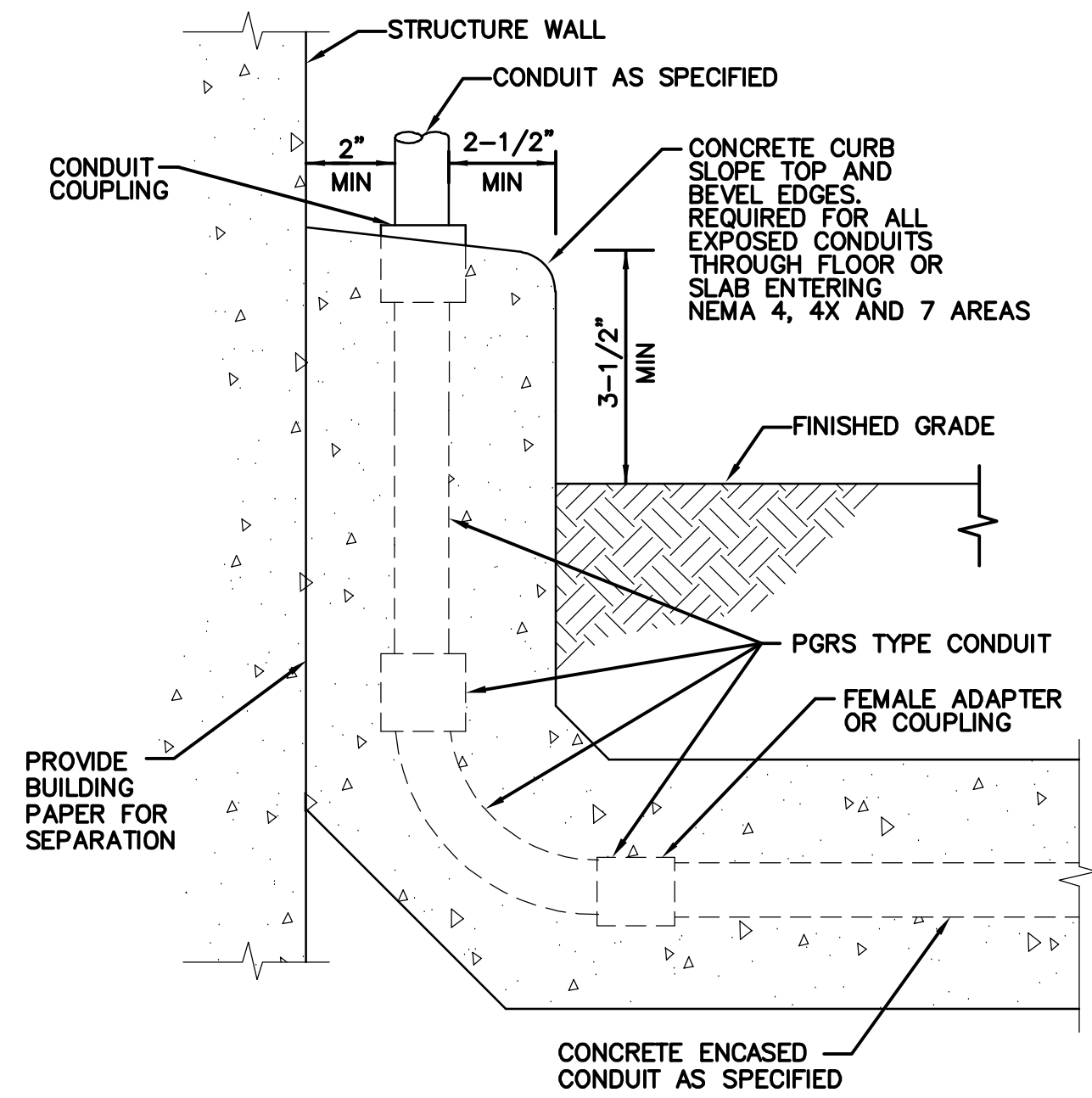
TYPICAL MODULAR SEAL CONDUIT PENETRATION

1 DETAIL
NO SCALE



CONDUIT CURB

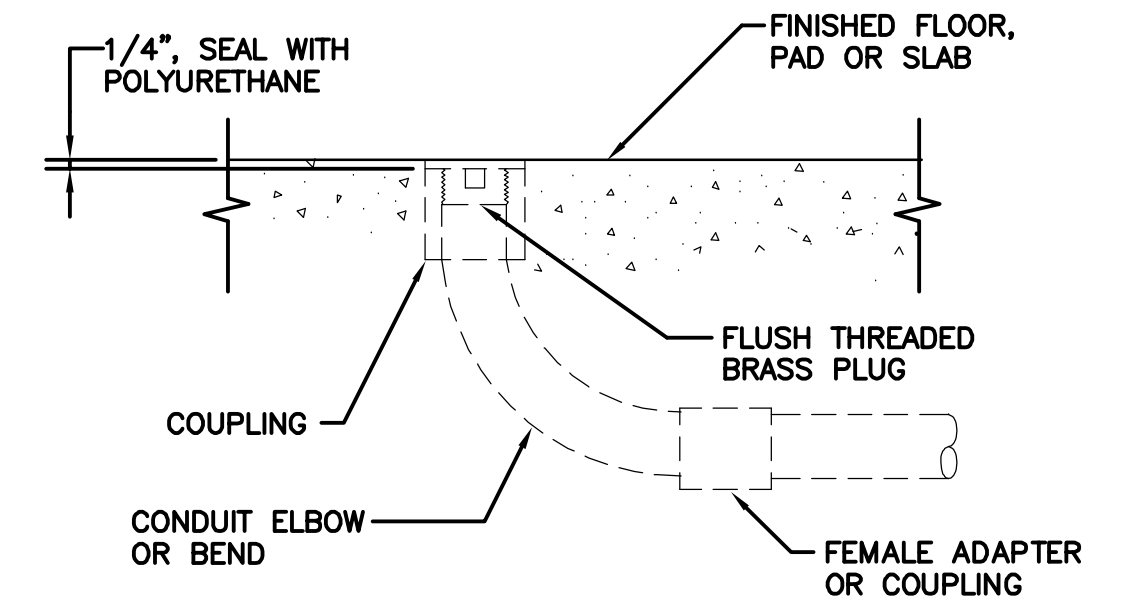
2 DETAIL
NO SCALE



NOTE:
PROVIDE 12" OF LIQUID TIGHT FLEXIBLE CONDUIT FOR CONNECTION TO EQUIPMENT RIGIDLY ATTACHED TO STRUCTURE. THE FLEXIBLE CONDUIT SHALL PROVIDE 1" DIFFERENTIAL MOVEMENT IN ALL DIRECTIONS.

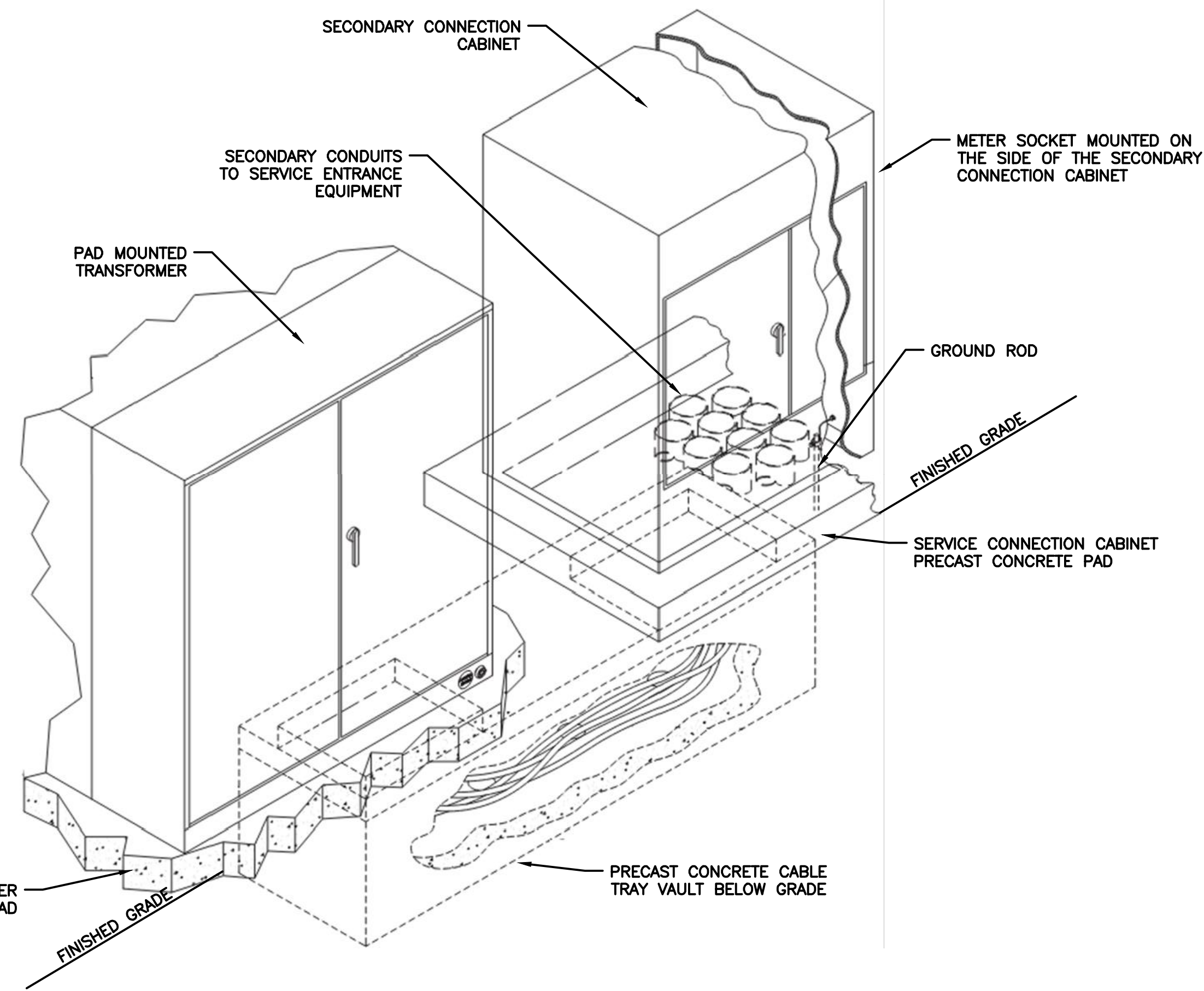
CONDUIT CURB AT FINISHED GRADE

3 DETAIL
NO SCALE



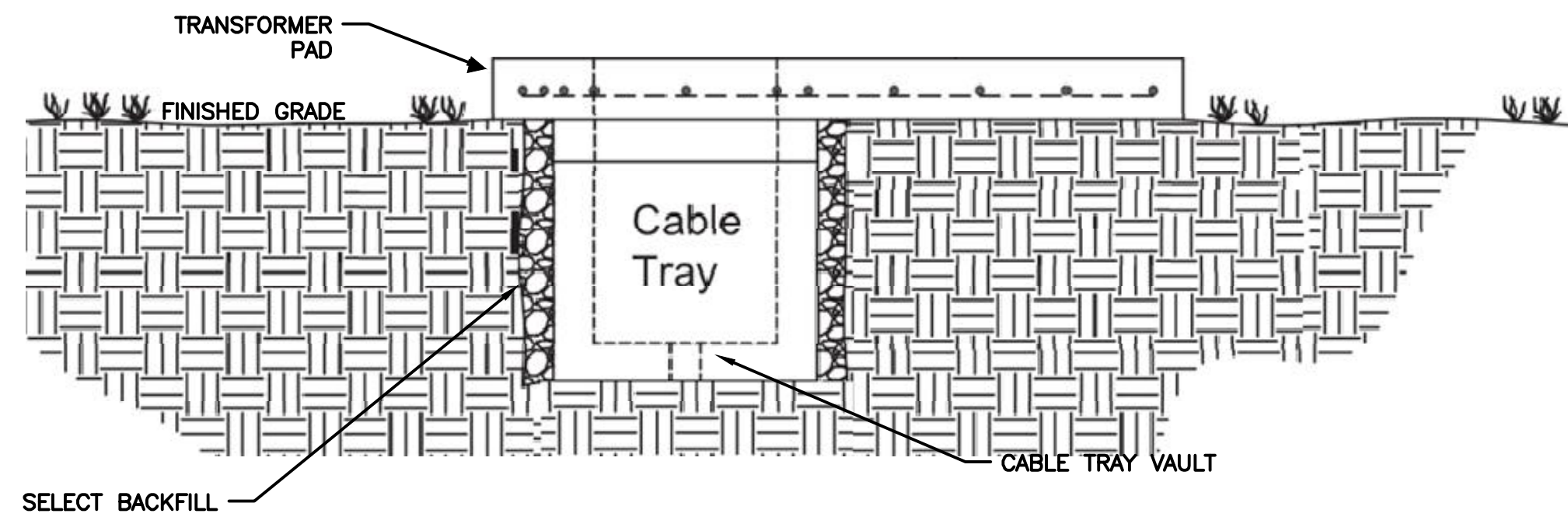
FLUSH CONDUIT TERMINATION IN SLAB

4 DETAIL
NO SCALE



UTILITY SERVICE AND METERING CONFIGURATION DETAIL

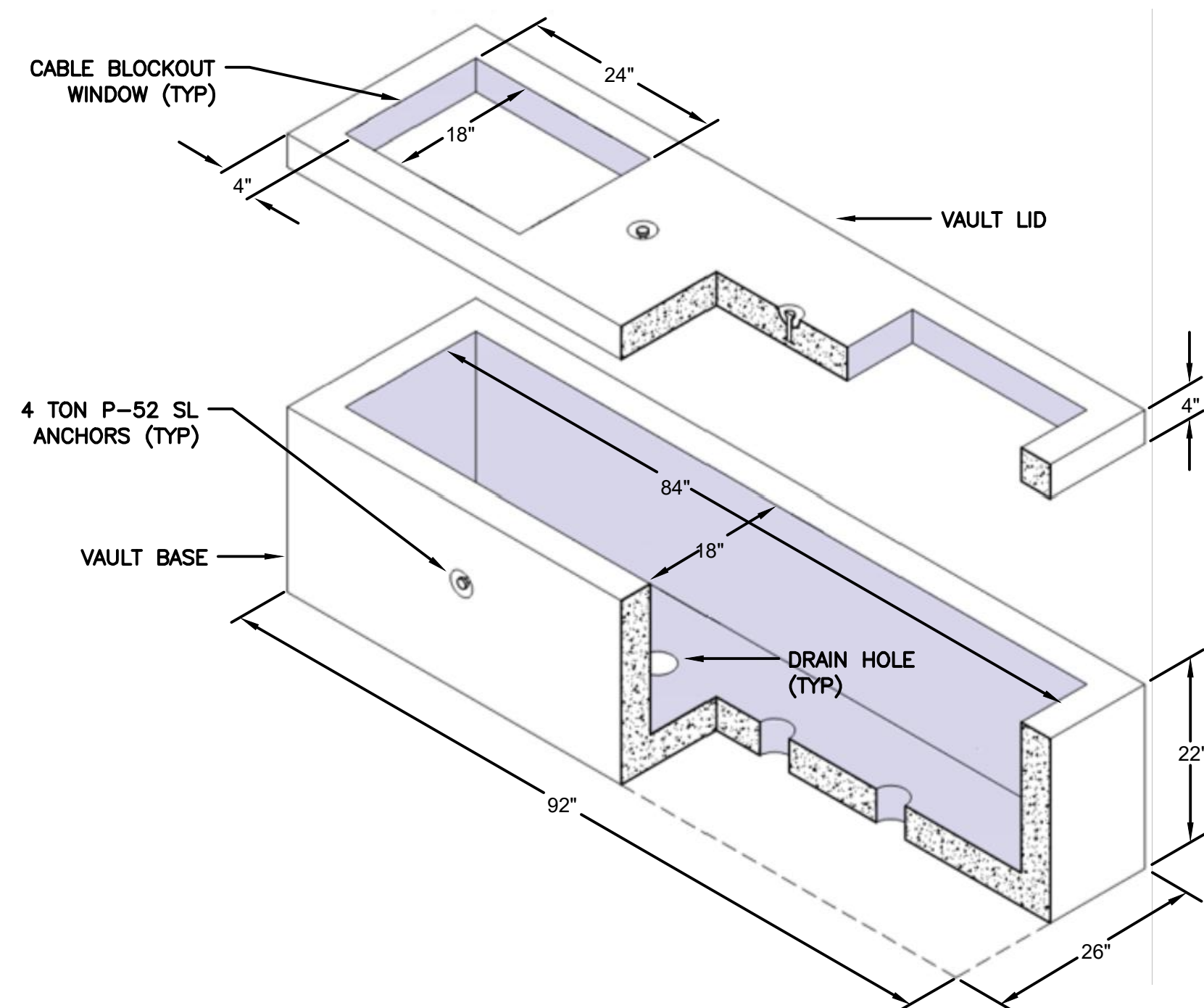
NO SCALE
NOTE:
1. RELATIVE ARRANGEMENT OF THE TRANSFORMER AND SECONDARY SERVICE CABINET VARIES DEPENDING ON THE APPLICATION REQUIREMENTS.



CABLE TRAY VAULT INSTALLATION DETAIL

NO SCALE
NOTE:
1. SOIL COMPACTION AT 95% STANDARD PROCTOR.

SERVICE DROP RESPONSIBILITIES		
WORK DESCRIPTION	PARTY TO FURNISH, OWN, AND MAINTAIN	PARTY TO INSTALL
PERMITS AND INSPECTIONS	CONTRACTOR	N/A
PRIMARY SERVICE TRENCH AND BACKFILL	N/A	CONTRACTOR
PRIMARY SERVICE CONDUCTORS/CONDUIT	UTILITY	UTILITY
TRANSFORMER	UTILITY	UTILITY
TRANSFORMER PAD	UTILITY	UTILITY
PRECAST CONCRETE CABLE TRAY VAULT	CONTRACTOR	CONTRACTOR
SERVICE CONNECTION CABINET (SCC)	CONTRACTOR	CONTRACTOR
SCC PRECAST CONCRETE PAD	CONTRACTOR	CONTRACTOR
SECONDARY CONDUCTORS		
TRANSFORMER TO SCC	UTILITY	UTILITY
SCC TO SERVICE ENTRANCE EQUIPMENT	CONTRACTOR	CONTRACTOR
SCC LINE SIDE TERMINATION LUGS	UTILITY	UTILITY
SECONDARY CONDUIT TO SERVICE ENTRANCE EQUIPMENT	CONTRACTOR	CONTRACTOR
SCC LOAD SIDE CONDUCTORS, LUGS, AND TERMINATION	CONTRACTOR	CONTRACTOR
CURRENT TRANSFORMERS	UTILITY	CONTRACTOR
METER SOCKET (NOTE 1)	UTILITY	CONTRACTOR
METER	UTILITY	UTILITY
METERING CIRCUIT CONDUCTORS	UTILITY	UTILITY
SCC GROUND ROD, GEC TO NEUTRAL BUS, CASE GROUND	CONTRACTOR	CONTRACTOR



CABLE TRAY VAULT DETAIL

NO SCALE

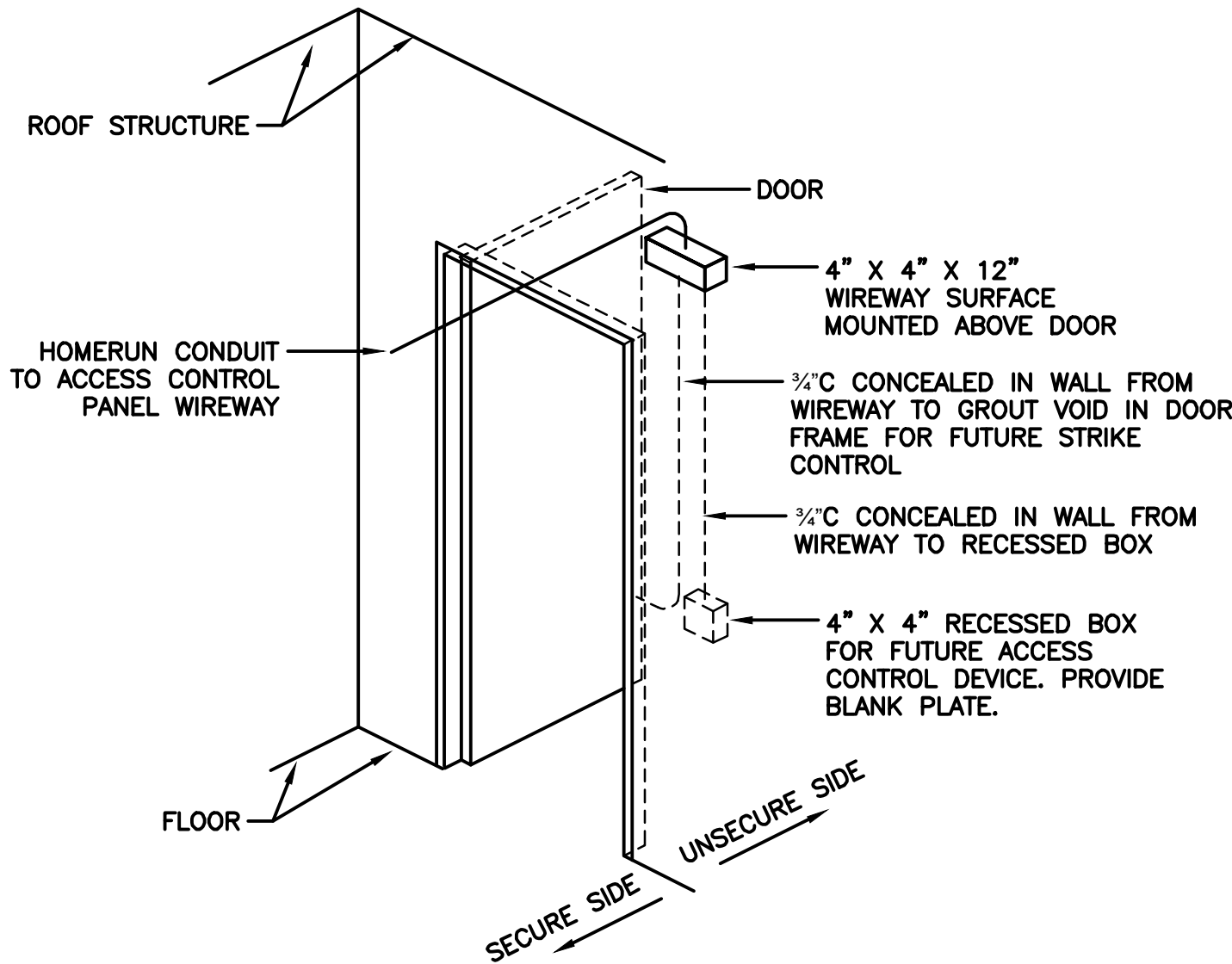
	A	B		C		D		E		F		G		H		I		J		K		L		M		N		O		P																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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Location: Electrical Room Mounting: Surface Fed From: TFR 9020																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Voltage: 208/120 Phase: 3 Wire: 4 Bus Amp: 225 Main OCP: 175A Interrupt Rating (AIC): 10,000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Load Description		P	Wire Size	Cct Bkr	Cnd Size	Cct No Phase			Cnd Size	Cct Bkr	Wire Size	P	Load Description																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - ROOF		1	12	20	3/4	1	A	2					RTU 1120, HVAC ROOF-TOP UNIT BREAK ROOM																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - PRETREAT/FILTER AREA		1	12	20G	3/4	3	B	4	3/4	30	10	2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
RECEPTACLES - PRETREAT/FILTER AREA		1	12	20G	3/4	5	C	6	3/4	20	12	1	RTU 1121 SERVICE REC AND LIGHT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - PRETREAT/FILTER AREA		1	12	20G	3/4	7	A	8	3/4	20	12	1	RTU 1122 SERVICE REC AND LIGHT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - CHEMICAL ROOM		1	12	20G	3/4	9	B	10	3/4	20	12	1	MAU 1101 SERVICE REC AND LIGHT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - CHEMICAL ROOM		1	12	20G	3/4	11	C	12	3/4	20	12	1	LCP 9000 UTILITY (NOTE 2)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - NaOCL CHEM PUMPS		1	12	20G	3/4	13	A	14	20	12	1		LCP 9000 UPS (NOTE 2)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - NaOH CHEM PUMPS		1	12	20G	3/4	15	B	16	3/4	20	12	1	ECP3100 UTILITY (NOTE 2)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
RECEPTACLES - ACH CHEM PUMPS		1	12	20G	3/4	17	C	18		20	12	1	ECP 3100 UPS (NOTE 2)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
MME 8601 CHLORINE DIOXIDE GENERATOR (NOTE 1)		3	10	20	3/4	19	A	20	3/4	20	12	1	ECP3200 UTILITY (NOTE 2)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P			
	LIGHT FIXTURE SCHEDULE																		
	TYPE	LAMPS			DESCRIPTION	VOLTAGE	MOUNTING TYPE AND HEIGHT	DETAIL	MANUFACTURER AND CATALOG NO.	NOTES									
		NO.	LUMENS	TYPE															
9	A	—	18,000	LED	INDUSTRIAL ROUND HIGH BAY PENDANT MOUNT LUMINAIRE, CORROSION RESISTANT DIE—CAST ALUMINUM HOUSING WITH OFF—SET ELECTRICAL ASSEMBLY, THERMOSET POWDER COAT FINISH, GLASS LENS, INTEGRAL 6kv SURGE PROTECTION, WET LOCATION.	277V	CEILING PENDANT 29' AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: JHBL 18000LM ACL WD 277 GZ10 35K 70CRI DWHXD										
8	B	—	2,000	LED	ARCHITECTURAL WALL—MOUNT LUMINAIRE, SINGLE PIECE DIE—CAST ALUMINUM HOUSING WITH POWDER COAT FINISH, NIGHTTIME FRIENDLY ZERO UPLIGHT, INTEGRAL 6kv SURGE PROTECTION, DAMP LOCATION.	277V	WALL SURFACE 10'6" AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: WDGE1 LED P2 35K 80CRI VF MVOLT SRM PE DDBXD										
	C	—	5,000	LED	48" INDUSTRIAL VAPOR TIGHT STRIP LIGHT, GASKETED POLYCARBONATE HOUSING AND CAPTIVE LATCHES, INTEGRAL 2.5kv SURGE PROTECTION, WET LOCATION.	277V	CEILING PENDANT 12' AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: CSV T L48 5000LM MVOLT 40K 80CRI										
7	D	—	12,000	LED	INDUSTRIAL ROUND HIGH BAY PENDANT MOUNT LUMINAIRE, CORROSION RESISTANT DIE—CAST ALUMINUM HOUSING WITH OFF—SET ELECTRICAL ASSEMBLY, THERMOSET POWDER COAT FINISH, GLASS LENS, INTEGRAL 6kv SURGE PROTECTION, WET LOCATION.	277V	CEILING PENDANT 20' AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: JHBL 12000LM ACL ND 277 GZ10 35K 70CRI DWHXD										
6	E	—	—	LED	SINGLE FACE EXIT SIGN WITH IMPACT—RESISTANT THERMOPLASTIC HOUSING, 6' HIGH LETTERS WITH 3/4" STROKE, WET LOCATION.	277V	WALL SURFACE HEIGHT AS INDICATED ON DRAWINGS	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: WLTE W1R										
5	F	—	640	LED	DUAL HEAD EMERGENCY FIXTURE WITH THERMOPLASTIC HOUSING, INTEGRAL BATTERY AND BATTERY CHARGER. SWIVEL LAMP HEADS, INTEGRAL TEST SWITCH AND STATUS INDICATOR, REMOTE TEST CAPABILITY.	277V	WALL SURFACE 96' AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: INDL SP640L UVOLT LTP SDRT	PROVIDE ONE REMOTE TEST KIT, CATALOG NO. RTKIT.									
	G1	—	3,300	LED	2'X2' RECESSED LAY—IN LOW PROFILE TROFFER TYPE LUMINAIRE WITH SQUARE ACRYLIC DIFFUSER.	277V	CEILING RECESSED	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: 2BLT2 33L SDSM EZ1 LP835										
4	G2	—	3,300	LED	2'X2' RECESSED LAY—IN LOW PROFILE TROFFER TYPE LUMINAIRE WITH SQUARE ACRYLIC DIFFUSER.	120V	CEILING RECESSED	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: 2BLT2 33L SDSM GZ10 LP835										
3	H	—	4,000	LED	48" LINEAR STRIP LUMINAIRE, COLD—ROLLED STEEL CHANNEL AND COVER WITH PLASTIC END CAPS, ROUND ACRYLIC LENS, INTEGRAL 2.5kv SURGE PROTECTION	277V	CEILING PENDANT 10' AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: CLX L48 4000LM SEF RDL MVOLT GZ10 35K 80CRI WH										
	J	—	—	LED	SINGLE FACE EXIT SIGN WITH IMPACT—RESISTANT THERMOPLASTIC HOUSING, 6' HIGH LETTERS WITH 3/4" STROKE,	277V	WALL SURFACE HEIGHT AS INDICATED ON DRAWINGS	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: EXRG M6										
2	K	—	220	LED	DUAL HEAD EMERGENCY FIXTURE WITH THERMOPLASTIC HOUSING, INTEGRAL BATTERY AND BATTERY CHARGER. SWIVEL LAMP HEADS, INTEGRAL TEST SWITCH AND STATUS INDICATOR.	277V	WALL SURFACE 96' AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: ELM2L M12										
1	L	—	220	LED	DUAL HEAD EMERGENCY FIXTURE WITH THERMOPLASTIC HOUSING, INTEGRAL BATTERY AND BATTERY CHARGER. FIXED LAMP HEADS, INTEGRAL TEST SWITCH AND STATUS INDICATOR.	277V	WALL SURFACE 96' AFF	—	LITHONIA or APPROVED EQUIVALENT CATALOG NO: ELM2LF M12										
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P			
	<div><div><div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div>Dewberry®</div><div>Dewberry Engineers Inc.</div><div>990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825—1802</div></div></div></div></div>		LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"—SCALE ACCORDINGLY)		<div>APPROVED:</div> <div>PRINCIPAL</div> <div>DATE:</div>		REVISIONS					TOWN OF SILT SILT, COLORADO			ELECTRICAL			DATE: 08/09/23 PROJECT NUMBER: 50159690 REVISION NO. C DRAWING NUMBER E—21	
REV.			DESCRIPTION	BY			DATE	APP.											
A			90% DESIGN ADDENDUM	AMJ			08/16/23	RAM											
B			CDPHE REVIEW SUBMITTAL	AMJ			09/29/23	RAM											
C			BUILDING DEPT REVIEW SUBMITTAL	AMJ			10/13/23	RAM											
	WATER TREATMENT PLANT IMPROVEMENTS										LIGHT FIXTURE SCHEDULE								

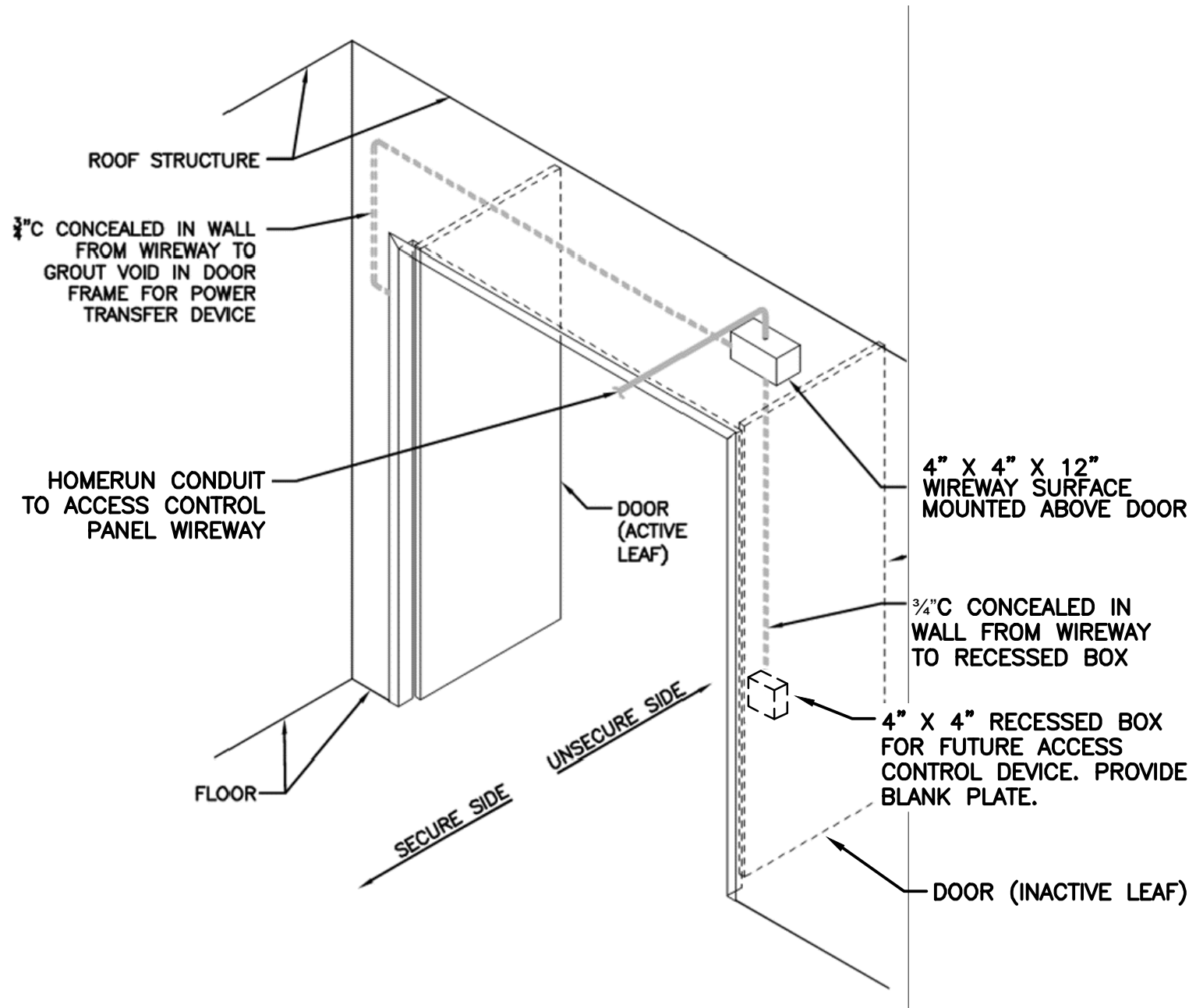
WATER TREATMENT PLANT
FIRE ALARM AND DETECTION SYSTEM RISER DIAGRAM

GENERAL NOTES:

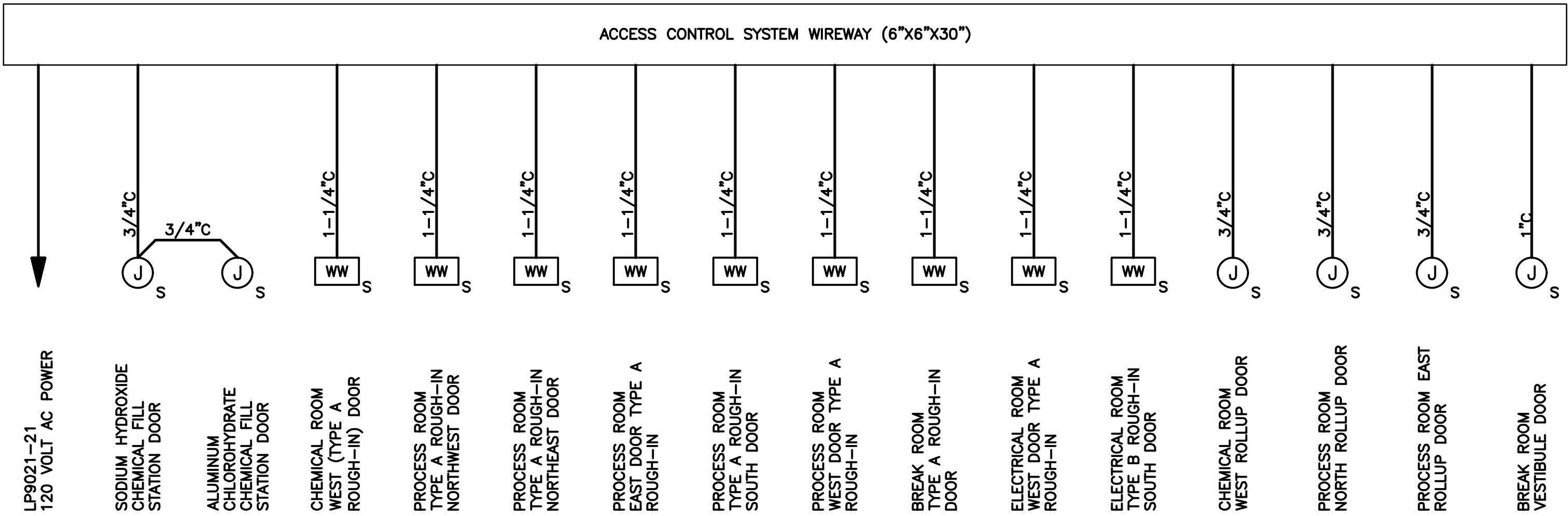
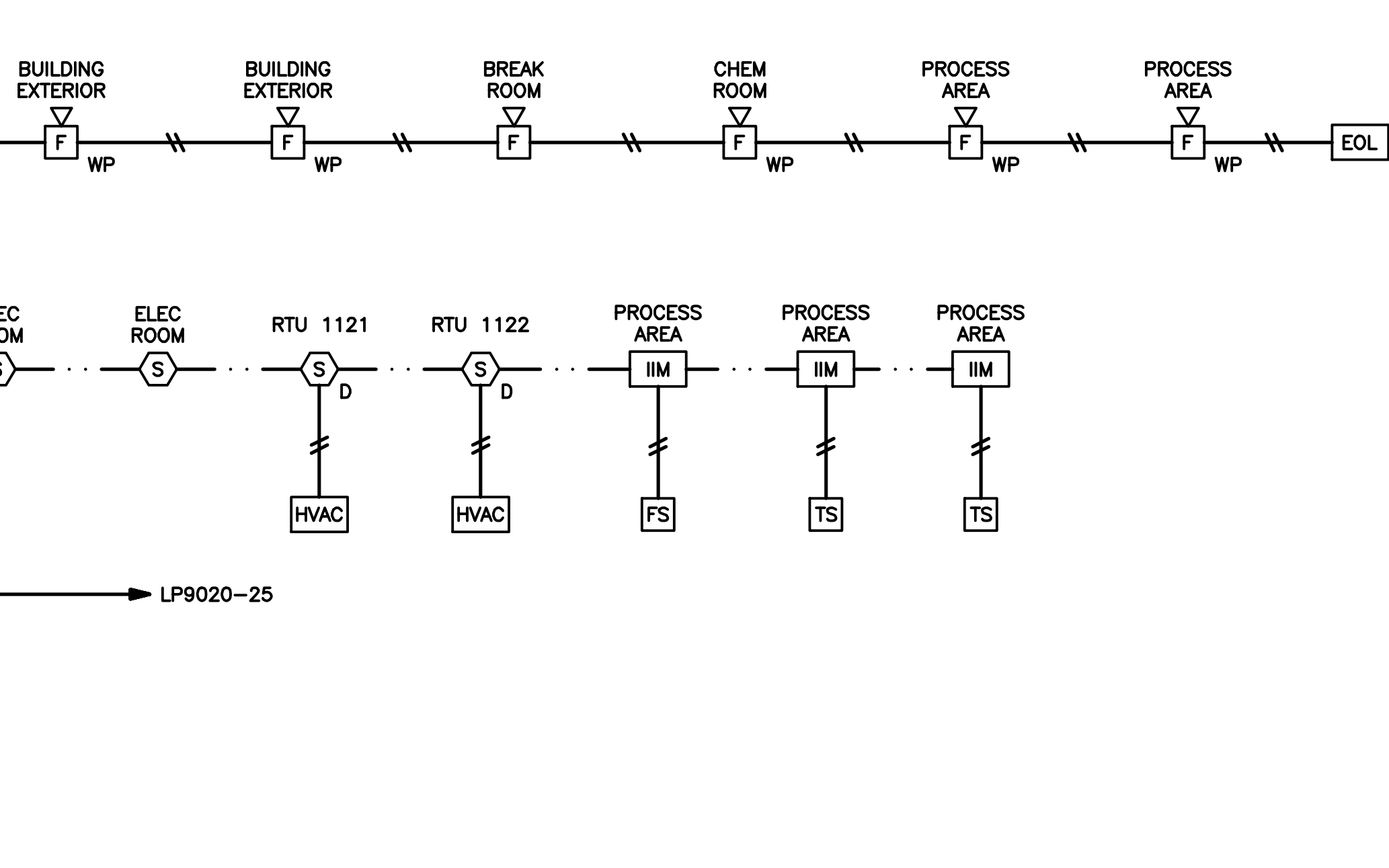
1. FIRE ALARM AND DETECTION SYSTEM RISER DIAGRAM REPRESENTS A CONCEPTUAL DESIGN BASED ON APPLICABLE NATIONAL, STATE, AND LOCAL CODE REQUIREMENTS. FINAL DESIGN OF A FULLY FUNCTIONAL FIRE ALARM AND DETENTION SYSTEM IN ACCORDANCE WITH THE REQUIREMENTS OF THE AUTHORITY HAVING JURISDICTION SHALL BE CONDUCTED BY THE FIRE ALARM AND DETENTION SYSTEM SUPPLIER. FINAL INSTALLED SYSTEM CONFIGURATION INCLUDING DEVICE COUNT AND CONDUIT AND CABLING REQUIREMENTS SHALL BE IN ACCORDANCE WITH THE FINAL DESIGN.
2. UNLESS OTHERWISE NOTED, CONDUITS FOR FIRE ALARM SYSTEMS SHALL BE SIZED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. MINIMUM CONDUIT SIZE SHALL BE 3/4".



ACCESS CONTROL CONDUIT ROUGH-IN - TYPE A
NO SCALE



ACCESS CONTROL CONDUIT ROUGH-IN - TYPE B
NO SCALE

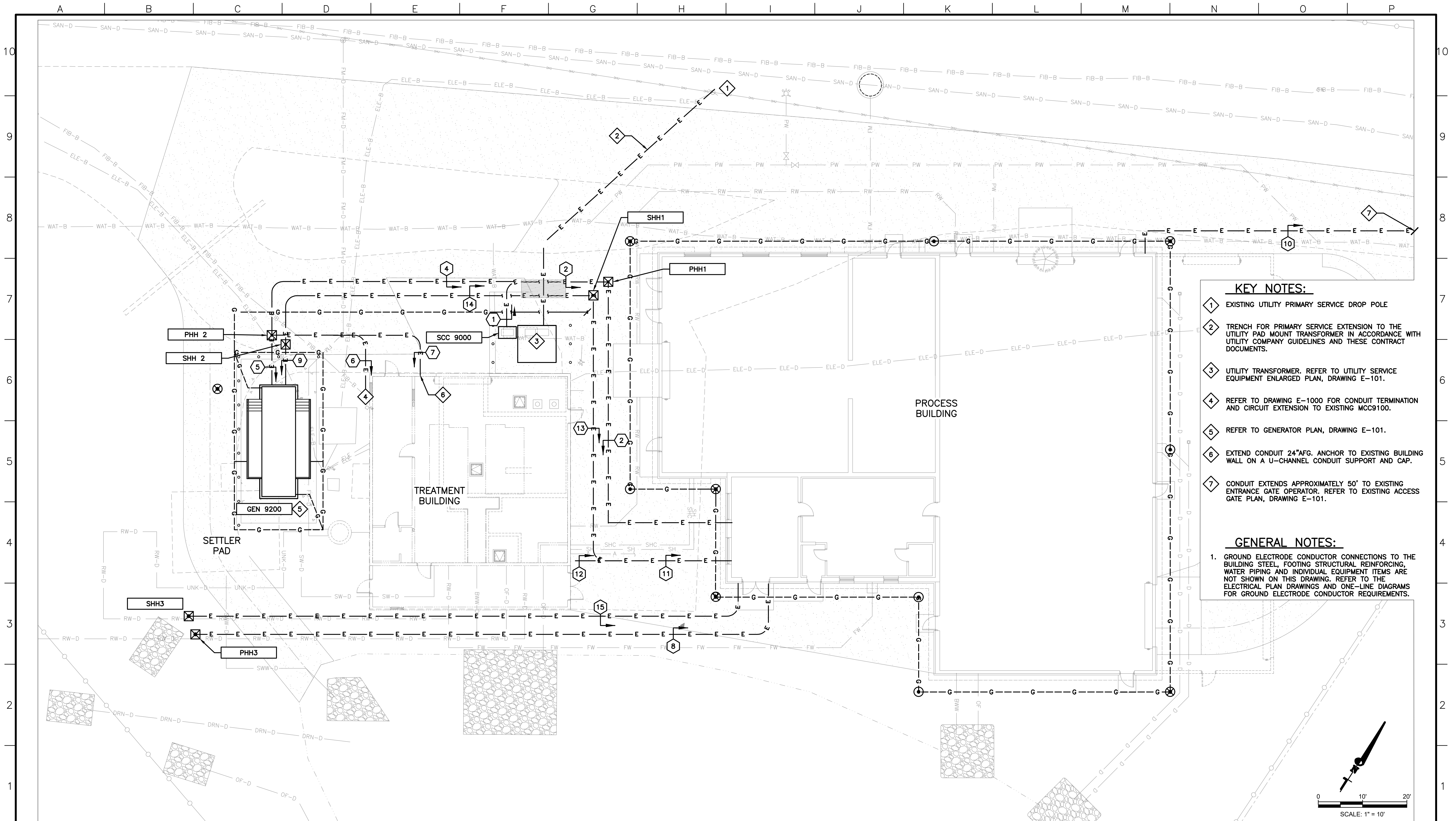


WATER TREATMENT PLANT - ACCESS CONTROL SYSTEM RISER DIAGRAM
NO SCALE

NOTES:

1. REFER TO ROUGH-IN DIAGRAMS, THIS SHEET, FOR CONDUIT ROUGH-IN REQUIREMENTS AT EACH PERSONNEL DOOR.
2. SECURITY JUNCTION BOXES AT THE ROLLUP DOORS SHALL BE MOUNTED 6" AFF AT THE LOCATION SHOWN ON THE PLAN DRAWINGS.
3. SECURITY JUNCTION BOXES AT THE CHEMICAL FILL STATION ACCESS DOORS SHALL BE MOUNTED 6" ABOVE THE TOP OF THE DOOR ON THE STRIKE SIDE OF THE DOOR.
4. PROVIDE 4' CONDUCTOR PIGTAIL ON THE 120 VOLT AC BRANCH CIRCUIT IN THE ACCESS CONTROL SYSTEM WIREWAY.
5. MOUNT THE ACCESS CONTROL SYSTEM 78" AFF AT THE LOCATION SHOWN ON THE PLAN DRAWINGS.
6. SECURITY SYSTEM JUNCTION BOXES SHALL BE SINGLE GANG WITH THREADED INLETS TOP, BOTTOM AND BOTH SIDES AND A BLANK GASKETED PLATE. PROVIDE THREADED PLUGS FOR ALL UNUSED OPENINGS.

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM



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LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)
DRAWING EDG59690-100
DRAWN AMJ
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

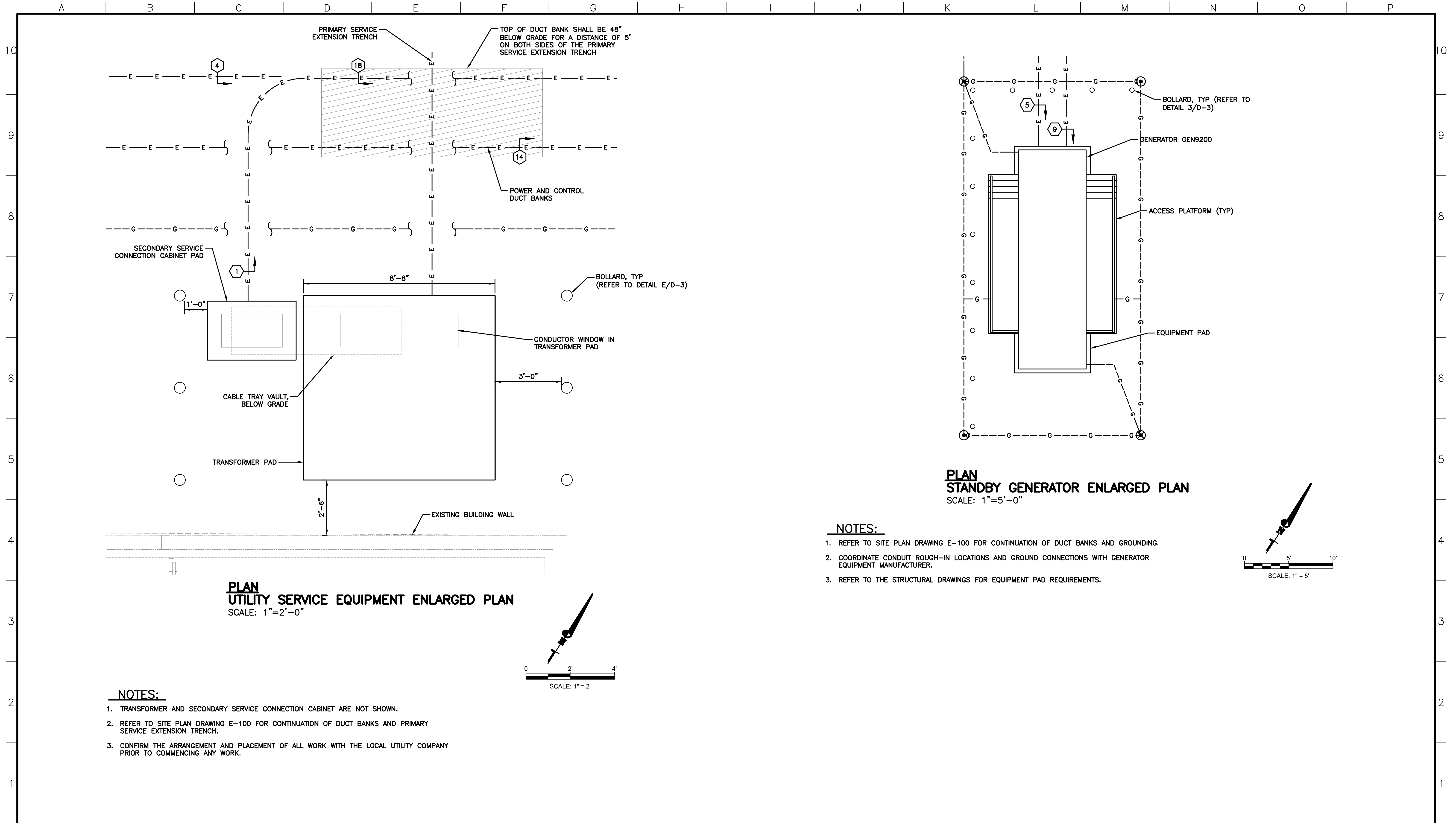
TOWN OF SILT
SILT, COLORADO

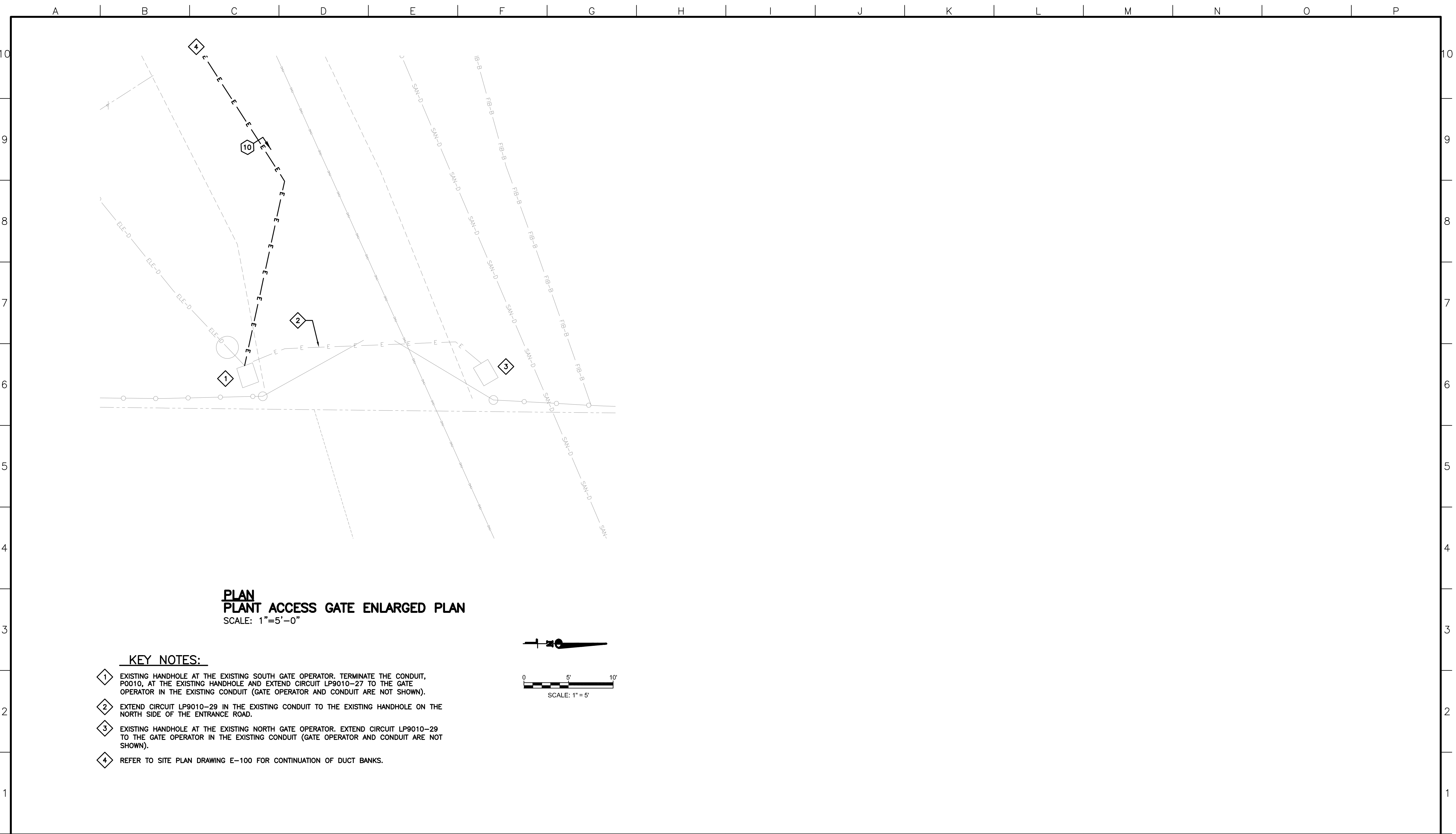
WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

SITE PLAN

DATE: 07/24/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
E-100
SHEET NUMBER

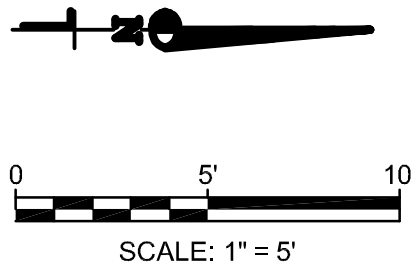




PLAN
PLANT ACCESS GATE ENLARGED PLAN
SCALE: 1"=5'-0"

KEY NOTES:

- 1 EXISTING HANDHOLE AT THE EXISTING SOUTH GATE OPERATOR. TERMINATE THE CONDUIT, P0010, AT THE EXISTING HANDHOLE AND EXTEND CIRCUIT LP9010-27 TO THE GATE OPERATOR IN THE EXISTING CONDUIT (GATE OPERATOR AND CONDUIT ARE NOT SHOWN).
- 2 EXTEND CIRCUIT LP9010-29 IN THE EXISTING CONDUIT TO THE EXISTING HANDHOLE ON THE NORTH SIDE OF THE ENTRANCE ROAD.
- 3 EXISTING HANDHOLE AT THE EXISTING NORTH GATE OPERATOR. EXTEND CIRCUIT LP9010-29 TO THE GATE OPERATOR IN THE EXISTING CONDUIT (GATE OPERATOR AND CONDUIT ARE NOT SHOWN).
- 4 REFER TO SITE PLAN DRAWING E-100 FOR CONTINUATION OF DUCT BANKS.



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LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY)	
DRAWING	EDG59690-102
DRAWN	AMJ
DESIGNED	RAM
CHECKED	RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

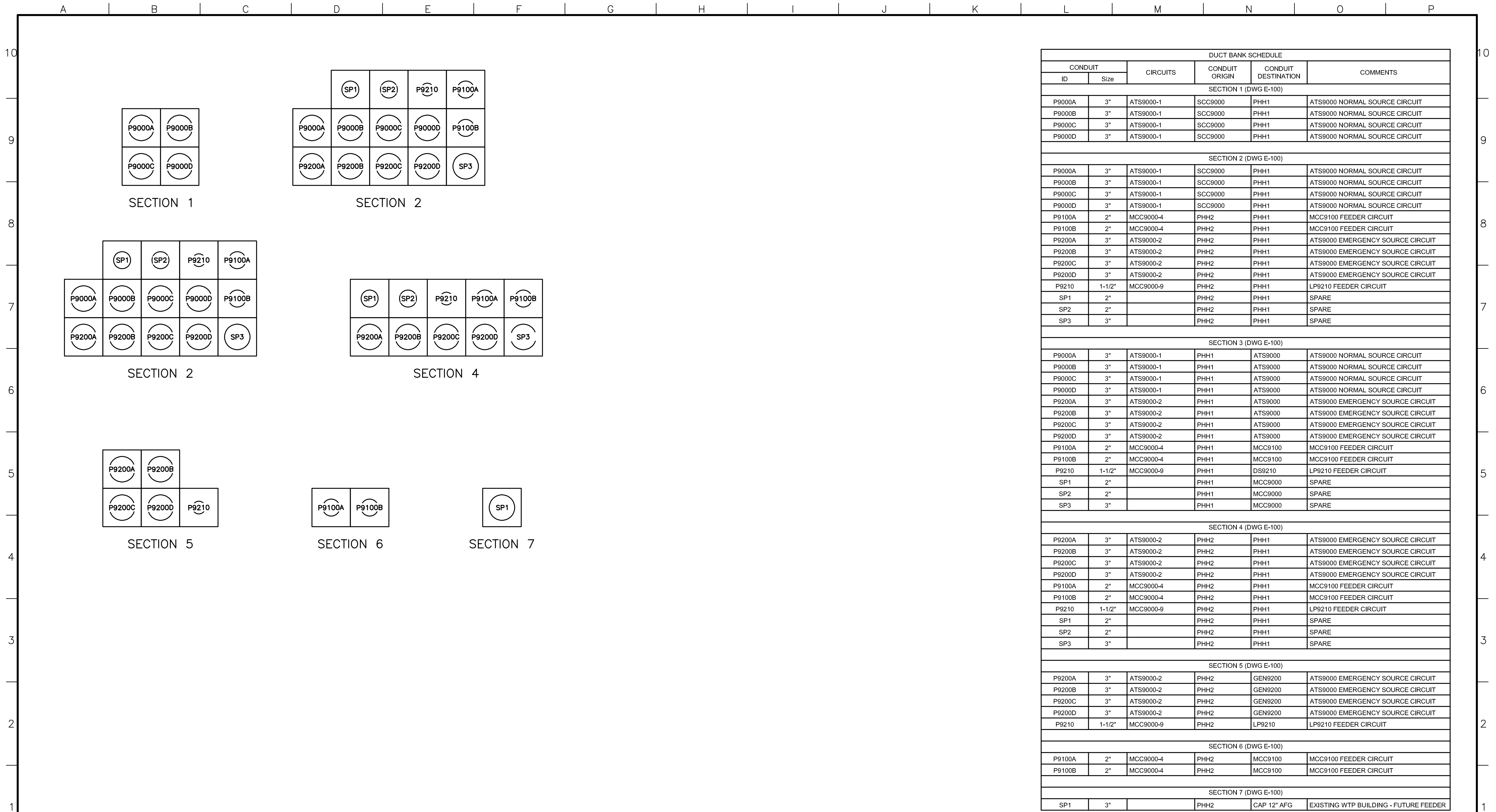
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

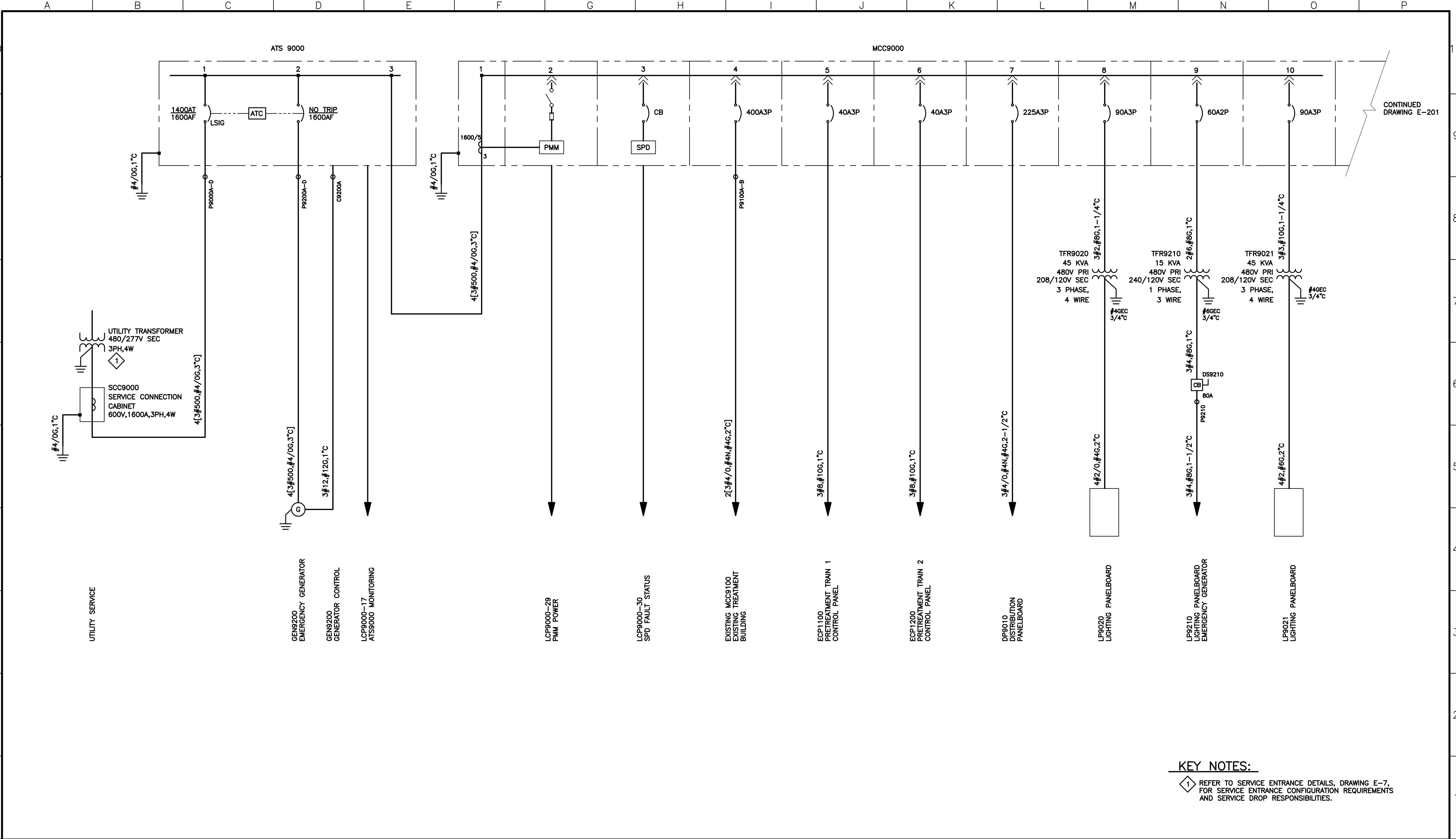
ELECTRICAL


ENLARGED SITE PLANS 2

DATE:	09/29/23
PROJECT NUMBER:	50159690
REVISION NO.	D
DRAWING NUMBER	E-102
SHEET NUMBER	









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LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2"=SCALE ACCORDINGLY)

DRAWING EDT59690-200
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

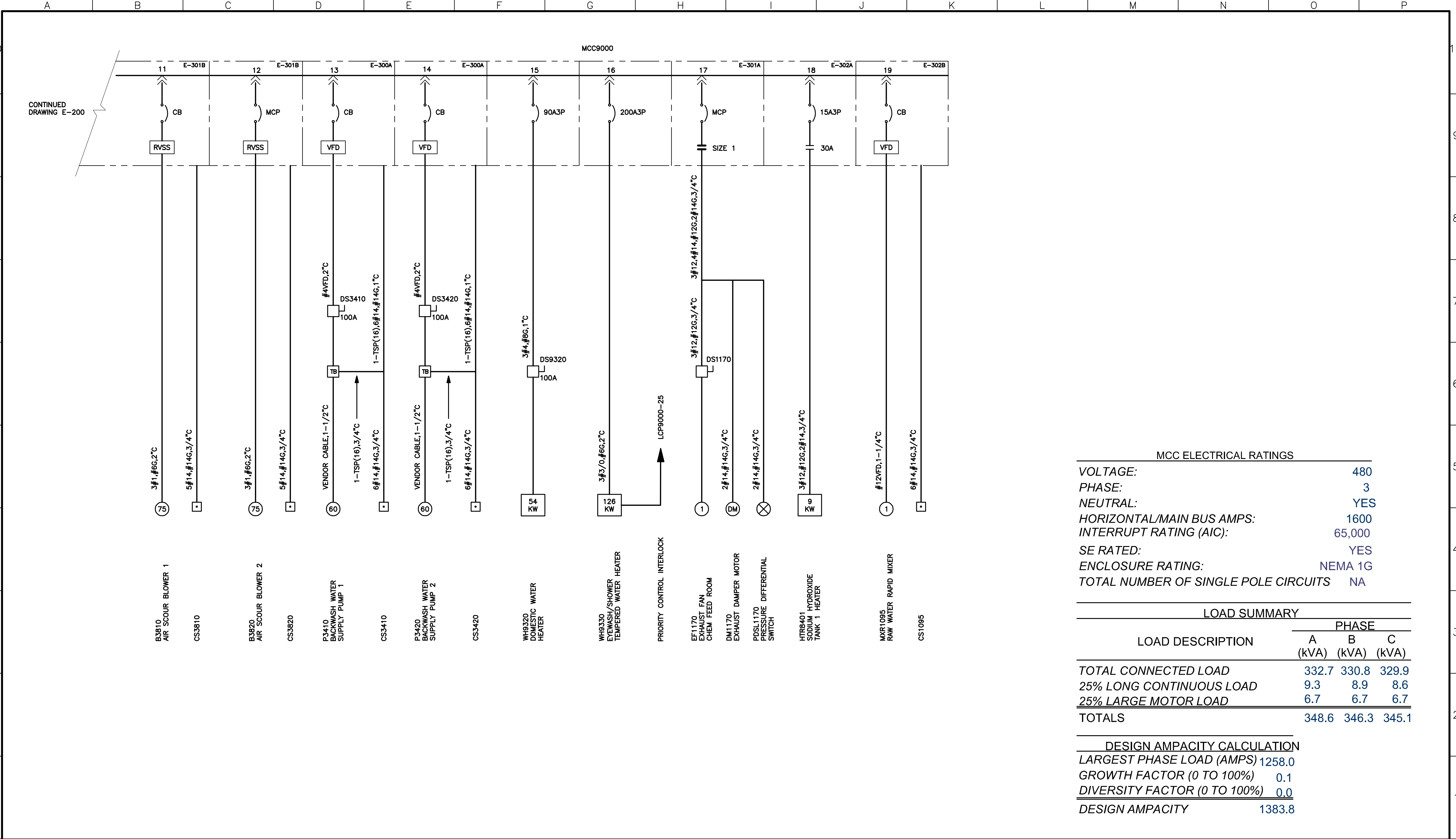
MOTOR CONTROL CENTER
MCC9000 ONE-LINE DIAGRAM 1

DATE: 05/15/23

PROJECT NUMBER: 50159690

REVISION NO. E


DRAWING NUMBER E-200



MCC ELECTRICAL RATINGS			
VOLTAGE:	480		
PHASE:	3		
NEUTRAL:	YES		
HORIZONTAL/MAIN BUS AMPS:	1600		
INTERRUPT RATING (AIC):	65,000		
SE RATED:	YES		
ENCLOSURE RATING:	NEMA 1G		
TOTAL NUMBER OF SINGLE POLE CIRCUITS	NA		

LOAD DESCRIPTION	PHASE		
	A (kVA)	B (kVA)	C (kVA)
TOTAL CONNECTED LOAD	332.7	330.8	329.9
25% LONG CONTINUOUS LOAD	9.3	8.9	8.6
25% LARGE MOTOR LOAD	6.7	6.7	6.7
TOTALS	348.6	346.3	345.1

DESIGN AMPACITY CALCULATION			
LARGEST PHASE LOAD (AMPS)	1258.0		
GROWTH FACTOR (0 TO 100%)	0.1		
DIVERSITY FACTOR (0 TO 100%)	0.0		
DESIGN AMPACITY	1383.8		



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LINE IS 2 INCHES
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DRAWING EDT59690-201

DRAWN AMJ

DESIGNED RAM

CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REV.

DESCRIPTION

BY

DATE

APP.

A60% DESIGN REVIEW SUBMITTALAMJ05/25/23RAM

B90% DESIGN REVIEW SUBMITTALAMJ07/31/23RAM

C90% DESIGN ADDENDUMAMJ08/16/23RAM

D CDPHE REVIEW SUBMITTALAMJ09/29/23RAM

E BUILDING DEPT REVIEW SUBMITTALAMJ10/13/23RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

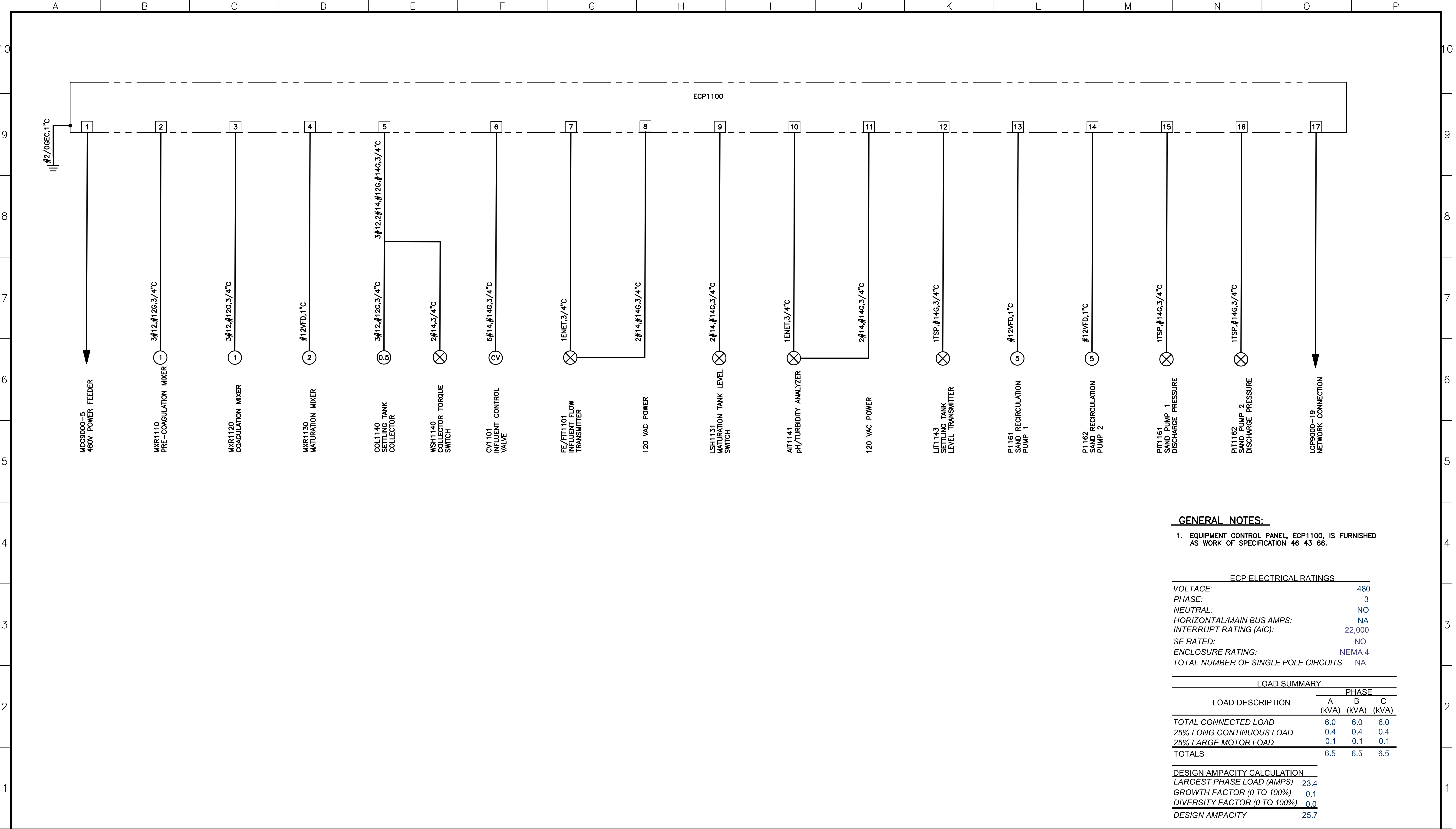
MOTOR CONTROL CENTER
MCC9000 ONE-LINE DIAGRAM 2

DATE: 05/15/23

PROJECT NUMBER: 50159690

REVISION NO. E


DRAWING NUMBER E-201



GENERAL NOTES:

1. EQUIPMENT CONTROL PANEL, ECP1100, IS FURNISHED AS WORK OF SPECIFICATION 46 43 66.

ECP ELECTRICAL RATINGS			
VOLTAGE:	480		
PHASE:	3		
NEUTRAL:	NO		
HORIZONTAL/MAIN BUS AMPS:	NA		
INTERRUPT RATING (AIC):	22,000		
SE RATED:	NO		
ENCLOSURE RATING:	NEMA 4		
TOTAL NUMBER OF SINGLE POLE CIRCUITS	NA		
LOAD SUMMARY			
LOAD DESCRIPTION	PHASE		
	A (kVA)	B (kVA)	C (kVA)
TOTAL CONNECTED LOAD	6.0	6.0	6.0
25% LONG CONTINUOUS LOAD	0.4	0.4	0.4
25% LARGE MOTOR LOAD	0.1	0.1	0.1
TOTALS	6.5	6.5	6.5
DESIGN AMPACITY CALCULATION			
LARGEST PHASE LOAD (AMPS)	23.4		
GROWTH FACTOR (0 TO 100%)	0.1		
DIVERSITY FACTOR (0 TO 100%)	0.0		
DESIGN AMPACITY	25.7		



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LINE IS 2 INCHES
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DRAWING EDT59690-202

DRAWN AMJ

DESIGNED RAM

CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

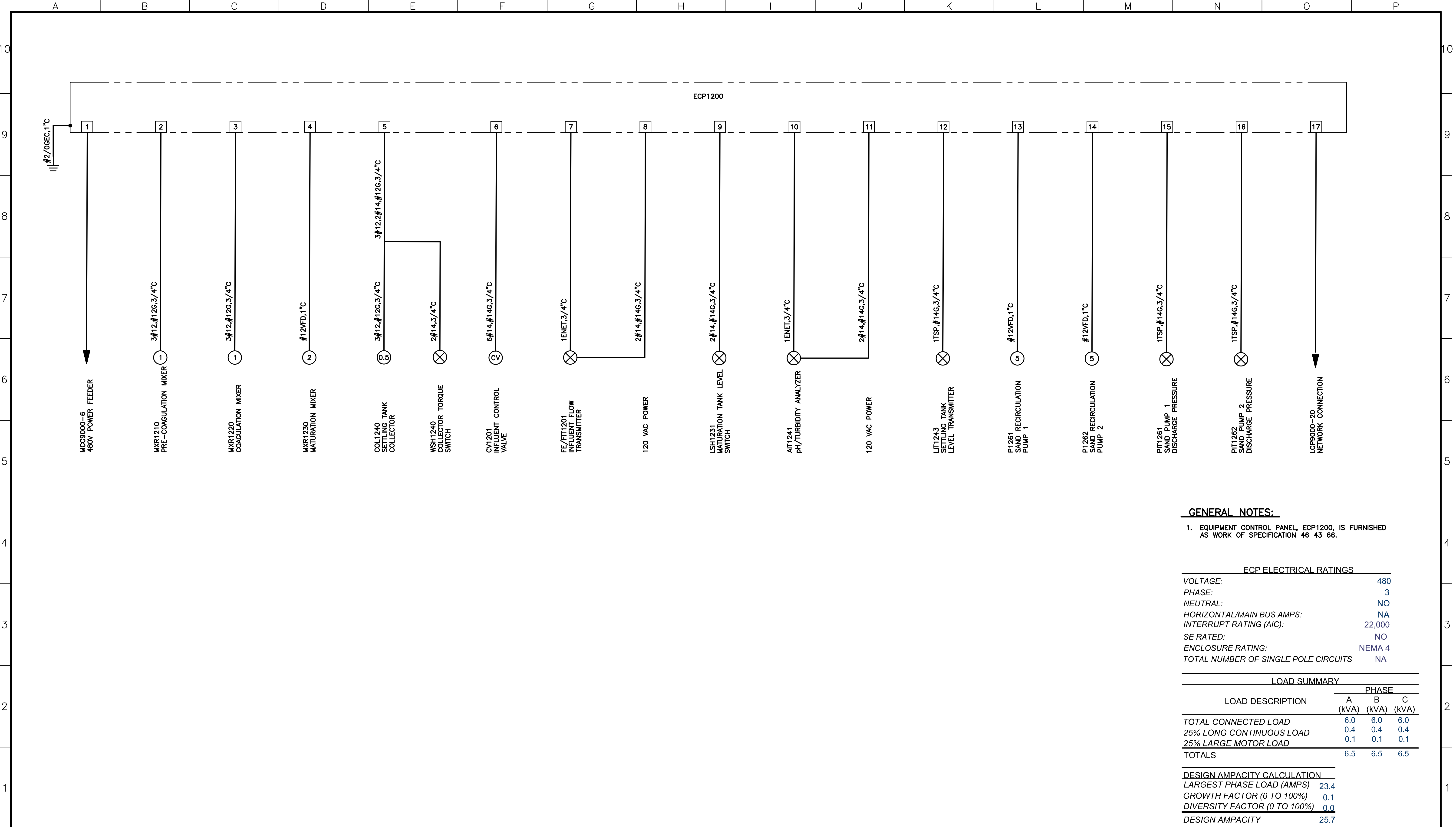
PRETREATMENT TRAIN 1
ECP1100 ONE-LINE DIAGRAM


DATE: 05/15/23

PROJECT NUMBER: 50159690

REVISION NO. E

DRAWING NUMBER E-202





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LINE IS 2 INCHES
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DRAWING EDT59690-203
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	ANJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

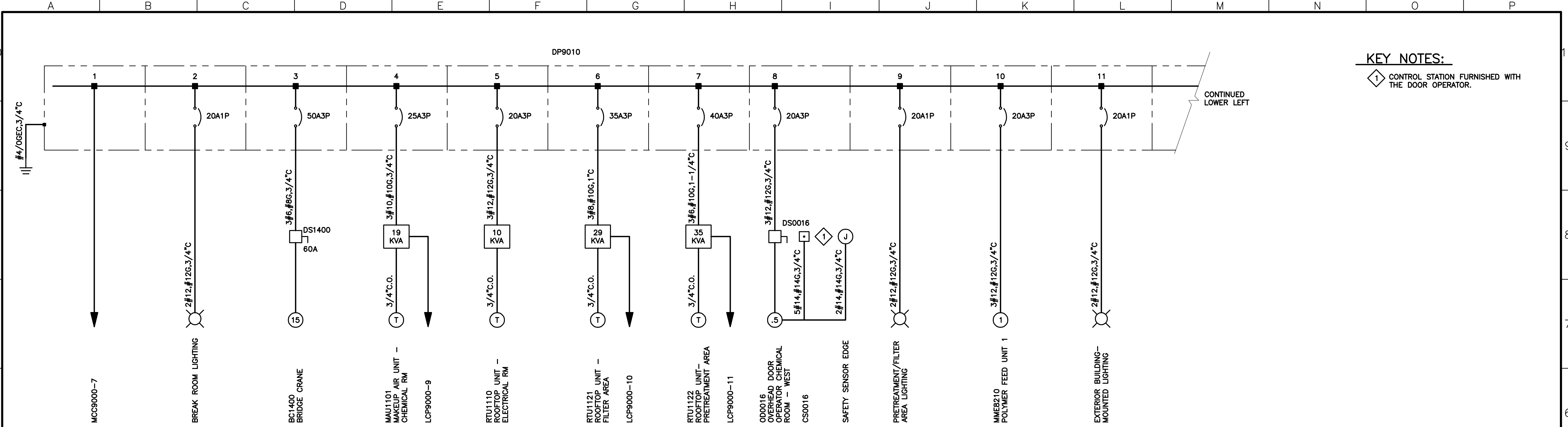
PRETREATMENT TRAIN 2
ECP1200 ONE-LINE DIAGRAM

DATE: 05/23/23

PROJECT NUMBER: 50159690

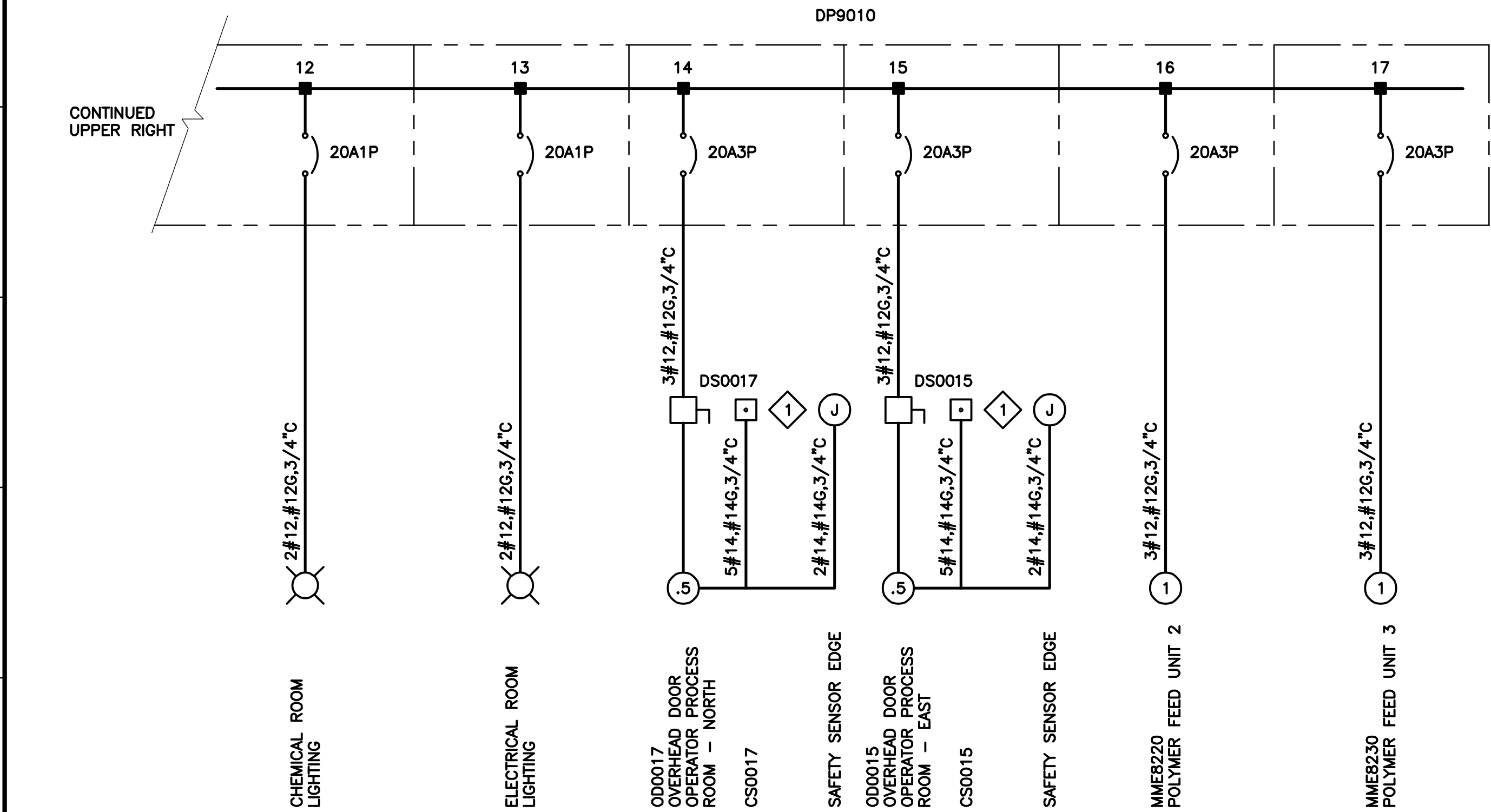
REVISION NO. E

DRAWING NUMBER E-203



KEY NOTES:


1 CONTROL STATION FURNISHED WITH THE DOOR OPERATOR.



PANELBOARD ELECTRICAL RATINGS		
VOLTAGE:	480	
PHASE:	3	
NEUTRAL:	YES	
HORIZONTAL/MAIN BUS AMPS:	225	
INTERRUPT RATING (AIC):	65,000	
SE RATED:	NO	
ENCLOSURE RATING:	NEMA 1G	
TOTAL NUMBER OF SINGLE POLE CIRCUITS	54	

LOAD SUMMARY			
LOAD DESCRIPTION	PHASE		
	A (kVA)	B (kVA)	C (kVA)
TOTAL CONNECTED LOAD	47.5	45.7	45.8
25% LONG CONTINUOUS LOAD	2.2	1.8	1.8
25% LARGE MOTOR LOAD	1.5	1.5	1.5
TOTALS	51.2	48.9	49.1

DESIGN AMPACITY CALCULATION	
LARGEST PHASE LOAD (AMPS)	184.6
GROWTH FACTOR (0 TO 100%)	0.1
DIVERSITY FACTOR (0 TO 100%)	0.0
DESIGN AMPACITY	203.1

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LINE IS 2 INCHES
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DRAWING EDT59690-204
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REV.

DESCRIPTION

BY

DATE

APP.

A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	ANJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

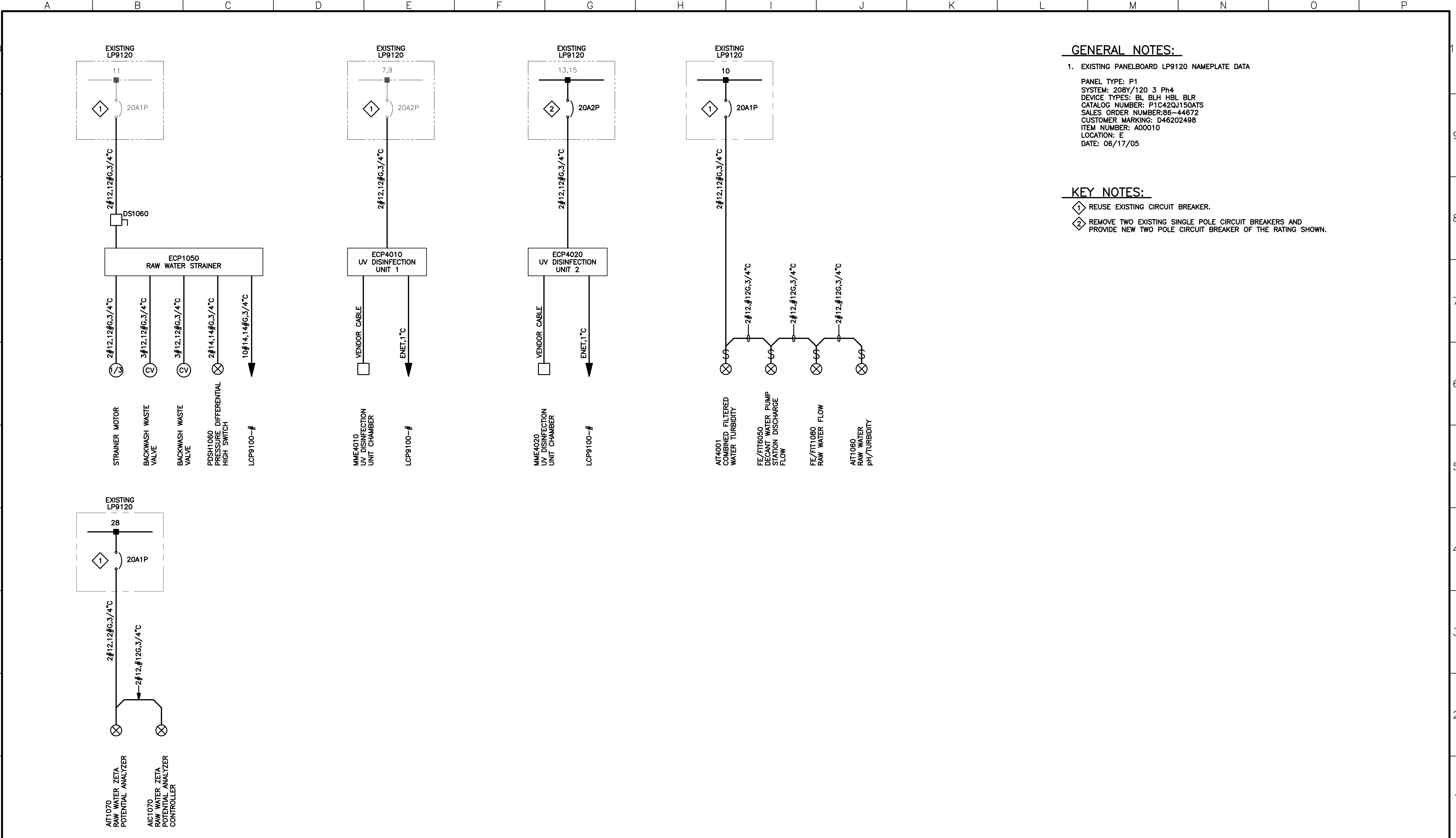
DISTRIBUTION PANELBOARD
DP9010 ONE-LINE DIAGRAM

DATE: 05/23/23

PROJECT NUMBER: 50159690

REVISION NO. E

DRAWING NUMBER E-204




GENERAL NOTES:

1. EXISTING PANELBOARD LP9120 NAMEPLATE DATA

PANEL TYPE: P1
SYSTEM: 208Y/120 3 Ph4
DEVICE TYPES: BL BLH HBL BLR
CATALOG NUMBER: P1C42QJ150ATS
SALES ORDER NUMBER:86-44672
CUSTOMER MARKING: D46202498
ITEM NUMBER: A00010
LOCATION: E
DATE: 06/17/05

KEY NOTES:

- 1 REUSE EXISTING CIRCUIT BREAKER.
- 2 REMOVE TWO EXISTING SINGLE POLE CIRCUIT BREAKERS AND PROVIDE NEW TWO POLE CIRCUIT BREAKER OF THE RATING SHOWN.



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DRAWING **EDT59690-205**

DRAWN **AMJ**

DESIGNED **SEF**

CHECKED **SEF**

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

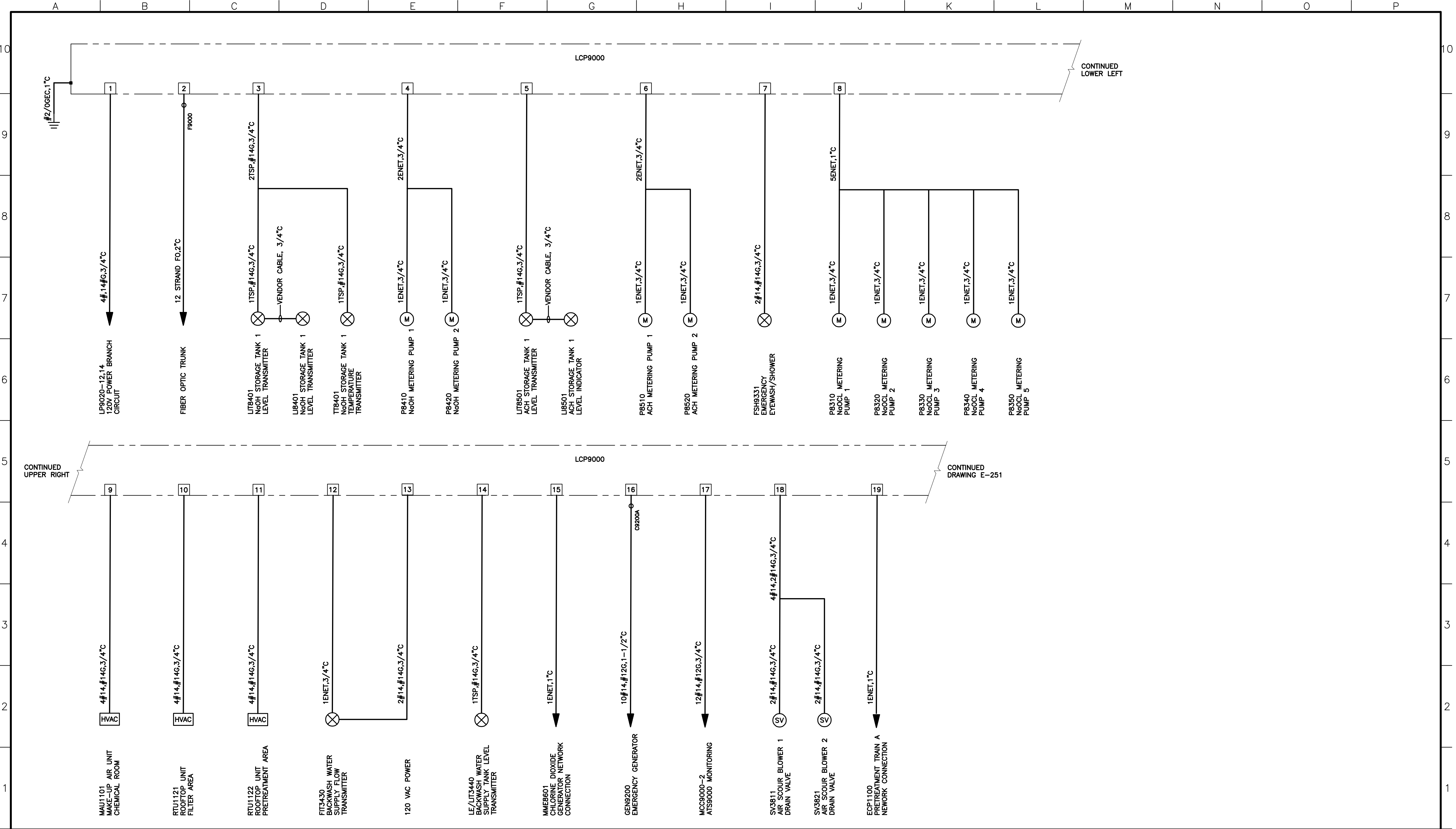
EXISTING LIGHTING PANLEBOARD LP9120
ONE-LINE DIAGRAMS AND MODIFICATIONS


DATE: **07/24/23**

PROJECT NUMBER: **50159690**

REVISION NO. **D**

DRAWING NUMBER **E-205**





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LINE IS 2 INCHES
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DRAWING EDT59690-250
DRAWN AMJ
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

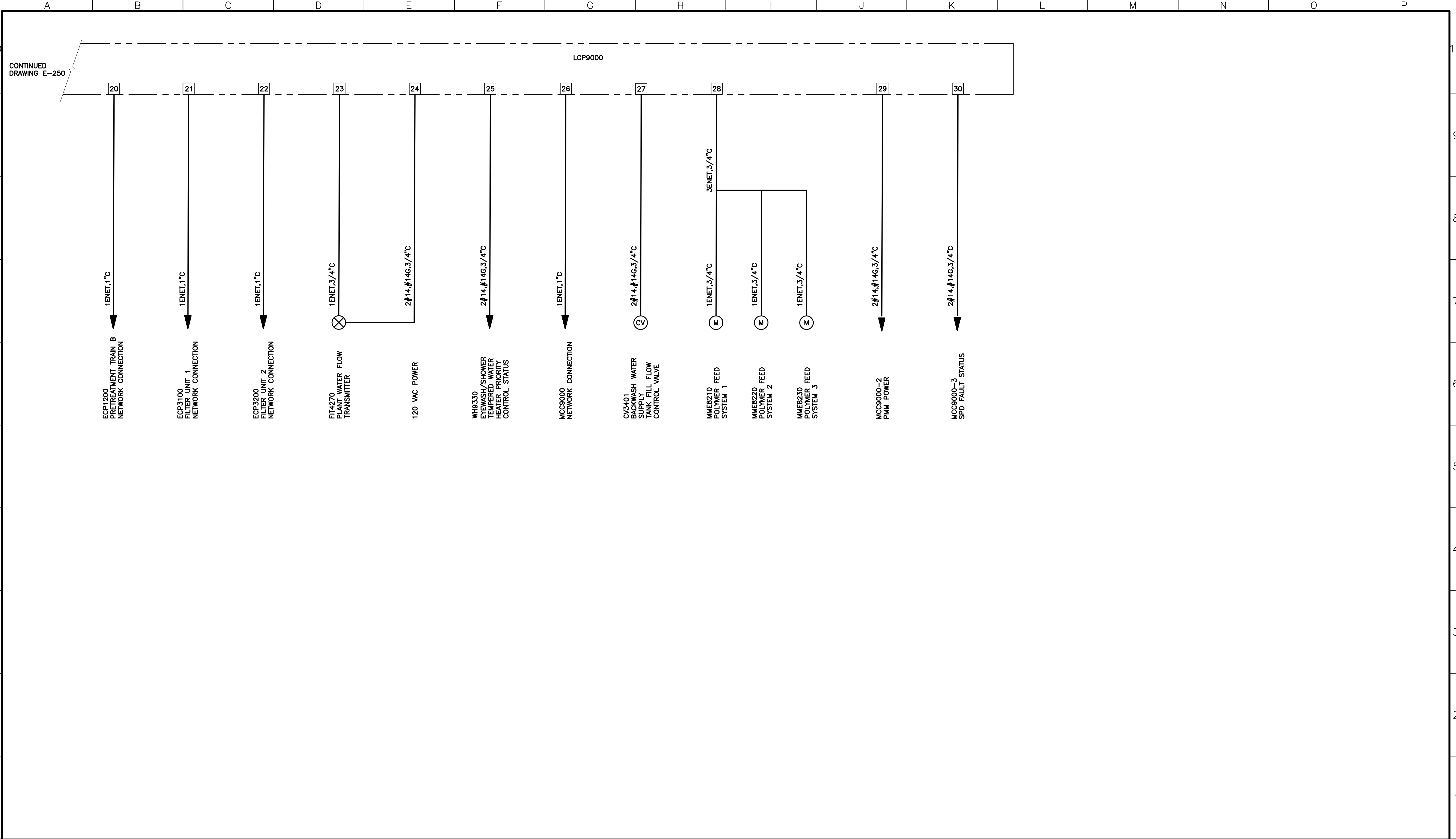
LCP9000 ONE-LINE DIAGRAM


DATE: 07/24/23

PROJECT NUMBER: 50159690

REVISION NO. D

DRAWING NUMBER E-250





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LINE IS 2 INCHES
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DRAWING EDT59690-251
DRAWN AMJ
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

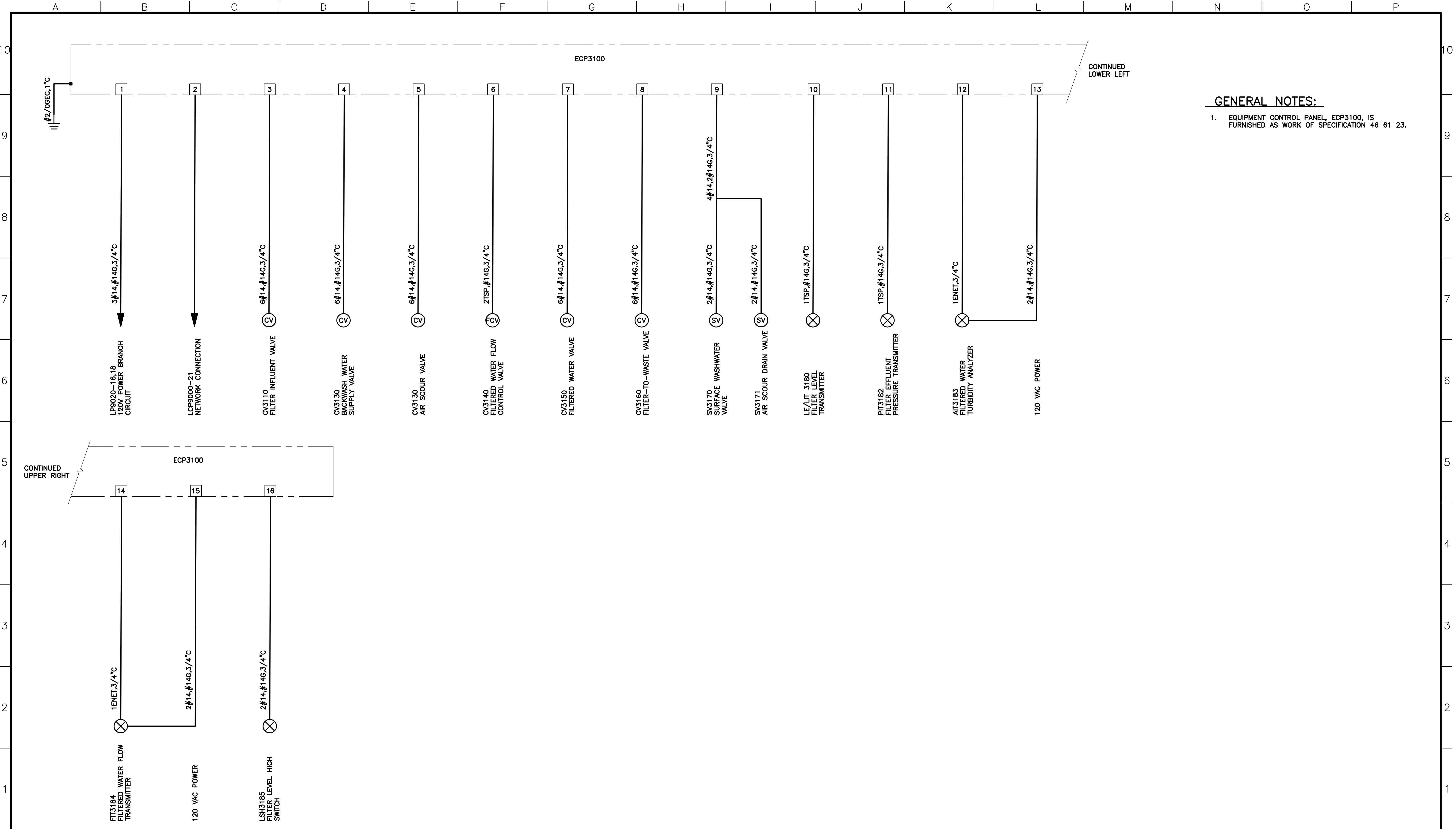
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

LCP9000 ONE-LINE DIAGRAM 2

DATE: 07/24/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER **E-251**



GENERAL NOTES:

- EQUIPMENT CONTROL PANEL, ECP3100, IS FURNISHED AS WORK OF SPECIFICATION 46 61 23.



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DRAWING EDT59690-252
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

**TOWN OF SILT
SILT, COLORADO**

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

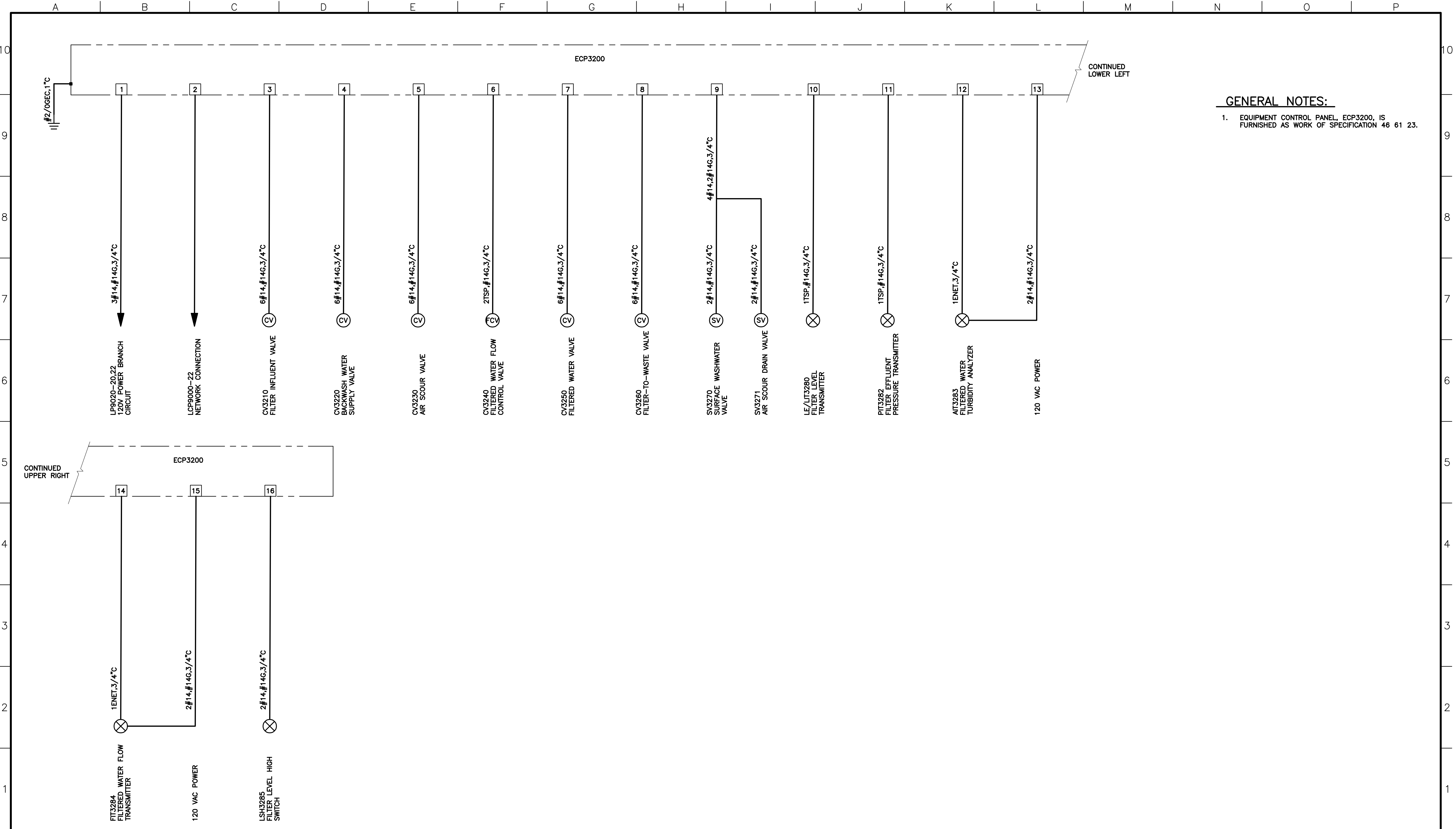
**FILTER 1 EQUIPMENT CONTROL PANEL
ECP3100 ONE-LINE DIAGRAM**

DATE: **05/15/23**

PROJECT
NUMBER: **50159690**

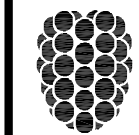
REVISION NO. **E**

DRAWING NUMBER
E-252



GENERAL NOTES:

1. EQUIPMENT CONTROL PANEL, ECP3200, IS FURNISHED AS WORK OF SPECIFICATION 46 61 23.



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LINE IS 2 INCHES
AT FULL SIZE
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DRAWING EDT59690-253
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

**TOWN OF SILT
SILT, COLORADO**

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

**FILTER 2 EQUIPMENT CONTROL
PANEL ECP3200 ONE-LINE DIAGRAM**

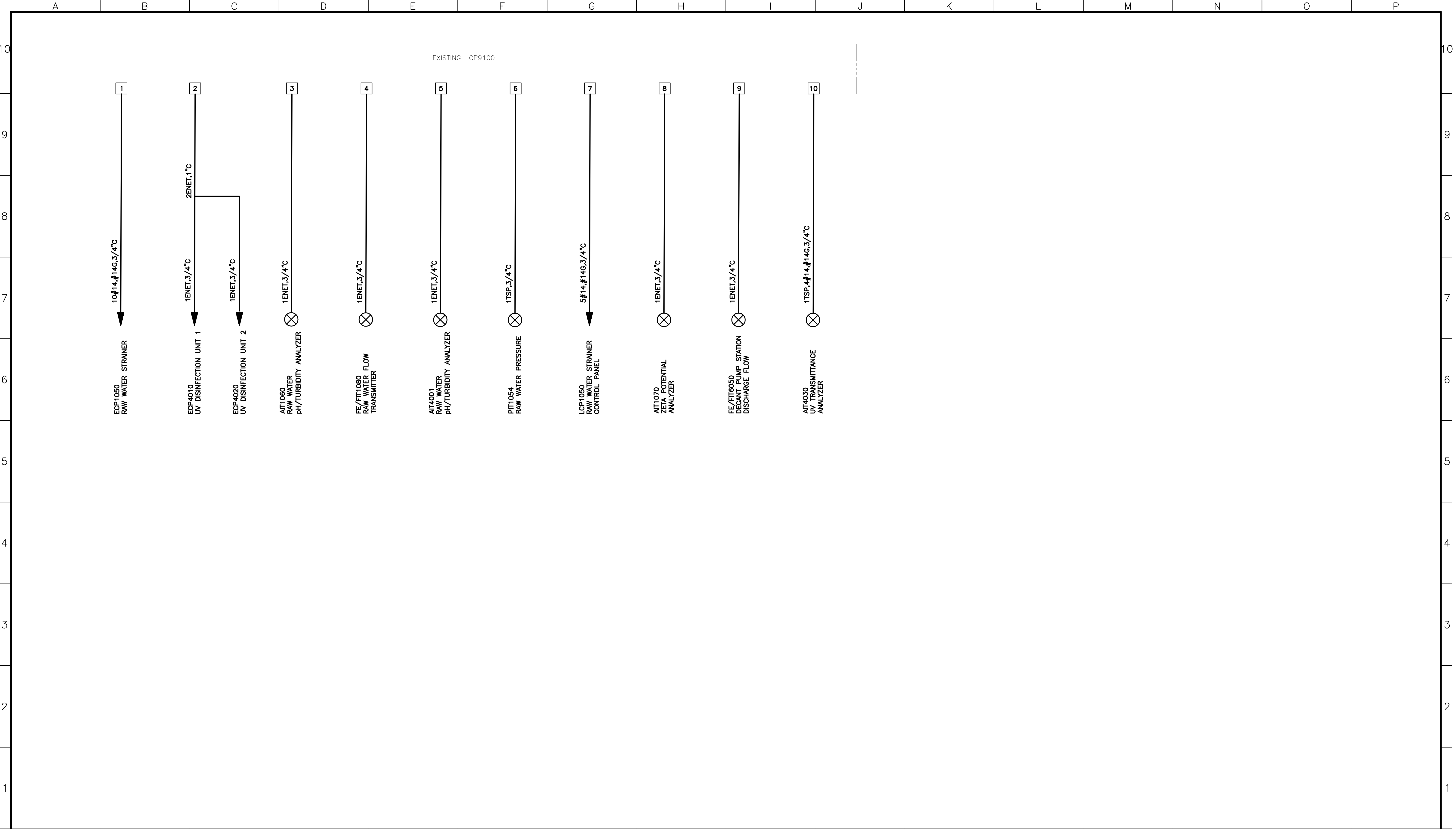
DATE: 05/15/23


PROJECT
NUMBER: 50159690

REVISION NO. E

DRAWING NUMBER

E-253





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LINE IS 2 INCHES
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DRAWING EDT59690-254
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS			
REV.	DESCRIPTION	BY	DATE
A	90% DESIGN ADDENDUM	AMJ	08/16/23
B	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23
C	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23

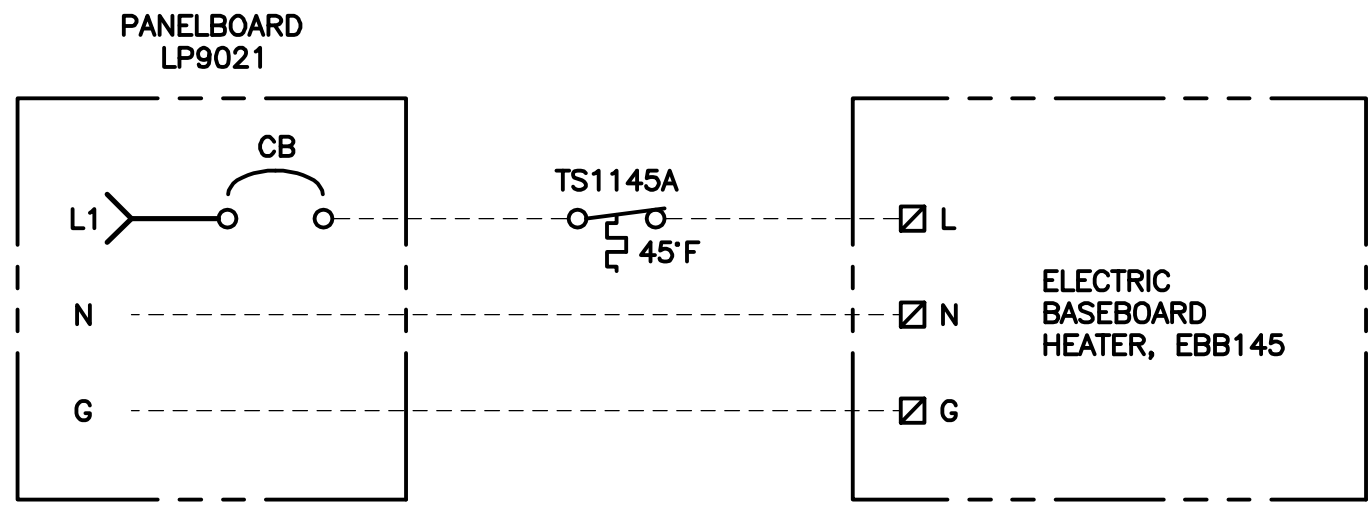
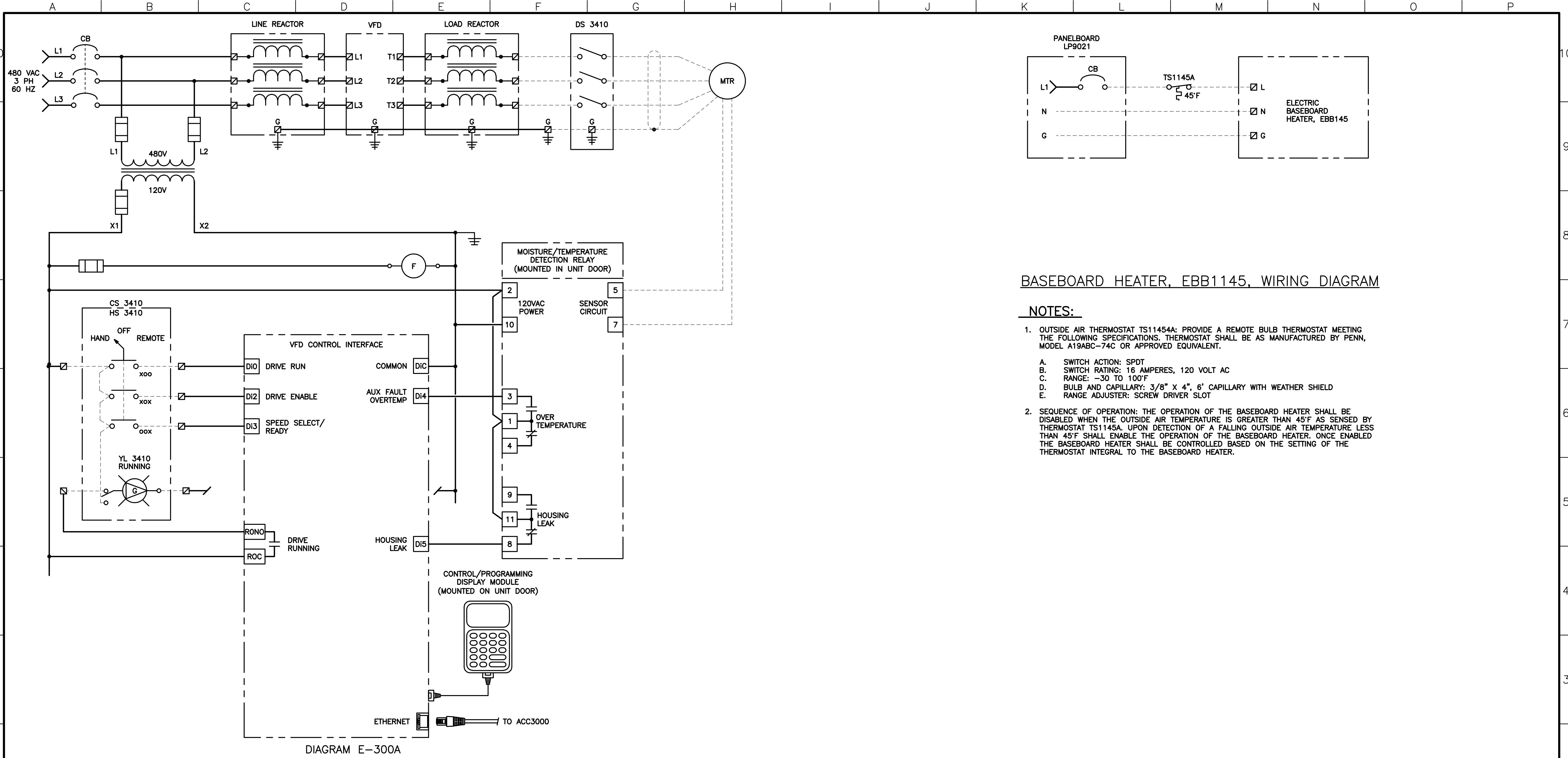
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

EXISTING LCP9100 CONTROL
PANEL ONE-LINE DIAGRAM

DATE: **08/09/23**
PROJECT
NUMBER: **50159690**
REVISION NO. **C**
DRAWING NUMBER
E-254



BASEBOARD HEATER, EBB1145, WIRING DIAGRAM

- NOTES:**
1. OUTSIDE AIR THERMOSTAT TS11454A: PROVIDE A REMOTE BULB THERMOSTAT MEETING THE FOLLOWING SPECIFICATIONS. THERMOSTAT SHALL BE AS MANUFACTURED BY PENN, MODEL A19ABC-74C OR APPROVED EQUIVALENT.
A. SWITCH ACTION: SPDT
B. SWITCH RATING: 16 AMPERES, 120 VOLT AC
C. RANGE: -30 TO 100°F
D. BULB AND CAPILLARY: 3/8" X 4", 6' CAPILLARY WITH WEATHER SHIELD
E. RANGE ADJUSTER: SCREW DRIVER SLOT
 2. SEQUENCE OF OPERATION: THE OPERATION OF THE BASEBOARD HEATER SHALL BE DISABLED WHEN THE OUTSIDE AIR TEMPERATURE IS GREATER THAN 45°F AS SENSED BY THERMOSTAT TS1145A. UPON DETECTION OF A FALLING OUTSIDE AIR TEMPERATURE LESS THAN 45°F SHALL ENABLE THE OPERATION OF THE BASEBOARD HEATER. ONCE ENABLED THE BASEBOARD HEATER SHALL BE CONTROLLED BASED ON THE SETTING OF THE THERMOSTAT INTEGRAL TO THE BASEBOARD HEATER.

DIAGRAM E-300A

EQUIPMENT	DESCRIPTION	FEEDER CIRCUIT
P 3410	BACKWASH WATER SUPPLY PUMP 1	MCC4000-13
P 3420	BACKWASH WATER SUPPLY PUMP 2	MCC4000-14

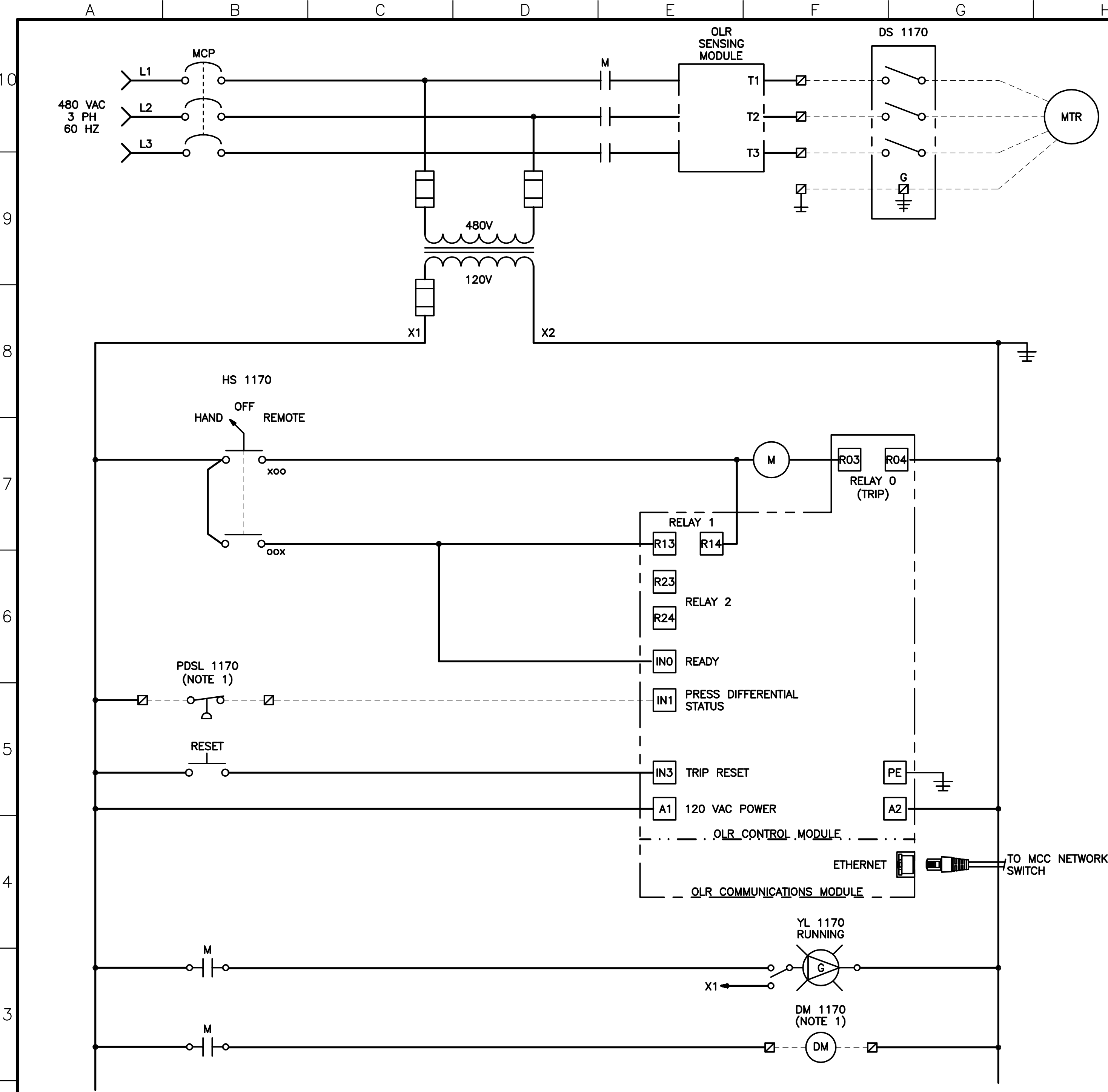


DIAGRAM E-301A

EQUIPMENT	DESCRIPTION	FEEDER CIRCUIT
EF 1170	EXHAUST FAN – CHEM FEED ROOM	MCC9000-17

NOTES:

1. EQUIPMENT FURNISHED WITH HVAC EQUIPMENT.

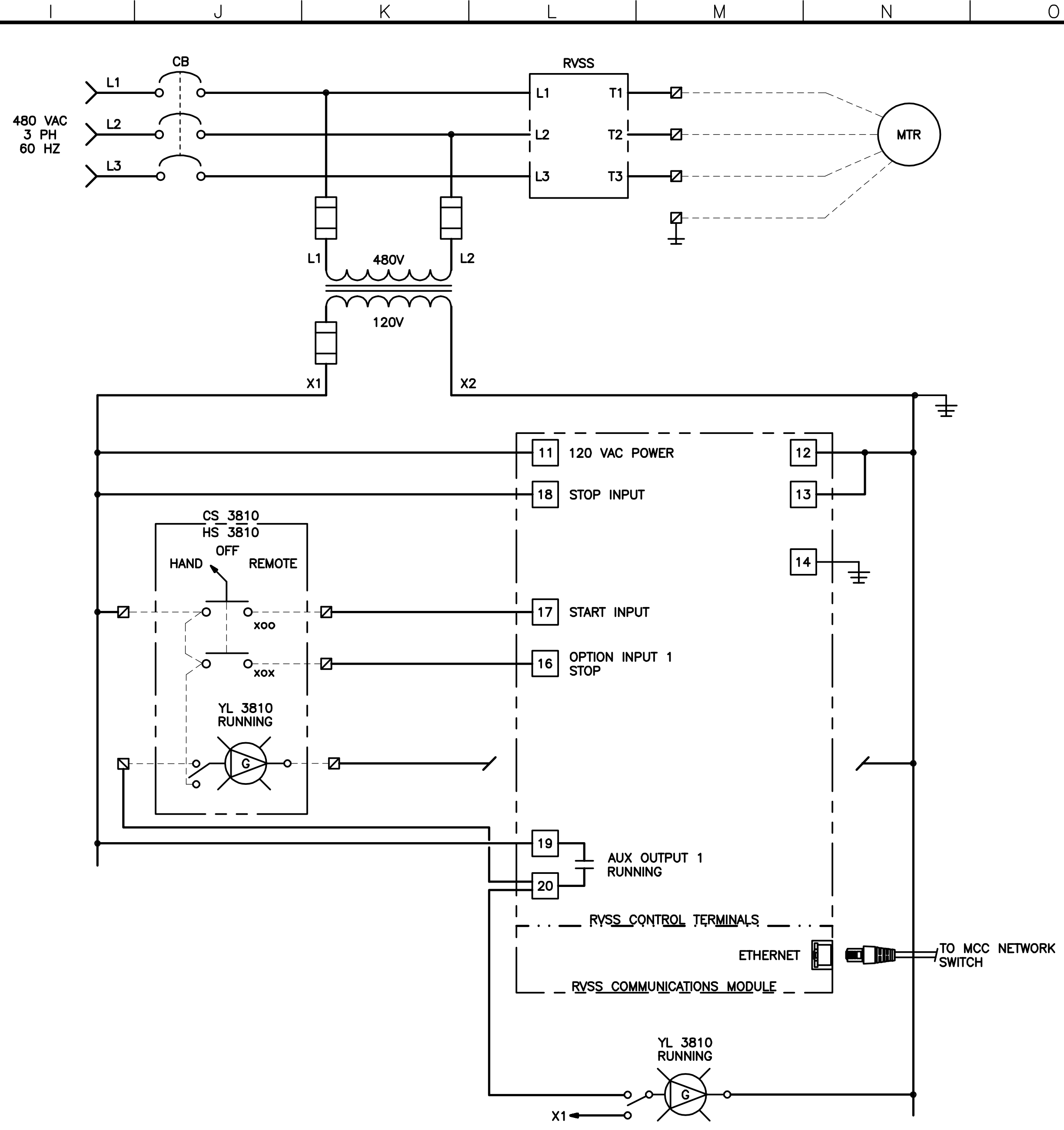


DIAGRAM E-301B

EQUIPMENT	DESCRIPTION	FEEDER CIRCUIT
P 3810	AIR SCOUR BLOWER 1	MCC 9000-11
P 3820	AIR SCOUR BLOWER 2	MCC 9000-12

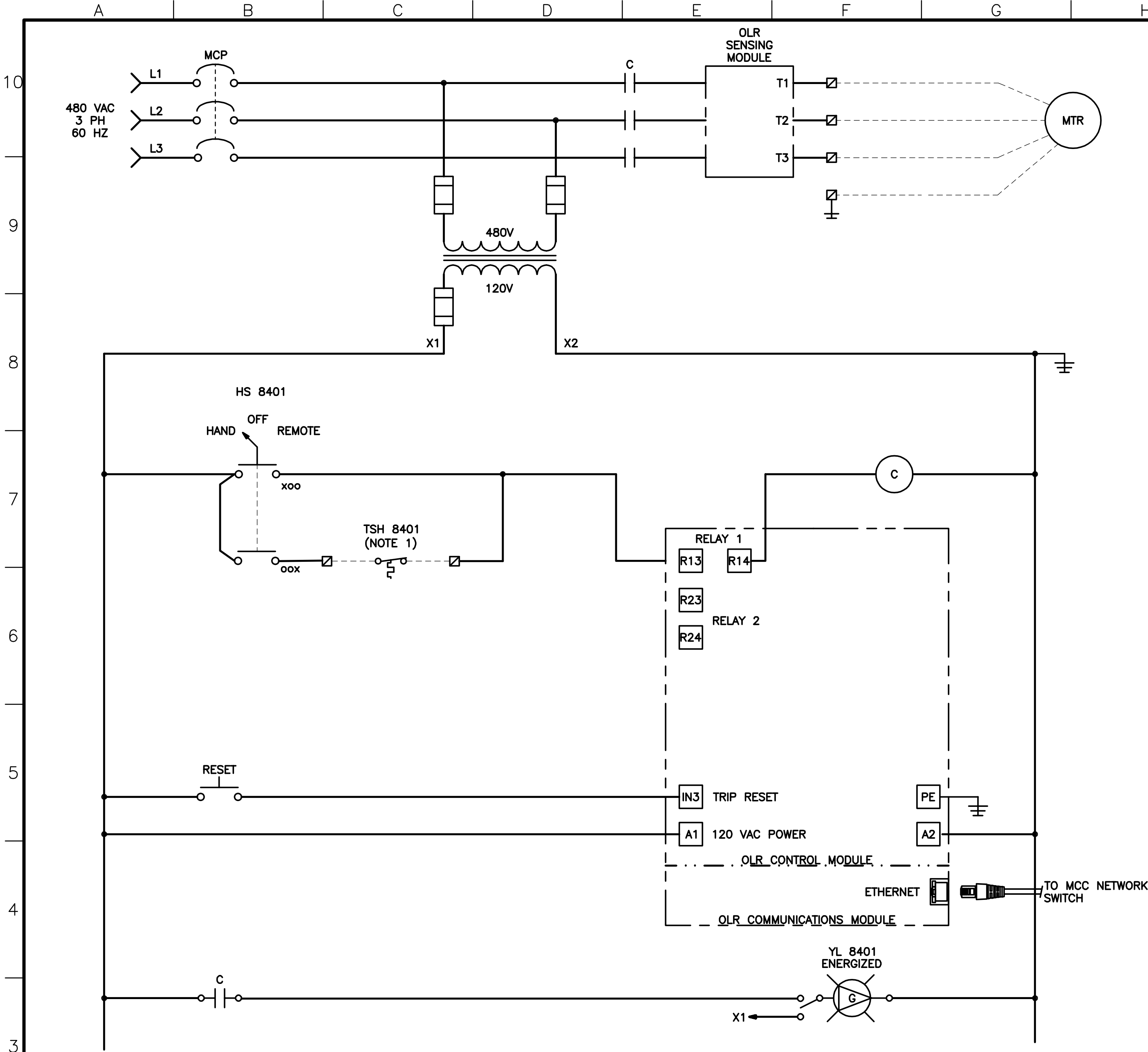


DIAGRAM E-302A

EQUIPMENT	DESCRIPTION	FEEDER CIRCUIT
HTR 8401	NaOH STORAGE TANK 1 HEATER	MCC9000-18

NOTES:

1. THERMOSTAT IS INTEGRAL TO THE HEATER ASSEMBLY.

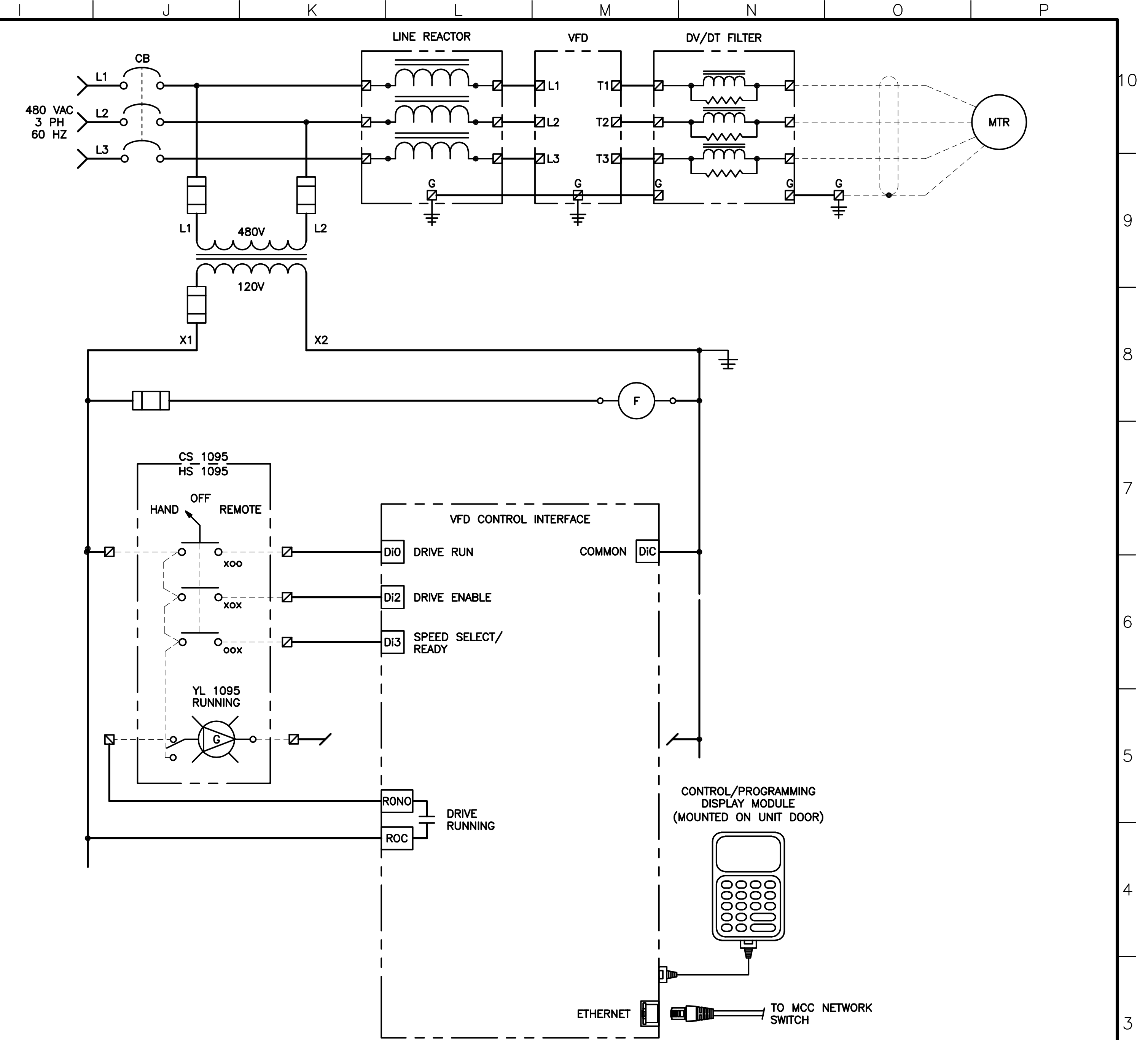
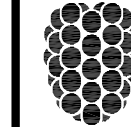


DIAGRAM E-302B

EQUIPMENT	DESCRIPTION	FEEDER CIRCUIT
MXR 1095	RAW WATER RAPID MIXER	MCC9000-19



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LINE IS 2 INCHES
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DRAWING EDG59690-302
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

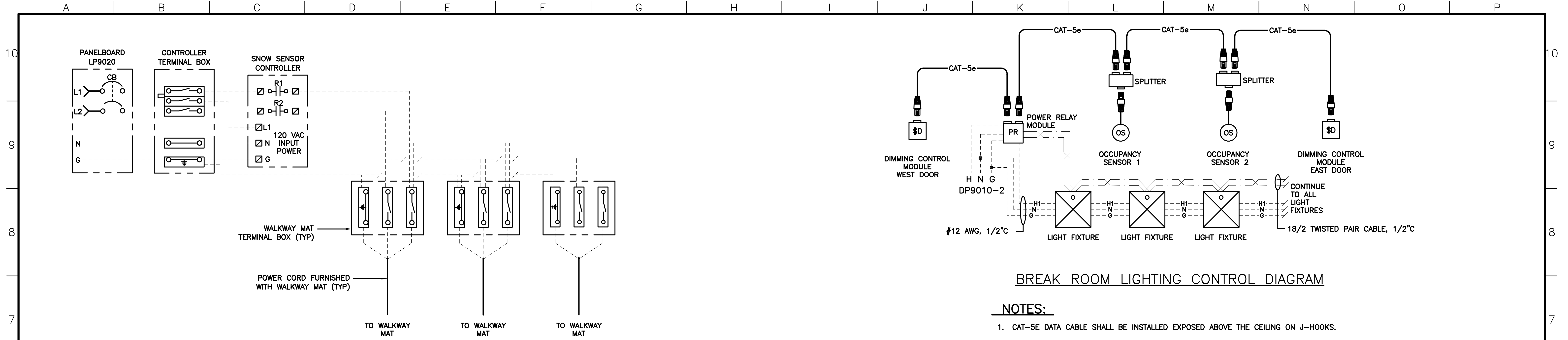
CONTROL DIAGRAMS 3

DATE: 07/24/23

PROJECT NUMBER: 50159690

REVISION NO. D

DRAWING NUMBER E-302

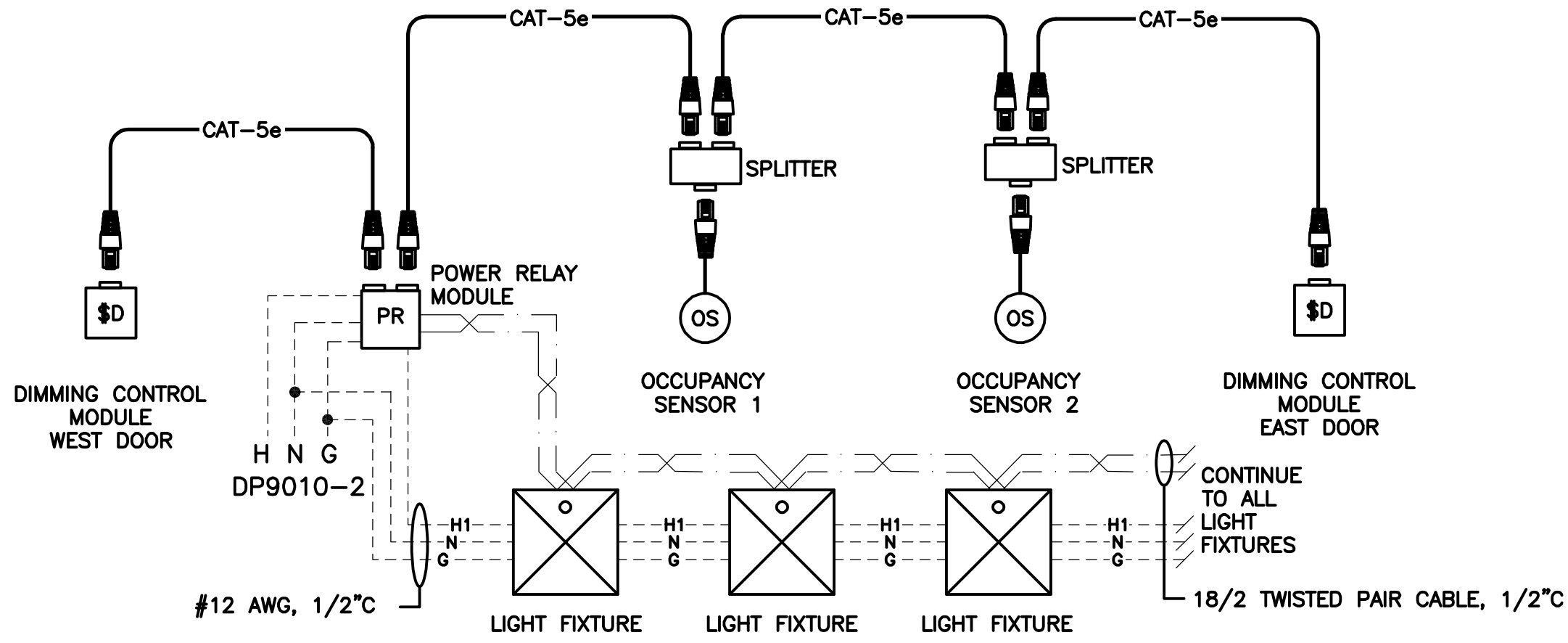


ROOF HEATED WALKWAY MAT WIRING DIAGRAM

NOTES:

1. MOISTURE SENSOR AND INTERCONNECTING CABLE ARE NOT SHOWN.
2. TERMINAL BLOCKS SHALL BE RATED 600 VOLT AC, 20 AMPERE MINIMUM WITH WIRING COMPARTMENTS RATED FOR #10 AWG CONDUCTORS.
3. SYMBOL LEGEND

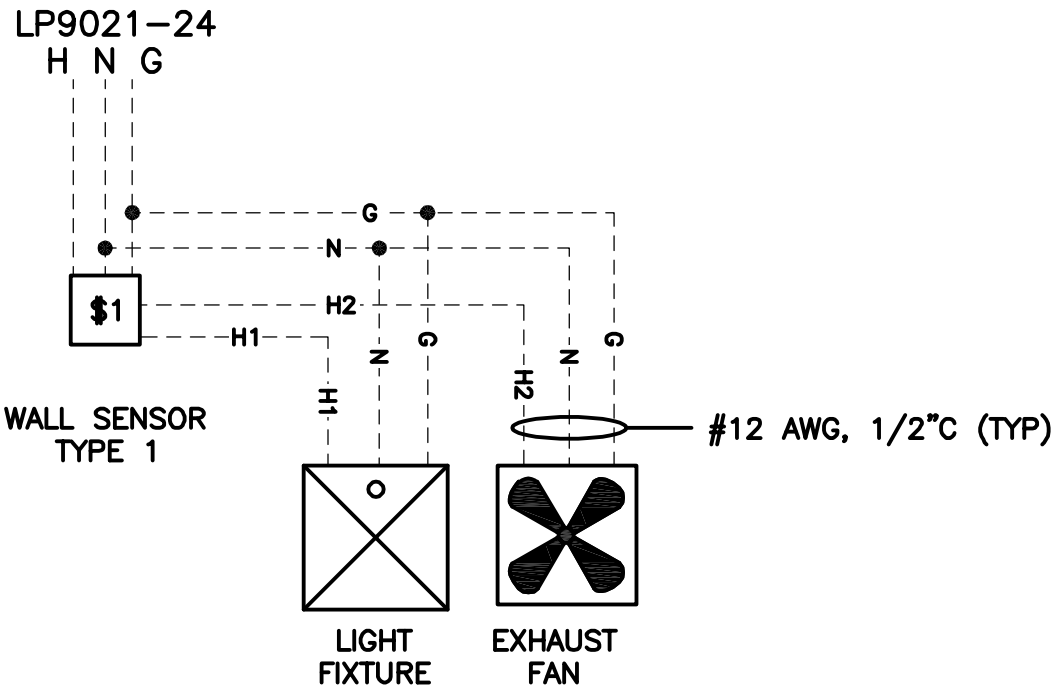
- | | |
|--|---|
| | DISCONNECT TERMINAL BLOCK (TYP) |
| | FEED-THROUGH TERMINAL BLOCK (TYP) |
| | GROUND TERMINAL BLOCK (TYP) |
| | TERMINAL BLOCKS CONNECTED WITH CENTER BRIDGE JUMPER |



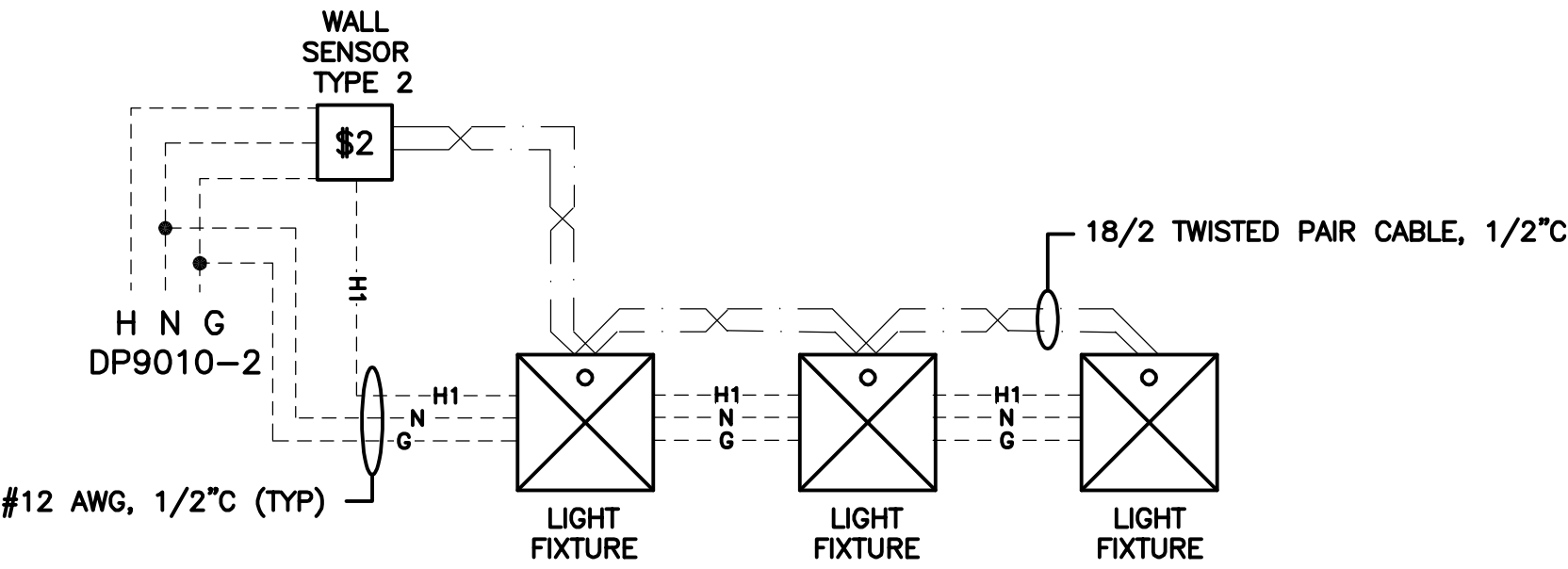
BREAK ROOM LIGHTING CONTROL DIAGRAM

NOTES:

1. CAT-5E DATA CABLE SHALL BE INSTALLED EXPOSED ABOVE THE CEILING ON J-HOOKS.
2. CAT-5E DATA CABLE SHALL BE ROUTED TO DIMMING CONTROL MODULE IN 1/2" CONDUIT FROM 6" ABOVE THE WALL IN THE CEILING SPACE DOWN TO THE DEVICE BOX.
3. SPLITTER FURNISHED WITH THE OCCUPANCY SENSOR.

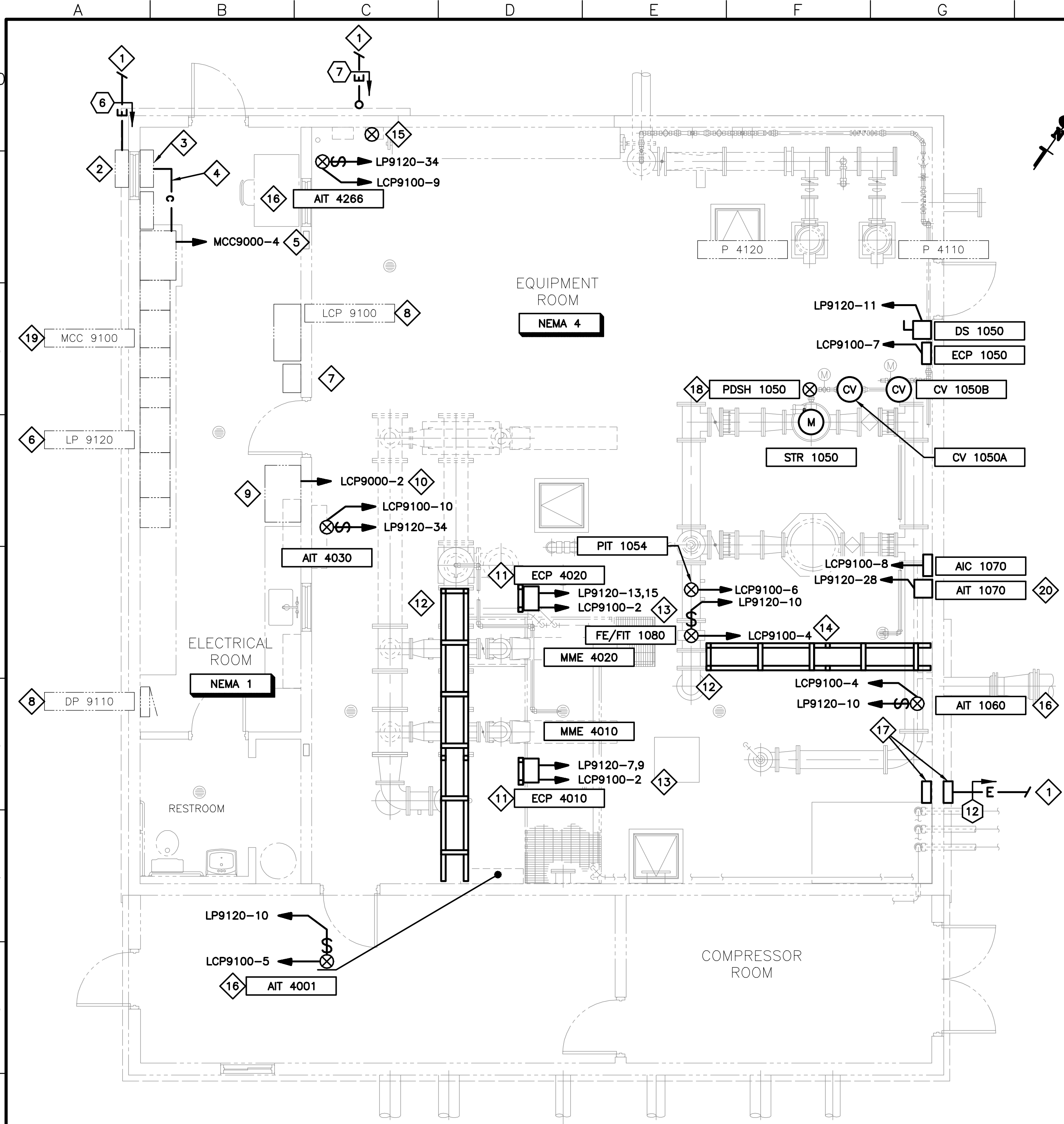


RESTROOM LIGHTING/FAN CONTROL DIAGRAM

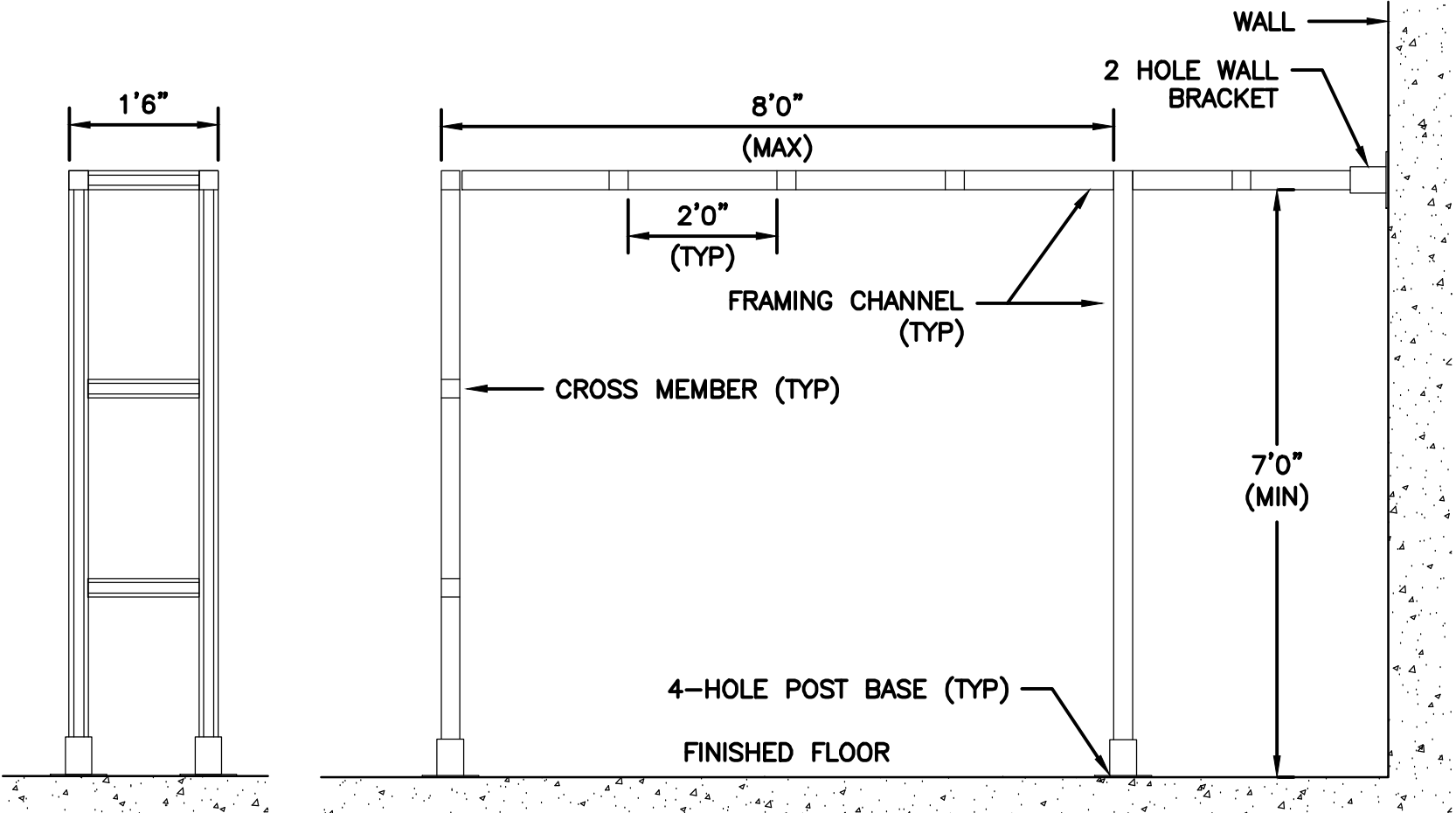


LABORATORY LIGHTING CONTROL DIAGRAM

 Dewberry [®] Dewberry Engineers Inc. 990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825-1802	LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY) DRAWING <u>EDG59690-303</u> DRAWN <u>AMJ</u> DESIGNED <u>RAM</u> CHECKED <u>RAM</u>	APPROVED:	REVISIONS					TOWN OF SILT SILT, COLORADO				ELECTRICAL				DATE: <u>09/29/23</u> PROJECT NUMBER: <u>50159690</u> REVISION NO. <u>B</u> DRAWING NUMBER E-303	
		PRINCIPAL	REV.	DESCRIPTION	BY	DATE	APP.										
		DATE:	A	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM										
			B	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM										
WATER TREATMENT PLANT IMPROVEMENTS								CONTROL DIAGRAMS 4									



PLAN
EXISTING WTP BUILDING POWER AND CONTROL PLAN
SCALE: 1/4"=1'-0



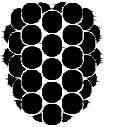
PLAN
OVERHEAD CONDUIT RACK DETAIL
SCALE: NTS

KEY NOTES:

- 1 REFER TO DRAWING E-100 FOR CONTINUATION OF THE DUCT BANK.
- 2 EXISTING WIREWAY MOUNTED APPROXIMATELY 30" AFG ON THE EXISTING BUILDING WALL. TERMINATE THE CONDUIT FROM DUCT BANK SECTION 5 AT THE EXISTING WIREWAY.
- 3 EXISTING PULL BOX. DRILL THE EXISTING BUILDING WALL AND EXTEND THE CONDUIT FROM DUCT BANK SECTION 5 BETWEEN THE WIREWAY AND PULL BOX.
- 4 EXTEND MCC9100 FEEDER CIRCUIT IN EXPOSED GRS CONDUIT FROM THE EXISTING PULL BOX TO THE MCC9100 MAIN CIRCUIT BREAKER.
- 5 MCC9100 FEEDER CIRCUIT VIA DUCT BANK SECTION 5.
- 6 EXISTING PANELBOARD LP9120 LOCATED IN MCC9100 SECTION 4. PROVIDE A NEW NAMEPLATE ON THE EXISTING PANELBOARD READING "LIGHTING PANELBOARD, LP9120".
- 7 EXISTING SCADA CONTROL PANEL TO REMAIN INTACT.
- 8 PROVIDE A NEW NAMEPLATE ON THE EXISTING PANELBOARD READING "DISTRIBUTION PANELBOARD, DP9110".
- 9 EXISTING SERVER/NETWORK HARDWARE EQUIPMENT CABINET.
- 10 FIBER OPTIC TRUNK CABLE VIA DUCT BANK SECTION 12. TERMINATE THE CONDUIT 6" ABOVE THE TOP OF THE SOUTHEAST CORNER OF THE CABLE. EXTEND FIBER OPTIC CABLE EXPOSED FROM CONDUIT INTO THE REAR OF THE CABINET. PROVIDE 6' CABLE PIGTAIL IN THE CABINET FOR TERMINATION.
- 11 MOUNT THE UV DISINFECTION UNIT CONTROL PANEL ON U-CHANNEL MOUNTING FRAME. REFER TO DETAIL 3/E-4.
- 12 FLOOR-SUPPORTED OVERHEAD CONDUIT RACK. REFER TO DETAIL ON THIS SHEET.
- 13 ROUTE CONDUITS ON THE CONDUIT RACK TO THE SOUTH WALL.
- 14 ROUTE CONDUITS ON THE CONDUIT RACK TO THE EAST WALL.
- 15 EXISTING ANALYZER CHLORINE RESIDUAL SENSOR, AE4266, TO BE RELOCATED TO ANALYZER SAMPLE PANEL BACKBOARD WITH ANALYZER CONTROLLER AIT4266 AND PH SENSOR AE4267.
- 16 ANALYZERS MOUNTED ON SAMPLE PANEL BACKBOARD. REFER TO DETAIL 2/I-1.
- 17 PULL BOX PB9100A MOUNTED 36" AFF. PULL BOX SHALL BE 12"x12"x6" NEMA 4X STAINLESS STEEL. EXTEND CONDUITS FROM DUCT BANK SECTION 12 THROUGH BUILDING WALL TO PULL BOX PB9100B MOUNTED ON THE INTERIOR WALL. EXTEND CIRCUIT LCP9000-2 FROM THE PB9100B TO THE EXISTING SERVER/NETWORK HARDWARE EQUIPMENT CABINET IN THE EXISTING ELECTRICAL ROOM.
- 18 PRESSURE SWITCH PROVIDED WITH THE STRAINER AND MOUNTED ON THE FRONT OF THE STRAINER BODY.
- 19 PROVIDE A NEW NAMEPLATE ON THE EXISTING MOTOR CONTROL CENTER MAIN CIRCUIT BREAKER SECTION READING "MOTOR CONTROL CENTER, MCC9100, MAIN CIRCUIT BREAKER".
- 20 PROVIDE A 1" CONDUIT BETWEEN THE ANALYZER ENCLOSURE AND THE ANALYZER CONTROLLER ENCLOSURE. COORDINATE CONDUIT TERMINATION POINTS WITH ANALYZER MANUFACTURER.

NOTES:

- 1. POST AND WALL BASES SHALL BE ANCHORED TO THE EXISTING FLOOR WITH 1/2" DIAMETER ADHESIVE SET ANCHOR BOLTS AND FLAT WASHERS WITH 4" MINIMUM EMBEDMENT (TYP).

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LINE IS 2 INCHES
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(IF NOT 2"=SCALE ACCORDINGLY)
DRAWING EPL59690-1000
DRAWN AMJ
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

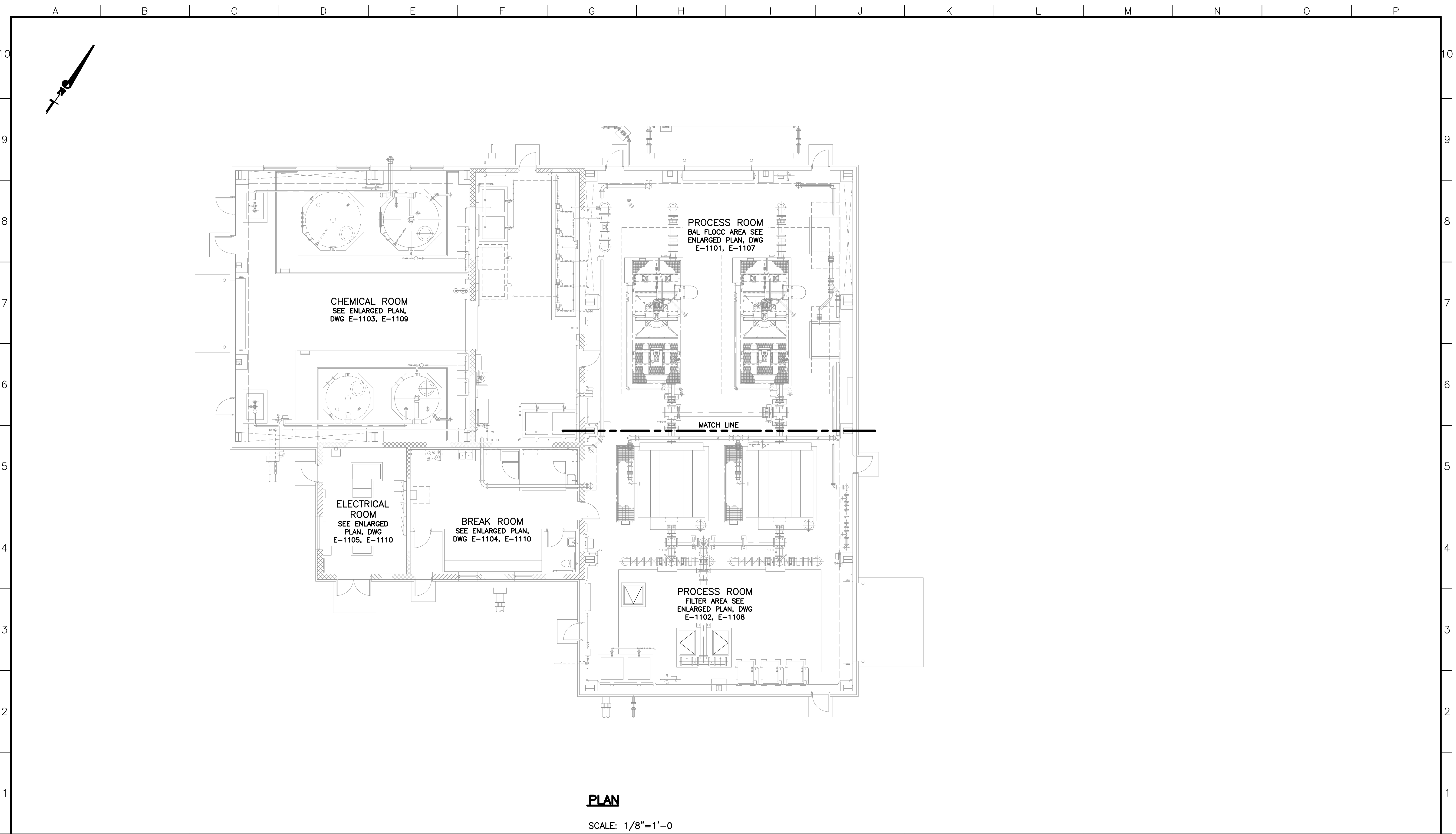
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL


EXISTING WTP BUILDING POWER
AND CONTROL PLAN

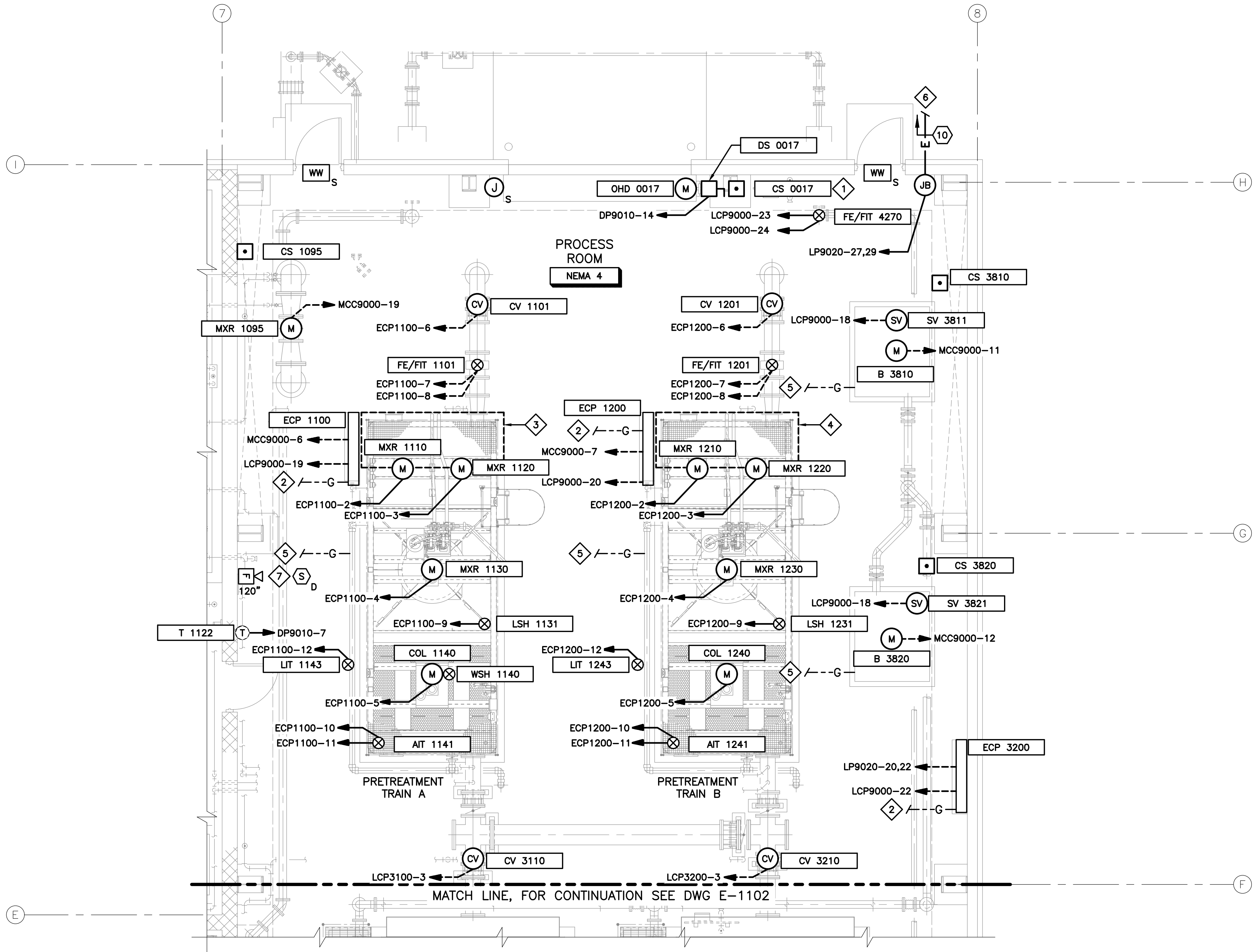
DATE: 07/24/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
E-1000
SHEET NUMBER



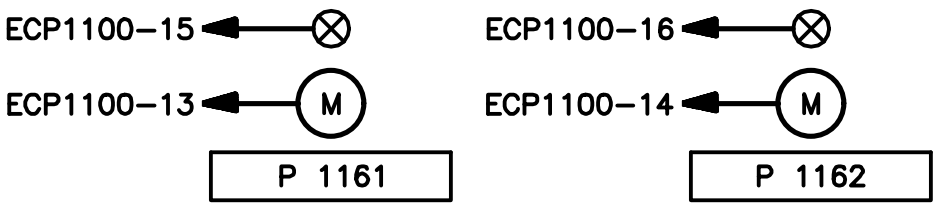
PLAN

SCALE: 1/8"=1'-0

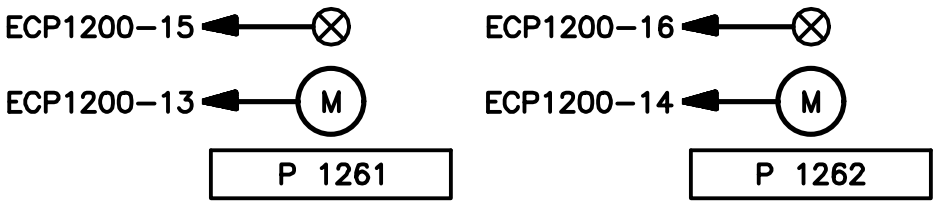
 Dewberry [®] Dewberry Engineers Inc. 990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825-1802	LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY) DRAWING EPL59690-1100 DRAWN <u>AMJ</u> DESIGNED <u>RAM</u> CHECKED <u>RAM</u>	APPROVED:	REVISIONS					TOWN OF SILT SILT, COLORADO	ELECTRICAL	DATE: 05/11/23 PROJECT NUMBER: 50159690 REVISION NO. E DRAWING NUMBER E-1100 SHEET NUMBER
		PRINCIPAL	REV.	DESCRIPTION	BY	DATE	APP.			
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			B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM			
			C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM			
DATE:	D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM					
	E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM					
WATER TREATMENT PLANT IMPROVEMENTS								WATER TREATMENT PLANT OVERALL GROUND LEVEL PLAN		



- KEY NOTES:**
- 1 CONTROL STATION FURNISHED WITH THE DOOR OPERATOR.
 - 2 GROUND CONDUCTOR FROM CONTROL PANEL TO FACILITY GROUND BAR IN THE ELECTRICAL ROOM.
 - 3 PRETREATMENT TRAIN A SAND RECIRCULATION PUMPS AND ASSOCIATED INSTRUMENTATION LOCATED BENEATH THE COAGULATION TANKS ON THE EQUIPMENT SKID. REFER TO THE PRETREATMENT TRAIN A SAND RECIRCULATION PUMP PLAN, THIS SHEET.
 - 4 PRETREATMENT TRAIN B SAND RECIRCULATION PUMPS AND ASSOCIATED INSTRUMENTATION LOCATED BENEATH THE COAGULATION TANKS ON THE EQUIPMENT SKID. REFER TO THE PRETREATMENT TRAIN B SAND RECIRCULATION PUMP PLAN, THIS SHEET.
 - 5 #2/0 GROUND CONDUCTOR FROM EQUIPMENT FRAME TO FACILITY GROUND BAR IN THE ELECTRICAL ROOM.
 - 6 REFER TO DRAWING E-100 FOR CONTINUATION OF THE DUCT BANK.
 - 7 SMOKE DETECTOR MOUNTED IN DUCTWORK ABOVE.



PRETREATMENT TRAIN A
SAND RECIRCULATION PUMP PLAN



PRETREATMENT TRAIN B
SAND RECIRCULATION PUMP PLAN

PLAN
PRETREATMENT AREA POWER AND CONTROL PLAN
SCALE: 1/4"=1'-0

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DRAWN AMJ
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CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
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B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

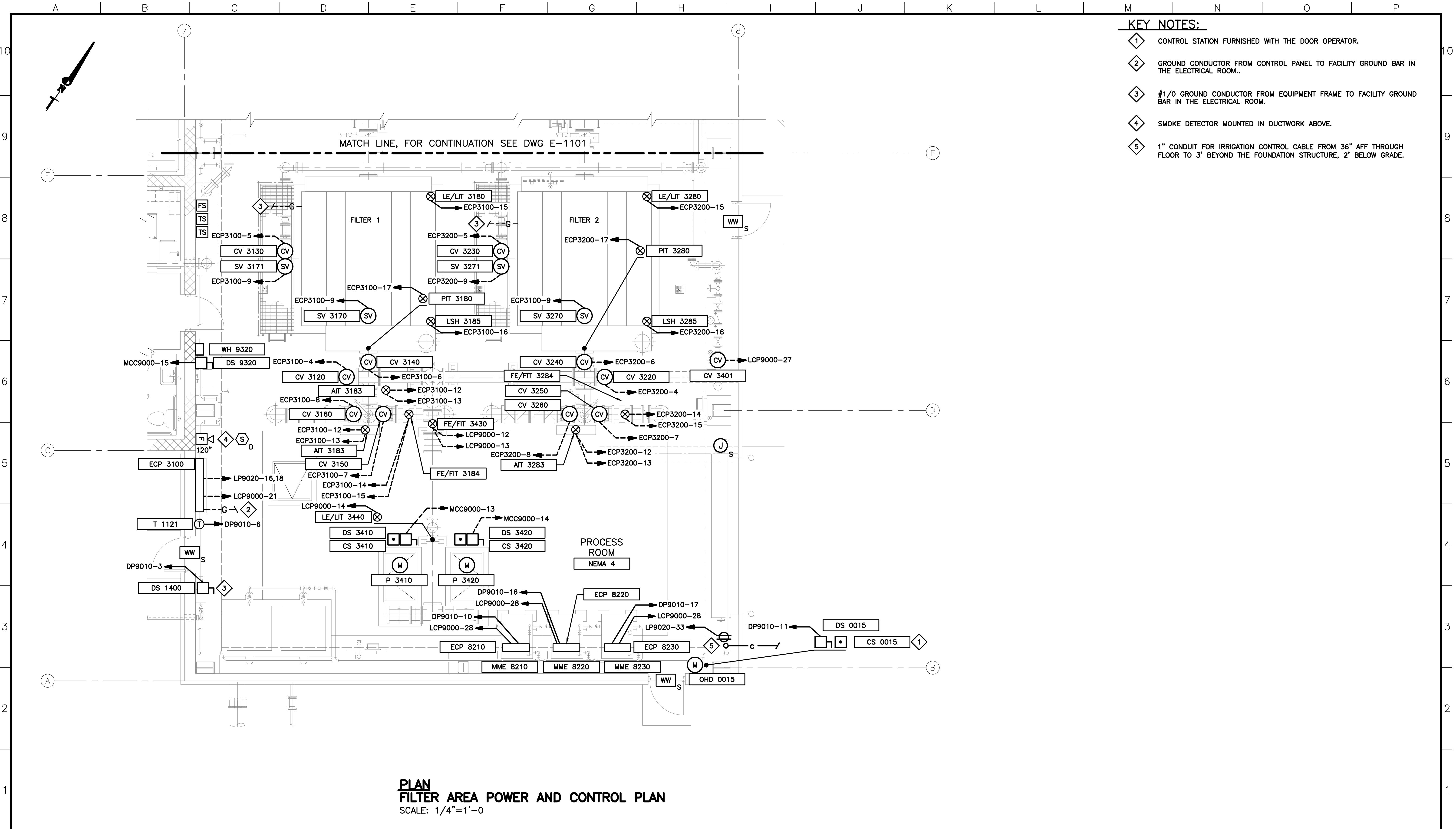
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

WATER TREATMENT PLANT
BALLASTED FLOCC AREA
POWER & CONTROL PLAN

DATE: 05/11/23
PROJECT NUMBER: 50159690
REVISION NO. E
DRAWING NUMBER
E-1101
SHEET NUMBER



KEY NOTES:

- 1 CONTROL STATION FURNISHED WITH THE DOOR OPERATOR.
- 2 GROUND CONDUCTOR FROM CONTROL PANEL TO FACILITY GROUND BAR IN THE ELECTRICAL ROOM..
- 3 #1/0 GROUND CONDUCTOR FROM EQUIPMENT FRAME TO FACILITY GROUND BAR IN THE ELECTRICAL ROOM.
- 4 SMOKE DETECTOR MOUNTED IN DUCTWORK ABOVE.
- 5 1" CONDUIT FOR IRRIGATION CONTROL CABLE FROM 36" AFF THROUGH FLOOR TO 3' BEYOND THE FOUNDATION STRUCTURE, 2' BELOW GRADE.

PLAN
FILTER AREA POWER AND CONTROL PLAN
SCALE: 1/4"=1'-0

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DRAWING EPL59690-1102
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP.
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B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

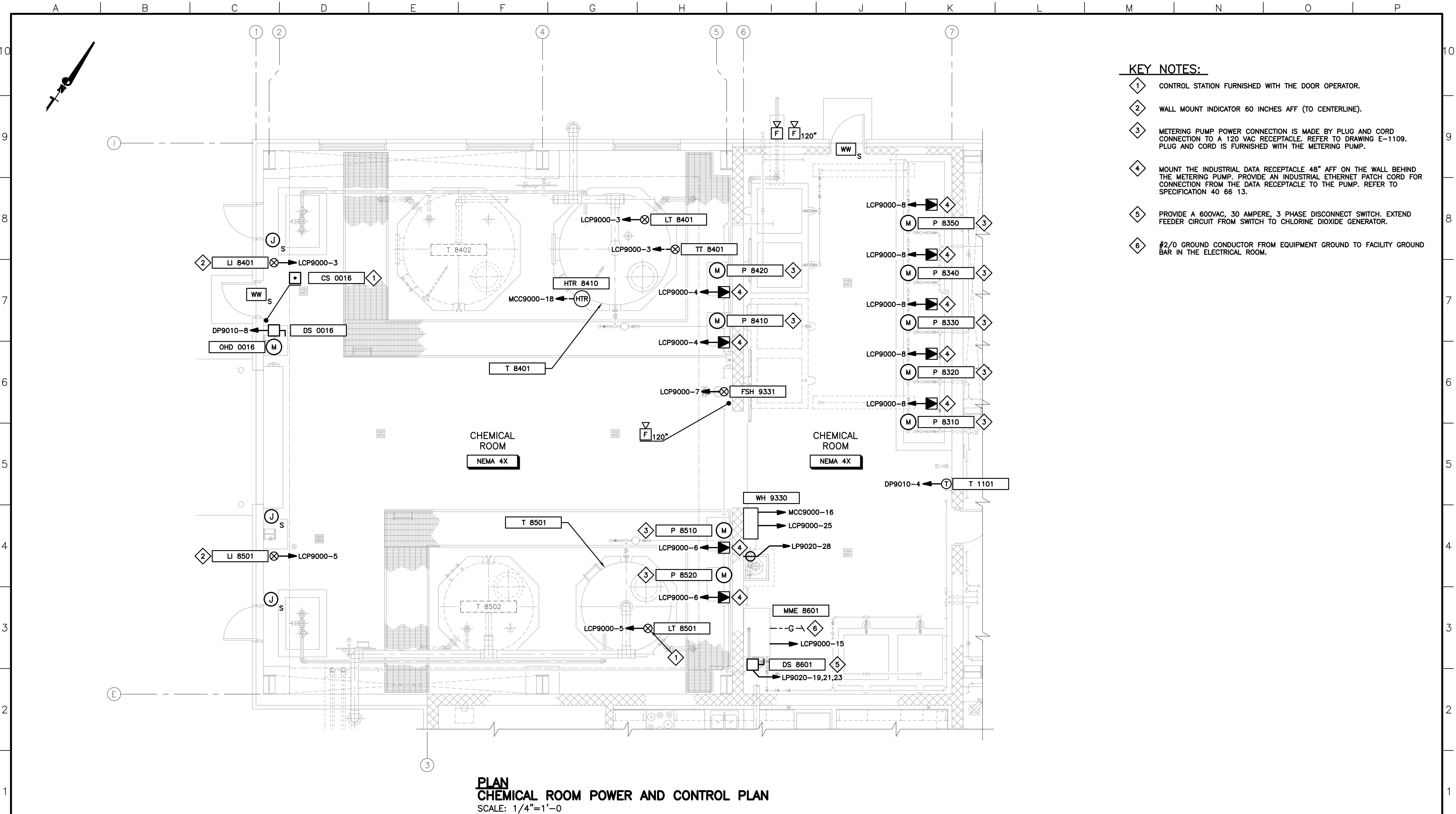
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

WATER TREATMENT PLANT FILTER
AREA POWER AND CONTROL PLAN

DATE: 05/12/23
PROJECT NUMBER: 50159690
REVISION NO. E
DRAWING NUMBER E-1102
SHEET NUMBER

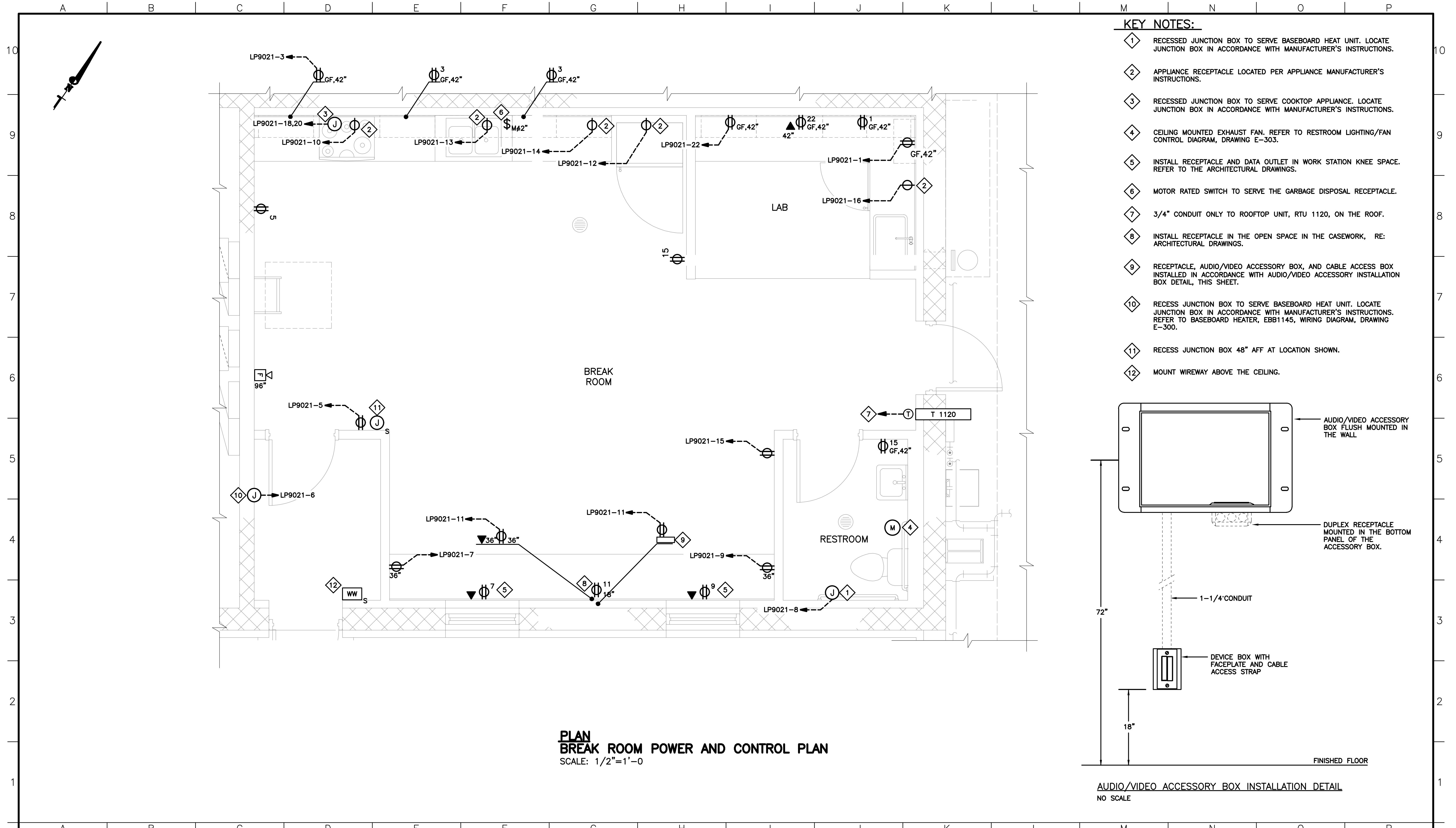


KEY NOTES:

- 1 CONTROL STATION FURNISHED WITH THE DOOR OPERATOR.
- 2 WALL MOUNT INDICATOR 60 INCHES AFF (TO CENTERLINE).
- 3 METERING PUMP POWER CONNECTION IS MADE BY PLUG AND CORD CONNECTION TO A 120 VAC RECEPTACLE. REFER TO DRAWING E-1109. PLUG AND CORD IS FURNISHED WITH THE METERING PUMP.
- 4 MOUNT THE INDUSTRIAL DATA RECEPTACLE 48" AFF ON THE WALL BEHIND THE METERING PUMP. PROVIDE AN INDUSTRIAL ETHERNET PATCH CORD FOR CONNECTION FROM THE DATA RECEPTACLE TO THE PUMP. REFER TO SPECIFICATION 40 66 13.
- 5 PROVIDE A 600VAC, 30 AMPERE, 3 PHASE DISCONNECT SWITCH. EXTEND FEEDER CIRCUIT FROM SWITCH TO CHLORINE DIOXIDE GENERATOR.
- 6 #2/0 GROUND CONDUCTOR FROM EQUIPMENT GROUND TO FACILITY GROUND BAR IN THE ELECTRICAL ROOM.

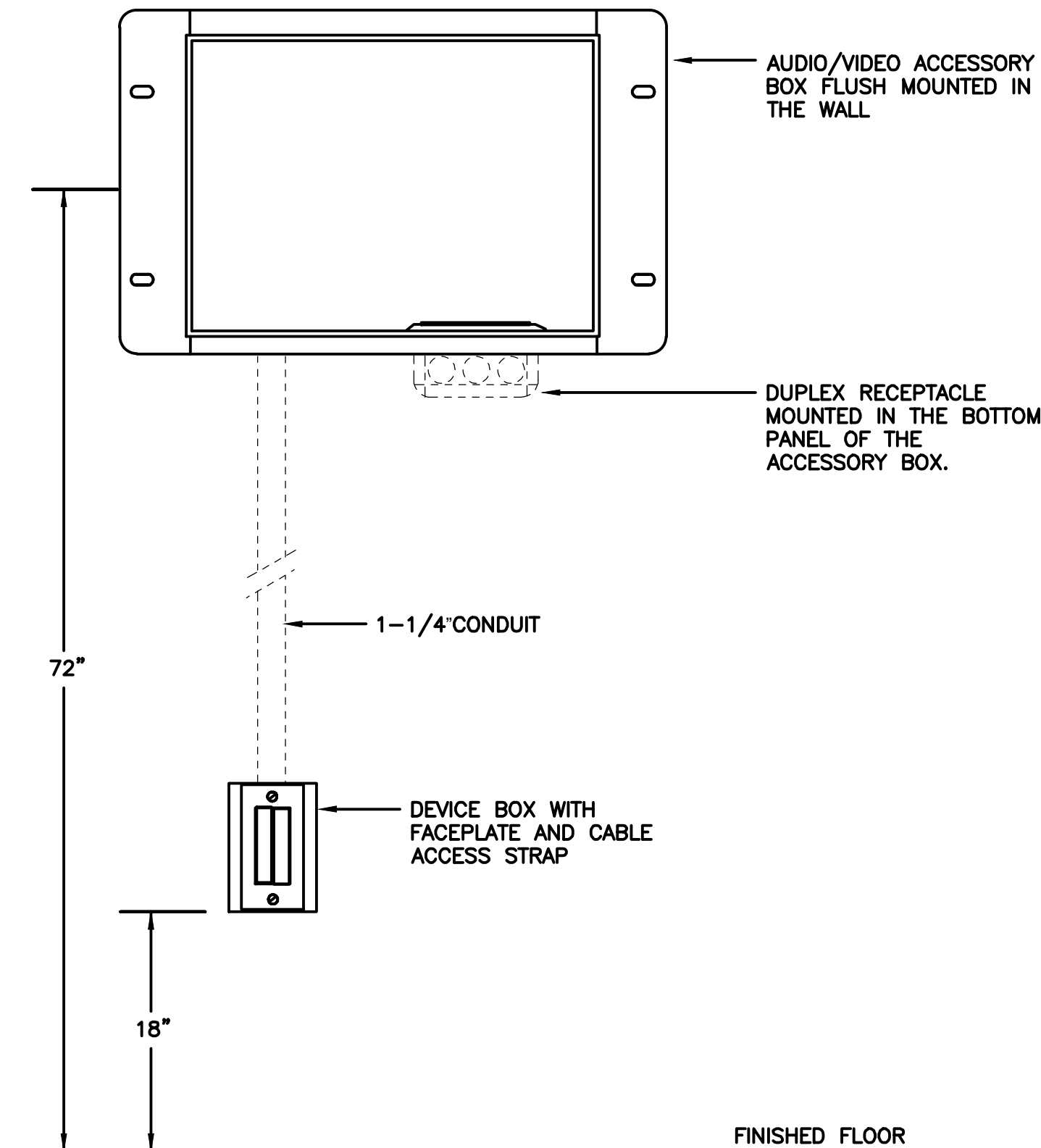
PLAN
CHEMICAL ROOM POWER AND CONTROL PLAN
SCALE: 1/4"=1'-0

REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM



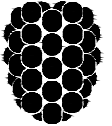
KEY NOTES:

- 1 RECESSED JUNCTION BOX TO SERVE BASEBOARD HEAT UNIT. LOCATE JUNCTION BOX IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
- 2 APPLIANCE RECEPTACLE LOCATED PER APPLIANCE MANUFACTURER'S INSTRUCTIONS.
- 3 RECESSED JUNCTION BOX TO SERVE COOKTOP APPLIANCE. LOCATE JUNCTION BOX IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
- 4 CEILING MOUNTED EXHAUST FAN. REFER TO RESTROOM LIGHTING/FAN CONTROL DIAGRAM, DRAWING E-303.
- 5 INSTALL RECEPTACLE AND DATA OUTLET IN WORK STATION KNEE SPACE. REFER TO THE ARCHITECTURAL DRAWINGS.
- 6 MOTOR RATED SWITCH TO SERVE THE GARBAGE DISPOSAL RECEPTACLE.
- 7 3/4" CONDUIT ONLY TO ROOFTOP UNIT, RTU 1120, ON THE ROOF.
- 8 INSTALL RECEPTACLE IN THE OPEN SPACE IN THE CASEWORK, RE: ARCHITECTURAL DRAWINGS.
- 9 RECEPTACLE, AUDIO/VIDEO ACCESSORY BOX, AND CABLE ACCESS BOX INSTALLED IN ACCORDANCE WITH AUDIO/VIDEO ACCESSORY INSTALLATION BOX DETAIL, THIS SHEET.
- 10 RECESS JUNCTION BOX TO SERVE BASEBOARD HEAT UNIT. LOCATE JUNCTION BOX IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. REFER TO BASEBOARD HEATER, EBB1145, WIRING DIAGRAM, DRAWING E-300.
- 11 RECESS JUNCTION BOX 48" AFF AT LOCATION SHOWN.
- 12 MOUNT WIREWAY ABOVE THE CEILING.



PLAN
BREAK ROOM POWER AND CONTROL PLAN
SCALE: 1/2"=1'-0

AUDIO/VIDEO ACCESSORY BOX INSTALLATION DETAIL
NO SCALE



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DRAWING EPL59690-1104
DRAWN AMJ
DESIGNED RAM
CHECKED RAM

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	60% DESIGN REVIEW SUBMITTAL	AMJ	05/25/23	RAM
B	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
C	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
D	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
E	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

WATER TREATMENT PLANT BREAK
ROOM POWER AND CONTROL PLAN

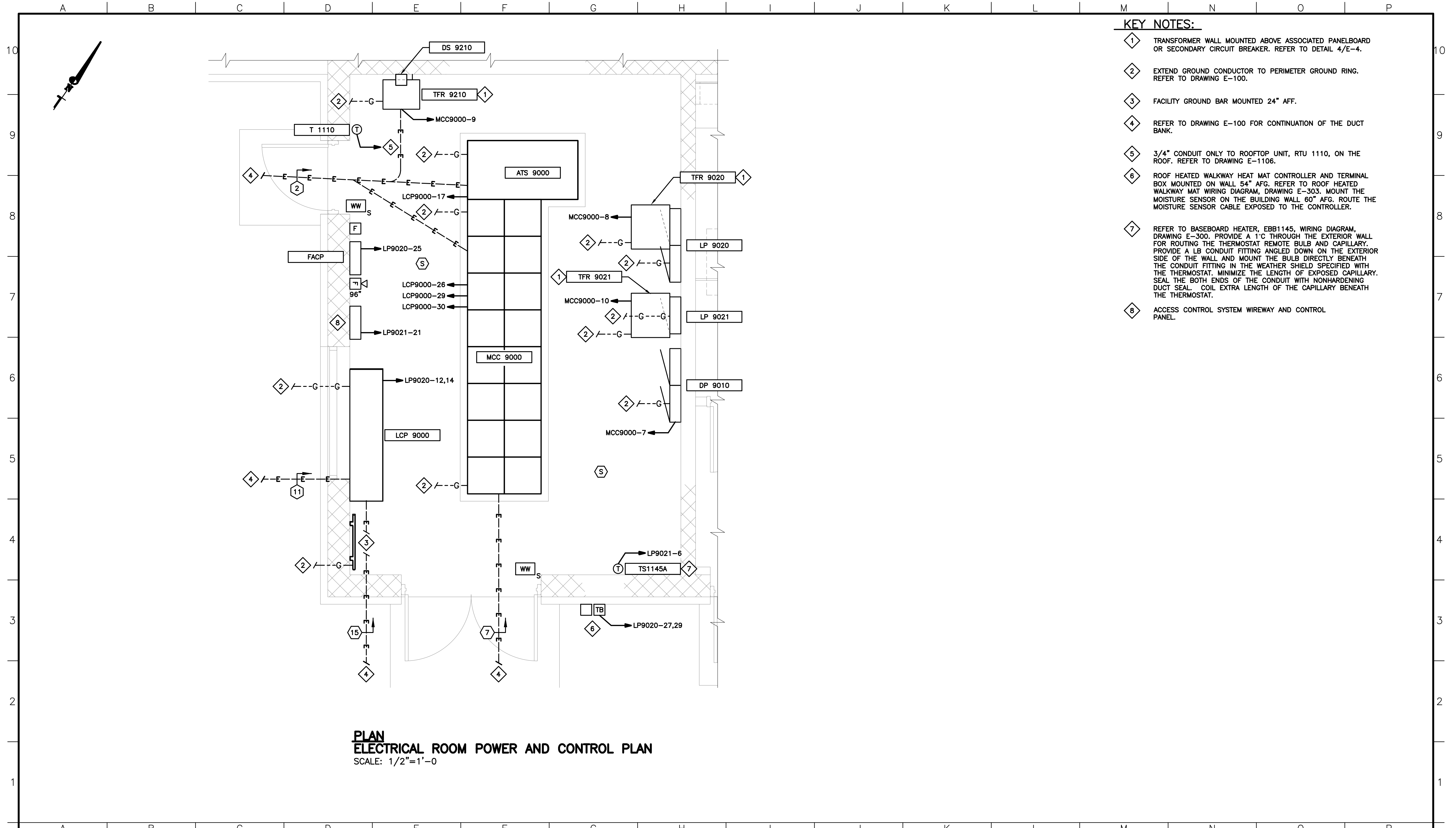
DATE: 05/12/23

PROJECT NUMBER: 50159690

REVISION NO. E

DRAWING NUMBER E-1104

SHEET NUMBER



PLAN
ELECTRICAL ROOM POWER AND CONTROL PLAN
SCALE: 1/2"=1'-0

- KEY NOTES:**
- 1 TRANSFORMER WALL MOUNTED ABOVE ASSOCIATED PANELBOARD OR SECONDARY CIRCUIT BREAKER. REFER TO DETAIL 4/E-4.
 - 2 EXTEND GROUND CONDUCTOR TO PERIMETER GROUND RING. REFER TO DRAWING E-100.
 - 3 FACILITY GROUND BAR MOUNTED 24" AFF.
 - 4 REFER TO DRAWING E-100 FOR CONTINUATION OF THE DUCT BANK.
 - 5 3/4" CONDUIT ONLY TO ROOFTOP UNIT, RTU 1110, ON THE ROOF. REFER TO DRAWING E-1106.
 - 6 ROOF HEATED WALKWAY HEAT MAT CONTROLLER AND TERMINAL BOX MOUNTED ON WALL 54" AFG. REFER TO ROOF HEATED WALKWAY MAT WIRING DIAGRAM, DRAWING E-303. MOUNT THE MOISTURE SENSOR ON THE BUILDING WALL 60" AFG. ROUTE THE MOISTURE SENSOR CABLE EXPOSED TO THE CONTROLLER.
 - 7 REFER TO BASEBOARD HEATER, EBB1145, WIRING DIAGRAM, DRAWING E-300. PROVIDE A 1" C THROUGH THE EXTERIOR WALL FOR ROUTING THE THERMOSTAT REMOTE BULB AND CAPILLARY. PROVIDE A LB CONDUIT FITTING ANGLED DOWN ON THE EXTERIOR SIDE OF THE WALL AND MOUNT THE BULB DIRECTLY BENEATH THE CONDUIT FITTING IN THE WEATHER SHIELD SPECIFIED WITH THE THERMOSTAT. MINIMIZE THE LENGTH OF EXPOSED CAPILLARY. SEAL THE BOTH ENDS OF THE CONDUIT WITH NONHARDENING DUCT SEAL. COIL EXTRA LENGTH OF THE CAPILLARY BENEATH THE THERMOSTAT.
 - 8 ACCESS CONTROL SYSTEM WIREWAY AND CONTROL PANEL.

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DRAWING EPL59690-1105
DRAWN AMJ
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REVISIONS				
REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

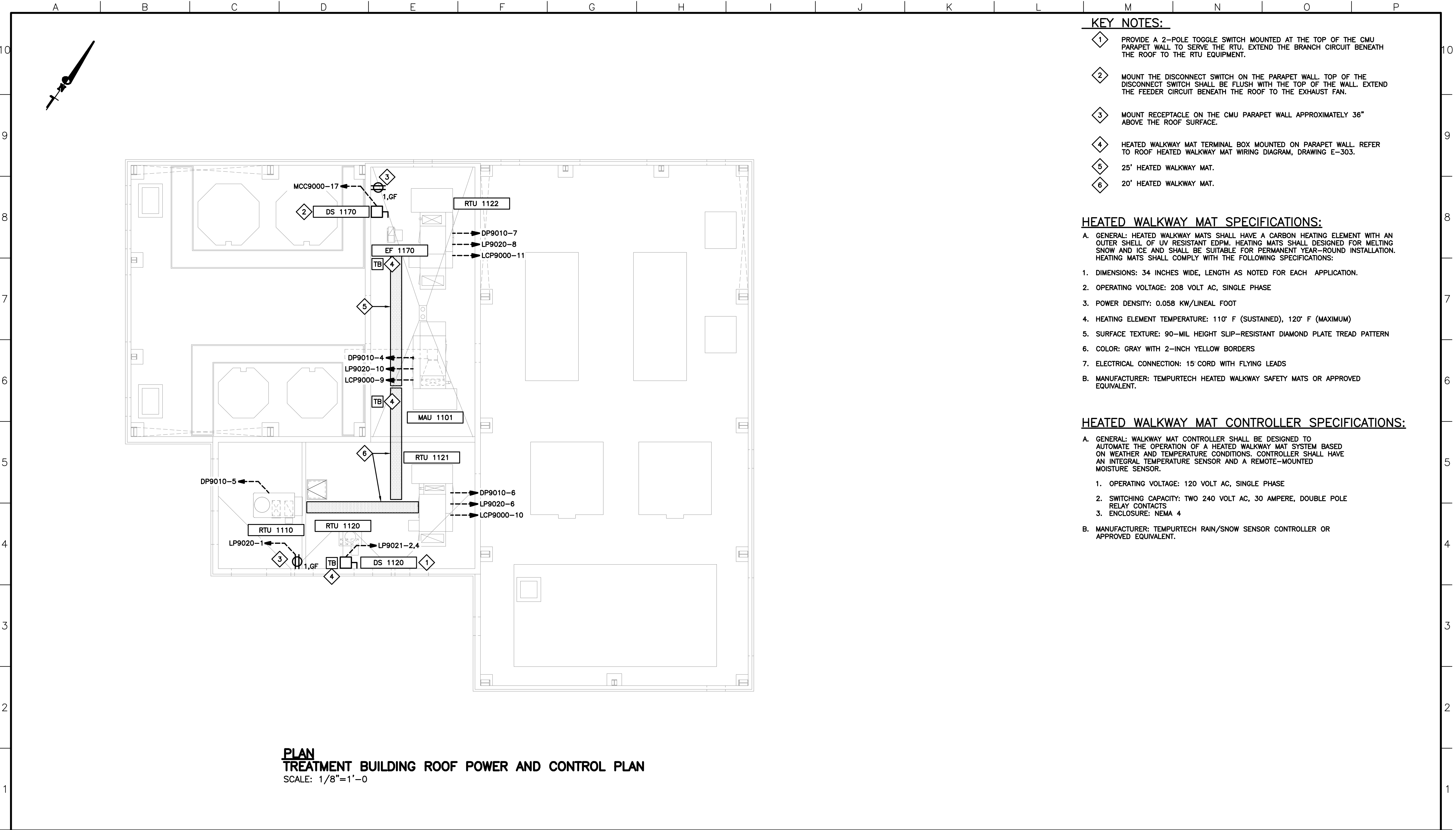
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

ELECTRICAL

WATER TREATMENT PLANT ELECTRICAL
ROOM POWER AND CONTROL PLAN

DATE: 07/24/23
PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER E-1105
SHEET NUMBER



PLAN
TREATMENT BUILDING ROOF POWER AND CONTROL PLAN
SCALE: 1/8"=1'-0

KEY NOTES:

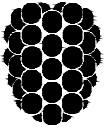
- 1. PROVIDE A 2-POLE TOGGLE SWITCH MOUNTED AT THE TOP OF THE CMU PARAPET WALL TO SERVE THE RTU. EXTEND THE BRANCH CIRCUIT BENEATH THE ROOF TO THE RTU EQUIPMENT.
- 2. MOUNT THE DISCONNECT SWITCH ON THE PARAPET WALL. TOP OF THE DISCONNECT SWITCH SHALL BE FLUSH WITH THE TOP OF THE WALL. EXTEND THE FEEDER CIRCUIT BENEATH THE ROOF TO THE EXHAUST FAN.
- 3. MOUNT RECEPTACLE ON THE CMU PARAPET WALL APPROXIMATELY 36" ABOVE THE ROOF SURFACE.
- 4. HEATED WALKWAY MAT TERMINAL BOX MOUNTED ON PARAPET WALL. REFER TO ROOF HEATED WALKWAY MAT WIRING DIAGRAM, DRAWING E-303.
- 5. 25' HEATED WALKWAY MAT.
- 6. 20' HEATED WALKWAY MAT.

HEATED WALKWAY MAT SPECIFICATIONS:

- A. GENERAL: HEATED WALKWAY MATS SHALL HAVE A CARBON HEATING ELEMENT WITH AN OUTER SHELL OF UV RESISTANT EDPM. HEATING MATS SHALL BE DESIGNED FOR MELTING SNOW AND ICE AND SHALL BE SUITABLE FOR PERMANENT YEAR-ROUND INSTALLATION. HEATING MATS SHALL COMPLY WITH THE FOLLOWING SPECIFICATIONS:
 - 1. DIMENSIONS: 34 INCHES WIDE, LENGTH AS NOTED FOR EACH APPLICATION.
 - 2. OPERATING VOLTAGE: 208 VOLT AC, SINGLE PHASE
 - 3. POWER DENSITY: 0.058 KW/LINEAL FOOT
 - 4. HEATING ELEMENT TEMPERATURE: 110° F (SUSTAINED), 120° F (MAXIMUM)
 - 5. SURFACE TEXTURE: 90-MIL HEIGHT SLIP-RESISTANT DIAMOND PLATE TREAD PATTERN
 - 6. COLOR: GRAY WITH 2-INCH YELLOW BORDERS
 - 7. ELECTRICAL CONNECTION: 15' CORD WITH FLYING LEADS
- B. MANUFACTURER: TEMPURTECH HEATED WALKWAY SAFETY MATS OR APPROVED EQUIVALENT.

HEATED WALKWAY MAT CONTROLLER SPECIFICATIONS:

- A. GENERAL: WALKWAY MAT CONTROLLER SHALL BE DESIGNED TO AUTOMATE THE OPERATION OF A HEATED WALKWAY MAT SYSTEM BASED ON WEATHER AND TEMPERATURE CONDITIONS. CONTROLLER SHALL HAVE AN INTEGRAL TEMPERATURE SENSOR AND A REMOTE-MOUNTED MOISTURE SENSOR.
 - 1. OPERATING VOLTAGE: 120 VOLT AC, SINGLE PHASE
 - 2. SWITCHING CAPACITY: TWO 240 VOLT AC, 30 AMPERE, DOUBLE POLE RELAY CONTACTS
 - 3. ENCLOSURE: NEMA 4
- B. MANUFACTURER: TEMPURTECH RAIN/SNOW SENSOR CONTROLLER OR APPROVED EQUIVALENT.



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DRAWING EPL59690-1106
DRAWN AMJ
DESIGNED SEF
CHECKED SEF

APPROVED:

PRINCIPAL

DATE:

REV.	DESCRIPTION	BY	DATE	APP.
A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM
B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM
C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM
D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM

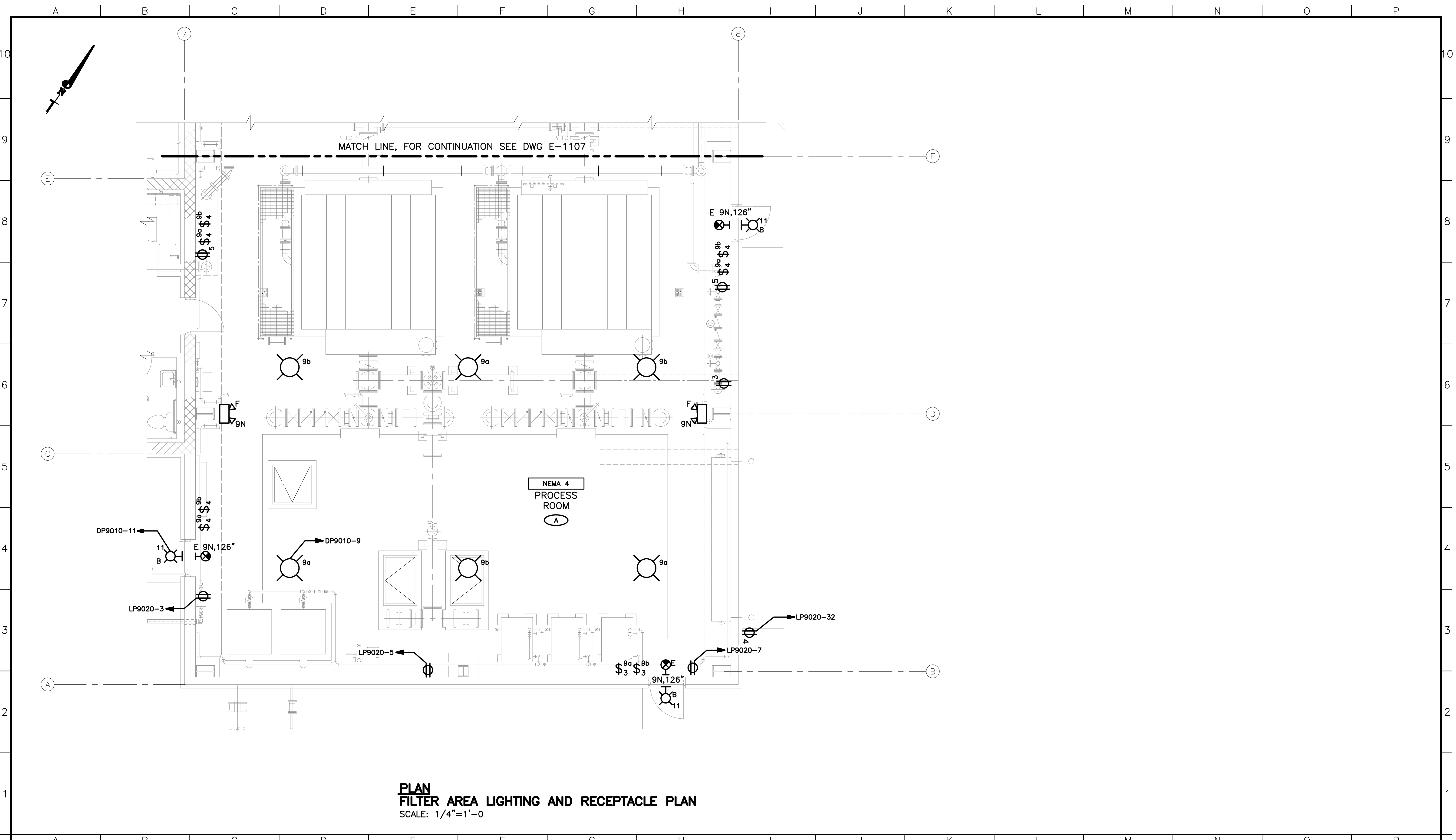
TOWN OF SILT
SILT, COLORADO

WATER TREATMENT PLANT IMPROVEMENTS

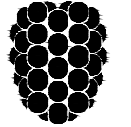
ELECTRICAL

WATER TREATMENT PLANT
TREATMENT ROOF POWER
AND CONTROL PLAN

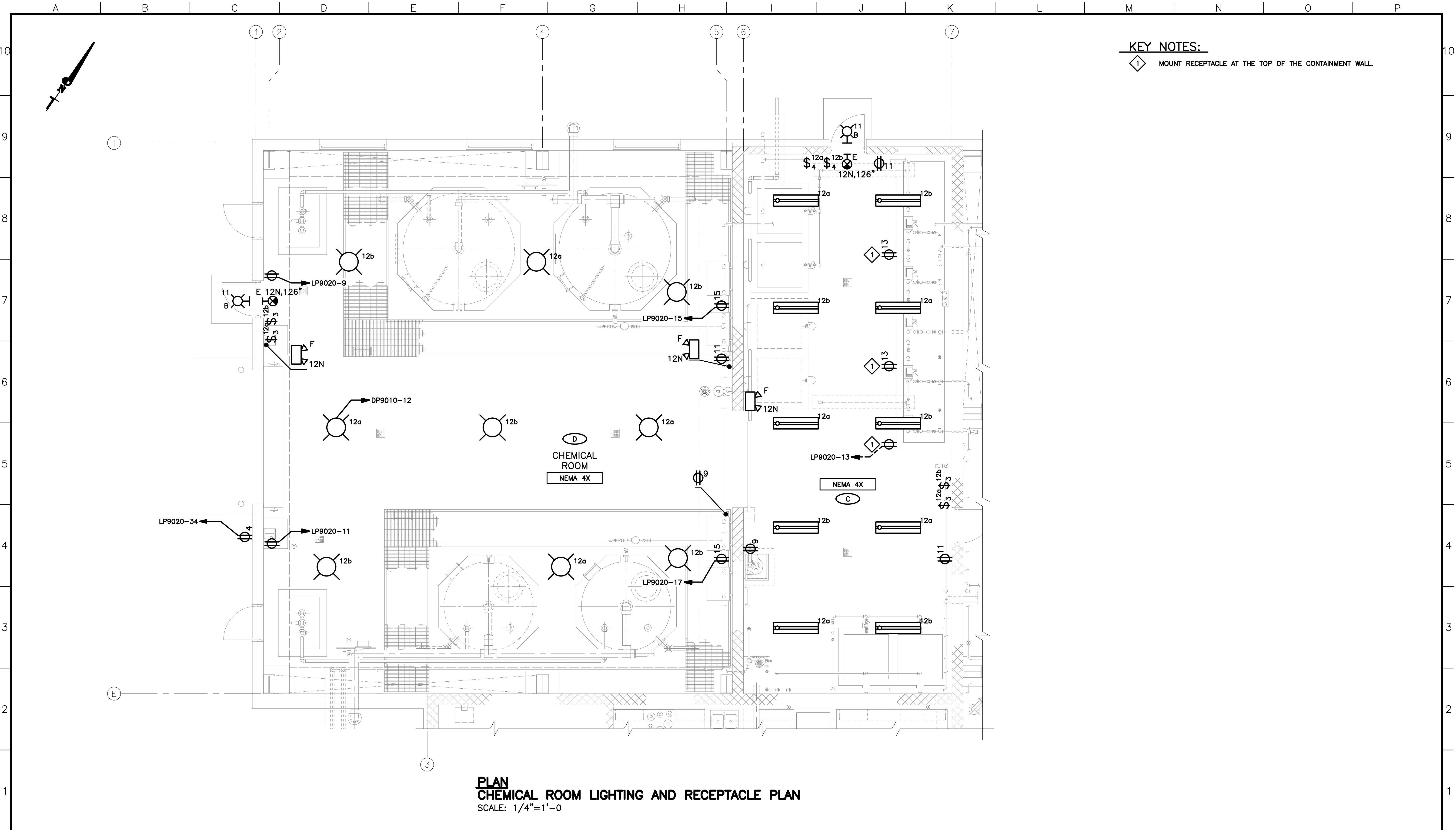
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PROJECT NUMBER: 50159690
REVISION NO. D
DRAWING NUMBER
E-1106
SHEET NUMBER

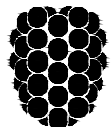


PLAN
FILTER AREA LIGHTING AND RECEPTACLE PLAN
SCALE: 1/4"=1'-0

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		PRINCIPAL	REV.	DESCRIPTION	BY	DATE	APP.					PROJECT NUMBER: 50159690
		DATE:	A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM	REVISION NO. D				
			B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM	DRAWING NUMBER E-1108				
	C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM	SHEET NUMBER						
	D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM							

WATER TREATMENT PLANT IMPROVEMENTS		WATER TREATMENT PLANT FILTER AREA LIGHTING AND RECEPTACLE PLAN	
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A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P			
<div>Dewberry[®] Dewberry Engineers Inc. 990 S. BROADWAY, SUITE 400 Denver, Colorado 80209 (303) 825-1802</div>		<div>LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"=SCALE ACCORDINGLY)</div> <div>DRAWING EPL59690-1109</div> <div>DRAWN AMJ</div> <div>DESIGNED SEF</div> <div>CHECKED SEF</div>	<div>APPROVED:</div> <div>PRINCIPAL</div> <div>DATE:</div>	REVISIONS					TOWN OF SILT SILT, COLORADO				ELECTRICAL				DATE: 07/12/23	
				REV.	DESCRIPTION	BY	DATE	APP.									PROJECT NUMBER: 50159690	
				A	90% DESIGN REVIEW SUBMITTAL	AMJ	07/31/23	RAM	WATER TREATMENT PLANT IMPROVEMENTS								REVISION NO. D	
				B	90% DESIGN ADDENDUM	AMJ	08/16/23	RAM									DRAWING NUMBER	
				C	CDPHE REVIEW SUBMITTAL	AMJ	09/29/23	RAM									E-1109	
				D	BUILDING DEPT REVIEW SUBMITTAL	AMJ	10/13/23	RAM					SHEET NUMBER					
												WATER TREATMENT PLANT CHEMICAL ROOM LIGHTING AND RECEPTACLE PLAN						

50159690

.....

TOWN OF SILT

WATER TREATMENT PLANT

Specifications

BUILDING DEPARTMENT SUBMITTAL
OCTOBER 2023



SUBMITTED BY
Dewberry Engineers Inc.
990 South Broadway, Suite 400
Denver, CO 80209
303.825.1802

SUBMITTED TO
Town of Silt
231 N. 7th Street
PO Box 70
Silt, Colorado 81652

TOWN OF SILT
WATER TREATMENT PLANT IMPROVEMENTS

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SCOPE

- A. Provide all labor, material, and services for the construction, start-up and initial operation of the Silt Water Treatment Plant (WTP) as shown and described in the Contact Documents.

1.02 EXISTING FACILITIES

- A. The Town of Silt's Water Treatment Plant (WTP), Public Water System Identification Number CO0123710, is located on the south side of River Frontage Road west of River Frontage Road/9th Street. The WTP was constructed in 2005 and consists of the following:

1. A raw water intake structure on the Colorado River including a screened intake and pump station with two submersible pumps.
2. Two alluvial wells adjacent to the Colorado River.
3. A process building with a process room, electrical/operations room, restroom, storage room, and compressor room. The process room houses a strainer, flash mixer, membrane filter skids, chemical systems, and finished water pumps.
4. A building housing a plate settler.
5. A clearwell/wet well that sits beneath a portion of the process building.
6. A backwash pond that receives wastewater flows from the WTP and overflows to the Colorado River.

1.03 NEW TREATMENT FACILITIES

- A. The proposed WTP will meet current and future capacity demands, treat the wide range of turbidity in the raw water, and remove iron and manganese from the water. The WTP will also provide required facility redundancy, accommodate planned future growth of the Town, and improve operations. The planned expansion will increase the permitted capacity of the plant to 1 million gallons per day (MGD) with plans for an expansion to increase the capacity to 2 MGD. The new WTP will include.

1. An automatically backwashing strainer
2. Ballasted flocculation pretreatment
3. Mixed media filtration system with greensand
4. A backwash water supply tank and pumps and blowers for filter backwashing
5. UV disinfection system
6. Chemical systems including polymer, sodium hypochlorite, sodium hydroxide, coagulant (aluminum chlorohydrate or ferric chloride), and chlorine dioxide
7. New electrical, instrumentation, and control equipment with automation
8. A new backup generator
9. A new building with process, chemical, electrical, and break rooms

10. Rehabilitation of the existing WTP building
11. Site civil work including roadways, underground piping and electrical, stormwater, grading, demolition, and landscaping.

END OF SECTION

SECTION 01 14 00

WORK RESTRICTIONS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Work shall be scheduled, sequenced, and performed in a manner which minimizes disruption to the operation and maintenance of existing utilities, plants, facilities, buildings, and shall be coordinated with Owner and other appropriate agencies.
- B. Work which affects or could affect Owner's operations shall not be performed without a specific detailed plan provided by the Contractor and approved in advance by Owner and Engineer as described in Sections 1.05 and 1.06 below.
- C. The Contractor shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under Section 01 32 00 - Construction Progress Documentation.
- D. Work shall be limited to areas shown on the plans unless Contractor receives written authorization from Owner.
- E. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work in order to meet the construction schedule accepted by Owner.

1.02 DEFINITIONS AND TERMS

- A. Outage or Shutdown: An event in which part or all of Owner's ongoing plant, facilities, and/or building activities are temporarily discontinued or temporarily out of service to allow for a portion of the Contractor's scheduled work activities to be completed.
- B. Operational Constraints: The work performance constraints required because of Owner's plant, facilities or building operations, which must be maintained at all times. These constraints shall be reflected in the Contractor's construction progress schedule.
- C. Outage Request Form: Form submitted in accordance with section 1.06 below.
- D. Construction Scheduling Constraints: The work performance constraints required because of construction phasing or sequencing with other parts of the work, calendar time constraints, special testing, commissioning, and work procedures. These constraints are in addition to the standard procedural constraints, such as shop drawings, testing, commissioning, training, and operational constraints. These types of constraints shall be included in the Contractor's construction progress schedule.
- E. Special Conditions: Certain special conditions, if any, related to performance of the Work. If they affect the scheduling of the Work, they shall also be included in the Contractor's construction progress schedule.

1.03 WORKING HOURS

- A. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at

the Site shall be performed during the regular working hours of 7:00am to 7:00pm, Monday through Friday, and the Contractor will not permit overtime work or the performance of Work on Saturday, Sunday, or any legal holiday observed by Owner without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Owner. For prior written notice to be considered by Owner, the written notice must be received by Owner 2 days prior to the date for which work outside of regular working hours is being requested. Owner shall not be responsible for any additional cost for overtime work, except as otherwise stated in the Contract Documents. Contractor is advised that some construction activities are subject to temperature restrictions and those restrictions are not waived for the allowable Construction period. In the event Contractor is authorized to allow work outside of regular working hours, Contractor shall be responsible for ensuring that Contractor personnel necessary to supervise the Work are also on-Site during such periods work is being performed outside of regular working hours.

B. Owner Observed Holidays

1. New Year's Day
2. Dr. Martin Luther King Day
3. President's Day
4. Memorial Day
5. Independence Day
6. Labor Day
7. Veteran's Day
8. Thanksgiving Day
9. Day after Thanksgiving
10. Christmas Day

1.04 NOTIFICATION REQUIREMENTS

- A. Contractor shall provide in writing a minimum of 10 days advance notice to Owner for each system, equipment, valve, power, component, etc. proposed for shutdown or disruption and the duration of the proposed shutdown or disruption, all of which shall be subject to Owner's approval, limitations and required sequencing and phasing.

1.05 OUTAGE REQUESTS

- A. Modifications to existing plants, facilities and buildings, the construction of new plants, facilities and buildings, and the connection of new utilities to existing plants, facilities and buildings may require the temporary outage or bypass of existing systems, processes, electrical power, equipment, plants, facilities or buildings. In such cases, the Contractor shall coordinate the work with the Owner. The Contractor shall submit an Outage Request Form, including a detailed outage plan and time schedule for construction activities which will make it necessary to remove systems, processes, electrical power, equipment, structures, roads, plants, facilities, buildings or other components from service.
- B. Complete outages that limit the plant, facility or building's ability to conduct normal operations shall not exceed 8 hours in duration. If a longer outage is required, the Contractor shall coordinate and schedule it with Owner.
- C. The Contractor is required to coordinate outages with the accepted schedules required under Section 01 32 00 – Construction Progress Documentation. Owner may adjust any required

outage dates by up to 6 weeks due to operational needs. Contractor shall not be entitled to seek a Potential Contract Change for adjustment of outage dates as provided in this section and communicated at least 2 weeks in advance.

- D. Outage plans shall be submitted to Owner for acceptance a minimum of 10 days in advance of the time that such outages are required. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of these Contract Documents. The outage plan shall describe the Contractor's method of procedure; bypass pumping as required; the length of time required to complete the operation; any necessary temporary power, controls, instrumentation, or alarms required to maintain control, monitoring, and alarms of the systems, processes or equipment; and the manpower and equipment which the Contractor shall provide in order to ensure proper operation of associated systems, processes and equipment. Costs for preparing and implementing the outage request forms and plans shall be the responsibility of the Contractor as part of the work.
- E. The existing roadways shall remain accessible, operational, and free from obstructions and debris during construction to allow for operations and maintenance access and deliveries to maintain operations. Contractor shall submit an outage plan for roadway outages with an alternate truck route proposed for the outage for review and approval by Owner.
- F. The Contractor shall not begin any work affecting existing utility, plant, facility, or building operations until specific written approval has been provided by Owner for each request.
- G. The Contractor will coordinate their planned procedure with Owner and Engineer. Owner and Engineer have the authority to modify any proposed outage or shutdown procedures if such procedures would adversely impact the operations of the utility, plant, facility or building.
- H. Owner and Engineer shall be notified in writing at least 7 days in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage request and plan are required. The Contractor shall provide written confirmation of the shutdown date and time 3 days prior to the actual shutdown.

1.06 TEMPORARY FACILITIES TO MAINTAIN CONTINUOUS OPERATION

- A. If construction activities cannot be completed within the time limits for planned shutdowns of pipelines, processes, and equipment set forth in this section, the Contractor shall provide such additional temporary plant, piping, equipment, and personnel necessary to comply with the requirements of this section. This shall include but not be limited to generators, pumps, electrical switchgear, wiring, piping, piping connections and supports, temporary structures, and manpower for setup, operation, and removal of temporary items. Where additional or temporary plant or equipment is to be provided, the Contractor shall provide information regarding the type, number, size, location, and other pertinent information as requested by the Owner for review.

1.07 METHOD OF PROCEDURE (MOP)

- A. Owner will provide MOP instructions at the preconstruction meeting. An example is provided below.
- B. Contractor shall prepare MOP for the following conditions:
 - 1. Shutdowns, diversions, and tie-ins to the existing facility, piping, or building.
 - 2. Shutdowns required for demolition or abandonment of existing facility, piping, or building.
 - 3. Process start-up and testing activities.
 - 4. Power interruption and tie-ins.

5. Switch over between temporary and permanent facilities, equipment, piping, electrical and instrumentation systems.
 6. Process constraints requiring interruption of operating processes or utilities.
- C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, or Owner, or Engineer.
- D. No consideration will be given to claims of additional time and cost associated with preparing MOPs required by Owner and Engineer to complete the work in a manner that facilitates proper operation of the utility, plant, facility, and building, and in compliance with local requirements.
- E. Where required to minimize interruptions while complying with specified sequencing constraints, provide temporary measures as necessary, including but not limited to, pumping, power, lighting, controls, instrumentation, safety devices, etc.

1.08 WORK SEQUENCE

- A. Contractor shall construct work in phases or stages to accommodate Owner's use and operation of the premises, utility systems, plant, facilities, and buildings during the construction period. The Contractor shall coordinate construction schedule, outages, and operations with Owner.
- B. Contractor shall allow for adequate time to clean up, as to not disrupt the operation and daily activities of facility personnel and staff.
1. While working the Contractor may be accompanied by Owner's inspectors and operators at all times during which Work is performed.
 2. Owner's inspectors and operators on site are not responsible for the Contractor's means and methods.
- C. Contractor shall perform the removal and placement of all utility, plant, facility, and building systems at an appropriate time not to endanger personnel and staff.
- D. The Contractor shall minimize all outages to the premises, utility systems, plants, facilities, and buildings and shall notify and coordinate all outages and the durations with Owner prior to commencing work to minimize interference with the daily operation and activities of the premises, utility systems, plants, facilities and buildings, including personnel and staff, as required by the Specifications.
- E. Contractor shall schedule Work with Owner to minimize interruptions to the utility, plant, facility, and building services.
- F. Contractor shall construct work in stages to provide for public convenience. Contractor shall not close off public use of facilities until completion of Work that provides alternative usage, except as approved by Owner.
- G. Contractor shall not interrupt or close off utility, plant, facility, and building services until completion of Work that will provide alternative service and usage, except as approved by Owner.

1.09 SUBMITTALS

- A. Contractor submittals required to be submitted shall include, but are not limited to the following:
1. Outage Plan
 2. Outage Request Form

3. Outage Request Log
4. Method of Procedure (MOP) Form
5. Method of Procedure (MOP) Log
6. Startup and Commissioning Plan

1.10 SPECIFIC CONSTRAINTS

A. The listing of constraints below does not mean that every constraint or special condition has been identified. Constraints and special conditions listed below do not relieve the Contractor of the responsibility for coordination and planning for completion of the Work in accordance with the Contract.

1. The existing WTP must remain in operation until the new WTP is commissioned and operation. Demolition of the existing WTP cannot begin until the new WTP is commissioned and operational. Equipment necessary for operation of the new WTP shown to be installed in the existing WTP building will need to be temporarily installed in an alternative location(s) to allow the new WTP to be commissioned and operate while the existing WTP is demolished. Depending on WTP flow rates the UV equipment may not be required to be installed temporarily while demolishing the existing WTP. Coordinate with the Engineer during construction.
2. Equipment and infrastructure (e.g. the raw water system, air compressor system, clearwell, finished water pump station, etc.) that is required for operation of the new WTP shall remain operational while the existing WTP equipment and piping is decommissioned and demolished.
3. Truck access to the wastewater treatment plant shall be maintained throughout construction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 13

PRODUCT SUBSTITUTIONS PROCEDURES

PART 1 GENERAL

1.01 SUBSTITUTIONS

- A. For a period of 30 days after the effective date of the Contract, Owner and Engineer will consider formal requests from Contractor for substitution of products in place of those specified. When specific manufacturers are listed, substitution requests will only be entertained for those items where "Engineer Approved Equal" is also listed. Contractor shall include a payment of \$2,000 with each substitution request to cover the engineering time to review and verify the product is equal to the specified product. After end of that period, requests will be considered only in case of product unavailability or other conditions beyond control of Contractor.
- B. Contractor shall submit requests for substitution for consideration using the attached Product Substitution Request Form. Substitutions submitted by any other manner will not be considered by Owner. Contractor shall limit each request to one proposed Substitution. Contractor shall submit the following supporting documentation with each Product Substitution Request Form:
1. Complete data substantiating compliance of proposed substitutions with requirements stated in Contract Documents. The burden of proving a substitution complies with the Contract Documents and the risk of any non-compliance is on Contractor.
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature; identify:
 - 1) Product description.
 - 2) Reference standards.
 - 3) Performance and test data.
 - c. Samples, as applicable.
 - d. Name and address of a minimum of 3 similar projects on which product has been used, and date of each installation.
 2. Itemized comparison of proposed substitution with product specified; list significant variations.
 3. Data relating to changes in construction schedule.
 4. Any effect of substitution on separate contracts.
 5. List of changes required in other work or products as a result of the substitution.
 6. Accurate cost data comparing proposed substitution with product specified. Change request for amount of any net change to Contract Price.
 7. Designation of required license fees or royalties.
 8. Designation of availability of maintenance services, sources, or replacement materials.
- C. Substitute products shall not be ordered or installed without Contractor submitting a Product Substitution Request Form along with supporting documentation as set forth in this Section and Contractor receiving notification in writing of acceptance from Owner and Engineer.

- D. Owner and Engineer will determine acceptability of proposed substitutions requested by the Contractor.

1.02 CONTRACTOR'S REPRESENTATION

- A. In submitting a Product Substitution Request Form, Contractor represents that:

1. It has investigated the proposed product and has determined that it is equal to or superior in all respects to that specified.
2. It will provide the same warranties or Bonds for substituted products as for the product specified or as required by Owner.
3. It will coordinate installation of accepted substitutions into the Work and will make such changes as may be required for Work to be complete in all respects.
4. It waives claims for additional costs caused by substitution which may subsequently become apparent.
5. Cost data is complete and includes related costs under its Contract, but not:
 - a. Costs under separate Contracts.
 - b. Engineer's costs for redesign or revision of Contract Documents.
6. Contractor shall include a payment of \$2,000 with each substitution request to cover the engineering time to review and verify the product is equal to the specified product, whether proposed substitute is accepted or rejected.
7. At Owner's discretion, Contractor will reimburse Owner for charges of Engineer or Engineer's consultants for any required redesign to incorporate the substitution, whether proposed substitute is accepted or rejected.

1.03 ENGINEER'S DUTIES

- A. Engineer will review Contractor's requests for substitution as defined in Section 01 33 00 – Submittal Procedures with reasonable promptness and advise Owner.
- B. Engineer will notify Owner in writing of Engineer's decision to accept or reject requested substitution.

1.04 OWNER DUTIES

- A. Owner will review Contractor's requests for substitution as defined in Section 01 33 00 – Submittal Procedures.
- B. Owner will notify Contractor in writing of Owner's decision to accept or reject requested substitution.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

PRODUCT SUBSTITUTION REQUEST FORM

To: _____

Project: _____

Specified Item: _____
Section Page Paragraph Description

The undersigned request consideration of the following:

PROPOSED SUBSTITUTION _____

Attached data includes product description, specifications, drawings, photographs, performance, and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

The undersigned certifies that the following paragraphs, unless modified by attachments are correct:

1. The proposed substitution does not affect dimensions shown on Drawings.
2. The undersigned will pay for changes to the building design, including engineering design, detailing, and construction costs caused by the requested substitution.
3. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
4. Maintenance and service parts will be locally available for the proposed substitution.

The undersigned further states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item.

Submitted by:

Signature _____

Firm _____

Address _____

Date _____

Telephone _____

Attachments

For use by Owner and Engineer

☐ Approved ☐ Approved as noted

☐ Not Approved ☐ Received too late

By _____

Date _____

Remarks _____

SECTION 01 32 00

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals

1. Preliminary Progress Schedule: Submit at least 7 days prior to preconstruction conference.
2. Detailed Progress Schedule:
 - a. Submit initial Detailed Progress Schedule within 20 days after Effective Date of the Agreement.
 - b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
 - c. 3-Week Look Ahead Schedule
3. Submit with Each Progress Schedule Submission:
 - a. Contractor's certification that Progress Schedule submission is actual schedule being utilized for execution of the Work.
 - b. Progress Schedule: One legible copy.
4. Prior to final payment, submit a final Updated Progress Schedule.

1.02 PROJECT MILESTONES

A. Include Project Milestones with Progress Schedule specified as follows and as described in the Owner-Contractor Agreement:

1. Substantial Completion: Work specified in Section 01 11 00, Summary of Work, with the following exceptions:
 - a. Revegetation requirements for permanent seeding and mulching in accordance with the Drawings and Sections 32 90 10, Revegetation and 32 92 00, Seeding.
2. Final Completion: Work specified in Section 01 11 00, Summary of Work.

1.03 PRELIMINARY PROGRESS SCHEDULE

A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 90 days, and a summary of balance of Project through Final Completion.

B. Show activities including, but not limited to the following:

1. Notice to Proceed.
2. Permits.
3. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
4. Early procurement activities for long lead equipment and materials.

5. Initial Site work.
 6. Earthwork.
 7. Specified Work sequences and construction constraints.
 8. Contract Milestone and Completion Dates.
 9. Major structural, mechanical, and equipment Work.
 10. System startup summary.
 11. Project close-out summary.
 12. Demobilization summary.
- C. Update Preliminary Progress Schedule monthly; as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.
- D. Format: Bar Chart.

1.04 DETAILED PROGRESS SCHEDULE

- A. In addition to requirements of General Conditions, submit Detailed Progress Schedule beginning with Notice to Proceed and continuing through Final Completion.
- B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.
- C. When accepted by Engineer, Detailed Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.
- D. Format: Bar Chart.
- E. Update monthly to reflect actual progress and occurrences to date, including weather delays.

1.05 PROGRESS SCHEDULE - BAR CHART

- A. General: Comprehensive bar chart schedule, generally as outlined in Associated General Contractors of America (AGC) 580, "Construction Project Planning and Scheduling Guidelines." If a conflict occurs between the AGC publication and this Specification, this Specification shall govern.
- B. Format
1. PDF or, if requested, white paper, 11-inch by 17-inch sheet size.
 2. Title Block: Show name of project and Owner, date submitted, revision or update number, and name of scheduler.
 3. Identify horizontally, across the top of the schedule, the time frame by year, month, and day.

4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
 5. Early start and early finish dates for each activity.
 6. Successor and predecessor activity numbers for each activity.
 7. Legend: Describe standard and special symbols used.
- C. Contents: Identify, in chronological order, those activities reasonably required to complete the Work, including as applicable, but not limited to:
1. Obtaining permits, submittals for early product procurement, and long lead time items.
 2. Mobilization and other preliminary activities.
 3. Initial Site work.
 4. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s).
 5. Subcontract Work.
 6. Major equipment design, fabrication, factory testing, and delivery dates.
 7. Sitework.
 8. Concrete Work.
 9. Conveying systems Work.
 10. Equipment Work.
 11. Mechanical Work.
 12. Other important Work for each major facility.
 13. Pipeline hydrostatic testing and disinfection.
 14. Equipment and system startup and test activities.
 15. Project closeout and cleanup.
 16. Demobilization.

1.06 PROGRESS OF THE WORK

- A. Updated Progress Schedule shall reflect:
1. Progress of Work to within 5 working days prior to submission.
 2. Approved changes in Work scope and activities modified since submission.
 3. Delays in Submittals or resubmittals, deliveries, or Work.
 4. Adjusted or modified sequences of Work.
 5. Other identifiable changes.
 6. Revised projections of progress and completion.
 7. Report of changed logic.
- B. Produce detailed subschedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

- C. If Contractor fails to complete an activity by its latest scheduled completion date and this failure is anticipated to extend Contract Times (or Milestones), the Contractor shall, within 7 days of such failure, submit a written statement as to how Contractor intends to correct nonperformance and return to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.
- D. Owner may order Contractor to increase equipment, labor force or working hours, at no additional cost to the Owner, if Contractor fails to:
 - 1. Complete a Milestone activity by its completion date.
 - 2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project.

1.07 THREE WEEK LOOK AHEAD

- A. Provide a three (3) week look ahead schedule that includes the week in which the schedule is presented plus the two successive weeks thereafter. Submit no later than 48 hours prior to weekly project progress meeting.

1.08 SCHEDULE ACCEPTANCE

- A. Engineer's acceptance will demonstrate agreement that:
 - 1. Proposed schedule is accepted with respect to:
 - a. Contract Times, including Final Completion and all intermediate Milestones are within the specified times.
 - b. Specified Work sequences and constraints are shown as specified.
 - c. Access restrictions are accurately reflected.
 - d. Startup and testing times are as specified.
 - e. Submittal review times are as specified.
 - 2. In all other respects, the Engineer's acceptance of the Contractor's schedule indicates that, in the Engineer's judgment, the schedule represents a reasonable plan for constructing the Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless the Contractor has explicitly called the nonconformance to the Engineer's attention in the submittal. Schedule remains the Contractor's responsibility and the Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct the Project in accordance with the Contract Documents.
- B. Unacceptable Preliminary Progress Schedule
 - 1. Make requested corrections; resubmit within 10 days.
 - 2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, during which time Contractor shall update schedule on a monthly basis to reflect actual progress and occurrences to date.
- C. Unacceptable Detailed Progress Schedule

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Supplemental transmittal forms:
 - 1. Operations and Maintenance Manual Transmittal Form
 - 2. Equipment Record Form
 - 3. Manufacturer's Installation Certification Form
 - 4. Manufacturer's Instruction Certification Form

1.02 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.03 SUBMITTAL PROCEDURES

- A. Forms: The preferred forms for submittals are as developed by the Engineer. Obtain consent of the Engineer prior to using other forms.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Submittals Schedule: Comply with requirements in Section 01 32 00, Construction Progress Documentation, for list of submittals and time requirements for scheduled performance of construction activities.
- D. Within 7 days after the date of commencement as stated in the Notice to Proceed, submit the following items for review:
 - 1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("Or Approved Equivalent") submittals as required in the Contract Documents.

- E. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review commences on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise when a submittal being processed must be delayed for coordination. It is considered reasonable that a complete and acceptable submittal is made to the Engineer by the first resubmittal on an item. Owner reserves the right to withhold monies to cover additional costs of the Engineer's review beyond the first resubmittal. The Engineer's maximum review period for each submittal or resubmittal will be 15 working days.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 working days for review of each resubmittal.
- F. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 6 by 8 inches on label or beside title block to record review and approval markings and action taken by Engineer.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Submittal number or other unique identifier, including revision identifier.
 - 1) Use the Specification Section number followed by a decimal point and then a sequential number (e.g., 06 10 00.01) for the submittal number. Resubmittals include an alphabetic suffix after another decimal point (e.g., 06 10 00.01.A).
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Other necessary identification.
- G. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.
- H. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

1. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.
- I. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Include the Engineer's standard submittal transmittal form, a reproducible copy of which is available from the Engineer, with each transmitted submittal. Submittals without the form or where applicable items on the form are not completed will be returned for resubmittal. Engineer will discard submittals received from sources other than Contractor.
1. Organization:
 - a. Use a single submittal transmittal form for each technical specification section or item or class of material or equipment for which a submittal is required. A single submittal covering multiple sections will not be acceptable, unless the primary specification references other sections for components.
 - b. On the transmittal form, index the components of the submittal and insert tabs in the submittal to match the components. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title or room number as applicable.
 - c. Unless indicated otherwise, match terminology and equipment names and numbers used in submittals with those used in the Contract Documents.
 - d. Disorganized submittals will be returned without review.
- J. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked "Reviewed with Engineer's action stamp."
- K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
1. Use for Construction: Use only final submittals with mark indicating "Reviewed with Engineer's action stamp" taken by Engineer.

1.04 PRECONSTRUCTION CONFERENCE SUBMITTALS

- A. At the preconstruction conference, submit the following items to the Engineer for review:
1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitute ("Or Approved Equivalent") submittals listed in the Bid.
 2. Obtain a list of permits and licenses, indicating the agency required to grant the permit, the expected date of submittal for the permit, required date for receipt of the permit, and required date for receipt of transferred permits obtained by the Owner.
 3. A Preliminary Baseline Schedule in accordance with Specification Section 01 32 00, Construction Progress Documentation.
 4. The preliminary site-specific safety plan.

1.05 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Manufacturer's catalog cuts.
 - e. Wiring diagrams showing factory-installed wiring.
 - f. Printed performance curves.
 - g. Operational range diagrams.
 - h. Compliance with specified referenced standards.
 - i. Testing by recognized testing agency.
 - 4. Number of Copies: Provide electronic copies of all Product Data submittals. Submittal comments will be returned electronically.
- C. Shop Drawings: Wherever called for in the Contract Documents or where required by the Engineer, furnish a Shop Drawing submittal. Shop Drawings may include detailed design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items. Include the signature and seal of an engineer registered in the appropriate branch in the State of Colorado, unless otherwise indicated, whenever design calculations are required to be submitted as part of a submittal. Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shop work manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Notation of coordination requirements.

- j. Notation of dimensions established by field measurement.
 - k. Relationship to adjoining construction clearly indicated.
 - l. Seal and signature of professional engineer if specified.
 - m. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
- 2. Transmittal Form: Include the Engineer's standard submittal transmittal form, a reproducible copy of which is available from the Engineer, with Shop Drawing submittals. A submittal without the form or where applicable items on the form are not completed will be returned for resubmittal.
 - 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8½ by 11 inches but no larger than 36 by 48 inches.
 - 4. Number of Copies: Submit one electronic copy ("PDF" format) of each submittal. Engineer will return a transcribed copy in non-editable electronic format.
 - 5. Collate and bind: Number every page in a submittal in sequence. Collate and staple or bound, as appropriate each copy of a submittal. The Engineer will not collate sheets or copies.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
- 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of appropriate Specification Section.
 - 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available. Copied color charts do not always represent colors accurately and will not be accepted.
 - a. Number of Samples: Submit three full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return one submittal with options selected for samples for verification.
 - 5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

- a. Number of Samples: Submit three sets of Samples. Engineer will retain two Sample sets; one Sample set will be returned.
 - E. Product Schedule or List: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location.
 - 1. Number of Copies: Submit one electronic copy ("PDF" format). Engineer will return one electronic copy.
 - a. Submittals Schedule: Comply with requirements specified in Specification Section 01 32 00, Construction Progress Documentation.
 - b. Application for Payment: Comply with Owner requirements.
 - c. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.
 - 2. Number of Copies: Submit an electronic copy of the subcontractor list, unless otherwise indicated. Engineer will return one electronic copy.
- 1.06 INFORMATIONAL SUBMITTALS
- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 - 1. Number of Copies: One electronic copy ("PDF" format). Engineer will not return copies.
 - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Include the signature of an officer or other individual authorized to sign documents on behalf of that entity for certificates and certifications.
 - 3. Test and Inspection Reports: Comply with requirements specified in Specification Section 01 45 16, Contractor Quality Control.
 - B. Contractor's Construction Schedule: Comply with requirements specified in Specification Section 01 32 00, Construction Progress Documentation.
 - C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of engineers, architects, and owners, and other information specified.
 - D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
 - E. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 - F. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 - G. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

- H. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- I. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- J. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- K. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- L. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- M. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- N. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- O. Operations and Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Specification Section 01 77 00, Closeout Procedures.
- P. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, used for calculations. Include page numbers.
- Q. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.
- R. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
 - 1. Statement on condition of substrates and their acceptability for installation of product.
 - 2. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.

1.07 RECORD DRAWINGS

- A. Maintain one full sized set of Drawings at the Site for the preparation of record drawings. On these, mark every project condition, location, configuration, and other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction. Give special attention to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings. Supplement record drawings by detailed sketches as necessary or as directed, to fully indicate the Work as actually constructed. These record drawings represent as-built conditions, including revisions made by addenda and change orders, and maintained up to date during the progress of the Work. Use red ink for alterations and notes. Notes identify relevant Change Orders by number and date.
- B. A current, electronic copy of record drawings shall be submitted to the Engineer by the 25th day of every month in conjunction with the monthly pay application as well as at completion of Work. Failure to submit current record drawings may result in payment application being rejected for approval as described in Article 7 of the agreement. Electronic copy of record drawings shall consist of a scanned image of the hardcopy markup or digitally marked up and annotated PDFs produced using Bluebeam, Adobe Acrobat, or other approved equivalent software showing as-built conditions. Paper copies of the record drawings may be required by the Engineer by the 25th day of every month in conjunction with the monthly pay application as well as at completion of Work. Failure to submit complete requested record drawings may result in payment application being rejected for approval as described in Article 7 of the agreement.
- C. Provide Engineer with access to record drawings during the construction period.

1.08 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1.09 ENGINEER'S ACTION

- A. General: Engineer will not receive submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Engineer will receive each submittal and forward to appropriate entity to make marks to indicate corrections or modifications required and return it. Engineer will stamp each submittal when received. Reviewing entity will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 - 1. NO EXCEPTIONS TAKEN: Submittal is approved, formal revision and resubmission will not be required.
 - 2. MAKE CORRECTIONS NOTED: Make the corrections on the submittal, but formal revision and resubmission will not be required.
 - 3. AMEND AND RESUBMIT: Amend and resubmit the required number of copies. Resubmittal of portions of multi-page or multi-drawing submittals will not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing

noted as "AMEND AND RESUBMIT," the submittal as a whole is deemed "AMEND AND RESUBMIT" and all 10 drawings are required to be resubmitted.

4. REJECTED: If a submittal is returned marked "REJECTED," the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed or is a substitution request not submitted in accordance with the Contract Documents. Prepare a new submittal that is in conformance with the Contract Documents and submit the required number of copies for review.
 5. INFORMATION ONLY: If a submittal is returned marked "INFORMATION ONLY," the submittal is for informational purposes only and has been received.
- C. Fabrication of an item may commence only after the Engineer has returned the pertinent submittals marked either "REVIEWED – NO EXCEPTIONS" or "REVIEWED – EXCEPTIONS NOTED." Corrections indicated on submittals are considered as changes necessary to meet the requirements of the Contract Documents and not as changes to the contract requirements.
 - D. Review submittals prior to submission to the Engineer. Sign and date each submittal as being correct and in strict conformance with the Contract Documents. In the case of Shop Drawings, date and sign each sheet. Note deviations from the Contract Documents on the transmittal sheet. The Engineer will only receive submittals that have been so verified. Non-verified submittals will be returned without action taken.
 - E. Corrections or comments made on the Contractor's Shop Drawings during review do not relieve the Contractor from compliance with Contract Drawings and Specifications. Review is for conformance to the program, design concept and general compliance with the Contract Documents only. The Contractor is responsible for confirming and correlating all dimensions and quantities, fabrication processes and techniques, coordinating the Work of all trades, satisfactory and safe performance of the Work, and the quality, means, and methods of construction.
 - F. Informational Submittals: Engineer will review each submittal and will not return it or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
 - G. Partial submittals are not acceptable, will be considered non-responsive, and will be returned without review.
 - H. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

1.10 SUPPLEMENTAL TRANSMITTAL FORMS

- A. Form 01 33 00-B: Submittal Transmittal
- B. Form 01 33 00-C: Operations and Maintenance Manual Transmittal Form
- C. Form 01 33 00-D: Equipment Record Form
- D. Form 01 33 00-E: Manufacturer's Installation Certification Form
- E. Form 01 33 00-F: Manufacturer's Instruction Certification Form

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

01 33 00 – B: SUBMITTAL TRANSMITTAL

Submittal Description: _____

Submittal No.: _____

Bid Package No(s): _____

Spec. Section: _____

Project: Water Treatment Plant Design

Contractor: _____

Engineer: Dewberry Engineers Inc.

Owner: Town of Silt

Routing	Date Sent	Date Received
Contractor / Field Eng		
Field Eng / Engineer		
Engineer / Field Eng		
Field Eng / Contractor		

We are sending you: ☐ Attached
☐ Under separate cover via _____
☐ Submittals for review and comment
☐ Product data for information only

Remarks: _____

Item No.	Date	Spec. Section No.	Description	Review action ^a	Reviewer initials	Review comments attached

Notes: (a) **NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected, Develop Replacement; I = Incomplete, not reviewed.**

Attach additional sheets if necessary.

Contractor:

(Certify either A or B)

- ☐ A. We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work as specified (no exceptions).
- ☐ B. We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

Item No.Deviation

Certified by: _____

Contractor's Signature _____

01 33 00-C. OPERATION AND MAINTENANCE MANUAL TRANSMITTAL FORM

Date: _____ Submittal No.: _____
 To: _____ Contract No: _____
 _____ Spec. Section: _____
 _____ Submittal Description: _____
 _____ From: _____
 Attention: _____

Checklist	Contractor		Construction Manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Startup, shutdown, and post-shutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Trouble-shooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance manhours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				
24. Calibration procedures				

Remarks: _____

 Contractor's Signature

01 33 00-D. EQUIPMENT RECORD FORM

EQUIP DESCRIP				EQUIP LOC			
EQUIP NO.		SHOP DWG NO.		DATE INST		COST	
MFGR				MFGR CONTACT			
MFGR ADDRESS						PHONE	
VENDOR				VENDOR CONTACT			
VENDOR ADDRESS						PHONE	
MAINTENANCE REQUIREMENTS						D	W
						M	Q
						S	A
						HOURS	
LUBRICANTS RECOMMENDED:							
ALTERNATIVE:							
MISC. NOTES:							
RECOMMENDED SPARE PARTS				ELECTRICAL NAMEPLATE DATA			
PART NO.	QUAN.	PART NAME	COST	EQUIP			
				MAKE			
				SERIAL NO.		ID NO.	
				MODEL NO.		FRAME NO.	
				HP	V	AMP	HZ
				PH	RPM	SF	DUTY
				CODE	INSL CL	DES	TYPE
				NEMA DES	C AMB	TEMP RISE	RATING
				MISC			
				MECHANICAL NAMEPLATE DATA			
				EQUIP			
				MAKE			
				SERIAL NO.		ID NO.	
				MODEL NO.		FRAME NO.	
				HP	RPM	CAP	SIZE
				TDH	IMP SZ	BELT NO.	CFM
				PSI	ASSY NO.	CASE NO.	
				MISC			

01 33 00-E. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No: _____ Specification Section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations and that the trial operation of the equipment item has been satisfactory.

Comments: _____

Date

Manufacturer

Signature of
Authorized Representative

Date

Contractor

Signature of
Authorized Representative

SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

PART 1 GENERAL

1.01 GENERAL

- A. This Specification provides procedures and requirements for environmental protection, and information to assist Contractor with environmental compliance.
- B. In the event of conflicts between this Specification and the requirements of Laws and Regulations; the more restrictive shall apply.
- C. Refer also to:
 - 1. Section 01 41 00 - Project Permits.
 - 2. Section 01 57 19 - Environmental Controls.
 - 3. Section 01 74 19 - Waste Management & Waste Disposal.

1.02 ENVIRONMENTAL REPRESENTATIVE

- A. Contractor shall designate a qualified individual(s) to be responsible for environmental compliance, whose primary or supplementary duties and responsibilities shall include implementing, coordinating, and monitoring the Work's environmental related activities in an organized, planned, efficient, and documented manner.
- B. Prior to commencing construction activities and when site conditions change, Contractor shall ensure employees, subcontractors, and suppliers have received the environmental compliance related training or instruction necessary.
- C. Contractor shall maintain Environmental Compliance Documentation in an organized and up-to-date environmental records binder or environmental management system.

1.03 ENVIRONMENTAL COMPLIANCE

- A. Contractor shall comply with all environmental related Laws and Regulations.
- B. Contractor shall obtain, comply with, and pay for all applicable Permits, perform all notifications, and coordinate all inspections, unless otherwise provided in the Contract Documents.
- C. Contractor shall comply with all applicable Permits obtained by Owner, unless otherwise provided in the Contract Documents
- D. Contractor shall identify all potential pollutant sources related to the Work that may adversely affect Environmental Receptors. Contractor shall plan for and design sufficient Best Management Practices (BMPs) / Control Measures to prevent impact from potential pollutant sources to Environmental Receptors for the duration of the Work.
 - 1. Examples of common pollutant generating activities include the delivery, handling, storing, loading, using, transporting, and disposing of liquids, solids, and/or gases.
 - 2. Examples of common pollutants include sediment (mud or dirt), excavated or imported Environmental Media, concrete washout water, stucco, paints, chemicals, solvents, fuels,

lubricants, pesticides, herbicides, fertilizers, cleaning products, trash, litter, garbage, and sanitary waste (e.g. portable toilets).

- E. Contractor shall be observant for Biological, Cultural, Historical, and Natural Resources within and near the project limits for the duration of Work and ensure they are protected.
- F. Contractor shall be observant of migratory birds to ensure no nesting birds will be impacted. A migratory bird survey is to be done by others unless otherwise specified in the Contract Documents. This applies to any Soil Disturbing Activity and/or demolition of buildings / structures and vegetation removal.
- G. Contractor shall ensure supervisors and workers involved with Work that has the potential of encounter or disturb asbestos containing material (ACM) have the necessary training to readily identify potential ACM common to the construction industry and the Work. Only Colorado certified individuals, consulting firms, general abatement contractors, and Colorado registered laboratories shall perform any Work involving friable and non-friable potential ACM.
- H. If Work includes the import of Contractor-sourced Environmental Media, Contractor shall perform a reasonable level of due diligence to assure that the material does not contain unacceptable levels of Hazardous Substances or Hazardous Materials, or regulated Debris.
- I. Contractor shall be knowledgeable of OSHA's Lead in Construction publication, No. 3142-12R, dated 2004.
- J. If any of the following are unexpectedly discovered within or near project limits (i.e., not identified as part of Work), Contractor shall not disturb, immediately stop work within the area, secure the area, and notify Owner' Representative.
 - 1. Potentially regulated Biological, Cultural, Historical, and/or Natural Resources.
 - 2. Injured or dead bird, bird parts, nest, or egg.
 - 3. Soil potentially contaminated with Hazardous Materials, Hazardous Substances, regulated Debris, or potential Regulated Asbestos Contaminated Soil (RACS).
 - 4. Liquids or material reasonably believed to contain asbestos, polychlorinated biphenyls (PCBs), lead, Hazardous Substances, or Hazardous Materials.
 - 5. Any containers of unknown liquids.
- K. Sampling, measurements, and inspections used to determine regulatory compliance shall be performed by appropriately trained and qualified personnel.
- L. Analytical testing used to determine regulatory compliance shall be performed by laboratories that maintain the qualifications / accreditations / certifications required by applicable Laws and Regulations. In the absence of specifically defined regulatory requirements, laboratories utilized shall at a minimum be accredited via the National Voluntary Laboratory Accreditation Program (NVLAP - accredited) or be approved by Utilities' Representative.
- M. Ensure proper waste management & disposal, as specified in Section 01 74 19 – Waste Management and Disposal.
- N. Ensure proper termination and/or transfer, if agreed, of all Permits and other continued environmental obligations.

1.04 REGULATORY AGENCY INSPECTIONS

- A. Regulatory inspections shall be conducted in a professional, coordinated, and well-organized manner:
1. For Pre-Scheduled Inspections, Contractor shall:
 - a. Notify Owner's Representative upon receiving knowledge of an impending inspection.
 - b. Schedule inspection to allow sufficient time for preparation, if possible.
 - c. Collaborate with Owner prior to the inspection to define roles & responsibilities, procedures, safety requirements, and security requirements to be followed during the inspection.
 - d. Collaborate with Owner immediately following the inspection to discuss any deficiencies identified and other necessary follow-up matters.
 2. For Unannounced Inspections, Contractor shall:
 - a. Normal courtesies should be conveyed.
 - b. The inspector should be taken to a convenient waiting area and asked to wait a reasonable length of time to allow for appropriate representatives to participate, and so that safety and security requirements to be followed during the inspection can be defined. A reasonable length of time would typically be ~30 minutes, but potentially longer depending on the project location and safety requirements.
 - c. Promptly notify and collaborate with Owner's Representative and/or Environmental Services Division.
 - d. Ask the inspector to schedule the inspection on a future date if appropriate representatives cannot be assembled.

1.05 PROHIBITION ON ASBESTOS CONTAINING MATERIAL

- A. No asbestos containing material shall be used, placed, installed, or otherwise incorporated into the Work, unless specified in the Contract Documents or approved in writing by Owner's Representative.
- B. Before submitting the final Application for Payment, Contractor shall furnish to Owner either:
1. A signed statement affirming that no asbestos containing material was used, placed, installed, or otherwise incorporated into the Work, or
 2. Documentation detailing the location and quantity of all asbestos containing material (i.e., those specified in the Contract Documents and those approved in writing by Utilities' Representative), and a signed statement affirming that no additional asbestos containing material was used, placed, installed, or otherwise incorporated into the Work.

1.06 SPILLS, LEAKS, DISCHARGES, & RELEASES

- A. If a Hazardous Substance or Hazardous Material is spilled, leaked, discharged, or otherwise released to the environment or Site, by Contractor, subcontractors, suppliers, or anyone else for whom Contractor is responsible, Contractor will take immediate steps to secure or otherwise isolate such condition, promptly notify Owner's Representative, and contain and clean up any such Hazardous Substance or Hazardous Material using only employees or subcontractors who have been properly trained in accordance with OSHA requirements for hazardous waste operations and emergency response. Contractor is responsible for making all notifications and

complying with all regulatory requirements related to such an incident. Any waste generated as a result of a spill, leak, discharge, or other release to the environment or Site by Contractor, subcontractors, suppliers, or anyone else for whom Contractor is responsible shall become the property of Contractor and shall be disposed of in accordance with all applicable requirements. In addition to cleanup and disposal costs, Contractor is responsible for all costs associated with demobilization, remobilization, medical examinations, and all other costs, claims, losses, and damages, including but not limited to attorney fees and litigation costs as well as fines and penalties, incurred by Owner as a result of any Hazardous Substance or Hazardous Material that is spilled, leaked, or otherwise released to the environment or Site by Contractor, subcontractors, suppliers, or anyone else for whom Contractor is responsible.

- B. If Contractor sourced Environmental Media originating outside of the project limits is placed on the project and is at any time found to be contaminated with unacceptable levels of Hazardous Substances or Hazardous Materials, such shall be considered a release and be managed by Contractor accordingly.
- C. Failure to stop Land Disturbing Activities when Debris is readily apparent can significantly augment costs to remedy Regulated Asbestos Contaminated Soil (RACS), if present. If such occurs, it shall be considered a release and be managed by Contractor accordingly.
- D. In case of an Emergency, such as a fire, explosion, injury, a discharge that cannot be safely managed / controlled, a discharge that has reached a waterway, or other event that presents an immediate risk to human health or the environment; Immediately Call 911, Contractor shall notify Owner's Representative as soon as possible.

1.07 SUBMITTALS

- A. Submittals to be provided by the Contractor shall include but are not limited to the following:
 - 1. Environmental Compliance Documentation
 - a. Upon request by Owner's Representative, or otherwise prior to final Application for Payment, furnish copies of Environmental Compliance Documentation.
 - 2. Asbestos Certification
 - a. Prior to final Application for Payment, furnish the documentation specified in Section 1.07 - Prohibition on Asbestos Containing Material

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 35 44

HEALTH, FIRE AND LIFE SAFETY PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Safety requirements
- B. Site specific safety procedures
- C. Lockout/tagout safety procedures
- D. Hot work operations

1.02 SAFETY REQUIREMENTS

- A. As defined in Exhibit E – Contractor Minimum Safety Requirements (CMSR).

1.03 SITE SPECIFIC SAFETY PROCEDURES

- A. Provide fire protection in all construction areas to the satisfaction of the Authority Having Jurisdiction (AHJ).
- B. During the construction phase, the Authority Having Jurisdiction may conduct oversight inspections to observe and provide recommendations regarding applicable safety standards.
- C. Contractor shall ensure compliance with the following minimum requirements at all times:
 - 1. Do not block exit corridors. Install signage clearly identifying exit routes.
 - 2. Provide physical barriers with appropriate warning signage to protect public areas from construction work.
 - 3. Conduct daily inspections to eliminate fire hazards and any other safety hazards.
 - 4. Periodic safety inspections may be performed on job sites by the AHJ. The AHJ will present Owner with a written summary of the findings who will then take these issues to the Contractor's superintendent, foreman, or other designated representative, and return the summary form with documentation of the resolution of safety items to AHJ. Abate deficient items in a timely manner. Include documentation and resolution of safety items presented in weekly Progress Meetings. Inspections by AHJ are spot-checks only. They are not all encompassing. These inspections and recommendations do not relieve the Contractor from obligations related to safe work practices as required under federal law.
 - 5. AHJ has the right to access the site at all times. Should a potential threat to personnel or property be observed, AHJ may require the hazard related operation immediately altered, or stopped, until adequate safeguards are addressed.
 - 6. If required, provide AHJ, through Owner, with a copy of Contractor's weekly safety meeting minutes and safety inspection reports.
 - 7. Provide signs used for proper identification of construction areas.
 - 8. Provide adequate number of appropriately rated fire extinguishers to be available on-site for emergency use in the construction area.

9. Ensure standpipes, pull stations, electrical panels, water control valves, and fire hydrants are accessible at all times.
10. Post emergency notification phone numbers provided by Contractor and Owner in all construction areas.
11. Notify Owner of any recordable or lost time injuries occurring on Owner's property within one 1 day and of any fatalities immediately.
12. Submit copies of all injury reports to AHJ, through Owner.
13. Equip construction personnel with personal protective equipment (PPE) where required. Coordinate with Owner to identify where use of PPE will be required.

1.04 LOCKOUT/TAGOUT SAFETY PROCEDURES

- A. Utilize Owner's program and procedures for the control of hazardous energy lockout/tagout including, but not limited to, locks, tags, and lockout devices. Provide Owner documentation that workers have received safety training in the control of hazardous energy through lockout/tagout. Contractor lockout/tagout programs and procedures shall meet Owner requirements and procedures.

1.05 HOT WORK OPERATIONS

- A. In addition to the requirements in the CMSR, the Contractor shall provide and enforce a program to control fires during hot work operations. Provide appropriately rated fire extinguishers, fire retardant protective covers (when needed), and any other hot-work related equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 41 00

PROJECT PERMITS

PART 1 GENERAL

1.01 WORK INCLUDES

- A. Project permits
- B. Abatement of air pollution and permit
- C. Abatement of noise pollution and permit
- D. Abatement of water pollution and permit
- E. Building permit and all other permits will be acquired by the Contractor. Engineer will submit contract drawings and specifications to building department for review and approval. Contractor will be responsible for obtaining and maintaining all required project permits. Contact Town of Silt Community Development Department for confirmation prior to construction.
- F. Electrical to secure permits as required
- G. Mechanical and plumbing to secure permits as required
- H. Earthwork to secure the GESC permit, stormwater discharge permit, and erosion control permits. These will be secured and work installed by the Contractor. After acceptance by the authorities, the Contractor will need to maintain until the completion of construction or as required by the permits.

1.02 SUBMITTALS

- A. State and local permits: At least 30 days prior to the start of construction, provide copies of all necessary state and local permits required to complete the Work in accordance with the provisions of Specification Section 01 33 00.
- B. Stormwater Management Plan (SWMP)
 - 1. At least 30 days prior to the discharge or handling of any waters, submit a detailed Stormwater Management Plan containing the following information:
 - a. Name of the person who will be responsible for implementing and carrying out the plan.
 - b. Precautions that will be taken to avoid discharge or accidental spills of oil into river, stream, watercourse, or lake.
 - c. Methods of handling and treating wastewater, including locations for best management practices, evaporation or settling ponds, and discharge points. Estimates of the amount of wastewater that may be handled and treated at each location.
 - d. Methods for preventing or controlling runoff and erosion for all construction sites, both during and after construction, including the following areas:
 - 1) Access roads

- 2) Stockpile and waste areas
 - 3) Construction plant and equipment yards
 - 4) All excavated surfaces
 - 5) Other impacted areas
- e. The SWMP shall relate the methods and descriptions above to the conditions of required permits.

1.03 PROJECT PERMITS

- A. Contractor will pay for all permit fees associated with construction of the project. Contractor will pay directly to Town of Silt and/or Colorado Department of Public Health and Environment, all fees and charges which are assessed by Town of Silt and CDPHE, which are associated and required to obtain the construction permits that are issued by the Town of Silt and CDPHE, for this Project. The Engineer and Owner will provide the coordination assistance necessary to obtain the Town of Silt and CDPHE permits. Permits include, but not limited to:
1. Building Permit – Owner/Engineer will submit the construction drawings for this permit. Contractor will complete the process and obtain the issued permit from the Town of Silt.
 2. Electrical Permit – Owner will apply for this permit, but Contractor must complete the process and obtain the issued permit from the Town of Silt.
 3. Mechanical Permit – Owner will apply for this permit, but Contractor must complete the process and obtain the issued permit from Town of Silt.
 4. Construction Dewatering Permit – Contractor will be responsible for completing this process.
 5. Construction Stormwater Permit – Engineer will assist with preparation of this permit. Contractor will coordinate and complete the process.
 6. Excavation Permit – Contractor must complete the process and obtain the permit from the Town of Silt.
 7. Demolition Permits – Contractor must complete the process and obtain the permits from the Town of Silt and CDPHE.
- B. Obtain all other state and local permits required for the Work.
- C. If the aggregate storage of oil at the Site is over 1,320 gallons or a single container has a capacity in excess of 660 gallons, prepare a Spill Prevention Control and Countermeasure (SPCC) Plan. The plan shall be prepared and certified by an engineering professional registered in the State of Colorado.
- D. All oil storage tanks shall be placed at least 20 feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and any other water source, and the area surrounding the tanks shall be diked to contain more than 1-1/2 times the volume of the largest tank, or more than half the volume of all tanks within the diked area, whichever is greater. Underground storage tanks shall be used only upon submission of a written management plan documenting all necessary regulatory compliance and approval of the Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 16

CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM):
 - a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.02 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.03 SUBMITTALS

A. Informational Submittals

1. CQC Plan: Submit, not later than 10 days after receipt of Notice to Proceed.
2. CQC Report: Submit, weekly, an original and one copy.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.
- B. Maintain complete inspection records and make them available at all times to the Owner and Engineer.
- C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.
- B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor's management and control with Owner Quality Assurance.
- C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager

- 1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
- 2. CQC System Manager may perform other duties on the Project.
- 3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
- 4. CQC System Manager shall report to the Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
- 5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
- 6. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate are the same as for designated CQC System Manager.

B. CQC Staff

- 1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Engineer.
- 2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
- 3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
- 4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.

- C. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

- A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:
 - 1. Preparatory Phase:
 - a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
 - b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required to meet Contract requirements.
 - c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
 - d. Perform prior to beginning Work on each definable feature of Work:
 - 1) Review applicable Contract Specifications.
 - 2) Review applicable Contract Drawings.
 - 3) Verify that all materials and/or equipment have been tested, submitted, and approved.
 - 4) Verify that provisions have been made to provide required control inspection and testing.
 - 5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
 - 6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
 - 7) Review the appropriate activity hazard analysis to verify safety requirements are met.
 - 8) Review procedures for constructing the Work, including repetitive deficiencies.
 - 9) Document construction tolerances and workmanship standards for that phase of the Work.
 - 10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.
 - 2. Follow-up Phase:
 - a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
 - b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.

- c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
- 3. Additional Preparatory Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General

- 1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
- 2. Construction will be permitted to begin only after acceptance of the CQC Plan.

B. Content

- 1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
 - a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
 - b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
 - c. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters also shall be included in the CQC Plan.
 - d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
 - e. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
 - f. Procedures for tracking preparatory and follow-up control phases and control, verification, and acceptance tests, including documentation.
 - g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
 - h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

- C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.
- D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

- A. As a minimum, include a CQC report in the weekly construction meeting and minutes. Account for all days throughout the life of the Contract.
- B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.
- C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
 - 1. Contractor/subcontractor and their areas of responsibility.
 - 2. Operating plant/equipment with hours worked, idle, or down for repair.
 - 3. Work performed today, giving location, description, and by whom.
 - 4. Test and/or control activities performed with results and references to specifications/plan requirements. List deficiencies noted along with corrective action.
 - 5. Material received with statement as to its acceptability and storage.
 - 6. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
 - 7. List instructions given/received and conflicts in Drawings and/or Specifications.
 - 8. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

3.07 SUBMITTAL QUALITY CONTROL

- A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Contractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

- A. Testing Procedure
 - 1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Perform the following activities and record the following data:
 - a. Verify testing procedures comply with contract requirements.
 - b. Verify facilities and testing equipment are available and comply with testing standards.

- c. Check test instrument calibration data against certified standards.
- d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
- e. Documentation:
 - 1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
 - 2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
 - 3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
 - 4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
 - 5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

3.09 COMPLETION INSPECTION

- A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.
- B. Punchlist
 - 1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
 - 2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
 - 3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify Owner.
 - 4. These inspections, and any deficiency corrections required, will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION

SECTION 01 45 29

TESTING AND INSPECTION REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing Laboratory Services.
- B. Qualification of Laboratory.
- C. Laboratory Duties.
- D. Limitations of Authority of Testing Laboratory.
- E. Contractor's Responsibilities.
- F. Specific Tests, Inspections, and Methods Required.
- G. Submittals.

1.02 RELATED SECTIONS

- A. Conditions of Contract: Inspections and testing required by laws, ordinances, rules, regulations, orders, or approvals of public authorities.
- B. Respective sections of Specifications: Certification of products.

1.03 TESTING LABORATORY SERVICES

- A. Contractor shall employ and pay for services of an independent testing laboratory to perform specified services and testing.
 - 1. Contractor shall cooperate with the laboratory to facilitate execution of its required services.
 - 2. Employment of laboratory shall in no way relieve Contractor's obligations to perform the Work.

1.04 QUALIFICATION OF LABORATORY

- A. Contractor shall ensure the independent testing laboratory meets "Recommended Requirements for Independent Laboratory Qualifications," published by American Council of Independent Laboratories.
- B. Contractor shall ensure the laboratory is authorized to operate in the State of Colorado.
- C. Contractor shall submit a copy of the report of inspection of facilities made by the National Institute of Standards and Technology for the laboratory during the most recent inspection, with memoranda of remedies of any deficiencies reported from the inspection.
- D. Contractor shall ensure that testing equipment:

1. Is calibrated at reasonable intervals by devices of accuracy traceable to either:
 - a. National Institute of Standards and Technology.
 - b. Accepted values of natural physical constants.

1.05 LABORATORY DUTIES

- A. Contractor shall require the laboratory to cooperate with Owner, Engineer, and Contractor and provide qualified personnel.
- B. Contractor shall require the laboratory to perform specified inspections, sampling, and testing of materials and methods of construction:
 1. In accordance with specified standards.
 2. That ascertain compliance of materials with requirements of Contract Documents.
- C. Contractor shall require the laboratory to promptly notify Owner, and Engineer, and Contractor of observed irregularities or deficiencies in the Work or products.
- D. Contractor shall require the laboratory to promptly submit electronic copies of written report of each test and inspection to Owner, and Engineer, and Contractor. Each report shall include:
 1. Results of testing.
 2. Testing logs.
 3. Outstanding deficiencies.
 4. Various statistical data.
 5. Testing curves.
- E. Contractor shall require the laboratory to promptly submit an electronic written report of each test and inspection and 1 copy each to Owner, and Engineer, and Contractor, and 1 copy to record documents file. Each report shall include:
 1. Date issued.
 2. Project title and number.
 3. Testing laboratory name, address, and telephone number.
 4. Name and signature of laboratory inspector.
 5. Date and time of sampling or inspection.
 6. Record of temperature and weather conditions.
 7. Date of test.
 8. Identification of product and Specification section.
 9. Location of sample or test in Project.
 10. Type of inspection or test.
 11. Results of tests and compliance with Contract Documents.
 12. Interpretation of test results, when requested by Owner and Engineer.
- F. Contractor shall require the laboratory to perform additional tests as required by Owner and Engineer.

1.06 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:

1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Approve or accept any portion of Work.
3. Perform any duties of Contractor other than independent third-party testing.
4. Stop the Work unless in identifying a life safety hazard.

1.07 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall cooperate with laboratory personnel and provide access to Work and to manufacturer's operations.

B. Contractor shall secure and deliver to laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

C. Contractor shall provide laboratory with preliminary design mix proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

D. Contractor shall furnish copies of products test reports as required to Owner and Engineer.

E. Contractor shall furnish incidental labor and facilities:

1. To provide access to Work to be tested to the laboratory.
2. To obtain and handle samples at Project Site or at source of product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

F. Contractor shall notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests. When tests or inspections cannot be performed after such notice, Contractor shall reimburse Owner for expenses incurred by Owner related to such scheduled testing.

G. Contractor is responsible for paying for all required testing and inspection services.

H. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by an independent testing company. Payment for re-testing or re-inspection will be Contractor's responsibility.

I. Contractor shall employ and pay for services of separate, equally qualified independent testing laboratory to perform additional inspections, sampling, and testing required:

1. For Contractor's convenience.
2. When initial tests indicate Work does not comply with Contract Documents.

J. Contractor shall make arrangements with laboratory and pay for additional samples and tests required for Contractor's convenience.

K. Nothing in this Specification shall relieve Contractor of its obligation to perform Work in accordance with requirements of the Contract Documents.

1.08 SPECIFIC TESTS, INSPECTIONS, AND METHODS REQUIRED

A. Specific test shall be performed in accordance with the Contract Documents. Testing may include but is not limited to:

1. Laboratory Compaction Characteristics of Soil Reports
2. Concrete Compressive Strength Test Reports
3. Field Density Test Reports
4. Summary of Reinforcing Steel Observations
5. Welding Inspection Test Reports

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTALS

A. Submittals to be provided by the Contractor shall include but are not limited to the following:

1. Material Test Reports: Contractor shall prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
2. Field Test Reports: Contractor shall prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 GENERAL

A. This section addresses the following:

1. Mobilization
2. Permits
3. Owner Field Office
4. Working hours
5. Temporary Owner
6. Protection of work and property
7. Temporary controls
8. Storage yards and buildings
9. Access roads and detours
10. Parking areas
11. Vehicular traffic
12. Snow removal
13. Cleaning during construction
14. Site restoration
15. Noxious weed control
16. Hazardous materials management
17. Equipment refueling, cleaning, and maintenance
18. Sustainable construction

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of Nurserymen: American Standards for Nursery Stock.
2. Federal Emergency Management Agency.
3. NFPA, National Fire Prevention Standard for Safeguarding Building Construction Operations.
4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
5. U.S. Department of Agriculture: Urban Hydrology for Small Watersheds.
6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years.

1.03 SUBMITTALS

A. Informational Submittals

1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
2. Temporary Utility Submittals:
 - a. Electric power supply and distribution plans.
 - b. Water supply and distribution plans.
 - c. Drainage plans.
 - d. Sanitary.
3. Temporary Construction Submittals:
 - a. Access Roads Plan: Routes, cross-sections, and drainage facilities. Comply with access road limitations and allowances shown on Drawings.
 - b. Parking area plans.
 - c. Field office, storage yard, and storage building plans, including gravel surfaced area.
 - d. Fencing and protective barrier locations and details.
 - e. Staging area location plan.
 - f. Traffic and Pedestrian Control and Routing Plans: As specified herein, and proposed revisions thereto.
4. Temporary Control Submittals:
 - a. Plan for disposal of waste materials and intended haul routes.
 - b. Noise control plan to mitigate construction noise and to comply with appropriate standards.
 - c. Water control plan for proposed ground and surface water control facilities.
 - d. Permits identified herein.
 - e. Dust control plan.
 - f. Spill Prevention, Control, and Countermeasures (SPCC) Plan, if required by 40 CFR Part 112 – Oil Pollution Prevention (for oil stored on site in combined quantities of 1,320 gallons or greater contained in storage tanks and other containers with capacities of 55 gallons or more). If a SPCC is not required by 40 CFR Part 112, prepare a Spill Contingency and Response Plan that includes procedures, instructions, and reports to be used in the event of a spill or release of oil, or hazardous or regulated substance.

1.04 MOBILIZATION

A. Mobilization shall include, but not be limited to:

1. Obtaining required permits.
2. Moving Contractor's field office, if furnished, and equipment required for first month operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.

4. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
 5. Arranging for an erection of Contractor's work and storage yard.
 6. Posting OSHA required notices and establishing safety programs and procedures.
 7. Having Contractor's superintendent at Site full time.
 8. Preparing approved preconstruction documentation, including, but not limited to, Baseline Schedule in accordance with Section 01 32 00, Construction Progress Documentation; Contractor's Quality Control Plan in accordance with Section 01 45 16, Contractor Quality Control; and necessary permits and submittals.
 9. Providing Pre-Existing Condition photographic and video documentation.
- B. Determination of a staging area designated for Contractor's temporary facilities.

1.05 PRODUCTS

2.01 OWNER'S FIELD OFFICE

- A. Furnish one trailer-type mobile structure with all-metal frame; all-metal exterior, sides, and roof; insulated double walls, floor, and roof; and security guard screens on all windows. Provide blinds or drapes on all windows.
- B. Furnish equipment specified for exclusive use of Engineer and Owner representatives.
- C. Ownership of equipment furnished under this article will remain, unless otherwise specified, that of Contractor.
- D. Equipment furnished shall be new or used in good condition in appearance and function.
- E. Minimum Features:
1. 110-volt lighting and wall plugs.
 2. Fluorescent or LED ceiling lights.
 3. Electric heating, and self-contained air conditioning unit, properly sized for Project locale and conditions. Provide ample electric power to operate installed systems.
 4. Railed stairways and landings at entrances.
 5. Exterior Doors:
 - a. Number: Two.
 - b. Type: Solid core.
 - c. Lock(s): Cylindrical, keyed alike.
 6. Number of Windows: Two.
 7. Minimum Interior Height: 8 feet.
- F. Floor Space: Minimum 300 square feet.
- G. Rooms: Two with minimum private office floor space of 100 square feet, and remainder configured for open meeting or storage space.
- H. Office Equipment - General

1. Two folding tables, 36 inches by 72 inches with surface located 29 inches from floor.
2. One 30-inch by 60-inch double-pedestal desk with surface located 29 inches from floor.
3. Two 4-drawer steel file cabinets with locks and 18-inch wide drawers.
4. Bottled cold water service with two extra bottles.
5. Desk chair
6. Twelve steel folding chairs.
7. Two wastepaper baskets.
8. One first-aid kit.
9. Two Tri-Class (ABC), dry chemical fire extinguishers, 10-pound.

PART 2 EXECUTION

3.01 LABOR - WORKING HOURS

- A. The hours of operation for construction shall be limited to 7:00 A.M. to 7:00 P.M., Monday through Friday, except in non-typical circumstances. Non-typical circumstances may include extended time needed to expeditiously restore traffic flow and public access, extended time needed to ensure public health and safety, or extended time needed to maintain utility service. Obtain approval from Owner, Engineer, and governing jurisdiction 3 days in advance of commencing work during non-typical circumstances. During emergency situations, including risks to public health and safety, work may proceed followed by notification to Owner, Engineer, and governing jurisdiction by the end of the next business day.
- B. Unless otherwise indicated, Contractor shall not perform work on Saturday, Sunday, or on any Owner legal holiday without approval from Owner, Engineer, and governing jurisdiction.

3.02 TEMPORARY OWNER

A. Power

1. Arrange temporary electrical power service for construction with the applicable power utility. Coordinate power takeoff points, voltage and phasing requirements, transformers and metering and pay the associated costs and fees. All temporary electrical facilities shall conform to the requirements of Subpart K of the OSHA Safety and Health Standards for Construction and the requirements of local authorities
2. Cost of electric power shall be borne by Contractor.

B. Lighting

1. Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.
2. All lighting used for night work, security around equipment storage areas, and night equipment maintenance shall be designed to prevent spillover, nuisance, or hazard effects of light and glare on adjacent locations and uses of land. Lighting shall be positioned to shine away from residences and oncoming traffic.
3. Install baffles on construction lighting fixtures to direct light onto the construction activity only in locations where safety is a concern, scenic quality will be affected, or near occupied homes and businesses.

4. Lighting used for security around equipment storage areas shall be positioned, to the extent practical, away from residences and oncoming traffic. The use of cut-off type luminaries is required. Light bulbs and light sources shall be shielded so that they are not directly visible from any adjacent lot or public roadway. Spillover of lighting for adjacent properties shall not exceed one-half of one (0.50) foot-candle measured at any point 10 feet beyond the temporary construction easement line or 10 feet beyond a property line, whichever is nearest to an occupied building.
5. Provide individual light sources not exceeding 150,000 lumens per light source (typical of a 1250W metal halide light). Light standards shall not exceed 24 feet in height. Generators used to power light sources shall not exceed 70 dB at 25 feet from the source.

C. Heating, Cooling, and Ventilating

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finishes from damage due to temperature or humidity.
2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Pay all costs of installation, maintenance, operation, removal, and fuel consumed.
4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.

D. Water: Make arrangements for and bear costs of providing water required for construction purposes and for drinking by construction personnel during construction. Potable water will not be available onsite.

E. Sanitary and Personnel Facilities: Provide and maintain facilities for Contractor's employees, subcontractors, and all other onsite employers' employees. Service, clean, and maintain facilities and enclosures.

F. Telephone Service: Each entity will furnish cellular phones for their use as necessary.

G. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).

3.03 PROTECTION OF WORK AND PROPERTY

A. General

1. Comply with Owner safety rules while on Owner property.
2. Use of Explosives: Blasting will not be allowed
3. Contact the Utility Notification Center of Colorado 5 days prior to any excavation.
4. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.

5. Schedule the Work so construction will not interfere with irrigation of cultivated lands or pasturelands. Construction may proceed during irrigation season, provided Contractor constructs temporary irrigation ditches, turnouts, and miscellaneous structures acceptable to property owners.
6. Provide continuous access for livestock through farm areas. Do not cut off ready access to portions of farmlands in which livestock are pastured, fed, and watered. Maintain existing fences required to restrain livestock. Keep gates closed and secure. Disturbance of livestock and wildlife shall be kept to an absolute minimum necessary for construction activities.
7. Maintain in continuous service all existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along the line of Work, unless other arrangements satisfactory to owners of said utilities have been made.
8. Where completion of the Work requires temporary or permanent removal or relocation of an existing utility, coordinate all activities with the owner of said utility and perform all work to their satisfaction.
9. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
10. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
11. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
12. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance. Before exposing a utility, obtain utility owner's permission. If service of any utility is interrupted as a result of Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
13. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
14. Restore original Site drainage.

B. Site Security

1. Erect temporary security fences. Fences shall be a minimum of 6 feet high constructed of standard chain link fence materials. Remove and relocate fences around open trenches at the end of each working day. Maintain all temporary fences as needed during the construction period.
2. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.
3. Site security measures shall be inspected daily and checked periodically by the Contractor's security personnel during non-working hours and days. Inspections and security checks shall be documented in the Contractor daily reports.
4. Contractor equipment shall be stored in a secure area or otherwise locked or disabled to prevent use by unauthorized persons during non-working hours.

C. Barricades and Lights

1. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
2. Provide signage and lighting to alert general public of construction hazards, which include, but are not limited to, surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and other public access areas.
3. Provide to protect existing facilities and adjacent properties from potential damage.
4. Locate to enable access by facility operators and property owners.
5. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.
6. Locate barricades at the nearest intersecting public thoroughfare on each side of the blocked section.
7. Illuminate barricades and obstructions with warning lights from sunset to sunrise.

D. Signs and Equipment

1. Conform to requirements of manual published by the Colorado Department of Transportation.
2. Portable TOW-AWAY-NO STOPPING Signs: Place where approved by police department.
3. Traffic Cones: Provide to delineate traffic lanes to guide and separate traffic movements.
4. High-Level Warning Flag Units: Provide in advance of traffic approaching the Work, each displaying three flags mounted at a height of 9 feet.
5. ROAD CONSTRUCTION AHEAD Signs: Provide 48-inch by 48-inch signs. Place in conspicuous locations, approximately 200 feet in advance of the Work, and facing approaching traffic.
6. DETOUR Signs: Provide right arrow or left arrow, placed as approved by controlling agency.
7. RIGHT or LEFT LANE CLOSED AHEAD Signs: Provide and place in advance of lane to be closed.
8. Provide at obstructions, such as material piles and equipment.
9. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.

E. Trees and Plantings

1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on the Drawings to remain undisturbed.
2. Where practical, tunnel beneath trees when on or near line of trench.
3. Employ hand excavation as necessary to prevent tree injury.
4. Do not stockpile materials or permit traffic within drip lines of trees.

5. Provide and maintain temporary barricades around trees.
6. Water vegetation as necessary to maintain health.
7. Cover temporarily exposed roots with wet burlap, and keep burlap moist until soil is replaced around roots.
8. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of Engineer.
9. Dispose of removed trees in a legal manner off the Site.
10. Balling and burlapping of trees indicated for replacement shall conform to recommended specifications set forth in the American Standards for Nursery Stock, published by American Association of Nurserymen. All balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by ball and not by top.
11. In event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.

F. Existing Structures

1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor's operations, obtain approval of property owner and Engineer.
2. Move mailboxes to temporary locations accessible to postal service.
3. Replace items removed in their original location and in a condition equal to or better than original.
4. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

G. Dewatering

1. Prepare, submit, and implement a water control plan, if necessary, that includes descriptions of proposed ground and surface water control facilities including, but not limited to: equipment, methods, standby equipment and power supply, pollution control facilities, discharge locations, and provisions for temporary water supply; drawings showing locations, dimensions, and relationships of elements of each system; design calculations demonstrating accuracy of proposed dewatering system and components.
2. Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works in accordance with Section 31 23 19, Dewatering and Drainage.

H. Archaeological and Paleontological – Unanticipated Discoveries

1. Follow the requirements in the State Revolving Fund Required Specifications.
2. Removal of Artifacts:
 - a. Finds are property of property owner. Do not remove or disturb finds without Owner's written authorization.

I. Endangered Species

1. Take precautions necessary and prudent to protect native endangered flora and fauna.

2. Notify Engineer of construction activities that might threaten endangered species or their habitats.
3. Owner will mark areas known as habitats of endangered species prior to commencement of onsite activities.
4. Additional areas will be marked as other habitats of endangered species become known during construction.

3.04 TEMPORARY CONTROLS

A. Air Pollution Control

1. Minimize air pollution from construction operations.
2. Ensure construction equipment (especially diesel equipment) meets Colorado opacity standards for operating emissions. Construction equipment shall be emissions tested at an approved facility prior to use on the site. This test shall be performed each year that the equipment is used on the project. The certificates of approval for each item of construction equipment shall be maintained by the Contractor and shall be available for inspection if requested.
3. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
4. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.

B. Noise Control

1. Noise Control Plan: Contractor shall submit a detailed plan to mitigate construction noise and to comply with OSHA, State of Colorado and local noise control standards, requirements, regulations, and ordinances including method of construction, equipment to be used, acoustical treatments, and work hour limitations as defined in the General Conditions, Article 6.02, Labor Working Hours, and in this specification section. The Noise Control Plan shall include the following requirements, as a minimum:
2. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels as defined by local noise control ordinances.
3. Restrict access to construction areas so that the public cannot be in close proximity to loud equipment.
4. Unless otherwise defined by local noise control ordinance, excessively high decibel level work, such as pile driving, characterized as a decibel scale of 100 or greater measured 25 feet from the source, shall be performed only between the hours of 9:00 a.m. and 5:00 p.m.
5. Comply with local noise ordinance as follows:
 - a. Restrict maximum noise level from construction activities, measured at the property line, to 80 decibels from 7 a.m. to 6 p.m., allowing for periodic exceedances of up to 10 decibels for up to 15 minutes out of an hour. Nighttime hours are from 6:00 p.m. to 7:00 a.m.
 - 1) Restrict maximum noise level from construction activities, measured at the property line, to 75 decibels during the nighttime hours.

- 2) Noise associated with vehicles is permissible up to 90 decibels, measured at the source.
6. Requirements of the Noise Control Plan shall be implemented and managed by the Contractor's Health and Safety Officer. Results of required noise monitoring shall be reported in the Contractor's daily reports.

C. Water Pollution Control

1. Divert sanitary sewage and non-storm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Owner agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and stormwater flow, including dewatering pump discharges.
3. Comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, "Guidelines for Erosion and Sedimentation Control Planning" and "Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity."
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

D. Erosion, Sediment, and Flood Control

1. Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.
2. Perform weekly site inspections of the work limits. Modify, correct, or reinstall temporary facilities per requirements of the jurisdiction having authority, Owner, or Engineer.

3.05 STORAGE YARDS AND BUILDINGS

A. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions. All materials and equipment shall be stored in secure areas.

B. Temporary Storage Buildings

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards and Fire Department codes.
4. Hazardous materials shall be stored according to product specifications, codes, and manufacturers' instructions.

3.06 ACCESS ROADS AND DETOURS

- A. Contractor may only use existing roads designated in the Contract Documents for transportation of construction equipment and materials. Construct all required off-road access roads only within easements, rights-of-way, and Project limits.
- B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.
- C. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.
- D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.
- E. Coordinate detours and other operations affecting traffic and access with Engineer and with local traffic authorities. Provide at least 72 hours' notice to Engineer of operations that will alter access to the Site or alter public traffic patterns.
- F. Where an access road crosses existing fences, install and maintain gates. Gates and gate posts shall conform to and be consistent with specifications and details pertinent to the type of fence being crossed.
- G. Upon completion of construction, restore ground surface disturbed by construction to original grade, or leave access roads in condition suitable for future use by Owner where designated on the drawings. Replace damaged or broken culverts with new culvert pipe of same diameter and material under access roads that are designated to remain in place.

3.07 PARKING AREAS

- A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner operations, or construction operations.
- B. Provide parking facilities for personnel working on the Project. Employees may not park personal vehicles or Contractor equipment within the traveled-way of existing roads, highways, and streets.

3.08 VEHICULAR TRAFFIC

- A. Traffic Control Plan: Plan and schedule for obtaining necessary approvals for changes so as not to delay progress of the Work.
- B. Traffic Routing Plan: Show sequences of construction affecting use of pedestrian pathways and vehicle roadways, time required for each phase of the Work, provisions for decking over excavations, and phasing of operations to provide necessary access, including plans for signing, barricading, and striping to provide passages for pedestrians and vehicles.
- C. Construct wheel wash and gravel access at entrance and exit points of construction area in accordance with the Drawings.
- D. Contractor shall not operate heavy equipment over any existing pipe when the earth cover is less than 3 feet.
- E. Comply with local and state laws and regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.

- F. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.
- G. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.
- H. Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property for periods greater than 2 hours, provide written notice to each owner so affected 3 days prior to such closure. In such cases, closings of up to 4 hours may be allowed. Closures of up to 10 hours may be allowed if a week's written notice is given and undue hardship does not result.
- I. Maintenance of traffic is not required if Contractor obtains written permission from Owner and tenant of private property, or from authority having jurisdiction over public property involved, to obstruct traffic at designated point.
- J. In making street crossings, do not block more than one-half the street at a time. Whenever possible, widen shoulder on opposite side to facilitate traffic flow. Provide temporary surfacing on shoulders as necessary.
- K. Maintain top of backfilled trenches before they are paved, to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.
- L. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.
- M. Notify fire department and police department before closing a street or portion thereof. Notify said departments when streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without written permission from fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish Contractor's night emergency telephone numbers to police department.
- N. Temporary Bridges
 - 1. Construct temporary bridges at points where maintenance of traffic across pipeline construction is necessary.
 - 2. Make bridges over public streets, roads, and highways acceptable to authority having jurisdiction thereover.
 - 3. Bridges erected over private roads and driveways shall be adequate for service to which they will be subjected.
 - 4. Provide substantial guardrails and suitably protected approaches.
 - 5. Provide footbridges not less than 4 feet wide with handrails and uprights of dressed lumber.
 - 6. Maintain bridges in place as long as conditions of the Work require their use for safety of public, except that when necessary for proper prosecution of the Work in immediate vicinity of bridge. Bridge may be relocated or temporarily removed for such period as Engineer may permit.

O. Detours

1. Where authority having jurisdiction requires that traffic be maintained over construction work in a public street, road, or highway, and traffic cannot be maintained on original roadbed or pavement, construct and maintain detour around the Work.
2. Detour Striping:
 - a. Five days prior to starting Work on each sequence of the Project where detour striping is required, notify controlling agency's Traffic Engineer's office to allow controlling agencies sufficient time to paint approved detour striping.
 - b. Clean pavement in area to be marked and have personnel available to assist painting crew by adjusting barricading for detour modification.
 - c. When detour striping is no longer needed, notify controlling agency's Traffic Engineer's office and sandblast off temporary detour lane markings which would not conform to permanent existing striping.

P. Coordinate traffic routing with that of others working in same or adjacent areas.

Q. Contractor shall monitor traffic control measures throughout the day and periodically during non-working hours and days and include monitoring observations in the daily reports.

3.09 SNOW REMOVAL

- A. Remove snow from within the limits of active construction work zones as necessary to facilitate construction. For purposes of snow removal, active construction work zones are generally defined as the contiguous area from inside the temporary construction barricades to adjacent right-of-way or easement line within the work limits as shown in the drawings.
- B. Remove snow from the access road as necessary to facilitate construction.
- C. Remove snow from temporarily closed sidewalks that are located within active construction work zones.
- D. Remove snow from work zones prior to re-opening to traffic.
- E. Local jurisdictions will be responsible for snow removal elsewhere including temporary detour routes and lane shifts adjacent to but outside temporary construction barricades.
- F. Haul and dispose of excess snow at locations approved by Engineer. Do not dispose of excess snow into right-of-way or private property without prior approval from Engineer.

3.10 CLEANING DURING CONSTRUCTION

- A. In accordance with Section 02 42 00, Cleaning, as may be specified in other Specification sections, and as required herein.
- B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose.
- C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, dispose of such waste materials, debris, and rubbish offsite.

- D. At least weekly, brush sweep entry drive and roadways, and all other streets and walkways affected by the Work and where adjacent to the Work.

3.11 SITE RESTORATION

- A. Contractor shall return disturbed land to former contours and shall revegetate with a weed-free, native seed mix suitable to the specific location and use as specified in other sections of these Specifications.
- B. Outbuildings disturbed during construction shall either be repaired using existing materials of construction and level of craftsmanship or replaced with a like-kind building.
- C. Restore roads and driveways so that:
 - 1. Surfaces are finished to match existing surfaces.
 - 2. Sealed roadways are finished to match existing seal (asphalt, spray seal, etc).
 - 3. Unsealed roadways match existing surface.
 - 4. Concrete roadways/driveways match existing surface. Portions of slab damaged or rendered unstable by undermining (whether inadvertently or deliberately) shall be included in the portion that is reconstructed.

3.12 NOXIOUS WEED CONTROL

- A. Contractor shall comply with all provisions of the "Colorado Noxious Weed Act" (CNWA), Title 35, Article 5.5.
- B. Contractor shall provide a person experienced in field identification of noxious weeds. This person shall proceed in advance of all ground-disturbing construction activities to physically locate existing noxious weeds that will be disturbed during construction.
- C. If CNWA List A species are found, Contractor shall provide mapping data to the State Weed Coordinator pertinent to each population including:
 - 1. Species name.
 - 2. Population location(s) including distribution and abundance.
 - 3. Estimated infested acreage.
- D. One of the following four methods shall be used to eradicate existing CNWA Class A, B, and C noxious weed populations within the project limits:
 - 1. Herbicides (Preconstruction Spray): Noxious weeds shall be sprayed with an appropriate herbicide prior to construction and prior to application of any soil management techniques. Infestations shall be sprayed by a certified applicator twice, 1 month and 2 weeks prior to construction.
 - 2. Hand-Pulling: Hand-pulling may be appropriate for small infestations of 1-1000 individual plants. If this technique is determined to be more effective relative to herbicide spraying, or if the weed population is adjacent to landowners who are known to object to herbicide use, hand-pulling will be used. In order to ensure that seeds or other reproductive propagules are not produced or spread, any plant with flowers, seeds, or other propagules will be placed in sealed plastic bags and disposed of by high intensity burning in a controlled environment that completely destroys seed viability or removal of plant

materials to a solid waste landfill which covers refuse daily with 6 inches of soil or alternative material.

3. Burning. Burning may also be effective depending on the weed species, its stage of growth, and the time of year. Blow torches may be used to burn seed heads to prevent new seed from entering the soil. This may be especially useful for annual and biennial plants like thistles (e.g. musk thistle). As with hand-pulling, this technique will be more efficient only for small infestations.
 4. Soil Management During Construction. Soil management is best applicable to larger infestations and species that produce profuse quantities of seed that persist in the soil. Soil management is best applicable to larger infestations, not less than 120 square yards and preferably greater than 500 to 1,000 square yards. Dense populations are more warranting of soil management. A few scattered individuals over a large area may not warrant soil management.
- E. Soil Management: Soils located beneath noxious weed locations will be removed to a minimum depth of 6 inches and shall be managed under one of the following options:
1. Stockpiled near the site of infestation, treated with a pre-emergent herbicide, flagged, and replaced after construction (for better herbicide distribution and effectiveness, the soil may be placed in successive layers, each layer treated successively).
 2. Transported to a designated stockpile area where it will be treated with either a pre-emergent herbicide or heat-treated to a temperature above 1,000 degrees F, and then may be replaced after construction (if this soil is not chosen for replacement, but borrow is chosen for fill replacement, then weed free borrow will be used as described below).
 3. Transported to an approved landfill area and buried with a minimum of 6 feet of weed-free soil cap.
- F. The following actions shall be taken to prevent spread of noxious weeds during construction.
1. Preconstruction Cleaning: All equipment shall be cleaned by high pressure air or water spray before entering the Project Site.
 2. Cleaning During Construction: All equipment shall be cleaned after work with weed-contaminated soils. High pressure water spray, high pressure air, or hand brushing may be used. If water is used, sediment basins shall be provided to control run-off wash water.
 3. Driving in noxious weed infested areas shall be avoided. Vehicles shall be inspected for weed seeds stuck in tire treads or mud on the vehicle and prevent them from being carried to unaffected areas. Infested vehicles shall not be cleaned in weed free areas.
 4. Borrow Material: If borrow material from outside the project limits is used for any part of the project, the borrow shall be weed free. Weed free borrow material shall be obtained from a borrow site inspected by a qualified botanist or environmental inspector knowledgeable about noxious weeds. If the botanist or environmental inspector determines that the borrow site is infested with noxious weeds, the top 18 inches (0.46 m) of material shall be removed and stored at the borrow site. The remaining material may then be used as borrow for the project.

3.13 HAZARDOUS MATERIALS MANAGEMENT

- A. Refer to the General Conditions for disclaimers related to potential existing Hazardous Conditions at the Site, the use of Hazardous Substances at the Site and the disposal of hazardous substances from the Site.

- B. Contractor shall comply with all regulations pertaining to handling, storage, and transportation of hazardous materials as set forth in the Code of Federal Regulation (CFR) 1910.120, DOT, EPA, and NRC regulations, as applicable. Compliance includes, but is not limited to adhering to proper storage containers, secondary containment, access control, security, signage, labeling, placarding, transporting, manifesting, and disposal.
- C. Prepare and implement Health, Safety and Environmental Plans including hazardous material management in compliance with Federal, State and Local regulations prior to mobilizing onsite for Project construction.
- D. The Contractor's Health and Safety Officer shall perform regular audits of the control and management of hazardous materials to:
 - 1. Identify any deficiencies that are noted and establish and implement necessary corrective actions. Activities related to hazardous materials management shall be included in the daily reports.
 - 2. Inspect the ground surface for any evidence of incidental spills or releases of petroleum or hazardous substances. Evidence includes, but is not limited to, soil staining, unusual odors or colors. Immediately notify the Engineer of any spill or release of hazardous materials or petroleum products identified.
 - 3. If a suspected Hazardous substance is encountered, refer to the Hazardous Substance Encountered by Construction Contractor flowchart in Figure 4.

3.14 EQUIPMENT REFUELING, CLEANING, AND MAINTENANCE

- A. Take measures to prevent spills during equipment refueling, cleaning, and maintenance. Place a 12 mil thick plastic liner or drip pan between the equipment and soil prior to work and contain all fluid. Maintain an adequate supply of absorbents during fueling and maintenance. Remove vehicles and equipment that are leaking fluids from the construction site. Clean up spills immediately and properly dispose of spilled materials and used absorbents. Notify Owner and Engineer of spills.

3.15 SUSTAINABLE CONSTRUCTION

- A. Prepare a materials handling plan including recycling and reuse. This plan shall identify materials expected to be encountered during demolition, site clearing, equipment maintenance, etc. In this plan, the Contractor shall define how these materials will be handled to maximize recycling and reuse opportunities and to minimize permanent disposal of such items including used motor oil, waste paper, removed asphalt, removed concrete, used tires, etc.

END OF SECTION

SECTION 01 56 39

TREE RETENTION AND PROTECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Report Documentation
 - 1. Materials Management Plan (MMP).

1.02 SUMMARY

- A. This section consists of retention and protection of trees during the construction of the project.
- B. Related Sections
 - 1. Division 01 Section "Erosion and Sedimentation Control".
 - 2. Division 02 Section "Demolition".
 - 3. Division 03 Section "Cast-In-Place Concrete".
 - 4. Division 31 Section "Clearing and Grubbing".
 - 5. Division 31 Section "Earth Moving".
 - 6. Division 31 Section "Excavating and Backfilling of Trenches".
 - 7. Division 31 Section "Watering".
 - 8. Division 32 Section "Aggregate Base Course".
 - 9. Division 32 Section "Asphalt Pavement".
 - 10. Division 32 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
 - 11. Division 32 Section "Soil Preparation".
 - 12. Division 32 Section "Topsoil".
 - 13. Division 32 Section "Turfgrass Seeding".
 - 14. Division 32 Section "Native Seeding".
 - 15. Division 32 Section "Sodding".
 - 16. Division 32 Section "Trees, Plants, and Groundcovers".
 - 17. Division 32 Section "Landscape Management and Maintenance".

1.03 DEFINITIONS AND REFERENCE STANDARDS

- A. Caliper Inch: The diameter of a tree six (6") inches above the root flare. The root flare is where the first main roots attach to the trunk.
- B. Diameter at Breast Height (DBH): The diameter of a tree measured at four and a half feet (4.5') above finished grade.

- C. Drip Line: The outermost edge of the tree's canopy or branch spread. The area within a tree's drip line is all the ground under the total branch spread.
- D. Established Tree: Trees on public property in fair or better condition with a trunk six inches (6") in diameter or greater.
- E. Exploratory Excavation: A method to determine the amount and size of tree roots under the surface. Methods may include hand excavation, a pneumatic air excavation tool, or water excavation.
- F. Water Excavation: Hydrovac excavation that utilizes high-pressure water to cut and liquefy the soil, while simultaneously using a vacuum to remove the soil from the excavation and will require that import fill is brought to the site to fill trenches after excavation.
- G. Impacted by Construction: Trees that are directly within or adjacent to the Limit of Work, within or adjacent to staging/storage areas, and within or adjacent to construction access areas that are affected in a negative way.
- H. Invasive Tree Species: Species that are on the Colorado State List for Noxious Weed Species. Anything on the A, B, or C list needs to be evaluated by the Town Forester for suitability.
- I. Project Consulting Arborist: An independent consultant with a degree in forestry, horticulture, arboriculture, plant pathology, entomology or plant biology; an American Society of Consulting Arborists (ASCA) registered consulting arborist, or an International Society of Arboriculture (ISA) Board Certified Arborist, with at least five (5) years of field experience, including tree preservation or on-site monitoring of public works or construction projects involving tree retention and protection.
- J. Pneumatic Air Excavation Tool: A tool specifically designed to excavate soil from around tree roots. Air Spade or Air Knife are examples of pneumatic air excavation tools.
- K. Suitability: The quality of a tree or trees appropriate for protection and preservation during construction projects. This quality is based on an assessment of tree health, structure, age, species factor and risk assessment, if pertinent.
- L. Tree Protection Work Plan: The tree protection plan is a plan based on the contract drawings that includes the Contractor's approach to working within and around the Tree Protection Zones.
- M. Tree Protection Zone (TPZ): The Tree Protection Zone is the area above and below grade around each tree where construction activities are limited or restricted to preserve tree health and structural integrity of the protected trees.
 - 1. The diameter of the tree shall be measured at four and one-half feet (4.5') above grade (referred to as diameter breast height). For every-one inch (1") of tree diameter the Tree Protection Zone shall extend one foot (1.0') radially from the base of the trunk or be placed at the dripline, whichever is greater.
 - 2. For areas with groups or groupings of trees, if the distance between trees is less than thirty feet (30'), the Tree Protection Zone may be combined and treated as one contiguous area to create a more clearly defined and manageable Tree Protection Zone.

1.04 SUBMITTALS

- A. All Submittals shall be approved by the Project Manager and the Project Consulting Arborist, prior to mobilization and any Work being conducted on site.

- B. Tree Protection Work Plan: Submit a tree protection work plan based on the Contract Drawings for approval. The plan shall include the following:
1. Existing conditions.
 2. Limit of Work.
 3. Tree caliper / diameter size, location of dripline, and Town site identification number.
 4. Tree Protection Zones with Tree Protection Zone sign locations.
 5. Tree protection fencing (chain link / orange plastic safety) shall correspond to the level of construction activity adjacent to protected tree(s). Including but not limited to areas of high traffic, material drop off/pickup, high intensity activity, and earthwork of greater intensity than grubbing. Notable trees shall include chain link fencing.
 6. Plan for the Work occurring within or adjacent to Tree Protection Zones:
 - a. Access routes, including designated routes for equipment and foot traffic by work crews to minimize soil compaction.
 - b. Proposed exploratory excavation locations and methods to remove soil from around tree roots within Tree Protection Zones.
 7. Maintenance of Tree Protection Zones and any trees affected by Construction during the Work.
 8. Trees identified for regular soil moisture readings.
 9. During construction, Tree Protection Plans may need to change per field conditions. The Contractor shall continue to update the Tree Protection Work Plan in the field as a redlined plan and submit for approval from the Project Manager and the Town Forester.
- C. Tree Protection Work Plan Updates: The Contractor shall submit a highlighted section of their Tree Protection Work Plan at the Construction Progress Meetings to discuss where they intend to work and what Tree Protection Zones may be impacted for the upcoming week.
- D. Pruning: Proposed methods, materials, the Licensed and Insured Arborist, and schedule for root pruning, branch pruning, and other tree maintenance shall be submitted for approval.
- E. Pneumatic Air Excavation: Type of pneumatic air excavation tool, the Licensed and Insured Arborist, and schedule for excavation shall be submitted for approval.
- F. Water Excavation: Type of hydrovac excavation tool, the Licensed and Insured Arborist, and the schedule for excavation shall be submitted for approval.
- G. Watering Plan and Schedule: The Contractor shall submit a watering plan and schedule prior to the start of work that details watering of all trees affected by the Project for approval. The below information shall be included:
1. Area of the project site to be watered and how watering will be phased based on construction.
 2. Location, Town site identification number (SID), and caliper inch of each tree to be watered.
 3. Total number of trees to be watered and total caliper inches. Identify the amount of water to be applied based on total caliper inches
 4. Schedule for watering during the duration of the project.
 5. How the trees will be watered:

- a. On-site irrigation system.
 - b. Temporary above ground irrigation system
 - c. Hydrant.
 - d. Water truck.
 - e. Combination of on-site irrigation, hydrant, and water truck.
- H. Soil Moisture and Watering Log: The Contractor shall fill out and submit the Town Forester watering log, attached as an Exhibit. Information on the watering log includes:
 - 1. Tree(s) watered, identified by the Town site identification number.
 - 2. Number of gallons of water applied to each tree during every watering period or irrigation schedule.
 - 3. Soil moisture level readings, on a scale of one to ten (1 – 10). Refer to Part 3 - Execution for soil moisture reading requirements.
 - 4. Dates of each watering.
 - 5. The Soil Moisture and Watering Log shall be provided monthly via email to the Town Forester and the Project Manager and reviewed at Construction Progress Meetings prior to the submittal of Pay Applications. Pay Applications will not be approved without receipt of the Soil Moisture and Watering Logs. If there appears to be an issue with on-site watering, Soil Moisture and Watering Logs may be requested at any time by the Town Forester. It's expected that these are updated per the Specifications to reflect on-site watering.

1.05 QUALITY CONTROL

- A. The Contractor and all their sub-contractors shall attend a Preconstruction Meeting as outlined in Division 01 "Project Meetings". When the Project requires new sub-contractors to be on-site to complete Work, the Contractor shall include the sub-contractors in the Construction Progress Meetings to review the requirements of this specification.
- B. Contractor shall comply with applicable requirements and recommendations of the most current versions of the following standards and guidelines. Where these conflict with other specified requirements, the more restrictive requirements shall govern.
 - 1. ANSI Z133.1: American National Standard for Tree Care Operations.
 - 2. ANSI A300: Tree, Shrub, and Other Woody Plant Management – Standard Practices – Parts - 1,2,5,6 and 8.
 - 3. Guide for Plant Appraisal – Current Edition: Authored by the Council of Tree and Landscape Appraisers; published by the International Society of Arboriculture.
- C. At its discretion, the Town may hire a Project Consulting Arborist to conduct daily observation of the Contractor's field crews during the critical phases of the project, including, but not limited to, demolition of existing concrete, root pruning, construction of retaining walls, irrigation, and construction of new curb or sidewalk in Tree Protection Zones.
- D. Motorized equipment and trailers, including but not limited to tractors, skid loaders, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts shall not be allowed access within Tree Protection Zones with the exception of paved surfaces. Should access be necessary within designated Tree Protection Zones the Town Forester or Project Consulting Arborist shall be notified and shall approve of the access route and driving surface prior to its use.

- E. Materials, supplies, tools, and construction facilities shall not be stockpiled or stored within the Tree Protection Zones unless otherwise approved by the Town Forester. Should temporary storage be approved by the Town Forester within designated Tree Protection Zone(s), the existing grade shall be covered with plywood as identified in Part 3 – Execution to help distribute the weight of equipment and to minimize soil compaction and rutting. Plywood and/or mulch are not acceptable bridging materials for driving over exposed tree roots.
- F. Under no circumstances shall any objects or materials be leaned against or supported by a tree's trunk, branches, or exposed roots. The attachment or installation of any sign, cable, wire, nail, swing, or any other material to trees that is not needed to help support the natural structure of the tree is prohibited. Standard arboricultural techniques such as bracing or cabling that are performed by professional arborists are acceptable upon approval of the Town Forester or Project Consulting Arborist.
- G. The Contractor shall notify the Town Forester prior to mobilization on site with their schedule for installation of tree protection. Tree protection shall be in place and approved prior to any work being conducted on-site, this includes erosion control.
- H. The Town Forester is not available for inspections and approval on weekends or holidays, unless previously approved by the Project Manager and the Town Forester.

PART 2 PRODUCTS

2.01 TREE PROTECTION FENCE

- A. Orange plastic safety fencing – minimum of forty-eight inches (48") in height, heavy duty T-posts.
 - 1. Twelve (12) gauge wire.
- B. Galvanized Chain-link – Six feet (6') in height. Steel chain link fence panels or rolls are acceptable.
- C. Tree Protection Zone signs printed and laminated by the Contractor. Refer to Appendix.

2.02 EXPLORATORY EXCAVATION

- A. Pneumatic Air Excavation Tool, AirSpade, Air Knife, or approved equal. The tool used shall not exceed ninety pounds per square inch (90 PSI).
- B. Water Excavation Tool, Hydrovac equipment. The tool shall not exceed sixty pounds per square inch (60 PSI) and shall utilize a rotary nozzle to minimize root damage.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The Contractor shall follow the approved Tree Protection Work Plans and access routes.
- B. If it appears any Work may cause damage to a tree, the Contractor shall contact the Project Manager and the Town Forester. The Project Manager and Town Forester will make the determination as to whether such damage is likely, and the next steps.

- C. Methods for working within a Tree Protection Zone shall be approved prior to the start of work and may include the following depending on project site conditions:
1. Pneumatic air excavation tool. Maximum pressure applied shall be an amount not to damage roots and shall not exceed ninety pounds per square inch (90 PSI). Pneumatic air excavation may not be allowed when in known asbestos areas.
 2. Water excavation. Maximum pressure applied shall be an amount not to damage roots and shall not exceed sixty pounds per square inch (60 PSI). Water excavation may be required when in known asbestos areas.
 3. Directional boring.
 4. Hand digging.
 5. Other methods approved by the Town Forester.

3.02 TREE PROTECTION FENCING

- A. Tree protection fencing shall be installed and approved by the Town Forester prior to any site activity, including installation of erosion control, and shall remain in place and maintained in the condition in which it was approved until removal is authorized by the Project Manager and the Town Forester.
- B. Tree protection fencing shall be installed one foot (1') offset from the existing or proposed hardscape.
- C. Tree protection fencing shall be constructed as follows:
1. Fencing shall be installed to surround the trees within the Limit(s) of Work.
 2. Orange plastic safety fencing is required as shown in the plans or as directed by the Town Forester.
 - a. The fencing shall be secured to metal t-posts with twelve-gauge (12) wire woven through the top of fencing along the entire length.
 - b. Heavy duty t-posts shall be placed every eight feet (8') so that wire and fence are taut.
 - c. Installation of the posts shall not result in injury to the tree above or below ground.
 3. Chain link fencing is required by the Town Forester, particularly where heavy construction activity is adjacent to existing trees, where Notable trees are located, or as required on the plans.
 - a. Chain link fence shall have posts installed no less than ten feet (10') on center, at a depth of twenty-four inches (24") minimum or utilize sandbags as shown in the Tree Retention and Protection Detail.
 - b. Installation of the posts shall not result in injury to tree above or below ground.

3.03 TREE PROTECTION SIGNS

- A. A standard Town Forester tree protection sign shall be placed one (1) per each Tree Protection Zone, minimum, or per the direction of the Town Forester.
1. The Contractor shall print and laminate eleven by seventeen-inch (11"x17") size tree protection signs. Refer to Appendix.

- a. The Contractor shall use zip ties on all four (4) corners of the signs to attach to the tree protection fencing.
- b. The tree protection signs shall be replaced within twenty-four (24) hours if they become unreadable, destroyed, missing, or per the direction of the Project Manager and/or the Town Forester.

3.04 DEMOLITION

- A. Caution shall be used during removal of existing street, curb, gutter, sidewalk, drain inlets, and other concrete and asphalt demolition, to minimize injury to tree root systems. The following procedures are acceptable when removing existing concrete.
 - 1. Breaking of the existing concrete and asphalt for removal shall be done in a manner that will minimize ground disturbance and vibration.
 - 2. Curbs and sidewalks within designated Tree Protection Zones shall be removed in a manner approved by the Town Forester. When removing existing sidewalks and curbs, care shall be taken to avoid injury to roots located under, over, or adjacent to paved surfaces.
 - 3. In instances where roots and root-trunk flares are growing over hardscape, caution shall be used to minimize damage during breaking of hardscape and removal of debris. Wood and bark tissues shall not be injured by equipment. The Contractor shall discuss methods and submit for approval from the Town Forester prior to demolition.
 - 4. Motorized equipment and trailers, including but not limited to tractors, skid steers, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts are limited to existing paved areas only and access must be approved by the Town Forester prior to entrance into the Tree Protection Zones.
 - a. If pre-approved by the Town Forester, the Contractor shall test compaction after removal of hardscape to determine the percent of Standard Proctor. If the Standard Proctor is ninety percent (90%) or above, the Contractor may be able to utilize the tested area with equipment as approved by the Town Forester. If it is determined that the compaction is adequate, but there are visible surface roots or tree roots that will be impacted, this method may not be suitable and may be denied by the Town Forester.
 - b. If equipment is approved by the Town Forester, tracking pads shall be placed on the surface.
 - 5. All excavation and debris material shall be hauled off or deposited outside of the Tree Protection Zones. At no time shall material be stored, even temporarily, within the Tree Protection Zones.

3.05 CONSTRUCTION IN TREE PROTECTION ZONES

- A. The Contractor shall protect all trees from injury due to construction related work. All injuries to trees shall be mitigated to the satisfaction of the Town Forester, and, if appropriate in accordance with guidelines established in the "Guide for Plant Appraisal" as available upon request from the Town Forester. All costs of such mitigating shall be charged to and paid by the Contractor or offending sub-contractor.
- B. If access within designated Tree Protection Zones is approved by the Town Forester or Project Consulting Arborist, the existing grade shall be covered with twelve inches (12") of wood mulch and overtopped by three-quarter inch (3/4") plywood with overlapping sheets, six-inches (6") minimum, or the plywood may be approved for use on the bottom of the mulch, to help distribute the weight of equipment and to minimize soil compaction and rutting. Mulch must be maintained

at twelve inches (12") and plywood must be replaced when it becomes damaged and cracked to the point of being ineffective as determined by the Town Forester.

1. Ground tracking mats or steel plates may be used as an alternative to plywood and may be required in high-traffic areas. Mulch is still required in combination with ground tracking mats or steel plates. Mats or plates must be appropriately sized for the type of equipment and shall be approved by the Project Manager or the Town Forester prior to installation.
- C. The following procedures shall be used when constructing any hardscape or drainage improvements:
1. All materials and equipment shall be kept on existing hardscape or within previously approved, compacted sub-base areas.
 2. Protect exposed roots from damage and contamination by stabilization materials and concrete.
 3. Locate concrete washouts outside of and away from Tree Protection Zones. Washout runoff shall be strictly contained within the washout area and shall not flow into Tree Protection Zones.
 4. When excavating, excavated soil shall be deposited in trucks and hauled off or deposited temporarily outside the Tree Protection Zones. Excavated and fill soil shall not be deposited, even temporarily, in Tree Protection Zones.
 5. If root pruning is needed, refer to section "Pruning".
- D. The compaction of sub soil within Tree Protection Zones shall not exceed eighty percent (80%) proctor density, unless the Contractor can confirm by testing that the existing compaction within the Tree Protection Zones already exceeds eighty percent (80%).
- E. If part of an approved plan, grading within the Tree Protection Zones shall be performed by hand or a method approved by the Town Forester. Any fill material that needs to be placed in the Tree Protection Zone shall be limited to a maximum of four inches (4") of fill material over the area. Fill should consist of sandy loam topsoil. Clay soils shall not be used as fill. When using fill soil, the existing surface to receive fill should be scarified by hand, while avoiding root damage, to a maximum depth of one inch (1") from the finished grade prior to placing fill material, to ensure proper incorporation of fill material. Any filling operation should not occur during water saturated soil conditions.
- F. Concrete or chemicals spilled within Tree Protection Zones shall be completely removed at the time of the spill. Contaminated soil shall be completely removed by hand and/or approved methods to minimize disturbance to root systems. Approved soil shall be added as necessary to restore the grade and the Contractor shall provide remedial tree maintenance as outlined in section "Tree Maintenance During Construction". Contact the Project Manager and the Town Forester immediately in the event of a spill within a Tree Protection Zone

3.06 TRENCHING

- A. When trenching is approved within the Tree Protection Zones by the Town Forester, the Work shall be dug by hand, pneumatic air excavation, water excavation, or be done by directional boring in a manner to minimize root damage.
- B. Whenever trenching exposes roots, as called out in section "Pruning", extending through the trench wall, the Contractor shall contact the Project Manager and the Town Forester or the Project Consulting Arborist immediately for inspection and evaluation. Refer to section "Pruning".

- C. Directional Boring: Bore shall be thirty-six inches (36") below grade, minimum for irrigation mainline and site utilities, unless otherwise approved by the Town Forester or the Project Consulting Arborist. For irrigation lateral lines the depth shall be between eighteen inches (18") and twenty-four inches (24"). The bore shall have a locator to measure and maintain depth. The Contractor shall verify depth is accurate with the Project Manager and the Town Forester.

3.07 IRRIGATION OR UTILITY INSTALLATION

- A. All Excavation, Irrigation, or Utility installation occurring within the Tree Protection Zones as indicated on the Contract Documents shall be marked out in the field and reviewed in the field with the Town Forester or Project Consulting Arborist prior to installation.

3.08 PRUNING

- A. Branch Pruning: Shall be the responsibility of the Contractor for construction equipment access, specialty pruning required for the Project, and any damage caused by the Contractor during the Project and shall be done by a Licensed, and Insured Arborist. Pruning shall only be done with approval and at the direction of the Town Forester or Project Consulting Arborist. Information on storm damage is found in section "Tree Maintenance During Construction".
- B. Root Pruning: Shall be done in accordance with ANSI A300 Root Management Standard latest edition and in accordance with Best Management Practices and be performed by a Licensed, and Insured Arborist.
 - 1. the Town Forester or Project Consulting Arborist shall be notified prior to any Work operation known or suspected to involve cutting of roots within the Tree Protection Zone. Tree roots shall not be pruned or cut unless their removal is unavoidable and shall be authorized by the Town Forester.
 - a. When contacting the Town Forester, provide the following information:
 - 1) Tree type and/or Town site identification number.
 - 2) Condition of the tree.
 - 3) Percent of disturbance anticipated within the Tree Protection Zone.
 - 4) Size of roots.
 - 2. All roots needing to be pruned or removed shall be cut cleanly with sharp hand tools, with oversight by the Town Forester or the Project Consulting Arborist. No wound dressings shall be used. Backfill shall promptly be installed over the exposed roots, filling all voids.
 - 3. Recommended root pruning tools shall be free of defects and have sharp cutting edges
 - a. Scissor-type lopper.
 - b. Scissor-type pruner.
 - c. Pruning saws designed specifically for tree work.
 - 4. After root-pruning, cover exposed roots within thirty (30) minutes to minimize desiccation. Roots may be covered with soil, mulch, or moistened burlap, and shall be kept moist until the final grade is established or roots are buried in soil.
 - 5. Where appropriate, and under the direction of the Town Forester or the Project Consulting Arborist, root restricting barriers can be installed in accordance with manufacturer's recommendations.
 - 6. If root pruning is authorized within the Tree Protection Zones, the Contractor shall provide remedial tree maintenance as identified in section "Tree Maintenance During Construction".

3.09 SURFACE AND EXPOSED ROOTS

- A. When encountered, exposed roots shall be worked around in a manner that does not damage the outer layer of the root surface or bark
 - 1. the Town Forester shall be notified should tree roots become exposed.
 - 2. Exposed roots must be wrapped in burlap and kept moist. At or below forty degrees (40°) F, the excavation area shall be covered in concrete blankets or as directed by the Town Forester.
 - 3. Exposed tree roots shall not be driven over. Plywood and/or mulch are not acceptable bridging materials for driving over exposed roots.

3.10 PROJECT SITE MONITORING

- A. The Contractor is responsible for monitoring and maintaining Tree Protection Zones throughout the duration of the Project until removal of the tree protection fencing is approved by the Project Manager and the Town Forester.

3.11 TREE MAINTENANCE DURING CONSTRUCTION

- A. Common Tree Maintenance: Practices that maintain the health and vigor of the tree, such as: watering, mulching, remedial pruning (if needed, and approved by the Town Forester). The Contractor shall be responsible for all trees impacted by Construction throughout the Project.
- B. Remedial Tree Maintenance: Practices such as soil remediation and soil/tissue sampling, and these practices are on an "as needed" basis, or as directed by Project Manager and the Town Forester. The Contractor shall be responsible for all trees impacted by Construction throughout the Project.
- C. Tree watering during Construction shall consist of the following minimum requirements for all trees within a Tree Protection Zone or otherwise impacted by Construction:
 - 1. Watering of trees shall occur throughout the year during Construction, including winter.
 - 2. Watering from May through September (growing season) shall consist of:
 - a. All trees within the Limit of Work and/or impacted by Construction shall be watered.
 - 3. Watering from October through April (winter) shall consist of:
 - a. Trees six inches (6") and smaller within the Limit of Work and/or impacted by Construction shall be watered.
 - b. All evergreens within the Limit of Work and/or impacted by Construction shall be watered.
 - c. Frequency shall be based on soil moisture readings, visual indicators, and weather conditions.
 - 4. When completing winter watering or growing season watering with a hydrant or water truck, minimum watering requirements shall be twenty-five (25) gallons of water per caliper inch of every tree with an equal application of water throughout the entire Tree Protection Zone. Watering shall occur when daytime temperatures are at or above forty degrees (40°) F.
 - 5. Watering frequency shall be based on the criteria above, visual indications, and on the average soil moisture level.

- a. The Contractor shall take soil moisture readings throughout the Project. The soil moisture shall have a measure between four (4) and eight (8) on the meter and shall be maintained during Construction.
 - b. Soil moisture readings shall be taken every week, at a minimum, during the Construction period and at a depth of twelve inches (12").
 - c. Readings shall be taken and recorded for twenty percent (20%) of the trees within the Limit of Work and impacted by Construction and shall be indicated on the Tree Protection Work Plan.
 - d. All readings shall be recorded and submitted as outlined in Part 1 – Submittals.
- 6. Depending on weather conditions, the Town Forester or Project Consulting Arborist may approve less frequent watering.
- 7. The Town Forester will look for visual indications to determine if watering is adequate during Construction. If it appears that the trees are suffering based on visual indications, the Town Forester will check the soil moisture levels and determine the corrective action. Criteria includes:
 - a. The surrounding soil and/or landscape is dry.
 - b. The surrounding vegetation is dying or dead.
 - c. The leaves on the trees are wilted.
 - d. Color.
- 8. At the Contractor's expense, they may install a temporary irrigation system to water with the approval of the Project Manager and the Town Forester.
- D. Branch and Root Pruning: Refer to Section "Pruning".
- E. Maintenance for Storm Damage or Emergencies: The Contractor shall coordinate trees affected by storm damage with the Town Forester. Guidelines for responsibilities are identified below:
 - 1. Non-imminent threat or immediate threat that is not a danger to the public: Considered low priority clearing and will be removed as time allows by the Town Forester. If the Contractor needs access to the Limit of Work, the Contractor shall remove the damage at their expense.
 - 2. Immediate threat that affects the public: Considered high priority clearing for the Town Forester and will be removed by the Town Forester inside the Limit of Work.
- F. The timing duration and frequency of necessary maintenance practices shall be determined and approved by the Town Forester or Project Consulting Arborist, based on factors associated with the site and affected trees.

3.12 TREE PROTECTION ZONE VIOLATION AND DAMAGE PENALTIES

- A. Verbal Warning: A verbal warning with instruction may be given at the discretion of the Town Forester.
- B. Written Warning: A written warning may be given at the discretion of the Town Forester.
- C. Fines: A fine of two thousand five hundred dollars (\$2,500.00) will be levied against the Contractor or any Sub-contractor for each violation of the Tree Protection Zones and/or damage. This includes but is not limited to, fencing not maintained as originally approved by the Town Forester, and any encroachments within the designated Tree Protection Zones. Fines will be

given for every occurrence and may exceed two thousand five hundred dollars (\$2,500). This fine shall be independent of any applicable damage penalty for the appraised value of the tree(s).

- D. Injuries and Damage to Existing Trees: Any plants designated as requiring retention or protection that are partially injured or lost due to Contractor neglect or unacceptable construction activities will result in a penalty as determined by the Town.

END OF SECTION

SECTION 01 57 19

ENVIRONMENTAL CONTROLS

PART 1 GENERAL

1.01 GENERAL

- A. This Specification provides procedures and requirements pertaining to environmental controls, and information to assist Contractor with environmental compliance.
- B. In the event of conflicts between this Specification and the requirements of the Laws and Regulations; the more restrictive shall apply.
- C. Unless otherwise directed by Owner, costs related to this Specification shall be considered inherent to Work, and be included in the Contract Price (i.e., no separate measurement and payment).
- D. Refer also to:
 - 1. Section 01 35 43 - Environmental Procedures.
 - 2. Section 01 41 00 - Project Permits.
 - 3. Section 01 74 19 - Waste Management & Waste Disposal.

1.02 POLLUTION CONTROL

- A. Contractor shall be aware of the drainage characteristics of the Site in relation to Environmental Receptors.
- B. Contractor shall provide, install, inspect performance of, and maintain sufficient BMPs / Control Measures to prevent impacts to the Site from potential pollutant sources, including sediment, to Environmental Receptors for the duration of the Work; especially to waterways or storm drain systems.
- C. Contractor shall prevent pollutants from being tracked off site via roadways. Contractor shall promptly clean up sediment and other pollutants that are tracked by vehicles out of the immediate Work zone.
- D. Contractor shall provide secondary containment for all Hazardous Substances and oil containing items with a capacity of ≥ 55 gallons (with the exception of motive power / vehicle containers). Contractor shall perform daily checks of storage areas and appropriately manage any contained stormwater. Containers holding incompatible materials must not be stored together.
- E. Contractor shall ensure that the appropriate types and quantities of spill response supplies and personal protective equipment (PPE) are readily available and strategically located on-Site. Contractor shall periodically perform an inventory check to ensure that used or missing materials are re-stocked.
- F. Contractor employees trained in emergency spill cleanup procedures must be present during the loading and unloading of Hazardous Substances or Hazardous Materials.
- G. Contractor shall not burn, bury, or discharge, any Hazardous Substances or Hazardous Materials.

1.03 OIL POLLUTION PREVENTION / SPCC PLAN

- A. Contractor shall ensure the design, construction, location, installation, and operation of all liquid fuel product tank systems greater than 60 gallons shall conform to the minimum standards prescribed by the applicable sections of NFPA fire code. This includes the testing and inspection requirements contained therein. (C.R.S. §8-20-231)
- B. The definition of “Facility” within 40 CFR Part 112 governs the overall applicability of the Oil Pollution Prevention regulations. Additionally, the regulations apply only to a “Facility” that, due to its location, can reasonably be expected to discharge oil as described in §112.1(b).
- C. The construction project Site shall be considered a “Facility”.
 - 1. If the aggregate storage capacity of all on-Site oil containing items that are ≥55 gallons (i.e., bulk storage containers, electrical / operational / manufacturing equipment, mobile refuelers, tank trucks, etc.) exceeds 1,320 gallons,
 - 2. And the location of the project can reasonably be expected to discharge oil as described in §112.1(b),
 - 3. Then Contractor shall comply with the requirements of 40 CFR Part 112 and prepare and implement a Spill Prevention, Control, and Countermeasure (SPCC) Plan.
- D. Only a Colorado registered Professional Engineer shall make a determination that, due to its location, the project cannot reasonably be expected to discharge oil as described in §112.1(b). Contractor shall provide to Owner such written determination (signed and stamped) with supporting rationale, if the “location” exemption is to be claimed.
- E. The regulations apply to oil of any kind or in any form (including but not limited to gasoline, diesel, fuel oil, motor oil, synthetic oil, mineral oil, gear oil, hydraulic oil, used oil, transmission fluid, engine fluids, metalworking fluids, compressor lubricants, turbine lubricants, asphalt cement, asphalt emulsions, asphalt cutbacks, grease, animal fats, and vegetable oils).

1.04 SOIL DISTURBING ACTIVITIES

- A. Contractor shall be knowledgeable of and comply with the CDPHE’s requirements for any person who disturbs Debris or exposes Debris during Soil Disturbing Activities (6 CCR 1007-2 Part 1 § 5.5).
- B. Prior to performing Soil Disturbing Activities, Contractor shall visually inspect the area for readily apparent Debris and indications of buried Debris or undocumented or artificial fill (i.e., encroached waterways, filled gullies, drainages, and similar features).
- C. Prior to project completion, Contractor shall revegetate disturbed areas with weed-free seed and weed-free mulch materials. Contractor shall use a seed mix that is appropriate in the surrounding landscape, with a preference for native species. Contractor shall ensure noxious weeds do not establish at the Site.

1.05 GRADING, EROSION, & SEDIMENT CONTROL

- A. Contractor shall provide, install, inspect performance, and maintain sufficient BMPs / Control Measures for all land disturbance activities to prevent increases in erosion and sedimentation over pre-construction conditions for the duration of the Work.
- B. Contractor shall determine and comply with the requirements of each Authority Having Jurisdiction (AHJ).

- C. Contractor shall preserve existing vegetation to the maximum extent practicable.
- D. Contractor shall minimize amount of bare soil exposed at one time.
- E. Water sprayed for dust control and irrigation shall be managed by Contractor to avoid causing runoff and erosion.

1.06 STORMWATER POLLUTION CONTROL

- A. Contractor shall not discharge stormwater to a sanitary sewer system without approval from AHJ.
- B. Contractor shall not discharge stormwater noted or suspected of being contaminated, without approval from AHJs.
- C. If the Area of Disturbance related to Work will be at least 1 acre of land (or is part of a larger common plan of development or sale that will disturb at least 1 acre), Contractor shall:
 - 1. Obtain and comply with a Colorado Discharge Permit System - Stormwater Construction Permit.
 - a. Prepare a Stormwater Management Plan (SWMP).
 - b. Complete and submit a Notice of Intent and Application for coverage at least 10 days prior to the start of construction activities.
 - c. Implement and maintain the SWMP. Provide necessary erosion control measures, such as surface roughening, seeding, soil binders, mulching, rolled erosion control products, slope drains, etc.
 - d. Provide necessary sediment control measures, such as silt fence, sediment control log, vehicle tracking control, straw bale barrier, rock sock, etc.
 - e. Control measures must not only be properly selected and installed, but also must be inspected, maintained, and properly repaired for the duration of the Work.
 - 2. Obtain executed Permit termination or transfer, if agreed.
- D. If the Area of Disturbance related to Work will be less than 1 acre of land, Contractor shall:
 - 1. Provide, install, inspect performance, & maintain sufficient BMPs / Control Measures to prevent impact from potential pollutant sources to stormwater.
- E. Local AHJs in many cases have their own stormwater requirements, such as those of a MS4 program. Where local requirements exist, Contractor shall comply with the requirements of both the CDPHE and local AHJs.
- F. If Work is on Federal Land, Contractor shall comply with the Federal agency's stormwater requirements.
- G. Concrete Washout
 - 1. Dispose in accordance with Section 01 74 19 - Waste Management & Waste Disposal.

1.07 WATER QUALITY CONTROL

- A. Contractor shall not dewater or discharge to private property, without written permission from the landowner and Owner.

B. Potable Water Discharges

1. Contractor shall comply with the current version of the CDPHE's Water Quality Policy 27 – Low Risk Discharge Guidance for Discharges of Potable Water.

C. Power Washing Operations

1. Contractor shall comply with the current version of the CDPHE's Water Quality Policy 27 – Low Risk Discharge Guidance for Discharges from Surface Cosmetic Power Washing Operations to Land.

D. Dewatering of Utility Vaults or Similar Structures

1. Contractor shall comply with the current version of the CDPHE's Vault Dewatering Guidance.

E. Dewatering or Discharging to Land, Surface Waters, and/or a Storm Sewer System

1. This section applies to uncontaminated groundwater, surface water, and/or stormwater commingled with groundwater or surface water (herein referred to as "source water"); regardless of whether the discharge is sporadic, intermittent, or continuous. If the "source water" has any reasonable potential to contain a pollutant at a concentration that is greater than a numeric water quality standard of the receiving water (i.e., assumed to be groundwater for discharges to land only), Contractor shall promptly notify Owner and pursue alternate allowable options.
2. Contractor shall, as appropriate:
 - a. Comply with the current version of the CDPHE's Water Quality Policy 27 – Low Risk Discharge Guidance for Discharges of Uncontaminated Groundwater to Land, and/or
 - b. Obtain and comply with the CDPHE's General Permit COG080000 for Discharges from Short-Term (< 2 years) Construction Dewatering Activities.
3. Contractor shall determine and comply with local dewatering requirements, if any, such as those of a MS4 program.
4. Contractor shall comply with the Colorado Department of Natural Resources – Division of Water Resources (DWR's) requirements (i.e., see the definition of Dewatering Wells in C.R.S 37-91-102, and the related rules).
 - a. This section applies to any groundwater dewatering discharge and/or pumping activities and is in addition to the CDPHE's dewatering requirements.
 - b. Contractor shall obtain approval from DWR:
 - 1) If discharge is to land and/or the nearest surface stream to the site, Contractor shall file a Notice of Intent to construct a dewatering well at least 72 hours before discharge commences.
 - 2) If discharge is taken off-site, then Contractor shall obtain a Well Permit and prepare a Substitute Water Supply Plan (SWSP). DWR requires a minimum of 120 days for review & approval.
5. If a Colorado Discharge Permit System - Stormwater Construction Permit has been obtained for the project, discharges to the ground of water from construction dewatering activities may be authorized by the CDPHE, provided that:

- a. The source is groundwater and/or groundwater combined with stormwater that does not contain pollutants in concentrations exceeding the State groundwater standards in Regulations 5 CCR 1002-41 and 42;
 - b. The source is identified in the SWMP;
 - c. BMPs are included in the SWMP, as required by Part I.C.3(c)(8);
 - d. These discharges do not leave the site as surface runoff or to surface waters; and
 - e. Requirements of local AHJs are not more stringent.
- F. Dewatering or Discharging to Publicly Owned Treatment Works (POTW) / Sanitary Sewer System
 - 1. Contractor shall comply with all applicable prohibitions and limitations of the local AHJ.
 - 2. Contractor shall not discharge any groundwater, surface water, or stormwater into a sanitary sewer, without approval from AHJ.
 - a. Contractor shall comply with the Colorado Department of Natural Resources – Division of Water Resources’ requirements (i.e., see the definition of Dewatering Wells in C.R.S. § 37-91-102, and the related rules).
- G. Hydrostatic Testing of Pipelines, Tanks, and Similar Vessels
 - 1. Contractor shall obtain and comply with the CDPHE’s General Permit COG604000 for Discharges Associated with Hydrostatic Testing of Pipelines, Tanks, and Similar Vessels.
- H. Discharges to Surface Water from Well Development and Pump Testing Activities
 - 1. Contractor shall obtain and comply with the CDPHE’s General Permit COG608000 for Discharges to Surface Water from Well Development and Pumping Test Activities.
- I. Underground Injection
 - 1. EPA Region 8’s Underground Injection Control Program
 - a. Not allowed.
- J. Discharges from Short-term (< 2 year) Remediation Activities
 - 1. Reserved.
- K. Discharges from Long-term (≥ 2 year) Remediation Activities
 - 1. Reserved.
- 1.08 AIR QUALITY CONTROL
 - A. General
 - 1. Contractor shall not create hazardous or nuisance air quality conditions.
 - 2. Contractor shall identify air pollution generating equipment or processes that may require Permits or associated submittals, such as a CDPHE Air Pollution Emission Notice (APEN).

B. Fugitive Dust & Particulate Control

1. Dust particles, aerosols, and gaseous by-products from construction activities, and processing and preparation of materials must be controlled by Contractor at all times.
2. Contractor shall furnish labor, equipment, and materials to control dust at all times, including evenings, holidays, and weekends.
3. Primary Fugitive Dust causes are typically wind erosion and mechanical disturbance.
 - a. High temperatures, low humidity, and windy conditions may merit augmented controls.
 - b. Cover trucks hauling dirt or other dust generating materials.
 - c. Vehicle speeds on unpaved haul routes shall be controlled.
 - d. Perform checks to monitor whether Fugitive Dust is being generated.
4. If Fugitive Dust is being generated, Contractor shall apply additional water or promptly initiate other dust control techniques. Contractor shall obtain approval from Owner for dust suppressants or dust control binders prior to use. CDPHE'S approval may also be needed. Contractor shall consider products that have significant bio-based content, when compared with competing products that serve the same purpose.
5. Contractor may be required to reduce or halt operations at times during high wind events causing Fugitive Dust emissions.
6. Contractor shall ensure that excavation, storage, handling, and transportation of Hazardous Substances and Hazardous Materials result in no visible dust migration.
7. Contractor shall be liable for any damage or harm resulting from dust originating from Contractor's operations.

C. Land Development Activities

1. For this section, Land Development refers to all land clearing activities, including but not limited to land preparation such as excavating or grading.
2. For Land Development activities that are <25 contiguous acres and <6 months in duration are exempt from CDPHE's permitting requirements:
 - a. Contractor shall use sufficient BMPs / Control Measures to minimize to the extent practicable the release of Fugitive Dust.
3. For Land Development activities that are ≥25 contiguous acres or ≥6 months in duration.
 - a. Contractor shall obtain and comply with the CDPHE - Air Pollution Control Division's General Construction Permit for Land Development Projects.
 - b. When the general permit isn't applicable or doesn't meet the unique needs of a facility, then CPDHE will issue an individual permit through the traditional construction permit process.

D. Construction Activities

1. Contractor shall determine local requirements, if any, and comply with requirements of AHJs applicable to all construction activities.

E. Demolition

1. Contractor shall obtain and comply with the CDPHE - Air Pollution Control Division's Demolition Notification Application for all demolition activities.

2. Contractor shall determine local requirements, if any, and comply with requirements of AHJs applicable to demolition activities.

F. Refrigerants

1. Contractor shall implement management practices and control measures to ensure that heating, ventilation, and air conditioning (HVAC) work involving refrigerants complies with 40 CFR Part 82 requirements.
2. Contractor shall ensure that technicians are certified, use certified equipment, and log work that requires the addition or removal of refrigerant.
3. Accidental venting of a refrigerant is a release and must be reported immediately by Contractor to Owner.

1.09 ASBESTOS

A. Demolition or Abatement

1. Contractor shall provide CDPHE notification for all demolitions of all facilities (see definition in AQCC's Regulation 8, Part B) and all Asbestos abatement projects that exceed the trigger levels, whichever is the lesser quantity. The notification requirements apply to both friable and non-friable asbestos materials.
2. Contractor shall obtain a CDPHE Permit for the abatement of friable asbestos projects where the quantity of asbestos containing material to be abated exceeds the trigger levels, whichever is the lesser quantity, and the work is in an area of public access.
3. Contractor shall determine local requirements, if any, and comply with requirements of AHJs applicable to demolition or abatement activities involving Asbestos.

1.10 LEAD BASED PAINT

- A. Manage in accordance with applicable Laws and Regulations.

1.11 ODOR CONTROL

- A. Contractor shall ensure that Work that causes excessive odors shall be performed only after coordination and collaboration with Owner. The Work may need to be performed during off-hours, unless odor control measures are implemented. Owner may stop Work if bothersome odors or vapors from the Work generate complaints from building occupants, site workers, and/or the public. Any additional cost associated with performing Work at night due to odor control concerns will be the sole responsibility of Contractor.

1.12 NOISE CONTROL

- A. Contractor shall provide methods, means, and facilities to minimize noise produced by construction operations and equipment.
- B. Contractor shall perform noise-producing work in less sensitive hours of the day or week.
- C. Contractor shall comply with all local sound codes and ordinances.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Maintain all facilities constructed for pollution control or Site protection, as long as the potential for pollution or damage from construction activities exists. At completion of the Work, and when authorized by Engineer or Owner, remove temporary fencing, silt barriers, backfill temporary ditches, and other temporary environmental protection measures, and restore the ground surface to original condition.
- B. The Engineer may direct Contractor to leave certain environmental control devices in place if such measures will benefit the Project or other portions of ongoing or scheduled work.

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Products.
- B. Products selection.
- C. Product delivery requirements.
- D. Receiving, unloading and storing.
- E. General storage.
- F. Enclosed storage.
- G. Exterior storage.
- H. Maintenance of storage.
- I. Maintenance of equipment.
- J. Product list.
- K. Existing product requirements.

1.02 PRODUCTS

- A. Unless specific products are specified in these Specifications, Contractor shall provide products of qualified manufacturers suitable for the intended use. Contractor shall provide products of each type by a single manufacturer unless specified otherwise.
- B. Contractor may only submit substitutions as defined in Section 01 25 13 – Product Substitution Procedures.
- C. Contractor shall not reuse materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- D. Contractor shall provide interchangeable components of the same manufacturer for components being replaced.
- E. Contractor shall provide products that comply with the Contract Documents, are undamaged, are Asbestos free, and, unless otherwise indicated, are new at time of installation.
- F. Contractor shall consider products that have a lesser or reduced effect on human health, the environment, regulatory obligations, and disposal costs when compared with competing products of similar quality that serve the same purpose.
- G. Where Contractor determines or has concerns that a specified product may not be appropriate for the intended application, Contractor shall immediately notify Owner and Engineer and seek

direction from Owner and Engineer prior to proceeding with use or application of the specified product.

1.03 PRODUCTS SELECTION

- A. When products are specified by standard or specification designations of technical societies, organizations, or associations only, Contractor shall provide products that meet or exceed reference standard and Specifications.
- B. When products are specified with names of manufacturers but no model numbers or catalog designations, Contractor shall provide:
 - 1. Products made by one of the named manufacturers that meet or exceed Specifications.
 - 2. An approved "Or Equal".
- C. When products are specified with names of manufacturers and model numbers or catalog designations, Contractor shall provide:
 - 1. Products with model numbers or catalog designations made by one of the named manufacturers.
 - 2. An approved "Or Equal".
- D. When products are specified with only one manufacture, brand or trade names, model numbers, or catalog designations, Contractor shall provide:
 - 1. Products specified by brand or trade name, model number, or catalog designation.
- E. When Products are specified with only one manufacturer followed by "Or Equal," Contractor shall provide:
 - 1. Products meeting or exceeding the Specifications of the specified manufacturer.
 - 2. An approved "Or Equal".

1.04 PRODUCT DELIVERY REQUIREMENTS

- A. Contractor shall transport and handle products in accordance with the manufacturer's instructions.
- B. Contractor shall promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Contractor shall provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
- D. Contractor shall maintain bill of ladings and delivery tickets for record documentation and to support invoicing as required.

1.05 RECEIVING, UNLOADING AND STORING

- A. Contractor shall receive and unload shipments to the Site from Suppliers of equipment under this Contract. Contractor shall receive and unload Owner-furnished equipment as defined in the Contract Documents.
- B. Contractor shall unload equipment as soon as possible after arrival.

- C. Contractor shall pay freight car and truck demurrage, detention, and any other costs which may be billed to Owner or Contractor due to Contractor's failure to unload cars or trucks within time required by freight companies.
- D. Contractor shall provide physical protection for equipment placed in storage, as follows:
 - 1. Store and maintain materials and equipment immediately after receipt until completed installation is accepted by Owner. Such storage and maintenance shall be in accordance with manufacturer's recommendations and requirements of these Specifications. Provide materials, equipment, and labor required for such storage and maintenance.
 - 2. Account for any deterioration of materials or equipment occasioned by improper storage or maintenance, and recondition, repair, or replace any such materials or equipment without additional cost to Owner.
 - 3. Maintenance performed as required by manufactures shall be documented and submitted to Owner and Engineer prior to installation.
- E. Contractor shall take custody of equipment and materials received, including Owner furnished equipment and materials, and shall be solely responsible for damage and shortages until acceptance of Contractor's work by Owner. Contractor shall inform Owner and Engineer immediately if Owner furnished equipment and material arrives damaged. Contractor shall provide photographs, bill of lading denoting damage signed by the deliverer, and any additional relevant documentation to record the defect of the Owner furnished equipment to assist in corrective action with the manufacturer.
- F. Storage areas may be allocated by Owner for Contractor's use. Contractor shall store equipment and materials in assigned or approved lay-down areas.

1.06 GENERAL STORAGE

- A. Contractor shall protect products from theft, vandalism and unauthorized access.
- B. Contractor shall arrange storage in manner to provide access for maintenance of stored items and for inspection.

1.07 ENCLOSED STORAGE

- A. Contractor shall store products subject to damage by elements in weathertight enclosures, as required by manufacturer's instructions.
- B. Contractor shall maintain temperature and humidity within ranges, as required by manufacturer's instructions.
- C. Contractor shall provide humidity control and ventilation for sensitive products, as required by manufacturer's instructions.
- D. Contractor shall store unpacked and loose products on shelves, in bins, or in neat groups of like items.

1.08 EXTERIOR STORAGE

- A. Contractor shall provide substantial platforms, blocking, or skids, to support fabricated products above ground and slope to provide drainage. Contractor shall protect products from soiling and staining.

- B. Contractor shall cover products subject to discoloration or deterioration from exposure to elements with impervious sheet material. Contractor shall provide such products with ventilation adequate to avoid condensation.
- C. Contractor shall store loose granular materials on clean, solid surfaces such as pavement, or on rigid sheet materials, to prevent mixing with foreign matter.
- D. Contractor shall provide surface drainage to prevent flow or ponding of rainwater.
- E. Contractor shall prevent mixing of refuse or chemically injurious materials or liquids.

1.09 MAINTENANCE OF STORAGE

- A. Contractor shall inspect stored products per the manufacturer's recommended schedule. Maintain log of inspections, make available to Owner upon request.
- B. Contractor shall verify storage facilities comply with manufacturer's product storage requirements.
- C. Contractor shall verify manufacturer required environmental conditions are maintained continually.
- D. Contractor shall verify surfaces of products exposed to elements are not adversely affected and if weathering of finishes is acceptable under requirements of Contract Documents.

1.10 MAINTENANCE OF EQUIPMENT STORAGE

- A. For equipment in long-term storage, Contractor shall ensure manufacturer's service instructions accompany each item, with notice of enclosed instructions shown on exterior of package.
- B. Contractor shall service equipment on a regularly scheduled basis in accordance with the manufacturer's recommendations, maintaining a log of services and submit such log as a record document.

1.11 PRODUCTS LIST

- A. Within 30 days after effective date of Contract, Contractor shall submit to Owner and Engineer a complete list of products, including those specified only by reference standard, which are proposed for installation.
- B. Tabulate products by Specification section number and title.
 - 1. List for each product, as applicable:
 - a. Name and address of manufacturer.
 - b. Trade name.
 - c. Model or catalog designation.
 - d. Manufacturer's data:
 - 1) Reference standards.
 - 2) Performance test data.
 - e. Storage requirements.
 - f. Manufacturer's maintenance requirement.
 - g. Warranty terms and contact information.

- h. Manufacturer's local representative contact information.

1.12 EXISTING PRODUCT REQUIREMENTS

- 1. The following items which are removed may be reused provided they are in good condition and their reuse is approved by Owner and Engineer.
 - a. N/A
- B. Materials removed from plants, facilities and buildings and not reused shall become property of Contractor unless otherwise specified.
- C. Salvageable materials and equipment removed and not reused shall be stored in place designated by Owner and shall remain Owner's property.
- D. At the Owner's option, Owner may obtain the value of all scrap materials removed from existing plants, facilities, buildings, structures, areas, or systems and not reused.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Submittals to be provided by the Contractor shall include but are not limited to the following:
 - 1. Product List.
 - 2. Maintenance Log.
 - 3. Custody Transfer Log.

END OF SECTION

SECTION 01 71 13

MOBILIZATION AND DEMOBILIZATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Requirements for Contractor mobilization and demobilization.

1.02 MOBILIZATION

- A. Mobilization shall include obtaining necessary permits, moving onto the site all materials and equipment, and furnishing and erecting plants, temporary buildings, and other construction facilities, as required for the completion of the work.
- B. Mobilization shall include but not be limited to the following items:
1. Preliminary submittals required in Section 01 33 00 prior to construction for mobilization.
 2. Moving on to the site all equipment required.
 3. Installing temporary construction utilities and communications devices.
 4. Providing temporary field office facilities to the approval of the Engineer.
 5. Obtaining all required permits.
 6. Obtaining all required bonds and insurance.
 7. Posting all OSHA required notices and establishment of safety programs.

1.03 DEMOBILIZATION

- A. Demobilization includes, but is not limited to, moving all equipment and surplus materials off the site, re-grading and restoring Contractor's equipment yard(s), final cleanup, and all other project closeout items including all items referenced in Specification Section 01 77 00.
- B. All submittals required in the Contract Documents for demobilization.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 23

SURVEYING

PART 1 GENERAL

1.01 SCOPE

- A. This Specification section specifies the requirements for surveying, field staking, and related Work to be completed by the Contractor.
- B. Perform all layout surveys required for the control and completion of the Work, and all necessary surveys to compute quantities of Work performed and to provide an acceptable record of the finished construction.

1.02 DESCRIPTION

- A. The Owner has established primary control to be used by Contractor for establishing lines and grades required for the Work. Primary control consists of control points in the vicinity of the Work as described and indicated on the Drawings.
- B. Preserve and maintain primary control points. Primary control points damaged or destroyed by the Contractor may be reestablished by the Engineer, and the expense of reestablishment will be deducted from amounts due, or to become due, to the Contractor.
- C. The Contractor shall check and verify, before beginning Work, all primary control points established by the Owner. Contractor shall advise the Engineer in writing that the points are acceptable or, if not, the reasons why not.
- D. Other survey markers and points may be found in the field. The Contractor shall not use any survey markers or points that are not identified as primary control. Found markers and points shall be staked, flagged, and preserved throughout the duration of the construction. Any markers and points within the limits of construction that may be disturbed by construction activity shall be brought to the immediate attention of the Engineer.

1.03 QUALITY ASSURANCE

- A. The Contractor shall furnish the services of experienced construction surveyors. Survey Work shall be under the supervision and direction of a land surveying professional who is registered in the State of Colorado and has a minimum of two (2) years responsible charge of construction surveys for construction similar in nature to that required by this Contract. Maintain sufficient qualified personnel to perform required surveying Work. All survey Work performed by Contractor shall be subject to field and office review by Engineer.
- B. Surveying discrepancies discovered by the Contractor shall be immediately reported to the Engineer. The Contractor shall perform additional surveys as required to determine the cause of the discrepancy and the corrective action required. Corrective action shall not be taken until authorized by the Engineer.

1.04 SUBMITTALS

- A. The Contractor shall advise the Engineer in writing that the primary control points are acceptable or, if not, the reasons why not.

- B. All record drawings shall be prepared and submitted in accordance with the Contract Documents and Specifications Sections 01 33 00 and 01 78 39.
- C. All survey notes shall be submitted for review by the Engineer if so desired. The Contractor shall maintain copies of all survey notes for his records.
- D. Administrative
 - 1. Survey Control Plan: A complete plan for the surveying required to lay out the Work, including methods and timetables for establishing lines and grades. The submitted plan shall include examples of survey staking, stake notations, and flagging for the various required surveys, markers, and control points.
 - 2. Surveyor Qualifications: Resumes of qualifying experience for the land surveying professional who will be responsible for the supervision and direction and for the field crew chief(s) who will perform all of the Contractor's survey Work.
 - 3. Daily Notes: If requested by the Engineer, submit a copy of the workday's survey notes at the conclusion of that workday.

1.05 LAYOUT OF WORK

- A. Use Owner-established primary control points to establish all lines and grades necessary to control and complete the Work.
- B. Establish, place, and replace as required, such additional monuments, control points, survey stakes, markers, and other controls as may be necessary for control, intermediate checks, and guidance of construction operations. Perform additional surveys as required for foundation mapping.

1.06 CONTRACTOR SURVEYS

- A. Surveys required, at a minimum:
 - 1. Alignment Staking – Each change in horizontal alignment; each 100 feet on tangent; each 50 feet on curves.
 - 2. Slope Staking – Each 50 feet on tangent; each 25 feet on curves; restake every 10 feet in elevation.
 - 3. Structure Staking (horizontal and vertical) – Footings and foundations; floor and wall corners; floor and wall penetrations; floor slopes with adequate spot elevations; conduct checks prior to and during construction.
 - 4. Cross Section – Each 100 feet on tangent, each 50 feet on curves. Original, final, and intermediate as required, for structure sites and other locations as necessary for quantity surveys.
 - 5. Pipelines and Appurtenant Structures – Alignment and structure staking as described above; all changes in vertical grade; all points of connection to existing system; all points of “day-lighting,” all valves, fittings, and appurtenances; each 25 feet where elevation control is critical and each 25 feet in each direction for 100 feet where gravity piping connects to and/or passes through a structure.
 - 6. Drainage Facilities and Structures (including curbs and gutters) – Alignment, structure, and cross section staking as described above; all changes in vertical grade; each swale control, check, and drop structure; each 25 feet where elevation control is critical and/or where the longitudinal slope is less than 2 percent; each 25 feet in each direction for 100 feet where swales, cross pans, or gutters drain into or out of piping or structures.

7. Roadways – Alignment, structure, and cross section staking as described above; all changes in vertical grade; all points of connection to existing system; top elevations of all structures with surfaces, accesses, and/or openings in or immediately adjacent to the roadway template.
8. Pavement Top (blue top) Staking – set hubs to top of subgrade and granular base course, and pavement surface: every 50 feet along any roadway at centerline and right and left at edge of shoulder and/or edge of pavement; at every change in centerline and/or cross slope grade; for parking and widened maneuvering areas every 25 feet at edges and no fewer than every 25 feet in a square grid pattern; checks after completion of each roadway layer and during final pavement placement.
9. Record – As required for structures and other features of the Work, and as may be needed to provide an acceptable record of the finished construction as required of Specification Section 01 78 39.

1.07 RECORDS

- A. Survey data shall be recorded in accordance with recognized professional surveying standards. Original field notes, computations, and other surveying data shall be recorded in standard survey field books. Notes or data not in accordance with standard formats will be rejected. Illegible notes or data, or erasures on any page of a field book will be considered sufficient cause for rejection of part or all of the field book. Therefore, rejection of part or all of a field book may necessitate resurveying. Corrections by ruling or lining out errors will be satisfactory.

1.08 DEGREE OF PRECISION

- A. Degree of precision shall be of an order high enough to satisfy tolerances specified for the Work and the following:
 1. Alignment of tangents and curves shall be within 0.1 foot.
 2. Structure points shall be set within 0.01 foot, except where installation or operation considerations require tighter tolerances.
 3. Cross section points shall be located within 0.1 foot, horizontally and vertically.
 4. Vertical elevation surveys shall close within 0.05 foot times the square root of the circuit length in miles.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The Contractor shall perform all construction surveying to standards of accuracy acceptable in the trades. Surveys shall be documented and repeatable. All markers and stakes shall be concisely and legibly annotated and flagged for their specific purpose.
- B. The Contractor shall lay out off-set construction staking to the satisfaction of the Engineer prior to beginning any ground disturbing activity except for clearing as necessary for surveying measurement and line-of-sight.
- C. The Contractor shall establish temporary benchmarks and control points as needed, and all lines and grades necessary to control the Work. The Contractor shall be responsible for all

measurements that may be required for the execution of the Work to the location, limits and tolerances prescribed in the Specifications or on the Drawings.

- D. The Contractor shall use the primary control points to layout and control the Work. The number of points required for grades, alignment, slopes, and structures shall be determined by the Contractor and be sufficient to meet the tolerances and accuracy required by the Contract Documents.
- E. The Contractor shall perform "as-built" surveys as required for all phases of the Work to maintain and update the record drawings.
- F. All concrete form work shall be checked to verify the finished concrete will be within the tolerances required by the Contract Documents.
- G. All pipelines, manholes, catch basins, fittings, valves and equipment shall be checked to assure they are within the lines and grades or tolerances required.
- H. The Contractor will furnish all equipment, materials, tools, and accessories required to perform the survey Work and field staking. Instruments shall be accurate to industry standards and maintained in good repair.

END OF SECTION

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cutting and patching requirements.
- B. Submittals.
- C. Materials.
- D. Inspection.
- E. Preparation.
- F. Performance.

1.02 CUTTING AND PATCHING REQUIREMENTS

- A. Contractor shall be responsible for cutting, fitting, and patching, including attendant excavation and backfill, required to complete Work or to:
 - 1. Make its several parts fit together properly.
 - 2. Uncover portions of Work to provide for installation of ill-timed Work.
 - 3. Remove and replace defective Work.
 - 4. Remove and replace Work not conforming to requirements of Contract Documents.
 - 5. Remove samples of installed Work as specified for testing.
 - 6. Provide routine penetrations of nonstructural surfaces for installation of piping, electrical conduit and any other work.

1.03 SUBMITTALS

- A. Contractor shall submit a written request to Owner and Engineer well in advance of any executing cutting or alteration which affects:
 - 1. Work of Owner or any separate Contractor.
 - 2. Structural value or integrity of any element of Project.
 - 3. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 4. Efficiency, operational life, maintenance, or safety of operational elements.
 - 5. Visual qualities of sight-exposed elements.
- B. The written request shall include:
 - 1. Identification of Project.
 - 2. Description of affected Work.

3. Explanation of necessity for cutting, alteration, or excavation.
 4. Effect on work of Owner or separate Contractor, or structural or weatherproof integrity of Project.
 5. Description of proposed Work:
 - a. Scope of cutting, patching, alteration, or excavation.
 - b. Trades who will execute Work.
 - c. Products proposed to be used.
 - d. Extent of refinishing to be done.
 6. Alternatives to cutting and patching.
 7. Written permission of any separate Contractor whose work will be affected.
- C. No cutting or alteration for which a written request is submitted shall be performed without written acceptance of Owner and Engineer.
- D. Contractor shall submit written notice to Owner and Engineer designating the date and time Work will be uncovered.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Contractor shall comply with specifications and standards for each specific product involved.

PART 3 EXECUTION

3.01 INSPECTION

- A. Contractor shall inspect existing conditions of Project, including elements subject to damage or to movement during cutting and patching.
- B. After uncovering Work, Contractor shall inspect conditions affecting installation of products, or performance of Work.
- C. Contractor shall report unsatisfactory or questionable conditions to Owner and Engineer in writing and not proceed with Work until Owner and Engineer have provided further instructions.

3.02 PREPARATION

- A. Contractor shall provide adequate temporary support as necessary to assure structural value or integrity of affected portion of Work.
- B. Contractor shall provide devices and methods to protect other portions of Project from damage and persons from injury.
- C. Contractor shall provide protection from elements for that portion of Project which may be exposed by cutting and patching Work and maintain excavations free from water.

3.03 PERFORMANCE

- A. Contractor shall execute cutting and demolition by method which will prevent damage to other Work and provide proper surfaces to receive installation of repairs.
- B. Contractor shall execute excavating and backfilling by methods which will prevent settlement or damage to other Work.
- C. Contractor shall employ the original installer or fabricator to perform cutting and patching for:
 - 1. Weather-exposed or moisture-resistant elements.
 - 2. Sight-exposed finished surfaces.
 - 3. Work that is currently under warranty by the original installer or fabricator.
- D. Contractor shall execute fitting and adjustment of products to provide finished installation to comply with specified products, functions, tolerances, and finishes.
- E. Contractor shall restore Work which has been cut or removed and install new products to ensure completed Work conforms to the requirements of Contract Documents.
- F. Contractor shall fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- G. Contractor shall refinish entire surfaces as necessary to provide even finish to match adjacent finishes:
 - 1. For continuous surfaces, refinish to nearest intersection.
 - 2. For assembly, refinish entire unit.
- H. Openings in existing concrete and masonry:
 - 1. Contractor shall create openings by:
 - a. Saw cutting completely through concrete or masonry or;
 - b. Scoring edges of opening with saw to at least 1-inch depth on both surfaces (when accessible) and removing concrete or masonry by chipping.
 - 2. Contractor shall not allow saw cuts to extend beyond limits of opening.
 - 3. Contractor shall make corners square and true by combination of core drilling and grinding or chipping.
 - 4. Contractor shall prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.
- I. Sizing of openings in existing concrete or masonry:
 - 1. Contractor shall make openings sufficiently large to permit final alignment of pipe and fittings without deflections.
 - 2. Contractor shall allow adequate space for packing around pipes and conduit to ensure water tightness.

J. Grouting pipes in place:

1. Contractor shall sandblast concrete surfaces and thoroughly clean sand and other foreign material from surfaces prior to placing grout.
2. Contractor shall grout pipes, sleeves, castings, and conduits in place by pouring grout under a head of at least 4-inches and vibrate grout into place. Contractor shall completely fill the spaces occupied by pipes, sleeves, castings, and conduits.
3. Contractor shall water cure the grout.

K. Connections to existing pipes:

1. Contractor shall cut existing pipe square.
2. Contractor shall properly prepare the ends for the connection indicated.
3. Contractor shall repair any damage to existing lining and coating.

L. Contractor shall rehabilitate all areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains.

1. Contractor shall fill areas in existing floors, walls, and ceilings from removed piping, conduit and fasteners with non-shrink grout and finish smooth.
2. Contractor shall remove concrete bases for equipment and supports by:
 - a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface. Do not cut existing reinforcement on floors.
 - b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
 - c. Patch with non-shrink grout to match adjacent grade and finish.
3. Contractor shall terminate abandoned piping and conduits with blind flanges, caps, or plugs.
4. Contractor shall refinish continuous surfaces to nearest intersection. Contractor shall refinish entire assemblies. Contractor shall finish restored surfaces to such planes, shapes, and textures that no transition between existing work and new work is evident in finished surfaces. In no case shall any new or existing surface be left in a raw, marred, or unfinished condition.

M. Contractor shall treat existing concrete reinforcement as follows:

1. Where existing reinforcement is to remain, protect, clean, and extend into new concrete.
2. Where existing reinforcement is not to be retained, cut off as follows:
 - a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
 - b. Where concrete surface at the removal line is the finished surface, cut reinforcement 2-inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

END OF SECTION

SECTION 01 74 19

WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General.
- B. Waste Management.
- C. Surplus Fill / Environmental Media.
- D. Surplus Chemicals, Products, & Substances.
- E. Recycling.
- F. Non-Hazardous Solid Waste Disposal.
- G. Non-Hazardous Liquid Waste Disposal.
- H. Asbestos Containing Waste Disposal.
- I. Submittals.

1.02 GENERAL

- A. This Specification provides procedures and requirements for waste management and disposal, and information to assist Contractor with assuring the proper management, storage, control, security, transportation, and disposition of waste generated as a result of the Work.
- B. In the event of conflicts between this Specification and the requirements of the Laws and Regulations; the more restrictive shall apply.
- C. Unless otherwise directed by Owner, costs related to this Specification shall be considered inherent to Work, and be included in the Contract Price (i.e., no separate measurement and payment).
- D. Refer also to:
 - 1. Section 01 35 43 - Environmental Procedures.
 - 2. Section 01 41 00 - Permit Requirements.
 - 3. Section 01 57 19 - Environmental Controls.

1.03 WASTE MANAGEMENT

- A. Contractor is responsible for the proper storage, management, transport, and disposal of Hazardous Materials and Hazardous Substances in accordance with all applicable Laws and Regulations. Unless otherwise directed by Owner, proper management of hazardous waste generated by Contractor as part of its work, including waste generated by unintentional spills, leaks, discharges, or releases, is the responsibility of Contractor. Contractor shall have primary generator responsibility for all such hazardous waste and shall manage such hazardous waste in

accordance with all applicable Laws and Regulations, including proper waste characterization through generator knowledge and/or analytical testing and any required notifications to AHJs regarding the generation of hazardous waste. Contractor shall be responsible for coordinating the shipment of all hazardous waste for which they have primary generator responsibility, including but not limited to obtaining required generator identification numbers, arranging for transport to a properly Permitted hazardous waste treatment, storage, and disposal facility, and signing all hazardous waste manifests.

- B. Contractor shall provide, install, inspect performance, and maintain sufficient BMPs / Control Measures during handling, storing, loading, transporting, and disposing of waste to prevent releases to Environmental Receptors; and with consideration of the public, Site occupants, worker health, and fire codes.
- C. Contractor shall train workers and Subcontractors on proper waste management procedures, as appropriate for the Work.
- D. Upon generation of waste, Contractor shall determine if it is universal, non-hazardous or hazardous, and promptly store and manage such waste accordingly; Contractor shall also consider labeling, employee training, and regulatory time limits on length of storage prior to shipment.
- E. If a determination regarding the type of waste cannot be made based on information from labels, safety data sheets, other written information, or knowledge of the material, then Contractor shall evaluate the waste using representative analytical testing (note: the disposal facility may also have testing requirements).
- F. Universal Waste includes batteries, pesticides, mercury-containing devices, mercury-containing lamps, aerosol cans, electronic devices and components. The Universal Waste Regulations provide an alternative set of reduced management standards that the Contractor can follow instead of the full hazardous waste requirements. Contractor shall utilize the Universal Waste Regulations for its benefits, if practicable and cost effective.
- G. Work involving friable and non-friable potential Asbestos containing waste shall only be performed by Colorado certified individuals, consulting firms, general abatement Contractors, and Colorado registered laboratories.
- H. If hazardous waste is generated by the Work:
 - 1. Contractor shall notify and collaborate with Owner to develop a mutual understanding regarding management roles and responsibilities in light of the requirements of this and other Related Specifications.
- I. Contractor shall ensure that sampling for waste characterization purposes shall be performed by appropriately trained and qualified personnel.
- J. Contractor shall ensure that laboratory analytical testing for waste characterization purposes shall be performed by appropriately qualified and certified laboratories.
- K. Contractor shall perform all coordination, profiling, characterization, and testing activities needed to obtain disposal facility's acceptance and transportation manifests; then load, transport, and dispose of the waste. Contractor shall transport waste in accordance with Department of Transportation (DOT) regulations. Document all quantities transported.
- L. For quality assurance, Contractor shall refer to the CDPHE's Compliance Bulletin's and other guidance documents, as amended at times.

1. Contaminated Shop Towels & Reusable Absorbents, August 2002.
2. Mercury Spill and Fluorescent Bulb Cleanup, September 2009.
3. P & U Listed Hazardous Wastes, Interpretive Memo, January 2008.
4. Used Antifreeze, August 2002.
5. Used Oil Generators, November 2007.

1.04 SURPLUS FILL / ENVIRONMENTAL MEDIA

- A. Prior to completion of the Work, all excess clean Environmental Media with no visible discoloration, unusual odors, or other apparent or reasonable potential to be contaminated (or Debris containing), shall be deemed property of the Contractor and removed by Contractor from the Site.

1.05 SURPLUS CHEMICALS, PRODUCTS, & SUBSTANCES

- A. Prior to completion of the Work, all excess unused chemicals, products, and substances (i.e., paints, lubricants, adhesives, cleaning products, etc.) brought on-site as part of the Work, shall be deemed property of the Contractor and removed by Contractor from the Site.

1.06 RECYCLING

- A. If practicable, Contractor shall recycle non-hazardous solid waste. If not practicable, Contractor shall dispose of the waste.
- B. Recyclers must be legitimate and legal and shall maintain any required government approvals.

1.07 NON-HAZARDOUS SOLID WASTE DISPOSAL

- A. A CDPHE Permitted - RCRA Subtitle D landfill is the minimum acceptable solid waste disposal option for Contractor.
- B. Alternate solid waste disposal options may be proposed by Contractor with detailed rationale; however, such disposal shall require Owner approval.

1.08 NON-HAZARDOUS LIQUID WASTE DISPOSAL

- A. Contractor shall dispose of all Work-generated non-hazardous liquid waste at Owner-approved facility.
- B. Alternate non-hazardous liquid waste disposal options may be proposed by Contractor with detailed rationale; however, such disposal shall require Owner approval.

1.09 HAZARDOUS WASTE DISPOSAL

- A. Contractor shall dispose of all Work-generated hazardous waste at the following Owner-approved landfills, depending on the hazardous waste characteristics:
 1. Clean Harbors – Deer Park, TX (Non-Metal Bearing Waste, Corrosive, Organic)
 2. US Ecology – Beatty, NV (Metals, PCB Debris)
 3. Veolia – Phoenix, AZ (Mercury Reclamation)

- B. Alternate hazardous waste disposal options may be proposed by Contractor, with detailed rationale; however, such disposal shall require Owner approval.

1.10 ASBESTOS CONTAINING WASTE DISPOSAL

- A. If the Work results in the generation of any asbestos containing waste, whether friable or non-friable, it shall be disposed of by Contractor at an approved landfill.
- B. Alternate Permitted disposal facilities may be proposed by Contractor, with detailed rationale; however, such disposal shall require Owner approval.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Submittals to be provided by the Contractor shall include but are not limited to the following:
 - 1. Waste Disposal Documentation
 - a. Upon request by Owner Representative, or otherwise upon substantial completion of Work, furnish copies of documentation necessary to demonstrate proper disposal of wastes (facility acceptance, laboratory reports, quantities, and executed transport manifests).

END OF SECTION

SECTION 01 75 00

STARTING OF SYSTEMS

PART 1 GENERAL

1.01 SCOPE

- A. Starting, testing, and demonstration procedures.

1.02 SUBMITTALS

- A. Provide the following information in accordance with Section 01 33 00:
1. Submit PDF of preliminary start-up, testing and demonstration schedule 15 calendar days prior to proposed dates. Include names of subcontractor, manufacturer, or organization proposed to perform services, and documentation to confirm their qualifications.
 2. Submit PDF of written report within 10 calendar days after each start-up.

1.03 QUALITY ASSURANCE

- A. Provide authorized and qualified manufacturer approved representative to inspect equipment installation prior to start-up and to supervise placing equipment in operation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify Engineer at least 24 hours in advance of start-up, testing, and demonstration. Prepare each system, equipment, and device for start-up, testing, and demonstrating. Provide all tools or instruments required for the work. Prepare equipment and systems for start-up and operation, as follows:
1. Inspect, adjust, and balance equipment and systems to assure that they are fully operational.
 2. Inspect bearings, clean, and remove foreign matter, and verify alignment.
 3. Lubricate according to manufacturer's instructions.
 4. Verify drive rotation, equipment speed, control sequence, and other conditions are correct and will not cause damage.
 5. Adjust tension, alignment, and equipment speed on belt and variable pitch sheaves drives.
 6. Inspect valves, clean bonnets and stems, adjust and tighten packing glands to assure no leakage while permitting valve stem operation without galling.
 7. Test electrical equipment to assure that meter readings and specific electrical characteristics, including motor amperage, agree with manufacturer's specifications.

Confirm that the wiring and support systems for equipment installed under separate contracts have been inspected and are completely operational.

8. Test to assure that controls are operational in automatic mode and that all remote-control points are functional.

3.02 STARTUP

A. Demonstration

1. Demonstrate that each individual component of each system and the related instrumentation and control equipment operate consistent with the Contract Documents. Demonstrate smooth operation, without excessive noise or vibration; equipment is responsive to manual and automatic controls; control and protective devices are properly set; and equipment will run on controlled or intermittent basis. Demonstrate alarm and safety lockout systems function correctly with instrumentation and control. Where no specific performance requirements are stated, demonstrate the equipment operates within normal equipment parameters.

B. Starting Systems

1. Coordinate sequence of start-up for various items of equipment, including Owner provided equipment. Place equipment in operation in proper sequence.
2. Provide operation and maintenance instruction to Owner's personnel in accordance with Section 01 78 23 prior to start-up any piece of equipment or system.
3. Start-up each piece of equipment or system only under the supervision of responsible and qualified manufacturer's representative.
4. Provide a written report certifying products have been properly installed and lubricated, are in accurate alignment, are free from undue stress imposed by connecting lines or anchor bolts, have been tested and proven consistent with the requirements of each specification section, have been satisfactorily operated under full load conditions, and have undergone satisfactory start-up.
5. Place the various items of equipment into operation, along with related piping and metering systems. Provide temporary piping systems when necessary to allow for initial testing and operation of pumping systems and treatment facilities.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Substantial completion.
- B. Final completion.
- C. Reinspection fees.
- D. Post Construction Inspections.
- E. Miscellaneous keys, wrenches, etc.
- F. Warranties and bonds.
- G. Adjustment of accounts.
- H. Application for final payment.

1.02 SUBSTANTIAL COMPLETION

- A. When the Contractor considers the Work is Substantially Complete, submit draft Certificate of Substantial Completion, with list of items to be completed or corrected. Prior to making such a request, the Contractor shall ensure:
 - 1. The Work is ready for its intended use.
 - 2. All work necessary for the safe, proper, and complete use or operation of the plant, facility or systems as intended has been completed.
 - 3. All facilities and/or equipment have been properly demonstrated to be functioning as required.
 - 4. Contractor has provided evidence of compliance with requirements of Authority Having Jurisdiction (AHJ):
 - a. Certificate of occupancy
 - b. Certificates of inspection
 - c. Mechanical
 - d. Electrical
 - 5. Equipment and systems have been tested in accordance with the commissioning procedures and in presence of Owner and Engineer and are operational.
 - 6. Contractor to walk with Owner and Engineer to develop a punch list to be included in the Certificate of Substantial Completion.
 - 7. All deficiencies and damage caused by Contractor has been corrected.
 - 8. Contractor has submitted and received acceptance of accurate record drawings for all work completed to date.

- a. Contractor shall label final documents with "PROJECT RECORD" in neat large printed letters.
- b. Contractor shall ensure entries are complete and accurate, enabling future reference by Owner.
- c. Contractor shall ensure drawings are legibly marked to record actual construction:
- d. Depths of various elements of foundation in relation to finish first floor datum.
- e. Horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements.
- f. Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.
- g. Field changes of dimension and detail.
- h. Changes made by Instruction to Contractor or by Change Order.
- i. Details not on original contract Drawings.
- j. Contractor shall ensure Specifications and Addenda are legibly marked to record:
- k. Manufacturer, trade name, catalog number, product model and number, and supplier of each product and item of equipment actually installed.
- l. Product substitutions or alternates utilized.
- m. Changes made by Instruction to Contractor or by Change Order, or by Addenda and modifications.
- n. Contractor shall make annotations in electronic format with the following color code:
- o. Additions: Red
- p. Deletions: Green
- q. Comments: Blue
- r. Dimensions: Graphite
- 9. Submitted and received acceptance of all specified warranties, bonds, guarantees, and operation and maintenance manuals.
- 10. Contractor has completed or provided all required training, testing, and start-up activities.
- 11. Contractor has delivered all required spare parts, maintenance stock items, and special tools.
- 12. Contractor has submitted all test documents and all O&M Manuals in accordance with Section 01 78 23 – Operating and Maintenance Data.
- 13. Contractor has refilled all bulk storage containers, tanks, totes, and vessels which are installed by the Contractor.
- B. Within 10 days of receiving notice from the Contractor that the Work is Substantially Complete, Contractor, Owner, and Engineer will inspect the Work to determine the status of completion.
- C. Should Owner and Engineer determine that the Work is not Substantially Complete, Owner will promptly notify Contractor in writing, giving reasons therefore.

- D. Contractor shall remedy deficiencies and send a second written notice of Substantial Completion to Owner and Engineer, and Owner and Engineer will reinspect Work within 10 days of receiving the second notice.
- E. When Owner and Engineer determine that Work is Substantially Complete and commissioning procedures have been completed, Owner and Engineer will prepare a Certificate of Substantial Completion in accordance with the General Conditions of the Contract after the following procedures have been completed:
 - 1. Owner and Engineer will review the Work and the punch list to assure all unfinished work is noted on a final punch list.
 - 2. Owner and Engineer will schedule and conduct a pre-final walk-through of the plant, facility or systems with the Contractor, and others, for the purpose of formally reviewing the Work, the final punch list, and the readiness of the Work for use. Engineer will furnish a copy of the final punch list to Contractor and any additional items noted during the walk-through will be added to the list.
 - 3. Upon completion of the pre-final walk-through, Owner and Engineer will establish the date for Substantial Completion as the date of the walk-through, provided the walk-through has verified that the Work is in fact ready for use and occupancy by Owner and meets all requirements for Substantial Completion set forth in the Specifications and the Contract. Upon approval of this request by Owner, the plant, facility, or systems will be considered Substantially Complete.

1.03 FINAL COMPLETION

- A. When the Contractor considers the Work is finally complete, it shall submit written certification that:
 - 1. All final punch list items have been corrected, signed off by the Contractor, Owner and Engineer, and Contractor has demonstrated completion to Owner and Engineer during a final walk-through.
 - 2. Equipment and systems have been tested in accordance with the commissioning procedures and in presence of Owner and Engineer and are operational.
 - 3. Project records have been submitted and approved by Owner and Engineer.
 - 4. Demobilization including removing temporary facilities and controls, and site cleanup are complete.
 - 5. The Contractor has furnished to Owner and Engineer releases from all Subcontractors and Suppliers who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.
 - 6. Restoration efforts have been completed per regulatory and permitting requirements.
 - 7. Contractor has provided evidence of compliance with requirements of AHJ.
 - 8. Acceptance and closeout of permits.
 - 9. Provided new permanent cylinders and key blanks for all locks.
 - 10. Provided all specified warranties, bonds, guarantees and operation and maintenance manuals.
 - 11. Contract Documents have been reviewed.
 - 12. Work has been inspected for compliance with Contract Documents.

13. Work has been completed in accordance with Contract Documents, and deficiencies listed with Certificate of Substantial Completion have been corrected.
 14. Work is complete and ready for final inspection.
- B. Owner and Engineer will inspect to verify status of completion with reasonable promptness.
 - C. Should Owner and Engineer consider that Work is incomplete or defective, it will promptly notify Contractor in writing, listing incomplete or defective Work.
 - D. Contractor shall take immediate steps to remedy deficiencies and send second written certification that Work is finally complete, and Owner and Engineer will reinspect Work.
 - E. When Owner and Engineer find Work is acceptable, they will consider closeout submittals.

1.04 REINSPECTION FEES

- A. In the event of any reinspection due to a failure of the Work to comply with Contract Documents, Owner may deduct the cost of such reinspection from the final payment to Contractor.

1.05 POST CONSTRUCTION INSPECTIONS

- A. At approximately 6 months and again at 11 months after the day of the Substantial Completion, when notified by Owner; Contractor, Owner, and Engineer shall inspect the Work in accordance with the provisions of the Contract Documents.
- B. The final inspection just prior to the end of the warranty period, shall identify any deficiencies to be corrected under warranty.
- C. Contractor shall be notified in writing of all deficiencies.
- D. Corrective work shall start on noted deficiencies within 10 days of receipt of notification to Contractor and be completed as provided in the notification.

1.06 MISCELLANEOUS KEYS, WRENCHES, ETC.

- A. At the completion of the project, all loose keys and wrenches shall be accounted for and turned over by Contractor to Owner, including:
 1. Hose bib keys.
 2. Adjustment keys and wrenches for door closers and panic hardware.
 3. Keys for electric switches, electrical panels, etc.
 4. Cabinets and casework keys.
 5. Keys for security and operational equipment.

1.07 WARRANTIES

- A. Definitions
 1. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

2. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.
- B. Contractor shall include all warranties for all equipment in the O&M Manual and in a consolidated electronic book indexed with a table of contents including.
 - C. The Contractor or manufacturers shall repair or replace without charge to Owner any part of any equipment which is defective or showing signs of undue wear within the correction and warranty period or replace the equipment with new equipment if the performance is unsatisfactory; furnishing all parts, materials, labor, shipping, and all costs necessary to return the equipment to its specified performance level.
 - D. The Contractor or manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the process, as defined by Owner. In the event Owner has to provide temporary equipment to replace function of warranted item requiring repair or replacement, Contractor shall reimburse Owner for such costs.
 - E. Warranty Equipment
 1. Rejection of Warranties: Owner reserves the right to reject warranties, and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
 2. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve Suppliers, manufacturers, and Subcontractors required to countersign special warranties with the Contractor.

1.08 ADJUSTMENT OF CONTRACT PRICE

- A. Contractor shall submit final statement of accounting, reflecting original Guaranteed Maximum Price (GMP), any changes to the GMP, and the actual final cost of the project. The final statement shall include the following:
 1. Original GMP.
 2. A detailed total final project cost including:
 - a. Unit prices and amounts of materials and equipment.
 - b. Labor hours and costs to complete construction.
 - c. Subcontractor costs.
 - d. Construction equipment costs or rental costs.
 - e. Change orders.
 - f. Deductions for uncorrected Work.
 - g. Other allowable adjustments.
 - h. Deductions for liquidated damages.
 3. Previous payments.
 4. Remaining due.
 5. Project savings.

1.09 APPLICATION FOR FINAL PAYMENT

- A. Administration actions and submittals which must precede or coincide with submittal of the final Application for Payment for Release of Retainage include the following:
1. Completion of Project closeout requirements.
 2. Assurance that Work not complete and accepted will be completed without undue delay.
 3. Transmittal of required Project construction records to Owner.
 4. Proof that taxes, fees, and similar obligations have been paid.
 5. Removal of temporary facilities and services.
 6. Removal of surplus materials, rubbish, and similar elements.
 7. Closeout of all permits.
 8. Change of door locks to Owner access.
 9. Advertisement (30-day) of the Release of Retainage has commenced.
- B. Contractor shall submit the final Application for Payment in accordance with procedures and requirements in General Conditions of Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE

- A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.
- B. O&M instructions must be submitted and accepted before on-site training may start.

1.02 QUALITY ASSURANCE

- A. Reference Codes and Specifications

- 1. No current government or commercial specifications or documents apply.

1.03 SUBMITTALS

- A. Submittal of operation and maintenance information in the O&M Manuals shall conform to this Specification section, Specification Section 01 33 00, and the requirements of the other individual Specification sections included in the Project Manual.
- B. The Contractor shall submit to the Engineer a sample of the binders, indices, and make-up of the O&M Manuals for review and approval. In addition, the Contractor shall supply a tabular listing of all the operation and maintenance information/instruction materials required for the Work with an appropriate labeling and sequencing scheme for the Engineer's review and approval.
- C. Prior to the Work reaching 50 percent completion, submit to the Engineer for approval the requisite number of review copies of the O&M Manuals with all specified material. If a resubmittal(s) is required, submit the same number of copies required for the initial review.
- D. Electronic Operation and Maintenance Manual submittal: For the initial Operation and Maintenance Manual (O&M Manual) submittals except as otherwise noted herein, submit electronic O&M Manuals portable document format (.pdf) file.
 - 1. O&M shall be indexed as described in Section 01 33 00.
 - 2. After initial review, resubmittal (if required), and acceptance of the electronic O&M Manuals, provide three (3) hard copies of all final operation and maintenance manual documentation organized in pre-approved binders per subparagraph 1.03.B.
 - 3. Furnish one (1) electronic/digital copies of the final O&M Manuals. The electronic copy shall be a single portable document format (.pdf) file. The electronic copy shall be a replica of the accepted hard copy, organized in the same manner as the hard copy. The electronic .pdf document must include bookmarks and sub-bookmarks for each individual section and piece of equipment to match the format of the hardcopy. Transitions between sections and individual pieces of equipment within sections must be clearly indicated by cover sheets or other similar methods as approved by the Engineer. To the greatest extent possible, electronic O&M shall be native files and NOT scanned copies of the paper O&M manual. Electronic O&M manuals shall be searchable.

- E. Submit all material for the final O&M Manuals prior to requesting certification of Substantial Completion.

PART 2 PRODUCTS

2.01 FORMAT AND CONTENTS

- A. Organize each of the O&M Manuals into sections paralleling the equipment Specifications sections in numerical order by the equipment numbers assigned in the Project Manual.
1. Use 3-ring, hard-back binders.
 2. A single binder may contain operation and maintenance information/instruction materials for several individual pieces of equipment, equipment assembly or subassembly, and material as appropriate to fill the binder.
 3. Label multiple O&M Manual binders as "Volume 1", "Volume 2," and so on.
 4. Furnish all operation and maintenance information material in the O&M Manuals on 8-1/2" x 11" commercially printed or typed forms or an alternative format accepted by the Engineer.
 5. Punch all loose data for binding. Arrange composition and printing so that punching does not obliterate any data.
 6. Print on the cover and binding edge of each volume of the O&M Manuals the Project title, and such other pertinent information as furnished and approved by the Engineer.
 7. Include the table of contents for the entire set in each binder, identified by the contents in each volume number.
 8. Identify each section of the O&M Manuals using heavy section dividers with reinforced holes and numbered plastic index tabs to permit easy location of desired information.
 9. Provide space in the manuals for additional material.
 10. In addition to the hard copy O&M Manuals, an electronic version of the O&M must be contained within each binder or set of binders in accordance with Subparagraph 1.03 E.3.
- B. Prepare and arrange each copy of the O&M Manuals as follows:
1. One copy of the Equipment Maintenance Data Summary Sheet for each item of equipment (see sample form under Part 4 of this Specification section).
 2. One copy of the Equipment Preventive Maintenance Data Summary Sheet for each item of equipment (see sample form under Part 4 of this Specification section).
 3. One copy of the manufacturer's operating and maintenance instructions for each item of equipment.
 - a. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting.
 - b. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts.
 4. List of electrical relay settings and control and alarm contact settings.
 5. Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems.

6. One valve schedule giving valve number, location, fluid, and fluid destination for each valve installed. Group all valves in same piping systems together in the schedule. Obtain a sample of the valve numbering system from the Engineer.
- C. Leave all operating and maintenance material that comes bound by the equipment manufacturer in its original bound state. Cross reference the appropriate sections of the O&M Manuals to the manufacturers' bound materials.

2.02 TYPES OF INFORMATION REQUIRED

A. General

1. Operation and maintenance information/instruction materials shall be adequately indexed, and shall contain the following information:
 - a. Contractor's names, addresses, and telephone numbers.
 - b. Alphabetical list of all system components with the name and address and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 - c. Guarantees and warranties of all equipment whenever applicable.
 - d. All data applicable to the installed equipment including, but not limited to: Shop Drawings, record drawings, installation instructions, lubrication instructions, wiring diagrams, operating instructions, start-up procedures, shut-down procedures, trouble-shooting and repair guides, emergency guidelines, spare part and supply lists and vendors, and other relevant information.
2. In addition, the O&M Manuals shall include all of the applicable items of information listed in this paragraph 2.02 for each system as well as for each maintainable piece of equipment, equipment assembly or subassembly, and material provided under this Contract.

B. Operating Instructions

1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
 - a. Safety precautions – List personnel hazards for equipment and list safety precautions for all operating conditions.
 - b. Operator prestart – Provide requirements to set up and prepare each system for use.
 - c. Startup, shutdown, and post shutdown procedures – Provide a control sequence for each of these operations.
 - d. Normal operations – Provide control diagrams with data to explain operation and control of systems and specific equipment.
 - e. Emergency operations – Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
 - f. Operator service requirements – Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

- g. Environmental conditions – Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. Preventive Maintenance

- 1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:
 - a. Lubrication data – Provide lubrication data, other than instructions for lubrication in accordance with subparagraph 2.01.B.3. above.
 - 1) A table showing recommended lubricants for specific temperature ranges and applications.
 - 2) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.
 - 3) A lubrication schedule showing service interval frequency.
 - b. Preventive maintenance plan and schedule.
 - 1) Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.
 - 2) Provide manufacturer's projection of preventive maintenance manhours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. Corrective Maintenance

- 1. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
 - a. Troubleshooting guides and diagnostic techniques:
 - 1) Provide step-by-step procedures to promptly isolate the cause of typical malfunctions.
 - 2) Describe clearly why the checkout is performed and what conditions are to be sought.
 - 3) Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or requires replacement.
 - b. Wiring diagrams and control diagrams: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces.
 - 1) Provide a complete and accurate depiction of the actual job-specific wiring and control Work.
 - 2) On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identified to actual installation numbering.
 - c. Maintenance and repair procedures: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
 - d. Removal and replacement instructions:

- 1) Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments.
 - 2) Provide tolerances, dimensions, settings, and adjustments required.
 - 3) Instructions shall include a combination of tests and illustrations.
- e. Spare parts and supply lists:
- 1) Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays.
 - 2) List spare parts and supplies that have a long lead time to obtain.
- f. Corrective maintenance manhours:
- 1) Provide manufacturer's projection of corrective maintenance manhours including craft requirements by type of craft.
 - 2) Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. Appendices

1. Include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. The following information shall be provided:
 - a. Parts identification – Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement.
 - 1) Include special hardware requirements, such as requirement to use high-strength bolts and nuts.
 - 2) Identify parts by make, model, serial number, and source of supply to allow reordering without further identification.
 - 3) Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part.
 - 4) Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.
 - b. Warranty information – List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or Contract Documents to keep warranties in force.
 - c. Personnel training requirements – Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly. The requirements of Specification Section 01 79 00 apply.
 - d. Testing equipment and special tool information – Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.
 - e. Calibration procedures – Where appropriate, provide instructions and procedures for calibration of all detection and measurement devices.

- 1) Information shall include required frequency of calibration, detailed method of calibration, equipment necessary to calibrate the end instruments, the secondary standard information on calibration of required test equipment, and a calibration log for each end instrument.
- f. O&M Manuals shall include completed and signed forms C through F attached to specification section C-F.

PART 3 EXECUTION

3.01 TRANSMITTAL PROCEDURE

- A. Unless otherwise specified, the O&M Manuals and associated operation and maintenance information and data shall be transmitted in accordance with Specification Section 01 33 00 accompanied by an Operation and Maintenance Manual Transmittal. In addition, the O&M Manuals should include an Equipment Maintenance Data Summary Sheet and an Equipment Preventive Maintenance Data Summary Sheet for each piece of equipment referenced. The Operation and Maintenance Manual Transmittal shall be used as a checklist to ensure O&M Manuals are complete. Only complete sets of operation and maintenance information and instructions will be reviewed for acceptance.
- B. For ease of identification, each manufacturer's brochure, handbook, and/or operation and maintenance materials shall be appropriately labeled with the equipment name and equipment number as it appears in the Project Manual. The information shall be organized in binders, as described in this Specification section.
- C. If manufacturers' standard brochures and handbooks are used to describe operation and maintenance procedures, such brochures and handbooks shall be modified to reflect only the model or series of equipment used on this Project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

3.02 PAYMENT

- A. Acceptable operation and maintenance information for the Project must be delivered to the Engineer prior to the Project being 75 percent complete. Progress payments for Work in excess of 75 percent completion will not be made until acceptable O&M Manuals and adequate operation and maintenance information have been delivered to Engineer and reviewed and accepted by the Engineer.

3.03 EQUIPMENT STARTUP

- A. Under no circumstance will Contractor be allowed to start up equipment until the final O&M Manuals have been received.

3.04 OWNER'S OPERATOR TRAINING

- A. The O&M Manuals must be submitted and accepted before on-Site training may start as required of Specification Section 01 79 00.

3.05 FIELD CHANGES

- A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

PART 4 FORMS

4.01 OPERATIONS AND MAINTENANCE FORMS

- A. The following forms are to be used for the purpose of preparing and submitting O&M Manuals.
 - 1. The Operation and Maintenance Manual Transmittal form is to be used when tendering O&M Manuals.
 - 2. The Equipment Maintenance Data Summary Sheet form is to be used to document all noted data applicable to each piece of installed equipment.
 - 3. The Equipment Preventive Maintenance Data Summary Sheet form is to be used to list and describe all preventive and scheduled maintenance.
- B. A digital version of these forms can be obtained from the Engineer upon request.
- C. O&M Manuals shall include completed and signed forms C through F attached to specification section C-F.

**OPERATION AND MAINTENANCE MANUAL TRANSMITTAL
SILT WATER TREATMENT PLANT**

Submittal Description: _____

Submittal No.: _____

Bid Package No(s): _____

Spec. Section: _____

Project: Silt Water Treatment Plant

Contractor: _____

Engineer: Dewberry Engineers Inc.

Owner: Town of Silt

Routing	Date Sent	Date Received
Contractor to Engineer		
Engineer to Contractor		

Checklist	Contractor	
	Satisfactory	N/A
1. Table of contents		
2. Equipment record forms		
3. Manufacturer information		
4. Vendor information		
5. Safety precautions		
6. Operator prestart		
7. Startup, shutdown, and post shutdown procedures		
8. Normal operations		
9. Emergency operations		
10. Operator service requirements		
11. Environmental conditions		
12. Lubrication data		
13. Preventive maintenance plan and schedule		
14. Trouble-shooting guides and diagnostic techniques		
15. Wiring diagrams and control diagrams		
16. Maintenance and repair procedures		
17. Removal and replacement instructions		
18. Spare parts and supply list		
19. Corrective maintenance manhours		
20. Parts identification		
21. Warranty information		
22. Personnel training requirements		
23. Testing equipment and special tool information		
24. Calibration procedures		

Remarks: _____

Contractor's Signature

EQUIPMENT MAINTENANCE DATA SUMMARY SHEET SILT WATER TREATMENT PLANT

Submittal No.: _____

General Information									
Service:					Type:		Equipment ID:		
Location:					Specification Section:				
Manufacturer:					Local Representative:				
Mechanical Nameplate Data									
Model No:			Serial No:			Frame/Case No:		Installed:	
Size:	Capacity:	TDH/ Pressure:	RPM:	Impeller Size:		Materials:			
Misc. Nameplate & Other Pertinent Info:			Recommended Spare Parts:			Provide Spare Parts:			
Electrical Nameplate Data									
Manufacturer:		Model No.:		Serial No.:		Frame No.:		Installed:	
Duty:		NEMA Design:	KVA Code:	Amb. Temp.:	Insulation Class:	Enclosure:			
Hp:	Volts:	Amps:		HZ:	Phase:	RPM:		SF:	
Shaft End Bearing:					Opposite End Bearing:				
Misc. Nameplate & Other Pertinent Info.				Recommended Spare Parts:		Provided Spare Parts:			

**EQUIPMENT PREVENTIVE MAINTENANCE DATA SUMMARY SHEET
SILT WATER TREATMENT PLANT**

Submittal No.: _____

General Information			
Service:		Type:	Equipment ID:
Location:		Specification Section:	
Manufacturer:		Local Representative:	
Task No.	Description	Frequency	Hours
	Maintenance Requirements		
D = Daily, W = Weekly, M = Monthly, Q = Quarterly, S = Semi-Annually, A = Annually, ST = Situational (explain)			

END OF SECTION

SECTION 01 78 39
RECORD DRAWINGS

PART 1 GENERAL

1.01 SCOPE

- A. Provide the Engineer with one neatly and legibly marked set of blueline prints of the contract drawings or an electronic CAD or PDF file showing the final location of structures, equipment, piping, appurtenances, and other ancillary items. Marking of the drawings shall be kept current and shall be done at the time the material and equipment is installed. These drawings shall be available to Owner and Engineer upon request.
- B. Completed record drawings shall be submitted to the Owner prior to and as a condition precedent to final acceptance, or in the case of substantially completed portions of the work, issuance of a partial completion certificate.
- C. See Section 01 77 00 Closeout Procedures for other Record Drawing requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 79 00

TRAINING

PART 1 GENERAL

1.01 SCOPE

- A. This Specification section contains requirements for training the Owner's personnel in the proper operation and maintenance of the equipment and systems installed under this Contract.

1.02 QUALITY ASSURANCE

- A. Where specified, provide on-the-job training of Owner's personnel. Training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS

- A. The following information shall be submitted in accordance with the provisions of Specification Section 01 33 00. The material shall be reviewed and accepted by the Engineer not less than three (3) weeks prior to the provision of training.
 - 1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
 - 2. Subject of each training session, identity, and qualifications of individuals to be conducting the training, and tentative date, time, and duration of each training session.
 - 3. Following completion of training, submit completed "Manufacturer's Certificate of Instructional Services" included in Part 4 of this Specification section.

PART 2 PRODUCTS

2.01 LESSON PLANS

- A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.
- B. Furnish ten (10) copies of necessary training manuals, handouts, visual aids, and reference materials to the Engineer at least one (1) week prior to each scheduled training session.
- C. One complete set of hard-copy originals of the lesson plans, training manuals, handouts, visual aids, and reference material suitably bound for proper organization and easy reproduction shall be delivered to the Engineer to become the property of the Owner to be used for future training. A digital copy of all materials shall also be provided in portable document format (.pdf).
- D. Format and Content
 - 1. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system.

2. As a minimum, training sessions shall cover the following subjects for each item of equipment or system:
 - a. Familiarization.
 - 1) Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and in the "Operation and Maintenance Data."
 - 2) Present the check-out procedures for the installation of the specific equipment items.
 - 3) Demonstrate each item of equipment and each system.
 - 4) Answer questions.
 - b. Safety.
 - 1) Using material previously provided, review safety references.
 - 2) Discuss proper precautions around equipment.
 - c. Operation.
 - 1) Review reference literature.
 - 2) Explain all modes of equipment and system operation—operator prestart, startup, shutdown, post shutdown, normal operation, and emergency operation.
 - 3) Review all operating parameters for specific equipment/system and any and all interrelated equipment/systems.
 - 4) Review all associated environmental conditions that could affect equipment/ system operation.
 - 5) Check out Owner's personnel on proper use of the equipment.
 - d. Preventive maintenance.
 - 1) Review reference material and provide instruction on preventive maintenance (PM) procedures including daily, weekly, monthly, quarterly, semiannual, annual, and situational jobs.
 - 2) Review craft requirements, tools and special tools, and time required to perform jobs.
 - 3) Show how to perform PM jobs.
 - 4) Show Owner's personnel what to look for as indicators of equipment problems.
 - e. Corrective maintenance.
 - 1) List possible problems.
 - 2) Discuss repairs.
 - 3) Point out special problems.
 - 4) Review needs for various crafts/skills and special tools.
 - 5) Review time requirements.
 - 6) Open up equipment and demonstrate procedures, where practical.
 - f. Parts and service.
 - 1) Show how to use previously provided parts lists and procedures for ordering parts.

- 2) Check over spare parts on hand.
 - 3) Make recommendations regarding additional parts that should be available.
 - 4) Provide name, address, and telephone numbers of local representatives to order parts and to get service and/or emergency help.
- g. "Operation and Maintenance Manuals."
- 1) Review any other material included in the "O&M Manuals."
 - 2) Update material, as required.

PART 3 EXECUTION

3.01 GENERAL

- A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this Contract.
1. Training shall take place at the Site of the Work and under the conditions specified in the following paragraphs.
 2. Provide all audio and/or visual equipment needed to present the required training.
 3. The O&M Manuals must be submitted and accepted in accordance with Specification Section 01 78 23 before on-Site training may start.

3.02 SCHEDULE

- A. Training shall be conducted in conjunction with operational testing and commissioning periods as specified.
1. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence.
 2. Arrange to have the training conducted on consecutive days, with no more than six (6) hours of classes scheduled for any one day.
 3. Concurrent classes shall not be allowed.

3.03 CLASSROOM TRAINING

- A. As a minimum, classroom equipment training for operations personnel will include the following services for each item of equipment and/or system as required in individual Specification sections:
1. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview. Discuss purpose and function of the equipment. Provide a working knowledge of the operating theory of the equipment.
 2. Operator prestart, startup, shutdown, post shutdown, normal, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
 3. Identify and discuss safety items and procedures.
 4. Routine preventive maintenance, including specific details on lubrication and maintenance. Required equipment exercise procedures and intervals. Operator

detection, without test instruments, of specific equipment trouble symptoms. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the “pass” and “no pass” test instrument readings. Routine and long-term calibration procedures.

5. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.
 6. Routine records keeping.
- B. Additional training services shall be provided, where specifically required in individual Specification sections.
- 3.04 FIELD TRAINING
- A. As a minimum, hands-on equipment training for Owner’s operations personnel will include identifying location of equipment and reviewing the purpose of piping, valves, and flow options; identifying instrumentation including location of primary element, location of instrument readout, basic operation, and information interpretation.
 - B. Discuss, demonstrate, and perform standard operating procedures and round checks. Discuss and perform the preventive maintenance activities and perform startup and shutdown procedures. Perform the required equipment exercise procedures. Perform routine disassembly and assembly of equipment if applicable. Identify and review safety items and perform safety procedures, if feasible.
 - C. Demonstrate preventive maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
 - D. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments, and calibration and troubleshooting equipment problems.

PART 4 FORMS

4.01 TRAINING FORM

- A. The following form is to be used for Owner’s training and record purposes. Digital versions of this form can be obtained upon request to the Engineer.

MANUFACTURER'S CERTIFICATE OF INSTRUCTIONAL SERVICES

PROJECT: _____

EQUIPMENT: _____ (Tag No. _____)

CONTRACTOR: _____

SPECIFICATION SECTION: # _____

ENGINEER: Dewberry Engineers Inc.

MANUFACTURER'S TRAINING CERTIFICATION

The undersigned manufacturer certifies that a service technician has instructed the treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein, and that the training included, but was not limited to the following:

Operation Check List:

1. _____ Start-up and operation in accordance with the manufacturer's O&M instructions.
2. _____ Shutdown procedure reviewed in accordance with the O&M Manual.
3. _____ Normal operation procedure reviewed.
4. _____ Primary sensing elements, vibration, oil level, temperature, filter, pressure, etc.
5. _____

Maintenance Check List:

1. _____ Described maintenance of this equipment as required by the O&M Manual.
2. _____ Described lubrication and periodic inspection as recommended by the manufacturer.
3. _____ Described preventive maintenance instructions.
4. _____ Described normal items to be reviewed for wear.
5. _____ Described special tools required, if any.
6. _____ Described preventive maintenance instructions.
7. _____ Safety and safe operation of this equipment as recommended by the Manufacturer.
8. _____ Trouble-shooting information and instruction.
9. _____ Hands on training – operation of the equipment by the Owner's operators.
10. _____ Review of the training as specified in the Contract Documents.
11. _____

MANUFACTURER: _____ certifies that
conducted training is in compliance with the Contract Documents.

Signature: _____

Title: _____ Date: _____

ENGINEER: Dewberry confirms the training as presented is in compliance with the Contract Documents.

Engineer Signature: _____

Title: _____ Date: _____

Engineer Signature: _____

Title: _____ Date: _____

OWNER: Town of Silt representative accepts the training as presented by the manufacturer's representative.

Owner Signature: _____

Title: _____ Date: _____

CONTRACTOR: _____ certifies that
training as presented is in compliance with the Contract Documents.

Signature: _____

Title: _____ Date: _____

END OF SECTION

SECTION 01 81 16

ENVIRONMENTAL CONDITIONS

PART 1 GENERAL

1.01 SCOPE

- A. This section describes the environmental conditions which have been observed at the site of the work and which may reasonably be anticipated throughout the life of the project.

1.02 SITE CONDITIONS

A. Climate

1. Weather conditions are typically as follows:

<u>Description</u>	<u>Range of Conditions</u>
Location	Silt, Garfield County, Colorado
Elevation, feet above mean sea level	5,460
Relative humidity, percent	
Average outdoors	53
Air temperature, degrees F	
Outdoors	-1 to 96
Indoors (Electric Room)	75
Indoors (all other spaces)	55 to 90
Barometric pressure, inches mercury	30.1
Prevailing winds	West or South

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END SECTION

SECTION 01 91 13

INSTALLATION, TESTING, AND COMMISSIONING

PART 1 GENERAL

1.01 SCOPE

- A. This Specification section specifies installation, testing, and commissioning of all mechanical, electrical and instrumentation systems. Testing and commissioning includes delivery acceptance tests and inspections, tests and inspections of items as installed, operational testing of completed sections of the facility, and commissioning of completed sections of the plant.

1.02 QUALITY ASSURANCE

A. Manufacturers' Operation and Maintenance Instructions

1. The Contractor shall have copies of operating and maintenance instructions from the manufacturers of all equipment to be installed, tested, and commissioned.
 - a. Operating instructions shall include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting procedures.
 - b. Maintenance instructions shall include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, and troubleshooting procedures as well as parts lists.
 - c. No startup or commissioning shall commence until a manufacturer's representative has visually inspected the installation, verified his approval of the installation by reviewing lubrication, filtration, and adjustment of all components. The manufacturer's representative must then start the equipment to assure it meets all of the manufacturer's recommendations, sign the provided compliance sheet, and inform the Engineer the equipment is ready for testing, training, and commissioning.
2. Related information shall be assembled for this Project in accordance with Specification Section 01 78 23.

B. Installation

1. All mechanical, electrical, and instrumentation equipment shall be installed in conformity with the details shown and specified in the Contract Documents and with the manufacturer's requirements.

C. Testing

1. All materials, equipment, and Work provided and/or installed as a part of this Contract shall be tested and inspected to demonstrate compliance with the Contract requirements. The Work shall include the equipment supplied by others but installed and/or connected by the Contractor. For the purpose of this Specification section, equipment shall mean any mechanical, electrical, instrumentation, or other device with one or more moving parts or device requiring an electrical, pneumatic or hydraulic connection.
2. Installed piping leakage tests and other piping tests shall be as specified in the Specification sections included in Division 33.

3. No tests specified herein shall be conducted until the item/system to be tested has been inspected and approval for the application of such test has been given by the Engineer.
4. Tests and inspections, unless otherwise specified or accepted, shall be in accordance with the recognized standards of the industry.
5. The Contractor shall see that scheduling and performance of all tests are coordinated with involved Subcontractors and Suppliers and other involved contractors.
6. The form of evidence of satisfactory fulfillment of requirements for delivery acceptance tests and inspections and tests and inspections of items installed shall be at the discretion of the Engineer, either by tests and inspections carried out in their presence or by their favorable acknowledgment of certificates or reports of tests and inspections carried out by others. Provide forms which indicate all test information, including specified operational parameters that are acceptable in content to the Engineer.

1.03 SUBMITTALS

- A. The following information shall be submitted in accordance with the provisions of Specification Section 01 33 00:
 1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of this Specification section, including:
 - a. Proposed plan for documenting the calibration of all test instruments.
 - b. Proposed plan for calibration of all instrument systems, including flow meters; level sensors; and pressure, weight, and analysis systems.
 - c. Sample forms for documenting the results of field pressure and performance tests and all other test forms required herein.
 2. Pre-operational check-out procedures reviewed and approved by the respective equipment manufacturers.
 3. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the Contractor for the systematic testing of all equipment and systems installed under this Contract.
 4. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this Contract. The schedule shall establish the expected time period (calendar dates) when the Contractor plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place. This schedule must be received at least four (4) weeks before testing begins.
 5. Completed test forms shall be provided for each item of mechanical, electrical, and instrumentation equipment provided or installed under this Contract and shall contain provisions for recording relevant performance data for original testing and not less than three retests. Separate sections shall be provided to record values for the preparation checkout and initials of representatives of the equipment manufacturers, the Contractor, and the Engineer.
 6. Completed Certificate of Installation, Inspection and Start-Up Services for each equipment installation. See Specification 01 33 00 for the required form.

PART 2 PRODUCTS

2.01 MATERIALS

A. Gauges, Meters, Recorders, and Monitors

1. Provide gauges, meters, recorders, and monitors as required by the Contract Documents and as required by the Engineer to supplement or augment the instrumentation system(s) provided under this Contract to properly demonstrate that all equipment satisfies the requirements of the Project Manual.
 - a. All devices employed for the purpose of measuring the performance of the facility's equipment and systems shall be specifically selected to provide a level of precision and accuracy consistent with the variables to be monitored.
 - b. All instruments shall be recently calibrated, and the Contractor shall be prepared at all times to demonstrate, through recalibration, the certainty of instruments employed for testing purposes. Calibration procedures shall be in accordance with applicable standards of ASTM, ISA, and IEEE.
2. The adequacy of all gauges, meters, recorders, and monitors shall be subject to review of the Engineer.

B. Records

1. Provide test forms for all installed and operational testing for each item of mechanical, electrical, and instrumentation equipment provided or installed under this Contract. Separate sections shall be provided to record values for the preparation checkout and initials of representatives of the equipment manufacturers, the Contractor, and the Engineer.
2. The Contractor shall maintain a master file of all equipment test forms, which shall be available for inspection by the Engineer. Upon completion of testing, the Contractor shall furnish the Engineer with the original and two copies of the test form for each equipment item.

2.02 METHODS

A. Installation

1. All equipment shall be installed by workers properly skilled in the trades and professions required to assure first-class workmanship. Where required by detailed Specifications or manufacturer requirements, installation of specific equipment item(s) shall be accomplished under the supervision of factory-trained installation specialists furnished by the equipment manufacturer(s). The Contractor shall be prepared to document the skills and training of all workers engaged in the installation of all equipment furnished either by the Contractor or the Owner.

B. Testing

1. Testing shall proceed on a step-by-step basis in accordance with the Contractor's written testing procedures.
 - a. Test all equipment, systems, structures, and the complete facility as a unit in an orderly, systematic manner.
 - b. Each individual step in the procedures shall be witnessed by a representative of the Engineer.

2. During the facility operational testing period, all equipment and systems shall be operated, to the greatest extent practicable, at conditions which represent the full range of operating parameters as defined by the Project Manual.

PART 3 EXECUTION

3.01 NOTIFICATION

- A. The Contractor shall notify the Engineer not less than 14 days prior to the date that the equipment and/or other materials or portions of the Work will be ready for inspection and testing.

3.02 ACCEPTANCE TESTS AND INSPECTIONS

- A. Acceptance tests and inspections shall be performed by the Engineer of all items delivered at the Site or to any authorized place of storage to confirm that such items are of the specified quality and workmanship. Should the Engineer find, in their opinion, indication of damage or deficient quality of workmanship, the Contractor shall provide the necessary documentation or conduct such tests deemed necessary by the Engineer to demonstrate compliance with the Contract Documents.
- B. Tests of items at the place of manufacture during and/or on completion of manufacture shall be conducted.
 1. Tests shall comprise of material tests, hydraulic pressure tests, electric and instrumentation subsystem tests, performance and operating tests and inspections in accordance with the relevant standards of the industry and more particularly as detailed in individual clauses of the Specifications.
 2. Results of tests shall satisfy the Engineer that the items tested and inspected comply with the requirements of the Contract Documents.

3.03 INSTALLED TESTS AND INSPECTIONS

A. General

1. All equipment installed by the Contractor shall be tested to the satisfaction of the Engineer before any facility is put into operation.
2. Tests shall be made to determine whether the equipment has been properly assembled, aligned, adjusted, and connected.
3. Any changes, adjustments or replacements required to make the equipment operate as specified shall be carried out by the Contractor as part of the Work.
4. Contractor will not be allowed to start up equipment or systems until the final Operation and Maintenance Manuals (O&M Manuals) have been received in accordance with Specification Section 01 78 23.
5. Provide temporary heating, ventilating, and air conditioning, utilities, supplies, labor, and Work for the areas requiring these services. Temporary facilities shall be maintained by the Contractor until permanent systems are in service.

B. Start-Up Plan

1. The procedures shall be divided into three distinct stages; preparation checkout, initial operation, and plant operational tests.

2. Testing procedures shall be designed to duplicate, as nearly as possible, all conditions of operation and shall be carefully selected to ensure that the equipment is not damaged.
3. Once the testing procedures have been reviewed by the Engineer, the Contractor shall produce checkout, alignment, adjustment, and calibration signoff forms for each item of equipment to be used in the field by the Contractor, Engineer jointly to ensure that each item of electrical and mechanical equipment has been properly installed and tested.

C. Preparation Checkout

1. The procedures shall provide a logical, step-wise sequence to ensure that all equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation.
2. Preparation checkout procedures shall include, but not necessarily be limited to:
 - a. Electrical and instrumentation system testing as specified in Specification sections included in Divisions 26 and 40.
 - b. Piping system pressure testing and cleaning as specified in Specification sections included in Division 33.
 - c. Alignment of equipment.
 - d. Preparation lubrication.

D. Initial Operation

1. Once all affected equipment has been subjected to the required preparation checkout procedures and the Engineer has witnessed the checkout and has not found deficiencies in that portion of the Work, individual systems may be started and operated under simulated operating conditions.
 - a. Nonpotable water shall be employed for the testing of all liquid systems except gaseous, oil or chemical systems.
 - b. Test media for these systems shall either be the intended fluid or a compatible substitute.
 - c. The equipment shall be operated for a sufficient period of time to determine machine operating characteristics including temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls.
 - d. When testing requires the availability of auxiliary systems such as electrical power, flushing or cooling water or control air that have not yet been placed in service, provide acceptable substitute sources capable of meeting the requirements of the machine, device, or system.
 - e. Disposal methods for test media shall be subject to review by the Engineer.
2. Test results shall be within the specified tolerances.
 - a. If tolerances have not been specified, test results shall conform to tolerances established by the equipment manufacturer or recognized industry practice.
 - b. Where the results of any installed test fails to comply with the Contract requirements for such test, then such repeat testing as may be necessary to achieve the Contract requirements shall be made at the expense of the Contractor.
 - c. In case of any doubt, dispute, or difference of opinion regarding test results, test methods, or test equipment, the Engineer may order the test to be repeated.

- 1) If the repeat testing, using such modified methods or equipment as the Engineer may require, substantially confirms the previous test results, then all costs in connection with the repeat testing will be paid by the Owner.
3. Once initial operation has been completed, all machines shall be rechecked for proper alignment, realigned, if necessary, and doweled in place.
 - a. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics.
 - b. Any deficiencies shall be corrected to the satisfaction of the Engineer.
 - c. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled, inspected, and then repaired.
 - d. Equipment that cannot be acceptably repaired shall be removed from the Site and replaced.
4. If any portion of the Work should fail to fulfill the Contract requirements during testing and adjustments or alterations are made, or if any portion of the Work is renewed or replaced, tests on that portion, together with all other affected portions of the Work, shall be repeated within a reasonable time in accordance with the specified conditions.

E. Operational Testing

1. After completion of all initial testing and the Engineer concurs that all equipment complies with the requirements of the Specifications, the Contractor shall fill all process systems and units with the specified fluid.
 - a. Process systems and units include all materials and equipment constructed or installed in the Contract, including Owner-provided equipment.
2. Upon completion of the filling operations, operate the completed systems and subsystems as a complete facility at various loading conditions, as directed by the Engineer.
3. All process units and systems shall be brought to full operating conditions, including temperature, pressure, and flow.
4. The duration of the operational test shall be at least three (3) days.
 - a. Each test day the complete facility shall be operated for at least eight (8) continuous hours.
 - b. During the three (3)-day period, the Contractor shall demonstrate the operation of all equipment and all systems installed under this Contract.
5. If operational testing is stopped for any reason related to the temporary testing systems, or the facilities or equipment furnished under this Contract, the operational testing program shall be repeated until the specified continuous period has been accomplished without interruption.
6. Once a system or subsystem has successfully completed the three (3)-day test period in the opinion of the Engineer, the Engineer shall issue a certificate of Partial Substantial Completion for the system or subsystem.
7. All costs for water, fuel, power, and chemical required during this plant operational test shall be borne by the Owner. The Contractor shall obtain nonpotable or potable water required to complete tests and inspections from the Owner. Arrangements shall be made through the Engineer.

3.04 OPERATIONAL INSTRUCTION

- A. During the testing of equipment, provide experienced factory-trained manufacturer's representatives of the various equipment items, or other qualified persons to instruct the Owner's personnel in the operations and care thereof. Training shall be in accordance with the requirements of Specification Section 01 79 00.

3.05 COMMISSIONING

A. General

1. After completing operational testing and certification of all systems and subsystems as Partially Substantially Complete, commissioning will begin. The facility or portion thereof shall be fully operational and performing all functions as specified.
2. The commissioning period for all systems shall be 14 days and commence following the certification of Partial Substantial Completion of all portions of the facility.
3. Contractor shall remove all temporary piping or other temporary facilities that may have been in use during the operational testing.
4. Contractor shall bear the costs of all necessary repairs or replacements, including labor and materials, required to keep operational the portion of the plant being commissioned.

- B. During the commissioning period, the Contractor shall provide on-call personnel including equipment manufacturer service representatives available 24 hours per day, seven (7) days per week for troubleshooting or emergency repair and maintenance of equipment.

1. On-call personnel assigned for troubleshooting, repair, or maintenance of equipment shall respond as soon as possible and in no case longer than 8 hours after notification to the Contractor.
2. On-call personnel shall be familiar with the facility equipment and operations and shall be acceptable to the Engineer.
3. In response to a request from the Engineer or Owner, on-call personnel shall be present at the Site for whatever period of time is required at whatever time of day necessary to restore normal operation of equipment.

- C. During the commissioning period, the Owner shall:

1. Provide Owner's operations and maintenance personnel who will be responsible for operation of the plant or portion of the plant being operated during this commissioning period.
2. Be responsible for all normal operational costs.

- D. At the end of the commissioning period and when all corrections required by the Engineer to assure a reliable and operational facility are complete, the Engineer shall issue a Certificate of Substantial Completion for the facility as a whole.

PART 4 FORMS

4.01 INSPECTION AND COMMISSIONING FORMS

- A. The following form is to be use for procedurally conducting inspections and commissioning, and for documentation purposes.

1. Certificate of Installation, Inspection and Start-Up Services to be used to document completing operational testing, certification, and commissioning for each item of mechanical, electrical, and instrumentation equipment provided or installed under this Contract.
- B. A digital version of these forms can be obtained upon request to the Engineer.

CERTIFICATE of INSTALLATION, INSPECTION and START-UP SERVICES

Page 1 of 3

PROJECT: _____

EQUIPMENT: _____ (Tag No. _____)

SPECIFICATION SECTION: # _____

CONTRACTOR: _____

OWNER: Town of Silt

ENGINEER: Dewberry Engineers Inc

MANUFACTURER'S EQUIPMENT CERTIFICATION

The undersigned manufacturer of the equipment item described above hereby certifies that the representative whose signature appears below has checked the installation of the equipment and that the equipment as specified in the Project Manual, has been provided in accordance with the manufacturer's recommendations and that the trial operation of the equipment item has been satisfactory.

Comments: _____

Manufacturer: _____

Authorized Representative (printed name) _____

Title _____

Signature _____ Date _____

Contractor: _____

Authorized Representative (printed name) _____

Title _____

Signature _____ Date _____

CERTIFICATE of INSTALLATION, INSPECTION and START-UP SERVICES

Page 2 of 3

PRE-OPERATION SYSTEM READINESS CHECK-OFF

PROJECT: _____ Date _____

EQUIPMENT: _____ (Tag No. _____)

- | | | | | | |
|-----|--|-------|-------|-------|-------|
| 1. | The equipment is installed in accordance with the manufacturer's recommendations, approved Shop Drawings and Contract Documents. | _____ | _____ | _____ | _____ |
| 2. | The equipment has been lubricated, and operated meeting the start-up criteria of the manufacturer. | _____ | _____ | _____ | _____ |
| 3. | Nothing in the installation voids any warranty | _____ | _____ | _____ | _____ |
| 4. | The equipment has been operated in the presence of the Engineer. | _____ | _____ | _____ | _____ |
| 5. | The equipment, as installed, is ready to be operated by others. | _____ | _____ | _____ | _____ |
| 6. | The manufacturer's start-up report is completed. | _____ | _____ | _____ | _____ |
| 7. | The equipment is ready for Start-up and Training. | _____ | _____ | _____ | _____ |
| 8. | The primary sensing elements are operational. | _____ | _____ | _____ | _____ |
| 9. | _____ | _____ | _____ | _____ | _____ |
| 10. | _____ | _____ | _____ | _____ | _____ |

CERTIFICATE of INSTALLATION, INSPECTION and START-UP SERVICES

Page 3 of 3

START-UP SERVICES

PROJECT: _____ Date _____

EQUIPMENT: _____ (Tag No. _____)

- | | | | | | |
|----|--|-------|-------|-------|-------|
| 1. | The equipment pre-operation system readiness check-off has been conducted in accordance with the manufacturer's recommendations. | _____ | _____ | _____ | _____ |
| 2. | The equipment has been started up in the presence of the Engineer. | _____ | _____ | _____ | _____ |
| 3. | The manufacturer's start-up report is completed and attached to this certification form. | _____ | _____ | _____ | _____ |
| 4. | The equipment has been successfully started up and is ready to be operated by others. | _____ | _____ | _____ | _____ |

END OF SECTION

SECTION 02 01 00

SITE PREPARATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Scope: This Specification section specifies Site preparation which consists of clearing, grubbing and demolition.
- B. Existing Conditions: The Contractor shall determine the actual condition of the Site as it affects this portion of Work.
- C. Protection: Site preparation shall not damage structures, landscaping, or vegetation adjacent to the Site. The Contractor shall repair or replace any damaged property.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

- A. Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the Work requires their removal.
- B. Material that is removed and is not to be incorporated in the Work shall be disposed of off the Site.

3.02 DEMOLITION AND REMOVAL

- A. Refer to Specification Section 02 42 13.

3.03 UTILITY INTERFERENCE

- A. The Owner has endeavored to determine the existence of utilities at the Site of the Work from the records of the owners of known utilities in the vicinity of the Work. The positions of such utilities as derived from these records are shown on the Drawings. No excavations were made to verify the locations shown for underground utilities. The Contractor shall determine the exact locations of utilities and service connections thereto. The Contractor shall make its own investigations, including exploratory excavations and contacting utility owners, to determine the locations and type of existing utilities, including service connections, prior to commencing Work which could result in damage to such utilities. The Contractor shall immediately notify the Engineer and the Owner as to any utilities discovered in a different position than indicated in the Contract Documents or which is not indicated in the Contract Documents.
- B. Known Utilities: The Contractor shall provide all labor, equipment, materials, and services necessary to remove, relocate, or maintain utilities indicated in the Contract Documents. The work on each utility shall be performed in a manner acceptable to the utility owner. The utility

owner has the option of doing such work with its own forces at the Contractor's expense or permitting the work to be performed by the Contractor.

- C. Service Connections: Locations of service connections may not be indicated in the Contract Documents. The Contractor shall provide all labor, equipment, materials, and services necessary to remove, relocate, or maintain service connections. The work on each service connection shall be performed in a manner acceptable to the service connection owner. The service connection owner has the option of doing such work with its own forces at the Contractor's expense or permitting the work to be performed by the Contractor.
- D. Unknown Utilities: When the location of a utility is materially different from that indicated in the Contract Documents, and it interferes with the Work in a manner which will require the removal or relocation of said utility, it shall be treated as a Change in the Work. The utility owner has the option of doing such work with its own forces at the Contractor's expense or permitting the work to be performed by the Contractor.

END OF SECTION

SECTION 02 42 00

CLEANING

PART 1 GENERAL

1.01 SCOPE

- A. Requirements: Contractor is responsible for cleaning its own product and removing its own debris. Periodic cleaning will be required throughout the construction progress. At the completion of work and immediately prior to final inspection, clean the entire project as follows:
1. Thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. Leave the structures and site in a complete and finished condition to the satisfaction of the Engineer.
 2. Direct all subcontractors to similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.
 3. Remove all temporary structures and all debris, including dirt, sand, gravel, rubbish and waste material.
 4. Should the Contractor not remove rubbish or debris or not clean the buildings and site as specified above, the Owner reserves the right to have the cleaning done at the expense of the Contractor.
- B. Employ experienced workers, or professional cleaners, for final cleaning.
- C. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
- D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.
- E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.
- F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.
- G. Remove snow and ice from access to structures during the construction progress.
- H. Vacuum clean all interior spaces, including inside cabinets.
- I. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.
- J. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.
- K. Clean interior of all panel cabinets, pull boxes, and other equipment enclosures.
- L. Wash and wipe clean all lighting fixtures, lamps, and other electrical equipment which may have become soiled during installation.
- M. Perform touch-up painting.

- N. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.
- O. Remove erection plant, tools, temporary structures and other materials.
- P. Remove and dispose of all water, dirt, rubbish or any other foreign substances.

1.02 FINAL INSPECTION

- A. After cleaning is complete the final inspection may be scheduled. The inspection will be done with the Owner and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02 42 13

DEMOLITION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section includes materials and equipment to be demolished and removed from the site as trash by the Contractor.
- B. Furnish all labor, material, equipment, and incidentals required to demolish, modify, or alter, existing facilities as shown or specified and as required for the installation of new mechanical equipment, piping, structural modifications, architectural features and appurtenances. Existing piping and equipment shall be removed and dismantled as necessary for the performance of structural, architectural, and piping alterations in accordance with the requirements herein specified.

1.02 PERFORMANCE REQUIREMENTS

- A. Existing Conditions
 - 1. Contractor shall visit the site and inspect the nature and condition of all facilities to be demolished, partially demolished, modified, or altered in any way prior to submittal of his Bid. No increase in cost or extension of Contract time will be considered for failure to know the conditions of the site and structures.
- B. Demolition and Disposal
 - 1. All other materials removed under the demolition Work, including dismantled equipment and materials, piping, pumps, fittings, valves, machinery, gates, reinforced structural concrete, concrete equipment pads, miscellaneous and structural metals, masonry, and other construction debris shall become the property of the Contractor and be removed from the site as trash. Trash and debris shall be disposed of legally, off the site, by Contractor. Upon removal from site, Contractor shall have the rights of salvage of materials.

1.03 QUALITY ASSURANCE

- A. Protection of Existing Facilities
 - 1. The Facility must remain in operation and fully functional during the entire Contract. All demolition operations shall be carefully coordinated and scheduled with the Owner and Engineer.
 - 2. The Contractor shall diligently protect existing structures, utilities and property of the Owner while proceeding with Work of this section and the entire Contract. All damage shall be repaired at once to the satisfaction of the Owner. All such repairs shall be at the expense of the Contractor and no claims for additional payment will be accepted.
 - 3. When removing materials or portions of existing structures and when making openings in walls, structural slabs and partitions, the Contractor shall provide barriers, dust screens, and other protective devices so as not to damage the structures beyond the limits necessary for the new Work, nor to damage the structures or contents by falling or flying

debris nor to transfer any heavy shocks and vibrations to structures to remain. Swinging weights shall not be used to demolish structures.

PART 2 MATERIALS AND METHODS

2.01 REPAIR AND RESTORATION

A. General

1. The Contractor shall alter or rework existing structures as shown and specified. Generally, when items of equipment and piping are removed, the areas and surfaces from which items were removed shall be left with a neat appearance and finish compatible with surrounding areas, colors, and surfaces. The Contractor shall do all painting, sanding, grouting, sacking, resurfacing, and other Work as necessary to comply with the above requirements. Prior to structural modifications, all surfaces shall be subject to inspection by the Engineer. Colors shall match existing colors as closely as possible. For replacement, repair or restoration of Work removed, comply with the specifications for the type of Work to be done.

B. Penetrations

1. Where holes in existing masonry or concrete are required to be sealed, unless otherwise specified or shown on the Drawings, they shall be sealed with cement mortar or concrete. The sides of the openings shall be provided with keyed joints and shall be suitably roughened to furnish a good bond and make a watertight joint. All loose or unsound material adjacent to the opening shall be removed and, if necessary, replaced with new material. The method of placing the concrete seal shall provide a suitable means of releasing entrapped air. Refer to the Drawings for reinforcement and waterstop requirements.

C. Modifications of Existing Structures

1. Where only a portion of the existing structure is to be removed, the existing concrete shall be sawed to neat lines as shown on the plans. Overcutting saw lines will not be allowed. Reinforcing steel shall be removed to a depth of two inches from the finished surface. Anchor bolts for equipment and structural steel removed shall be cut off 1-inch below the concrete surface. Surface shall be finished as specified in Division 3.
2. When connections are to be made to existing concrete structures, the existing reinforcing steel shall be exposed to a depth of 12 inches and all bars mechanically spliced to the new reinforcing steel unless indicated otherwise on the Drawings.

D. Piping Modifications

1. Where necessary or required for the purpose of making piping connections, cut existing pipelines and provide suitable plugs, bulkheads, or other means to hold back the flow of water or other liquids, all as required in the performance of the Work under this Contract. The remaining open ends of all piping, valves, fittings, and appurtenances that are removed shall be plugged with standard pipe plugs or closed with flanges so that there will be no leakage through the closure. Bypass pumping will be required during some of the demolition operations.

PART 3 EXECUTION

3.01 GENERAL

A. Control of Hazard and Nuisance Conditions

1. All demolition, salvage, and renovation Work shall be conducted in a manner which will protect the environment, promote public health and safety, and preclude nuisance conditions, in strict conformance with the requirements of specification Section 01 35 43, Environmental Procedures. In addition, Contractor shall enforce the following safety requirements:
 - a. No open fires will be permitted on-site.
 - b. Smoking will only be permitted in designated areas of the plant as directed by the Owner.
 - c. The use and locations of fuel fired construction heaters are to be coordinated with the Owner and Engineer.
 - d. All cutting, grinding and welding activities shall be performed in well ventilated areas and with prior approval from the Owner and Engineer.

B. Demolition of Existing Structures

1. Structures that are shown on the plan to be demolished shall be removed completely, regardless if they are above or below existing or proposed ground or grade. This Work may be done in any manner selected by the Contractor, reviewed and approved of by the Owner and Engineer, that does not endanger adjacent structures and property. The use of explosives will not be permitted for any purposes.
2. Structural steel members shall be cut into sections of such weight and size as will permit convenient handling, hauling, and storage. Concrete to be demolished and removed shall be broken into pieces not greater than 24-inches in any dimension by methods reviewed and approved of by the Engineer and Owner.

C. Grading and Backfill

1. All excavation made in connection with this item and all openings below permanent ground caused by the removal of a structure shall be backfilled with suitable material and graded to match the proposed grading plan. That portion of the backfill which will support any portion of a roadbed, driveway, or structure shall be backfilled and compacted in accordance with specification Section 31 05 00, Earthwork.

D. Weather Protection

1. Removal of windows in exterior walls, or other elements providing weather protection, shall not be started until temporary weatherproof enclosures are in place or can be put in place immediately after such removal.

E. Existing Trees

1. Extreme care should be taken when working around existing trees. No excavation or compaction shall take place within the tree drip line except with prior permission of the Owner or where the tree is shown for removal on the drawings.

END OF SECTION

SECTION 03 00 55

ADHESIVE BONDING OF REINFORCEMENT AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SCOPE

- A. This section covers bonding reinforcing bars and all thread rods in concrete using epoxy adhesive.

1.02 QUALITY ASSURANCE

A. References

1. The publications referred to hereinafter form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this section and the listed standards, the requirements of this section shall prevail.
 - a. International Code Council – Evaluation Service, Inc. (ICC-ES):
 - 1) AC308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
 - b. ASTM International:
 - 1) C881 Standard Specification for Epoxy Resin Base Bonding System for Concrete
 - c. Society for Protective Coatings (SSPC):
 - 1) SP-1 Surface Preparation Standards – Solvent Cleaning

B. Definitions

1. Evaluations Report: Report prepared by ICC-ES, the documents testing and review of the adhesive product to confirm that it conforms to the requirements of ICC-ES AC58.

1.03 SUBMITTALS

- A. The Contractor shall submit the information below in accordance with Section 01 33 00, Submittal Procedures.

1. Product Data

- a. Submit technical data for adhesives, including:
 - 1) Independent testing laboratory results indicating allowable loads in tension and shear for masonry walls of the types shown on the Drawings, with load modification factors for temperature, spacing, edge distance and other variables.
 - 2) Handling and storage instructions.
 - 3) Installation instructions.
- b. Quality control submittals:

- 1) Special inspections: Detailed instructions for special inspection to comply with the International Building Code.
- 2) Evaluation report confirming that the product complies with the requirements of ICC-ES AC308.

1.04 DELIVERY AND HANDLING

A. Store and protect as follows, unless manufacturer has stricter requirements.

1. Store adhesive components on pallets or shelving in a covered-storage area protected from weather.
2. Control temperature to maintain storage within manufacturer's recommended temperature range.
 - a. If products are stored at temperatures outside manufacturer's recommended temperature range, test components prior to use by methods acceptable to the Engineer to determine if the products still meet specified requirements.
3. Dispose of products that have passed their expiration date.

1.05 PROJECT CONDITIONS

A. Seismic design category as shown on the Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive system

1. Adhesive shall have a current Evaluation Report showing compliance with ICC-ES AC308 for use in cracked concrete and for seismic design categories as shown on the Drawings.
2. Materials
 - a. In accordance with ASTM C 881, Type IV, Grade 3, Class B or C depending on site conditions.
 - b. 2-component, 100 percent solids, insensitive to moisture.
 - c. Cure temperature, pot life, and workability: compatible with the required use and the environmental conditions.

B. Packaging

1. Furnished in side-by-side cartridges with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle. Nozzle designed to thoroughly blend the components for injection from the nozzle directly into prepared hole.
2. Container markings that include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers

1. One of the following or equal:

- a. Hilti, Inc.: RE – 500 V3 Adhesive Anchor System.
- b. Simpson Strong-Tie Company, Inc.: SET-XP.

D. All Thread Rods

- 1. As specified in Sections 05 10 00 and 05 50 00, Structural Metals and Miscellaneous Metalwork.

E. Reinforcing Steel

- 1. As specified in Section 03 30 00, Cast-in-Place Concrete Reinforcement and Grout.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide epoxy adhesive packaged that is disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio and fit into a manually or pneumatically operated caulking gun. Dispense components through a mixing nozzle that thoroughly mixes components.

3.02 HOLE SIZING AND INSTALLATION

A. Drilling Holes

- 1. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device, and mark locations on surface of concrete. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without approval by Engineer.

B. Hole Drilling Equipment

- 1. Electric or pneumatic rotary impact type with medium or light impact. Drill bits to be Carbide tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacture or required as a "condition of use" in the ICC Evaluation Report submitted. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce the bond. Where edge distance are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- 2. Hole diameter to be the reinforcing bar diameters or all thread rod diameter plus 1/8 inch.

C. Obstructions in Drill Path

- 1. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling hole and fill the hole with drypack mortar. Relocate the hole to miss the obstruction and drill another hole. Repeat the above until the hole has been drilled to the required depth.
- 2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the structural member and endanger the stability of the structure. Drypack holes which hit obstructions and allow drypack to reach strength equal to the existing concrete before drilling adjacent holes. Epoxy grout may be substitute for drypack with acceptable to engineer.

3. Install reinforcing bars and all thread rods to depth, spacings, and locations as indicated on the Drawings. Do not install epoxy bonded all-thread rods or reinforcing bars in overhead applications.

3.03 INSTALLATION

A. Cleaning Holes

1. Insert long air nozzle into hole and blow out loose dust. Use Compressed air that is free of oil, water or other contaminants that will reduce the bond. Use a stiff brush to brush hole to dislodge compacted drilling dust, then use compressed air again. The final hole shall be clean and dry before installation.

B. Cleaning Reinforcement and All Thread Rods

1. Solvent clean reinforcing bar and all thread rods over the embedment length in accordance with SSPC SP-1 Solvent Cleaning. Provide an oil and grease free surface to promote bonding of adhesive to steel. Clean reinforcing bars and all thread rods over embedment length to bare metal. The reinforcing bars and all thread rods shall be free oil, grease, paint, dirt, mill scale, rust or other coatings that will reduce the bond.

C. Filling Hole with Epoxy

1. Fill hole with epoxy before inserting the reinforcing bar or all-thread rod. Fill hole with epoxy starting from bottom of hole. Fill hole without creating air voids. Fill hole with sufficient epoxy so that excess epoxy is extruded out of the hole when the reinforcing bar or all thread rod is inserted into the hole. Prior to installing epoxy, installer shall be trained by manufactures representative.

END OF SECTION

SECTION 03 10 00

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SCOPE

- A. This section specifies the work necessary to furnish, place, and remove all formwork for cast-in-place concrete.

1.02 QUALITY ASSURANCE

A. References

1. The publications referred to hereinafter form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of the referenced publications in effect at the time of bid shall govern. In case of conflict between the requirements of this section and the listed standards, the requirements of this section shall prevail.
2. American Concrete Institute (ACI) publications:
 - a. ACI-347 - Recommended Practice for Concrete Formwork
3. International Conference of Building Officials (ICBO) Publications:
 - a. 2018 IBC - International Building Code, 2013 Edition
4. U.S. Project Standard (PS) Publications:
 - a. PS-1 - Product Standard for Construction and Industrial Plywood

B. Regulatory Requirements

1. Except as modified by the requirements specified herein and/or the details on the plans, concrete formwork shall conform to the International Building Code (IBC), Chapter 19, "Concrete", Referenced Edition, and the American Concrete Institute – 347 (ACI-347), Recommended Practice for Concrete Formwork.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 Submittal Procedures. The Contractor shall submit mill affidavits stating the grade and physical properties of form materials before the materials are delivered to the site. The affidavits shall demonstrate that the materials and procedures comply with the specifications of this section.
1. Information on proposed forming system:
 - a. Submit in such detail as the Engineer may require to ensure that the intent of the Specifications herein can be complied with for the proposed concrete forms.
 - b. Alternate combinations of plywood thickness and stud spacing may be submitted.
 2. Form release agent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Forms for Exposed Finish Concrete

1. Unless otherwise indicated, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on plans. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.
2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark. Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover the entire area.
3. Studs and wales shall be a minimum 2-inch by 4-inch lumber and contain no loose knots and be free of warps, cups, and bows.

B. Forms for Unexposed Finish Concrete

1. Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal, or other acceptable material as determined by the Construction Representative. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Form Ties

1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent deflection, and to prevent spalling concrete surfaces upon removal.
2. Provide ties so that portion remaining within concrete after removal of exterior parts is at least 1-1/2 inch from the outer concrete surface. Provide form ties which will leave a hole not larger than 1 in. diameter in the concrete surface. Provide neoprene waterseal washer that is located near the center of the concrete. Correctly size the neoprene plugs for taper tie holes, such that after they are driven, plugs are to be located in the center third of the wall thickness.

D. Incidentals

1. External angles:
 - a. Where not otherwise indicated on the Drawings, provide 3/4-inch bevel, formed by true dimensioned wood or solid plastic chamfer strip on walkways, slabs walls beams, columns, and openings.
 - b. At expansion joints, provide 1/4-inch bevel formed by true dimensioned wood or solid plastic chamfer strip.

E. Form Release Agent

1. Provide commercial formulation formcoating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

PART 3 EXECUTION

3.01 INSTALLATION OF FORMS

A. General

1. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position.
2. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
3. Construct forms in compliance with ACI 347, to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.
4. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
5. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
6. Chamfer all exposed corners and edges with 3/4 inch chamfers unless otherwise noted on the plans, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints. Fillets are not required unless otherwise noted on the drawings.

B. Exposed Surface Form Tolerances

1. Forms for exposed concrete surfaces shall be designed and constructed so that the formed surface of the concrete does not undulate excessively in any direction between studs, joists, form stiffeners, form fasteners, or wales. Undulations exceeding either 3/32 in. or 1/270 of the center to center distance between studs, joists, form stiffeners, form fasteners or wales will be considered to be excessive. Should any form or forming system, even though previously approved for use, produce a concrete surface with excessive undulations, its use shall be discontinued until modifications satisfactory to the Construction Representative have been made. Portions of concrete structures with surface undulations in excess of the limits herein may be rejected by the Construction Representative.

C. Form Ties

1. Install factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed and spaced to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

D. Provisions for Other Trades

1. Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

E. Cleaning and Tightening

1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing after concrete placement if required to eliminate mortar leaks and maintain proper alignment.

3.02 PREPARATION OF FORM SURFACES

1. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.
2. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
3. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.03 REMOVAL OF FORMS

- A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 100°F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 14 days and until the concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.
- D. Removal of form ties from surfaces, fill holes as follows:
 1. Remove form ties from surfaces.
 2. Roughen cone shaped tie holes by sandblasting before repair.
 3. Dry pack cone shaped tie holes with dry-pack mortar. Mix proportions for dry pack mortar to be by weight of 1 part Portland cement to two parts of concrete sand. Use only enough water so that resulting mortar will crumble to the touch after being formed into a ball by hand.

3.04 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE, REINFORCEMENT, AND GROUT

PART 1 GENERAL

1.01 SCOPE

- A. This Section specifies cast-in-place concrete and reinforcement for footings, slabs, floors, walls, channels, pavements, sidewalks, curbs, pipe bedding encasement, electrical conduit encasement, and miscellaneous structures.

1.02 QUALITY ASSURANCE

A. Quality Control by Contractor

1. All concrete testing will be done in accordance with the General Conditions to demonstrate conformance with the specified requirements for cast-in-place concrete. The Contractor shall provide the services of Owner and Engineer approved independent testing laboratory shall comply with the requirements of ASTM E329. Costs of testing laboratory services shall be borne by Owner.

B. Basis for Quality

1. Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified. Unless specified otherwise, all formwork shall conform to ACI 347.

C. References

1. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ACI 211.1	Recommended Practice for Selecting Proportions for Normal and Heavy Weight Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 347	Concrete Formwork
ACI 350	Code Requirements for Structural Concrete and Commentary
ASTM A185	Steel Welded Wire, Fabric, Plain for Concrete Reinforcement
ASTM A615/A615M	Deformed and Plain Billet Steel Bars for Concrete Reinforcement
ASTM C31	Standard Method of Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Standard Test for Compressive Strength of Cylindrical Concrete Specimens

ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Ready Mixed Concrete
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Standard Test for Slump of Portland Cement Concrete
ASTM C150	Portland Cement
ASTM C172	Sampling Fresh Concrete
ASTM C260	Air Entraining Admixtures for Concrete
ASTM C309	Liquid Membrane Forming Compounds for Curing Concrete
ASTM C494	Chemical Admixtures for Concrete
ASTM D75	Standard Practice for Sampling Aggregates
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
CRSI PRB	Placing Reinforcing Bars
CRSI MSP 1	Manual of Standard Practice

1.03 SUBMITTALS

A. Mix Design: Reports of concrete mix designs shall be provided in accordance with Section 01 33 00. Requirements for the reports are specified in paragraph 03 30 00 2.02 D.

1. Full details, including mix design calculations for concrete mixes proposed for each class of concrete used.
2. Include information on correction of batching for varying moisture content of fine aggregates.
3. Include calculations for required compressive strength f'_{cr} , based on past test records from same source.
4. Compressive strength test results f'_c , for trial batch or from prior performance of the proposed mix design.

B. Manufacturer's Data: Copies of manufacturer's data shall be provided for the following:

1. Curing compounds
2. Bonding compounds
3. Admixtures
 - a. Admixtures shall conform to ASTM C494, be of a type that increases workability and reduces water demand of concrete but will not increase shrinkage. Admixtures shall be subject to approval as to type and amount used. Admixtures shall contain no more than 1% chloride ions.

C. Test Reports: Three copies of reports from the concrete supplier shall be provided certifying that all concrete materials comply with the specifications and all test requirements. Concrete aggregate tests shall not be more than 90 days old.

1. Coarse aggregate:
 - a. Abrasion loss.

- b. Clay lumps and friable particles.
 - c. Coal and lignite.
 - d. Materials finer than 200 sieve.
 - e. Reactivity.
 - f. Shale and chert.
 - g. Soundness.
- 2. Fine aggregate:
 - a. Clay lumps.
 - b. Color.
 - c. Decantation.
 - d. Reactivity.
 - e. Shale and chert.
 - f. Soundness.
- D. Ready mixed Concrete Truck Delivery Tickets: Each load of ready mixed concrete delivered to the job site shall be accompanied by a delivery ticket showing the information listed in ASTM C94, Section 16.
- E. Fly ash and slag Certificate of Compliance: Identify source of material and certify compliance.
- F. For conditions that promote rapid drying of freshly placed concrete such low humidity, high temperature, and wind: Corrective measures for use prior to placing concrete.
- G. Placing Drawings: The Contractor shall prepare reinforcement placing drawings conforming to the requirements of ACI 315. Placing drawings shall include bar lists, schedules, bending details, placing details, and placing plans and elevations as required to fully delineate this portion of the work.
- H. Certified Mill Test Reports: The Contractor shall submit certified mill test reports for the reinforcement supplied.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement: Cement shall be Portland Cement, ASTM C150, Type I-II LA, unless otherwise indicated on the Drawings.
 - 1. The cement shall not contain more than 0.60% by weight of alkalis, calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O when determined by either direct intensity flame photometry or by the atomic absorption method. The instrument and procedure used shall be qualified as to precision and accuracy in accordance with the requirements of ASTM C114.
 - 2. The autoclave expansion shall not exceed 0.100%.
 - 3. Mortar, containing the portland cement to be used and Ottawa sand, shall not expand in water more than 0.010% and shall not contract in air more than 0.048%.

4. All cement used in the manufacture of cast-in-place concrete for exposed surfaces of like elements of a structure shall be from the same cement mill.
5. Cement shall be protected from exposure to moisture until used. Sacked cement shall be piled to permit access for tally, inspection, and identification of each shipment.

B. Aggregates

1. General: Fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates shall be tested in accordance with ASTM C136. Aggregates shall be non-reactive and shall be washed before use. In lieu of the use of ASTM C227 to determine alkali reactivity of the aggregates as specified therein, the alkali reactivity shall be "innocuous" as determined by ASTM C289. When sources of aggregates are changed, test reports shall be provided for the new material. The tests specified shall be performed prior to commencing concrete work.
2. Fine Aggregate: Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33. Fine aggregate shall be washed clean, shall be uniformly screen graded, and shall contain not more than 2% by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth, loam, mica or similar materials. Fine aggregate shall be graded uniformly from fine to coarse.
3. Coarse Aggregate: Coarse aggregate shall be hard, dense and durable crushed rock free from injurious amounts of soft and friable particles, alkali, organic matter and other deleterious substances. Gradation of each coarse aggregate size specified in paragraph 03 30 00-2.02 B shall conform to ASTM C33-Table 2. Screened aggregate is unacceptable.

C. Pozzolan

1. Pozzolan shall be Class F fly ash in accordance with ASTM C618, Class F or C, may be used in concrete made with Type II portland cement.

D. Admixtures

1. General: Admixtures shall be compatible with the concrete. Calcium chloride or admixtures containing calcium chloride are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the concrete mix grout.
2. Water-reducing Admixtures: Water-reducing admixtures shall be ASTM C494, Type A or D, and shall be Master Builders, Pozzolith or Polyheed; or equal.
3. Air Entraining Agent: Air entraining agent shall be Master Builders, MB AE10; or equal. The air entraining agent added shall produce, in accordance with ASTM C260, an entrained air content specified in paragraph 03 30 00-2.02 B for each class of concrete.

E. Water: Water for washing aggregate, for mixing and for curing shall be potable and free from oil and deleterious amounts of acids, alkalis, and organic materials.

F. Color Pigment (when required): Pigment for colored concrete by Davis Colors or engineer approved equal. Maximum 2.5 pounds per yard required. Color to be selected by architect during submittal process.

2.02 CONCRETE CHARACTERISTICS

- A. Mix Proportioning: Concrete shall be normal weight concrete composed of specified cement, admixtures, aggregates and water proportioned and mixed to produce a workable, strong, dense, and impermeable concrete.
- B. Concrete shall be provided in accordance with the following:

Concrete class	ASTM coarse aggregate size	Min. cement content, sacks/cu yd concrete	Pozzolan, Percent by weight of cement	Maximum water/cement ratio by weight	Air content percent	Slump in inches	Minimum ^a 28-day compressive strength, psi
A	67	6.0	18-20	0.40 - 0.45	5±1	2-4	4,500
B ^b	467	3.25	None	0.65	4±1	4-6	3,000

Notes for table:

^a Compressive strength shall be determined at the end of 28 days based on test cylinders made and tested in accordance with ASTM D39.

^b Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.

- C. Use: Concrete shall be provided by class for the corresponding use listed as follows:

Type of Use	Class of Concrete
Structural Concrete	A
Pipe bedding and encasement, electrical conduit encasement (duct banks) and concrete fill placed outside of the building footprint.	B

- D. Control. Before beginning concrete work, the Contractor shall determine the proper proportions of materials for class of concrete A and B. Methods for selecting and adjusting proportions of the ingredients shall be in accordance with ACI 211.1. Reports from the concrete supplier of each mix design shall state whether the items reported comply with the specifications and shall show (1) the expected strength, (2) corresponding slump, (3) weights and test results of the ingredients, and (4) other physical properties necessary to check each mix design. Copies of the reports shall be submitted in accordance with paragraph 03 30 00 1.03.

2.03 CURING AND SEALING COMPOUNDS

- A. Curing and sealing compound shall be Master Builders, Masterseal; A. C. Horn Inc., Horn Clearseal EM180; Burke Company Spartan-Cote WB Cure Seal Hardner; or equal; conforming to ASTM C309. Curing compounds shall be clear and shall be applied in accordance with the manufacturer's instructions, except as otherwise specified.

2.04 BAR REINFORCEMENT

- A. Reinforcing bars shall be deformed billet steel in conformance with ASTM A615, including supplementary requirements. Bars shall be Grade 60, except ties or field-bent bars where specified shall be Grade 40. Bars to be welded shall be Grade 40 or shall be deformed billet steel conforming to ASTM A706. ASTM A616 or ASTM A617 steel shall not be used. Bars provided as dowels for future construction and bars where specified shall be epoxy-coated in conformance with ASTM A775.

2.05 WIRE FABRIC

- A. Wire fabric shall be welded steel mesh conforming to ASTM A185.

2.06 WIRE AND PLAIN BARS

- A. Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A82.

2.07 TIE WIRE

- A. The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ W 461H.

2.08 BAR SUPPORTS

- A. Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI MSP-1 and placed in accordance with CRSI PRB. Concrete block supports shall be provided for footing and slabs on grade. Stainless steel or plastic protected plain steel supports shall be provided for other work.

2.09 DRYPACK GROUT

- A. Drypack grout shall be a mixture of approximately one part cement, 1-1/2 to 2 parts sand, water reducing admixture, and sufficient water to make a stiff workable mix.

2.10 NON-SHRINK GROUT

- A. Non-shrink grout shall have non-metallic aggregate. Acceptable products are SikagROUT 212, by Sika Corporation, Five Star grout; or equal.

2.11 EPOXY GROUT FOR CRACK REPAIR AND DOWEL ANCHORAGE

- A. Except as noted below, epoxy grout shall be a high modulus, two-component, moisture insensitive, 100 percent solids, thermosetting modified polyamide epoxy compound. The consistency shall be a paste form capable of not sagging in horizontal or overhead anchoring configurations. Material shall conform to ASTM C881 Type 1, Grade 3, such as Adhesive Engineering Concrete 1440 series, Sika Corporation Sikadur Hi-Mod Series, Adhesive Technology Corporation Solidbond 200 or equal, and shall have a heat deflection temperature in excess of 130 degrees F.
- B. Epoxy for pressure grouting/crack injection shall be a two component, moisture insensitive, high modulus, injection grade, 100 percent solids, blend of epoxy-resin compounds. The consistency shall be as required to achieve complete penetration in hairline cracks and larger. Material shall conform to ASTM C881 Type 1 Grade 1, such as Sika Corporation Sikadur 52, Adhesive Engineering Company SCB products, Adhesive Technology Corporation SLV 300 series, or equal.

2.12 POLYMER CONCRETE (FOR RESURFACING OR PATCHING)

- A. Polymer concrete (for resurfacing or patching) shall consist of a liquid binder and dry aggregate mixed together to make a mortar or grout of a consistency as required for the application. The liquid binder shall be a chemical and oil resistant, stress relieved, low modulus, moisture insensitive, two-component epoxy-resin compound. The consistency shall be similar to lightweight oil for proper mixing with aggregate. Material shall conform to ASTM C881 Type 3 Grade 1, such as Sika Corporation Sikadur Lo-Mod series, Adhesive Engineering Concrete 1470, Adhesive Technology Corporation 400 series, or equal.

2.13 WATERSTOPS

- A. Hydrophilic waterstops shall be Adeka Ultra Seal, by Asahi Denka Kogyo K.K.; Hydrotite CJ-1020-2K by Greenstreak; or approved equal.
- B. PVC Waterstops
 - 1. PVC waterstops shall be manufactured from virgin polyvinyl chloride (PVC) conforming to the CRD-C572.
 - 2. PVC waterstops in construction joints shall be Greenstreak Type 679, or equal. Waterstops in expansion joints shall be Greenstreak Type 732, or equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Construction of cast-in-place concrete shall be in accordance with the pertinent recommendations contained in ACI Manual of Concrete Practice of 300 Group.

3.02 FABRICATION OF REINFORCING

- A. Reinforcing steel shall not be bent or straightened in a manner which will injure the material. Bars with kinks or with bends not shown shall not be used. Heating or welding bars shall only be permitted where specified or approved by the Engineer. Bars shall not be welded at the bend.

3.03 PLACEMENT OF REINFORCING

- A. Reinforcing steel shall be placed in accordance with CRSI PRB and CRSI MSP-1.
- B. Reinforcing steel shall be positioned accurately and secured against displacement by using annealed iron wire at intersections and shall be supported by concrete or metal chairs, spacers or metal hangers. Tack welding of cross bars is not acceptable. Bars shown on the drawings shall not be repositioned (buried) to act as support bars. Additional bars shall be provided as required for supports. Steel rods and pegs may be used to support reinforcing steel on rock foundations. Reinforcing steel shall be placed in such a manner as to not damage waterproofing membrane or plastic lining which has been previously applied or constructed. Reinforcing steel shall be shop-bent or slightly relocated where necessary to clear waterstop. Reinforcing steel shall not be placed on fresh concrete or forced into fresh concrete.
- C. Supports for embedded items shall not be welded to the reinforcement. Additional reinforcement may be provided for this purpose.
- D. Electrical conduit shall be centered vertically in the slab with a minimum of 2 inches clear all around. Chairs or bolsters shall be provided for this purpose. Conduit shall not be tied directly to reinforcement.

3.04 SPLICING REINFORCING

- A. Reinforcing steel shall be spliced as shown. Additional splices may be provided where approved by the Engineer.
- B. In slabs, beams, girders and walls, reinforcing steel shall not be spliced in areas of maximum stress. Splices of adjacent bars shall be staggered at least one splice length, unless otherwise specified. Splices in welded wire fabric shall be at least 1 1/2 meshes wide.

3.05 CLEANING REINFORCING

1. Reinforcing steel shall be cleaned of mill rust scale, dried concrete, or other coatings that may reduce bond. Reinforcement reduced in section is not acceptable. When concrete placement is delayed, reinforcement shall be cleaned by sandblasting if directed by the Engineer.

3.06 CONCRETE

- A. Concrete shall be truck-mixed, ready-mixed concrete conforming to the applicable portions of ASTM C94. Materials shall be proportioned by weighing. The Contractor shall be responsible for producing concrete of the specified characteristics.
- B. Concrete shall be delivered to the site of work, and discharge shall be completed within 1 1/2 hours after introduction of the water to the mixture.

3.07 CONVEYING AND PLACING CONCRETE

- A. Conveying Concrete: Concrete shall be conveyed from the mixer to the forms in accordance with ACI 301, Chapter 8. Concrete which has segregated in conveying shall be removed from the site of the work.
- B. Placing Concrete: Concrete shall be placed in accordance with ACI 301, Chapter 8, and ACI 304, Chapter 6. Pumped concrete shall be the class and consistency specified in paragraph 03 30 00 2.02.
 1. Placing Concrete in Hot Weather: In hot weather (above 85 degrees F), concrete shall be placed in accordance with ACI 305R.
 2. Placing Concrete in Cold Weather: In cold weather (below 45 degrees F), concrete shall be placed in accordance with ACI 306R.

3.08 CONCRETE FORMWORK

- A. Formwork shall be installed in accordance with ACI 347.

3.09 CURING AND SEALING

- A. General: Concrete curing shall be completed by water curing or by using a clear membrane-curing compound or by a combination of both methods. Repairs or treatment of concrete surfaces shall be coordinated so that interruption of the curing will not be necessary.
- B. Concrete surface temperature shall be maintained between 50 degrees F and 80 degrees F for at least 5 days. Curing concrete in hot weather (above 85 degrees F) shall be in accordance with ACI 305 R. Curing concrete in cold weather (below 45 degrees F) shall be in accordance with ACI 306 F.
- C. Water Curing: When water curing is used, concrete shall be kept wet continuously for a minimum of 10 days after placement. Absorptive mats or fabric may be used to retain moisture during the curing period.
- D. Curing Compound: When curing compound is used, it shall be applied as soon as the concrete has set sufficiently so as not to be marred by the application or immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, quantities used, application procedures, and installation precautions shall be followed in strict compliance with the manufacturer's instructions.

- E. Curing compound shall not be used on concrete surfaces to be coated, waterproofed, or moisture-proofed.

3.10 PROTECTION

- A. Concrete shall be protected from injurious action by sun, rain, flowing water, frost and mechanical injury.

3.11 CONSTRUCTION JOINTS

- A. Construction joint locations shall be coordinated with the Engineer and formed as specified. Wall construction joints shall coincide with stucco joints shown on plan elevations. A rough surface of exposed concrete aggregates shall be produced using a surface retardant at construction joints. The limit of the treated surfaces shall be 1 inch away from the joint edges. Within 24 hours after placing, retarded surface mortar shall be removed either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregates. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting. Sandblasting, if used, shall remove 1/8 inch of laitance film and shall expose coarse aggregate to insure adequate bond.
- B. Reinforcing steel and welded wire fabric shall be continued across construction joints. Waterstops shall be provided in construction joints at locations as specified.

3.12 EXPANSION JOINTS

- A. Expansion joints shall be as specified. Reinforcement or other embedded metal items bonded to the concrete shall not extend through expansion joints. Waterstops shall be provided in expansion joints as specified in paragraph 03 30 00 2.14.

3.13 INSERTS AND EMBEDMENTS

- A. Inserts: Where pipes, castings or conduits are to pass through structures, the Contractor shall place such pipes or castings in the forms before placing the concrete, or he may provide openings in the concrete for subsequent insertion of such pipes, castings or conduits. Such openings shall be provided with waterstops and construction joint as shown and shall have a slight flare to facilitate grouting and permit the escape of entrained air during grouting.
- B. Additional reinforcement shall be provided around large openings as shown. The grout shall be drypack grout as specified in paragraph 03 30 00-2.10.
- C. Embedments: Gate frames, gate thimbles, special castings, channels or other miscellaneous metal parts that are to be embedded in the concrete shall be set and secured in the forms prior to concrete placement. Unless otherwise specified, anchor bolts and inserts shall be embedded in concrete as shown. The Contractor shall provide inserts, anchors or other bolts necessary for the attachment of piping, valves, metal parts and equipment. Operators or sleeves for gate or valve stems shall be positioned to clear reinforcing steel, conduit and other embedments, and to align accurately with equipment.

3.14 MODIFICATION OF EXISTING CONCRETE

- A. Existing concrete shall be removed and the remaining surfaces resurfaced as specified. The remaining concrete shall be protected from damage. Clean lines shall be made by sawing through the existing concrete. The concrete may be broken out after initial saw cuts in the event thickness prevents cutting through. Where it is not possible to use a saw, the initial cuts shall be made with chipping hammers. These cuts shall be sufficient to prevent damage to the remaining

concrete. In general, an opening in existing concrete shall be oversized 1 inch on all sides and built back to the correct dimension with an epoxy grout. Where oversized openings cannot be made, the concrete shall be cut to the correct dimension, with the exposed reinforcing cut back an additional 1-inch and the resulting hole filled with epoxy grout. Cut or broken concrete surfaces shall be resurfaced with an epoxy grout. Concrete surfaces to be coated shall be dry. Where new concrete adjoins existing concrete surfaces or surfaces which have been cut, such surfaces shall be cleaned by sandblasting to remove laitance, loose coatings and foreign materials, and coated with the bonding compound just prior to the placement of the new concrete. Bonding compounds shall be as specified in paragraph 03 30 00 2.03. Unless otherwise specified, continuity of reinforcing steel shall be obtained across the joint either by exposing existing bars to provide sufficient laps with new bars or by welding existing bars with new bars. Dowels shall be drilled and set with epoxy grout into existing concrete.

3.15 FORMED SURFACE FINISHES

- A. Repair of Surface Defects: Surface defects, including tie holes, minor honeycombing or otherwise defective concrete shall be repaired in accordance with ACI 301, Chapter 9. Areas to be patched shall be cleaned. Patches on exposed surfaces shall be finished to match the adjoining surfaces after they have set. Patches shall be cured as specified for the concrete. All surface protrusions shall be removed from exterior wall surfaces that are to be insulated with expandable foam insulation.
- B. Finishing
 - 1. Finish A: Finish A shall be a grout clean finish in accordance with ACI 301, Section 10.3.2. Surfaces shall be lightly sandblasted prior to sacking. For interior areas not exposed to moisture or weather, water used in the mortar shall be mixed with a PVA bonding compound as recommended by the manufacturer. Unless otherwise specified, Finish A shall be provided for all surfaces exposed to view, both painted and unpainted.
 - 2. Finish B: Finish B shall be the same as Finish A, except that the final burlap rubbing may be omitted, providing the steel trowel scraping removes the loose buildup from the surface. Finish B shall be provided for waterproof and moisture-proof coated surfaces.
 - 3. Finish C: Finish C shall be a finish which has surface imperfections less than 3/8 inch in any dimension. Surface imperfections greater than 3/8 inch shall be repaired or removed and the affected areas neatly patched. Finish C or smoother shall be provided for interior surfaces of tanks and channels from 1 foot below minimum water surfaces and down and otherwise unfinished interior surfaces.
 - 4. Finish D: Unless otherwise specified, Finish D shall be the finish for surfaces not exposed to view in the finish work or by other construction, which may be left as they come from the forms, except that tie holes shall be plugged and defects greater than 1/2 inch in any dimension shall be repaired.

3.16 SLAB FINISHES

- A. General: Where finish is not specified, floor slabs shall receive steel troweling. Dry cement shall not be used on new concrete surfaces to absorb excess moisture. Edges shall be rounded to a radius of 1/2 inch. Joints shall be grooved to a radius and depth of 1/4 inch each.
- B. Float Finish: Float finish shall conform to ACI 301, Section 11.7.2. Floating shall be performed with a hand or power driven float. Floating of any one area shall be the minimum necessary to produce the finish specified. Floating shall compact and smooth the surface and close any cracks and checking of surfaces. Float finish shall be applied to surfaces of channel and tank bottom slabs and to footings.

- C. Steel Trowel Finish: Steel trowel finish shall conform to ACI 301, Section 11.7.3. Immediately after final troweling, the surface shall be cured and protected as specified in paragraphs 03 30 00 3.09. Steel trowel finish shall be provided on floors unless specified otherwise.
- D. Broomed Finish: Broomed finish shall conform to ACI 301, Section 11.7.4. Broomed finish shall be provided for walks, tops of walls, slabs on grade exposed to atmosphere, and where otherwise specified.

3.17 FIELD SAMPLING AND TESTING OF CONCRETE

- A. General: Field sampling and testing shall be performed by the independent testing laboratory specified in paragraph 03 30 00-1.02A. Samples of concrete shall be taken at random locations and at such times to represent the quality of the materials and work throughout the project. The laboratory shall provide the necessary labor, materials and facilities for sampling, casting, handling and storing the concrete samples at the site of work. The minimum number of samples and tests are specified in paragraph 03 30 00 3.17C.
- B. Sampling: Concrete shall be sampled as follows and tested in accordance with paragraph 03 30 00 3.17 C. Samples of plastic concrete shall be obtained in accordance with ASTM C172. Samples for pumped concrete shall be taken at the hose discharge point. Samples for other concrete shall be taken at the hopper of transit mix truck.
- C. Testing
 - 1. Strength Tests: The strengths specified for the design mix shall be verified by the testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site.
 - 2. Standard cylinders shall represent the concrete placed in the forms. One set of three standard cylinders shall be cast for each 50 cubic yards, or fraction thereof, for concrete placed in structures, building slabs and footings, but at least three cylinders shall be taken from any one batch. Casting, handling and curing of cylinders shall be in accordance with ASTM C31. Additional cylinders shall be provided when an error in batching is suspected. For the first 24 hours after casting, the cylinders shall be kept moist in a storage box constructed and located so that its interior air temperature will be between 60 and 80 degrees F. At the end of 24 hours, the cylinders shall be transported to the testing laboratory.
 - 3. Testing of specimens for compressive strength shall be in accordance with ASTM C39. Tests shall be made at 7 and 28 days from time of casting. One test cylinder from each group of three shall be tested at the end of 7 days, and two shall be tested at the end of 28 days. Each strength test result shall be the average of the strengths of two test cylinders at 28 days, except that if one cylinder in a set of two shows evidence of low strength due to improper sampling, casting, handling or curing, the result of the remaining one cylinder shall be used.
 - 4. The average of any three consecutive 28 day strength test results of the cylinders representing each class of concrete shall be equal to or greater than the specified strength and not more than 10 percent of the strength test results shall have values less than the specified 28 day strength for the total job concrete. No individual strength test results shall be less than the specified strength by more than 500 pounds per square inch.
 - 5. Certified reports of the test results shall be provided directly to the Engineer. Test reports shall include sufficient information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump and ambient temperature shall be noted.

6. If the 28 day test results fall below the specified compressive strength for the class of concrete required for any portion of the work, adjustment in the proportions, water content, or both, shall be made as necessary at the Contractor's expense. Changes and adjustments shall be reported in writing to the Engineer.
 7. If compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C42 and any other analyses or load tests acceptable to the Engineer. Costs of such tests shall be borne by the Contractor.
- D. Tests for Consistency of Concrete: The slump shall be as specified when measured in accordance with ASTM C143. Samples for slump determination shall be taken from the concrete during placing. Slump tests shall be performed whenever standard cylinders are cast.
- E. Final Laboratory Report: A final report, prepared by the testing laboratory, shall be provided at the completion of all concreting. This report shall summarize the findings concerning concrete used in the project and provide totals of concrete used by class and structure.

3.18 WATERTIGHTNESS, TESTING AND REPAIR:

- A. Concrete tanks and channels which have walls or slabs that are subjected to hydrostatic pressure, shall be tested for watertightness. The tests shall be made prior to application of waterproofing coating. Testing shall consist of filling the tank with water to the maximum operating water surface for at least 24 hours. Wet spots, leakage, or seepage revealed by the test, including those caused by shrinkage of concrete, honeycombed areas, construction joints, or other sources shall be repaired by either or both of the following methods:
1. Grouting of the joint by drilling grout holes to the affected crack or honeycombed area, installing injection ports and forcing expansive urethane grout into the joint under pressure.
 2. Cutting of a bevel groove on the water side of the joint. The groove shall be 1/2 to 3/4 inch in width and depth and shall be caulked with joint sealer in accordance with manufacturer's instructions.

3.19 CLEAN-UP

- A. Upon completion of the work and prior to final inspection, the Contractor shall clean all concrete surfaces, except outside sidewalks or paved areas and those having curing and sealing compound.

3.20 DEFECTIVE CONCRETE

- A. Any concrete which has spalls, honeycombs, cracks, or soft areas shall be removed and repaired. No repairs shall be made until the defects have been reviewed and method of repair approved by the Engineer.
- B. Remove all defective or damaged concrete, including honeycombed, sand streaked, or fractured material from the area to be repaired. Chip out areas to one inch minimum depth. Edge shall be squared with the surface to eliminate feather edges.
- C. Before placing the repair material obtain Engineer inspection. Clean area free of shipping dust, dried mortar, and all other foreign materials.

- D. Keep surfaces to be repaired continuously wet for at least three hours prior to placing new concrete or mortar. No free water on the surface when the repair material is placed.
- E. Apply a bonding agent to the area to be repaired before placing repair material. Apply the bonding agent per manufacturer's published instructions attached to container.

3.21 UNSATISFACTORY CONCRETE

- A. Any concrete placed which fails to meet or exceed the specified strength requirements as determined from molded cylinders or cores, or to meet the density or surface requirements, or which has been frozen during placing or curing, shall be removed and replaced with satisfactory materials at the Contractor's expense.
- B. Method of determining unsatisfactory concrete: visual appearance characteristic of rain or freeze damage to concrete which is apparent to the Engineer.

END OF SECTION

SECTION 03 35 43

POLISHED CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Polished concrete.

1.02 ACTION SUBMITTALS

1. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Test Reports: Certified test reports, from an Independent Testing Laboratory, showing compliance with specified performance criteria and physical properties as cited in "Performance Requirements"

B. Certificates

1. Product and installer certificates signed by the manufacturer certifying materials meet specified performance characteristics and criteria and physical requirements.
2. Current installation contractor's certificate signed by manufacturer declaring contractor as a certified installer of polishing system, prior to bidding of project.

1.04 CLOSEOUT SUBMITTALS

A. Warranty: Submit warranty documents specified.

B. Maintenance Data: For polished concrete finishing to include in maintenance manuals. Also include the following:

1. Manufacturer's instructions on maintenance renewal of applied treatments.
2. Protocols and product specifications for joint filling, crack repair and/or surface repair.

1.05 QUALITY ASSURANCE

A. Manufacturers Qualifications

1. Manufacturer has a minimum of 5 years' experience in manufacturing components similar to or exceeding requirements of project.
2. Manufacturer must be able to provide technically trained field representative during construction and approving application method.

B. Installer Qualifications

1. Installer experienced in performing work of this section who has specialized in installation work similar to that required for this project.

2. Installer trained and having current certification for RetroPlate Concrete Polishing System.

C. Mock-Ups

1. Mock-up size: 4'x4' floor area at job site, at location as directed under conditions similar to those which will exist during actual placement; divide mock-up area into 4 equal zones, allowing for sequential attempts to determine amount of aggregate exposure, and color (if required) and shine selection.
2. Mock-up will be used to judge workmanship, concrete substrate preparation, operation of equipment, material application, color selection and shine level.
3. Allow 24-hours for inspection of mock-up before proceeding with work.
4. When accepted, mock-up will demonstrate minimum standard of quality required for this project; once mock-up approved by the authorized individual(s), the General Contractor is responsible for protecting the approved mock-up for the duration of the project.
5. Sequence with Other Work: Comply with manufacturer's written recommendations for sequencing construction operations; it is the General Contractor's responsibility to ensure that all other trades are aware of necessary sequencing and protection required prior to, during and after the installation of the polished concrete floor finish.

1.06 DELIVERY, STORAGE & HANDLING

A. Ordering

1. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays

B. Delivery

1. Deliver materials in manufacturer's original packaging with identification labels and seals intact.

C. Storage and Protection

1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
2. Protect Concrete Slab
 - a. Protect from petroleum stains during construction.
 - b. Diaper all hydraulic lifts and power equipment.
 - c. Restrict vehicular parking; drop cloths will be placed under vehicles parked on slab
 - d. No pipe cutting machinery will be used on interior floor slab.
 - e. Steel will not be placed on interior floor slab to avoid rust staining.
 - f. No acids or acidic detergents will come into contact with slab

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install work until ambient temperature and humidity conditions are maintained at levels indicated in reference standards.

1.08 WARRANTY

- A. Project Warranty: Refer to Contract Conditions for project warranty provisions.
- B. Manufacturer's Warranty: Submit for owner's acceptance, manufacturer's standard warranty document executed by authorized company official; manufacturer's warranty is in addition to and does not limit, other rights owner may have under contract documents.

PART 2 PRODUCTS

2.01 GENERAL

- A. Ensure concrete finishing components and materials are from single source, from single manufacturer.

2.02 POLISHED CONCRETE FINISHING PRODUCTS

A. Basis of Design Product

- 1. Curecrete Distribution, Inc. (dba Advanced Floor Products; RetroPlate System) 1203 Spring Creek Place, Springville, UT 84663; (801) 489-5663.

B. Proprietary Products/Systems

- 1. Hardener, Sealer, Densifier: RetroPlate 99 – penetrating, water based, odorless liquid, VOC compliant, environmentally safe chemical, leaves no film on surface
- 2. Concrete Grinding Accelerant, Concrete Clarity Enhancer: KickStart
- 3. Joint Filler: CreteFill Pro 85 (Moisture Insensitive) – semi-rigid, 2-component, self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with a choice of 65, 75 or 85 Shore-A hardness depending on project needs
- 4. Oil Repellent Sealer: RetroPel
- 5. Stain Protector: RetroGuard
- 6. Cleaning Solution: CreteClean Plus / CreteClean Plus-Single Dose
- 7. Topically Applied, Transparent Concrete Dye: RetroPlate Concrete Dye Concentrate; RetroGuard is recommended protection for polished surfaces that receive dye; contact Curecrete for color choices, samples and application instructions.
- 8. Polished Concrete Dye Color: Final dye color will be determined during mock-up review when specified for per project; Note: dye appearance is affected by the color of the concrete mix, along with the light source under which it will be viewed.

2.03 APPEARANCE

- A. Aggregate Appearance Class: Class A – Cement Fines (Commonly called: Cream Finish) 85-95% fines; 5-15% fine aggregate.
- B. Polish: Level 3: High sheen, 800 grit.

PART 3 EXECUTION

3.01 MANUFACTURERS INSTRUCTIONS

- A. Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions, product carton installations and Curecrete's (Advanced Floor Products') Spec-Data sheets.

3.02 EXAMINATION

- A. Site Verification of Conditions
 - 1. Verify that concrete substrate conditions, which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of finishing materials.
 - 2. Verify concrete is cured to 28 days or 3500 psi strength.

3.03 PREPARATION

- A. Ensure surfaces are clean and free of dirt and other foreign matter harmful to performance of concrete finishing materials
- B. Examine surface to determine soundness of concrete for polishing.

3.04 INSTALLATION

- A. Floor Surface Polishing and Treatment
 - 1. Provide densified and polished concrete floor treatment in entirety of slab as indicated by approved drawings; provide consistent finish in all contiguous areas.
 - 2. Perform work prior to installation of fixtures and accessories
 - 3. Deliver a consistent finish in all contiguous areas utilizing KickStart to achieve the approved and designated Concrete Polishing Council's
 - 4. Diamond-polish concrete floor surfaces utilizing KickStart in conjunction with proper grinding equipment as recommended by polishing system representative.
 - a. Comply with manufacturer's recommended polishing grits for each sequence using KickStart to achieve desired finish level; level of shine shall match that of approved mock-up
 - b. Expose aggregate in concrete surface only as determined by approved mock-up
 - c. All concrete surfaces shall be as uniform in appearance as possible.
 - 5. Apply RetroPlate 99 hardener, densifier as follows:
 - a. Apply RetroPlate 99 at 200 ft² per gallon, according to manufacturer's directions.
 - b. Apply RetroGuard or RetroPel according to manufacturer's directions.
 - 1) Remove defects and re-polish defective areas.
 - 2) Finish edges of floor and adjoining materials in a clean and sharp manner.
- B. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match approved mockup.

- C. Control and dispose of waste products produced by grinding and polishing operations.

3.05 FINAL CLEANING

- A. Mechanically scrub treated floors for seven days with soft to medium pads using approved cleaner CreteClean Plus / CreteClean Plus – Single Dose
- B. Upon completion, general contractor must remove surplus and excess materials, rubbish, tools, and equipment
- C. Leave one master case of CreteClean Plus Single Dose (12 oz) and instructions for initial cleanings

3.06 PROTECTION

- A. Protect installed product (polished floors) from damage during construction
- B. Apply polished concrete finish system to cured and prepared slabs.
 - 1. Machine grind floor surfaces to receive polished finishes level and smooth.
 - 2. Neutralize and clean polished floor surfaces.

END OF SECTION

SECTION 04 20 00

UNIT MASONRY

PART 1 GENERAL

1.01 SUMMARY

- A. Provide all labor, materials, and equipment necessary for the completion of masonry work as shown on the Drawings and herein specified.
- B. The work under this section includes liquid polymeric admixture added to the concrete masonry units at the time of manufacture, and to the mortar for wall construction at the time of mixing to accomplish the water repellency in the masonry specified herein.
- C. Build into masonry all bolts, anchors, reinforcing, frames, and accessories required for completion of the Work.
- D. Related Requirements
 - 1. Section 08 11 00 - Hollow Metal Doors and Frames.

1.02 QUALITY ASSURANCE

- A. Comply with Chapter 21 of the 2018 International Building Code.
- B. Special Inspections: The Owner will provide the services of an Engineer approved independent testing laboratory that shall comply with the requirements of Chapter 21 of the International Building Code. Costs of testing, laboratory services and field inspection shall be borne by the Owner.
 - 1. Full Allowable Stress Design:
 - a. Provide prism tests in accordance with 2018 IBC Section 2105 for masonry. Provide a set of 5 prisms made and tested prior to start of construction for each masonry material. During construction provide one set of 3 prisms for each 5,000 square feet of masonry wall. The tested strength of these prisms must equal or exceed 2,000 psi.
 - b. An independent inspector shall be present and inspect the work during preparation of masonry wall prisms, sampling and placing of all hollow block units, placement of reinforcement, and immediately prior to and during all grouting of all masonry on the project.
 - 1) Inspector shall be certain that all grout spaces are clear and ready to receive grout and that all reinforcing is properly placed and held against displacement during grouting operations.
 - 2) Inspector shall observe that all grout is properly consolidated and then reconsolidated after 15 minutes using mechanical vibrators.
 - 3) Inspector shall be certain all head and bed joints are installed full per 3.02, H. of this specification.
 - 2. Upon completion the independent inspector shall submit a final signed report to the Building Department, Architect and Structural Engineer stating whether, to the best of

his/her knowledge, the work was accomplished in conformance with the contract documents.

- C. CMU Manufacturer qualifications: CMU Manufacturer shall be certified by the manufacturer of the integral CMU water repellant admixture, through testing of CMU produced by the CMU Manufacturer using the water repellant manufacturer's standard Spray Bar Test and applicable ASTM test methods.
 - 1. A portion of the specified CMU shall be tested by the manufacturer of the integral CMU water repellant admixture within 48 hours of CMU production for water repellency and compliance with specified performance requirements.
 - 2. Submit evidence and results of testing to the Architect.
- D. Masonry Installer Qualifications: For erection of the work of this section, installer who is trained, experienced in and familiar with the requirements specified. Installer shall have demonstrated experience in installation of work similar to the major components of the work specified herein and have been in business under the same company name for the last 5 years. The installer must currently be a Certified Masonry Contractor by the Rocky Mountain Masonry Institute unless specifically approved in the approved contractors list below.
- E. Coordination of Cleaning Work: The General Contractor shall be responsible to monitor, and log progress of completion, and schedule cleaning of exterior masonry walls in accordance with the requirements specified in 04 20 00 3.03.
 - 1. Cleaning process for completed exterior masonry walls shall occur a minimum of 7 days and a maximum of 14 days after erection of wall.
 - 2. Schedule cleaning operations to coincide within the stated time frame. Include multiple operations at time junctures as required to comply with this requirement.
- F. Masonry Units: Comply with the requirements and criteria of the National Concrete Masonry Association, Brick Institute of America, ASTM C-90, ASTM C216 and ACI 530.1 for masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances.
- G. Water Repellant Concrete Masonry Units and Mortar for Wall Construction: Comply with the performance requirements of the following:
 - 1. Water Permeance of Masonry: ASTM E 514-74. Capable of achieving a Class E rating.
 - 2. Flexural Bond Strength of Masonry: ASTM C1357. No statistically lower masonry flexural bond strength shall occur as a result of adding integral water repellant CMU and mortar admixtures when compared to a control (containing no admixtures) CMU and mortar.
 - 3. Compressive Strength of Masonry Prisms: ASTM C 1314. No statistically lower compressive strength of prisms shall occur as a result of adding integral water repellant CMU and mortar admixtures when compared to a control (containing no admixtures) CMU and mortar.
 - 4. Drying Shrinkage of CMU: ASTM 426. No statistically higher drying shrinkage of CMU shall occur as a result of adding integral water repellant CMU admixtures when compared to a control (containing no admixtures) CMU.
 - 5. Drying Shrinkage of Mortar: ASTM C 1148. No statistically higher drying shrinkage of mortar shall occur as a result of adding integral water repellant mortar admixtures when compared to a control (containing no admixtures) mortar.

- H. Fire Performance Characteristics: Comply with the requirements for materials and installation established by governing authorities for the construction and fire-resistance rating indicated or required by Code. Provide materials and construction identical to those assemblies whose fire endurance has been determined by testing in compliance with ASTM E119 or as acceptable to the authority having jurisdiction.
- I. Efflorescence: Protect masonry construction to prevent efflorescence. Take all necessary measures to eliminate moisture from entering incomplete walls, which have not received parapet copings or water repellents. Remove all efflorescence prior to applying water repellents.
- J. Insulation installer qualifications: Provide letter or certificate from insulation manufacturer showing installer is trained, certified, and an approved installer.
- K. Pre-construction Conference: At least one month prior to starting above-grade masonry work, schedule a preconstruction conference to discuss compliance with the Contract Documents. The participants shall include General Contractor, Masonry Contractor, Masonry Contractor's Cleaning installer, Architect, Project Engineer, Structural Engineer, and Owner's representative. Schedule conference after review and approval of submittals for work of this section, but prior to erection of masonry sample panel.

1.03 SUBMITTALS

- A. Prior to fabrication of masonry units, upon request submit (2) samples of each type of concrete masonry unit to Architect for review. Review is for color and texture only.
- B. Contractor shall submit reinforcement shop drawings and block placement drawings.
- C. Submit product literature for masonry reinforcing, ties, control joints, and all other specified accessories, insulation material, and cleaning material.
- D. Submit certificates stating compliance with specifications for masonry unit grades, types and classes, and Certification Report indicating CMU manufacturer is certified by water repellant CMU admixture manufacturer.
- E. Submit sample warranties for integral CMU water repellant indicating compliance with special warranties required in 04 20 00 1.07.
- F. Submit test reports/certification prepared by a qualified independent laboratory indicating compliance with the specified performance requirements for integral CMU and mortar water repellency as tested using ASTM E 514-74, ASTM E 514-02, ASTM C 1357, ASTM C 1314, ASTM C 1148 and ASTM C 426.
- G. Submit the proposed design mortar mixes for each type of mortar to be used. Submit test reports for mortar materials indicating conformance to these specifications and ASTM C 270. Submit test reports for field sampling and testing mortar in conformance to these specifications and ASTM C 780.
- H. Submit mix designs for grout for masonry reinforcement. Submit test reports for grout materials including conformance to ASTM C 476. Provide test results from an independent testing laboratory certifying conformance to grout strength requirements. Submit test reports for field sampling and testing grout in conformance to ASTM C 1019.
- I. Sample panel: Prior to constructing walls, construct a sample panel demonstrating typical wall construction for review by the Architect. The panel shall be 8'-8" high and 8'-0" wide with one 90° corner and 2'-0" wide return wall, one finished opening and with all types of water repellant CMU

and mortar to be provided to illustrate the mortar color, extremes of masonry color and texture ranges, mortar jointing work, and typical masonry control joint. The panel shall be placed such that the 8'-0" exterior face is oriented to the south. The panel shall be constructed with the specified 12" split face CMU at the base, with the custom 8" to 12" CMU transition unit set at a height of 4'-0", and the specified 8" ground face CMU to the 8'-8" height. The sample panel shall not be a part of the permanent construction. Approved panel shall indicate quality of and shall be the basis for acceptance of permanent masonry construction. Leave sample panel in place until masonry work is complete and accepted by Architect to insure minimum deviation from the sample panel. Perform all construction procedures on the sample panel, including cleaning, application of Water Repellant specified in Section 07 19 00, and sealants specified in Section 07 92 00.

1. Demonstrate ability to keep insulation and grout isolated and in certain cells in any sequence of placement and demonstrate materials will be restricted to cells and bond beams intended to receive each material.
2. Demonstrate construction within required tolerances for wall plumb, joint construction and bond pattern. Demonstrate installation of reinforcing, flashing, all other accessories, and joint finishing.
3. Demonstrate mortar jointing and control joint.
4. Demonstrate embedded flashing system and weep system with through wall flashing as detailed on drawings.
5. Allow 7-14 days after panel erection for mortar to fully cure prior to review by Architect.
6. Clean panel within specified time requirements for Cleaning prior to review by Architect.
7. After Architect's review and acceptance, apply Water Repellant as specified in Section 07 19 00 to establish coverage rates and warranty.
8. Do not commence permanent masonry work until acceptance of the sample panel.

1.04 PROJECT/SITE CONDITIONS

- A. Cold weather preparation: Before beginning work, remove ice or snow formed on top of foundation wall or base construction upon masonry will set. Carefully apply heat until top surface is dry to the touch.
- B. Cold weather construction requirements: Implement cold weather construction procedures when any of the following conditions exist:
 1. The ambient temperature falls below 40° F.
 2. The temperature of masonry units is below 40° F.
 3. Do not lay masonry units having a temperature below 20° F. Remove visible ice on masonry units before unit is laid.
 4. When ambient temperature is between 25° F and 20° F, use heat sources on both sides of the masonry under construction and install wind breaks when wind velocity is in excess of 15 mph.
 5. When ambient temperature is below 20° F, provide an enclosure for the masonry under construction and use heat sources to maintain temperatures above 32° F within the enclosure.
 6. When mean daily temperature is between 40° F and 25° F protect completed masonry from rain or snow by covering with a weather resistive membrane for 24 hrs. after construction.

7. When mean daily temperature is between 25° F and 20° F, completely cover completed masonry with insulating blankets or equal protection for 24 hrs. after construction.
8. When mean daily temperature is below 20° F, maintain masonry temperature above 32° F for 24 hrs. after construction by enclosure with supplementary heat.
9. Remove and replace work which has been frozen or damaged by freezing conditions.
10. Failure to follow cold weather procedures shall be prima facie evidence that masonry has frozen. Such masonry shall be removed and replaced.

C. Cold Weather Mortar and Grouting Requirements

1. Temperature of masonry to be grouted must be greater than 35° F when grout is placed. Place grout in masonry at a minimum temperature of 70° F and a maximum temperature of 120° F. Maintain grouted masonry above 35° for 24 hrs. following placement of grout.
2. Heat sand and mixing water when the air temperature is below 40° F. to provide mortar and grout temperatures between 40° F and 120° F when used.
3. Do not heat sand or water above 120° F.

D. Temperature of masonry to be grouted must be greater than 35° F when grout is placed. Place grout in masonry at a minimum temperature of 70° F and a maximum temperature of 120° F. Maintain grouted masonry above 35° for 24 hrs. following placement of grout.

E. Hot weather construction requirements for all masonry construction: Implement hot weather construction procedures when the ambient air temperature exceeds 95° F, or 90° F with a wind velocity greater than 8 mph. Comply with requirements of Construction Recommendations of TEK 3-1A (1995) of the National Concrete Masonry Association TEK Manual.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Store all masonry units and materials off the ground in a manner to prevent damage, deterioration, contamination, or wetting by rain, snow, or ground water. Reject cement which has become caked, partially set, or otherwise deteriorated, or any material which has become damaged or contaminated. Cover all masonry materials to protect from elements.
- B. Store water repellant admixture in an area where temperature is maintained between 40- 110 degrees. Do not allow admixture to freeze; discard any frozen admixture.

1.06 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranties

1. Integral CMU and mortar water repellant admixture shall be warranted by the admixture manufacturer to be free of defects and to meet manufacturers published physical and chemical properties.
2. CMU Manufacturer shall warrant that integral CMU water repellant admixture has been provided at the appropriate dosage rate in all CMU units transported to the project site for use in exterior wall construction.

3. Masonry Installer shall warrant that only CMU and mortar containing the water repellant admixture has been installed in exterior walls.

1.07 PROTECTION OF WORK

- A. Protect facing material and all adjoining work against staining. Keep tops of walls covered with non-staining waterproof covering when work is not in progress. Extend cover 24" down face of wall, hold cover securely in place. When work is resumed, clean top surface of work of all loose mortar.
- B. Prevent grout or mortar from staining the face of exposed masonry. Protect all sills, ledges, projections, and adjacent materials from damage.
- C. Be responsible for the protection and bracing of the masonry during construction to prevent damage or loss due to wind.
- D. Do not apply loads for at least three days after building masonry columns or walls.

PART 2 PRODUCTS

2.01 MASONRY

- A. Concrete Masonry Units Manufacturers: Provide concrete masonry units as manufactured by Basilite Concrete Products LLC.
- B. Concrete Masonry Units (CMU): Light weight load-bearing units conforming to ASTM C90-95 for hollow units and solid units, Type 1 (Moisture Controlled). Provide 2,000 psi units. Comply in all respects with the block requirements of the National Concrete Masonry Association.
 1. Nominal size: 16" long by 8" high by 8" wide and 16" long by 8" high by 12" wide as indicated on Drawings.
 2. Provide closed cell units at sills of window openings, louvers, etc. where masonry is left exposed.
 3. Provide the following custom shapes or specifically detailed units as indicated on the drawings:
 - a. Custom 16" long by 8" high by 8" wide to 12" wide transition unit as detailed on drawings.
 - b. Custom 4" long by 8" high by 4" wide sloped corner unit for use at exterior corners at transition units.
 - c. 16" long by 8" high by 6" wide units at elevator door opening.
 - d. 16" long by 8" high by 10" wide units at Wet Chemical Lab.
 - e. 16" long by 8" high by 4" wide at pier caps.
- C. Colors
 1. CMU Color "A": Split Face and Ground Face Color 638, as noted on drawings.
 2. CMU Color "B": Split Face and Ground face Color 635 as noted on drawings.
 3. Natural grey color at interior and above ceiling walls as indicated on the drawings.

- D. Integral CMU Water Repellant: Integral liquid polymeric admixture mixed with concrete during production of CMU. Product: RainBloc Water Repellant Masonry Unit Admixture, manufactured by ACM Chemistries, Inc.

2.02 GROUT AND MORTAR MATERIALS

A. Materials

1. Portland Cement: Type I-II, except Type III may be used for cold weather construction. Provide low alkali, Portland cement conforming to ASTM C150 (UBC Standard No. 19-1). Masonry cements or plastic cements are not permitted. Provide white Portland cement meeting same requirements where called for. Do not use fly ash as a partial cement replacement in mortar. Maximum percentage of alkali shall be as specified in Table 1A of ASTM C150 for low alkali cement.
2. Hydrated Lime: Type S, ASTM C 207.
3. Sand: ASTM C 144.
4. Grout Aggregates - ASTM C 404 size 1 for fine aggregate, 3/8" maximum for coarse aggregate.
5. Water: Clean, potable, and free from deleterious quantities of acids, alkalis, and organic materials.
6. Mortar Pigment: Not to exceed 10% of the weight of Portland cement.
7. Admixtures: Use of air entraining admixtures or admixtures containing chloride are not permitted except as specified by the Architect/Engineer and as approved by the Building Official.
 - a. No air entraining admixtures may be used.
 - b. No antifreeze compounds may be added to the mortar.
 - c. No air entraining admixtures may be used.

2.03 MORTAR

- A. For CMU: Provide pre-blended mortar consisting of Type S lime, Portland cement, masonry sand and color mix for on-site mixing with water. "Masons Mix Type N" pre-blended mortar, manufactured by USM Masonry Products Company, 112 S. Santa Fe Drive, Denver, Colorado, 80223.
1. Under controlled conditions in a factory weigh the dry mortar mix materials including cementitious material and color. Completely dry and pre-blend the ingredients of the pre-blended material off the jobsite.
 2. Add only clean, potable water at the jobsite.
 3. Pre-blended Portland cement and lime product is to be a performance-based mix containing Type I-II Portland Cement and Type "S" Lime, with the specified color pigment added as required to achieve color specified by Architect.
 4. Design Criteria: Comply with ASTM C-270, Type N 1,200 min. psi and 1,400 max. psi.
- B. Integral Water Repellant Mortar admixture: Integral liquid polymeric admixture for mortar added during mixing. Product: RainBloc for Mortar Admixture, manufactured by ACM Chemistries, Inc.
- C. Delivery, Storage and Handling

1. Deliver cement/lime mix to the jobsite in waterproof bulk sacks weighing 3,000 pounds, for silo dispensing for on-site mixing.
 2. Store cement/lime mix in accordance with manufacturer's printed instructions to prevent contamination by extraneous chemicals.
 3. Store materials in a clean, dry location protected from dampness and freezing.
 4. Store cementitious ingredients in weather-tight enclosures and protect against contamination and warehouse set.
 5. Stockpile and handle aggregates to prevent contamination from foreign materials.
- D. Mixing: Thoroughly mix in quantities needed for immediate use. Mix materials in a mechanical paddle type mixer for a period of time not less than 5 minutes nor more than 10 minutes with the amount of water required for the desired workability.
1. Use mortar within 2 hours of mixing at temperatures over 80° F. and 2-1/2 hours at temperatures under 50° F.
 2. Control batching procedure to ensure proper proportions of sand added to pre-blended cement/lime product by measuring material by volume.
 3. The consistency of mortar may be adjusted to the satisfaction of the mason by retempering with water. Mortar may be retempered once within 2 ½ hours after initial mixing to compensate for water lost due to initial evaporation. Retempering shall be done by addition of water into a formed basin within the mortar and then working the mortar into the water. Mortar shall not be retempered by splashing water over the surface.
- E. Mortar Color
1. For colored masonry, and synthetic stone: Pure Mineral oxide pigment. Selected by the Architect from the full range of either SGS "A" or SGS "H" Series colors. One color shall be selected from actual material sample box for each masonry product specified, including one at split and ground face CMU Color "A", one at ground face CMU Color "B".
 2. For standard gray concrete masonry units: Standard gray mortar.
- 2.04 GROUT
- A. Delivery, Storage and Handling
1. Deliver and store manufactured products in original, unopened containers.
 2. Store materials in a clean, dry location protected from dampness and freezing.
 3. Store cementitious ingredients in weather-tight enclosures and protect against contamination and warehouse set.
 4. Stockpile and handle aggregates to prevent contamination from foreign materials.
- B. Grout: Conform to ASTM C476-91. Provide grout with a minimum 28-day compressive strength of 2,000 psi.
1. Fine grout proportions: One part Portland cement; not more than 1/10-part hydrated lime; 2-1/4 to 3 parts (by volume) damp loose sand.
 2. Course grout proportions: One part Portland cement; not more than 1/10-part hydrated lime; 2 to 3 parts (by volume) damp loose sand, and 1 to 2 parts (by volume) pea gravel.

3. Proportion water to produce a consistency, which will allow pouring without segregation of components. Provide grout slump of 9 inch plus or minus one inch. Provide cohesive and homogeneous grout.

C. Field Mixing Grout

1. All cementitious materials and aggregate shall be mixed between 3 and 10 minutes in a mechanical mixer with the amount of water to produce a spreadable, workable consistency. Dry mixes for grout, which have been preblended in a factory, shall be mixed at the jobsite until workable, but not to exceed 10 minutes.
2. Control batching procedure to ensure proper proportions by measuring material by volume.
3. The consistency of mortar may be adjusted to the satisfaction of the mason by retempering with water.
4. Discard all grout, which has begun to harden. Also discard grout, which is more than 1-1/2 hours old.

- D. Transit-Mixed Grout: May be used. Continually rotate at idle speed from the time the water is added until the grout is discharged.

2.05 STEEL

- A. Lintels: Conform to ASTM 36, size and bearing as shown on the Drawings.
- B. Reinforcement Bars: Billet steel deformed bars, uncoated finish, ASTM A615, Grade 40, for #3 bar, ties and stirrups, Grade 60 for all other.

2.06 MASONRY CORE INSULATION (FOAMED IN PLACE)

- A. Foamed-in-Place Insulation: Core-Fill 500 Foam Insulation as manufactured by Tailored Chemical Products, Inc. or equivalent. Ph. # 1 (800) 627-1687. Local installer: Colorado Foam Insulation or other manufacturer trained and approved applicator. Ph. # (303) 274- 0497.
- B. An amino-plast foam insulation. Two component thermal insulation produced by combining a plastic resin and catalyst foaming agent surfactant which, when properly rationed and mixed together with compressed air produce a cold -setting foam insulation in the hollow cores of hollow unit masonry walls.
1. Fire-Resistance Ratings: Minimum four (4) hour fire resistance wall rating (ASTM E-119) for 8" and 12" concrete masonry units when used in standard two (2) hour rated CMU's.
 2. Surface Burning Characteristics: Maximum flame spread, smoke developed, and fuel contributed of 15, 75 and 0 respectively.
 3. Combustion Characteristics: Must be noncombustible, Class A building material.

2.07 MASONRY ACCESSORIES

A. Horizontal Reinforcing

1. General: Standard truss or ladder fabricated from 9 gauge cold-drawn steel wire conforming to ASTM A82, with deformed continuous side rods and plain cross-rods. Use prefabricated corners and tee sections at all building corners and intersections. Provide with one longitudinal side rod for each bed joint. Provide overall width approximately 2" less than the thickness of wall. Manufactured by Dur-O-Wal, Inc. or equal.

2. Single wythe walls: Dur-O-Wal 3100 Truss or 3200 Ladur.
 3. Coating: Hot-dipped galvanized per ASCE/ACI 530.1 coating requirements, ASTM A 153, Class B2, 1.50 oz per square foot.
- B. Reinforcing Bar Positioners: D/A 812, 811, or 816 as required, 9-gauge wire with mill galvanized finish, sizes to fit masonry unit as manufactured by Dur-O-Wal, Inc. or equal.
- C. Grout Screen: D/A 1015-1017, Dur-O-Stop. A monofilament screen that prevents grout fall through while maintaining positive bond in mortar joint. Corrosion proof material in width required for cell size, as manufactured by Dur-O-Wal, Inc. or equal.
- D. Control Joint: D/A2001 as manufactured by Dur-O-Wal, Inc., or equal.
- E. Through Wall Flashing: 5-ounce electrolytic copper sheet, uniformly coated on both sides with acid proof, alkali proof, elastic bituminous compound, factory applied, weighing no less than 6 ounces per square foot, H&B C-Coat Flashing by Hohmann & Barnard Inc. or equal by Dur-O-Wal.
- F. Embedded Flashing System: Provide a 2-component system as indicated on the Drawings at all ungrouted cores of split-face concrete masonry units, as manufactured by MortarNet, 541 S. Lake St., Gary, IN 46403, Local representative: Ed Nagel, PROSOCO, tel. 720-490- 5922.
1. Flashing Pan & Weep Spout: High density polyethylene pan with integral concaved weep spouts sized to cover individual cells in concrete masonry units in individual pieces placed horizontally as indicated on the Drawings. Blok-Flash as manufactured by MortarNet.
 - a. Extent: Install embedded Flashing Pan & Weep Spouts at base of wall and at the top of each bond beam and grouted door and window lintels in the following locations:
 - 1) All split-face concrete masonry unit walls.
 - 2) The 12" ground face concrete masonry unit wall on Grid Line 4, from grid line K to the west for the full extent of the wall.
 2. Vertical Mesh Elements: 1/8" thick, 90% open weave anti-microbial polyester mesh as manufactured by MortarNet.
 - a. Size: 7 x 7 inches for installation vertically at the exterior face of ungrouted cells of split face concrete masonry units, as recommended by manufacturer and indicated on drawings.
 - b. Extent: Vertical mesh elements shall be installed at the following locations:
 - 1) All ungrouted cells of all split face concrete masonry units.
 - 2) All ungrouted cells of the 12" ground face concrete masonry unit wall on Grid Line 4, from grid line K to the west for the full extent of the wall.
 - 3) Install mesh from the Flashing Pan & Weep Spout at wall base and bond beams extending up to the next bond beam for the full extent of the wall.
 - 4) At locations where 12" split face masonry transitions to 8" ground face masonry, the mesh shall extend up to the first bond beam in the 8" ground face masonry.
 3. Pea-Stone: Size as required by manufacturer.

- G. Weep System: Provide a 2-component system as indicated on the Drawings, as manufactured by MortarNet, 541 S. Lake St., Gary, IN 46403, Local representative: Ed Nagel, PROSOCO, tel. 720-490-5922.
1. Weep Vents: 2 1/4 x 3 1/2 x 1/2 inch, 90% open weave polyester mesh bonded with a flame retardant adhesive. Mortar Net as manufactured by MortarNet. Color as selected by Architect from manufacturers standard colors.
 2. Embedded Flashing System Drainage Mesh: 1/8" thick, 90% open weave anti- microbial polyester mesh as manufactured by MortarNet, for installation behind Weep Vents as detailed on Drawings. Lap mesh to provide a 3/8" thickness to match mortar head joint thickness.
- H. Corrugated Wall Ties: DA990, 22 gage x 7/8 inch wide x 7 inch long hot dip galvanized steel, as manufactured by Dur-O-Wal, Inc. or equal.
- I. Dovetail Anchors: DA100 and DA720 3/16" wire tie fitted to 12 ga. dovetail anchor, 24 ga. dovetail slot with filler strip; as manufactured by Dur-O-Wal, Inc. or equal.

2.08 CLEANING MATERIALS

- A. ProSoCo "Sure-Klean Custom Masonry Cleaner" as suited to surfaces and conditions and other types as recommended and necessary to clean particular stains or surfaces. Use of muriatic acid is prohibited.

PART 3 EXECUTION

3.01 GENERAL

A. Construction Practices

1. Cover the wall cavity and masonry unit cores when work is not in progress to keep water from entering the wall cavity or cores. Provide sufficient ballast to keep cover in place.
2. Scaffold planks next to the wall should be pulled back to avoid splash on the wall. Tip planks daily to remove excess mortar and dirt.
3. Remove mortar droppings, especially those containing integral water repellent, while wet before they harden. Light brushing when mortar has taken its initial set will help with cleaning. After mortar set wall must be brushed daily. Cleaning procedures specified below are not to be substituted for proper daily construction practices.
4. Remove grout spills immediately by washing and brushing.
5. When floors or adjacent concrete slabs are placed prior to masonry work, place sand on floor next to wall and against the wall to keep mortar from sticking to the wall and concrete.

3.02 ERECTION

A. Built-in Members

1. Ascertain from various trades and coordinate where all chases or opening for vents, pipes, wires, ducts, etc., are to go and construct all such chases as shown or required.
2. Build in all anchors, bolts, flashing, wall plugs, nailing strips, beams, etc., as may be required. Place these materials according to directions of those who furnish them.

3. Coordinate with electrical trades so outlets are centered on or aligned with masonry joints in exposed work.
 4. Fully grout steel door frames set into masonry as wall is being built.
- B. Wetting Masonry
1. Do not wet concrete masonry units.
- C. Bond
1. Lay all masonry in running bond unless otherwise shown on the Drawings.
 2. Lay all masonry so that only finished faces are exposed to view.
- D. Integral Water Repellant CMU: Use only masonry units manufactured containing specified water repellant admixture for exterior wall construction.
- E. Integral Water Repellant Mortar: Use only mortar containing specified integral water repellant admixture at the manufacturer's recommended addition rate and mixed according to the manufacturer's recommended instructions for exterior wall construction.
- F. Joining of Work
1. Where fresh masonry joins masonry that is partially set, clean, and lightly wet the exposed surface of the set masonry so as to obtain the best possible bond with the new work. Remove all loose masonry and mortar.
 2. When it becomes necessary to "stop off" a horizontal run of masonry, rake back in each course and, if grout is used, stop the grout 4 in. back of the rake. Toothing is not permitted for joining new work.
 3. The foundation surface which is to receive masonry shall be clean and damp, and all laitance shall be removed.
 4. Where joining new work to existing or repairing or finishing walls where selective demolition has exposed unfinished masonry or left a void in the masonry, remove existing surrounding masonry and tooth in new masonry to extent required so that all adjacent parallel and perpendicular masonry surfaces have continuous and unbroken, finished masonry appearance.
- G. Joints
1. All joints in masonry shall be slightly concave, almost flush, tooled with an approved jointer, 3/8" nominal thickness, unless indicated otherwise.
 2. Tool joints when they are thumbprint hard to maximize resistance to water penetration and minimize hairline cracks between the mortar and CMU.
 3. Steel jointers may be used except that stainless steel jointers must be used where white or a light colored mortar is used.
 4. The use of a minimum 16" long sled runner is required at horizontal joints.
 5. Fill joints in masonry work and joints between masonry work and other material required in connection therewith, with mortar as each course is laid. All bed and head joints shall be solidly filled with mortar. The thickness of mortar joints shall be uniform and true to dimensions, consistent with masonry unit dimensional tolerances.
 6. Joints that will remain concealed may be struck flush.

H. Laying

1. Lay all masonry units plumb and true to lines with completely filled head and bed joints. Furrowing of bed joints is not permitted. Joints will be randomly tested to ensure full depth joints are provided. Closures shall be rocked into place with the head joint mortar thrown against the two adjacent units in place. All masonry shall be shoved at least 1/2" into place.
2. Prevent grout or mortar from staining the face of masonry to be left exposed. If grout or mortar does contact the face of such masonry, remove immediately. Protect adjacent construction from damage during construction.
3. Keep cavity or air space and face of masonry free of mortar droppings.

I. Tolerances for Construction

1. Variation from the plumb in the lines and surfaces of columns, walls and arises shall not exceed 1/4" in 10', 3/8" in a story height of 20' maximum. Variation from plumb for external corners, expansion joints and other conspicuous lines, shall not exceed 1 1/4" in any story or 20' maximum.
2. Variation from the level of the grades indicated on the Drawings for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines shall not exceed 1/4" in any bay or 20', nor 1/2" in 40' or more.
3. Variation of the linear building line from its established position in plan and related portion of columns, walls and partition shall not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.
4. Variation in cross-sectional dimensions of columns and thickness of walls shall not exceed minus 1/4", nor plus 1/2" from the dimensions indicated on the Drawing.
5. Joints shall be straight, clean, with a uniform thickness of 3/8".

J. Reinforcement

1. General: Refer to Drawings for principal horizontal and vertical reinforcing. All reinforcement shall be continuous.
2. Reinforcement Bars: Accurately position and secure against displacement from the location shown on the Drawings. In splicing vertical reinforcement, or attaching to dowels, the bars shall be placed in contact and wired. Provide a minimum of 36 bar diameter lap splices. Horizontal reinforcement may be placed as the work progresses. Use bar positioners for vertical reinforcing bars. Locate positioners at top of first masonry course, 1 course below the top of the wall and a minimum of 192 bar diameters in between.
3. Horizontal Reinforcement: Installed in the first and second bed joints immediately above lintels and below sills at openings, and in bed joints at 16" vertical intervals elsewhere. Extend joint reinforcement a minimum of 24" past edge of opening except where control joints occur adjacent to openings. All other reinforcement shall be continuous except that it shall not pass through vertical masonry control joints, except where so noted on Drawings. Side rods shall be lapped at least 6" at splices. Reinforcement shall be so placed as to assure a 5/8" mortar cover measured from outside face of mortar joint at faces exposed to exterior and not less than 1/2" elsewhere. Use prefabricated corners at wall intersections and pilasters.

K. Grouting

1. General

- a. Grout spaces less than 2" in width using fine grout. Grout spaces greater than 2" in width using coarse grout.
 - b. Grout lifts shall not exceed 6 times the width of the grout space, with a maximum of 48 inches high. Use low-lift grouting techniques.
2. Placement: Place as indicated on drawings. Where not otherwise indicated, provide 1- #5 vertical each side of each opening with a 2 ft. minimum extension past sill and head, and 1-#5 vertical full height at all unsupported edges and each side of each control and/or expansion joint.
3. Construct with vertical alignment of cells and other spaces to be grouted to provide continuous unobstructed openings.
4. Mortar in bed joints shall be struck flush to faces of masonry unit adjacent to grout spaces. Keep mortar droppings out of grout space.
5. Use a mechanical vibrator when grouting to insure proper consolidation of the grout in cells. Reconsolidate grout after water absorption into masonry units.
6. When the grouting is stopped for one half hour or longer, stop pouring of grout 1-1/2" below the top of the uppermost unit. Where bond beams occur, stop grout pour a minimum of 1/2" below top of masonry.
7. Use grout screen below all thru wall brick bond beams to control flow of grout into insulated cells below.

L. Through Wall Flashing and Weep System

1. Clean surfaces of foundation where flashing will be installed. Install flashing flat and flush to surface.
2. Unless shown otherwise on the Drawings, install flashing below the bottom course of masonry at the top of foundation walls at grade, where metal wall studs occur.
3. Provide flashing in lengths as long as practicable.
4. Lap ends not less than 1-1/2 inches for interlocking type and 6 inches set in a bed of mastic at other locations. Seal all laps as necessary to ensure watertight construction. Provide dams at ends of flashing where masonry abuts concrete and where flashing ends within the masonry.
5. Seal flashing at locations where reinforcing bars penetrate flashing with an elastomeric sealant compatible with flashing.
6. Wherever through-wall flashing occurs, provide weep system as indicated on Drawings to drain the flashing to the exterior. Provide weep system at 32 inches on center maximum.

M. Embedded Flashing System

1. Install Vertical Mesh Elements and Flashing Pan & Weep Spouts in accordance with manufacturers' instructions in locations specified and indicated on the Drawings. Include shallow layer of pea-stone to keep weep channels clear.
2. Provide Flashing System at lintels above openings in exterior walls at 12" concrete masonry units. This includes doors, windows, and openings for mechanical equipment.

N. Control Joints: Install in accordance with the drawings. If not shown on drawings, coordinate location of control joints with Architect.

1. Do not extend joint reinforcement through control joint.

2. Use copper flashing material, preformed neoprene or rubber to provide bond break.
3. Clean and seal joints with backer rod and sealant.

O. Curing

1. At least 3 days shall elapse before applying a concentrated load to walls such as beams, metal joists, trusses or girders.
2. Wall construction may proceed continuously above door, window and other wall opening lintels.

3.03 MASONRY CORE INSULATION

A. General: Install foamed-in-place insulation from interior, or as specified otherwise, prior to installation of interior finish work; comply with manufacturer's instructions.

B. Installation

1. Fill all open cells and voids in exterior hollow concrete masonry walls and where shown otherwise on the drawings.
2. At walls receiving interior wall finishes: Pump the foam through a horizontal row of 5/8" holes drilled into the mortar joints every 8" on center. Repeat this method at vertical intervals between horizontal bond beams as required to fill all ungrouted masonry cells. Patch all holes and retool masonry joint to provide a continuous tooled joint.
3. At exposed CMU walls receiving no interior covering or wall paint finish: Pump the foam into the top of the open cell of the CMU wall at intervals as recommended by the manufacturer. Repeat this method as wall is constructed.
4. Fill all open cells below window sills.

3.04 PARGING

A. Parge predampened masonry walls, where indicated, with Type S or Type N mortar applied in 2 uniform coats to a total thickness of 3/4". Scarify first parge coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8" per foot. Form a wash at top of parging and cove at bottom.

C. Damp-cure parging for at least 24 hours and protect the parging until cured.

3.05 REPAIRING & POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

3.06 FINAL CLEANING

A. General

1. The General Contractor shall monitor the progress of the work and be responsible to initiate the cleaning process at the appropriate time as work progresses.

2. Application of specified cleaner and cleaning process specified herein shall occur a minimum of 7 days and a maximum of 14 days after completion of exterior wall construction.
3. Schedule cleaning operations to ensure compliance to the time frame indicated. Scheduling of one cleaning process at the end of all exterior wall construction is not acceptable unless all installation work is complete and cleaning process is done within the 14-day time frame.
4. Use of acid, sandblasting, and high-pressure cleaning (over 1000 psi) is strictly prohibited, and cause for rejection of masonry work.

B. Preparation

1. Point all holes in exposed masonry and cut out and repoint defective joints.
2. Remove efflorescence using dry brushing and rinsing with water. If this is not effective the appropriate specified cleaner may be used after consultation with the cleaner manufacturer for appropriate dilution rates and timing of cleaning
3. Do not sandblast or apply high pressure washing to remove efflorescence.

- C. Protection: Provide coverings and masking to protect plant materials and other non- masonry surfaces from damage due to cleaning operations. Protect landscape and lawn areas by keeping them wet through the use of a soaker hose that provides a slow but steady mist of water to areas adjacent to masonries being cleaned.

D. Environmental Conditions

1. Ambient and substrate temperature must be above 40° F to proceed with cleaning operations without special requirements. If either the ambient or substrate temperatures are below 40°, water must be heated to a minimum of 120° and a maximum of 200° to achieve acceptable cleaning environmental conditions.
2. Cleaning operations must be conducted at a time such that the masonry surfaces will have adequate time to thoroughly dry without fear of freezing.

E. Test

1. Test cleaning application and methods on the sample wall panel to determine suitability, dilution rate, and results, prior to application on finished structure.
2. The fundamental consideration for cleaning procedures is to do minimal or no damage to the masonry substrates while achieving a wall clean of mortar, grout, or dirt.
3. Test samples of adjacent non-masonry materials that cannot be protected for possible reaction with the cleaning materials.
4. Test procedures will include evaluation of materials and techniques proposed for cleaning procedures and protection of surrounding and adjacent non-masonry surfaces from cleaning solutions and rinse waters.
5. Obtain Architect's approval of results of sample panel cleaning before proceeding with cleaning of permanent masonry.

F. Prewetting and Rinsing

1. Thoroughly prewet all surfaces with clear water prior to application of cleaners. The purpose of prewetting (do not saturate) is to limit the activity of the cleaning solution to

the masonry surface and prevent the cleaning solution from being too readily absorbed by dry masonry units.

2. Use high-pressure equipment for prewetting and rinsing procedures using 400 to 800 PSI and a flow rate of four to six gallons per minute. Flow down the wall using a flared nozzle. High-pressure application of cleaning materials is not permitted.

G. Cleaning Process

1. Scrape off excess mortar deposits with wooden scrapers or other nonmetallic scraping devices.
2. Thoroughly prewet (DO NOT SATURATE) a large area of the masonry surface to be cleaned.
3. Using a densely packed soft-fibered masonry washing brush or low-pressure spray (50 PSI maximum), apply the prepared (diluted) cleaning solution freely.
4. Allow the cleaning solution to stay on the wall for two to three minutes depending upon drying conditions. (Do not allow the cleaning solution to dry in.)
5. Scrape off excess mortar deposits and reapply the cleaning solution.
6. Rinse treated surfaces thoroughly with fresh water, flowing downward. Remove all cleaning compounds, dirt, etc.

- H. Clean and protect surfaces as recommended by the manufacturer. Marred or damaged faces are cause for rejection.

3.07 CLEAN UP

- A. Remove all debris and excess material resulting from the work and legally dispose of it.
- B. As masonry work progresses, keep clean with burlap or brush and at completion thoroughly clean all masonry work.
- C. Protect all adjacent surfaces susceptible to damage due to masonry installation. Thoroughly clean these surfaces upon completion of masonry work to render to new condition.

END OF SECTION

SECTION 05 10 00
STRUCTURAL METALS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies structural metals consisting of standard shapes, fasteners, rods and plates that are used in structural supports, fabrications and connections.

1.02 QUALITY ASSURANCE

A. General

1. Structural assemblies and shop and field welding shall meet the requirements of the AISC Manual of Steel Construction.
2. The use of salvaged, reprocessed or scrap materials shall not be permitted.

B. References

1. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design - 9th Edition
ASTM A36/A36M	Structural Steel
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A307	Carbon Steel Externally Threaded Standard Fasteners
ASTM A320/A320M	Alloy-Steel Bolting Materials for Low Temperature Service
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A666	Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar for Structural Applications
ASTM B308	Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded
AWS-B3.0	Welding Procedures and Performance Qualifications
AWS-D1.1	Structural Welding Code - Steel

1.03 SUBMITTALS

- A. Comply with Section 01 33 00. Submit shop drawings showing materials, fabrication details, mark numbers, connections, and dimensions. Drawings shall be adequate to show compliance with the Drawings and to represent manufacture, handling, and erection.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel

1. Materials for structural metals shall be as specified as follows:

<u>Material</u>	<u>Specification</u>
Standard rolled steel sections	ASTM A36
Pipe columns	ASTM A53, Grade B
Structural steel tubing	ASTM A500, Grade B
Structural bars, plates and similar items	ASTM A36 or A283, Grade D
Stainless steel	ASTM A666, Grade A, Type 304
Stainless steel bolts, nuts and washers	ASTM A320, Type 304
Steel bolts	ASTM A325

- B. Aluminum: Unless otherwise specified, aluminum shall be extruded from 6061-T6 or 6063-T6 alloy, conforming to ASTM B308.

2.02 FABRICATION

- A. Fabrication shall be in accordance with the AISC Manual of Steel Construction and the Aluminum Association Aluminum Construction Manual.

PART 3 EXECUTION

3.01 INSTALLATION

A. General

1. Measurements shall be verified at the job site.
2. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or drilled. No drifting of bolts nor enlargement of holes will be allowed to correct misalignment. Mismatched holes shall be corrected with new material.
3. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.
4. Metalwork to be embedded in concrete shall be as specified in Section 03 30 00. Metalwork shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete after design strength is attained, and the metalwork shall be grouted in place in accordance with Section 03 30 00. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned.
5. Structural steel completely encased in concrete shall not be galvanized or painted and shall have a clean surface for bonding to concrete. Metalwork, which is bent, broken or otherwise damaged, shall be repaired or replaced by the Contractor.

B. Welding

1. Welding shall be done by operators who have been qualified by tests as prescribed by AWS D1.1 Sect. 7 to perform the type of work required. The quality of welding shall conform to AWS Code for Arc Welding in Building Construction Section 4, Workmanship.
2. Unless otherwise specified, continuous welds shall be provided on all structural members that are exposed to weather or submerged in water or wastewater or that are in process areas, and continuous seal welds shall be provided on both sides of all plates or structural shapes that are in contact with or submerged in water or wastewater or that are in process areas.

C. Bolted Connections

1. Bolted connections shall conform to AISC Framed Beam Connections and shall be bearing type connections with threads excluded from shear planes. Stainless steel bolts shall be provided in submerged or wet locations.

3.02 CORROSION PROTECTION

- A. Unless otherwise specified, all structural metal and structural steel, including that used in the fabrication of process equipment, shall be coated in accordance with Section 09 90 00. All steel members and steel fabrications that are to be installed in process or exterior areas are to be hot-dip galvanized as specified in Section 05 91 00. Surface preparation shall be as specified in Section 09 90 00 and shall include the following operations:

1. Grind the exterior and interior edges of all flame-cut plates or members to a smooth surface.
2. Grind all sharp edges off of the sheared plates and punched holes.
3. Grind uneven or rough welds with high beads to a smooth finish.

- B. Coating application requirements shall be as specified in Section 09 90 00.

- C. Bolts, nuts, screws, and washers shall be coated with mechanically applied zinc coating in accordance with ASTM B695. Coating thickness shall be Class 50. All connection hardware in wet or submerged conditions shall be stainless steel.

3.03 CLEANING

- A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal ladders.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufactured metal ladders.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Samples: For each type and finish.

D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 WARRANTY

A. Limited Warranty: Five years against defective material and workmanship, covering parts only, no labor or freight. Defective parts, if deemed so by the manufacturer, will be replaced at no charge, freight excluded, upon inspection at manufacturer's plant which warrants same.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified, certified professional engineer to design ladders.

B. Structural Performance of Aluminum Ladders: Ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

2.02 METAL LADDERS

A. General

1. Capacity: Unit shall support a 1,500 lb (680 kg) loading without failure.
2. Performance Standard: Units designed and manufactured to meet or exceed ANSI A14.3, OSHA 1910.23, OSHA 1910.28 and OSHA 1910.29.

B. Aluminum Ladders

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ACL Industries
 - b. O'Keefe's Inc.
 - c. Precisions Ladders, LLC
2. Components:
 - a. Space stringers 18 inches apart unless otherwise indicated.
 - b. Stringers: Continuous extruded-aluminum channels or tubes, not less than 3 inches deep, 3/4 inch wide, and 1/8 inch thick.
 - c. Rungs: Extruded-aluminum tubes, not less than 2 1/4 deep, not less than 3/4 inch high and not less than 1/8 inch (3.2 mm) thick, with serrated tread surfaces.
 - d. Fall Arrest System: Complete system with rail, sleeves, and harness to limit any fall to 6 inches (152 mm). Removeable Post for Hatch Access Ladders with Fall Arrest System. Harness by others.
 - e. All welded construction.
 - f. Standard: Mill finish on aluminum ladder components.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Field Welding: Comply with the following requirements:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

END OF SECTION

SECTION 05 50 10

ANCHOR BOLTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies anchor bolts complete with washers and nuts. Unless otherwise specified, anchor bolts shall be hot dip galvanized or type-304 stainless steel as shown on the Drawings. All anchor bolts in wet, submerged or process areas shall be stainless steel.

1.02 REFERENCES

- A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures
ASTM A36/A36M	Structural Steel
ASTM A307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A320/A320M	Alloy Steel Bolting Materials for Low Temperature Service
IBC	International Building Code

1.03 SUBMITTALS

- A. The following information shall be provided in accordance with Section 01 33 00 for all bolt systems not cast-in-place:
1. Data indicating load capacities.
 2. Chemical resistance.
 3. Temperature limitations.
 4. Installation instructions.

PART 2 PRODUCTS

2.01 GENERAL

- A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a limiting maximum over-sizing of 1/4 inch. Unless otherwise specified, minimum anchor bolt diameter shall be 1/2 inch.
- B. Tapered washers shall be provided where mating surface is not square with the nut.
- C. Expansion, wedge, or adhesive anchors set in holes drilled in the concrete after the concrete is placed will not be permitted in substitution for cast-in-place anchor bolts except where approved by the Engineer or otherwise specified. Upset threads shall not be acceptable. Plywood or metal base plate templates are required for all cast-in-place anchor bolts.

2.02 MATERIALS

- A. Anchor bolt materials shall be as specified as follows:

<u>Material</u>	<u>Specification</u>
Steel bolts	ASTM A307, Grade A
Fabricated steel bolts	ASTM A36
Stainless steel bolts, nuts, washers	ASTM A320, Type 304 ^a
Expansion anchors	HILTI, Red Head or equal
Wedge anchors	ITT, Phillips Drill Co., or equal.
Adhesive anchors	HILTI, Simpson Strong-Tie, or equal

Note: ^aUse Type 316 where specified or shown on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

- A. Fieldwork, including cutting and threading, shall not be permitted on galvanized items. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Grouting of anchor bolts with non-shrink or epoxy grouts, where specified, shall be in accordance with Section 03 30 00.

3.02 CAST-IN-PLACE ANCHOR BOLTS

- A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or block-outs shall be formed in the concrete and the metalwork shall be grouted in place in accordance with Section 03 30 00. The surfaces of metalwork in contact with concrete shall be thoroughly cleaned.
- B. After anchor bolts have been embedded, their threads shall be protected by grease or synthetic base graphite lubricant and the nuts run on. Anchor bolts in contact with process water shall be coated with NSF 61 compliant lubricant.

3.03 ADHESIVE ANCHOR BOLTS

- A. Use of adhesive or capsule anchors shall be subject to the following conditions:
1. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable. Overhead applications (such as pipe or mechanical supports) shall be disallowed.
 2. Anchor diameter and grade of steel shall be per contract documents or per equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.
 3. Embedment depth and bore diameter shall be as specified. Adhesive capsules of different diameters may be used to obtain proper volume for the embedment, but no more than two capsules per anchor may be used. When installing different diameter capsules in the same hole, the larger diameter capsule shall be installed first. Any extension or protrusion of the capsule from the hole is prohibited.

4. Embedment depth and bore diameter shall be as specified. Two-part injection adhesives are to be supplied in individually sealed, equal volume cartridges. The epoxy components shall be thoroughly mixed when dispensed through a static spiral mixing/dispensing nozzle. Bulk hand mixed and measured adhesives will not be allowed.
5. All installation recommendations by the anchor system manufacturer shall be followed carefully, including maximum hole diameter and minimum embedment length.
6. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.
7. Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.
8. Anchor shall be left undisturbed and unloaded for full adhesive curing period.
9. Concrete temperature (not air temperature) shall be compatible with curing requirements of adhesives per adhesive manufacturer. Anchors shall not be placed in concrete below 40 degrees F.

3.04 EXPANSION ANCHORS

- A. Use of expansion or wedge type anchors shall be subject to conditions 1,4, and 5 specified in paragraph 05 50 10 3.03 and approval by the Engineer. Expansion or wedge anchors may not be substituted for cast-in-place or adhesive set anchors.
- B. The Contractor shall supply the Engineer with the current evaluation report from the International Conference of Building Officials for the particular brand of expansion or adhesive anchor systems to be used.

END OF SECTION

SECTION 05 52 00

GUARDRAILING AND HANDRAILING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies prefabricated aluminum guardrailing and handrailing.
- B. Work of this section shall apply to all process related structures. Refer to Section 05 50 00 for railing and guardrail for non-process related civil site improvements.

1.02 QUALITY ASSURANCE

- A. General: Guardrailing and handrailing shall conform to the standards of the Occupational Safety and Health Administration (OSHA) and the International Building Code (IBC).
- B. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM A320/A320M	Alloy-Steel Bolting Materials for Low-Temperature Service
ASTM B241/ B241M	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

1.03 SUBMITTALS

- A. Comply with Section 01 33 00. Submit complete shop drawings showing materials, layout and connection details. Shop drawing shall be accompanied by a letter certifying that the drawings represent construction which conforms to OSHA and IBC standards.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Guardrailing and handrailing materials shall be as specified as follows:

<u>Material</u>	<u>Component</u>
Aluminum	ASTM B241, alloy 6061-T6 or 6063 T6
Bolts, nuts and washers	ASTM A320, Type 304

2.02 FABRICATION

- A. General
 - 1. Pipe cuts shall be clean, straight, square and accurate for minimum joint gap. Work shall be done in conformance with the guardrail manufacturer's instructions. Work shall be free from blemishes, defects, and misfits of any type which can affect durability, strength, or appearance.

2. Guardrailing and handrailing shall be connected by screws or bolts. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Wherever needed because of the thickness of the metal, holes shall be subpunched and reamed or drilled. Railing components with mismatched holes shall be replaced. No drifting of bolts nor enlargement of holes will be allowed to correct misalignment.

B. Aluminum Handrails

1. Aluminum guardrails and handrails shall be Wesrail as manufactured by Moultrie Manufacturing Company; Connectorail as manufactured by Julius Blum and Company, Inc.; C V Pipe rail as manufactured by Crane-Veyor Corporation; or equal modified to meet specified requirements.
2. Aluminum railing components shall have a clear satin anodized architectural Class I finish of minimum 0.7 mil thickness. Rails, posts, stanchions, and specials shall be fabricated from 1 1/2-inch diameter, Schedule 40 cylindrical sections.
3. Toeboards shall be provided where specified on the drawings. Toeboards shall be aluminum with a minimum thickness of 3/16 inch and shall be bolted to the vertical railing supports. Toeboards shall be designed to allow for thermal contraction and expansion.

PART 3 EXECUTION

3.01 GENERAL

- A. Guardrailing and handrailing shall be as specified and shown on the drawings. Measurements for railings shall be field verified before fabrication.
- B. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.
- C. Metal to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed. Where required, recesses or blockouts shall be formed in the concrete, and the metalwork shall be grouted in place after concrete has attained its design strength in accordance with Section 03 30 00.

END OF SECTION

SECTION 05 53 00

METAL GRATING, FLOOR PLATES, AND COVER PLATES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies floor grating, floor plates, and cover plates.

1.02 REFERENCES

- A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design-9th Edition
ASCE Journal Vol. 88 ST6-62	Suggested Specifications for Structures of Aluminum Alloys 6061 T6 and 6063 T6
ASTM A36/A36M	Structural Steel
ASTM A569/A569M	Steel, Sheet and Strip, Carbon, Hot Rolled, Commercial Quality
ASTM B210	Aluminum and Aluminum Alloy Drawn Seamless Tubes
ASTM B221	Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes and Tubes

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aluminum: Aluminum grating bearing bars and aluminum floor plates and cover plates shall be of alloy 6061 T6 conforming to ASTM B221. Aluminum grating cross bars shall be of an alloy conforming to either ASTM B221 (extrusions) or B210 (drawn).
- B. Steel: Steel grating bearing bars and cross bars shall be of welding quality mild carbon steel conforming to ASTM A569. Steel floor plates and cover plates shall be of structural quality steel conforming to ASTM A36. All steel grating shall be hot-dip galvanized.

2.02 FABRICATION

- A. General
1. Rough weld beads and sharp metal edges on gratings and plates shall be ground smooth. Welds exposed to view shall be uniform and neat. Welds to be galvanized shall be sandblasted prior to galvanizing.
 2. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes

shall be sub-punched and reamed or shall be drilled. Cutting, drilling, punching, threading and tapping shall be performed prior to hot dip galvanizing.

B. Grating

1. General: Grating shall be as specified. Both bearing bars and cross bars shall be continuous. Openings shall be banded with bars having the same dimensions as the bearing bars. Perimeter edges shall be banded with bars flush at the top surface of the grating and 1/4 inch clear of the bottom surface. Bars terminating against edge bars shall be welded to the edge bars when welded construction is used. When crimped or swaged construction is used, bars at edges shall protrude a maximum of 1/16 inch and shall be peened or ground to a smooth surface. No single piece of grating shall weigh more than 80 pounds unless specifically detailed otherwise.
2. Aluminum Grating: Unless otherwise specified, grating shall be fabricated of aluminum. Bearing bars shall be punched to receive the cross bars. After insertion in the bearing bars, cross bars shall be deformed by a hydraulic press or similar means to permanently lock the bars into the bearing bar openings. Fabrication methods employing bending or notching of bearing or cross bars will not be permitted. Aluminum grating shall be Gary Galok, Seidelhuber, or equal.
3. Steel Grating: Steel grating shall be used only where specified or shown on the plan. Steel grating shall be hot dip galvanized. Notching, slotting, or cutting the top or bottom edges of bearing bars to receive cross bars will not be permitted unless each intersection of bars is fully welded to restore each bearing bar to its full cross-sectional strength.
4. Floor and Cover Plates: Floor and cover plates (Checkered Plate) shall be Alcoa C 102 aluminum tread plate, Reynolds diamond tread plate, or equal, unless specifically detailed otherwise. Hinged cover plates shall be as specified and shall be set flush with surrounding floor. No single piece of floor and cover plate shall weigh more than 80 pounds unless specifically detailed otherwise.

PART 3 EXECUTION

3.01 INSTALLATION

A. General

1. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.
2. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Aluminum in contact with concrete shall be protected by a heavy coat of bituminous paint.
3. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete after it has attained its design strength and the metalwork grouted in place as specified in Section 03 30 00. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned. If accepted, recesses may be neatly cored in the concrete.

- B. Grating, Floor and Cover Plates: Grating, floor and cover plates shall be field measured for proper cutouts and proper sizes. Field welding of aluminum grating and cover plates, where specified, shall be in accordance with ASCE Vol. 88 ST6.

3.02 CLEANING

- A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat. Damaged surfaces of galvanized metals shall be repaired as specified in Section 05 91 00.

END OF SECTION

SECTION 05 91 00

HOT-DIP ZINC COATING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies hot dip zinc coating.

1.02 REFERENCES

- A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM A123	Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Safeguarding Against Embrittlement of Hot Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM A384	Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies
ASTM A385	Providing High Quality Zinc Coatings (Hot Dip)
ASTM A780	Repair of Damaged Hot Dip Galvanized Coatings
MILSPEC	Paint, High Zinc Dust Content, Galvanizing Repair DOD P 21035

1.03 SUBMITTALS

- A. The following information shall be provided in accordance with Section 01 33 00:
1. Zinc dust zinc oxide coating manufacturer's product data showing conformance to the specified product.
 2. Manufacturer's recommendation for application of zinc dust zinc oxide coating.
 3. Coating applicator's Certificate of Compliance that the hot dip galvanized coating meets or exceeds the specified requirements of ASTM A123 or A153, as applicable.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Zinc Coating: Zinc coating material shall be as specified in ASTM A153.
- B. Zinc Dust Zinc Oxide Coating: Zinc dust zinc oxide coating shall conform to MILSPEC DOD-P 21035. Coating shall be as manufactured by Z.R.C. Chemical Products Co., Galvicon Co., or equal.

2.02 FABRICATION REQUIREMENTS

- A. Fabrication practices for products to be galvanized shall be in accordance with applicable portions of ASTM A143, A384 and A385.

PART 3 EXECUTION

3.01 APPLICATION

- A. Steel members, fabrications and assemblies shall be galvanized after fabrication in accordance with ASTM A123.
- B. Unless otherwise specified or shown on the plan, fabricated steel items shall be hot dip zinc coated. Anchor bolts and nuts 5/8 inch and larger shall be hot dip zinc coated in accordance with ASTM A153. Anchor bolts and nuts smaller than 5/8 inch and all other bolts, screws, nuts, washers and other minor steel fasteners shall be A304 stainless steel.

3.02 COATING REQUIREMENTS

- A. Coating weight shall conform with paragraph 5.1 of ASTM A123 or Table 1 of ASTM A153, as appropriate.

3.03 REPAIR OF DEFECTIVE GALVANIZED COATING

- A. Where zinc coating has been damaged after installation, substrate surface shall be first cleaned and then repaired with zinc dust zinc oxide coating in accordance with ASTM A780. Application shall be as recommended by the zinc dust zinc oxide coating manufacturer. Coating shall consist of multiple coats to dry film thickness of 8 mils.
- B. Items not physically damaged, but which have insufficient or deteriorating zinc coatings, and items damaged in shipment or prior to installation, shall be removed from the project site for repair by the hot-dip zinc coating method.

END OF SECTION

SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Rooftop equipment bases and support curbs.
2. Wood blocking, cants, and nailers.
3. Plywood backing panels.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

1.03 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.

PART 2 PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWP U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated.
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.

2.03 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- C. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Plywood backing panels.

2.04 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.05 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

2.06 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.

3.02 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 06 41 16

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Cabinet hardware and accessories.
3. Solid Surface countertops.
4. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. Shop Drawings

1. Include plans, elevations, sections, and attachment details.

D. Samples: For each exposed product and for each color and texture specified.

1.04 SUSTAINABLE DESIGN SUBMITTALS

A. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

B. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

C. Environmental Product Declaration (EPD)

1. Provide Environmental Product Declarations for each product which conform to ISO 14025 and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
 - a. Preferred EPD Type: Product-specific Type III EPD – Products with third-party certification (Type III), including external verification in which the manufacturer is explicitly recognized as the participant by the program operator.
 - b. Alternate EPD Type: Industry-wide (generic) EPD – Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator.

D. Low Emitting Materials

1. Product Data:

- a. Indicating product complies with California Department of Public Health's (CDPHE) Standard Method v1.1-2010 General Emissions Evaluation. Provide Total Volatile Organic Compounds (TVOC) Range.
- b. Indicating product's VOC content is lower than that allowed by the California Air Resources Board (CARB) 2007 regulation.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Research reports.
- C. Field quality control reports.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.07 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

PART 2 PRODUCTS

2.01 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Regional Materials: Manufacture wood products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- D. Certified Wood: Certify wood products as "FSC Pure" or "FSC Mixed Credit" in accordance with FSC STD-01-001 and FSC STD-40-004.
- E. Type of Construction: Frameless.
- F. Door and Drawer-Front Style: Flush overlay.
- G. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Abet Laminati Inc.
 - b. Formica Corporation.
 - c. Lamin-Art, Inc.
 - d. Pionite; a Panolam Industries International, Inc. brand.
 - e. Wilsonart LLC.
- H. Laminate Cladding for Exposed Surfaces:
 1. Horizontal Surfaces: Grade HGS.
 2. Vertical Surfaces: Grade HGS.
 3. Edges: PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.
- I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.
- K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 1. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Solid colors, gloss and matte finishes.
 - b. Solid colors with core same color as surface, gloss and matte finishes
 - c. Wood grains, gloss and matte finishes
 - d. Patterns, gloss and matte finishes
- L. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABA Industries.
 - b. Avonite, Inc.
 - c. E. I. du Pont de Nemours and Company.
 - d. Formica Corporation.
 - e. LG Chemical, Ltd.
 - f. Meganite Inc.; a division of the Pyrochem Group.

- g. Nevamar Company, LLC; Decorative Products Div.
- h. Samsung; Cheil Industries Inc.
- i. Swan Corporation (The).
- j. Transolid, Inc.
- k. Wilsonart International; Div. of Premark International, Inc.

2.02 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
 - 2. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
 - 3. Particleboard (Medium Density): ANSI A208.1, Grade M-2-Exterior Glue.
 - 4. Softwood Plywood: DOC PS 1, medium-density overlay.
 - 5. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.03 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction as determined by testing performed on identical products by a qualified testing agency.
 - 1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

2.04 CABINET HARDWARE AND ACCESSORIES

- A. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
 - 1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
 - 2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.

- B. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.
- C. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.
- D. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
- E. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.
- F. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- G. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Side mount.
 - a. Type: Full extension.
 - b. Material: Galvanized steel ball bearing slides.
 - c. Motion Feature: Push to open and Self-closing mechanism.
- H. Door Locks: ANSI/BHMA A156.11, E07121.
- I. Drawer Locks: ANSI/BHMA A156.11, E07041.
- J. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- K. Grommets for Cable Passage: 2-inch (51-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Color: Black.
- L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
 - 1. Satin Stainless Steel: ANSI/BHMA 630.
- M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.05 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.06 FABRICATION

- A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- C. Solid-Surfacing-Material Countertops
 - 1. Solid-Surfacing-Material Thickness: 1/2 inch.
 - 2. Colors, Patterns, and Finishes: As selected from manufacturer's full range.
 - 3. Fabricate sills in one piece. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.
- B. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- E. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

END OF SECTION

SECTION 06 74 13

FIBERGLASS REINFORCED GRATINGS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. This section covers the design, fabrication, and installation of FRP grating components for use in interior areas as specified and shown on the Drawings.

1.2 SUBMITTALS

- A. Submit shop drawings, product data, model numbers, materials of construction, and details of installation in accordance with Section 01 33 00.
- B. Certification stamped by a structural or civil engineer registered in Colorado that all products and materials meet all performance and design requirements.
- C. Copies of all grating load test results.

1.3 QUALITY ASSURANCE

- A. All materials shall be new and of the best quality of their respective kind.
- B. All materials and FRP components specified herein shall meet or exceed the standards of the Occupational Safety and Health Administration (OSHA) and the Uniform Building Code (UBC).
- C. All items specified herein shall meet the requirements of ASTM specifications D3917, D3918, D3647, D4385, and E-84.

PART 2 PRODUCTS

2.1 GENERAL

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Unless otherwise specified, minimum structural properties shall be:

<u>Parameter</u>	<u>Value</u>
Area, in ² /ft of width	2.88
Modulus of Elasticity, in ⁴ /ft of width	0.96
Section Modulus, in ³ /ft of width	0.94
2-in Bearing Bars	Values per foot of width
Open Space, percent	72
Approximate Weight, lbs/ft ²	4.0

- B. Grating shall have a maximum deflection of 0.562 inches when supported up to 4-foot centers and subjected to a concentrated safe load of 520 pounds per lineal foot. Minimum thickness shall be 2-inch with 2-inch square grid. Surface shall be slip resistant with a concave profile.
- C. The resin system shall be corrosion resistant vinyl ester and shall have a flame spread rating of 25 or less per ASTM E-84. Resin system shall be premium grade and include ultraviolet inhibitor and fire retardant.
- D. Color shall be yellow.
- E. Grating shall be molded in one piece with concave walking surface. The tops of lengthwise and crosswise bars shall be in the same plane. Mesh pattern shall be square.
- F. All metallic hardware, nuts, and bolts shall be type 304 stainless steel.
- G. Grating manufacturer shall be Strongwell DuraGrate 2" thick 2" square mesh or Engineer-approved equal.

PART 3 EXECUTION

3.1 GENERAL

- A. All work shall be installed clean, straight, square, and accurate with even joints. Work shall be free from blemishes, poor joining misfits, or any other anomalies that may affect durability functionality, and/or appearance.
- B. All items shall be installed as shown on the Drawings, in accordance with manufacturer's recommendations, and these specifications. Any discrepancies shall be brought to the attention of the Engineer immediately.
- C. All measurements shall be field verified before fabrication and all components shall be fitted accurately.
- D. Bolts to be embedded in concrete shall be placed accurately and held in correct position while the concrete is place.
- E. Adhesives for connections shall be field applied under the direct supervision of manufacturer's representative.
- F. At joints to be bonded, surface preparation, materials, mixing, application, and curing shall comply with manufacturer's recommendations.

3.2 GRATING

- A. The Contractor shall install grating in sheet sizes compatible with the support conditions shown on the Drawings and shall require a minimum of field cutting.
- B. FRP grating shall be fabricated by the open mold process. Grating shall be slip resistant. Field conditions shall be pre-measured prior to cut outs.
- C. Type M clips shall be used to attach grating to supports.

- D. All cut edges, holes, and abrasions shall be completely sealed with compatible resin as recommended by the manufacturer. No uncoated edges or exposed fibers shall be allowed.

- END OF SECTION -

SECTION 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes

1. Cold-applied, emulsified-asphalt dampproofing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.02 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. APOC, Inc; a division of Gardner Industries.
2. BASF Corporation.
3. Brewer Company (The).
4. ChemMasters, Inc.
5. Euclid Chemical Company (The); an RPM company.
6. Henry Company.
7. Karnak Corporation.
8. Mar-flex Waterproofing & Building Products.
9. W.R. Meadows, Inc.

- B. Trowel Coats: ASTM D1227, Type II, Class 1.

- C. Fibered Brush and Spray Coats: ASTM D1227, Type II, Class 1.

- D. Brush and Spray Coats: ASTM D1227, Type III, Class 1.

2.03 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

- B. Emulsified-Asphalt Primer: ASTM D1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.
- C. Protection Course: ASTM D6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.
 - 1. Thickness: Nominal 1/4 inch.
- D. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on one side or both sides with plastic film, nominal thickness 1/4 inch, with a compressive strength of not less than 8 psi per ASTM D1621, and maximum water absorption by volume of 0.6 percent per ASTM C272/C272M.

PART 3 EXECUTION

3.01 APPLICATION, GENERAL

- A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.
 - 1. Apply dampproofing to provide continuous plane of protection.
 - 2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
- B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
 - 1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 - 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

3.02 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Concrete Foundations: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat one fibered brush or spray coat at not less than 3 gal./100 sq. ft. or one trowel coat at not less than 4 gal./100 sq. ft..

3.03 PROTECTION COURSE INSTALLATION

- A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

END OF SECTION

SECTION 07 27 26

FLUID APPLIED MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Vapor-permeable, fluid-applied air barriers.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For air-barrier assemblies.

1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.04 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested in accordance with ASTM E2357.

2.02 HIGH-BUILD AIR BARRIERS, VAPOR PERMEABLE

- A. High-Build, Vapor-Permeable Air Barrier: Synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils or thicker over smooth, void-free substrates.
 - 1. Synthetic Polymer Type:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide DuPont de Nemours, Inc.; DuPont™ Sealant for Tyvek® Fluid Applied System.
 - 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. pressure difference; ASTM E2178.
 - b. Vapor Permeance: Minimum 10 perms; ASTM E96/E96M, Desiccant Method, Procedure A.
 - c. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.
 - d. Adhesion to Substrate: Minimum 30 lbf/sq. in. when tested according to ASTM D4541.
 - e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.03 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- F. Bridge expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.02 INSTALLATION

- A. Install materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
 - 3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 - 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- C. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames.
- D. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.
- E. High-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply air-barrier material in full contact around protrusions such as masonry ties.
- F. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.03 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
- B. Remove masking materials after installation.

END OF SECTION

SECTION 07 53 23

ETHYLENE PROPYLENE DIENE MONOMER (EPDM) ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Adhered EPDM membrane roofing system.
- B. Cover board.
- C. Roof insulation.

1.02 RELATED SECTIONS

- A. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, cants, curbs, and blocking.
- B. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counter flashings.

1.03 REFERENCES

- A. Roofing Terminology: Refer to the following publications for definitions of roofing work related terms used in this Section:
 - 1. ASTM D 1079 "Standard Terminology Relating to Roofing and Waterproofing."
 - 2. Glossary of NRCA's "The NRCA Roofing Manual."
 - 3. Roof Consultants Institute "Glossary of Roofing Terms."
- B. Sheet Metal Terminology and Techniques: SMACNA "Architectural Sheet Metal Manual."

1.04 DESIGN CRITERIA

- A. General: Installed roofing membrane systems shall remain watertight; and resist specified wind uplift pressures, thermally induced movement, and exposure to weather without failure. Roof system shall withstand the following design loads within limits and under conditions indicated determined in accordance with the 2018 IBC.
 - 1. Basic Wind Speed – 115 mph
 - 2. Importance Factor – 1.0
 - 3. Exposure Category – C
- B. Material Compatibility: Roofing materials shall be compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.
- C. Installer shall comply with current code requirements based on authority having jurisdiction.
- D. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL,

FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

1.05 SUBMITTALS

- A. Product Data: Manufacturer's data sheets for each product to be provided.
- B. Detail Drawings: Provide roofing system plans, elevations, sections, details, and details of attachment to other Work, including:
 1. Base flashings, cants, and membrane terminations.
 2. Tapered insulation, including slopes.
 3. Crickets, saddles, and tapered edge strips, including slopes.
 4. Insulation fastening patterns.
 5. List project Importance Factor, Wind Speed and Exposure on Detail Drawings.
- C. Verification Samples: Provide for each product specified.
- D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
- E. Maintenance Data: Refer to manufacturer's latest published documents.
- F. Guarantees: Provide manufacturer's current guarantee specimen.
- G. Prior to beginning the work of this section, roofing sub-contractor shall provide a copy of the final System Assembly Letter issued by Manufacturer indicating that the products and system to be installed shall be eligible to receive the specified manufacturer's guarantee when installed by a manufacturer's certified contractor in accordance with our application requirements, inspected and approved by a manufacturer's Technical Representative.
- H. Prior to roofing system installation, roofing sub-contractor shall provide a copy of the Guarantee Application Confirmation document issued by Manufacturer indicating that the project has been reviewed for eligibility to receive the specified guarantee and registered.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and is eligible to receive the specified manufacturer's guarantee.
- B. Manufacturer Qualifications: Qualified manufacturer that has [UL listing] for roofing system identical to that used for this Project.
- C. Testing Agency Qualifications: Independent testing agency with the experience and capability to conduct the testing indicated, as documented in accordance with ASTM E329.
- D. Test Reports:

1. Roof drain and leader test or submit plumber's verification.
- E. Source Limitations: Obtain all components from the single source roofing system manufacturer guaranteeing the roofing system. All products used in the system shall be labeled by the single source roofing system manufacturer issuing the guarantee.
- F. Fire-Test-Response Characteristics: Roofing materials shall comply with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
- 1.07 DELIVERY, STORAGE, AND HANDLING
- A. Deliver roofing materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.
- 1.08 PROJECT CONDITIONS
- A. Weather Limitations: Proceed with installation only when current and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and guarantee requirements.
- 1.09 WARRANTY
- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
1. Single-source special guarantee includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, cover board, walkway products, manufacturer's expansion joints, manufacturer's edge metal products, and other single-source components of roofing system marketed by the manufacturer.
 2. Warranty Period: 30 years from Date of Substantial Completion.
 3. Minimum 30 year "Total Systems," no dollar limitation (NDL), non-prorated labor and materials warranty to correct defective roofing materials, including installation.
 4. Wind Speed Warranty: Provide Manufacturer's wind-speed coverage matching or exceeding Design Criteria Wind Speed, Importance Factor and Exposure.
- B. Installer's Warranty: Submit roofing Installer's warranty, including all components of roofing system for the following guarantee period:
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by Johns Manville or comparable products by one of the following:
1. Carlisle SynTec Incorporated
 2. Firestone Building Products
 3. GenFlex Roofing Systems
 4. Versico Roofing Systems

2.02 ETHYLENE PROPYLENE DIENE MONOMER ROOFING MEMBRANE - EPDM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide JM EPDM NR by Johns Manville.
1. Non-reinforced uniform, flexible sheet made from Ethylene Propylene Diene Monomer, ASTM D 4637, Type I.
 - a. Thickness (minimum): 90 mils (2.2 mm)
 - b. Exposed Face Color: Black.
 - c. Factory Inseam Tape: 6-inch (150-mm) wide minimum, butyl splice tape with release film.

2.03 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's sheet flashing of same material, type, reinforcement, thickness, and color as sheet membrane. Basis of design: JM EPDM Peel & Stick Flashing
- C. Primer Material: Manufacturer's standard synthetic-rubber polymer primer. Basis of design: JM EPDM Tape Primer Plus
- D. Liquid Applied Flashing: Manufacturer's single ply liquid and fabric reinforced flashing system created with a fleece polyester scrim and a two-component polyurethane based liquid applied flashing material, consisting of a liquid resin and a curing agent. Basis of design: JM SP Liquid Flashing Resin and JM SP Liquid Flashing Scrim
- E. Liquid Applied Flashing Primer: Manufacturer's single ply liquid flashing primer. Basis of design: JM Single Ply Membrane Primer (Low VOC), JM SP Liquid Flashing Concrete Primer, or JM SP Liquid Flashing Metal and Wood Primer
- F. Seaming Material: Manufacturer's standard 6-inch wide minimum, butyl splice tape with release film. Basis of design: JM EPDM Seam Tape Plus
- G. Sealing Strip: Manufacturer's standard 6-inch- (150-mm-) wide, 45 mil (1.14 mm) thick minimum, cured EPDM with factory-laminated, self-adhering seam tape. Basis of design: JM EPDM Peel & Stick Sealing Strip

- H. Bonding Adhesive: Manufacturer's standard bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings. Basis of design: JM LVOC Membrane Adhesive
- I. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.
- J. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, with anchors. Basis of design: JM Termination Systems
- K. Membrane Battens: Manufacturer's standard polymer or aluminum-zinc-alloy-coated steel sheet, pre-punched. Basis of design: Membrane Battens
- L. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer. Basis of design: High Load Fasteners and Plates.
- M. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, termination reglets, T-joint cover, cover strips, sealants and other accessories. Basis of design: JM EPDM/PVC Pourable Sealer, JM One-Part Pourable Sealer, JM EPDM Peel & Stick Inside/Outside Corners, JM EPDM Peel & Stick Pipe Boots, JM EPDM Peel & Stick Pourable Sealer Pockets, JM EPDM Peel & Stick Sealing Strip, JM EPDM Peel & Stick T-Joint Patch, JM EPDM Protective Stone Mat, JM EPDM Reinforced Termination Strip with Tape (RTS), JM EPDM 10" RPS (Reinforced Perimeter Strip), JM EPDM Pre-Taped Curb Flashing, JM Single Ply LVOC Caulk, JM Weathered Membrane Cleaner, and JM Single Ply Sealing Mastic
- N. Edge Metal Components
 - 1. Expansion Joints: Provide factory fabricated weatherproof, exterior covers for expansion joint openings consisting of flexible rubber membrane, supported by a closed cell foam to form flexible bellows, with two metal flanges, adhesively and mechanically combined to the bellows by a bifurcation process. Provide product manufactured and marketed by single-source membrane supplier that is included in the special warranty. Basis of design: Expand-O-Flash
 - 2. Coping System: Manufacturer's factory fabricated coping consisting of a base piece and a snap-on cap. Provide product manufactured and marketed by single-source membrane supplier that is included in the special warranty. Basis of design: Presto-Lock Coping
 - 3. Fascia System: Manufacturer's factory fabricated fascia consisting of a base piece and a snap-on cover. Provide product manufactured and marketed by single-source membrane supplier that is included in the special warranty. Basis of design: Presto-Tite Fascia (Single Ply Systems)
 - 4. Metal/Membrane Flashing: Specially designed and manufactured flashing for sealing and waterproofing. JM EPDM Metal/Membrane Flashing
 - 5. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing and Trim."

2.04 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads sourced from membrane roofing system manufacturer. Basis of design: JM EPDM Peel & Stick Walkpads

2.05 COVER BOARD

- A. Gypsum Board: ASTM C 1177, coated glass-mat facer, water-resistant gypsum substrate for mechanically attached roof applications, 1/2 inch (13 mm) thick. Basis of design: Dens Deck Roof Board

2.06 ROOF INSULATION

- A. General: Preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 2, Grade 2 (20 psi) , Basis of design: ENRGY 3 CGF.
 - 1. Provide insulation package in multiple layers.
 - 2. Minimum Long-Term Thermal Resistance (LTTR): 5.7 per inch.
 - 3. Provide multiple layers of insulation as required to provide R-30 minimum.
 - a. Determined in accordance with CAN/ULC S770 at 75°F (24°C)

2.07 TAPERED INSULATION

- A. Tapered Insulation: ASTM C 1289, Type II, Class 2, Grade 2 (20 psi), provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48), unless otherwise indicated. Basis of design: Tapered ENRGY 3 CGF

2.08 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.
- B. Provide factory preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated. Basis of design: DiamondBack Pre-Cut Crickets, DiamondBack Pre-Cut Miters or Tapered Fesco Edge Strip
- C. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and furnished by roofing system manufacturer. Basis of design: UltraFast Fasteners and Plates
- D. Wood Nailer Strips: Comply with requirements in Division 06 Section "Miscellaneous Rough Carpentry."

PART 3 EXECUTION

3.01 EXAMINATION

- A. General
 - 1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
 - 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

B. Steel Decks

1. Verify that surface plane flatness and fastening of steel roof deck complies with industry standards.
2. Ensure general rigidity and proper slope for drainage.
3. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units more than 1/16 inch out of plane relative to adjoining deck.
4. Unacceptable panels should be brought to the attention of the General Contractor and Project Owner's Representative and shall be corrected prior to installation of roofing system.

3.02 PREPARATION

- A. Clean and remove from substrate sharp projections, dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.
- C. If applicable, prime surface of deck with asphalt primer at a rate recommended by roofing manufacturer and allow primer to dry.
- D. Proceed with each step of installation only after unsatisfactory conditions have been corrected.

3.03 INSULATION INSTALLATION

- A. Coordinate installation of roof system components so insulation and cover board are not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system manufacturer's written instructions for installation of roof insulation and cover board.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation boards with long joints in a continuous straight line. Joints should be staggered between rows, abutting edges and ends per manufacturer's written instructions. Fill gaps exceeding 1/4 inch with like material.
- E. Install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- F. Trim surface of insulation boards where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- G. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- H. Preliminarily Fastened Insulation [for Mechanically Fastened Membrane Systems]: Install insulation with fasteners at rate required by roofing system manufacturer or applicable authority, whichever is more stringent.
- I. Fasten top layer to resist uplift pressure at corners, perimeter, and field of roof.

3.04 COVER BOARD INSTALLATION

- A. Coordinate installing membrane roofing system components so cover board is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof cover board.
- C. Install cover board with long joints in a continuous straight line. Joints should be staggered between rows, abutting edges and ends per manufacturer's written instructions. Fill gaps exceeding 1/4 inch (6 mm) with cover board.
 - 1. Cut and fit cover board within 1/4 inch of nailers, projections, and penetrations.
- D. Trim surface of cover board where necessary at roof drains so completed surface is flush and does not restrict flow of water.
 - 1. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- E. Mechanically Fastened Cover Board: Install cover board and secure to deck using mechanical fasteners designed and sized for fastening specified cover board to deck type.
 - 1. Fasten to resist uplift pressure at corners, perimeter, and field of roof.

3.05 ROOFING MEMBRANE INSTALLATION, GENERAL

- A. Install roofing membrane in accordance with roofing system manufacturer's written instructions, applicable recommendations of the roofing manufacturer and requirements in this Section.
- B. Where roof slope exceeds 1/2 inch per 12 inches (1:24), contact the membrane manufacturer for installation instructions regarding installation direction and backnailing.
- C. Cooperate with testing and inspecting agencies engaged or required to perform services for installing roofing system.
- D. Coordinate installing roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is imminent.
 - 1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
 - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
 - 3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.06 ADHERED ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing in accordance with membrane roofing system manufacturer's written instructions.
 - 1. Unroll roofing membrane and allow to relax before installing.
 - 2. Install sheet in accordance with roofing system manufacturer's written instructions.

- B. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Bonding Adhesive: Apply [solvent-based] bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.
- D. Mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- E. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- F. Field Fabricated Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.
- G. Tape to Tape Installation: Align membrane for appropriate overlap, remove release liners and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation.
- H. Tape to Standard Sheet Installation: Align membrane for appropriate overlap, clean and prime non-taped face of splice area, remove release liners and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation.
- I. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

3.07 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with membrane roofing system manufacturer's written instructions.
- B. Apply solvent-based bonding adhesive at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- C. Apply single ply liquid applied flashing system per manufacturer's written instructions.
- D. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- E. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive.
- F. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.08 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical representative to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- C. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 PROTECTION AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each of the following

1. Underlayment materials.
2. Elastomeric sealant.
3. Butyl sealant.
4. Epoxy seam sealer.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.

- C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested.
- B. Evaluation Reports: For copings and roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.
- C. Sample warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Special warranty.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 - 1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.07 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 - 1. Design Pressure: As indicated on Drawings.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
 - 1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).
- C. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40; prepainted by coil-coating process to comply with ASTM A755/A755M.
 - 1. Surface: Smooth, flat and with manufacturer's standard clear acrylic coating on both sides.
 - 2. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 3. Color: As selected by Architect from manufacturer's full range.
 - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.03 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
- C. Solder
 - 1. For Zinc-Coated (Galvanized) Steel: ASTM B32, with maximum lead content of 0.2 percent.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- I. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cheney Flashing Company.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products, Inc.
 - d. Hohmann & Barnard, Inc.
 - e. Keystone Flashing Company, Inc.

- f. Metal-Era, Inc.
 - g. National Sheet Metal Systems, Inc.
 - h. OMG, Inc.
- 2. Material: Galvanized steel, 0.022 inch thick.
- 3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
- 4. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
- 5. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
- 6. Accessories:
 - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
- 7. Finish: With manufacturer's standard color coating.

2.04 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
 - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances
 - 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
 - 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams
1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

2.05 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96-inch-long sections.
3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
4. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
 - a. Galvanized Steel: 0.022 inch thick.
 - b. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.

1. Hanger Style: Strap
2. Fabricate from the following materials:
 - a. Galvanized Steel: 0.022 inch thick.
 - b. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

C. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

- D. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

2.06 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Copings: Fabricate in minimum 96-inch-long, but not exceeding 12-foot-long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, solder or weld watertight. Shop fabricate interior and exterior corners.

1. Fabricate from the following materials:
 - a. Galvanized Steel: 0.040 inch thick.
 - b. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.

- B. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

- C. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Galvanized Steel: 0.022 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

- D. Roof-Penetration Flashing: Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds and sealant.
 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.

4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
 6. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 7. Do not field cut sheet metal flashing and trim by torch.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
 - a. Form joints to completely conceal sealant.
 - b. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
 - c. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
 2. Do not solder metallic-coated steel and aluminum sheet.
 3. Do not use torches for soldering.
 4. Heat surfaces to receive solder, and flow solder into joint.

- a. Fill joint completely.
- b. Completely remove flux and spatter from exposed surfaces.

3.02 INSTALLATION OF ROOF-DRAINAGE SYSTEM

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters
 - 1. Join sections with riveted and soldered joints or joints sealed with sealant.
 - 2. Provide for thermal expansion.
 - 3. Attach gutters at eave or fascia to firmly anchor them in position.
 - 4. Provide end closures and seal watertight with sealant.
 - 5. Slope to downspouts.
 - 6. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet apart. Install expansion-joint caps.
- C. Downspouts
 - 1. Join sections with 1-1/2-inch telescoping joints.
 - 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
 - 3. Locate hangers at top and bottom and at approximately 60 inches o.c.
 - 4. Provide elbows at base of downspout to direct water away from building.
- D. Parapet Scuppers
 - 1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 2. Loosely lock front edge of scupper with conductor head.
 - 3. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.
- E. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch below scupper or gutter discharge.
- F. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches in direction of water flow.

3.03 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.
 - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
 - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

- B. Copings
 - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
 - 1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
 - 2. Extend counterflashing 4 inches over base flashing.
 - 3. Lap counterflashing joints minimum of 4 inches.
- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.04 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.05 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.06 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION

SECTION 07 72 00
ROOF ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Roof hatches.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
- B. Shop Drawings: For roof accessories.
- C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 PRODUCTS

2.01 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AES Industries, Inc.
 - b. Curbs Plus, Inc.
 - c. Greenheck Fan Corporation.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.079 inch thick.

1. Finish: Mill phosphatized.

D. Construction

1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
4. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
5. Liner: Same material as curb, of manufacturer's standard thickness and finish.
6. Nailer: Factory-installed wood nailer under top flange on side of curb, continuous around curb perimeter.
7. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
8. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
9. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.02 ROOF HATCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Type S roof hatch by Bilco Company or comparable product by one of the following:

1. AES Industries, Inc.
2. Babcock-Davis.
3. Bristolite Skylights.
4. Custom Solution Roof and Metal Products.
5. Dur-Red Products.
6. Hi Pro International, Inc.
7. J. L. Industries, Inc.
8. Metallic Products Corp.
9. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
10. Naturalite Skylight Systems; Vistawall Group (The).
11. Nystrom.
12. O'Keeffe's Inc.
13. Pate Company (The).
14. Precision Ladders, LLC.

- B. Type and Size: Single-leaf lid, 36 by 36 inches.

- C. Construction: The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.
- D. Aluminum: Cover and frame are 11 gauge (2.3 mm) aluminum.
- E. Cover: Breakformed, hollow-metal design with 1" (25 mm) concealed fiberglass insulation, 3" (76 mm) beaded, overlapping flange, fully welded at corners, and internally reinforced for 40 psf (195 kg/m²) live load.
- F. Curb: 12" (305 mm) in height with integral capflashing, 1" (25 mm) fiberboard insulation, fully welded at corners, and 3-1/2" (89 mm) mounting flange with 7/16" holes (11 mm) provided for securing frame to the roof deck.
- G. Gasket: Extruded EPDM rubber gasket permanently adhered to cover.
- H. Hinges: Heavy-duty pintle hinges with 3/8" (9 mm) Type 316 stainless steel hinge pins.
- I. Latch: Slam latch with interior and exterior turn handles and padlock hasps.
- J. Lift Assistance: Compression spring operators enclosed in telescopic tubes. Automatic hold-open arm with grip handle release.
- K. Performance Ratings: Complies with UL 790 Class A (burning brand test).
- L. Finish: Aluminum: Mill Finish.
- M. Hardware: Engineered composite compression spring tubes. Steel compression springs with electrocoated acrylic finish. Type 316 Stainless steel hinges. All other hardware is zinc plated/chromate sealed.
- N. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder. Post locks in place on full extension; release mechanism returns post to closed position.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Examine substrates to which construction attaches or abuts, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of construction of the work of this section.
- B. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- C. Failure to call attention to defects or imperfections will be construed as acceptance and approval of substrate conditions. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation and full responsibility for completed work.
- D. Furnish inserts and anchoring devices to be built into other work for installation of access hatches.
- E. Install hatches securely to decks and curbs in accordance with manufacturer's instructions in locations shown on the drawings. Provide weathertight installation.

- F. Coordinate with installation of deck coating or flooring system and related flashings.
- G. Apply backing paint on aluminum surfaces of unit in contact with cementitious or dissimilar materials.

3.02 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
- B. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 72 53

SNOW GUARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Rail-Type, Flat-Mounted Snow Guards.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Rail-Type Snow Guards: Bracket, 12-inch-long rail, and installation hardware.
 - a. For units with factory-applied finishes, submit manufacturer's standard color selections.

D. Provide 20 lineal feet of Snow Guards and mounting accessories to Owner for future use.

E. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified and certified professional engineer to design snow guards, including attachment to roofing material and roof deck, applicable for attachment method, based on the following:

1. Roof snow load.

2. Snow drifting
 3. Roof slope.
 4. Roof type.
 5. Roof dimensions.
 6. Roofing substrate type and thickness.
 7. Snow guard type.
 8. Snow guard fastening method and strength.
 9. Snow guard spacing.
 10. Coefficient of Friction Between Snow and Roof Surface: 0.
 11. Factor of Safety: As shown on drawings.
- B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
1. Snow Loads: As indicated on Drawings.

2.02 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Flat-Mounted Snow Guards

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Alpine SnowGuards, a division of Vermont Slate & Copper Services, Inc.
 - b. Berger Building Products, Inc.
 - c. IceBlox Inc.
 - d. Rocky Mountain Snow Guards, Inc.
 - e. S-5! Attachment Solutions; Metal Roof Innovations, Ltd.
 - f. Sieger Snow Guards Inc.
 - g. TRA Snow and Sun, Inc.
2. Description: Units fabricated from metal baseplate anchored to fixed bracket and equipped with two bar(s), rail(s), or pipe(s).
3. Brackets and Baseplate: ASTM B209 (ASTM B209M) aluminum; mill finish.
4. Bars: ASTM B221 (ASTM B221M) aluminum; mill finish.
 - a. Profile: Round.
5. Seam clamps: ASTM B221 (ASTM B221M) aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install snow guards according to manufacturer's written instructions.
 - 1. Space rows as indicated on Drawings.
 - 2. Space rows as recommended by manufacturer.
- B. Attachment for Standing-Seam Metal Roofing:
 - 1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
 - 2. Pad-Type, Flat-Mounted Snow Guards:
 - a. Mechanically attach to metal roofing according to manufacturer's instructions.

END OF SECTION

SECTION 07 84 13

PENETRATION FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.

1.02 PREINSTALLATION MEETINGS

- ###### A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product data.

- ###### B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.04 INFORMATIONAL SUBMITTALS

- ###### A. Listed system designs.

1.05 CLOSEOUT SUBMITTALS

- ###### A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

- a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."

2.02 PENETRATION FIRESTOPPING SYSTEMS

- A. Description: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. 3M Fire Protection Products.
 - b. Balco; a CSW Industrials Company.
 - c. International Fireproof Technology Inc.
 - d. Tremco Incorporated.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 - 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
- C. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.
- D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 EXECUTION

3.01 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- D. Install fill materials by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.02 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.03 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION

SECTION 07 84 43
JOINT FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated construction.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines.

1.04 INFORMATIONAL SUBMITTALS

- A. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.05 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

- a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."

2.02 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
 - 1. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
 - 2. Provide firestop products that do not contain ethylene glycol.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. 3M Fire Protection Products.
 - b. Owens Corning.
 - c. Specified Technologies, Inc.
 - d. Tremco Incorporated.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

2.03 ACCESSORIES

- A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

- C. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- D. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
 - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.02 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft.
- B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.03 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Mildew-resistant joint sealants.
6. Latex joint sealants.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.04 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Field-adhesion-test reports.

C. Sample warranties.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

1.06 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 JOINT SEALANTS, GENERAL

- A. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.02 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. GE Construction Sealants; Momentive Performance Materials Inc.
- b. Sika Corporation; Joint Sealants.
- c. The Dow Chemical Company.

- B. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. GE Construction Sealants; Momentive Performance Materials Inc.
- b. Pecora Corporation.
- c. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
- d. Polymeric Systems, Inc.
- e. Sherwin-Williams Company (The).
- f. The Dow Chemical Company.

2.03 URETHANE JOINT SEALANTS

- A. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. LymTal International Inc.

2.04 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Adfast.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. Pecora Corporation.
 - d. Soudal USA.
 - e. The Dow Chemical Company.
 - f. Tremco Incorporated.

2.05 JOINT-SEALANT BACKING

- A. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Adfast.
 - b. Alcot Plastics Ltd.
 - c. Construction Foam Products; a division of Nomaco, Inc.
 - d. Master Builders Solutions.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.06 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove laitance and form-release agents from concrete.
 - 2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.02 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with ASTM C1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

1. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.03 FIELD QUALITY CONTROL

- A. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.04 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
 1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 2. Joint Sealant: Urethane, M, P, 50, T, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between plant-precast architectural concrete units.
 - c. Control and expansion joints in unit masonry.
 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
 1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Interior hollow-metal doors and frames.
2. Exterior hollow-metal doors and frames.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.03 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Field quality control reports.

1.04 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.05 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Curries Company; ASSA ABLOY.
 2. Rocky Mountain Metals, Inc.
 3. Steelcraft; an Allegion brand.
 4. West Central Manufacturing, Inc.

2.02 PERFORMANCE REQUIREMENTS

- A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. when tested according to ASTM C518.

2.03 INTERIOR STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch.
 - d. Edge Construction: Model 2, Seamless.
 - e. Core: Manufacturer's standard Vertical steel stiffener.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch.
 - b. Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: Full profile welded.

2.04 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.

- c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A40 coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Manufacturer's standard vertical steel stiffener with insulation.
2. Frames:
- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
 - b. Construction: Thermally broken, full profile welded.

2.05 FRAME ANCHORS

- A. Jamb Anchors:
- 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 - 3. Post-installed Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
- 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.06 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 08 80 00 - Glazing.

2.07 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
 - 2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
 - 3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.08 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 EXECUTION

3.01 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION

- A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 2. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Solidly pack mineral-fiber insulation inside frames.
 4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 5. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

- C. Glazing: Comply with installation requirements in Section 08 80 00 - Glazing and with hollow-metal manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

A. Inspections

1. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
2. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.04 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Insulated service doors.

B. Related Requirements

1. Section 05 50 00 - Metal Fabrications, for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.02 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
2. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance data.

C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.06 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction and ICC A117.1.
- B. Structural Performance: Exterior doors shall withstand the following design loads within limits and under conditions indicated determined in accordance with the 2018 IBC and ASTM E1300:
 1. Design Wind Pressures:
 - a. Basic Wind Speed – 115 mph
 - b. Importance Factor – 1.0
 - c. Exposure Category – C
 - d. Wind Enclosure - Enclosed

2.02 DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Thermiser Max Insulated Rolling Door by Cornell, 24 Elmwood Avenue, Mountain Top, PA 18707, Telephone: (800) 233-8366 or comparable product by one of the following:
 1. Cookson.
 2. Clopay Building Products.
 3. Amarr.
- C. Operation Cycles: Door components and operators capable of operating for not less than 50,000.
- D. Fabrication
 1. Slat Material: No. 6F: Galvanized Steel/Galvanized Steel: Manufacturer recommended gauge based on performance requirements. Minimum 24/24 gauge, Grade 40, ASTM A 653 galvanized steel zinc coating.
 2. Insulation: 7/8 inch (22 mm) foamed-in-place, closed cell urethane.
 3. Total Slat Thickness: 15/16 inch (24 mm).
 4. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84.
 5. R-value: 8.0.
- E. Exterior and Interior Slat Finish
 1. GalvaNex Coating System (Stock Colors).
- F. Endlocks: Fabricate interlocking sections with high strength nylon or galvanized cast iron endlocks on alternate slats each secured with two 1/4" rivets. Provide windlocks as required to meet specified wind load.

- G. Insulated Bottom Bar: Reinforced extruded aluminum interior face with full depth insulation and exterior skin slat to match curtain material and gauge. Minimum 4" tall x 1-1/16" thickness.
1. Finish:
 - a. Exterior: Match slats.
 - b. Interior: Powder coat to match slats.
 2. Air Infiltration Certification Label: Must be affixed to bottom bar.
- H. Guides
1. Thermal break required. Minimum 3/16 inch structural steel angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar. Top 16-1/2" of coil side guide angles to be removable for ease of curtain installation and as needed for future curtain service
 2. Powder Coat (Stock Colors): Zirconium treatment followed by a baked-on polyester powder coat; minimum 2.5 mils (0.065 mm) cured film thickness.
- I. Counterbalance Shaft Assembly
1. Barrel: Steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width.
 2. Spring Balance: Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door to ensure that maximum effort to operate will not exceed 25 lbs. Provide wheel for applying and adjusting spring torque.
- J. Brackets: Fabricate from minimum 3/16-inch steel plate with permanently lubricated ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures.
1. Powder Coat (Stock Colors): Zirconium treatment followed by a baked-on polyester powder coat; minimum 2.5 mils cured film thickness.
- K. Hood: Minimum 24 gauge galvanized steel with reinforced top and bottom edges. Provide minimum 1/4-inch steel intermediate support brackets as required to prevent excessive sag.
1. Finish: GalvaNex Coating System (Stock Colors).
- L. Weatherstripping
1. Bottom Bar:
 - a. Manually Operated Doors: Replaceable, bulb-style, compressible EDPM gasket extending into guides.
 - b. Motor Operated Doors: Sensing/weather edge with neoprene astragal extending full width of door bottom bar.
 2. Guides: Replaceable vinyl strip on guides sealing against both sides of curtain.
 3. Lintel Seal: Double brush seal with EPDM sandwiched between the two brush seals at door header to impede air flow.
 4. Hood: Neoprene/rayon baffle to impede air flow above coil.

2.03 OPERATION

- A. Motor – Standard Use – Model MG (Industrial Duty Gear Head) Operator: The operator must not extend above or below the door coil when mounted front-of-coil. Rated for a maximum of 20 cycles per hour (not to be used for consecutive hours) UL, Totally Enclosed Non-Ventilated gear head operators rated 1/2 hp as recommended by door manufacturer for size and type of door, 480 Volts, 3-Phase. Provide complete with electric motor and factory pre-wired motor control terminals, maintenance free solenoid actuated brake, emergency manual chain hoist and control station(s). Motor shall be high starting torque, industrial type, protected against overload with an auto-reset thermal sensing device. Primary speed reduction shall be heavy-duty, lubricated gears with mechanical braking to hold the door in any position. Operator shall be equipped with an emergency manual chain hoist assembly that safely cuts operator power when engaged. A disconnect chain shall not be required to engage or release the manual chain hoist. Operator drive and door driven sprockets shall be provided with #50 roller chain. Provide an integral Motor Mounted Interlock system to prevent damage to door and operator when mechanical door locking devices are provided. Operator shall be capable of driving the door at a speed of 8 to 9 inches per second (20 to 23 cm/sec). Fully adjustable, driven linear screw type cam limit switch mechanism shall synchronize the operator with the door. The electrical contractor shall mount the control station(s) and supply the appropriate disconnect switch, all conduit and wiring per the overhead door wiring instructions.
- B. Control Station
 - 1. Surface mounted: "Open/Close/Stop" push buttons; NEMA 1
- C. Control Operation
 - 1. Momentary Contact to Close: Fail-safe, UL325-2010 Compliant Entrapment Protection for Motor Operation
 - a. NEMA 4X photo eye sensors consisting of a transmitter and receiver that are to be mounted within 6" of the floor, projecting an IR beam across the entire width of the door. Electrical contractor to provide low voltage wiring from the transmitter and receiver to the door operator.
 - 2. Sensing/Weather Edge: Automatic reversing control by an automatic sensing switch within neoprene or rubber astragal extending full width of door bottom bar
 - a. Electric sensing edge device. Provide a wireless sensing edge connection to motor operator eliminating the need for a physical traveling electric cord connection between bottom bar sensing edge device and motor operator.

2.04 ACCESSORIES

- A. Locking
 - 1. Masterkeyable cylinder operable from coil side of bottom bar, options for all types of operation. Provide interlock switches on Motor operated units.
 - a. Standard Mortise Cylinder.
- B. Operator and Bracket Mechanism Cover: Minimum 24 gauge galvanized steel sheet metal cover to enclose exposed moving operating components at coil area of unit. Finish to match door hood.
- C. Trim Package: Minimum 16-gauge powder coated steel to match guides.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings.
- B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates.
- C. Commencement of work by installer is acceptance of substrate.

3.02 INSTALLATION

- A. General: Install door and operating equipment with necessary hardware, anchors, inserts, hangers and supports.
- B. Follow manufacturer's installation instructions.

3.03 ADJUSTING

- A. Following completion of installation, including related work by others, lubricate, test, and adjust doors for ease of operation, free from warp, twist, or distortion.

3.04 CLEANING

- A. Clean surfaces soiled by work as recommended by manufacturer.
- B. Remove surplus materials and debris from the site.

3.05 DEMONSTRATION

- A. Demonstrate proper operation to Contracting Officer.
- B. Instruct Contracting Officer in maintenance procedures.

END OF SECTION

SECTION 08 45 23

TRANSLUCENT WALL PANEL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes the insulated, translucent sandwich panel system and accessories as shown and specified. Work includes providing and installing:

1. Flat insulated, translucent sandwich panels

1.02 SUBMITTALS

- A. Submit manufacturer's product data. Include construction details, material descriptions, profiles, and finishes of components.

- B. Submit shop drawings. Include plans, elevations, and details.

- C. Samples:

1. Submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below.

- a. Sandwich panels: 7" x 12" units
- b. Factory finished aluminum: 3" long sections

- D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.

- E. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.

1. Reports required (if applicable) are:

- a. Flame Spread and Smoke Developed (UL 723) – Submit UL Card
- b. Burn Extent (ASTM D 635)
- c. Color Difference (ASTM D 2244)
- d. Impact Strength (UL 972)
- e. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
- f. Bond Shear Strength (ASTM D 1002)
- g. Beam Bending Strength (ASTM E 72)
- h. Insulation U-Factor (NFRC 100)
- i. NFRC System U-Factor Certification (NFRC 700)
- j. NFRC Visible Light Transmittance (NFRC 202)

- k. Solar Heat Gain Coefficient (NFRC or Calculations)
- l. Condensation Resistance Factor (AAMA 1503) (Thermally Broken, insulated panels only)
- m. Air Leakage (ASTM E 283)
- n. Structural Performance (ASTM E 330)
- o. Water Penetration (ASTM E 331)
- p. Fire Penetration of Exterior Wall Assemblies Using a Direct Flame Impingement Exposure (ASTM E2707)

1.03 CLOSEOUT SUBMITTALS

- A. Provide field maintenance manual to include in project maintenance manuals.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications

- 1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope, and location. At least three of the projects shall have been in successful use for ten years or longer.
- 2. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural, and water infiltration testing of sandwich panel systems by an accredited agency.
- 3. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components, and production sandwich panels for conformance with AC177 "Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems" as issued by the ICC-ES.

- B. Installer's Qualifications: Installation shall be by an experienced installer, which has been in the business of installing Kalwall panel systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope, and type.

1.05 PERFORMANCE REQUIREMENTS

- A. The manufacturer shall be responsible for the configuration and fabrication of the complete panel system.

- 1. When requested, include span analysis data.
- 2. Standard panel system shall have less than 0.01 cfm/ft² air leakage by ASTM E 283 at 6.24 PSF (50 mph) and no water penetration by ASTM E 331 at 15 PSF; and structural testing by ASTM E 330.
- 3. Structural Loads. Provide system capable of handling the following loads:
 - a. Positive Wind Load (PSF): 25 PSF Ultimate
 - b. Negative Wind Load (PSF): 23 PSF Ultimate

- B. Deflection Limits

Based on project conditions or requirements of authorities having jurisdiction, more stringent deflection criteria than those specified in options in subparagraphs below may be required. Building codes include different deflection criteria depending on whether panel systems are classified as components and cladding or as part of the main wind-force-resisting system (for example, where a panel system is the structural roof). For discussion of deflection criteria, see "Deflection" Article in the Evaluations in Section 08 45 00 "Translucent Wall and Roof Assemblies."

1. Walls: Limited to L/120 of clear span for each assembly component.
- C. Thermal Movements: Allow for thermal movements from ambient- and surface-temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 110 deg F (43 deg C), ambient; 150 deg F (66 deg C), material surfaces.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver panel system, components, and materials in manufacturer's standard protective packaging.
- B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

1.07 WARRANTY

- A. 20 year Limited Warranty against external exposure of the reinforcing glass fibers.
- B. Provide manufacturer's and installer's written warranties agreeing to repair or replace panel system work, which fails in material or workmanship, within 5 year from the date of delivery. Failure of material or workmanship shall include deterioration of finish on metal in excess of normal weathering; and defects in accessories; insulated, translucent sandwich panels; and other components of the work.
- C. Extended Panel Warranty
 1. 10 year Limited Warranty covering separation of faces from grid core affecting structural strength, noticeable surface fiber exposure of the exterior panel face, and/or abnormal color change of the exterior face sheet.
 2. 20 year Limited Warranty against external exposure of the reinforcing glass fibers.
- D. Extended Manufacturer's factory applied Finish Warranty
 1. Finish Warranty: 10 year Limited Warranty for Manufacturer's factory applied corrosion resistant finish against cracking, peeling, and adhesion failure.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. The basis for this specification is for products manufactured by Kalwall Corporation. Other manufacturers may bid this project subject to compliance with the performance requirements of this specification and submission of evidence thereof. Listing other manufacturers' names in this

specification does not constitute approval of their products or relieve them of compliance with all the performance requirements contained herein.

B. Kalwall Corporation, Tel: (800) 258-9777 – Email: info@kalwall.com

2.02 PANEL COMPONENTS

A. Face Sheets

1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.
 - a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
 - b. Face sheets shall not deform, deflect, or drip when subjected to fire or flame.
2. Interior face sheets:
 - a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 25 and smoke developed no greater than 450 when tested in accordance with UL 723.
 - b. Burn extent by ASTM D 635 shall be no greater than 1".
3. Exterior face sheets:
 - a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 5 years outdoor South Florida weathering at 5° facing south as measured on a white sample, with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
 - b. Strength: Exterior face sheet shall be uniform in strength, impenetrable by hand held pencil and repel an impact minimum of 70 ft. lbs. without fracture or tear when impacted by a 3-1/4" diameter, 5 lb. free-falling ball per UL 972.
 - c. Erosion Protection: Integral, embedded-glass erosion barrier.
4. Appearance:
 - a. Exterior face sheet: Smooth, 0.070" thick and White in color.
 - b. Interior face sheet: Smooth, 0.045" thick and White in color.
 - c. Face sheets shall not vary more than $\pm 10\%$ in thickness and be uniform in color.

B. Grid Core

1. Thermally Broken Composite I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".
2. I-beam Thermal break: Minimum 2", thermoset fiberglass composite. Poured and de-bridged thermal break is not acceptable.

C. Laminate Adhesive

1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives".

2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.
3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:
 - a. 50% Relative Humidity at 68° F: 540 PSI
 - b. 182° F: 100 PSI
 - c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI
 - d. Accelerated Aging by ASTM D 1037 at 182° F: 250 PSI

2.03 PANEL CONSTRUCTION

- A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
 1. Thickness: 4 inches
 2. Grid Core Insulation: Fill panel cores with air
 3. Panel U-factor by NFRC certified laboratory: 4" thermally broken grid 0.55
 4. Complete insulated panel system shall have NFRC certified U-factor of 0.53
 5. Visible Light Transmittance (VLT):
 - a. Visible LT (NFRC 202) by NFRC certified laboratory: 45%. For White/White face.
 6. Solar heat gain coefficient: 0.44%
 7. Grid pattern as viewed: Nominal size 12 x 24 ; pattern Shoji
- B. Standard panels shall deflect no more than 1.9" at 30 PSF in 10'-0" span without a supporting frame by ASTM E 72.
- C. Panels shall meet the conditions of acceptance according to ASTM E2707 Fire Penetration of Exterior Wall Assemblies Using a Direct Flame Impingement Exposure:
 1. Absence of flame penetration through the wall assembly at any time.
 2. Absence of evidence of glowing combustion on the interior surface of the assembly at the end of the 60-min observation period.
 3. Absence of evidence of flame, glow, and smoke if the test is terminated prior to the completion of the 60-min observation period.
- D. Thermally broken, insulated panels: Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.

2.04 ALUMINUM CLAMPTITE INSTALLATION SYSTEM

- A. Aluminum Clamptite Installation System
 1. Thermally Broken-Flat extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamptite screw type closure system.

- B. Sealing tape: Manufacturer's standard, pre-applied to aluminum clampite installation system at the factory under controlled conditions.
- C. Fasteners: 300 series stainless steel screws for aluminum clampite installation system, excluding final fasteners to the building.
- D. Finish:
 - 1. Mill

PART 3 EXECUTION

3.01 EXAMINATION

- A. Installer shall examine substrates, supporting structure, and installation conditions.
- B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Metal Protection
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by sealant manufacturer for this purpose.
 - 2. Where aluminum will contact concrete, masonry, or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by sealant manufacturer.

3.03 INSTALLATION

- A. Install the panel system in accordance with the manufacturer's fabrication drawings and suggested installation instructions.
 - 1. Anchor component parts securely in place by permanent mechanical attachment system.
 - 2. Accommodate thermal and mechanical movements.
 - 3. Seal aluminum clampite installation system as shown on the manufacturer's fabrication drawings and suggested installation instructions.
- B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturers fabrication drawings and suggested installation instructions.

3.04 FIELD QUALITY CONTROL DELETE THIS SECTION IF NOT APPLICABLE.

- A. Water Test: Installer to test a representative section of installed materials according to procedures in AAMA 501.2.
- B. Repair or replace work that does not pass testing or that is damaged by testing and retest work.

3.05 CLEANING

- A. Clean the panel system, interior and exterior, immediately after installation.

- B. Refer to manufacturer's written recommendations.

END OF SECTION

SECTION 08 51 13
ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes aluminum windows for exterior locations.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
- C. Samples: For each exposed product and for each color specified.

1.04 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranties.

1.05 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
1. Warranty Period:
- a. Window: 10 years from date of Substantial Completion.
- b. Glazing Units: 10 years from date of Substantial Completion.
- c. Aluminum Finish: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 WINDOW PERFORMANCE REQUIREMENTS

- A. Structural Performance: Windows shall withstand the following design loads within limits and under conditions indicated determined in accordance with the 2018 IBC and ASTM E1300:
1. Design Wind Pressures:
- a. Basic Wind Speed – 115 mph
- b. Importance Factor – 1.0

- c. Exposure Category – C
 - d. Wind Enclosure – Enclosed
- B. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Window Certification: AAMA certified with label attached to each window.
- C. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 - 1. Minimum Performance Class: AW.
 - 2. Minimum Performance Grade: 40
- D. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.32 Btu/sq. ft. x h x deg F.
- E. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.40.
- F. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 52.
- G. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

2.02 ALUMINUM WINDOWS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Arcadia, Inc.
 - 2. Custom Window Company.
 - 3. EFCO Corporation.
 - 4. Kawneer North America, an Arconic company.
 - 5. Manko Window Systems, Inc.
- B. Types: Aluminum Windows
- C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
 - 1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
- D. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered where indicated on Drawings.
- E. Insulating-Glass Units: ASTM E2190.
 1. Glass: ASTM C1036, Type 1, Class 1, q3.
 - a. Tint: Clear.
 - b. Kind: Fully tempered where indicated on Drawings.
 2. Lites: As shown on drawings.
 3. Filling: Fill space between glass lites with air.
 4. Low-E Coating: Pyrolytic on second surface.
- F. Refer to Section 08 80 00 - Glazing for additional requirements.
- G. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.
- H. Hardware, General: Provide manufacturer's standard corrosion-resistant hardware sized to accommodate sash weight and dimensions.
 1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.
- I. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
- J. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
 1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.03 ACCESSORIES

- A. Subsills: Thermally broken, extruded aluminum subsills in configurations indicated on Drawings.
- B. Column Covers: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- C. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- D. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- E. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

2.04 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.

- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.05 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 1. Color: As selected by Architect from Medium Bronze, Dark Bronze and Black.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- E. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- F. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware
2. Electronic access control system components

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section "Alternates" for alternates affecting this section.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
 - a. "Metal Doors and Frames"
 - b. "Flush Wood Doors"
 - c. "Stile and Rail Wood Doors"
 - d. "Interior Aluminum Doors and Frames"
 - e. "Aluminum-Framed Entrances and Storefronts"
 - f. "Stainless Steel Doors and Frames"
 - g. "Special Function Doors"
 - h. "Entrances"
6. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
7. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL LLC

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
 - a. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - b. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
 - a. Wiring Diagrams: For power, signal, and control wiring and including:
 - 1) Details of interface of electrified door hardware and building safety and security systems.
 - 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
4. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect's hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each hardware set cross-referenced to indications on Drawings.
 - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for hardware.
 - 8) Door and frame sizes and materials.
 - 9) Degree of door swing and handing.
 - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.

5. Key Schedule:

- a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
- b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
- c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
- d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
- e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
- f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.

D. Closeout Submittals

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Final approved hardware schedule edited to reflect conditions as installed.
 - d. Final keying schedule
 - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
 - f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing

1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
 - a. Fire door assemblies, in compliance with NFPA 80.
 - b. Required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.
 - c. Can inspect and verify components are in working order upon completion of installation.
 - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications

1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
3. Electrified Door Hardware
 - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

4. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference
 - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.
 - 3) Requirements for key control system.
 - 4) Requirements for access control.
 - 5) Address for delivery of keys.
2. Pre-installation Conference
 - a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Inspect and discuss preparatory work performed by other trades.
 - c. Inspect and discuss electrical roughing-in for electrified door hardware.
 - d. Review sequence of operation for each type of electrified door hardware.
 - e. Review required testing, inspecting, and certifying procedures.
 - f. Review questions or concerns related to proper installation and adjustment of door hardware.
3. Electrified Hardware Coordination Conference:
 - a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.07 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
 - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - a) Schlage L Series: 3 years
 - 2) Exit Devices
 - a) Von Duprin: 3 years
 - 3) Closers
 - a) LCN 4000 Series: 30 years

1.08 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Approval of alternate manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category are only to be considered by official substitution request in accordance with section 01 25 13.
- B. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

- A. Fabrication
 - 1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer's recognized installation standards for application intended.
 - 2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 - 3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.
- C. Cable and Connectors
 - 1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
 - 2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
 - 3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

- A. Manufacturers and Products
 - 1. Scheduled Manufacturer and Product:
 - a. Ives 5BB series

B. Requirements

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
5. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 MORTISE LOCKS

A. Manufacturers and Products

1. Scheduled Manufacturer and Product
 - a. Schlage L9000 series

B. Requirements

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.

4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
7. Provide motor based electrified locksets that comply with the following requirements:
 - a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
 - b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case.
 - c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
 - d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate "hot levers" in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
 - e. Connections – provide quick-connect Molex system standard.
8. KEY OVERRIDE OPTION WHEN XL13-439 IS SPECIFIED IN HARDWARE SETS. Provide locks with a key override feature built into the chassis that allows the outside key to retract the deadbolt and/or latchbolt, overriding the inside thumbturn when it is being held in the locked position.
9. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Vandlgard: Provide levers with vandal resistant technology for use at heavy traffic or abusive applications.
 - b. Lever Design: 06A

2.05 EXIT DEVICES

A. Manufacturers and Products

1. Scheduled Manufacturer and Product:
 - a. Von Duprin 98/35A series

B. Requirements

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide smooth touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.

5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturer's approved strikes.
9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
11. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
12. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
13. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
14. Provide electrified options as scheduled.
15. Top latch mounting: double- or single-tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
16. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.06 KEYING

A. Scheduled System

1. New factory registered system:
 - a. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
2. Existing factory registered system:
 - a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements

1. Construction Keying:
 - a. Temporary Construction Cylinder Keying.
 - 1) Provide construction cores that permit voiding construction keys without cylinder removal, furnished in accordance with the following requirements.
 - a) Split Key or Lost Ball Construction Keying System.
 - b) 3 construction control keys, and extractor tools or keys as required to void construction keying.
 - c) 12 construction change (day) keys.

- 2) Owner or Owner's Representative will void operation of temporary construction keys.
- b. Replaceable Construction Cores.
 - 1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - a) 3 construction control keys
 - b) 12 construction change (day) keys.
 - 2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.
2. Permanent Keying:
 - a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - 1) Master Keying system as directed by the Owner.
 - b. Forward biting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 - c. Provide keys with the following features:
 - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
 - 3) Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.
 - d. Identification:
 - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
 - 2) Identification stamping provisions must be approved by the Architect and Owner.
 - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
 - 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
 - e. Quantity: Furnish in the following quantities.
 - 1) Change (Day) Keys: 3 per cylinder/core.
 - 2) Permanent Control Keys: 2.
 - 3) Master Keys: 6.

2.07 KEY CONTROL SYSTEM

A. Manufacturers

1. Scheduled Manufacturer:
 - a. Telkee
2. Acceptable Manufacturers:
 - a. HPC
 - b. Lund

B. Requirements

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 - b. Provide hinged-panel type cabinet for wall mounting.

2.08 DOOR CLOSERS

A. Manufacturers and Products

1. Scheduled Manufacturer and Product:
 - a. LCN 4040XP series

B. Requirements

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.

9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.09 PROTECTION PLATES

A. Manufacturers

1. Scheduled Manufacturer
 - a. Ives

B. Requirements

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.10 DOOR STOPS AND HOLDERS

A. Manufacturers

1. Scheduled Manufacturer:
 - a. Ives

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button or thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.11 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers

1. Scheduled Manufacturer:
 - a. Zero International

B. Requirements

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.

2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.12 SILENCERS

A. Manufacturers

1. Scheduled Manufacturer:
 - a. Ives

B. Requirements

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.13 DOOR POSITION SWITCHES

A. Manufacturers

1. Scheduled Manufacturer:
 - a. Schlage

B. Requirements

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.14 FINISHES

A. FINISH: BHMA 626/652 (US26D); EXCEPT:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Aluminum Geared Continuous Hinges: BHMA 628 (US28)
3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
4. Protection Plates: BHMA 630 (US32D)
5. Overhead Stops and Holders: BHMA 630 (US32D)
6. Door Closers: Powder Coat to Match
7. Wall Stops: BHMA 630 (US32D)
8. Latch Protectors: BHMA 630 (US32D)

- 9. Weatherstripping: Clear Anodized Aluminum
- 10. Thresholds: Mill Finish Aluminum

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
 - 3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
 - 4. Installation Guide for Doors and Hardware: DHI TDH-007-20
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.
- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Lock Cylinders:

1. Install construction cores to secure building and areas during construction period.
 2. Replace construction cores with permanent cores as indicated in keying section.
 3. Furnish permanent cores to Owner for installation.
- J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:
1. Conduit, junction boxes and wire pulls.
 2. Connections to and from power supplies to electrified hardware.
 3. Connections to fire/smoke alarm system and smoke evacuation system.
 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
 5. Connections to panel interface modules, controllers, and gateways.
 6. Testing and labeling wires with Architect's opening number.
- K. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- L. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- M. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- N. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- O. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- P. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- Q. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- R. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- S. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.
- 3.03 ADJUSTING
- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Spring Hinges: Adjust to achieve positive latching when door can close freely from an open position of 30 degrees.

2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets: Presented on the following pages.

95038 OPT0332447 Version 1

Legend:

 Link to catalog cut sheet












 Electrified Opening

Hardware Group No. 1

For use on Door #(s):

1 2 3 4 5 6
7 8

Provide each SGL door(s) with the following:














QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		630	IVE
1	EA	PANIC HARDWARE	9875-L-NL-03		626	VON
1	EA	MORTISE CYLINDER	(MATCH EXSTING KEY SYSTEM)		626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	RAIN DRIP	142AA		AA	ZER
1	SET	GASKETING	429AA-S		AA	ZER
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	VERIFY SILL CONDITION		A	ZER
1	EA	DOOR CONTACT	7764 / 679-05 AS REQUIRED	 	628	SCE

Hardware Group No. 2

For use on Door #(s):

14

Provide each PR door(s) with the following:






QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 5 X 4.5 NRP		630	IVE
1	EA	PANIC HARDWARE	9847-EO		626	VON
1	EA	PANIC HARDWARE	9847-L-NL-03		626	VON
1	EA	RIM CYLINDER	(MATCH EXISTING KEY SYSTEM)		626	FAL
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	RAIN DRIP	142AA		AA	ZER
1	SET	GASKETING	429AA-S		AA	ZER
2	EA	DOOR SWEEP	39A		A	ZER
2	EA	MEETING STILE	8194AA		AA	ZER
1	EA	THRESHOLD	VERIFY SILL CONDITION		A	ZER
2	EA	DOOR CONTACT	7764 / 679-05 AS REQUIRED	 	628	SCE

Hardware Group No. 3

For use on Door #(s):

13

Provide each SGL door(s) with the following:







QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	PRIVACY LOCK	L9040 03A L583-363 L283-722		626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	SET GASKETING	488SBK		BK	ZER

Hardware Group No. 4

For use on Door #(s):

9

Provide each SGL door(s) with the following:







QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	PANIC HARDWARE	98-L-06		626	VON
1	EA	RIM CYLINDER	(MATCH EXISTING KEY SYSTEM)		626	FAL
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
3	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 5

For use on Door #(s):

12

Provide each SGL door(s) with the following:







QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	PASSAGE SET	L9010 03A		626	SCH
1	EA	SURFACE CLOSER	4040XP EDA TBWMS		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
3	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 6

For use on Door #(s):

11

Provide each SGL door(s) with the following:








QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	PANIC HARDWARE	98-L-NL-06		626	VON
1	EA	RIM CYLINDER	(MATCH EXISTING KEY SYSTEM)		626	FAL
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
3	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 7

For use on Door #(s):

10

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	PASSAGE SET	L9010 03A		626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	SET GASKETING	488SBK		BK	ZER
1	EA	DOOR SWEEP	111AA		AA	ZER
1	EA	THRESHOLD	VERIFY SILL CONDITION		A	ZER

Hardware Group No. OH01

For use on Door #(s):

15

16

17

Provide each RU door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1			HARDWARE BY MANUFACTURER			

END OF SECTION

SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Glass for doors and storefront framing.
2. Glazing sealants and accessories.

1.02 COORDINATION

- ###### A.
- Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.03 ACTION SUBMITTALS

- ###### A.
- Product Data: For each type of product.
- ###### B.
- Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- ###### C.
- Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

- ###### A.
- Preconstruction adhesion and compatibility test report.
- ###### B.
- Sample warranty.

1.05 QUALITY ASSURANCE

- ###### A.
- Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.06 CLOSEOUT

- ###### A.
- Warranty.

1.07 WARRANTY

- ###### A.
- Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the International Building Code and ASTM E 1300.

1. Design Wind Pressures: As indicated on Drawings.
2. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

- B. Windborne-Debris-Impact Resistance: Exterior glazing shall comply with basic protection testing requirements in ASTM E 1996 for applicable Wind Zone when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on Project and shall be installed in same manner as glazing indicated for use on Project.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located more than 30 feet above grade.

- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.02 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

- B. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements, is not less than the thickness indicated and is compatible with Aluminum Storefront System.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.03 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

2.04 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
 - 1. Sealing System: Dual seals.
 - 2. Spacer: Manufacturer's standard spacer material and construction.

2.05 GLAZING SEALANTS

- A. General
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Colors of Exposed Glazing Sealants: As selected by Owner from manufacturer's full range.
 - 3. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

2.06 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.07 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

PART 3 EXECUTION

3.01 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.02 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

3.03 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.04 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.05 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.

3.06 INSULATING GLASS SCHEDULE

- A. Glass Type [GL-1]: Pyrolytic Low-e, tinted, fully tempered Insulating Glass with. Exterior.
 - 1. Overall Unit Thickness: 1 inch.
 - 2. Thickness of Each Glass Lite: 1/4 inch.
 - 3. Outdoor Lite: Solar Bronze, Fully Tempered Glass.
 - 4. Interspace Content: Air.
 - 5. Indoor Lite: Clear fully tempered float glass. Pyrolytic Coated on third surface (3).
 - 6. Performance Values:
 - a. Exterior Reflectance: 7%.
 - b. SC: 0.36.
 - c. SHGC: 0.31.
 - d. U-Value: 0.29.
 - 7. Low-E Coating: Solarban 60 Low-E coating by PPG Industries, Inc. or equivalent.
 - 8. Location: Third Surface (3).
 - 9. Outdoor Appearance: Bronze color, low-reflective glass product
- B. Glass Type [GL-2]: Insulating Glass. Interior.
 - 1. Overall Unit Thickness: 1 inch.
 - 2. Thickness of Each Glass Lite: 1/4 inch.
 - 3. Indoor Lite: Clear fully tempered float glass.
 - 4. Interspace Content: Air.
 - 5. Indoor Lite: Clear fully tempered float glass.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions and exterior furring.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 FRAMING SYSTEMS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: Comply with ASTM C 645; roll-formed from hot-dipped galvanized steel; complying with ASTM A 653/A 653M G40 (Z120) or having a coating that provides equivalent corrosion resistance. A40 galvanized products are not acceptable.
 - a. Coatings shall demonstrate equivalent corrosion resistance with an evaluation report acceptable to the authority having jurisdiction.

C. Studs and Runners: ASTM C 645.

1. Steel Studs and Runners:

- a. Minimum Base-Metal Thickness: 25 ga minimum base-metal thickness unless noted otherwise.
- b. Depth: As indicated on Drawings.

1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

- a. Products: Subject to compliance with requirements, provide the following:
- b. Double Track System. 6" leg overtrack that allows for 2 1/2" of movement each way, 20ga, by Dietrich Metal Framing or approved equal.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. 6" minimum x longest available length, 20-gauge, flat stock.

- E. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.
- F. Cold-Rolled Furring Channels: 25 ga minimum base-metal thickness.
 - 1. Depth: 3-5/8".
 - 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
 - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

2.02 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226/D 226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8-inch-thick, in width to suit steel stud size.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.02 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 2. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- E. Direct Furring
 - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Interior gypsum board.
2. Tile backing panels.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum wallboard.
2. Gypsum board, Type X.
3. Gypsum ceiling board.
4. Mold-resistant gypsum board.
5. Cementitious backer units.
6. Joint treatment materials.
7. Sound-attenuation blankets.
8. Acoustical sealant.

B. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. Verify ceiling and wall materials comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.02 GYPSUM BOARD, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Regional Materials: Manufacture products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

- C. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.03 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Gypsum.
 - b. Georgia-Pacific Gypsum LLC.
 - c. USG Corporation.
- 2. Thickness: 5/8 inch.
- 3. Long Edges: Tapered.

B. Gypsum Board, Type X: ASTM C1396/C1396M.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Gypsum.
 - b. Georgia-Pacific Gypsum LLC.
 - c. USG Corporation.
- 2. Thickness: 5/8 inch.
- 3. Long Edges: Tapered.

C. Gypsum Ceiling Board: ASTM C1396/C1396M.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Gypsum.
 - b. Georgia-Pacific Gypsum LLC.
 - c. USG Corporation.
- 2. Thickness: 5/8 inch.
- 3. Long Edges: Tapered.

D. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Gypsum.
 - b. Georgia-Pacific Gypsum LLC.
 - c. USG Corporation.
- 2. Core: 5/8 inch, Type X.
- 3. Long Edges: Tapered.

4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.04 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. James Hardie Building Products, Inc.
 - c. USG Corporation.
 2. Thickness: 5/8 inch.
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.05 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.

2.06 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape
 1. Interior Gypsum Board: Paper.
 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
- D. Joint Compound for Tile Backing Panels
 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.07 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.
 - 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 - 2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- E. Acoustical Sealant
 - 1. Verify sealant has a VOC content of 250 g/L or less.
 - 2. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 EXECUTION

3.01 INSTALLATION AND FINISHING OF PANELS

- A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- B. Comply with ASTM C840.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- E. Prefill open joints and damaged surface areas.
- F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 90 00 - Coatings.

H. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.02 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION

SECTION 09 30 13

CERAMIC TILING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Glazed wall tile.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples

1. Each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide samples of each color blend.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.04 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.05 QUALITY ASSURANCE

A. Installer Qualifications

1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.

1.06 CLOSEOUT

A. Warranties.

PART 2 PRODUCTS

2.01 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.02 TILE PRODUCTS

- A. Ceramic Wall Tile (CWT): Glazed wall tile.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Marazzi Tile, Inc.
 - b. American Olean; Division of Dal-Tile International Inc.
 - c. Daltile; Division of Dal-Tile International Inc.
 - d. Deutsche Steinzeug America, Inc.
 - e. Florida Tile Industries, Inc.
 - f. Florim USA.
 - g. Laufen.
 - h. Grupo Porcelanite.
 - i. Portobello America, Inc.
 - j. Seneca Tiles, Inc.
 - k. United States Ceramic Tile Company.
2. Module Size: 4-1/4 by 4-1/4 inches.
3. Thickness: 5/16 inch.
4. Face: Plain with modified square edges or cushion edges.
5. Finish: Bright, opaque glaze.
6. Tile Color and Pattern: As selected by Owner from manufacturer's full range.
7. Grout Color: As selected by Owner from manufacturer's full range.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Sanitary Cover Base: Flat top sanitary cove case, module size 4-1/4 by 4-1/4 inches.
 - b. Wainscot Cap: Bullnose cap, module size 4-1/4 by 4-1/4 inches.
 - c. External Corners for Thin-Set Mortar Installations: Bullnose shape, same size as adjoining flat tile.
 - d. Internal Corners: Field-buttet square corners.

2.03 TILE BACKING PANELS

- A. As specified in Section 09 29 00 - Gypsum Board.

2.04 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kerabond/Keralastic by MAPEI or comparable product by one of the following:
 - a. Bonsal American; an Oldcastle company.
 - b. Laticrete International, Inc.
2. For wall applications, provide nonsagging mortar.

2.05 GROUT MATERIALS

A. Polymer-Modified Tile Grout: ANSI A118.7.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Keracolor U by MAPEI or comparable product by one of the following:
 - a. Bonsal American; an Oldcastle company.
 - b. Laticrete International, Inc.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
- B. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- C. Failure to call attention to defects or imperfections will be construed as acceptance and approval of substrate conditions. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation and full responsibility for completed work.

3.02 PREPARATION

- A. Blending: For tile exhibiting color variations, use factory blended tile or blend tiles at Project site before installing.
- B. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.03 INSTALLATION

- A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications

for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Ceramic Mosaic Tile: 1/16 inch.
 - 2. Glazed Wall Tile: 1/16 inch.
- G. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
 - 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 - Joint Sealants.
- H. Grout Sealer: Apply grout sealer to grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.04 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Wall Installations, Metal Studs or Furring:
 - 1. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.
 - a. Tile Type: CWT.
 - b. Thin-Set Mortar: Latex- portland cement mortar.
 - c. Grout: Polymer-modified unsanded grout.

END OF SECTION

SECTION 09 51 23
ACOUSTICAL TILE CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Evaluation reports.
- C. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Provide 100 square feet of acoustical panels and exposed suspension systems to Owner for future use.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to NVLAP.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Verify ceiling products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.02 ACOUSTICAL PANEL CEILINGS, GENERAL

- A. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- B. Acoustical Panel Standard: Comply with ASTM E 1264.
- C. Metal Suspension System Standard: Comply with ASTM C 635.
- D. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

2.03 SUSPENDED ACOUSTICAL CEILINGS

- A. Manufacturers: Subject to compliance with requirements, provide listed below or approved equivalent products by one of the following manufacturers:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed Corp.
 - 3. Chicago Metallic Corporation.
 - 4. Tectum Inc.
 - 5. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Acoustical Panels
 - 1. Basis-of-Design Product for SAC 'A': Frost ClimaPlus HighNRC/High-CAC by USG Interiors, Inc.
 - a. Color: White.
 - b. LR: .89
 - c. NRC: .80
 - d. CAC: 38
 - e. Edge/Joint Detail: SLB
 - f. Thickness: 7/8"
 - g. Modular Size: 24 by 24 inches

2.04 METAL SUSPENSION SYSTEM

- A. Material: Double-web G30 hot-dipped galvanized painted steel tee.
- B. Color: Flat White.
- C. Basis-of-Design Product for SAC 'A': DX/DXL by USG Interiors, Inc. or equivalent.
 - 1. Tee System: 15/16"
 - 2. ASTM Class: Heavy Duty

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install acoustical panel ceilings to comply with ASTM C 636/C 636M according to manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."
- B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders and comply with layout shown on reflected ceiling plans.
 - 1. Arrange directionally patterned acoustical panels as indicated on reflected ceiling plans.

END OF SECTION

SECTION 09 65 13

RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Resilient base.
2. Resilient molding accessories.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.

1.03 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive resilient products.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.

C. Install resilient products after other finishing operations, including painting, have been completed.

1.04 CLOSEOUT

A. Provide 10 lineal feet of each color of resilient base to Owner for future use.

PART 2 PRODUCTS

2.01 RESILIENT BASE

A. Resilient Base

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Armstrong World Industries, Inc.
- b. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
- c. Flexco, Inc.
- d. Johnsonite.
- e. Roppe Corporation, USA.
- f. VPI, LLC; Floor Products Division.

2. Resilient Base Standard: ASTM F 1861.
 - a. Material Requirement: Type TS (rubber, vulcanized thermoset).
 - b. Manufacturing Method: Group I (solid, homogeneous).
 - c. Style:
 - 1) Cove (base with toe) unless noted otherwise.
 - 2) Straight (flat or toeless) at carpeted areas.
3. Minimum Thickness: 0.125 inch.
4. Height: 4 inches.
5. Lengths: Coils in manufacturer's standard length.
6. Outside Corners: Preformed.
7. Inside Corners: Preformed.
8. Finish: Matte.
9. Colors and Patterns: As selected by Owner from full range of industry colors.

2.02 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
 1. Verify adhesives have a VOC content of 50 g/L or less.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Accessories: Prepare according to ASTM F 710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
 4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.02 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.

3.03 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- B. Cover resilient products until Substantial Completion.

END OF SECTION

SECTION 09 90 00

COATINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies architectural and industrial coating systems, including surface preparation and application requirements.

1.02 REFERENCES

- A. All coating materials shall conform to the following references. In case of discrepancies between the referenced specifications and this section, the more stringent requirement shall prevail.

<u>Reference</u>	<u>Title</u>
ASME A13.1-1996	Scheme for the Identification of Piping Systems
ASTM D4258-83(1999)	Standard Practice for Surface Cleaning Concrete for Coating
NSF/ANSI Std. 61	Drinking Water System Components – Health Effects
SSPC-SP1	Surface Preparation Specifications No. 1 - Solvent Cleaning
SSPC-SP2	Surface Preparation Specification No. 2 - Hand Tool Cleaning
SSPC-SP3	Surface Preparation Specification No. 3 - Power Tool Cleaning
SSPC-SP-5/NACE No. 1	Surface Preparation Specification No. 5 - White Metal Blast Cleaning
SSPC-SP6/NACE No. 3	Surface Preparation Specification No. 6 - Commercial Blast Cleaning
SSPC-SP7/NACE No. 4	Surface Preparation Specification No. 7 - Brush-off Blast Cleaning
SSPC-8	Surface Preparation Specification No. 8 - Pickling
SSPC-SP10/NACE No. 2	Surface Preparation Specification No. 10 - Near-White Blast Cleaning
SSPC-11	Surface Preparation Specification No. 11 - Power Tool Cleaning to Bare Metal

1.03 ABBREVIATIONS

- A. The abbreviations used in this Section shall have the following definitions:

<u>Abbreviation</u>	<u>Title</u>
ASTM	American Society for Testing and Materials
DFT	Dry Film Thickness
SFPG	Square Feet Per Gallon
SSPC	Society for Protective Coatings

1.04 QUALITY ASSURANCE

- A. Regulations: Comply with federal, state, and local air pollution and environmental control regulations limiting the emission of volatile organic compounds, blast cleaning, confined space entry (if required), and deposition of spent aggregate and debris.
- B. Standards and Guidelines: Perform surface preparation and painting in accordance with these Specifications, the paint manufacturers' printed recommendations and the following standards and guidelines. The more stringent requirements shall apply.
 - 1. Paint manufacturer's instructions.
 - 2. SSPC PA Guide No. 3, Guide to Safety in Paint Applications.
 - 3. Federal, state, and local agencies having jurisdiction.
- C. Project Standards: Finish one complete space or item of each color scheme showing selected colors, finish texture, materials, and quality of work for inspection and acceptance by Engineer. After approval, sample spaces or items shall serve as a standard for all similar work.
- D. Submittals: Submit manufacturer's information for each material specified in accordance with Section 01 33 00.
 - 1. Technical product data sheets and material Safety Data Sheets
 - 2. Submit certificate of compliance attesting that all paints proposed are free of lead, chromate, and heavy metals free, and meet federal, state, and local requirements limiting the emissions or volatile organic compounds (VOC).
 - 3. Color Data: Provide complete fan deck, color card or actual color chips illustrating full range of color availability.
 - 4. Samples: Submit 2 samples, 12 x 12 inch in size illustrating colors and textures for each surface finishing product scheduled.
 - 5. Test Reports: Flame spread per ASTM E-84 for paints requiring rating per NFPA 101.
 - 6. O&M Manuals: Submit color number and formula for each color and type of paint.

1.05 PACKAGING AND LABELING.

- A. Deliver materials to job site in original, new, and unopened packages and containers bearing manufacturer's name and label, and following information:
 - 1. Name of material
 - 2. Manufacturer's stock number and date of manufacture
 - 3. Thinning instructions
 - 4. Application instructions
 - 5. Color name and number
 - 6. Handling instructions and precautions
 - 7. Hazardous warning labels
- B. Store materials not in actual use in tightly covered containers at a minimum temperature of 45 degrees F in a well-ventilated area. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

- C. Remove oily rags and waste daily. Take precautions to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.06 EXTRA STOCK

- A. At the Completion of painting, deliver to the Owner one full gallon of each paint color and type used along with the color number or formula for each color. Epoxy and High performance coatings are not included in this requirement.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Apply coatings only when the temperature of surfaces to be coated and surrounding air temperatures are between 50 degrees F and 90 degrees F, unless otherwise permitted by manufacturer's printed instructions.
- B. Do not apply in snow, rain, fog or mist, or when relative humidity exceeds 85 percent, or to damp or wet surfaces, unless otherwise permitted by manufacturer's instructions.
- C. Allow wet surfaces to dry thoroughly and attain the temperature and conditions specified before proceeding with or continuing the coating operation.
- D. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature and relative humidity within the area can be maintained within limits specified during application and drying periods.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Quality: Provide manufacturer's highest quality products suitable for intended service. Provide primer and finish coats produced by same manufacturer. Furnish thinners, cleaners, driers, and other additives as recommended by manufacturer of the particular coating.
- B. All coating materials that come into with raw water, settled water, filtered water, potable water or substances that are mixed with any of the preceding shall be NSF 61 certified.
- C. Acceptable Manufacturers: Acceptable manufacturers are Glidden, Sherwin-Williams, PPG Pittsburgh Paints, Themec, and Sauereisen.

2.02 MIXING

- A. Multiple-Component Coatings
 - 1. Prepare using the contents of the container for each component as packaged by paint manufacturer.
 - 2. No partial batches will be permitted.
 - 3. Do not use multiple-component coatings that have been mixed beyond their pot life.
 - 4. Furnish small quantity kits for touchup painting and for painting other small areas.
 - 5. Mix only components specified and furnished by paint manufacturer.
 - 6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors

1. Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at the site.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for application and notify Engineer in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Starting of coating work will be construed as Contractor's acceptance of surfaces and conditions within any particular area.
- C. Do not cover over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable coating system.
- D. Notify Owner and Engineer a minimum of 7 days prior to the start of shop or field surface preparation work and coating application work.

3.02 PREPARATION

- A. Weld/ pipe grinding required to prepare surfaces for coating shall be completed prior to pressure testing piping.
- B. Clean surfaces prior to applying coating or surface treatments. Remove oil and grease before mechanical cleaning.
- C. Program cleaning and coating processes so contaminants from the process will not fall onto wet, newly coated surfaces.
- D. Perform preparation and cleaning in compliance with manufacturer's instructions and as herein specified, for each substrate condition.
- E. Meet applicable Federal, State, and Local air pollution and environmental control regulations for blast cleaning, confined space entry (if required) and deposition of spent aggregate and debris.
- F. Shop Blast Cleaning
 1. Structural steel, metal doors and frames, metal louvers, and similar items, may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning.
 2. Field Abrasive Blasting: Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed.
 3. Protection of Items not to be painted:
 - a. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

- b. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- c. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- d. Mask openings in motors to prevent paint and other materials from entering the motors.

3.03 SURFACE PREPARATION

A. Metal Surfaces

1. Where indicated, meet requirements of the Steel Structures Painting Council Specifications. The words "solvent cleaning", "hand tool cleaning", "wire brushing", and "blast cleaning", or similar words of equal intent in these Specifications or in paint manufacturer's specifications refer to the applicable SSPC Specifications.
2. Prepare welds and adjacent areas such that there is no undercutting or reverse ridges on weld bead, no weld spatter on or adjacent to weld or any other area to be painted, no sharp peaks or ridges along weld bead. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
3. Clean metal surfaces using abrasive blast, or wet or vacu-blast methods. Follow coating manufacturers' recommendations for wet blast additives and first coat application. Hand tool clean areas that cannot be cleaned by power tool cleaning.
4. Pre-blast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.
5. Blast Cleaning Requirements:
 - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
 - b. Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.
 - c. Use only dry blast cleaning methods.
 - d. Do not reuse abrasive, except for designed recyclable systems.
 - e. Meet applicable Federal, State, and Local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
6. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.

- b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

B. Concrete Surfaces

1. Do not begin until 30 days after concrete has been placed. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
2. Blast clean to remove loose concrete and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval subject to producing desired profile.
3. Secure coating manufacturer's recommendations for additional preparation if required for excessive bug holes exposed after blasting.
4. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.
5. If hardeners, curing compounds or sealers are to be applied on concrete, use mechanical surface preparation methods.

C. Plastic Surfaces

1. Hand sand plastic surfaces to be coated with a medium grit sandpaper to provide tooth for the coating system.
2. Large areas may be power sanded or brushoff blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

D. Masonry Surfaces

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter and clean masonry surfaces of mortar and grout spillage and other surface deposits using specified nonmetallic fiber brushes and commercial detergent cleaner followed by rinsing with clean water.
2. Leave surfaces clean and dry prior to painting unless otherwise required for proper adhesion. Paint masonry surfaces to be of uniform texture and free of surface imperfections that would impair the finished appearance.

E. Wood Surfaces

1. Replace damaged wood surfaces or repair in a manner acceptable to Owner prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
 - a. Synthetic-based wood putty approved by paint manufacturer for the paint system.
 - b. For natural finishes, color of wood putty shall match color of finished wood.
 - c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.

- d. Apply putty before or after the prime coat, depending on compatibility and putty manufacturer's recommendations.
- e. Use a cellulose type putty for stained wood surfaces.
- 5. Ensure surfaces are clean and dry prior to painting.

F. Gypsum Board

- 1. See Architectural Surface Finishes in this specification for required surface preparation.
- 2. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

G. Existing Surfaces to be Painted

- 1. Detergent wash and rinse with fresh water. Clean loose, abraded, or damaged coatings to substrate by Hand or Power Tool, SP 2 or SP 3. Perform blasting as required to restore damaged surfaces.

3.04 SURFACE CLEANING METHOD

A. Brushoff Blast Cleaning

- 1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC-SP 7, Brushoff Blast Cleaning. Use abrasives consisting of either wet or dry blasting sand, grit, or nut shell. Select various surface preparation parameters such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage. Verify parameter selection by blast cleaning a trial area that will not be exposed to view. Owner or Engineer will approve acceptable trial blast cleaned area and will use area as a representative sample of surface preparation. Repair or replace surfaces damaged by blast cleaning.

B. Acid Etching

- 1. After pre-cleaning, spread the following solution by brush or plastic sprinkling can: 1 part commercial muriatic acid reduced by 2 parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
- 2. Application:
 - a. Application Rate: Approximately 2 gallons per 100 square feet.
 - b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
 - c. Acid will react vigorously for a few minutes, during which time brushing is continued.
 - d. After bubbling subsides (10 minutes), hose down the remaining slurry with high pressure clean water.
 - e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
 - f. Thoroughly rinse to remove any residual acid surface condition which can impair adhesion.
- 3. Ensure surface is completely dry before application of coating.
- 4. Apply acid etching, to obtain a "grit sandpaper" surface profile. If not, repeat treatment.

C. Solvent Cleaning

1. Remove foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action. Meet requirements of SSPC-SP 1.

3.05 APPLICATION

- A. General: Protect workers and work areas from fire and health hazards resulting from handling, mixing, and application. Use primer and undercoat material produced by same manufacturer as finish coats. Use only thinners approved by the manufacturer. Allow sufficient time between coats to allow wet surfaces to dry thoroughly and attain the temperature and conditions specified before applying subsequent coatings. Provide "Wet Paint" signs to protect fresh finishes.
- B. Temperature: Apply coatings only when the temperature of surfaces to be coated and surrounding air temperatures are between 50 degrees F and 90 degrees F, unless otherwise permitted by manufacturer's printed instructions.
- C. Inclement Weather: Do not apply coatings in snow, rain, fog or mist, or when relative humidity exceeds 85 percent, or to damp or wet surfaces, unless otherwise permitted by manufacturer's instructions. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature and relative humidity within the area can be maintained within limits specified during application and drying periods.
- D. Multiple Component Coatings: Prepare using the contents of the container for each component as packaged by paint manufacturer. Mix only components specified and furnished by paint manufacturer. Do not intermix additional components to adjust color or otherwise, even within the same generic type of coating. Discard multiple component coatings that have been mixed beyond their pot life.
- E. Film Thickness: Apply the minimum number of coats specified without regard to coating thickness. Apply additional coats as needed to obtain minimum required paint thickness. Maximum film build per coat shall not exceed coating manufacturer's recommendations.
- F. Successive Coatings: Sand wood and metal lightly between coats to achieve required finish. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat. Where more than one coat is applied, vary shade or tint of successive coats to provide a visual indicator of holidays or coating defects.
- G. Factory Finished Equipment: Do not paint architectural components and equipment supplied with a factory-finished final coating including:
1. Architectural woodwork and casework, prefinished partition systems, acoustic materials, entrance doors and frames.
 2. Metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze, metal toilet enclosures, and similar finished materials.
 3. Finished mechanical equipment including valves, damper operators, linkages, sensing devices, motor and fan shafts, moving parts of operating units, elevator equipment, sprinkler heads or other fire-detection elements.
 4. Finished electrical equipment including light fixtures, switch gear and distribution cabinets.

5. Equipment identification plates bearing performance rating, name or model, or any code-required labels such as Underwriters' Laboratories and Factory Mutual.
- H. Bare and Shop Primed Surfaces: Prime bare surfaces. Repair shop primed surfaces with compatible primer and apply mist coat of primer, 1 mil dry film thickness. After welding, prepare and prime holdback areas as required for paint system in accordance with manufacturer's instructions. Apply final coating.
- I. Concrete, Masonry, and Porous Surfaces
 1. Filler/Surfer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface defects.
 2. Prime Coat: May be thinned to provide maximum penetration and adhesion as recommended by paint manufacturer, dependent on surface and type of coating. Provide multiple coats to comply with specified DFT.
 3. Water Base Coating: Apply to damp surface, but free of running water.
- J. Painting Inaccessible Surfaces: Coat surfaces of equipment and structural steel framing to be bolted together or joined closely to structures or to one another prior to assembly or installation.
- K. Repainting: Verify that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified. If an aged, plural-component material is to be topcoated, contact coating manufacturer concerned for additional surface preparation requirements. Check compatibility by application to a small area prior to starting painting. If lifting or other problems occur, request disposition from Engineer. Apply one spot coat of the specified primer to bare areas, overlapping prepared existing coating. Apply one full finish coat of the specified primer or finish coat(s) overall. Feather surrounding intact coating.
 1. Factory Finished Surfaces: Schedule inspection with Owner or Engineer before priming or top coating factory finished items delivered to site. Prepare surfaces using specified primer and apply finish paint system.
 2. Ductile Iron Pipe: For pipe with asphaltic varnish finish, apply a coat of tar shop seal coat prior to application of the finish coat.

3.06 INSPECTION AND TESTING

- A. Provide adequate staging and lighting for inspection of surface or coating. Visually inspect coated surfaces to ensure complete coverage and mil thickness including edges, angles, flanges, and other similar areas.
- B. Thickness Testing: After coated areas have dried sufficiently, measure coating thickness specified in mils with a calibrated magnetic type dry film thickness gauge. Test finish coat, except zinc primer, galvanizing, and elastomeric coatings in excess of 25 mils dry, for discontinuities with an electrical holiday detector. Test coatings in excess of 25 mils dry with high voltage units recommended by the coating manufacturer. Check each coat for correct mil film thickness. Do not make measurement before a minimum of 8 hours after application of coating.
- C. Acceptance Criteria: Acceptability of finished coatings and color schemes shall be evaluated against the Project Standards defined in Part 1 of this Section. Evidence of runs, bridges, shiners, laps, holidays, or other imperfections is cause for rejection.

3.07 REPAIR OF DAMAGED COATINGS AND TOUCHUP

- A. At completion of work of other trades, touch-up and restore damaged or defaced coated surfaces. Repair abraded areas on factory finished items as recommended by manufacturer. Carefully blend repaired areas into original finish. Prepare surface and repair defects in accordance with written recommendations of coating manufacturer. If item has an improper finish color, or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required. Apply finish coats, including touchup and damage repair coats to present a uniform texture and matching color.

3.08 CLEANING

- A. During progress of work, remove discarded materials, rubbish, cans, and rags from site at end of each work day. Upon completion of work, clean window glass and spattered surfaces. Remove spattered coatings by washing and scraping, using care not to scratch or otherwise damage finished surfaces. Correct any damage to work of other trades by cleaning, repairing, replacing, and repainting. Remove temporary protective wrappings provided for protection of work, after completion of coating operations.

3.09 COLOR CODE

- A. The following color code is selected from the Sherwin Williams digital color palette, which can be found at www.sherwin-williams.com/homeowners/color/find-and-explore-colors/. Match from other acceptable manufacturers.

Color Coding Schedule

Color Number	Color Name
SW 6892	Carnival (Orange)
SW 6431	Leapfrog (Olive Green)
SW 2933	Greenhouse (Dark Green)
SW 4086	Safety Blue
SW 7669	Summit Gray (Light Gray)
SW 4084	Safety Yellow
SW 6767	Aquarium (Aqua)
SW 4081	Safety Red
SW 4009	Walnut Brown
SW 7661	Reflection (Light Gray)
SW 7757	High Reflective White
SW 9116	Serengeti Grass (light brown)

Color Coding Schedule – Administration Building

Color Number	Color Name
P1	Benjamin Moore; White Drift; OC-138
P2	Sherwin Williams; Ceiling Bright White; SW7007
P3	Benjamin Moore; Black Jack; 2133-20
P4	Sherwin Williams; Debonair; SW9139
P5	Sherwin Williams; Slate Tile; SW7624
P6	Benjamin Moore; Springfield Tan; AC-5
P7	Sherwin Williams; Kilim Beige; SW6106

3.10 PIPE MARKERS

- A. Pipes exposed or concealed in accessible spaces: Provided with plastic markers for coding pipe. Markers shall be the mechanically attached type that are easily removable. They shall not be the adhesive applied type of marker.
1. Pressure sensitive legends applied to plastic backing, strapped or otherwise mechanically attached to pipe conforming to ASME A13.1-1996.
 2. Coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.
 3. Materials resistant to petroleum-based oils and grease and meeting criteria for humidity, solar radiation, rain, salt, fungus, and leakage as specified in MIL-STD- 810C.
 4. Markers shall withstand continuous operating temperature range of –40 to 180 degrees F.
 5. Include uni- and bidirectional arrows in the same size as legends to indicate flow direction.
 6. Pipe labels shall show flow pipe type as shown on the P&IDs.
 7. Legends and arrows shall be white on blue or red backgrounds and black on yellow or green backgrounds.
 8. Manufactured by W.H. Brady Company or Seaton Name Plate Corporation or equal.
- B. Pipe Marking sizes shall be as shown in the following schedule:

Pipe Marking Sizes

Outside Diameter of Pipe Covering (inches)	Legend Height (inches)
Less than 1-½	1/2
1-½ through 3	1-1/8
Greater than 3	2-1/4

3.11 PIPE COLORS

- A. Pipe colors shall match existing piping systems where appropriate. Coordinate color selection with Owner.
- B. All pipe shall contain a pipe label marker according to the following Pipe Label Color Schedule.

Pipe Color Schedule

Pipe System	Service	Color Name	Color Number
A	Aeration Air	Greenhouse (Dark Green)	SW 2933
ACH	Aluminum Chlorohydrate	Carnival (Orange)	SW 6892
BWS	Backwash Supply	Safety Blue with White Band	SW 4086
BWW	Backwash Waste	Serengeti Grass (Light Brown)	SW 9116
CLO	Chlorine Dioxide	Safety Yellow with Violet Band	SW 4084
D	Drain	Summit Gray (Light Gray)	SW 7669
DW	Decant Water	Leapfrog (Olive Green)	SW 6431
FTW	Filter to Waste	Summit Gray (Light Gray)	SW 7669
FW	Filtered Water	Aquarium (Aqua)	SW 6767

Pipe System	Service	Color Name	Color Number
NG	Natural Gas	Safety Red	SW 4081
NPW	Non-potable Water	Leapfrog (Olive Green) with White Band	SW 6431
NPW	Fire Service	Safety Red with White Stripe	SW 4081
PA	Pressurized Air	Greenhouse (Dark Green)	SW 2933
PD	Pumped Drain	Summit Gray (Light Gray)	SW 7669
PDW	Pumped Decant Water	Leapfrog (Olive Green)	SW 6431
POL	Polymer	Carnival (Orange) with Green Band	SW 6892
PW	Potable Water	Safety Blue	SW 4086
RW	Raw Water	Leapfrog (Olive Green)	SW 6431
SC	Sodium Chlorite	High Reflective White	SW 7757
SH	Sodium Hydroxide	Safety Yellow with Green Band	SW 4084
SHC	Sodium Hypochlorite	Safety Yellow	SW 4084
SRW	Solids Residual Waste	Walnut Brown	SW 4009
STW	Settled Water	Aquarium (Aqua)	SW 6767
TD	Tank Drain	Summit Gray (Light Gray)	SW 7669
V	Vent	Reflection (Light Gray)	SW 7661

3.12 ARCHITECTURAL SURFACE FINISHES

A. The scope of this painting schedule involves Architectural finishes for the entire building. These finishes include, but are not limited to:

1. Interior and exterior gypsum board walls and ceilings.
2. Interior masonry unit and cast-in-place concrete walls.
3. Interior and exterior miscellaneous metals, brows, awnings, equipment screens support steel, lintels, and bollards.
4. Interior exposed steel structural columns, deck angles, and beams.
5. Hollow metal doors and frames.
6. Interior steel roof joists and roof deck.
7. Sectional overhead door steel angle door jambs.
8. Unless otherwise indicated, paint all exposed interior and exterior conduit and piping.

B. Gloss Levels: Paint gloss levels specified herein are based on the following ranges:

Description	Gloss Range	ASTM D523 Test Method
Flat	0-15	85°
Eggshell	5-20	60°
Satin	15-35	60°
Semi-Gloss	35-65	60°
Gloss	Over 65	60°

C. Special Architectural Finish Requirements

1. Verify that substrate conditions are ready to receive Work. Should any surface be found to be unsuitable to produce a proper finish, notify in writing and do not apply material until the surfaces are made satisfactory. Application of paint to any surface shall be deemed to be acceptance of that surface and full responsibility shall be borne by the Contractor throughout the guarantee period.
2. First quality preparation, painting and finishing is required. Dirt, grit or dust in paint or finish, runs, sags or drips of paint or finish or irregularity of finish is cause for rejection. Remove rejected finishes, repair, re-prime and refinish as required to achieve first quality finish.
3. Work and storage areas must be free of dust during application of paint finishes. Spaces to receive finishes must be clean prior to finishing. Do not apply finishes in spaces with accumulated rubbish, dust or dirt or where construction activity is present.
4. Provide finish coats that are compatible with substrate materials or with prime coats specified in other sections.
5. Patch painting will not be acceptable; total affected area shall be finished. Terminate painting only at corners or joints.
6. Use only coatings with NFPA 101A or B rating in rated exit routes.
7. Gypsum Board Surfaces: Latex fill minor defects. Spot prime defects after repair.
8. Remove all signs, hardware, cover plates, light fixtures, accessories and similar items prior to finishing. Replace after finish operations are completed.

D. ARCHITECTURAL COATINGS

1. Gypsum Board Substrates:
 - a. Latex System:
 - 1) Prime Coat: Primer, latex, interior:
 - a) S-W ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils (0.102 mm) wet, 1.0 mils (0.025 mm) dry.
 - 2) Intermediate Coat: Latex, interior, matching topcoat.
 - 3) Topcoat: Latex, interior, eggshell:
 - a) S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series, at 4.0 mils (0.102 mm) wet, 1.7 mils (0.043 mm) dry, per coat.

3.13 INDUSTRIAL COATING SCHEDULES

- A. See the following Industrial Coating Schedules for coating systems.

Surface/Exposure	Surface Preparation	Primer		Intermediate Coat		Final Coat		Total DFT, mils
		Type	DFT, mils	Type	DFT, mils	Type	DFT, mils	
Factory Primed Steel (Not scheduled as an architectural surface)								
Exterior exposed	SSPC-SP6	Factory Primed	----	Polyamide epoxy, 2 component, 58% solids volume	5	Aliphatic acrylic polyurethane, 2 component, 54% solids volume	5	10

Surface/Exposure	Surface Preparation	Primer		Intermediate Coat		Final Coat		Total DFT, mils
		Type	DFT, mils	Type	DFT, mils	Type	DFT, mils	
Interior exposed	SSPC-SP6	Factory Primed	----	Polyamide epoxy, 2 component, 58% solids volume	5	Polyamide epoxy, 2 component, 56% solids volume	5	10
Ductile Iron Pipe								
Below Grade	See Section 33 14 13							
Interior exposed	SSPC-SP6 to near black color	Polyamide epoxy, 2 component, 56% solids volume	5	----	----	Polyamide epoxy, 2 component, 56% solids volume	6	11
Exterior exposed	SSPC-SP6 to near black color	Polyamide epoxy, 2 component, 56% solids volume	5	Polyamide epoxy, 2 component, 56% solids volume	6	Aliphatic acrylic polyurethane, 2 component, 54% solids volume	3	14
Immersed	SSPC-SP10 to gray-white color	Polyamide epoxy, 2 component, 56% solids volume, NSF certified w/ NSF/ANSI Std. 61	5	----	----	Polyamide epoxy, 2 component, 56% solids volume, NSF certified w/ ANSI/NSF Std. 61	6	11
Steel (Pipe, Structural, Equipment)								
Below Grade – Pipe	See Section 33 14 13 for pipe							
Interior exposed	SSPC-SP10	Polyamide epoxy, 2 component, 56% solids volume	5	----	----	Polyamide epoxy, 2 component, 56% solids volume	6	11
Exterior exposed	SSPC-SP10	Polyamide epoxy, 2 component, 56% solids volume	5	----	----	Aliphatic acrylic polyurethane, 2 component, 54% solids volume	5	10
Immersed	SSPC-SP10	Polyamide epoxy, 2 component, 56% solids volume, NSF certified w/ NSF/ANSI Std. 61	5	----	----	Polyamide epoxy, 2 component, 56% solids volume, NSF certified w/ ANSI/NSF Std. 61	6	11

Surface/Exposure	Surface Preparation	Primer		Intermediate Coat		Final Coat		Total DFT, mils
		Type	DFT, mils	Type	DFT, mils	Type	DFT, mils	
PVC and CPVC								
Interior exposed	Scarify	Polyamide epoxy, 2 component, 56% solids volume	3	----	----	Same as prime coat	3	6
Exterior exposed	Scarify	Polyamide epoxy, 2 component, 56% solids volume	3	----	----	Aliphatic acrylic polyurethane, 2 component, 54% solids volume	3	6
Concrete and Masonry								
Interior floors/walls of chemical containment Areas Note: Coatings shall be inspected and certified by a NACE certified inspector.	Shot blast or mechanically abrade	Polyamide epoxy, 2 component, 96% solids volume	6	Aggregate-filled polyamide epoxy, 2 component and aggregate as per coating manuf., 97% solids volume with aggregate	2 @ 1/16-inch for 1/8-inch total	Polyamide epoxy, 2 component, 98% solids volume	8	> 1/8-inch
Non- Ferrous Metals and Galvanized Steel								
Interior exposed	Per coating manuf.	Polyamide epoxy, 2 component, 56% solids volume	3	----	----	Polyamide epoxy, 2 component, 56% solids volume	5	8
Exterior exposed	Per coating manuf.	Polyamide epoxy, 2 component, 56% solids volume	5	----	----	Aliphatic acrylic polyurethane, 2 component, 54% solids volume	5	10
Immersed	Per coating manuf.	Polyamide epoxy, 2 component, 56% solids volume, NSF certified w/ NSF/ANSI Std. 61	5	----	----	Polyamide epoxy, 2 component, 56% solids volume, NSF certified w/ ANSI/NSF Std. 61	6	11

Note:

- Where NSF/ANSI 61 certification is called for, it shall only be required in potable water treatment systems.

END OF SECTION

SECTION 09 91 00

POLYURETHANE COATING

PART 1 GENERAL

1.01 REQUIREMENT

- A. The Work of this section includes the materials, installation, and testing of a polyurethane pipe coating system.
- B. Except as described in this section, the coating system shall be in accordance with ANSI/AWWA C222 for straight pipe sections and fittings and ANSI/AWWA C216 for specials and field joints.

1.02 REFERENCES

A. Commercial Standards

- 1. AWWA C216, Heat-Shrinkable, Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
- 2. AWWA C217, Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
- 3. AWWA C222, Polyurethane Coatings for Interior and Exterior of Steel Water Pipe and Fittings.
- 4. AWWA C604, Installation of Steel Water Pipe 4-inches and Larger.
- 5. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- 6. NACE SP-0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
- 7. Society for Protective Coatings (SSPC):
 - a. SP-1, Solvent Cleaning Surface Preparation.
 - b. SP-2, Hand Tool Cleaning Surface Preparation.
 - c. SP-3, Power Tool Cleaning Surface Preparation.
 - d. SP-6, Commercial Abrasive Blast Surface Preparation.
 - e. SP-10, Near White Metal Abrasive Blast Surface Preparation.

1.03 SUBMITTALS

- A. Make submittals in accordance with Section 01 33 00, Submittal Procedures.
- B. Action Submittals
 - 1. Provide the following coating manufacturer certifications:
 - a. Shop applied coating system applicator is an approved applicator.
 - b. Shop applied coating system applicator's equipment meets the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.

- c. Shop applied coating system applicator's personnel are trained by the coating manufacturer in the application and use of equipment for the coating material being applied. Identify the shop applied coating system applicator personnel certified by the coating manufacturer.
2. Provide certification of training from the heat shrink sleeve coating manufacturer or steel pipe manufacturer for exterior field coating of pipe joint applicators. Provide list of certified personnel proposed to be utilized on this project. Certification shall be effective within 12 months of starting the exterior field coating application.
3. Submit catalog cuts and other manufacturer's information for materials provided on a system-by-system basis.
4. Furnish a Material Safety Data Sheet (MSDS), the manufacturer's technical data sheets, and paint colors available (where applicable) for each product used in coating system.
5. Technical and performance information that demonstrate coating system materials compliance with Specification.
6. Provide to the ENGINEER a copy of the manufacturer's coating application quality assurance manual prior to beginning coating application.

1.04 QUALITY ASSURANCE

- A. Shop Applied Coating System Applicator's Experience and Certification: Coating applicator shall be certified by the coating manufacturer as an approved applicator. Coating applicator's personnel shall be trained in the coating material being applied by the coating manufacturer. Shop equipment shall be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings. Equipment not meeting the coating manufacturer's written requirements will be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the coating manufacturer and Engineer.
- B. The coating manufacturer shall provide a qualified technical representative, employed by the coating manufacturer, at the shop applied coating facility for 1 day, minimum, at the start of coating application. During this visit, the manufacturer's representative shall conduct inspections as required to ensure that coating application is in conformance with their recommended methods and conditions.
- C. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating application as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this Project.
- D. Field Coating of Pipe Joint Applicator's Certification or Experience: Exterior field coating of pipe joint applicators shall be certified and trained by the heat shrink sleeve coating manufacturer or steel pipe manufacturer.
- E. Provide the Engineer a minimum of 7 days advance notice of the start of any shop coating work and a minimum of 3 days advance notice for field work.
- F. Inspection Devices: Furnish inspection devices that are calibrated and in good working condition for the detection of holidays and measurement of coating film thickness.
- G. Inspection: At a minimum, tests shall include holiday detection, adhesion testing, and coating film thickness. Perform adhesion testing on each pipe coated during the first full day of coating

application and as requested by the Engineer if surface preparation or coating application is suspect.

- H. Perform complete holiday detection of field coatings and repair defects.
- I. Immediately before the coated pipe is lowered into the trench, provide a visual and field electrical holiday inspection of the pipe coating as specified in Paragraph 3.9.
- J. Provide a log of visual and electric holiday inspections.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Handle pipe in accordance with AWWA C222 and in such a manner as to protect the pipe and coating from damage.
- B. Do not install coated pipe until the coating has developed full adhesion and cure.
- C. Take precaution during coating application, storage, loading, transportation, unloading, laying and installation to protect and prevent damage to pipe and coating. Lift pipe in accordance with AWWA C604 and pipe manufacturer's instructions in a manner that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.
- D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. Heavily pad pipe contact locations with carpet during shipment to the Project Site and from the storage yard to the point of installation.
- E. Do not store pipe on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Do not lay pipe on asphalt without suitable padding at contact points.
- F. Inspect pipe at the Project Site for damage. Repair damage to the pipe or coating as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, replace the damaged section at the sole expense to the Contractor.
- G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk on the coating except when absolutely necessary and approved by the Engineer. When permitted, use shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating.

PART 2 PRODUCTS

2.01 GENERAL

- A. Store, handle, and apply coatings per the manufacturer's written directions. Clean and coat exterior pipe surfaces in accordance with referenced AWWA Standards, written directions of the coating manufacturer, and these Specifications, whichever is more stringent. Prepare other surfaces to be coated as required for steel pipe, as applicable.
- B. Provide polyurethane coating from a single manufacturer. Substitutions will not be permitted.

- C. All coatings and linings that could come into contact with potable water or any substance that will be mixed with or otherwise come into contact with potable water will meet the requirements of NSF 61.

2.02 EXTERIOR SHOP-APPLIED COATINGS

A. Plural Component Polyurethane

1. Apply plural component polyurethane coating system (referred to hereafter as polyurethane system) in accordance with AWWA C222, except as modified herein.
2. Coating: Self-priming, plural component, 100 percent solids, polyurethane, suitable for burial or immersion, and the product of one of the following approved manufacturers:
 - a. Futura Coatings (Protec II), Hazelwood, Missouri.
 - b. Carboline Company, St. Louis, Missouri
 - c. No substitutions.

B. Coating Thickness

1. Exterior Surface:
 - a. Minimum 30 mil DFT, or
 - b. Minimum 60 mil DFT for 100-feet each side where pipeline crosses cathodically-protected facilities. The limits of thicker coating are indicated in the Drawings.
2. The polyurethane system may be applied to any maximum dry film thickness as recommended by the manufacturer. When applied at the maximum dry film thickness, the coating system shall pass all performance requirements as specified in AWWA C222.4.2.
3. The dry film thickness of the coating shall be measured in accordance with SSPC-PA 2. The averages listed in SSPC-PA 2 shall be deleted and no single gauge reading shall be less than the specified minimum thickness.

2.03 FIELD EXTERIOR JOINT COATING

A. Field coat pipe joints with heat-shrink sleeves after pipe assembly in accordance with AWWA C216. Heat Shrinkable Sleeves:

1. Filler Tape: Extruded butyl rubber compound compatible with heat shrink sleeve. Polyken 939 or approved equivalent.
2. Heat Shrink Sleeve: Covalence WPCT or Canusa Aqua-Shield. No substitutions accepted.
 - a. Minimum Total Thickness: 90 mils.

2.04 FIELD REPAIR OF COATINGS

A. General

1. Field coating shall be compatible with the shop-applied coating system or shall be provided by the same manufacturer.
2. Apply coating to field joints using only personnel trained by the field coating manufacturer or steel pipe manufacturer.

B. Polyurethane Coating

1. Repair polyurethane coating system in accordance with the coating manufacturer's recommended procedures.
2. Coating material for repairs greater than 6 inches diameter shall be the same as the existing coating, or for repairs less than 6 inches diameter, repair coating as recommended by the polyurethane coating manufacturer, subject to Engineer approval. Repair coating shall have adhesion and performance characteristics equal to the existing coating.

2.05 FIELD COATING OF ACCESS MANWAYS, COUPLINGS, AND FLANGES

- A. Field coat access manways and couplings with wax tape in accordance with AWWA C217. Apply manufacturer's filler to eliminate voids and provide smooth surfaces for tape.
- B. Field coat flanges and blind flanges in accordance with Section 09 90 04, Painting, System No. 1, or wax tape in accordance with AWWA C217. Apply manufacturer's filler to eliminate voids and provide smooth surface for tape.

PART 3 EXECUTION

3.01 GENERAL

- A. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of coating manufacturer whose product is to be applied.

3.02 ENVIRONMENTAL CONTROLS

A. General

1. Provide heating, cooling, or dehumidification equipment as required to meet the surface preparation and coating application environmental requirements as specified and recommended by the coating manufacturer.
2. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
3. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
4. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent or whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.
5. Do not apply coatings when:
 - a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the paint manufacturer or these Specifications,
 - b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
6. Where weather conditions or Project requirements dictate, provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as specified and in accordance with the manufacturer's coating application recommendations.

B. Temperature Control

1. When temperatures are above or below the coating manufacturer's recommended application temperatures, provide temperature controls to permit Work to proceed within the temperature limitations of the Project.
2. Heat with indirect fired heaters that do not increase humidity levels within the Work area. Size heaters for the area to be heated.
3. Provide tenting, baffles, or bulkheads as required to zone and control the heating or cooling effectiveness.

3.03 SHOP-APPLIED COATING SYSTEM

A. General

1. Strict conformance to the requirements of the manufacturer's coating application manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating. Remove rejected coating to bare metal and reapply using proper application methods in accordance with the quality assurance manual and the requirements of these Specifications.
2. Coating applied under improper environmental conditions will be rejected and removed to bare metal and reapplied under proper environmental conditions.
3. Pipes and other items that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected and the coating removed to bare metal and recoated.

B. Surface Preparation

1. Remove visible oil, grease, dirt, and contamination in accordance with SSPC-SP1, solvent cleaning.
2. Remove surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal by filing or grinding prior to abrasive surface preparation.
3. In cold weather or when moisture collects on the pipe and the temperature of the pipe is less than 45 degrees F, preheat pipe to a temperature above 50 degrees F and 5 degrees F above dew point.
4. Clean pipe by abrasive blasting with a mixture of steel grit and shot to produce the surface preparation cleanliness as specified. Clean recycled abrasive of debris and spent abrasive.
5. Protect prepared pipe from humidity, moisture, and rain. Keep pipe clean, dry, and free of flash rust. Remove flash rust, imperfections, or contamination on cleaned pipe surface by reblasting prior to primer application.
6. Complete priming and coating of pipe the same day as surface preparation.
7. Surface Preparation: SSPC-SP10, Near White Metal blast, 3.0 mil profile, minimum, or as required by the manufacturer, whichever is greater.

C. Polyurethane Coating Application

1. Maintain pipe temperature between 75- and 100-degrees F and 5 degrees F above dew point during coating application. Perform coating application in an environmentally controlled area that meets or exceeds the written environmental application requirements of the coating manufacturer.

2. Thickness: Additional thickness may be required to pass the holiday and coating defects limitations as specified in this section.
3. Test coating adhesion and holiday testing as specified in this section.
4. Complete coating repairs as specified in this section.

D. Holdbacks and Cutbacks

1. 6 inches, minimum.
2. Make coating cutbacks or holdbacks straight and cut through the full thickness of the coating. Complete cutbacks in a manner that permits field coating of joints in accordance with the manufacturer's recommendations and as specified herein.

3.04 FIELD COATING OF PIPE JOINTS - EXTERIOR

- A. Coat exterior pipe joints with heat-shrinkable sleeves in accordance with AWWA C216 and as specified herein. Apply heat shrinkable sleeves to field joints using personnel trained by the heat shrink manufacturer or steel pipe manufacturer.
1. Prepare pipe surface as follows:
 - a. Adhere to OSHA and EPA regulations and coating manufacturer's recommendations for surface preparation and coating application.
 - b. Power tool clean in accordance with SSPC-SP3 for shop blasted surfaces that have been coated with storage primer.
 - c. Hand tool clean areas to be coated in accordance with SSPC-SP2 that cannot be cleaned with power tool cleaning.
 - d. Solvent clean surfaces to be coated in accordance with SSPC-SP1.
 - e. Remove burrs, sharp edges, and weld spatter prior to abrasive blasting.
 2. Apply filler tape at lap joints, step downs, and other discontinuities. Lap joints containing 1:1 sloped fillet welds do not require filler tape.
 3. Fit coating material to area as recommended by manufacturer based on type and recovery of material.
 4. Shrink the coating material to tightly conform to pipe joint and overlap shop coating using manufacturer's recommended heat sources and methods.
- B. Completely remove and replace finish coatings having wrinkles, gaps, holes, or burns until acceptable coverage is achieved.
- C. Coating application is prohibited when there is water or slurry in bell holes.
- D. Holiday Testing
1. Clean and dry the pipe surface when tested.
 2. To avoid damage to the coating, the electrode should always be kept in motion while test voltage is being applied. Always keep the electrode in firm contact with the coated surface. Move the electrode in an even manner over the surface at an approximate rate of 0.5 to 1 foot of travel per second. Do not exceed 1 foot of travel per second as the maximum rate of speed during holiday testing.
 3. Mark location of detected holidays for repair. Retest after repair.

3.05 FIELD REPAIR OF COATING

A. General

1. Repair areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects. Repair areas where no holidays are detected but are visually damaged.
2. Clean area to be repaired for a minimum distance of 6 inches in all directions from the damaged area by solvent wiping.

B. Polyurethane Coating Repairs

1. Complete shop and field coating repairs in accordance with the manufacturer's written instructions and these Specifications, whichever is more stringent.
2. Unless otherwise accepted by Engineer, do not provide coating repairs on any joint of pipe greater than an average of 2 per 100 square feet of surface area per joint of pipe or an individual defect greater than 6 inches in diameter. Holidays within a 4 inch radius of a holiday shall be counted as a single holiday.
3. Unless otherwise accepted by Engineer, blast pipes exceeding the maximum number or size of coating defects to bare metal and recoat.
4. Unless otherwise accepted by Engineer, pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at no additional cost to the Owner.
5. Repair surface defects, that do not expose the metal substrate by power tool sanding with coarse sandpaper to roughen the coating surface and feathering the edges of the defect for a minimum of 3 inches around the defect. Apply a single coat of the specified patch coating material to a properly prepared surface at the specified coating thickness.
6. Prepare deep defects, defined as defects which penetrate to the metal substrate or expose the metal substrate to the metal substrate by power tool sanding to expose the metal and feather the coating edges a minimum of 6 inches. Reblast the metal surface and surrounding coating to equal cleanliness and profile as the original surface preparation. Roughen existing coating to the equivalent of coarse sandpaper by abrasive blasting. Apply one coat of the specified coating material over the repaired surface at the specified thickness.

3.06 WAX TAPE COATING INSTALLATION

- #### A.
- Coat bolts and nuts of all buried or exposed flanges, blind flanges, couplings, dismantling joints, etc. with three-part, cold-applied wax tape coating system consisting of primer, wax tape, and tape outerwrap.

B. Wax Tape Application

1. Ensure surfaces are free from loose rust, scale, paint, dirt, and other foreign matter in accordance with SSPC-SP2.
2. Apply primer by hand or brush to surfaces to be coated. Work primer into crevices, around studs and nuts, and completely cover exposed metal surfaces.
3. Extend primer a minimum of 3-inches onto adjacent surfaces of the pipe.
4. Apply wax tape immediately after primer application.
 - a. Cut short lengths of tape and place around each bolt head and nut.

- b. Work tape into crevices around studs and nuts.
 - c. Cover entire primed area with wax tape using minimum overlap of 55% of tape width.
 - d. Work tape into crevices and contours of irregular shaped surfaces and smooth out to obtain continuous protective layer with no voids or spaces under tape.
5. Apply tape outerwrap to wax tape installation. Extend plastic wrap a minimum of 3-inches beyond wax tape using a minimum overlap of 55% of plastic material width to apply two layers of overwrap.

3.07 SHOP QUALITY CONTROL

A. General

- 1. Owner's representative may conduct additional quality assurance inspection and testing for final acceptance of the pipeline coatings. Coating repairs for quality assurance testing shall be repaired by the applicator as specified herein.

B. Adhesion Testing

1. General

- a. In addition to the testing protocol required in AWWA C222, provide a minimum of four adhesion tests on four separate pipe joints for every production day.
- b. Repair coating damage from adhesion testing.
- c. Perform adhesion tests not less than 24 hours after coating application.
- d. Pipe joints will be randomly selected for adhesion testing. If any one of the pipe joints tested fails the adhesion test, two additional tests shall be performed on that pipe joint. If any one of the additional tests fails, that pipe joint shall be rejected. An additional two pipe joints from that day's production shall be tested for every rejected pipe joint.

2. Polyurethane Adhesion Testing

- a. Polyurethane coatings shall have an adhesion to steel of 1,500 pounds per square inch, minimum.
- b. Test polyurethane coating adhesion to steel substrates using pneumatic pull off equipment, such as HATE equipment or equal, in accordance with ASTM D4541 and AWWA C222, except as modified in this section.
- c. Glue dollies for adhesion testing to the coating surface and allow to cure for a minimum of 12 hours. Score coating around the dolly prior to conducting the adhesion test. Dollies shall be concave or convex to fit the pipe surface on any pipe less than 30 inches in diameter.
- d. Failure shall be by adhesive failure only. Adhesive failure is defined as separation of the coating from the steel substrate on over 20 percent of the bonded surface. Glue failures in excess of the minimum required tensile adhesion are acceptable as meeting the specified adhesion requirements.
- e. Randomly select repair patches on the polyurethane coating for adhesion testing in a manner as described herein and at the discretion of the person conducting the adhesion tests. Inter-coat adhesion of repairs shall be not less than 50 percent of the specified polyurethane coating adhesion requirements to steel.

3. Holiday Testing:
 - a. Polyurethane Coatings:
 - 1) Conduct holiday tests on the completed coating after a minimum of 1-hour cure using a high voltage spark test in accordance with NACE Standard SP-0188 and these Specifications.
 - 2) Perform holiday testing at a voltage of 100 volts per mil of the average coating thickness.
 - 3) Use the average dry film thickness testing results to determine the coating thickness used for holiday testing.
4. Dry Film Thickness Testing: Test coatings for dry film thickness in accordance with SSPC PA-2 using a properly calibrated magnetic pull off or eddy current equipment.

3.08 FIELD QUALITY CONTROL

- A. Provide a visual and field electrical holiday inspection of the pipe coating immediately before the coated pipe is lowered into the trench.

B. Electrical Coating Inspection

1. Electrically test field applied coatings and pipe coating repairs with a portable high-voltage holiday detector. Test areas as directed by the ENGINEER. Provide equipment and conduct testing in accordance with NACE Standard SP-0188 and the coating manufacturer's written directions for type and thickness of coating being tested. Furnish one portable high-voltage detector for each pipe laying crew.
2. Set electrical holiday test equipment at voltage as recommended by coating manufacturer. Set the minimum test voltage for a particular coating type and thickness to be within 20 percent of the voltage as determined by the following formula:

$$\text{Testing Voltage} = 1250\sqrt{T}$$

Where T = Average coating thickness in mils (0.001 inch)

3. Provide the type of detector with the minimum and maximum voltage setting, inspection speed, and holiday detector electrode type (wire brush or electrically conductive silicone or coil spring) as recommended by the coating manufacturer for the coating type and thickness being tested. Maintain the holiday test equipment in good working condition per detector manufacturer's recommendations.
4. Adjust the holiday detector during testing to the correct voltage setting and operate in accordance with holiday detector manufacturer recommendations. Recheck voltage setting at start of each day and a minimum of two times during the day and when requested by Engineer.
5. Provide the holiday detector with an audible signal when electrical contact is made between the pipeline and the electrode at holidays (defects) in the coating. Provide a good ground and a low electrical resistance between the holiday detector and the pipeline. Make only direct connections to uncoated areas or to the pipe ends at the pipe joint cut back areas.
6. Clean and dry the pipe surface when testing. To avoid damage to the coating, the electrode always be kept in motion while test voltage is being applied. Always keep the electrode in firm contact with the coated surface. Move the electrode in an even manner

over the surface at an approximate rate of 0.5 to 1 foot of travel per second. Do not exceed 1 foot of travel per second as the maximum rate of speed during holiday testing.

7. Mark location of detected holidays for repair. Retest after repair.

END OF SECTION

SECTION 10 11 00
VISUAL DISPLAY UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Magnetic Whiteboards
2. Tackboards

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachment to other work.
- C. Samples: For each type of visual display unit indicated.
- D. Product Schedule: For visual display units.

1.03 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranties.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Warranties.

1.05 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MAGNETIC WHITEBOARDS

- A. Basis of Design Product: Provide the following product or approved equivalent.
1. Magnetic Whiteboard 'A': Visionary Magnetic Glassboard, by MooreCO, Inc. or approved equal.
 - a. Size: 3'x4'.

- b. Thickness: 1/8".
- c. Backing: Full Steel, magnetic.
- d. Color: Gloss white.
- e. Mounting Style: Wall Offset with (4) 1" stainless steel mounts.
- f. Surface: 1/8" tempered glass.
 - 1) Non-ghosting and non-staining surface.

2.02 TACKBOARDS

A. Basis of Design Product: Provide the following product or equivalent.

1. Tackboard: Colored Cork Tackboard with Aluminum Trim, by MooreCO, Inc. or approved equal.
 - a. Size: 3'x4'.
 - b. Panel Construction: .25" thick Colored Cork permanently adhered to a .25" thick layer of durable and moisture-resistant MDF.
 - c. Trim: .88" Clear Anodized Aluminum with hairline mitered corners.
 - d. Color: To be selected from Manufacturer's full range of 12 colored cork colors.
 - e. Mounting Style: Concealed
 - f. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

B. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.

1. Verify adhesives have a VOC content of 50 g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 EXECUTION

3.01 INSTALLATION

- #### A. General:
- Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, non-combustible in wall blocking, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

END OF SECTION

SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Public-use washroom accessories.
2. Custodial accessories.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each finish specified, full size.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Delegated-Design Submittal: For grab bars and shower seats.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.03 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Warranties.

1.05 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with applicable provisions in the Americans With Disabilities Act and Architectural Barriers Act Accessibility Guidelines.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
2. Shower Seats: Installed units are able to resist 250 lbf applied in any direction and at any point.

2.02 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Seachrome Corporation.
 - h. Tubular Specialties Manufacturing, Inc.
2. Description: Double-roll dispenser with shelf.
3. Mounting: Surface mounted.
4. Operation: Noncontrol delivery with standard spindle.
5. Capacity: Designed for 4-1/2- or 5-inch-diameter tissue rolls.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

B. Recessed Towel / Waste Unit

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-3940 Recessed Wall Combination Towel / Waste Unit or comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bradley Corporation.
 - d. Brey-Krause Manufacturing Co.
 - e. GAMCO Specialty Accessories; a division of Bobrick.
 - f. Seachrome Corporation.
 - g. Tubular Specialties Manufacturing, Inc.
2. Mounting: Recessed
3. Unit includes convertible folded paper towel module and 6-gallon waste receptacle.
4. Seamless beveled flange.
5. Dispenses 600 C-fold or 800 multifold towels.

6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Soap Dispenser

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Seachrome Corporation.
 - h. Tubular Specialties Manufacturing, Inc.
2. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
3. Mounting: Vertically oriented, surface mounted.
4. Materials: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Refill Indicator: Window type.

D. Grab Bar

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Oatey.
 - h. Seachrome Corporation.
 - i. Tubular Specialties Manufacturing, Inc.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/2 inches.
5. Configuration and Length: As indicated on Drawings.

E. Mirror Unit

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Seachrome Corporation.
 - h. Tubular Specialties Manufacturing, Inc.
2. Frame: Stainless steel, adjustable tilt.
 - a. Corners: Manufacturer's standard.
3. Size: As indicated on Drawings.

F. Hook

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Seachrome Corporation.
 - h. Tubular Specialties Manufacturing, Inc.
2. Description: Double-prong unit.
3. Mounting: Exposed.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Provide one hook on back of restroom door.

2.03 CUSTODIAL ACCESSORIES

A. Custodial Utility Shelf

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.

- c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Tubular Specialties Manufacturing, Inc.
- 2. Description: With exposed edges turned down not less than 1/2 inch and supported by two triangular brackets welded to shelf underside.
 - 3. Size: 16 inches long by 6 inches deep.
 - 4. Material and Finish: Not less than nominal 0.05-inch-thick stainless steel, ASTM A480/A480M No. 4 finish (satin).

B. Custodial Mop and Broom Holder

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Tubular Specialties Manufacturing, Inc.
- 2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
- 3. Length: 36 inches (914 mm).
- 4. Hooks: Four.
- 5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
- 6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch-thick stainless steel.
 - b. Rod: Approximately 1/4-inch-diameter stainless steel.

2.04 FABRICATION

- A. Keys: Locksets are not required. If provided, provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Government's representative.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Activar Construction Products Group, Inc. - JL Industries.
 - b. Amerex Corporation.
 - c. Ansul by Johnson Controls Company.
 - d. Babcock-Davis.
 - e. Badger Fire Protection.
 - f. Buckeye Fire Equipment Company.
 - g. Fire End & Croker Corporation.
 - h. Guardian Fire Equipment, Inc.
 - i. Kidde Residential and Commercial Division.
 - j. Larsens Manufacturing Company.
 - k. MOON American.
 - l. Nystrom.
 - m. Potter Roemer LLC; a Division of Morris Group International.
 - n. Pyro-Chem; Tyco Fire Suppression & Building Products.
 - o. Strike First Corporation of America (The).
2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

- B. Multipurpose Dry-Chemical Type: UL-rated 5-pound nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.03 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Activar Construction Products Group, Inc. - JL Industries.
 - b. Amerex Corporation.
 - c. Ansul by Johnson Controls Company.
 - d. Babcock-Davis.
 - e. Badger Fire Protection.
 - f. Buckeye Fire Equipment Company.
 - g. Fire End & Croker Corporation.
 - h. Guardian Fire Equipment, Inc.
 - i. Kidde Residential and Commercial Division.

- j. Larsens Manufacturing Company.
- k. Nystrom.
- l. Potter Roemer LLC; a Division of Morris Group International.
- m. Pyro-Chem; Tyco Fire Suppression & Building Products.
- n. Strike First Corporation of America (The).

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

- 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: Top of fire extinguisher to be at 42 inches above finished floor.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

SECTION 11 00 00

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Scope: This section specifies general requirements applicable to all mechanical equipment specified in Divisions 40, 41, 43, and 46. The Contractor is responsible for ensuring all mechanical equipment meets the requirements of this section in addition to the specific requirements of the individual equipment specification section. Where the requirements of this section are in conflict with the requirements of an individual equipment specification section, the individual equipment specification shall take precedence. The Contractor shall be responsible for coordinating the installation of the equipment.
- B. Equipment Lists: Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Contractor and are not complete listings of all equipment, devices and material to be provided under this contract. The Contractor agrees to prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.02 QUALITY ASSURANCE

- A. Arrangement: The arrangement of equipment shown on the Drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual equipment installation requirements. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations.
- B. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)

- C. Unit Responsibility: Where specified in individual equipment specification sections, the Contractor shall assign unit responsibility to, and obtain each system from, the supplier of the primary or driven equipment. The supplier shall provide all components of the system to enhance compatibility, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components such that all equipment is compatible and operates properly to achieve the performance requirements specified. Assignment of unit

responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided elsewhere in the Contract Documents.

- D. Warranty: All equipment and systems specified in Divisions 40, 41, 43, and 46 shall be warranted against defects in materials and workmanship for a period beginning from date of purchase and extending through the correction period in CMAR contract documents. During the warranty period, the equipment will be repaired or replaced at no cost to the Owner.
- E. The equipment manufacturer shall coordinate with suppliers of related equipment specified elsewhere in the Contract Documents to ensure proper operation and interface between system components.

1.03 SUBMITTALS

- A. Provide the following submittals, as applicable, for each unique equipment item and unique set of performance requirements in accordance with Section 01 33 00. Items 1 through 10 listed below must be submitted, reviewed by the engineer, and accepted prior to shipping of equipment.
 - 1. Manufacturer's data including complete manufacturer model number, materials of construction, equipment configuration, details of installation, equipment weight, and equipment coatings.
 - 2. Dimensioned fabrication drawings showing the entire assembly. This shall include a materials list, sizes, piping connections, ASTM designations where appropriate, thicknesses, construction, and description of all major components.
 - 3. A copy of the Contract Document control diagrams and process and instrumentation diagrams, with addenda updates that apply to the equipment, marked to show specific changes necessary for the supplied equipment. If no changes are required, the Drawing(s) shall be marked "no changes required."
 - 4. A copy of the individual equipment specification section with addenda updates that apply to the equipment specification section, with each paragraph check marked to show specification compliance or marked to show deviations.
 - 5. Electrical data and control and wiring diagrams, including a bill of materials, elementary control diagrams, connection diagrams, dimensioned panel layout drawings, and manufacturer's catalog data for all system components.
 - 6. Pump performance or equipment head loss curves and data, marked to indicate the operating limits recommended for stable operation between which the equipment may be operated without surge, cavitation, or vibration. The performance curves shall indicate each condition point specified showing head, power, efficiency, and NPSH required on the ordinate plotted against capacity on the abscissa. The performance curves shall indicate performance over the entire operating range of the pump from shutoff to maximum capacity for full and reduced speeds.
 - 7. Certified factory test data as specified where required in the individual equipment specification. One pump of each type (if pumps are identical test only one), 15 horsepower and greater, shall be tested for performance at the factory to determine head vs. capacity, efficiencies, and kilowatt draw required for the points that are specified. All tests shall be run in accordance with the latest edition of the American Institute Standards. If any deviation from the testing is found the pump shall be rejected. Provide certification of factory tests verifying design requirements. Testing shall also include the following:
 - a. Hydrostatic test with data recorded.

- b. Hydraulic test with minimum of 5 readings between shutoff head and 25 percent above design capacity, recorded on data sheets as defined by the Hydraulic Institute, signed, dated and certified.
- c. Certified pump curves showing head/flow, bhp, efficiency, NPSH curves.
- d. Certification that the pump horsepower demand will not exceed the rated motor horsepower beyond the 1.2 service rating at any point on the curve.
- e. Impeller, motor rating and electrical connections shall be checked for compliance to specific requirements.
- f. Submersible Pumps shall include the following additional items:
 - 1) Motor and cable insulation test for moisture content of insulation defects.
 - 2) After submerged test run of 30 minutes under 6 feet of water, item f shall be re-tested.
- 8. Warranty information as specified in Paragraph 1.02.D and Section 01 33 00.
- 9. Equipment Record Form as specified in Section 01 33 00.
- 10. Motor Data Form as specified in Section 11 05 13.
- 11. Submit operation and maintenance manuals as specified in Section 01 78 23, accompanied by an O&M Manual Transmittal Form.
- 12. Proposed on-site testing and start-up procedures in step-by-step detail in accordance with Section 01 91 13. Submittal of all test reports.
- 13. Certificate of Installation, Inspection and Start-up Services form as specified in Section 01 91 13.
- 14. Manufacturer's Certification of Instructional Services form as specified in Section 01 79 00.

PART 2 PRODUCTS

2.01 FLANGES AND PIPE THREADS

- A. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125 for maximum normal operating pressures of 150 psi or ANSI B16.1, Class 250 for maximum normal operating pressures of 300 psi, unless otherwise specified. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.
- B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.
- C. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS

- A. Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA standards for Load Ratings and Fatigue Life for Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10

rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

- B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.
- C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C (140 degrees F) and shall be equipped with a filler pipe and an external level indicator gauge.
- D. All bearings accessible to touch and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C (149 degrees F) or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature or appropriate shielding shall be provided that will prevent inadvertent human contact.

2.03 V-BELT ASSEMBLIES

- A. Unless otherwise specified, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.
- B. Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.
- C. Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion-proof equipment is specified.

2.04 PUMP SHAFT SEALS

- A. General: Where mechanical seals are specified, seals shall be self-contained cartridge type single or double mechanical seals as specified in individual equipment sections. Unless specified otherwise, mechanical seals shall conform to the requirements set forth in this paragraph.
- B. Mechanical Seals
 - 1. Single Cartridge Seal: balanced o-ring, multi-spring design with self-aligning faces, one-piece investment cast gland with flush, quench and drain ports, 316 SS construction, carbon vs. silicon carbide faces, carbon restriction bushing in atmospheric side of gland. Single mechanical seals shall be AESSEAL SCUSI or CURC as recommended by the manufacturer on a pump by pump basis; seals by other manufacturers will not be accepted.
 - 2. Double Cartridge Seal: double balanced o-ring, multi-spring design with self-aligning faces inboard and outboard, one-piece investment cast gland, connection built-in to gland for inlet and outlet of barrier fluid, carbon vs. silicon carbide inboard faces, carbon vs. chrome oxide outboard faces. Double mechanical seals shall be AESSEAL CDSA; seals by other manufacturers will not be accepted.

3. Pumps used for hazardous chemicals and or abrasive fluids shall be equipped with double mechanical seals with built-in barrier fluid ports unless otherwise specified or requested by Owner.
4. For submersible pumps use AESSEAL T05 component seal or manufacturers equivalent, double mechanical seals for abrasives and single mechanical seals for clean water.

C. Shaft Packing

1. Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in subparagraph 2.04.B for the applicable pump and operating conditions.
2. Unless otherwise specified, lantern rings shall be bronze or Teflon, packing shall be die-molded packing rings of non-asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC-20. Threaded lantern ring removal tools shall be provided with spare parts for each pump.

D. Seal Water Regulating and Monitoring System

1. Seal water monitoring system shall be a complete unified component capable of controlling all necessary aspects of the seal water system for pumps or equipment utilizing a packing gland type, single mechanical type, or double mechanical type shaft seal. Complete monitoring system shall include the single component control unit, mounting stand or bracket and associated hardware, and all necessary hoses, quick couplings, check valves, hose nipples, and hose couplings required for a complete and functioning system.
2. The base of the control unit shall be constructed of 7/8" thick, 316 stainless steel to accommodate fittings. Seal connections shall be 1/4" NPT for shaft sizes up to 2" diameter and pumped fluid temperature < 120 deg F. For shafts > 2" diameter or pumped fluid temperatures > 120 deg F, unit shall have min. 3/8" connections. Unit shall include a push button test and clean system for the flow meter which can be activated while unit is in operation. Unit shall utilize orifice shaped valves to allow larger particles of dirt and debris to pass through without stopping the flow or plugging the unit. Pressure gauge shall be glycerin filled. Unit shall come equipped with an inductive low-flow alarm sensor that utilizes an AC signal (20-250 VAC) to communicate to the process control system.
3. Complete seal water monitoring system as specified shall be John Crane Safeunit Model SFP or SFD or approved equal. Unit shall be provided with connections as follows or per manufacturer's written instructions:
 - a. Packing gland or single seal flush type seal water system
 - 1) John Crane Safeunit Model SFP
 - 2) 1 connection – service water supply to unit
 - 3) 1 connection – seal water supply from unit to the shaft seal
 - b. Double mechanical type seal water system
 - 1) John Crane Safeunit Model SFD
 - 2) 1 connection – service water supply to unit

- 3) 1 connection – seal water supply from unit to shaft seal
- 4) 1 connection – seal water return from shaft seal to unit
- 5) 1 connection – drain line from unit

2.05 COUPLINGS

- A. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taperlock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.
- B. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or approved equal couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.06 GUARDS

- A. Exposed moving parts shall be provided with guards which meet the requirements of OSHA. Guards shall be fabricated of 14-gauge steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.07 GAUGE TAPS, TEST PLUGS, AND GAUGES

- A. Gauge taps shall be provided on the suction and discharge sides of pumps, blowers, compressors, and as shown in the Drawings. Pressure and vacuum gauges shall be provided where specified.

2.08 NAMEPLATES

- A. A manufacturer's nameplate shall be provided for each piece of equipment and shall identify the manufacturer's name and address, and the specific style and/or model of the equipment provided.
- B. Project identification nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible location with stainless steel screws or drive pins.
- C. Project identification nameplates for pumps shall indicate rated head and flow, pump operating speed (rpm), and impeller diameter.

2.09 LUBRICANTS

- A. The Contractor shall provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.10 ANCHOR BOLTS

- A. Anchor bolts shall be designed for lateral forces for both pullout and shear. Anchor bolts shall be 304 stainless steel and comply with the requirements of Section 05 50 10.

2.11 SPARE PARTS

- A. Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a suitable box, identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the exterior of the box.

PART 3 EXECUTION

3.01 GENERAL

- A. The manufacturer shall assume responsibility for packaging to prevent transit and handling damage.
- B. Store, install, and start-up each specified equipment system, including accessories, where shown on the Drawings, as specified herein, and as recommended by the equipment manufacturer's written instructions. Bring any discrepancies immediately to the attention of the Engineer.
- C. Final coatings, where required, shall be in accordance with Section 09 90 00.

3.02 INSTALLATION AND FIELD TESTING

- A. All certification of factory tests and materials shall be submitted and approved by the Engineer before shipping equipment.
- B. The Contractor shall install the equipment and make any and all necessary modifications and/or adjustments required to obtain satisfactory operation. Accurately place anchor bolts for skid attachment to floor using dimensions as per the manufacturer installation data.

- C. Provide lubrication and lubrication fittings before operating as per manufacturer's recommendations. Extend fitting to allow easy access and without having to remove covers or guards.
- D. Provide factory certified service technician to inspect the installation, unless otherwise specified.
- E. All equipment shall be field tested after installation in accordance with Section 01 91 13, the Contract Documents, the requirements of this section, and the requirements of the individual equipment specification to demonstrate satisfactory operation and performance, without causing excessive noise, cavitation, vibration, leakage, overheating, or other operational deficiencies. Field testing shall be performed under the supervision of an experienced field representative of the manufacturer, who shall supervise the testing and shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
- F. Start-up: Start-up, check and operate equipment over the entire operational range and speed range.
- G. Pump Systems: Pumps systems shall be tested for compliance with the following:
 - 1. Vibration shall be within amplitude limits recommended in the Hydraulic Institute Standards and shall be recorded at a minimum of four pumping conditions defined by the engineer.
 - 2. Pump performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions. Each power lead to the motor shall be checked for proper current balance. All instrumentation necessary to conduct the testing shall be provided by the Contractor.
- H. The installation and initial operation of all components shall be certified on the Certificate of Installation, Inspection and Start-up Services form as specified in Section 01 91 13.
- I. Electrical and controls testing shall conform to the requirements of Section 01 91 13 and Divisions 26 and 40.
- J. TRAINING
 - 1. Unless otherwise specified, training addressing the theory of operation, testing, troubleshooting, and maintenance of equipment item and system shall be provided. Training shall be conducted in accordance with Section 01 79 00 and shall be certified on Manufacturer's Certificate of Instructional Services in Section 01 79 00. Minimum training duration shall be as specified in the individual equipment specification.

END OF SECTION

SECTION 11 05 13

ELECTRIC MOTORS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies low-voltage alternating current induction motors, 250 horsepower or less. This section does not specify medium voltage (over 600 volts) motors and specialty motors such as submersible motors, hoist motors, valve operator motors or torque rated motors. Unless specified otherwise, electric motors shall be provided by the manufacturer of the driven equipment under the provisions of Section 11 00 00. Unless specified otherwise in the particular equipment specifications, motors shall be provided in compliance with this specification Section.

1.02 QUALITY ASSURANCE

- A. General: Motors shall be built in accordance with UL 674, UL 1004, NEMA Standard MG 1, and to the requirements specified.
- B. References: This section contains references to the following documents. They are a part of this section as specified and modified. In the event conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
IEEE 112	Standard Test Procedures for Polyphase Induction Motors and Generators
IEEE 841	Standard for Petroleum and Chemical Industry – Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – Up to and Including 500 HP
NEMA ICS 2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA MG 1	Motors and Generators
UL 674	Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 1004	Standard for Rotating Electrical Machines – General Requirements

- C. Testing: Motors rated 100 horsepower and greater shall be assembled and performance tested at the factory. Test results shall be submitted with the equipment operation and maintenance data. Factory tests shall include the following:
1. No load current.
 2. Full load current.
 3. Breakdown torque.
 4. Locked rotor current.

5. Locked rotor torque.
6. Hi-potential test.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
1. Completed motor data form (Form 11 05 13, appended to the end of this section).
 2. For motors 100 horsepower and larger, a motor heating curve.
 3. Motor outline, dimensions, and weight.
 4. Motor connection diagram indicating requirements for all electrical connections.
 5. Manufacturer's descriptive information relative to motor features and conformance with specified standards.

1.04 AMBIENT CONDITIONS

- A. Motors shall be rated for continuous operation at nameplate horsepower under the following conditions:
1. Temperature (max): 40 degrees Centigrade
 2. Elevation: 5,400 feet above sea level.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. The following manufacturer's motors generally meet the class and performance requirements of this specification when furnished with appropriate modifications and additional features as specified:
1. Baldor
 2. General Electric
 3. Reliance Electric Co.
 4. US Motor

2.02 GENERAL

- A. Nameplates: Motor nameplates shall be engraved or stamped stainless steel or brass. Information shall include those items enumerated in NEMA Standard MG 1, paragraph 10.37, 10.38 or 20.60, as applicable. Nameplates shall be permanently fastened to the motor frame and shall be positioned to be easily visible for inspection.
1. Additional Markings:
 - a. Nameplates for motors 1/2 horsepower and larger shall indicate the ABMA L-10 rated life for the motor bearings.
 - b. Nameplates for motors 2 horsepower and larger shall list the NEMA nominal efficiency.

- c. Nameplates for inverter duty motors shall identify the motor as inverter duty.
 - d. Nameplates for IEEE 841 compliant motors shall indicate IEEE 841 compliance.
 - e. Nameplates for explosion proof motors shall also indicate UL frame temperature limit code.
- B. Construction: All motors provided under this specification shall have the following features of construction unless otherwise specified:
 - 1. Cast iron frames for motors 1/2 horsepower and larger. Steel frames for motors smaller than 1/2 horsepower. Aluminum frame motors will not be permitted.
 - 2. Cast metal fan blades and shrouds.
 - 3. Cadmium plated hardware.
 - 4. Non-hygroscopic leads.
 - 5. Class B temperature rise above 40 degrees C ambient.
 - 6. NEMA design B.
 - 7. NEMA F1 mounting configuration.

2.03 MOTORS LESS THAN 1/2 HORSEPOWER

- A. General: Unless otherwise noted on the Drawings or Specifications, motors less than 1/2 horsepower shall be squirrel cage, single phase, capacitor start, induction run type. Construction features listed in paragraph 11 05 13-2.02 may be as normally supplied by the equipment manufacturer. Single phase motors shall have Class B insulation. Small fan motors may be split-phase or shaded-pole type. Windings shall be copper.
- B. Rating: Motors shall be rated 115 volts, single phase, 60 hertz, and shall be continuous time rated in conformance with NEMA Standard MG 1, paragraph 10.35. Motors shall be non-overloading at all points of the equipment operation.
- C. Enclosures: Motor enclosures shall be as defined in NEMA MG 1. Unless otherwise specified, motors shall have totally enclosed fan cooled or totally enclosed non-ventilated enclosures. Explosionproof motors shall bear the UL Label for Class I, Division 1, Group D hazardous locations.

2.04 MOTORS 1/2 HORSEPOWER THROUGH 250 HORSEPOWER

- A. General: Motors 1/2 horsepower through 250 horsepower shall be three phase, squirrel cage, full voltage start induction type. Unless otherwise specified, motors shall have a NEMA MG 1-1.16 design for the duty service imposed by the driven equipment such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.
- B. Rating: Motors shall be rated 460 volts, three phase, 60 Hz, and shall be continuous time rated in accordance with NEMA Standard MG 1, paragraph 10.35. Unless specified otherwise, motors shall have a service factor of 1.15, but shall not be required to exceed their nameplate rating at any point in the service range of the driven equipment.
- C. Efficiency: Motors shall be premium energy efficient type. Motor minimum nameplate efficiency, determined in accordance with IEEE 112B testing procedures, when operating on a sinusoidal power source shall be as specified in NEMA MG1 for premium efficiency electric motors.

D. Classifications

1. General: Motors shall conform to the requirements specified in the following paragraphs. Definition of terms shall be in accordance with NEMA MG 1. Temperature rise for all motor types shall not exceed that permitted by Note II, paragraph 12.42, NEMA MG 1.
2. Type 1 Motors: Type 1 motors shall have drip-proof guarded enclosures with Class F insulation and Class B temperature rise at the motor's nominal rating.
3. Type 2 Motors: Type 2 motors shall be totally enclosed, fan-cooled with Class F insulation and Class B temperature rise at the motor's nominal rating.
4. Type 2S Motors: Type 2S motors shall be totally enclosed, fan-cooled designed for severe duty applications. Type 2S motors shall conform to the requirements of IEEE 841. Motor nameplate shall indicate IEEE 841 compliance.
5. Type 3 Motors: Type 3 motors shall be explosionproof motors, UL listed in accordance with UL 674 for Class I, Group D hazardous atmospheres. The motor shall have Class F insulation and shall conform to IEEE 841. An UL-approved breather/drain device shall be provided in the motor drain hole.

E. Thermal Protection: Type 2 and Type 3 motors, 50 horsepower and larger, shall be provided with Type 1 thermal protection as defined in NEMA MG 1-12.53.1 unless otherwise specified. Motor manufacturer shall provide any auxiliary equipment required to monitor the thermal protection devices. Auxiliary equipment shall have normally closed NEMA ICS 2 B300 contacts and shall be housed in NEMA 250 enclosures as follows:

1. Type 2 Motors: NEMA 4
2. Type 3 Motors: NEMA 7D

F. Inverter Duty Motors: Motors specified as inverter duty in the process equipment specifications shall have the features of the specified motor classification (Refer to paragraph 11 05 13-2.04 D) in addition to the features specified herein for inverter duty motors.

1. Motors intended for use with adjustable frequency controllers shall not exceed NEMA MG 1, Class B, temperature rise when operating over the specified speed range with the specified load speed/torque characteristic. Inverter duty motors may be NEMA MG1-1.16, Design A.
2. Motors intended for use with adjustable frequency controllers shall be inverter duty motors specifically designed for inverter service for the speed range and load torque characteristic required by the associated driven equipment. Inverter duty motor shall be designed to operate over the speed or frequency range specified. Motor insulation shall be designed to meet NEMA MG 1, Part 31 (1600 volt peak at a minimum of 0.1 micro-second rise time).
3. Motors shall be premium energy efficient type with a minimum nameplate efficiency as specified in paragraph 11 05 13-2.04 C at rated load on sine wave power at the base voltage and frequency rating. Motors shall have a 1.15 service factor on sine wave power at the base voltage and frequency rating and a 1.0 service factor on inverter power throughout the specified speed range.
 - a. Shaft Grounding Unit: Where specified, inverter duty motors shall be equipped with a shaft grounding unit mounted on the fan housing with stub shaft extended from the motor shaft. Grounding unit shall be equipped with two brushes, totally enclosed and sealed against environmental contamination.
 - b. Winding Overtemperature Protection: All inverter duty motors shall be provided with stator winding overtemperature protection. Overtemperature protection shall

be NEMA MG 1-12.53, Type 1 winding and locked rotor overtemperature protection. Detectors shall be positive thermal protection (PTC) thermistors with leads brought out to a terminal block in an auxiliary conduit box integral to the motor. Thermistor characteristics shall comply with IEC 60034-11-2. Two thermistors shall be provided in each phase of the stator winding. All thermistor leads (2 per thermistor) shall be labeled and terminated in the motor auxiliary conduit box.

- c. **Blower-Cooled Motors:** Where specified, or required by the specified application requirements, inverter duty motors shall be totally enclosed, air-over, blower-cooled (TEBC). Blowers shall be driven at constant speed by 460-volt, 3-phase motors in conformance with Type 2 requirements as specified in paragraph 11 05 13-2.04 D. Blower and ducting shall be an integral part of the main motor frame. Air intake filter shall be provided. Scroll case shall be cast aluminum or iron, and fan wheel shall be Type 304 stainless steel.
- G. **Vertical Motors:** Vertical motors shall be solid-shaft P-base type specifically designed for vertical installation. Universal position motors are not acceptable. Vertical motors shall conform to Type 2, Type 3, and/or inverter duty motor requirements as specified. Thrust bearing rating shall be compatible with the loads imposed by the driven equipment.
- H. **Conduit Boxes:** Conduit boxes shall be cast iron, split construction with threaded hubs. Conduit boxes shall be sized at least one size larger than NEMA standard for the given motor size. Conduit boxes shall be designed to rotate in order to permit installation in any of four positions 90 degrees apart. Motors shall be furnished with petroleum-resistant gaskets at the base of the conduit box and between the halves of the conduit box. Motors shall have grounding lug located within the box for the ground connection. Minimum length of pigtail leads shall be 12 inches for motors up to 50 horsepower, and 16 inches for motors larger than 50 to 250 horsepower.
 - 1. A separate, auxiliary conduit box shall be provided for terminating the leads of internal motor accessories including thermal protective devices, space heaters, etc.
- I. **Bearings:** Bearings may be oil or grease lubricated ball or angle contact roller bearings rated for a minimum L-10 life of 100,000 hours in accordance with ABMA 9-1990 or 11-1990 at the ambient temperature specified. Motor designs employing cartridge type bearings will not be accepted. Bearings shall be fitted with lubricant fill and drain or relief fittings.
- J. **Lifting Eyes:** Motors weighing more than 50 pounds shall be fitted with at least one lifting eye.
- K. **Current Imbalance:** Current imbalance, based upon the lowest value measured, shall not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:
 - 1. Under 5 horsepower: 25 percent
 - 2. 5 horsepower and above: 10 percent
- L. **Space Heaters:** Where specified, space heaters shall be sized and designed to prevent condensation inside the motor enclosure after shutdown. Heaters shall be cartridge or flexible wraparound type. Heaters shall be rated 120 volts, single phase, 60 Hz. The space heater rating in watts and volts shall be noted on the motor nameplate or on a second nameplate. Space heater terminals shall be brought to a separate terminal block or pigtails in the conduit box.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which motors are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF MOTORS

- A. Install motors and accessories in accordance with manufacturer's instructions. Manufacturer's installation instructions shall be available at the project site.
- B. Remove any slushing compound on shaft or other parts using a petroleum-type solvent.
- C. Remove shaft shipping braces after motor is placed in its final location.
- D. Install motor securely on firm, level foundation.
- E. Install shaft coupling or sheave in accordance with manufacturer's instructions. Do not modify motor shaft to accommodate coupling or sheave.
- F. Align the motor shaft with the load shaft. Meet the most stringent of the motor manufacturer's requirements for shaft alignment or the driven equipment manufacturer's requirements for shaft alignment.
- G. Verify that line voltage and phases agree with motor nameplate.
- H. Ground motors according to manufacturer's instructions and the requirements of Specification 26 05 26.
- I. Make electrical connections to motors using materials and methods in accordance with Specification 26 05 19. Use motor lead splicing kits to insulate and seal connections to leads.

3.03 FIELD INSPECTIONS AND TESTS

- A. Verify that motor is lubricated in accordance with manufacturer's instructions.
- B. Before energizing, turn motor shaft by hand to ensure free rotation.
- C. Verify that the area around motor fan cooling air inlets is free of debris that could be drawn into motor or motor fan during operation.
- D. Check external bolted connections for proper torque.
- E. Before energizing motor with driven equipment, verify proper alignment of motor shaft with load shaft. Provide alignment test report.
- F. Inspect and test motor installations in accordance with the requirements of Specification 26 08 00.

END OF SECTION

Form 11 05 13
Motor Data Form

Driven Equipment Name: _____ Equipment Numbers: _____
Driven Equipment Description: _____
Driven Equipment Location: _____

Motor Nameplate Markings

Manufacturer: _____ Manufacturer Type: _____
Frame: _____ Horsepower: _____ Service Factor: _____
Volts: _____ Phase: _____ Temperature Rating: _____ °C
Full Load Amps: _____ Frequency: _____ Locked Rotor Amps: _____
Design Letter: _____ Code Letter: _____ Insulation Class: _____
RPM: _____ Time Rating: _____

Motor Efficiency

Guaranteed minimum efficiency: _____
Nameplate or nominal efficiency: _____

Motor Enclosure Type

_____ Open drip proof
_____ Totally enclosed, fan-cooled
_____ Explosionproof (Class I, Division 1)
_____ Other: _____

Motor Construction Features

Inverter Duty (NEMA MG 1, Part 31):
Winding Overtemperature Protection (PTC Thermistors in each winding):
Cast Iron Frame:
IEEE 841 Compliant
NEMA Mounting Configuration:
Bearing Life (Hours):

YES	NO
YES	NO
YES	NO
YES	NO

SECTION 11 30 13
RESIDENTIAL APPLIANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cooking appliances.
2. Refrigeration appliances.
3. Dishwashing appliances.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.
- C. ENERGY STAR: Product Data for indicated products, showing compliance with requirements for ENERGY STAR product labeling.

1.04 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Field quality-control reports.
- C. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Warranties.

1.06 WARRANTY

- A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 COOKTOPS

- A. Electric Cooktop:
 - 1. GE 30" Built-In Touch Control Electric Cooktop
 - 2. Model: JP5030DJBB
 - 3. Color: Black

2.03 MICROWAVE OVENS

- A. Microwave Oven
 - 1. GE Profile Series 2.1 Cu. Ft. Over-the-Range Sensor Microwave Oven, or equal.
 - 2. Model: PVM9005FMDS
 - 3. Color: Black Slate

2.04 REFRIGERATOR/FREEZERS

- A. Refrigerator
 - 1. Energy Star compliant.
 - 2. GE 21.8 Cu. Ft. Counter-Depth Side-By-Side Refrigerator, or equal.
 - 3. Model: GZS22IENDS
 - 4. Color: Black Slate.
 - 5. Include ice maker and chilled water dispenser.

2.05 DISHWASHING

- A. Built-In Dishwasher
 - 1. GE Profile Top Control with Stainless Steel Interior Dishwasher with Sanitize Cycle & Dry Boost with Fan Assist, or equal.
 - 2. Model: PDT715SFNDS
 - 3. Color: Black Slate.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

B. Coordinate with Plumbing Division for connection to Ice Make wall box.

3.02 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 12 34 50

STEEL LABORATORY CASEWORK AND RELATED PRODUCTS

PART 1 GENERAL

1.01 SUMMARY

- A. Provide all labor and material for the complete installation of metal base and wall cabinets, countertops, sinks, service fittings, appliances, equipment and accessories as indicated on the Drawings and as specified herein.
- B. Section Includes:
1. Metal Base Cabinets
 2. Metal Wall Cabinets
 3. Epoxy Resin Countertops
 4. Sinks and Service Fittings
 5. Shelving Assemblies
 6. Appliances
 7. Safety Cabinets
 8. Furnish all cabinets and casework, including tops, ledges, supporting structures. Include delivery to the building, set in place, level, and scribe to walls and floors as required. Furnish and install all filler panels, knee space panels and scribes as shown on drawings.
 9. Furnish and deliver all utility service outlet accessory fittings, electrical receptacles and switches identified on drawings as mounted on the laboratory furniture. All plumbing and electrical fittings, not preinstalled in equipment, will be packaged separately and properly marked for delivery to the appropriate contractor.
 10. Furnish and deliver, for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.
 11. Furnish service strip supports where specified, and setting in place service tunnels, service turrets, supporting structures and reagent racks of the type shown on the drawings.

1.02 ACTION SUBMITTALS

- A. Product Data and Manufacturer's Data: Submit manufacturer's data and installation instructions for the following:
1. Metal Base Cabinets
 2. Metal Wall Cabinets
 3. Epoxy Resin Countertops
 4. Sinks and Service Fittings
 5. Shelving Assemblies
 6. Appliances

7. Safety Cabinets

- B. Provide data indicating compliance with SEFA 8.
- C. Submit manufacturer's printed product information highlighting products required for this installation.
- D. Submit shop drawings, showing casework, countertop layout, support details, locations of sinks, fittings, equipment and accessories. Provide minimum 1/4" = 1'-0" scale elevations of all casework. Show all closers, end caps, filler strips and joints between units and other components and construction.
 - 1. Completely describe and illustrate features, materials, fabrication, including rough-in details for plumbing, electrical and ventilation connections.
 - 2. Key units to designations on the drawings.
 - 3. Show required field measurements beyond manufacturer's control. Establish and maintain applicable rough-in and field dimensions.
- E. Submit color samples for selection.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified manufacturer.

1.04 QUALITY ASSURANCE

- A. Single Source Responsibility for Manufactured Casework: To ensure consistent quality and one source responsibility the casework must be supplied and installed by a single company. Subcontracting or using contract labor to install the casework is unacceptable.
- B. The steel laboratory furniture contractor shall also provide worktops all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.
- C. General Performance: Provide certification that furniture shall meet the performance requirements described in SEFA 8.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: The design for laboratory casework is based on Kewaunee Scientific Corporation Research Collection Laboratory Furniture. Provide the named product or a comparable product by one of the following:
 - 1. Thermo Fisher Scientific
 - 2. Mott

2.02 QUALITY STANDARD

- A. Provide cabinets that comply with Scientific Equipment and Furniture Association - SEFA 8.

2.03 CABINET STYLE

- A. Steel: Cabinet bodies, drawer bodies, shelves, drawer heads and door assemblies shall be fabricated from Cold Rolled Steel.
- B. Drawer and Door Style: Advantage - Overlay – 12 - The outer drawer and door head shall have a channel formation on all four sides to eliminate sharp raw edges of steel and the top front corners shall be welded and ground smooth. Drawer and door, when closed, shall rest against face of cabinet shell, creating a 3/4" overlay front with 1/8" reveal. Drawer and door pulls shall be anodized aluminum-recessed style.

2.04 MATERIALS

A. General Requirements

- 1. It is the intent of this specification to provide a high-quality steel cabinet specifically designed for the laboratory environment.

B. Steel

- 1. Cold Rolled Steel:
 - a. Cold rolled sheet steel shall be prime grade 12, 14, 16, 18 and 20 gauge U.S. Standard; roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches or other injurious effects.

C. Glass

- 1. Glass used for framed sliding and swinging doors shall be 1/8" float glass. Glass used for unframed sliding doors, shall be 1/4" float glass. Glass used in hazardous locations shall be 7/32" laminated safety float glass.
- 2. Hardware and Trim:
 - a. Drawer and Door Pulls:
 - 1) Rounded Aluminum – 1 - Pull shall be of modern design, offering a comfortable handgrip, and be securely fastened to doors and drawers with screws. All pulls shall be satin finish aluminum, with a clear, lacquer finish. Two pulls shall be required on all drawers over 24" long. Use of plastic pulls (molded or extruded), or a design not compatible for usage by the handicapped will not be acceptable.
 - b. Sliding Door Pulls:
 - 1) Flush pulls for sliding doors shall be aluminum, with clear, lacquer finish, providing a recessed finger grip. Finger holes or slots machined into doors will not be acceptable.
 - c. Hinges:
 - 1) Hinges shall be made of Type 304 stainless steel .089 thick, 2-1/2" high, with brushed satin finish, and shall be the institutional type with a five knuckle bullet type barrel. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted. Doors under 36" in height shall be hung on one pair of hinges, and doors over 36" high shall be hung on 3 hinges.

- d. Locks:
 - 1) Disk Tumbler: Locks when shown or called for shall be a 5-disc tumbler with heavy duty interchangeable cylinder. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers. Locks shall have capacity for 2000 primary key changes. Master key one level with the potential of 10 different, non-interchangeable master key groups.
- e. Elbow Catches:
 - 1) Elbow catches and strike plates shall be used on left hand doors of double door cases where locks are used, and are to be burnished cast aluminum, with bright brass finish.
- f. Shelf Adjustment Clips:
 - 1) Shelf adjustment clips shall be nickel-plated steel.
- g. Leg Shoes:
 - 1) Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Shoes shall be a pliable, black vinyl material. Use of a leg shoe, which does not conceal leveling device, will not be acceptable.
- h. Base Molding: See section 09 65 13 for Resilient Base and Accessories.
- i. Support Rods, Upright Rod Assemblies and Rod Sockets:
 - 1) Upright rods, cross rods and ring support rods, where specified, shall be anodized Duralumin (2" or 3/4" dia., as required). Rod sockets shall be chrome-plated brass, secured through tabletops with lock nut and spring washer. Rod clamps shall be heavy duty, designed to securely hold rod assembly in any position. Use of wood rod assemblies will not be accepted
- j. Label Holders:
 - 1) Label holders, provide (1) at each door and drawer front, shall be self adhesive type aluminum with satin finish and designed for 2 1/2" x 1 1/8" cards, unless otherwise specified.
- k. Sink Supports:
 - 1) Sink supports shall be the hanger type, suspended from top front and top rear horizontal rails of sink cabinet by four 1/4" dia. rods, threaded at bottom end and offset at top to hang from two full length reinforcements welded to the front and rear top rails. Two 3/4" x 1 2/2" x 12 gauge channels shall be hung on the threaded rods to provide an adjustable sink cradle for supporting sinks. When sink capacity exceeds 3,750 cu. in., the sink supports shall be suspended from full-length reinforcements welded to the two end rails. Two 1" x 2" x 10 gauge full-length channels shall be hung from the four 1/4" dia. rods to provide an alternate sink cradle.
- l. Support Struts:
 - 1) Support struts shall consist of two 16 gauge channel uprights fastened top and bottom by two adjustable "U" shaped spreaders, each 12 gauge, 1 1/2" x length required formed from galvanized steel. Struts shall be furnished to support drain troughs, and to support worktop at plumbing space under heavy loads. Support struts can be furnished with hangers at extra cost when specified, to support mechanical service piping and drain lines.

2.05 PERFORMANCE

A. Casework components shall withstand the following loads without damage to the component or to the casework operation:

1. Steel base unit load capacity: up to 200 lbs. of uniformly distributed load per square foot of cabinet top area.
2. Base cabinet corner gussets with leveling bolts shall support 500 lbs. per corner
3. Suspended units: 300 lbs.
4. Utility tables (4-legged): 300 lbs.
5. Drawers in a cabinet: 150 lbs.
6. Hanging wall cabinets: 300 lbs.
7. Load capacity for shelves of base units, wall cases and tall cases: 40 lbs. per square foot up to 200 lbs.
8. Swinging doors on floor-mounted casework shall support 200 lbs. suspended at a point 12" from hinged side, with door swung through an arc of 160 degrees. Weight load test shall allow only a temporary deflection, without permanent distortion or twist. Door shall operate freely after test and assume a flat plane in a closed position.
9. Each adjustable and fixed shelf 4 ft. or shorter in length shall support an evenly distributed load of 40 lbs. per square ft. up to a maximum of 200 lbs., with nominal temporary deflection, but without permanent set.
10. Steel Paint System Finish and Performance Specification:
 - a. Steel Paint System Finish:
 - 1) After Cold Rolled Steel and Textured Steel component parts have been completely welded together and before finishing, they shall be given a pre paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.
 - 2) After the phosphate treatment, the steel shall be dried, and all steel surfaces shall be coated with a chemical and corrosion resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, ensuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.
 - 3) The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS.
 - b. Performance Test Results (Chemical Spot Tests):
 - 1) Testing Procedure:
 - a) Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and

covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2 ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

2) Test Evaluation:

a) Evaluation shall be based on the following rating system.

- (1) Level 0 – No detectable change.
- (2) Level 1 – Slight change in color or gloss.
- (3) Level 2 – Slight surface etching or severe staining.
- (4) Level 3 – Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

b) After testing, panel shall show no more than three (3) Level 3 conditions.

3) Test Reagents

Test No.	Chemical Reagent	Test Method
1	Acetate, Amyl	Cotton ball & bottle
2	Acetate, Ethyl	Cotton ball & bottle
3	Acetic Acid, 98%	Watch glass
4	Acetone	Cotton ball & bottle
5	Acid Dichromate, 5%	Watch glass
6	Alcohol, Butyl	Cotton ball & bottle
7	Alcohol, Ethyl	Cotton ball & bottle
8	Alcohol, Methyl	Cotton ball & bottle
9	Ammonium Hydroxide, 28%	Watch glass
10	Benzene	Cotton ball & bottle
11	Carbon Tetrachloride	Cotton ball & bottle
12	Chloroform	Cotton ball & bottle
13	Chromic Acid, 60%	Watch glass
14	Cresol	Cotton ball & bottle
15	Dichloroacetic Acid	Cotton ball & bottle
16	Dimethylformamide	Cotton ball & bottle
17	Dioxane	Cotton ball & bottle

Test No.	Chemical Reagent	Test Method
18	Ethyl Ether	Cotton ball & bottle
19	Formaldehyde, 37%	Cotton ball & bottle
20	Formic Acid, 90%	Watch glass
21	Furfural	Cotton ball & bottle
22	Gasoline	Cotton ball & bottle
23	Hydrochloric Acid, 37%	Watch glass
24	Hydrofluoric Acid, 48%	Watch glass
25	Hydrogen Peroxide, 3%	Watch glass
26	Iodine, Tincture of	Watch glass
27	Methyl Ethyl Ketone	Cotton ball & bottle
28	Methylene Chloride	Cotton ball & bottle
29	Mono Chlorobenzene	Cotton ball & bottle
30	Naphthalene	Cotton ball & bottle
31	Nitric Acid, 20%	Watch glass
32	Nitric Acid, 30%	Watch glass
33	Nitric Acid, 70%	Watch glass
34	Phenol, 90%	Cotton ball & bottle
35	Phosphoric Acid, 85%	Watch glass
36	Silver Nitrate, Saturated	Watch glass
37	Sodium Hydroxide, 10%	Watch glass
38	Sodium Hydroxide, 20%	Watch glass
39	Sodium Hydroxide, 40%	Watch glass
40	Sodium Hydroxide, Flake	Watch glass
41	Sodium Sulfide, Saturated	Watch glass
42	Sulfuric Acid, 33%	Watch glass
43	Sulfuric Acid, 77%	Watch glass
44	Sulfuric Acid, 96%	Watch glass
45	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46	Toluene	Cotton ball & bottle
47	Trichloroethylene	Cotton ball & bottle
48	Xylene	Cotton ball & bottle
49	Zinc Chloride, Saturated	Watch glass

*Where concentrations are indicated, percentages are by weight.

11. Performance Test Results (Heat Resistance):

- a. Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

12. Performance Test Results (Impact Resistance):
 - a. A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.
13. Performance Test Results (Bending Test):
 - a. An 18 gauge steel strip, finished as specified, when bent 180o over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.
14. Performance Test Results (Adhesion):
 - a. Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197 68, "Standard Method of Test for Adhesion of Organic Coatings".
15. Performance Test Results (Hardness):
 - a. The test sample shall have a hardness of 4 H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8 H is the hardest, and next in order of diminishing hardness are 7 H, 6 H, 5 H, 4 H, 3 H, 2 H, F, HB, B (soft), 2 B, 3 B, 4 B, 5 B (which is the softest). The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel like manner until one is found that will cut or scratch the film. The pencil used before that one that is, the hardest pencil that will not rupture the film is then used to express or designate the hardness.

2.06 CONSTRUCTION

A. Steel Base Cabinet Construction

1. General:
 - a. The steel furniture shall be of modern design and shall be constructed in accordance with the best practices of the Scientific Laboratory Equipment Industry. First class quality casework shall be insured by the use of proper machinery, tools, dies, fixtures and skilled workmanship to meet the intended quality and quantity for the project.
 - b. All cabinet bodies shall be flush front construction with intersection of vertical and horizontal case members, such as end panels, top rails, bottoms and vertical posts in same plane without overlap. Exterior corners shall be spot welded with heavy back up reinforcement at exterior corners. All face joints shall be welded and ground smooth to provide a continuous flat plane.
 - c. Each cabinet shall be complete so that units can be relocated at any subsequent time without requiring field application of finished ends or other such parts.
 - d. Case openings shall be rabbeted on all four sides for both hinged and sliding doors to provide a dust resistant case.
 - e. All cabinets shall have a cleanable smooth interior. Bottom edges shall be formed down on sides and back to create easily cleanable corners with no burrs or sharp edges, and front edge shall be offset to create a seamless drawer and door recess rabbet for dust stop.

2. Steel Gauges: Gauges of steel used in construction of cases shall be 18 gauge, except as follows:
 - a. Ends, backs, case tops and bottoms, bases, exterior door panels, and vertical posts: 18 gauge.
 - b. Top front and intermediate rails, gussets, table legs, frames, leg rails, and stretchers: 16 gauge.
 - c. Drawer suspensions, door and case hinge reinforcements and L-shaped front corner gussets: 14 gauge.
 - d. Table leg corner brackets and leveler gussets: 12 gauge.
 - e. Corner gussets for leveling bolts and apron corner braces, 12 gauge.
 - f. Corner gussets for leveling bolts and apron corner braces, 12 gauge.
 - g. Hinge reinforcements, case and drawer suspension channels, 14 gauge.
 - h. Top and intermediate front horizontal rails, table aprons and reinforcement gussets, 16 gauge.
 - i. Drawer assemblies, door assemblies and adjustable shelves, 20 gauge.
3. Base Cabinets:
 - a. End uprights shall be formed into not less than a channel formation at top, bottom, back and front. The front edge shall further offset to form a strike for doors and drawers, and shall be perforated for the support of drawer channels, intermediate rails and hinge screws. An upright filler shall be screwed in place in all cupboard units to close the back of the channel at front of the upright and to provide a smooth interior for the cupboard to facilitate cleaning. The upright filler shall be perforated with shelf adjustment holes at not more than 2" centers painted prior to assembly. The inside front of the upright shall be further reinforced with a full height 14 gauge hinge reinforcement angle.
 - b. Top horizontal rail on base cabinets shall interlock within the flange at top of end panels for strength, but shall be flush as face of unit. Top rail shall have a full width rabbet for swinging doors and drawers. Reinforcements shall be provided at all front corners for additional welded strength between vertical and horizontal case members.
 - c. Intermediate rails shall be provided between doors and drawers, but shall not be provided between drawers unless made necessary by locks in drawers. When required, intermediate rails shall be recessed behind doors and drawer fronts, and designed so that security panels may be added as required.
 - d. Intermediate vertical uprights shall be furnished to enclose cupboards when used in a unit in combination with a half width bank of drawers. However, to allow storage of large or bulky objects, no upright of any type shall be used at the center of double door cupboard units.
 - e. Cabinet bottom, and bottom rail shall be formed of one piece of steel except in corner units and shall be formed down on sides and back to create a square edge transition welded to cabinet end panels, and front edge shall be offset to create a seamless drawer and door recess rabbet for dust stop.
 - f. Toe space rail shall extend up and forward to engage bottom rail to form a smooth surfaced fully enclosed toe space, 3" deep x 5" high. Whenever toe space base is omitted for units to set on building bases on separate steel bases, then the toe space rail shall extend back 4 1/2".

- g. Back construction shall consist of a top and bottom rail, channel formed for maximum strength and welded to back and top flange of end uprights, open for access to plumbing lines. Cupboard units only shall be provided with removable back panels.
 - h. Die formed gussets, with multiple ends for strength, shall be furnished in each bottom corner of base units to ensure rigidity, and a 3/8" 16 leveling bolt, 3" long, shall engage a clinch nut in each gusset. Access to the leveling bolts shall be through plug buttons in the bottom pan. Each leveling bolt and gusset shall be capable of supporting 500 lbs. Access to leveling bolts through toe space or leveling bolts requiring special tools to adjust are not acceptable.
 - i. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear; formed down 3/4" at each end, shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf.
 - j. Drawer bodies shall be made in one piece construction including the bottom, two sides, back and front. They shall be fully coved at interior bottom on all four sides for easy cleaning. The top front of the inner drawer body shall be offset to interlock with the channel formation in drawer head providing a 3/4" thick drawer head.
 - k. Drawer suspension assembly shall consist of 2 sections providing a quiet, smooth operation on ball bearing nylon rollers. All drawers shall be self closing from a point 5" open. Cabinet channels shall maintain alignment of drawer and provide an integral drawer stop, but the drawer shall be removable without the use of tools. Drawers shall provide 13 5/8" front to back clearance when fully extended. Drawers shall rise when opened thus avoiding friction with lower drawers and/or doors. Drawer suspension system shall incorporate a double stop, lock open feature. Case suspension channels shall be Galvanized Steel, drawer suspension channels shall be Cold Rolled Steel. Drawer suspension channels on Stainless Steel Cabinets shall be zinc plated after they are formed.
 - l. Steel Door assembly (two piece) for solid pan swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material.
 - m. Steel Drawer/door assemblies shall be painted prior to assembly. Both shall be punched for attaching drawer pulls. Likewise, inner pan formation of door and drawer body shall be indented for in field installation of locks when required.
 - n. Doors shall be readily removable and hinges easily replaceable. Hinges shall be applied to the cabinet and door with screws. Welding of hinges to either cabinet or door will not be acceptable.
 - o. Knee space panels, where shown or specified, shall be 18 gauge, finished same as casework cabinets, and easily removable for access to mechanical service areas.
4. Steel Swinging Door Upper Cabinet Construction:
- a. Swinging door storage cabinets shall have a completely finished interior same as exterior.
 - b. End uprights shall be formed at the front in a 1" channel formation with the inside flange formed to provide a 31/32" x 1/2" door recess. The back of the upright

shall be formed to a 2-1/2" formation. A 14 gauge hinge reinforcement, same as specified for BASE CABINETS, shall be welded to inner side of front uprights.

- c. Cabinet tops shall be formed into a 1" x 1-3/16" channel shape at front, with a 31/32" x 1/2" offset for door recess, and with flange at rear and sides for electro-welding cabinet top to cabinet back and ends.
- d. Cabinet flush bottoms shall be formed with a 1" wide front fascia and a 13/16" channel shape formation at front edge flanged back and up to create a door recess rabbet for dust stop.
- e. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes on not more than 1" centers. Holes shall be set in a channel formation in cabinet back and enclosed by end uprights.
- f. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear, formed down 3/4" at each end, shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf.
- g. Glazed swinging doors shall be 3/4" thick and consist of an inner and outer door pan welded to form a single unit. Outer door pan shall be 18 gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3" wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18 gauge steel, flanged at all four sides, pierced for a glass opening in center of the door, with 14 gauge hinge reinforcements welded in place. Doors shall be glazed with 1/8" float glass, held in place by a rubber or vinyl gasket around the entire edge of the glass. Outer door pan shall be pierced for a recessed flush pull, as described under HARDWARE.
- h. Door assembly (two piece) for solid panel swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed into a channel or flanged shape at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material.

B. Inner Shelves: Provide in lengths and depths indicated on drawings.

2.07 WORKSURFACES

A. Materials

1. Kemresin Epoxy Resin Tops

- a. Epoxy Resin tops shall consist of modified epoxy resin that has been especially compounded and cured to provide the optimum physical and chemical resistance properties required of a heavy-duty laboratory table top. Tops and curbs shall be a uniform mixture throughout their full thickness and shall not depend upon a surface coating that is readily removed by chemical and/or physical abuse. Tops and curbs shall be non-glaring. Tops shall be 1" thick, exposed edges beveled top and bottom, and drip grooves provided on the underside at all exposed edges. 4" high curbs at the backs and ends of tops shall be 1" thick and bonded to the deck to form a square watertight joint. Sink cutouts shall be smooth and uniform without saw marks with the top edge beveled. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness. Corners of sink cutouts shall be radiused not less than 3/4".

- b. Service Ledge: Provide service ledge where indicated on the drawings, 6" high x 7 1/4" deep unless otherwise shown. Provide end cap fillers where exposed ends occur.

B. Performance Requirements: Molded Epoxy Resin

1. Physical Properties:

Flexural Strength (A.S.T.M. Method D790-90) =	15,000 PSI
Compressive Strength (A.S.T.M. Method D695-90) =	30,000 PSI
Hardness, Rockwell E (A.S.T.M. Method D785-89) =	100
Water Absorption (A.S.T.M. Method D570-81)% by weight, 24 Hours =	0.04
% by weight, 7 Days =	0.05
% by weight, 2 Hour Boil =	0.04
Specific Gravity =	1.97
Tensile Strength =	8,500 PSI

2. Performance Test Results (Heat Resistance):

- a. A high form porcelain crucible, size 0, 15 ml capacity, shall be heated over a Bunsen burner until the crucible bottom attains an incipient red heat. Immediately, the hot crucible shall be transferred to the top surface and allowed to cool to room temperature. Upon removal of the cooled crucible, there shall be no blisters, cracks or any breakdown of the top surface whatsoever.

3. Performance Test Results (Chemical Resistance):

- a. Tops shall resist chemical attacks from normally used laboratory reagents. Weight change of top samples submerged in the reagents* listed in the next paragraph for a period of seven (7) days shall be less than one-tenth of one percent, except that the weight change for those reagents marked with ** shall be less than one percent. (Tests shall be performed in accordance with A.S.T.M. Method D543-67 at 77° F.).

*Where concentrations are indicated, percentages are by weight.

Acetic Acid, Glacial	Iso-Octane
Acetic Acid, 5%	Kerosene
Acetone	Methyl Alcohol
Ammonium Hydroxide, 28%	Mineral Oil
Ammonium Hydroxide, 10%	Methyl Ethyl Ketone
Aniline Oil	Nitric Acid, 70%**
Benzene	Nitric Acid, 40%
Carbon Tetrachloride	Nitric Acid, 10%
Chromic Acid, 40%**	Oleic Acid
Citric Acid, 10%	Olive Oil
Cottonseed Oil	Phenol, 5%
Dichromate Cleaning Solution**	Soap Solution, 1%
Diethyl Ether	Sodium Carbonate, 20%
Dimethyl Formamide	Sodium Carbonate, 2%
Distilled Water	Sodium Chloride, 10%
Detergent Solution, 1/4%	Sodium Hydroxide, 50%
Ethyl Acetate	Sodium Hydroxide, 10%

Ethyl Alcohol, 95%	Sodium Hydroxide, 1%
Ethyl Alcohol, 50%	Sodium Hypochlorite, 5%
Ethylene Dichloride	Sulfuric Acid, 85%
Heptane	Sulfuric Acid, 30%
Hydrochloric Acid, 37%	Sulfuric Acid, 3%
Hydrochloric Acid, 10%	Toluene
Hydrogen Peroxide, 28%	Transformer Oil
Hydrogen Peroxide, 3%	Turpentine

NOTE: Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

4. Performance Test Results (Chemical Spot Tests - 24 Hours):
 - a. Chemical spot tests shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.
 - b. Ratings:
 - 1) A = No effect or slight change in gloss.
 - 2) B = Slight change in color or marked loss of gloss.
 - 3) C = Slight surface etching or severe staining.
 - 4) D = Swelling, pitting, or severe etching.

Reagents*	Rating
Acetic Acid, 98%	A
Acetone**	A
Ammonium Hydroxide, 28%	A
Carbon Tetrachloride**	A
Chloroform**	A
Chromic Acid, 60%	C
Chromic Acid, 40%	C
Dichromate Cleaning Solution***	C
Dimethyl Formamide	A
Ethyl Acetate**	A
Ethyl Alcohol**	A

Reagents*	Rating
Formaldehyde, 37%	A
Formic Acid, 90%	A
Hydrochloric Acid, 37%	A
Hydrofluoric Acid, 48%	C
Hydrogen Peroxide, 28%	A
Methanol**	A
Methylethyl Ketone**	A
Nitric Acid, 70%	B
Phenol, 85%	A
Phosphoric Acid, 85%	A
Sodium Carbonate, 20%	A
Sodium Hydroxide, 40%	A
Sodium Hydroxide, 10%	A
Sodium Hypochlorite, 5%	A
Sulfuric Acid, 96%	D
Sulfuric Acid, 85%	A
Toluene**	A
Wrights Blood Stain	A
Xylene**	A

Where concentrations are indicated, percentages are by weight.

** Indicates these solvents tested with cotton and jar method.

*** Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

2.08 SINKS CUPSINKS, AND DRAINS

- A. Sink and Drain Accessories: Kemresin Tub Sink No. 1007-00, 24" long x 8" high x 16" wide. Provide with No. 429 chrome plated brass "P" trap assembly. Trap is the deep seal drum type; is complete with sink outlet connection and clean-out plug; centrifugal action, anti-siphon type; 1 1/2" size. Provide No. 424 chrome plated brass sink outlet complete with integral cross bar, two fiber gaskets and locknut. 1 1/2" I.P.S. male straight thread outlet.

2.09 FITTINGS

- A. Sink Service Fitting: No. W-0340-00. Deck mounted hot and cold water mixing gooseneck faucet (vacuum breaker type). Provide fitting with No. W-0358-00 wrist blade handles (4" long) in lieu of four-arm handles.

2.10 ACCESSORIES

- A. Laboratory Pegboard: No. K7-1901-00. 29" high x 20" wide x 3/4" th. pegboard with 32 black polypropylene pegs (4 5/8" long x 1/2" diameter). Provide finished backs when exposed to view. No. F-2939-00 Stainless Steel Drip Trough, 1 1/2"H x 2 1/2"W x 20"L, mounted to bottom of pegboard. Furnish with 1/2" OD drain outlet.
- B. Eye Wash / Drench Hose Unit: EW1022 deck mounted dual purpose eye wash and drench hose unit with two gentle spray outlet heads angled at 45° and squeeze valve with locking clip. Manufactured by WaterSaver Faucet Co. One at each sink in Laboratory and Pilot Testing.

2.11 APPLIANCES

A. Lab Compact Refrigerator: GE® Compact Refrigerator

1. Model: GCE06GSHSB
 - a. Color: Stainless Steel

PART 3 EXECUTION

3.01 FABRICATION

- A. Fabricate to dimensions, profiles and details shown. Trim all exposed edges. Provide ample allowance for cutting and fitting. Use full length material to extent possible.

3.02 EXAMINATION

- A. Examine substrates to which construction attaches or abuts, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of construction of the work of this section.
- B. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- C. Failure to call attention to defects or imperfections will be construed as acceptance and approval of substrate conditions. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation and full responsibility for completed work.

3.03 INSTALLATION

- A. Examine the substrate and the conditions under which the work under this section is to be performed. Verify ventilation outlets, service connections and supports are in correct and scheduled location. Do not proceed until unsatisfactory conditions have been corrected.
- B. Install cabinets, countertops, equipment and accessories in strict accordance with manufacturer's written instructions. Use proper type of anchoring devices for materials encountered.
- C. Verify adequacy of backing. Reinforcement of stud walls to support wall-mounted cabinets is done during wall erection by trade involved, but responsibility for accurate location and sizing of reinforcement is a part of this work.
- D. Cut, fit, patch and provide supplementary support framing where required for proper and complete installation.
- E. Set and secure casework in place, rigid, plumb, level and in true alignment. Anchor work securely to substrate, using appropriate fasteners attached to blocking. Install wall-hung and structure hung cabinets to firmly and rigidly support cabinet weight plus normally expected cabinet content weight.
- F. Use concealed joint fasteners to align and secure adjoining cabinet units and counter tops. Provide maximum of 1/16" joint width in countertops, completely filled and flush with abutting edges.
- G. Verify location of plumbing, mechanical and electrical services. Provide cutouts for plumbing fixtures and fittings. Provide cutouts for other electrical or mechanical services.

- H. Carefully scribe casework which abuts other building materials. Provide chemical resistant, permanently elastic sealant, where scribing will not achieve closure to adjacent surfaces.

3.04 ADJUSTMENT AND CLEANING

- A. Adjust moving or operating parts to function smoothly and correctly. Patch and repair damage to finishes. Replace components that are chipped, dented, broken or non-functioning.
- B. After completion of installation, clean completed installation of all dirt, grime, fingerprints and protective coverings.

END OF SECTION

SECTION 13 34 19

METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install metal building systems that consist of integrated sets of mutually dependent components including structural framing, roof panels, wall panels, accessories, additional equipment support members, masonry veneer attachment and lintels, and anchor rods as shown on the Drawings and as specified herein.
- B. This section also includes the design, fabrication, installation and testing of a fully electrically powered hoist, bridge, crane rails, and crane system including all ancillary items and equipment that is required to connect to the metal building system.

1.02 SUBMITTALS

- A. Submit, in accordance with Section 01 33 00 - Submittal Procedures
- B. Calculations: submit structural calculations stamped and signed by a qualified Professional Engineer registered in the State of Colorado. Calculations will include all appropriate code minimum lateral and gravity demands. Capacity of the metal building systems will be determined by the appropriate code minimum standard.
- C. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of the following metal building system components:
 - 1. Structural-framing system.
 - 2. Prefinished Insulated Metal roof panels.
 - 3. Prefinished Insulated Metal wall panels.
 - 4. Flashing and trim.
 - 5. Accessories.
- D. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer registered in the State of Colorado, responsible for their preparation.
 - 2. Anchor-Bolt Plans: Submit anchor-bolt plans before foundation work begins. Include location, diameter, embedment, and projection of anchor bolts required to attach metal building to foundation. Indicate vertical and horizontal column reactions at each location. Moment connections of structural framing system to the foundation are not allowed.
 - 3. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include structural framing provisions for overhead and personnel doors, mechanical equipment openings, louvers, windows, suspended piping, and suspended equipment. Indicate welds and bolted connections distinguishing between shop and field applications. Include transverse cross-sections.

E. Bridge Crane System:

1. Complete catalog information, descriptive literature, materials of construction and specification on hoist.
2. Manufacture's product data including materials of construction, equipment configuration, details of installation and equipment weights.
3. Dimensioned shop drawings showing the entire assembly.
4. Calculations and loads to the metal building system, stamped and sealed by a Professional Engineer registered in the State of Colorado.
5. Manufacture's installation and operation manual.
6. Metal Roof and Wall Systems:
 - a. Profile.
 - b. Gauge of both exterior and interior sheet.
 - c. Location, layout, and dimensions of panels.
 - d. Location and type of fasteners.
 - e. Masonry veneer attachment system and lintels.
 - f. Shape and method of attachment of all trim.
 - g. Locations and type of sealants.
 - h. Installation sequence.
 - i. Coordination Drawings: Provide elevation drawings and building sections which show panels in relationship to required locations for structural support. Include panel details and details showing attachment to structural support.
 - j. Other details as may be required for a weathertight installation
 - k. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
 - 1) Flashing and trim. Include conditions at doors, windows, louvers, and pipe penetrations.
 - 2) Gutters.
 - 3) Downspouts.
 - 4) Snow Retention System
 - l. Design Data, Test Reports: Provide manufacturer test reports indicating product compliance with requirements.
 - m. Manufacturer Erection Instructions: Provide manufacturer's written installation instructions including proper material storage, material handling, installation sequence, panel locations, and attachment methods, details and required trim and accessories.

F. Wall and Roof Panel Analysis: Provide panel calculations to verify panels will withstand the design loads indicated without detrimental effects or deflection exceeding L/120. Include effects of thermal differential between the exterior and interior panel facings and resistance to fastener pullout.

G. Finish Samples: Factory applied color finish demonstrating match to specified wall and roof panel color.

- H. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below.
1. Metal Roof and Wall Panels: Nominal 12 inches long by actual panel width.
- I. Product Certificates: For each type of metal building system, signed by product manufacturer.
1. Letter of Design Certification: Signed and sealed by a Colorado qualified professional engineer. Include the following:
 - a. Name and location of Project.
 - b. Order number.
 - c. Name of manufacturer.
 - d. Name of Contractor.
 - e. Building dimensions including width, length, height, and roof slope.
 - f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
 - g. Governing building code and year of edition.
 - h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads to include bridge crane, pipe supports, lighting and HVAC equipment.
 - i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
 - j. Building-Use Category: Indicate category of building use and its effect on load importance factors.
 - k. AISC Certification for Category MB: Include statement that metal building system and components were designed and produced in an AISC Certified Facility by an AISC Certified Manufacturer.
- J. Welding Certificates
- K. Erector Certificate: Signed by manufacturer certifying that erector complies with requirements.
- L. Manufacturer Certificate: Signed by manufacturer certifying that products comply with requirements.
- M. Qualification Data: Demonstrate compliance with Quality Assurance requirements.
1. For erector and manufacturer qualifications.
 2. For metal panel manufacturer and installer qualifications.
- N. Material Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
1. Structural steel including chemical and physical properties.
 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 4. Zinc Coatings.

- 5. Nonshrink grout.
- 6. Hot-Dip zinc coating.
- 7. Bridge Crane Components.
- O. Source quality-control test reports.
- P. Field quality-control test reports.
- Q. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for insulation and vapor retarders. Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.
- R. Surveys: A survey shall be performed showing final elevations and locations of major members. The survey shall indicate discrepancies between actual installation and the Contract Documents. Surveying services will be performed by an Engineer approved professional surveyor selected and paid for by the Contractor.
- S. Maintenance Data: For metal panel finishes to include in maintenance manuals.
- T. Warranties: Special warranties specified in this Section.
- U. Meetings: Provide for up to 8 hours of coordination and review meetings with the Engineer and Architect. Meetings are to be held at the Engineer's office. Additionally, attendance of the metal building pre-erection conference is mandatory for the metal building manufacturer.

1.03 REFERENCES

- A. American Institute of Steel Construction
 - 1. Code of Standard Practice for Steel Buildings and Bridges.
 - 2. Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design.
 - 3. Load and Resistance Factor Design Specification for Structural Steel Buildings.
- B. American Iron and Steel Institute
 - 1. Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. Load and Resistance Factor Design Specification for Steel Structural Members.
- C. American Society of Civil Engineers
 - 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- D. American Welding Society
 - 1. AWS D1.1 - Structural Welding Code - Steel
 - 2. AWS D1.3 - Structural Welding Code - Sheet Steel.
- E. ASTM International
 - 1. ASTM A 36/A 36M - Specification for Carbon Structural Steel

2. ASTM A 123/A 123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
3. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
4. ASTM A 325 - Specification for Structural Bolts, Steel, Heat Treated, 120/1 05 ksi Minimum Tensile Strength
5. ASTM A 480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
6. ASTM A 490 - Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
7. ASTM A 500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
8. ASTM A 529/A 529M - Specification for High-Strength Carbon-Manganese Steel of Structural Quality
9. ASTM A 563 - Specification for Carbon and Alloy Steel Nuts
10. ASTM A 572/A 572M - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
11. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
12. ASTM A 755/A 755M - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
13. ASTM A 780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
14. ASTM A 792/A 792M - Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
15. ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
16. ASTM A 992/A 992M - Specification for Steel for Structural Shapes for Use in Building Framing
17. ASTM A 1008/A 1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
18. ASTM A 1011/A 1011M - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
19. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus
20. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
21. ASTM C 273 - Standard Test Method for Shear Properties of Sandwich Core Materials
22. ASTM B 370 - Specification for Copper Sheet and Strip for Building Construction
23. ASTM B 882 - Specification for Pre-Patinated Copper for Architectural Applications
24. ASTM B 695 - Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
25. ASTM C 273 - Test Method for Shear Properties of Sandwich Core Materials

26. ASTM C 297 - Test Method for Flatwise Tensile Strength of Sandwich Constructions
27. ASTM C 578 - Specification for Rigid, Cellular Polystyrene Thermal Insulation
28. ASTM C 591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
29. ASTM C 612 - Specification for Mineral Fiber Block and Board Thermal Insulation
30. ASTM C 645 - Specification for Nonstructural Steel Framing Members
31. ASTM C 920 - Specification for Elastomeric Joint Sealants
32. ASTM C 991 - Specification for Flexible Glass Fiber Insulation for Metal Buildings
33. ASTM C 1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
34. ASTM C 1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
35. ASTM C 1289 - Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
36. ASTM C 1311 - Specification for Solvent Release Sealants
37. ASTM C 1363 - Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus
38. ASTM D 226 - Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
39. ASTM D 523 - Standard Test Method for Specular Gloss
40. ASTM D 522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
41. ASTM D 714 - Standard Test Method for Evaluating Degree of Blistering of Paints
42. ASTM D 968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
43. ASTM D 1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
44. ASTM D 1621 - Test Method for Compressive Properties of Rigid Cellular Plastics
45. ASTM D 1622 - Test Method for Apparent Density of Rigid Cellular Plastics
46. ASTM D 1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
47. ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
48. ASTM D 1929 - Standard Test Method for Determining Ignition Temperature of Plastics
49. ASTM D 2126 - Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
50. ASTM D 2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates
51. ASTM D 2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
52. ASTM D 2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

53. ASTM D 2856 - Test Method for Open-Cell Content of Rigid Cellular Plastics by the Air Pycnometer
54. ASTM D 3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
55. ASTM D 3359 - Standard Test Methods for Measuring Adhesion by Tape Test
56. ASTM D 3363 - Standard Test Method for Film Hardness by Pencil Test
57. ASTM D 3656 - Specification for Insect Screening and Louver Cloth Woven from Vinyl Coated Glass Yarns
58. ASTM D 4145 - Standard Test Method for Coating Flexibility of Prepainted Sheet
59. ASTM D 4214 - Test Methods for Evaluating the Degree of Chalking of Exterior Paint films
60. ASTM D 4397 - Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
61. ASTM D 5894 - Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV Condensation Cabinet)
62. ASTM D 6226 - Standard Test Method for Open Cell Content of Rigid Cellular Plastics.
63. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of panels for Building Construction.
64. ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials
65. ASTM E 94 - Guide for Radiographic Examination
66. ASTM E 96 -Test Methods for Water Vapor Transmission of Materials
67. ASTM E 108 - Test Methods for Fire Tests of Roof Coverings
68. ASTM E 119 - Test Methods for Fire Tests of Building Construction and Materials
69. ASTM E 164 - Practice for Ultrasonic Contact Examination of Weldments
70. ASTM E 165 - Test Method for Liquid Penetrant Examination
71. ASTM E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
72. ASTM E 329 - Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
73. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
74. ASTM E 408 - Test Methods for Total Normal Emittance of Surfaces Using Inspection Meter Techniques
75. ASTM E 709 - Guide for Magnetic Particle Examination
76. ASTM E 903 - Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
77. ASTM E 1514 - Specification for Structural Standing Seam Steel Roof Panel Systems
78. ASTM E 1592 - Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
79. ASTM E 1646 - Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference

80. ASTM E 1680 - Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems
 81. ASTM E 2140 - Test Method for Weather Penetration of Metal Roof Panel Systems by Static Water Pressure Head
 82. ASTM F 436 - Specification for Hardened Steel Washers
 83. ASTM F 568M - Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners
 84. ASTM F 844 - Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
 85. ASTM F 959 - Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
 86. ASTM F 1554 - Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
 87. ASTM F 1852 - Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 88. ASTM G 153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
 89. ASTM G 154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
- F. CMAA:
- G. Crane Manufacture's Association of America:
1. Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
- H. FM Global (FM)
1. FM 4880 - Approval Standard for Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems
 2. FM 4881 - Approval Standard for Class 1 Exterior Wall Systems.
 3. FM 4471 - Approval Standard for Class 1 Panel Roofs.
- I. Federal Specification
1. FS RR-W-365 - Wire Fabric (Insect Screening)
- J. International Building Code (IBC): 2015 Edition.
- K. Metal Building Manufacturers Association
1. Metal Building Systems Manual.
- L. National Association of Architectural Metal Manufacturers
1. Metal Finishes Manual for Architectural and Metal Products.
- M. National Fire Protection Agency (NFPA)

1. NFPA 259: Standard Test Method for Potential Heat of Building Materials.
 2. NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components
- N. North American Insulation Manufacturers Association (The)
1. NAIMA 202 - Standard for Flexible Fiber Glass Insulation to be Laminated for Use in Metal Buildings
- O. Research Council on Structural Connections
1. Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.
- P. Sheet Metal and Air Conditioning Contractors' National Association - SMACNA
1. Architectural Sheet Metal Manual.
- Q. SSPC: The Society for Protective Coatings
1. SSPC-Paint 12 - Paint Specification No. 12: Cold Applied Asphalt Mastic Painting System with Extra Thick Film
 2. SSPC-Paint 15 - Paint Specification No. 15: Steel Joist Shop Paint
 3. SSPC-Paint 20 - Paint Specification No. 20: Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic")
 4. SSPC SP 2 - Surface Preparation Specification No.2: Hand Tool Cleaning
 5. SSPC-SP 3 - Surface Preparation Specification No.3: Power Tool Cleaning
- R. Structural Engineering Institute/American Society of Civil Engineers
1. SEI/ASCE 7 - Minimum Design Loads for Buildings and Other Structures
- S. Underwriters Laboratories Inc.
1. UL 580 - Tests for Uplift Resistance of Roof Assemblies
 2. Fire Resistance Directory, Current edition.
- T. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- 1.04 SYSTEM DESCRIPTION
- A. General: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing, metal roof panels, metal wall panels, and accessories complying with requirements indicated.
1. Provide metal building system of size and with spacings, slopes, and spans indicated.
- B. Primary Frame Type

1. Single-Span Rigid Frame: Solid-member, structural-framing system without interior columns. The pre-engineered building columns shall have pinned bases and shall transfer no moments to the foundation.
 2. Rigid Modular Frame: Lateral load resisting moment frame without diagonal rods or cables. Moment frames shall have pinned bases and shall transfer no moments to the foundation.
 3. Brace Frame: Lateral load resisting brace frame shall be in the opposite direction of the lateral resisting moment frames.
- C. End-Wall Framing: Manufacturer's standard, for buildings not required to be expandable, consisting of load-bearing end-wall and corner columns, and rafters.
- D. Secondary Frame Type: Manufacturer's standard purlins and joists and exterior-framed (bypass) girts.
- E. Eave Height: as indicated by nominal height on Drawings.
- F. Bay Spacing: as indicated on Drawings.
- G. Roof Slope: as indicated on Drawings.
- H. Roof System: Architectural grade appearance standing seam. Prefinished steel exterior and interior faces with foamed in place polyurethane (polyisocyanurate) core with concealed fastening and mechanically seamed side lap.
- I. Exterior Wall System: Architectural grade appearance with striated profile. Prefinished steel exterior and interior faces with foamed in place polyurethane (polyisocyanurate) core with concealed fastening and double interlocking joint system.

1.05 SYSTEM PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Engineer metal building systems according to procedures in MBMA's "Metal Building Systems Manual."
 2. Design Loads: As indicated on Drawings.
 3. Design Loads: As required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
 4. Roof Live Loads: As indicated on the drawings. Roof live load shall have no reductions.
 - a. Building Occupancy: As indicated on Drawings
 5. Roof Snow Loads: As indicated on the drawings.
 - a. Occupancy Category IV, Importance Factor $I_s = 1.20$.
 6. Wind Loads: Include horizontal loads induced by a basic wind speed corresponding to:
 - a. 115 mph with 3 second gust, Exposure C. (ASCE 7)
 - b. Occupancy Category IV, Importance Factor $I_w = 1.00$.
 7. Collateral Loads: Include additional dead loads other than the weight of metal building system for permanent items such as sprinklers, mechanical systems, piping, electrical

systems, and ceilings with a minimum 20 psf collateral load. Confirm final design collateral loads with equipment manufacturer's approved submittals.

8. Load Combinations: Design metal building systems to withstand the most critical effects of load factors and load combinations as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
 9. Deflection Limits: Engineer assemblies to withstand design loads with deflections no greater than the following:
 - a. Purlins and Rafters: Vertical deflection of 1/120 of the span.
 - b. Girts: Horizontal deflection of 1/120 of the span.
 - c. Main Structural Members: Vertical deflection of $l/$ of the span.
 - d. Metal Roof Panels: Vertical deflection of 1/120 of the span.
 - e. Metal Wall Panels: Horizontal deflection of 1/120 of the span.
 - f. Horizontal Drift: $0.0015 \times$ story height.
 10. Design secondary framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings.
 11. Provide metal panel assemblies capable of withstanding the effects of loads and stresses indicated, based on testing according to ASTM E 1592.
 12. Metal building system shall be designed to be independent of all masonry construction. No loads from the metal building system shall be imparted to the masonry.
- B. Seismic Performance: Design and engineer metal building systems capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures":
1. Site Classification: D
 2. Mapped Spectral Response Accelerations: $SS = 0.187g$, 0.2 second response, $SI = 0.057g$, 1.0 second response
 3. Spectral Response Coefficients: $SDS = 0.305g$, $SD1 = 0.078g$
 4. Seismic Design Category C
 5. Occupancy Category IV, Occupancy Importance Factor = 1.5
- C. Thermal Movements: Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Wall Panel Performance Criteria
1. Structural Test: Structural performance shall be verifiable by witnessed structural testing for simulated wind loads in accordance with ASTM E72.
 2. Thermal Properties: The panel shall provide a nominal R-value of 7.2 [hr·ft²·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 75°F mean temperature and 8.0 [hr·ft²·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 35°F mean temperature. See the drawings for required panel thicknesses.

3. Fatigue Test: There shall be no evidence of metal/insulation interface delamination when the panel is tested by simulated wind loads (positive and negative loads), when applied for two million alternate cycles of L/180 deflection.
4. Water Penetration: There shall be no uncontrolled water penetration through the panel joints at a pressure differential of 20 psf, when tested in accordance with ASTM E331.
5. Air Infiltration: Air infiltration through the panel shall not exceed 0.001 cfm/sf at 20 psf air pressure differential when tested in accordance with ASTM E283.
6. Panels shall have a minimum sound transmission coefficient (STC) of 22 when tested in accordance with ASTM E90 and rated in accordance with ASTM E413.
7. Humidity Test: Panels shall exhibit no delamination or metal interface corrosion when subjected to 158 deg. F temperature and 100 percent relative humidity for a total of 1200 hours (50 days).
8. Fire Test Response Characteristics: Steel-faced panels with polyisocyanurate (ISO) core shall fully comply with Chapter 26 of International Building Code regarding the use of Foam Plastic.
 - a. FM 4880: Class I rated per FM Global, panels are approved for use without a thermal barrier and do not create a requirement for automatic sprinkler protection.
 - b. NFPA 285 Intermediate Scale Multi-story Fire Evaluation; successfully passed acceptance criteria.
 - c. UL 263 Fire Resistive Rating; classified as a component of a fire-rated wall assembly for 1-hour and 2-hour rating Design No. U053 (rated assemblies include appropriate layers of fire-rated Type X Gypsum board).
 - d. ASTM D1929 Minimum Flash and Self Ignition; established for foam core.
 - e. NFPA 259 Potential Heat Content; established for foam core.
9. Insulating Core: Polyisocyanurate (ISO) core, ASTM C591 Type IV, CFC and HCFC free, with the following minimum physical properties:
 - a. Core is minimum 91 percent closed cell when tested in accordance with ASTM D6226
 - b. Foam density: 2.3 - 2.6 pounds per cubic foot when tested in accordance with ASTM D1622
 - c. Compressive Stress when tested in accordance with ASTM D1621:
 - 1) Parallel to Rise: minimum of 19 psi
 - 2) Perpendicular to Rise: 23 psi
 - d. Shear Stress: Minimum of 25 psi when tested in accordance with ASTM C273
 - e. Tensile Stress: Minimum of 19 psi when tested in accordance with ASTM D1623
 - f. Dimensional Stability when tested in accordance with ASTM D2126:
 - 1) High Temperature Aging at 158 deg. F and plus 100% relative humidity for 14 days: less than 6 percent volume change
 - 2) High Temperature Aging at 212 deg. F and ambient humidity for 14 days: less than 4 percent volume change
 - 3) Low Temperature Aging at minus 40 deg. F and ambient humidity at 14 days: one percent volume change

- g. Flame Spread and Smoke Developed Tests on exposed Insulating Core when tested in accordance with ASTM E84:
 - 1) Flame Spread: Less than 25
 - 2) Smoke Developed: Less than 450

E. Bridge Crane:

- 1. Top running single girder.
- 2. Capacity: 6 tons
- 3. CMAA service class: C – medium duty
- 4. Hoist type: Single reeved electric wire rope hoist.
- 5. Hoist available lift: 24'-0"
- 6. ANSI hoist service class: HST-H4 heavy duty
- 7. Crane speeds and control:
 - a. Hoist: 20/3.3 FPM 2 speed magnetic contactor
 - b. Trolley: 65 FPM via variable frequency drive.
 - c. Bridge: 100 FPM via variable frequency drive.
- 8. Crane operator interface: Radio remote control with backup traveling pendant control.
- 9. Electrical enclosure: NEMA 12
- 10. Crane Paint: Safety Yellow alkyd enamel
- 11. Surface preparation: SSPC-SP1 and SSPC-SP3
- 12. Maximum deflection: The maximum vertical deflection of the girder produced by the weight of the hoist, trolley and the rated load not to exceed L/888.
- 13. Imposed lateral and impact loads from the bridge crane shall be shown on metal building structural calculations.

F. Roof Panel Performance Criteria

- 1. Structural Test: Design shall be verified by representative structural test for wind loads in accordance with ASTM E72. The deflection criteria shall be L/240.
- 2. Thermal Properties: The panel shall provide a nominal R-value of 7.2 [hr·ft²·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 75°F mean temperature and 8.0 [hr·ft²·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 35°F mean temperature. See the drawings for required panel thicknesses.
- 3. Fatigue Test: There shall be no evidence of metal/insulation interface delamination when the panel is tested by simulated wind loads of 20 psf (positive and negative loads), when applied for two million alternate cycles.
- 4. Bond Strength: No metal primer interface corrosion and/or delamination shall occur after 1000 hours at 140°F and 100% relative humidity. No delamination shall occur after 2-1/2 hours in a 2 psi 212°F autoclave.
- 5. Water Penetration: There shall be no uncontrolled water leakage at pressures of up to 20 psf when tested in accordance with ASTM E331 and ASTM E1646. Tested assembly must include endlap and sidelap conditions.

6. Air Infiltration: Air infiltration through the roof shall not exceed 0.003 cfm/sf at 6.24 psf air pressure differential when tested in accordance with ASTM E283 and ASTM E1680. Tested assembly must include endlap and sidelap conditions.
7. Hailstorm Rating: Factory Mutual 1 SH hailstorm rating.
8. Wind-Uplift Rating: Units shall be rated and carry the following listing:
 - a. UL 580, Class 90 uplift rating for 5 foot spans with a minimum 14 gauge purlins.
9. Fire Classification: Factory Mutual Class 1A Approval when installed at a maximum roof slope of 2:12.
10. Insulating Core: Polyisocyanurate (ISO) core, ASTM C591 Type IV, CFC and HCFC free, with the following minimum physical properties:
 - a. Core is minimum 88 percent closed cell when tested in accordance with ASTM D6226
 - b. Foam has a density of 2.3 - 2.6 pounds per cubic foot when tested in accordance with ASTM D1622
 - c. Compressive Strength: 14 – 22 psi
 - d. Shear Strength: 15 psi (to rise)
 - e. Tensile Strength: Minimum of 29 psi
 - f. Flame Spread and Smoke Developed Tests on exposed Insulating Core when tested in accordance with ASTM E84:
 - 1) Flame Spread: Less than 25
 - 2) Smoke Developed: Less than 450

G. Wall and Roof Panel Paint Finish Characteristics

1. Gloss: 15 +/- 5 measured at 60 degree angle tested in accordance with ASTM D523.
2. Pencil Hardness: HB-H minimum tested in accordance with ASTM D3363.
3. Flexibility, T-Bend: 1-2T bend with no adhesion loss when tested in accordance with ASTM D4145.
4. Flexibility, Mandrel: No cracking when bent 180 deg. around a 1/8 mandrel as tested in accordance with ASTM D522.
5. Adhesion: No adhesion loss tested in accordance with ASTM D3359.
6. Reverse Impact: No cracking or adhesion loss when impacted 3000 x inches of metal thickness (lb-in), tested in accordance with ASTM D2794.
7. Abrasion Resistance: Nominal 65 liters of falling sand to expose 5/32 inch diameter of metal substrate when tested in accordance with ASTM D968.
8. Graffiti Resistance: Minimal effect.
9. Acid Pollutant Resistance: No effect when subjected to 30 percent sulfuric acid for 18 hours, or 10 percent muriatic acid for 15 minutes when tested in accordance with ASTM D1308.
10. Salt Fog Resistance: Passes 1000 hours, when tested in accordance with ASTM B117 (5 percent salt fog at 95 deg. F).
11. Cyclic Salt Fog and UV Exposure: Passes 2016 hours when tested in accordance with ASTM D5894.

12. Humidity Resistance: Passes 1500 hours at 100 percent relative humidity and 95 deg. F, with a test rating of 10 when tested in accordance with ASTM D2247, and D714.
13. Color Retention: Passes 5000 hours when tested in accordance with ASTM G153 and G154.
14. Chalk Resistance: Maximum chalk is a rating of 8 when tested in accordance with ASTM D4214, Method A.
15. Color Tolerances: Maximum of 5 Δ E Hunter units on panels when tested in accordance with ASTM D2244.

1.06 QUALITY ASSURANCE

- A. Erector Qualifications: An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is approved by the manufacturer.
- B. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.
 1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.
 2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer registered in the State of Colorado.
- C. Metal Panel Manufacturer and Installer Qualifications
 1. Manufacturer Qualifications: Manufacturer shall have a minimum of five (5) years experience in the production of insulated wall and roof panels. Manufacturer shall demonstrate past experience with examples of projects of similar type and exposure.
 2. Installer Qualifications: Authorized by the manufacturer and the work shall be supervised by a person having a minimum of five (5) years experience installing specified insulated wall panels on similar type and size projects.
- D. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- E. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal building system and are based on the specific system indicated.
 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's written approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.
- F. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- G. Structural Steel: Comply with AISC's "Specification for Structural Steel Buildings--Allowable Stress Design, Plastic Design," or AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings," for design requirements and allowable stresses.
- H. Cold-Formed Steel: Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members," or AISI's "Load and Resistance Factor Design Specification for Steel Structural Members," for design requirements and allowable stresses.

- I. Pre-Erection Conference: Conduct conference at Project site. Review methods and procedures related to metal building systems including, but not limited to, the following:
 - 1. Inspect and discuss condition of foundations and other preparatory work performed by other trades.
 - 2. Review structural load limitations.
 - 3. Review and finalize construction schedule and verify availability of materials, Erector's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review required testing, inspecting, and certifying procedures.
 - 5. Review weather and forecasted weather conditions and procedures for unfavorable conditions.
 - 6. Review of protection and security of equipment installed in facility prior to start of metal building erection.
- J. Pre-installation Roof Assembly Conference: Conduct conference at Project site. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:
 - 1. Examine purlin and rafter conditions for compliance with requirements, including flatness and attachment to structural members.
 - 2. Review structural limitations of purlins and rafters during and after roofing.
 - 3. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
 - 4. Review temporary protection requirements for metal roof panel assembly during and after installation.
 - 5. Review roof observation and repair procedures after metal roof panel installation.
- K. Pre-installation Wall Assembly Conference: Conduct conference at Site. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:
 - 1. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 2. Review structural limitations of girts and columns during and after wall panel installation.
 - 3. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
 - 4. Review temporary protection requirements for metal wall panel assembly during and after installation.
 - 5. Review wall observation and repair procedures after metal wall panel installation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling. Deliver panel materials and components in manufacturer's original, unopened, undamaged packaging with identification labels intact.
- B. Store roofing panel materials on dry, level, firm, and clean surface using the three inch factory provided foam supports under the panels. Use of wood substitute is not acceptable. Stack no more than two bundles high. Elevate and ventilate to allow air to circulate and moisture to escape.

- C. Store wall panel materials on dry, level, firm, and clean surface. Stack no more than two bundles high. Elevate one end of bundle to allow moisture run-off, cover and ventilate to allow air to circulate and moisture to escape.
- D. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- E. Protect foam-plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
 - 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.08 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements
 - 1. Established Dimensions for Foundations: Comply with established dimensions on approved anchor-bolt plans, establishing foundation dimensions and proceeding with fabricating structural framing without field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.
 - 2. Established Dimensions for Metal Panels: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.09 COORDINATION

- A. Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00.
- B. Coordinate installation of roof equipment and snow guard.
- C. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Prefinished Metal Finish Warranty: Standard form in which manufacturer agrees to repair or replace metal panels that evidence deterioration of fluoropolymer finish, including flaking or peeling from approved primed metal substrate, chalk in excess of 8 when tested in accordance with ASTM D4214, Method A, and /or color fading in excess of 5 ΔE Hunter units on panels when tested in accordance with ASTM D2244.
 - 1. Warranty Period: Twenty (20) years from date of Substantial Completion.

- B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam, metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Provide products by one of the following:

B. Basis-of-Design Products

1. The design for metal building structural system is based on a hybrid single-span rigid frame configuration with lateral load resisting moment and braced frames. Subject to compliance with requirements, provide the complete structure by one of the following:
 - a. Varco Pruden Buildings, A Division of BlueScope Buildings North America, Inc.
 - b. Butler Manufacturing Company.
 - c. Star Building Systems; Division of Robertson-Ceco Corporation.
 - d. Or Engineer and Architect approved equal.
2. The design for metal building prefinished insulated metal wall and roof panel systems is based on a Nucor Building Systems. Subject to compliance with requirements, provide the named product or an equal product by one of the following:
 - a. Nucor Building Systems
 - b. Or approved equal.

2.02 SUBSTITUTION LIMITATIONS

- A. Substitution of the manufacturers listed in the Basis-of-Design section above will be required to submit a request for substitution as required in: Instructions To Bidders, Article 11.
- B. Substitution requests for the metal wall and roof panels shall include at a minimum the following information and include clearly highlighted descriptions demonstrating equality to the specified products and their installation:
1. Demonstrate compliance with quality assurance criteria.
 2. Name of the materials and description of the proposed substitute(s).
 3. Drawings, cut sheets, performance criteria and test data.
 4. Physical samples of proposed substitute(s).
 5. Color sample demonstrating ability to provide required finish system and color match to the specified color.

2.03 STRUCTURAL-FRAMING MATERIALS

- A. W-Shapes: ASTM A 992/A 992M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
1. Finish: Hot-dip zinc coating, ASTM A 123.

- B. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 361A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
1. Finish: Hot-dip zinc coating, ASTM A 123.
- C. Plate and Bar: ASTM A 361A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
1. Finish: Hot-dip zinc coating, ASTM A 123.
- D. Steel Pipe: ASTM A 531 A 53M, Type E or S, Grade B.
1. Finish: Hot-dip zinc coating, ASTM A 123.
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B or C, structural tubing.
1. Finish: Hot-dip zinc coating, ASTM A 123.
- F. Structural-Steel Sheet: Hot-rolled, ASTM A 1011A 1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low Alloy Steel (HSLAS), Grades 45 through 70; or cold-rolled, ASTM A 10081 A 1008M, Structural Steel (SS), Grades 25 through 80, or High-Strength Low Alloy Steel (HSLAS), Grades 45 through 70.
1. Finish: Hot-dip zinc coating, ASTM A 123.
- G. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low Alloy Steel (HSLAS), Grades 50 through 80; with G60 coating designation; mill phosphatized.
- H. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low Alloy Steel (HSLAS), Grades 50 through 80; with G90 coating designation.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 7921 A 792M, Structural Steel (SS), Grade 50 or 80; with Class AZ50 coating.
- I. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A, carbon-steel, hex-head bolts; ASTM A 563 carbon-steel hex nuts; and ASTM F 844 plain (flat) steel washers.
1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- J. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type I, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
2. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex-head steel structural bolts with splined ends.
- a. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- K. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type I, heavy hex steel structural bolts.
- L. Unheaded Anchor Rods: ASTM F 1554, Grade 36; ASTM A 36/A 36M; ASTM A 307, Grade A.

1. Configuration: Straight.
 2. Nuts: ASTM A 563 heavy hex carbon steel.
 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 4. Washers: ASTM F 436 hardened carbon steel.
 5. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- M. Headed Anchor Rods: ASTM F 1554, Grade 36; ASTM A 307, Grade A, straight.
1. Nuts: ASTM A 563 heavy hex carbon steel.
 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 3. Washers: ASTM F 436 hardened carbon steel.
 4. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- N. Threaded Rods: ASTM A 5721 A 572M, Grade 50.
1. Nuts: ASTM A 563 heavy hex carbon steel.
 2. Washers: ASTM F 436 hardened carbon steel.
 3. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- 2.04 PREFINISHED INSULATED METAL WALL PANELS:
- A. Panel Description
1. Model: Nucor Metl-Span CF Mesa insulated metal wall panel
 2. Thermal Value: R 35 minimum
 3. Panel thickness: 4 inches
 4. Panel width: 42 inches
 5. Panel Lengths: Full wall heights without horizontal seams.
 6. Panel Attachment: Consisting of fasteners and steel attachment clip completely concealed within the panel side joint.
 7. Exterior Face of Panel:
 - a. Material:
 - 1) Steel coil material shall be in accordance with ASTM A755: AZ50 Galvalume®/ Zinalume® (55 percent aluminum, 45 percent zinc) in accordance with ASTM A792
 - 2) Gauge: 22 gauge
 - b. Profile:
 - 1) Profile description – 300R Series: Linear striations, running the length of panel, across entire panel face
 - c. Texture: Smooth
 - d. Exterior Finish:
 - 1) Color: As selected by Architect from Manufacturer's full range of Premium and Standard Colors.

- 2) Finish System: 1.0 mil. Fluoropolymer (PVDF) Two Coat system: 0.2 mil primer with 0.8 mil Kynar 500 (70 percent) SOLID color coat.
 - 3) Solar Reflective Index (ASTM E 1980): 36
 - 4) Solar Reflectivity (ASTM E 903, C 1549): .34
 - 5) Emissivity (ASTM C 1371): .87
8. Interior Face of Panel:
- a. Material:
 - 1) Steel coil material shall be in accordance with ASTM A755: [AZ50 Galvalume®/ Zinalume® (55 percent aluminum, 45 percent zinc) in accordance with ASTM A792.
 - 2) Gauge: 22 gauge
 - b. Profile:
 - 1) Profile description - Minor Rib
 - c. Texture: Unembossed
 - d. Interior Finish:
 - 1) Finish System: PVDF finish, dry film thickness of 1.0 mil including primer
 - 2) Color: As selected by Architect from Manufacturer's full range of Premium and Standard Colors.

2.05 PREFINISHED INSULATED METAL ROOF PANELS

A. Panel Description

1. Model: Nucor Metl Span CFR IMP Insulated Metal Roof Panel, R35.
2. Thermal Value: R 35 minimum
3. Panel thickness: 4 inches
4. Panel width: 42 inch wide
5. Panel length: Roof panels are less than the maximum 52 ft. allowable. Provide panels in single length as shown on the drawings.
6. The side joint shall consist of a 2 inch vertical sidelap, mechanically seamed, with fasteners and thermally broken attachment clip completely concealed within the side joint.
7. Exterior Face of Panel:
 - a. Material:
 - 1) Steel coil material shall be in accordance with ASTM A755: AZ50 Galvalume®/ Zinalume® (55 percent aluminum, 45 percent zinc) in accordance with ASTM A792
 - 2) Gauge: 22 gauge
 - 3) Yield: 33 ksi minimum
 - b. Exterior Profile: 2" high standing seam with a Mesa profile between the seams
 - c. Texture: Embossed
 - d. Exterior Finish:

- 1) Color: As selected by Architect from Manufacturer's full range of Premium and Standard Colors.
 - 2) Finish System: 1.0 mil. Fluoropolymer (PVDF) Two Coat system: 0.2 mil primer with 0.8 mil Kynar 500 (70 percent) SOLID color coat.
 - 3) Solar Reflective Index (ASTM E 1980): 36
 - 4) Solar Reflectivity (ASTM E 903, C 1549): .34
 - 5) Emissivity (ASTM C 1371): .87
8. Interior Face of Panel:
- a. Material:
 - 1) Steel coil material shall be in accordance with ASTM A755: [AZ50 Galvalume®/ Zinalume® (55 percent aluminum, 45 percent zinc) in accordance with ASTM A792.
 - 2) Gauge: 26 gauge
 - b. Interior Profile: Mesa, nominal 1/8"
 - c. Texture: Unembossed
 - d. Interior Finish:
 - 1) Finish System: PVDF finish, dry film thickness of 1.0 mil including primer
 - 2) Color: Selected from the current Kingspan Insulated Panels stock color chart.

2.06 MISCELLANEOUS MATERIALS

A. Wall Panel Fasteners

1. Self drilling fasteners shall be corrosion resistant plated steel with neoprene washer, as recommended by manufacturer.
2. Material: Hex-head type with steel and neoprene washer and 12 gauge stainless steel clip supplied by the manufacturer.
3. Size: As recommended by manufacturer.
4. Exposed Exterior Fasteners: Any fastener in an exposed condition to the building exterior shall be provided with a finish color to match the panel color.

B. Roof Panel Fasteners

1. Self drilling fasteners shall be cadmium plated steel, designed to resist maximum negative pulloff loads and hold the face sheet mechanically to the structural support.
2. Thermally broken attachment clip.
3. Vibration resistant type (anti-backout threads) fasteners. Self-drilling flathead screws with sealing washers and square drives, designed to resist back out by increasing thread friction as screw loosens.

C. Perimeter Trim

1. Fabricated perimeter trim and metal flashing: Unless noted otherwise on the Drawings materials shall be minimum 24 gauge with coating and color matching exterior face of insulated metal wall panel.

2. Extruded perimeter trim: Shall be extruded aluminum 6063-T5 alloy with spray applied PVF Unless noted otherwise on the Drawings coating in same color as exterior face of insulated metal wall panel.
 3. Sealants: Butyl, non-skinning/curing type as recommended by manufacturer.
 4. Butyl Tape: As recommended by manufacturer.
- D. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- F. Snow Retention System: See specification section 077253 for Snow Retention System requirements.
- G. Anchor Bolts: Metal building manufacturer shall provide cast-in-place, hot-dip galvanized, ASTM A-307 headed anchor bolts, bolt templates and all building frame to foundation connection hardware.

2.07 FABRICATION, GENERAL

- A. General: Design components and field connections required for erection to permit easy assembly.
1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
 2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.
- B. Tolerances: Comply with MBMA's "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."
- C. Metal Panels: Fabricate and finish metal panels at the factory to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

2.08 STRUCTURAL FRAMING

- A. General
1. Primary Framing: Shop fabricate framing components to indicated size and section with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.
 - a. Make shop connections by welding or by using high-strength bolts.
 - b. Join flanges to webs of built-up members by a continuous submerged arc-welding process.
 - c. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
 - d. Weld clips to frames for attaching secondary framing members.
 - e. Finish: Hot-dip zinc coating, ASTM A 123, after fabrication.

- f. Column bases shall be pinned base attachments; no moments shall be transferred through the base plates into the foundation.
 - g. Steel corbels shall be attached to metal building columns and not metal building roof, as shown on the drawings.
 - 2. Secondary Framing: Shop fabricate framing components to indicated size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
 - a. Make shop connections by welding or by using non-high-strength bolts.
 - b. Finish: Hot-dip zinc coating, ASTM A 123, after fabrication.
- B. Primary Framing: Manufacturer's standard structural primary framing system, designed to withstand required loads and specified requirements. Primary framing includes moment and braced frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.
 - 1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.
 - 2. Single-span Rigid Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
 - 3. Exterior Column Type: Tapered.
- C. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:
 - 1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates. Locate end wall columns as shown on the plan.
- D. Secondary Framing: Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, G-90 galvanized standard material, unless otherwise indicated, to comply with the following:
 - 1. Purlins: C- or Z-shaped sections, built-up steel plates, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.
 - a. Depth: As required to comply with system performance requirements.
 - 2. Girts: C- or Z-shaped sections, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange and with minimum 2-1/2-inch- wide flanges.
 - a. Depth: As required to comply with system performance requirements.
 - 3. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch diameter, cold-formed structural tubing to stiffen primary frame flanges.
 - 4. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
 - 5. Base or Sill Angles: Minimum 3-by-2-by-0.0598-inch zinc-coated (galvanized) steel sheet.
 - 6. Purlin and Girt Clips: Manufacturer's standard sections. Provide galvanized clips where clips are connected to galvanized framing members.

7. Secondary End-Wall Framing: Manufacturer's standard sections. Framing for Openings: Coldformed channel shapes or structural-steel shapes. Frame head and jamb of door openings, and head, jamb, and sill of other openings.
 8. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from coldformed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.
- E. Bracing: Provide adjustable wind bracing as follows:
1. Rods: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50; or ASTM A 529/A 529M, Grade 50; minimum 1-inch diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
 2. Cable: ASTM A 475, minimum 1/4-inch diameter, extra-high-strength grade, Class B zinc-coated, 7-strand steel; with threaded end anchors.
 3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
 4. Moment Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
 5. Diaphragm Action of Metal Panels: Design metal building to resist wind and seismic forces through diaphragm action of metal panels.
 6. Bracing: Provide wind bracing using any method specified above, at manufacturer's option.
- F. Bolts: Provide hot-dipped galvanized bolts for structural-framing components that are galvanized.

2.09 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following tests and inspections and to submit reports.
- B. Special Inspector: Owner will engage a qualified special inspector to perform the following tests and inspections and to submit reports. Special Inspector will verify that manufacturer maintains detailed fabrication and quality-control procedures and will review the completeness and adequacy of those procedures to perform the Work.
1. Special inspections will not be required if fabrication is performed by a manufacturer registered and approved by authorities having jurisdiction to perform such Work without special inspection.
 - a. After fabrication, submit certificate of compliance with copy to authorities having jurisdiction certifying that Work was performed according to Contract requirements.
- C. Tests and Inspections
1. Bolted Connections: Shop-bolted connections shall be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 2. Welded Connections: In addition to visual inspection, shop-welded connections shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at inspector's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.

- b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. For the record, prepare written report, endorsed by Erector, listing conditions detrimental to performance of work.
- B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with Erector present, for compliance with requirements and metal building system manufacturer's tolerances.
 - 1. Coordinate with land surveyor to perform surveying. Surveying services will be performed by an Engineer approved professional surveyor selected and paid for by the Contractor.
- C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place, unless otherwise indicated.

3.03 ERECTION OF STRUCTURAL FRAMING

- A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.
- B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.
- C. Set structural framing accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.
- D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.
- F. The installation of the crane rails, corbel rail supports, and bridge crane by the metal building manufacture. Installation of crane will be performed in conjunction with erection of the metal building.
- G. Primary Framing and End Walls: Erect framing true to line, level, plumb, rigid, and secure. Level baseplates to a true even plane with full bearing to supporting structures, set with doublenutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist cure grout for no less than seven days after placement.
1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - a. Joint Type: Snug tightened or pretensioned.
- H. Secondary Framing: Erect framing true to line, level, plumb, rigid, and secure. Fasten secondary framing to primary framing using clips with field connections using non-high-strength bolts.
1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
 2. Locate and space wall girts to suit openings such as doors and windows.
 3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.
- I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
1. Tighten rod and cable bracing to avoid sag.
 2. Locate interior end-bay bracing only where indicated.
- J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.
- K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.04 METAL WALL AND ROOF PANEL INSTALLATION, GENERAL

A. Examination

1. Provide field measurements to the manufacturer as required to achieve proper fit of the preformed wall panel envelope.
2. Examine individual panels upon removing from the bundle. Notify manufacturer of panel defects. Do not install defective panels.
3. Examine edges of panels and any slight overfill of insulation shall be carefully removed.
4. Examine primary and secondary framing to verify that structural panel support members and anchorages have been installed within alignment tolerances required by manufacturer. All deviations from structural tolerances shall be corrected prior to the installation of wall or roof panels.
 - a. Supporting steel for wall panels: Support members shall be installed within the following tolerances:
 - 1) Plus or minus 1/8 inch in 5 feet in any direction along plane of framing
 - 2) Plus or minus 3/8 inch cumulative in 20 feet in any direction along plane of framing.
 - 3) Plus or minus 3/4 inch from framing plane on any elevation.
 - 4) Verify that bearing support has been provided behind horizontal joints of vertical panel systems and behind vertical joints of horizontal panel systems. Width of support shall be as recommended by manufacturer.
 - b. Supporting steel for roof panels: Support members shall be installed within the following tolerances:
 - 1) In the plane of the roof: 0-inches inward, 1/2"- outward.
5. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before metal panel installation.

B. General

1. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - a. Utilize power tools having controlled torque adjusted to install fasteners without damage to washer, screw threads, or metal panels. Install screws in predrilled holes.
 - b. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
 - c. Install metal panels perpendicular to structural supports, unless otherwise indicated.
 - d. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
 - e. Locate and space fastenings in uniform vertical and horizontal alignment.

- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying

rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal panel manufacturer.

3.05 METAL ROOF PANEL INSTALLATION

A. General

- 1. Provide metal roof panels of full length from eave to ridge.

B. Panel Installation

- 1. Remove protective film before installation, or immediately thereafter to prevent sunlight damage.
- 2. Cut panels, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blades or a band saw prior to installation. Ventilate area where polyurethane dust is generated. Personnel should wear respiratory and eye protection devices.
- 3. Apply butyl sealant vapor seal around interior perimeter of roof assembly per panel manufacturer's instructions.
- 4. Apply butyl tape on panel sidelaps and clip assemblies per panel manufacturer's instructions.
- 5. Secure units to the steel supports with manufacturer's recommended fastener.
- 6. Place panel fasteners through predrilled top clip and base clip, concealed within the side joint of the panel.
 - a. Heads of concealed fasteners shall be insulated from the exterior environment to prevent condensation and "ice balling" from occurring on the fastener shaft.
- 7. Endlap sealing tape and butyl to panel surface: Not required as roof panels will have no endlaps.
- 8. Endlap panel stitch fasteners to be vibration resistant type. Stitch fasteners are not required as roof panels will have no endlaps.
- 9. As each panel is installed, crimp hidden clip assembly prior to placement of next panel.
- 10. Replace metal panels and trim that have been damaged.

C. Trim Installation

- 1. Place trim to determine the location of the closure strips, sealant and ridge closure trims.
- 2. Apply butyl tape above and below the foam closure strip and seat the closure strip firmly in the tape to ensure a continuous seal. If any voids exist add butyl caulking and reseal the closure.
- 3. Place a continuous layer of butyl tape on top of the metal ridge closure trims for the length of the building.
- 4. Fasten the exterior ridge trim to the metal ridge closure trims, per manufacturer's recommendations, on center with 1/4 inch by 7/8 inch low profile vibration resistant stitch fasteners.

3.06 METAL WALL PANEL INSTALLATION

A. General

1. Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

B. Panel Installation

1. Installation shall be in accordance with manufacturer's installation guidelines and recommendations.
2. Install panels plumb, level, and true-to-line to dimensions and layout indicated on approved shop drawings.
3. Cut panels prior to installing, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blade per manufacturer's instructions. Personnel should wear respiratory and eye protection devices.
4. Butyl Weather Barrier Sealant:
 - a. Apply non-skinning butyl sealant as shown on shop drawings and manufacturer's installation instructions as necessary to establish the vapor barrier for the panels.
 - b. Use non-skinning butyl tube sealant only for tight metal-to-metal contact.
 - c. Do not use non-skinning butyl tube sealant to bridge gaps.
5. Place panel fasteners through pre-punched holes in attachment clips, concealed within the joint of the panel. Secure units to the structural supports. Space clips as recommended by manufacturer or otherwise indicated on the approved shop drawings.

C. Trim Installation

1. Place trim and trim fasteners only as indicated per details on the approved shop drawings.
2. Field drill weep holes where appropriate in horizontal trim; minimum 1/4-inch diameter at 24 inches on center.
3. Place a continuous strip of butyl tube sealant between the inside back face of closure trims and interior panel faces for proper weather seal.

D. Sealant Installation for Exposed Joints

1. Clean and prime surfaces to receive exterior exposed sealants in accordance with sealant manufacturer's recommendations.
2. Follow sealant manufacturer's recommendations for joint width-to-depth ratio, application temperature range, size and type of backer rod, and compatibility of materials for adhesion.
3. Direct contact between butyl and silicone sealants shall not be permitted.

E. Field Quality Control

1. Field Water Test: After completing portion of metal wall panel assembly including accessories and trim, contractor shall test a 2-bay area selected by the architect for water penetration in accordance with AAMA 501.2.

3.07 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 2. Install components for a complete metal wall panel assembly including trim, copings, comers, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 3. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- D. Downspouts: Join sections with 1-1/2-inch joints. Provide hangers designed to hold downspouts securely to walls similar to SMACNA Figure 1-35I. Locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
1. Fabricate open downspouts with liner matching downspout color.
 2. Fabricate elbows at base of downspouts to direct water away from building.
 3. Tie downspouts to underground drainage system indicated.
- E. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.
- F. Snow Retention System
1. See specification section 07 72 53 for Snow Retention System installation requirements.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing and inspecting agency to perform the following tests and inspections and to submit reports to the Engineer and Architect.
- B. Special Inspector: Contractor will engage a qualified special inspector to perform the following tests and inspections and to submit reports to the Engineer and Architect.
- C. Tests and Inspections
 - 1. High-Strength, Field-Bolted Connections: Connections shall be[tested and] inspected during installation according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 2. Welded Connections: In addition to visual inspection, field-welded connections shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at inspector's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
 - 3. All Crane equipment shall be operated through a complete lift and lowering cycle and through a complete travel of the bridge and trolley to determine that the equipment will perform smoothly and safely and that the pendant cable length is sufficient to permit operation. All tests shall be carried out with the bridge crane equipment loaded at 125% of the capacity. The bridge crane provider shall provide the test weight loads for a dynamic load test. The bridge crane provider shall correct and defects without any expense to the Owner.
 - 4. The crane manufacture shall provide two (2) training sessions of up to four (4) hours in duration each. The training shall include but not limited to familiarity with the system, safe operation practices, required maintenance of the system and review of all provided literature. The first train session to be held for the Owner. Contractor is to hold training immediately after successful testing is completed and the system is ready for service.
- D. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

3.09 REPAIR OF DEFECTIVE GALVANIZED COATING

- A. Where zinc coating has been damaged after cutting, installation or welding, substrate surface shall be first cleaned and then repaired with zinc dust-zinc oxide coating in accordance with ASTM A780. Application shall be as recommended by the zinc dust-zinc oxide coating manufacturer. Coating shall consist of multiple coats to dry film thickness of 8 mils.
- B. Items not physically damaged, but which have insufficient or deteriorating zinc coatings, and items damaged in shipment or prior to installation, shall be removed from the project site for repair by the hot-dip coating method.

3.10 CLEANING AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.
 - 1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or SSPC-SP 3, "Power Tool Cleaning."
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Section 09900.
- D. Metal Panels
 - 1. Remove temporary protective coverings and strippable films, if any, as metal panels are installed.
 - 2. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
 - 3. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
 - 4. Only minor scratches and abrasions will be allowed to be touched up. Contractor shall utilize touch up paint supplied by the panel supplier.
 - a. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
 - b. The Architect / Engineer will have the final decision as to what will be considered and acceptable or unacceptable repair.
 - 5. Protect finished installation as required to ensure finishes will be without damage at time of final completion of the project.

END OF SECTION

SECTION 13 47 13

CATHODIC PROTECTION (GALVANIC ANODE TYPE)

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, and equipment and perform all work necessary for a complete and operational sacrificial anode cathodic protection system for the water line piping as shown on the drawings and specified herein.

1.02 QUALIFICATIONS

- A. The cathodic protection systems shall be tested by a National Association of Corrosion Engineers (NACE) Certified Corrosion Specialist or Cathodic Protection Specialist. The Specialist shall be on-site to conduct all field testing and shall complete all reports and manuals.
- B. In lieu of NACE certification, the testing personnel must be able to provide documented recent experience in the installation and/or design of cathodic protection systems for buried metal pipelines and structures similar in size and scope as detailed in these specifications and shall also have a valid Professional Engineering License to perform such testing or design.

1.03 SUBMITTALS

- A. Prior to the installation of any cathodic protection materials, the Contractor shall submit for approval, data on the following items:
 - 1. Magnesium anodes
 - 2. Test stations, terminal boards, and shunts
 - 3. Exothermic weld caps/coating
 - 4. Conductors, test station wires, and joint bond wires
 - 5. Wire splice kits
 - 6. Wire terminal connectors
 - 7. Exothermic weld equipment and materials
 - 8. Wire and cable marker tags
 - 9. Insulating flange kits and insulating mechanical couplings
 - 10. Marker tape
 - 11. Contractor qualifications
 - 12. Testing procedures
- B. After completion of the cathodic protection installation, the Contractor shall submit a Test Report and Operation and Maintenance Manual for the cathodic protection system.

PART 2 PRODUCTS

2.01 SACRIFICIAL ANODES

- A. Dimensions of the magnesium anodes shall conform to the dimensions for standard sizes of anodes and of the weights specified. All magnesium anodes shall be cast around a galvanized steel core (flat strap or spring) and be made of high potential magnesium alloy conforming to the following compositions by weight:

1.	Aluminum	0.01% Max.
2.	Manganese	0.50% Min. to 1.30% Max.
3.	Zinc	0.005% Max.
4.	Copper	0.02% Max.
5.	Nickel	0.001% Max.
6.	Iron	0.03% Max.
7.	Other Impurities	0.05% Each Max.
8.	Other Impurities	0.30% Total Max.
9.	Magnesium	Balance

- B. Sacrificial anodes shall be 48-pound (bare weight) Farwest ULTRAMAG High Potential Magnesium Anodes or approved equal.
- C. Contractor shall furnish spectrographic analyses or a letter of compliance on samples from each heat or batch of anodes used on this project.
- D. Sacrificial anodes shall be provided with specific backfill in a permeable cloth sack. The weight and nominal dimensions of the packaged anode shall be as follows:
- 48 lb. bare anode (5.50" X 5" X 31") = approx. 100 lb. packaged
(8" Dia. X 38"L)
- E. Sacrificial anodes shall be packaged in a permeable cloth bag with a prepared backfill mixture of 75% gypsum, 20% bentonite, 5% sodium sulfate, and shall be of the quick wetting type. Anodes shall be centered in the backfill material.
- F. All anodes shall be shipped and stored in waterproof bags.
- G. Anode lead wires shall be black #12 AWG Type USE-2 single conductor, stranded copper wire. Lead wires shall be a minimum of 25 feet in length. The lead wires shall be connected to the galvanized steel core of the anode by silver soldering and this connection shall be sealed with a waterproof epoxy or electrical potting compound.

2.02 WIRE CONDUCTORS

- A. Test station wires shall be #12 AWG and #8 AWG Type RHW-2/RHH-2/USE-2 single conductor, stranded copper wire. Wire color coding shall be as stated herein or shown on the Drawings.
- B. Joint bond wires, except where stated otherwise, shall be black #4 AWG Type HMWPE single conductor, stranded copper.

- C. Joint bond wires for mechanical coupling follower rings shall be black #8 AWG Type HMWPE single conductor, stranded copper wire.

2.03 WIRE SPLICE CONNECTIONS

- A. All splices of buried test station or anode wires shall be made using a mechanical connector and soldered then sealed with an epoxy type material. Splice kits shall be Royston "MINI SPLICE-RIGHT" with Burndy KS-90 split bolt or approved equal.

2.04 EXOTHERMIC WELDS

- A. All electrical cable connections to the buried piping shall be made by an exothermic weld. Exothermic type weld materials including the proper size and type of weld cartridges and welder molds for use on steel pipe shall be by Erico Products Inc. "CADWELD" or Burndy "THERMOWELD" or approved equal.
- B. Copper sleeves specifically designed for the purpose shall be crimped on all bare wire ends of all stranded cables prior to exothermic welding to improve mechanical strength and thermal capacity.

2.05 EXOTHERMIC WELD COATING AND BACKFILL SHIELD

- A. Exothermic weld backfill shields shall be composed of plastic weld caps, prefilled with mastic, specifically made for the purpose and installed in accordance with the manufacturer's directions. Weld caps shall be Royston Labs Handy Cap 2 or approved equal.

2.06 TEST STATIONS

- A. Flush mount cathodic protection test stations shall consist of a concrete test station enclosure, cast iron lid, terminal block with studs, and shunt.
- B. Flush mount test station boxes shall be Christy Mfg. Model "G05", or approved equal, with the lid inscribed with the words "CP TEST". Boxes shall be placed on flat blocking.
- C. Flush mount test station terminal boards shall be CP Test Services Model NM-5 or NM-7 or approved equal. Terminal boards shall be manufactured from a minimum 3/16" thick plastic or glass reinforced laminate with minimum dimensions of approximately 3 inches by 4 inches. Terminal board hardware shall be nickel plated brass and consist of either five or seven, as appropriate, 1/4-inch diameter by 1-1/4-inch-long bolts with double nuts, flat washers, and lock washers.
- D. Test stations shall also be furnished with a Cott Mfg. Co. calibrated 0.01 ohm - 8 ampere (color code yellow) test station shunt or approved equal. Exception: the shunt is not required at test stations designated as insulating fitting type test stations with no anodes or pipe casing type test stations with no anodes.

2.07 INSULATING FLANGE KITS

- A. Dielectric flange kit materials shall consist of full faced gaskets, bolt sleeves, non-metallic washers, and steel backing washers.
- B. Gaskets shall be "Type E" (full face) phenolic with either a Buna-N o-ring type sealing element or a full neoprene facing on both sides of the gasket.

- C. Insulating bolt sleeves shall be a two-piece sleeve and washer set consisting of a glass reinforced epoxy (GRE) bolt sleeve and washer similar to the G10 material as manufactured by Pikotek. The insulating bolt sleeve and washer shall fit within the bolt facing of the flange and shall allow for the standard size bolt or stud for the flange to be inserted.
- D. The steel backing washers shall be 1/8" thick, cadmium plated, hot rolled steel and shall fit within the bolt facing on the flange.

2.08 INSULATING MECHANICAL COUPLINGS

- A. Insulating mechanical couplings (IMC) shall be Dresser "Style 39", Rockwell "416" or Romac "IC501", or Baker "Series 216" without pipe stop.

2.09 WIRE AND CABLE MARKER TAGS

- A. Marker tags shall be permanent and shall be made of weather resistant/UV light resistant nylon and shall be attached to a plastic non-releasing holding device and cable fastening tail similar to Panduit Corporation Part No. PLF1MA. The marker tag writing surface shall have minimum dimensions of 0.75" L x 1.0" W.
- B. Marker tag identification shall be completed by using a waterproof ink nylon marker pen designed specifically for this purpose similar to Panduit PFX-0 or 3M ScotchCode SMP marking pen.

2.10 MARKER TAPE

- A. Marker tape for buried cables shall consist of 3-inch wide, 4-mil thick, non-adhesive polyethylene that is impervious to alkalis, acids, and other soil components.
- B. Marker tape shall be yellow in color with black lettering.
- C. Marker tape shall be imprinted with the following repeated message:

"CAUTION BURIED CATHODIC PROTECTION CABLE BURIED BELOW"

PART 3 EXECUTION

3.01 GENERAL

- A. The cathodic protection system shall be installed in compliance with the applicable portions of NACE Standard RP-01-69 latest revision.

3.02 WORKMANSHIP

- A. All materials and equipment shall be in accordance with the directions of the manufacturer to conform with the specification documents.

3.03 SACRIFICIAL ANODE INSTALLATION

- A. Contractor shall procure, store, and install high potential magnesium anodes as indicated herein.
- B. Anodes shall have approved waterproofing protection at all times prior to installation. Damaged anodes or anode wires shall not be used and replacement anodes installed instead. Anode waterproofing protection shall be removed before installing the anode.

- C. The specified high potential magnesium anodes shall be installed at the locations indicated herein. Anode locations or spacing may be adjusted slightly to clear other buried or topographical obstructions with prior approval of the Engineer.
- D. The specified magnesium anodes shall be installed completely dry and shall be lowered into the excavated (augered or otherwise) holes as shown on the Drawings by rope sling or by grasping the cloth gather. The anode lead wire shall not be used in lowering the anodes. The anode shall be backfilled with fine native excavated soil (imported sand or other select backfill shall not be allowed) in six-inch layers and each layer shall be hand tamped around the anode. Care must be exercised not to strike the anode or lead wire with the tamper. After the anode has been backfilled approximately halfway, a minimum of ten gallons of fresh water shall be added and allowed to soak into and around the anode. After water absorption by the anode and surrounding soil, continue backfilling and tamping with native soil to a point approximately six inches above the anode. Add another five gallons minimum of fresh water and allow to soak into the soil. After the water has soaked in, backfilling and soil compaction may be completed to the top of the hole. Anodes shall be installed as shown on the Drawings.

3.04 TEST STATION INSTALLATION

- A. The Contractor shall install cathodic protection test stations as shown on the Drawings and specified herein. Place flush mount type test station boxes on flat blocking to minimize settlement.
- B. Test stations shall be installed directly over the pipe unless otherwise indicated on the Drawings. For offset test station box locations, buried cable marker tape shall be installed from the pipe trench to the test station location as shown on the Drawings.
- C. Test station wiring shall be arranged and completed as shown on the Drawings. Extend flush mount test station wiring 2 feet above the top of the test station box and then coil the excess inside the box.
- D. Wire connections to the test station terminal boards for conductor sizes of #8 AWG and larger shall be made with single hole terminal lugs of corrosion resistant bronze, copper, or nickel plated brass similar to Blackburn Type L (socket), Square D Company Type LU, Burndy SCRULUG Type KPA or other approved equal.
- E. Wire connections to the test station terminal boards for conductor sizes of #14 through #10 AWG shall be terminated with a properly sized uninsulated support ring tongue compression connector similar to Panduit P10-14R-L or Burndy Hylug Type YAV Box Ring Tongue connectors, or other approved equal. Additionally, all wires shall be soldered to the ring tongue connectors.
- F. Test station wires shall be color coded as shown herein and each wire shall be permanently identified using nylon marker tags and plastic cable ties as shown on the Drawings and specified herein. Marker tag identification shall be completed by using block type lettering with the letter size to be a minimum of 1/8" high and shall specify test station number, pipe diameter, and pipe material. Test Station numbering shall be as indicated herein or shown on the Drawings.

3.05 WIRE CONNECTIONS TO BURIED PIPING

- A. Anode wire, test station wire, and joint bond wire connections to specified buried piping shall be accomplished by exothermic welding. The surface of the pipe shall be cleaned with a grinder or metal file to a bright, shiny condition. The exothermic weld shall be completed using the appropriate weld charge and welder as per the manufacturer's recommendations. A properly sized copper wire sleeve shall be installed around the bare wire end prior to welding to improve

weld strength and thermal capacity. Completed welds shall be capable of withstanding moderate hammer blows.

- B. After cooling, the weld and surrounding metal surface shall be cleaned, primed, and covered an exothermic weld cap. Any exposed metal not covered by the weld cap shall be primed and tape wrapped with approved pipeline coating materials. The weld cap shall also be secured to the pipe with pipeline tape wrap.

3.06 WIRE SPLICE CONNECTIONS

- A. Buried splice connections of anode and/or test station wires shall be completed with a splice connection kit.
- B. Installation of the splice connection kit shall be completed per the manufacturer's instructions with the exception that the wires shall also be soldered to the split bolt or crimp connector after tightening.

3.07 ELECTRICAL ISOLATION

- A. Electrical isolation of the buried waterline piping shall be accomplished by the use of insulating flange kits, insulating mechanical couplings, or a piece of non-metallic piping and fittings where specified herein or shown on the Drawings. In the event an insulating coupling is restrained using harness rods, each rod shall be insulated using a properly sized one-piece insulating sleeve and washer with steel backing washer.
- B. Insulating flange kits shall be ordered according to pipe size and pressure rating of the flange and shall be installed per the manufacturer's instructions. Care shall be exercise so as not to damage the insulating bolt sleeves.
- C. All bare or non-coated pipe that is exposed during the excavation on the non-cathodically protected side of insulated flanges or insulated mechanical couplings shall be coated and wrapped if the pipe is steel or reprimed and encased in a double polyethylene wrap if it is ductile iron.

3.08 JOINT BONDING

- A. All non-welded pipe joint connections including mechanical couplings, tees, elbows, valves, etc., except those specified to be insulating joints or those used with PVC pipe, shall be electrically bonded, coated, and wrapped or reprimed and encased with a double polyethylene wrap to ensure electrical continuity. Blow-off and hydrant piping must also be bonded.
- B. Bond wires shall be stranded #4 AWG Type HMWPE and installed as shown on the Drawings.
- C. Joint bond wires for mechanical coupling follower rings shall be stranded #8 AWG Type HMWPE and installed as shown on the Drawings.

3.09 TESTS AND MEASUREMENTS

- A. Upon completion of the cathodic protection system installation work, the Contractor shall perform testing to ensure proper operation of the system.
- B. All cathodic protection system tests shall be conducted by the Contractor's Corrosion Specialist, Cathodic Protection Specialist, or Corrosion Engineer. Unless otherwise authorized, no testing shall be conducted without the presence of a representative of the Owner.

- C. Electrical continuity of pipe joints shall be verified by field testing after completion of the pipeline installation. The Contractor shall submit a written procedure for such testing prior to the start of construction.
- D. After the installation of all specified test stations, anodes, and electrical isolation fittings, the Contractor shall obtain pipe-to-soil and anode-to-soil potential measurements using a saturated copper/copper sulfate reference electrode and a voltmeter with a minimum input impedance of 10 meg-ohms. Measurements shall be obtained before (native state potentials) and after connection of the anode wires in the test station boxes.
- E. Measurements shall be obtained at all test stations, midpoints between test stations, and any other locations deemed appropriate by the Contractor's Corrosion Specialist or Corrosion Engineer.
- F. The reference electrode shall be positioned in the soil directly over the pipe or structure where possible.
- G. Current output of the sacrificial anodes shall be obtained after connecting the anode wires in the test station boxes and utilizing the shunt provided in each test station.
- H. All anode current output and pipe-to-soil and anode-to-soil potential measurements shall be recorded including the test date in tabular form in an 8-1/2" X 11" format. The test data shall be included in the Operation and Maintenance Manual to be submitted at the completion of the Project.

3.10 CATHODIC PROTECTION CRITERIA

- A. Cathodic protection level shall be considered satisfactory when all pipe-to-soil potential measurements at all locations are -0.85 volts or more negative and all anode-to-soil potential measurements are -1.5 volts or more negative when referenced to a copper/copper sulfate electrode. IR drops in the soil shall be compensated for in the measurements.

3.11 INADEQUATE PROTECTION

- A. Inadequate pipe joint continuity and/or cathodic protection levels due to defective or incorrect installation work shall be corrected by and at the sole expense of the Contractor.

3.12 OPERATION AND MAINTENANCE MANUAL

- A. The Contractor's Corrosion Specialist, Cathodic Protection Specialist, or Corrosion Engineer shall prepare and furnish a written O&M Manual upon completion of the cathodic protection system testing.
- B. The O&M Manual shall be organized into the following sections to facilitate future review:

<u>Section No.</u>	<u>Title</u>
1.	Cathodic Protection System Description
2.	Test Measurements and Field Data
3.	Preventative Maintenance and Troubleshooting Procedures

- C. Section Organization

- 1. Section 1 should contain a written description of the structures to be protected and their cathodic protection systems including details of the pipe sizes, pipe materials including locations of any change in pipe material, and coating; type and location of anodes, test

stations, and insulating fittings; and the number of separate CP areas (electrically isolated pipe sections). The extent of each CP area should be defined by the location of piping end points and/or insulating fittings and the number of anodes and test stations installed in each CP area under this project should be indicated. In addition to the written description, a schematic of the CP system layout shall be completed showing the pipeline, valves, streets, fencelines, ditches and other topographic highlights, and all test stations.

2. Section 2 should contain a written report of the tests conducted at the completion the system installation under this project with the test data obtained listed in the previously specified tabular form.
3. Section 3 should contain any manufacturer's equipment maintenance information as well as a written description of basic sacrificial anode cathodic protection system preventative maintenance and troubleshooting procedures including equipment necessary, the frequency and extent of pipe-to-soil surveys, interpretation of the pipe-to-soil potential data, proper documentation of survey data, how to locate defective insulating fittings, and what are underground "shorts" and how should they be located.

3.13 AS-BUILT DRAWINGS

- A. The Contractor shall maintain at the job site one full set of full-size Contract Drawings marked to show any deviations which have been made from the Contract Drawings as well as any appropriate field construction notations. Approved dimensioning and scale of all anode and test station locations shall be included. Upon completion of the work, the marked sets of prints shall be submitted to the Engineer.

END OF SECTION

SECTION 21 13 00

WET PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies sprinkler systems for buildings and structures.
- B. Products specified in this Section with installation not in Contract include sprinkler cabinets with spare sprinklers and sprinkler wrenches. Deliver to the Owner's maintenance personnel.
- C. Related Sections: The following sections contain requirements related to this section:
 - 1. Division 01 Section 01 33 00 – Submittals.
 - 2. Division 01 Section 01 78 23 – Operation and Maintenance Manuals.
 - 3. Division 33 Section 33 14 13 – Pipe and Fittings.
 - 4. Division 33 Section 33 14 19 – Valves and Operators.

1.02 DEFINITIONS

- A. Pipe sizes used in this Section are nominal pipe size (NPS) specified in inches. Tube sizes are standard tube size specified in inches.
- B. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.
- C. Other definitions for fire protection systems are included in referenced NFPA standards.

1.03 SYSTEM DESCRIPTION

- A. Wet Pipe Sprinkler System: System with automatic sprinklers attached to piping system containing water and connected to water supply so that water discharges immediately from sprinklers when they are opened by fire.
- B. Dry Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.
- C. Sprinkler System Protection Limits: All spaces within areas indicated. Include closets, toilet and locker room areas, each landing of each stair, and special applications areas.

1.04 SYSTEM PERFORMANCE REQUIREMENTS

- A. Contractor shall review existing site conditions, design, and obtain approval from authority having jurisdiction for fire protection systems specified. The authority having jurisdiction is the Colorado River Fire Rescue.
- B. Minimum Pipe Sizes: Not smaller than sizes indicated for connection to water supply piping, standpipes, and branches from standpipes to sprinklers.

- C. Conduct fire hydrant flow tests as required to obtain hydraulic data needed to prepare design for hydraulically calculated systems.
- D. Hydraulic Calculations: The actual water supply must be verified by test using 2 hydrants as close to the point of connection as possible, preferably witnessed (or performed) by a local fire official. Allow 10% cushion between the water supply and demand. Calculations start at the water main connection under the street and must include the backflow preventor and all valves and fittings. Limit water velocity to 25 fps, except use 18 fps for any segment with a vane type waterflow switch (to comply with UL listing).
- E. Minimum Design Density: Ordinary Hazard (Group 2) is the minimum design accepted for most areas in the building. The minimum design density is to be 0.20 gpm/SF for the hydraulically most remote 1,500 SF. An area reduction may be utilized where applicable. For dry systems, increase the area of application by 30%.
- F. Extent of Sprinkler Coverage: The chemical room shall be the area with fire sprinklers.
- G. Electrical Supervision: Electrical supervision per NFPA 72 is required for all sprinkler control valves. Normally closed valves to test headers, rooftop hose connections, etc. are permitted to be provided with locks, in lieu of electrical supervision.
- H. Components and Installation: Capable of producing piping systems with the following minimum working pressure ratings except where indicated otherwise.
 - 1. Sprinkler Systems: 175 psig.

1.05 SUBMITTALS

- A. Product data for fire protection system components. Include the following:
 - 1. Backflow preventers.
 - 2. Valves.
 - 3. Specialty valves, accessories, and devices.
 - 4. Alarm devices: Include electrical data.
 - 5. Fire department connections: Include type of fire department connection; number, size, type, and arrangement of inlets; size and direction of outlet; and finish.
 - 6. Sprinklers, escutcheons, and guards: Include sprinkler flow characteristics, mounting, finish, and other data.
- B. Sprinkler system drawings identified as "working plans," prepared according to NFPA 13.
- C. Submit hydraulic calculations based on actual conditions according to NFPA 13.
- D. Submit completed State of Colorado Division of Fire Safety Plan Registration Form.
- E. Test reports and certificates as described in NFPA 13. Include "Contractor's Material & Test Certificate for Aboveground Piping" and "Contractor's Material & Test Certificate for Underground Piping."
- F. Maintenance data for each type of fire protection specialty specified, for inclusion in "Operating and Maintenance Manual" specified in Division 01 Section "Project Closeout."

- G. 2 copies of NFPA 13A "Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems." Deliver to Owner's maintenance personnel.
- H. 2 copies of NFPA 25 "Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems." Deliver to Owner's maintenance personnel.
- I. 2 copies of NFPA 1962 "Standard for the Care, Use, and Service Testing of Fire Hose Including Couplings and Nozzles." Deliver to Owner's maintenance personnel.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.
- B. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.
- C. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Comply with requirements of authority having jurisdiction for submittals, approvals, materials, hose threads, installation, inspections, and testing.
- E. Comply with requirements of Owner's insurance underwriter for submittals, approvals, materials, installation, inspections, and testing.
- F. Contractor Qualifications and Responsibilities: The Contractor must be licensed as required by the local authority having jurisdiction. The Contractor may be required to furnish evidence of satisfactory performance on previous sprinkler system installations of equivalent size, type, and complexity. The Contractor shall furnish all parts, materials, and labor required for a complete and operating system in accordance with all applicable requirements, even if each needed item is not specifically shown or described in the plans or specs. The Contractor is also responsible for the inevitable adjustments in sprinkler locations, sprinkler quantity, and piping required for full compliance with the International Building Code, International Fire Code, NFPA standards, and the project plans and specifications. Shop drawings are to be submitted to the Engineer for review prior to construction and must include the hydraulic calculations. Without such calculations, they cannot be given proper review and will not be accepted. After the project is completed all required Material and Test Certificates shall have been submitted by the Contractor. Approval of samples, cut sheets, shop drawings, and other matter submitted shall not relieve the Contractor's responsibility for full compliance with project plans and specifications, unless the attention of the Engineer is called to each non-complying feature by accompanying letter, and the Engineer subsequently gives written authorization for the specific deviations. If any conflict is observed between this document and the project plans, referenced Codes, or Standards, obtain a ruling from the authority having jurisdiction before proceeding with purchase of materials, fabrication, or installation of the system. Failure to do so may cause the Contractor to be held liable for any cost or delay incurred as a result.
- G. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:
 - 1. NFPA 13 "Standard for the Installation of Sprinkler Systems".

2. NFPA 70 "National Electrical Code".
3. NFPA 14 "Standard for Standpipes".

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Specialty Valves, Water Motor Alarms, and Air Pressure Maintenance Devices:
 - a. ASCOA Fire Systems, Figgie International Co.
 - b. Central Sprinkler Corp.
 - c. Firematic Sprinkler Devices, Inc.
 - d. Gem Sprinkler Co. Div., Grinnell Corp.
 - e. Globe Fire Sprinkler Corp.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Star Sprinkler Corp.
 - h. Viking Corp.
 - i. Victaulic Corporation
2. Backflow Preventers:
 - a. Ames Co., Inc.
 - b. Cla Val Co.
 - c. Conbraco Industries, Inc.
 - d. Febco.
 - e. Hersey Products, Inc., Grinnell Corp.
 - f. Watts Regulator Co.
 - g. Wilkins Regulator Div., Zurn Industries, Inc.
3. Waterflow Indicators and Supervisory Switches:
 - a. Gamewell Co.
 - b. Gem Sprinkler Co. Div., Grinnell Corp.
 - c. Potter Electric Signal Co.
 - d. Reliable Automatic Sprinkler Co., Inc.
 - e. System Sensor Div., Pittway Corp.
 - f. Victaulic Company of America.
 - g. Watts Regulator Co.
4. Fire Department Connections:
 - a. Badger Powhatan, Figgie International Co.
 - b. Croker Div., Fire End and Croker Corp.

- c. Elkhart Brass Mfg. Co., Inc.
 - d. Firematic Sprinkler Devices, Inc.
 - e. Gem Sprinkler Co. Div., Grinnell Corp.
 - f. Guardian Fire Equipment, Inc.
 - g. Potter Roemer Div., Smith Industries, Inc.
 - h. Reliable Automatic Sprinkler Co., Inc.
 - i. Sierra Fire Equipment Co.
5. Sprinklers:
- a. ASCOA Fire Systems, Figgie International Co.
 - b. Central Sprinkler Corp.
 - c. Firematic Sprinkler Devices, Inc.
 - d. Gem Sprinkler Co. Div., Grinnell Corp.
 - e. Globe Fire Sprinkler Corp.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Star Sprinkler Corp.
 - h. Viking Corp.
6. Hose Valves and Racks and Hose:
- a. Badger Powhatan, Figgie International Co.
 - b. Croker Div., Fire End and Croker Corp.
 - c. Elkhart Brass Mfg. Co., Inc.
 - d. Guardian Fire Equipment, Inc.
 - e. Potter Roemer Div., Smith Industries, Inc.
 - f. Sierra Fire Equipment Co.
7. Indicator Valves:
- a. Gem Sprinkler Co. Div., Grinnell Corp.
 - b. Grinnell Supply Sales Co., Grinnell Corp.
 - c. Kennedy Valve Div., McWane, Inc.
 - d. Milwaukee Valve Co., Inc.
 - e. Nibco, Inc.
 - f. Sprink Line by Sprink, Inc.
 - g. Victaulic Company of America.
8. Fire Protection Service Gate and Check Valves:
- a. Gem Sprinkler Co. Div., Grinnell Corp.
 - b. Kennedy Valve Div., McWane, Inc.
 - c. Nibco, Inc.
 - d. Stockham Valves and Fittings, Inc.
 - e. Victaulic Company of America.

9. Grooved Couplings for Steel Piping:
 - a. Grinnell Supply Sales Co., Grinnell Corp.
 - b. Gustin Bacon Div., Tyler Pipe Subsid., Tyler Corp.
 - c. Sprink Line by Sprink, Inc.
 - d. Stockman Valves and Fittings, Inc.
 - e. Victaulic Company of America.
10. Electrically Operated Alarm Bell:
 - a. Fire-Lite Alarms; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.
11. Dry Pipe System Riser Mounted Air Compressor:
 - a. Gast Manufacturing Inc.
 - b. General Air Products, Inc.
 - c. Viking Corporation

2.02 PIPES AND TUBES

- A. Refer to Part 3 Articles "Sprinkler System Piping Applications" for identification of systems where pipe and fitting materials specified below are used.
- B. Steel Pipe: ASTM A 135, Schedule 10 through 5-inch sizes and NFPA 13 specified wall thickness for 6 inch through 10 inch sizes, with plain ends, black and galvanized, for rolled groove and welded joints.
- C. Steel Pipe: ASTM A 53, Schedule 40 with plain ends, black for threaded joints.
- D. Steel Pipe: ASTM A 53, Schedule 40, Galvanized with plain ends.

2.03 PIPE AND TUBE FITTINGS

- A. Steel Fittings: ASTM A 234/A 234M, seamless or welded: ASME B16.9, butt welding; or ASME B16.11, socket-welding type for welded
- B. Steel Flanges and Flanged Fittings: ASME B16.5.
- C. Grooved-End Fitting for Steel Pipe: UL-listed and FM-approved, ASTM A 536, Grade 5-45-12 ductile iron or ASTM A 47 Grade 32510 malleable iron, with grooves or shoulders designed to accept grooved couplings.

2.04 GENERAL DUTY VALVES

- A. Refer to Division 33 Section "Valves and Operators" for general duty ball and check valves.

2.05 FIRE PROTECTION SERVICE VALVES

- A. General: UL listed and FM approved, with 175 psig non shock minimum working pressure rating.
 1. Option: Valves for use with grooved piping may be grooved type.

- B. Gate Valves, 2 Inches and Smaller: UL 262, cast bronze, threaded ends, solid wedge, outside screw and yoke, rising stem.
- C. Indicating Valves, 2 1/2 Inches and Smaller: Butterfly or ball type, bronze body with threaded ends, and integral indicating device.
 - 1. Indicator: Electrical 115 volts a.c., prewired, 2 circuit, supervisory switch.
- D. Gate Valves, 2 1/2 Inches and Larger: UL 262, iron body, bronze mounted, taper wedge, outside screw and yoke, rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.
- E. Indicator Posts: UL 789, wall type, cast iron body, with windows for target plates that indicate valve position, extension rod and coupling, locking device, and red enamel finish.
 - 1. Operation: Operating wrench.
- F. Swing Check Valves, 2 1/2 Inches and Larger: UL 312, cast iron body and bolted cap, with bronze disc or cast-iron disc with bronze disc ring and flanged ends.
- G. Butterfly Check Valves, 4 Inches and Larger: UL 213, split clapper style, cast iron body with rubber seal, bronze alloy discs, stainless steel spring and hinge pin.

2.06 SPECIALTY VALVES

- A. Riser Check Valves: UL 193, 175 psig working pressure, designed for vertical installation, with cast iron flanged inlet and outlet, bronze grooved seat with O ring seals, and single hinge pin and latch design. Provide trim sets for drain, electric sprinkler alarm switch, and pressure gages.
 - 1. Option: Grooved end connections for use with grooved end piping.
- B. Ball Drip Valves: UL 1726, automatic drain valve, 3/4-inch size, spring loaded, ball check device with threaded ends.
- C. Dry Pipe Valves: UL 260, differential-pressure type. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
- D. Air-Pressure Maintenance Device: UL 260, automatic device to maintain air pressure in piping. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.
- E. Dry Pipe System Riser Mounted Air Compressor: UL listed riser mounted air compressor for fire protection system, fractional motor horsepower, 120-volt, single phase, 60 Hz.

2.07 SPRINKLERS

- A. Automatic Sprinklers: With heat responsive element conforming to:
 - 1. UL 199, for applications except residential.
- B. Sprinkler types and categories are as indicated and as required by application. Furnish automatic sprinklers with nominal 1/2 inch orifice for "Ordinary" temperature classification rating except where otherwise indicated and required by application.

- C. Sprinkler types, features, and options include:
1. Coated, painted, or plated sprinklers.
 2. Concealed ceiling sprinklers, including cover plate.
 3. Extended coverage sprinklers.
 4. Pendent sprinklers.
 5. Recessed sprinklers, including escutcheon.
 6. Sidewall sprinklers.
 7. Upright sprinklers.
- D. Sprinkler Finishes: Chrome plated, bronze, and painted.
- E. Special Coatings: Wax, lead, and corrosion resistant paint.
- F. Sprinkler Escutcheons: Materials, types, and finishes for following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome plated steel, 1 piece, flat.
 2. Sidewall Mounting: Chrome plated steel, 1 piece, flat.
- G. Sprinkler Guards: Wire cage type, including fastening device for attaching to sprinkler.
- H. Sprinkler Cabinets: Finished steel cabinet and hinged cover, with space for minimum of 6 spare sprinklers plus sprinkler wrench, suitable for wall mounting. Include number of sprinklers required by NFPA 13 and 1 wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each style sprinkler on Project.

2.08 SPECIALTY SPRINKLER FITTINGS

- A. Specialty Fittings: UL listed and FM approved, made of steel, ductile iron, or other materials compatible with system materials and applications where used.
- B. Sprinkler Alarm Test Fittings: Ductile iron housing with 1 1/2 inch inlet and outlet, integral test valves, combination orifice and sight glass, and threaded or locking lug ends.

2.09 ALARM DEVICES

- A. Alarm Devices: Types and sizes that will match piping and equipment connections.
- B. Waterflow Indicators: UL 346, electrical supervision type, vane type waterflow detector, rated to 250 psig and designed for horizontal or vertical installation. Include 2 SPDT (single pole, double throw) circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere, 125 volts a.c. and 0.25 ampere, 24 volts d.c.; complete with factory set, field adjustable retard element to prevent false signals and tamper proof cover that sends a signal when cover is removed.
- C. Pressure Switches: UL 753, waterflow switch with retard, electrical supervision type, SPDT (single pole, double throw), normally closed contacts, designed to operate on rising pressure and signal water flow.

- D. Supervisory Switches: UL 753, for valves, electrical-supervision type, SPDT (single-pole, double throw), normally closed contacts, designed to signal controlled valve in other than full open position.
- E. Electrically Operated Alarm Bell: UL 464, Vibrating, Alarm Bell, 8-inch minimum diameter, red-enamel factory finish, suitable for outdoor use. Provide with same voltage as building fire alarm system.

2.10 PRESSURE GAUGES

- A. Pressure Gauges: UL 393, liquid filled, 3 1/2 to 4 1/2 inches diameter dial with dial range of 0 to 250 psig.

2.11 BACKFLOW PREVENTERS

- A. General: ASSE standard backflow preventers, of size indicated for maximum flow rate indicated and maximum pressure loss indicated.
 - 1. Working Pressure: 150 psig minimum except where indicated otherwise.
 - 2. Bronze, cast iron, steel, or stainless steel body with flanged ends.
 - 3. Interior Lining: FDA approved epoxy coating, for backflow preventers having cast iron or steel body.
 - 4. Interior Components: Corrosion resistant materials.
- B. Reduced Pressure Zone Double Detector Check Assembly Backflow Preventers: ASSE 1013 suitable for continuous pressure application, consisting of OS&Y gate valves on inlet and outlet. Include two 2 positive seating check valves, test cocks, pressure-differential relief with ASME A112.1.2 air gap fitting, and bypass with displacement type water meter. Meter shall read in gallons. All valves and components shall be rated for continuous pressure application.
 - 1. Pressure Loss: 12 psig maximum, through middle third of flow range.

2.12 FIRE DEPARTMENT CONNECTIONS

- A. Exposed, Wall Type Fire Department Connections: UL 405, cast brass body; chrome plated, NH standard thread inlets according to NFPA 1963 and matching local fire department threads; and threaded NPS outlet. Include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet; and round wall escutcheon plate with marking "AUTOMATIC SPRINKLER." Confirm exact fire department connection type with the local Authority Having Jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine walls and partitions for suitable thickness, fire and smoke rated construction, framing for cabinets, and other conditions where cabinets are required to be installed.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.02 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Refer to Part 2 of this Section for detailed specifications on pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping may be joined with flanges instead of indicated joints. Use grooved end fittings with grooved couplings that are made by the same manufacturer and that comply with listing when used together for grooved coupling joints.
- B. Wet-Pipe Systems Sizes 2 ½" Inches and Larger: ASTM A 135 or A 795, Schedule 10 steel pipe with rolled groove ends, grooved end steel pipe fittings, and grooved coupling joints.
- C. Wet-Pipe Systems Size 2 Inches and Smaller: ASTM A53, schedule 40 steel pipe with threaded fittings.
- D. Dry Pipe Systems: Size 2 Inches and Smaller: ASTM A53, schedule 40 steel pipe, Galvanized with threaded fittings.
- E. Dry Pipe Systems: Sizes 2 ½" Inches and Larger: ASTM A 135 or A 795, Schedule 10 steel pipe, galvanized with rolled groove ends, grooved end steel pipe fittings, and grooved coupling joints.

3.03 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves.
 - 2. Throttling Duty: Use ball valves.

3.04 JOINT CONSTRUCTION

- A. Refer to Division 33 Section "Pipe and Fittings" for basic piping joint construction.
- B. Grooved End Pipe and Grooved End Fitting Joints: Use grooved end fittings and grooved couplings that are made by the same manufacturer and that are listed for use together. Groove pipe and assemble joints with grooved coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
 - 1. Groove Type: Rolled.
- C. Dissimilar Materials Piping Joints: Make joints using adapters compatible with both piping materials.
- D. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling when joining plastic pipe and fittings with solvent cements.

3.05 SERVICE ENTRANCE PIPING

- A. Connect fire protection piping to water service piping of size and in location indicated for service entrance to building. Water service piping is specified in Division 33.
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories required at connection to fire service piping.
- C. Contractor shall obtain copy of NFPA 24 certification before installation of sprinkler system in building.

3.06 PIPING INSTALLATIONS

- A. Refer to Division 33 Section "Pipe and Fittings" for basic piping installation.
- B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved "working plans" for sprinkler piping require written approval from authority with jurisdiction. File written approval with the Engineer prior to deviating from approved "working plans".
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes 2 inches and smaller. Unions are not required on flanged devices or in piping installations using grooved couplings.
- E. Install flanges or flange adapters on valves, apparatus, and equipment having 2 1/2 inch and larger connections.
- F. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13 on exterior of building.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install alarm devices in piping systems.
- I. Hangers and Supports: Comply with NFPA 13. Install according to NFPA 13.
 - 1. Install hanger and support spacing and locations for steel piping joined with grooved mechanical couplings according to manufacturer's written instructions for rigid systems.
- J. Install pressure gages on riser or feed main and at each sprinkler test connection. Include pressure gages with connection not less than 1/4 inch and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.

3.07 SPECIALTY SPRINKLER FITTING INSTALLATIONS

- A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.08 VALVE INSTALLATIONS

- A. Refer to Division 33 Section "Valves and Operators" for installation of general duty valves. Install fire protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and the authority having jurisdiction.
- B. Gate Valves: Install fire protection service valves supervised open, located to control sources of water supply except from fire department connections. Where there is more than 1 control valve, provide permanently marked identification signs indicating portion of system controlled by each valve.
- C. Riser Check Valves: Install valves in vertical position for proper direction of flow.

3.09 SPRINKLER APPLICATIONS

- A. Rooms without Ceilings: Upright sprinklers.
- B. Rooms with Suspended Ceilings: Concealed sprinklers.
- C. Lobby/Reception Area: Concealed sprinklers.
- D. Wall Mounting: Sidewall sprinklers.
- E. Sprinkler Finishes: Use sprinklers with following finishes:
 - 1. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - 2. Concealed Sprinklers: Rough brass, with factory painted white cover plate.

3.10 SPRINKLER INSTALLATIONS

- A. Install sprinklers in patterns per NFPA 13, including cages where required.
- B. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.

3.11 CONNECTIONS

- A. Connect to specialty valves, hose valves, specialties, fire department connections, and accessories.
- B. Electrical Connections: Power wiring is specified in Division 16.
- C. Connect alarm devices to fire alarm system.

3.12 FIELD QUALITY CONTROL

- A. Perform field acceptance tests of each fire protection system.
 - 1. Flush, test, and inspect sprinkler piping systems according to NFPA 13 Chapter "System Acceptance."
- B. Replace piping system components that do not pass test procedures specified. Then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
 - 1. Report test results promptly and in writing to Engineer.
 - 2. Report test results promptly and in writing to authority having jurisdiction when required.
- C. Contractor's Inspection of System: The Contractor shall thoroughly inspect the completed system to assure compliance with this document, project plans and specs, and applicable Codes and Standards.
- D. Contractor's Material and Test Certificates: Prior to the final inspection by the AHJ and /or the Owner's representative, complete and submit three (3) copies each of the NFPA-required certificates for aboveground, and underground, piping. Send to Engineer for distribution.

3.13 CLEANING

- A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.14 COMMISSIONING

- A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturer, proceed as follows:
 - 1. Verify that specialty valves, trim, fittings, controls, and accessories have been installed correctly and operate correctly.
 - 2. Verify that specified tests of piping are complete.
 - 3. Check that damaged sprinklers and sprinklers with paint or coating not specified have been replaced with new, correct type of sprinklers.
 - 4. Check that sprinklers are correct type, have correct finish and temperature ratings, and have guards where required for applications.
 - 5. Check that potable water supplies have correct type of backflow preventer.
 - 6. Check that hose valves and fire department connections have threads compatible with local fire department equipment and have correct pressure rating.
 - 7. Fill wet pipe sprinkler systems with water.
 - 8. Check for correct type and size hose valves, racks, hoses, and nozzles.
 - 9. Energize circuits to electrical equipment and devices.
 - 10. Adjust operating controls and pressure settings.
- B. Coordinate with fire alarm system tests. Operate systems as required.

3.15 TRAINING

- A. Contractor shall conduct one training session to familiarize the building maintenance personnel with the fire protection systems. Instructions shall include information regarding system features, operations, maintenance, repairs, emergency procedures, etc. The training session shall be at least two hours in duration.
- B. Schedule training with at least 7 days advance notice.

3.16 IDENTIFICATION

- A. All exposed sprinkler piping, including exterior piping, shall be painted red.
- B. All required tags shall be applied to related sprinkler valves.
- C. All sprinkler data plates shall be completed and filled out in permanent stamped markings.

END OF SECTION

SECTION 22 07 00

PIPING INSULATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Piping insulation.
- B. Adhesive, fasteners, and reinforcement.
- C. Recovering.
- D. Underground insulation.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - ASTM B 209 Aluminum and Aluminum-Alloy Sheet and Plate
 - ASTM C 533 Calcium Silicate Block and Pipe Thermal Insulation
 - ASTM C 534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - ASTM C 547 Mineral Fiber Preformed Pipe Insulation
 - ASTM C 552 Cellular Glass Thermal Insulation
 - ASTM C 591 Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation
 - ASTM D 2842 Water Absorption of Rigid Cellular Plastics
 - ASTM E 84 Surface Burning Characteristics of Building Materials
 - ASTM E 96 Water Vapor Transmission of Materials
 - B. National fire Protection Association (NFPA).
 - NFPA 255 Method of Test of Surface Burning Characteristics of Building Materials
 - C. Underwriters Laboratory, Inc. (UL).
 - UL 723 Test for Surface Burning Characteristics of Building Materials
- ##### 1.03 SUBMITTALS
- A. Submit product data for each insulation system specified hereinafter to include:
 - 1. Insulation.
 - 2. Jackets and covers.
 - 3. Adhesives.
 - 4. Coatings.
 - 5. Sealants and cements.

1.04 SAFETY REQUIREMENTS

- A. Fire and Smoke Hazard Classification Rating of Composite Assembly (comprised of insulation, jacket and adhesive): comply with NFPA 255, ASTM E 84, and UL 723 as follows:
1. Flame Spread Rating: Not to exceed 25.
 2. Fuel contributed: Not to exceed 50.
 3. Smoke Developed: Not to exceed 50.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fibrous Glass Insulation

1. Insulation: Rigid molded fiber glass pipe covering having a density of 4 lbs/cu. ft., in compliance with ASTM C 547, having a k-factor of approximately 0.24 @ 75°F (0.35 @ 24°C), and suitable for temperatures from -40°F to 450°F (-40°C to 232°C). Minimum insulation thickness on the piping insulation is 1 inch. Alternatively, submit calculations showing a reduced thickness is sufficient to meet the requirements of the specification.
2. Valve, Fitting and Flange Covers: Pre-molded PVC covers with fiber glass insert.
3. Jacket: Factory applied vapor barrier all-service type with adhesive held lap seams (field applied adhesive or self-sealing lap) and adhesive held lap seam butt strips.

B. Recovering Jackets

1. Canvas: 6 oz/sq yd (200 g/sq m) canvas attached with the manufacturer's recommended lagging fire retardant adhesive.
2. Aluminum:
 - a. Factory or field applied 0.016 inch (0.4 mm) smooth 5005 alloy aluminum. Straps shall be aluminum or stainless steel.
 - b. Fitting Covers: Factory fabricated from not lighter than 0.020 inch (0.5 mm) smooth 5005 alloy aluminum.
3. Glass Cloth Jackets: 9 oz/sq yd (305 g/sq m) 300 psi (207 kPa) bursting strength.

C. Adhesives, Joint and Lap Tapes: Manufacturer's standard for the insulation applied and fully compatible with all materials applied to the system. Adhesive for application of glass cloth covering shall be nonflammable wet and meet fire spread specification dry.

D. Fasteners

1. Staples: Outward clinching monel or stainless steel.
2. Wire: 19 gauge (1.3 mm) soft annealed galvanized, or 14 gauge (1.9 mm) copper clad steel or nickel copper alloy.
3. Bands: ¾ inch (20 mm) nominal width, brass, galvanized steel, aluminum or stainless steel.

E. Reinforcements

1. Tape for Flexible Unicellular Insulation: Scotch No. 472, Nashua PE-12 or approved equal recommended by the insulation manufacturer.
2. Hexagonal Wire Netting: 1 inch mesh, 22 gauge (0.85 mm) galvanized steel.
3. PVC Fitting Cover: Pliable PVC, color matching, vapor barrier, with pressure sensitive tape.

PART 3 EXECUTION

3.01 PREPARATION

- A. Do not install covering before piping and equipment has been tested and approved.
- B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.02 APPLICATION - PIPE, VALVES, AND FITTINGS

- A. Low Temperature – 40-60°F(4.5-16°C):

1. Insulation: Fibrous glass.
2. Thickness:

Item	Pipe Diameter	Insulation Thickness
All others	Up to 50 mm (2 inches)	13 mm (2 inch)
All others	50 - 150 mm (2 - 6 inches)	25 mm (1 inch)
All others	Over 150 mm (6 inches)	38 mm (1-1/2 inch)

3. Installation:
 - a. Refer to INSTALLATION - GENERAL, for additional requirements.
 - b. Stagger longitudinal joints.
 - c. Tightly butt the sections and seal longitudinal seams of vapor barrier jacket with vapor barrier lap adhesive in addition to the self-sealing feature.
 - d. Seal circumferential end joints with butt strips of vapor barrier material and vapor barrier lap adhesive.
 - e. Staples shall not be used.
 - f. Seal pipe ends, valves, and fittings with vapor barrier coating.
 - g. Jacket shall be free of pinholes or openings.
 - h. Cover valves, fittings, flanges, and specialties with pre-molded glass fiber covering having same thickness as adjacent insulation, or use job fabricated or precut insulation. Vapor barrier must be continuous throughout installation.
 - 1) On pipe sizes 65 mm (2-2 inches) and under, apply insulating cement in successive layers not exceeding 20 mm (3/4 inch) thickness per layer to a thickness equal to insulation on adjacent pipe. Finish with canvas or glass cloth covered with a seal coat of lagging adhesive. Apply coat of vapor barrier coating.

- 2) On pipe sizes 80 mm (3 inches) and over, apply mitered fiberglass insulation to a thickness equal to insulation on adjacent pipe.
 - 3) Fasten with wire mesh or galvanized wire. Point with insulating cement. Finish with 6 mm (1/4 inch) of finishing cement and canvas or glass cloth covered with a seal coat of lagging adhesive. Apply coat of vapor barrier coating.
 - 4) Cover valves, fittings, flanges, and specialties at equipment, where insulation may be removed for maintenance, with flexible elastomeric insulation as specified.
 - 5) Finish with PVC cover. Seal cover joints with vapor barrier coating or vapor barrier adhesive tape.
- i. Where anchors are secured to piping to be insulated, the anchor shall be insulated same as piping for a distance not less than four times the insulation thickness, to prevent condensation. Insulation shall be vapor sealed as specified for fittings.

B. Medium Temperature – 61 to 211 Degrees F (16 to 99 Degrees C):

1. Application:
 - a. Heating hot water.
2. Insulation: Fibrous glass or flexible elastomeric for heat pump piping; fibrous glass for heating hot water.
3. Thickness.
 - a. Source water supply and return: 1 inch (25 mm).
 - b. Heating hot water and hot water recirculating:

Pipe Diameter		Insulation Thickness	
(inches)	(mm)	(inches)	(mm)
Thru 1 inch	25	1	25
1 ¼ to 3	32 to 80	1 ½	40
Over 3	Over 80	2	40

4. Installation:
 - a. Refer to INSTALLATION for additional information.
 - b. Stagger longitudinal joints.
 - c. Tightly butt the sections and seal longitudinal seams of jacket with adhesive or the self-sealing feature.
 - d. Seal circumferential end joints with butt strips and lap adhesive.
 - e. In addition, outward clinch staples 6 inch (150 mm) o.c. shall be used on all longitudinal seams of fibrous glass insulation.
 - f. For piping covered with fibrous glass insulation, cover fittings, flanges, and specialties with premolded glass fiber covering having same thickness as adjacent insulation or use job fabricated or precut insulation.
 - 1) Exception: Unions, flexible connectors, valves, safety and relief valves and discharge piping, exposed piping through floor for convectors and radiators.

- 2) On pipe sizes 2 ½ inch (65 mm) and under, apply insulating cement in successive layers not exceeding ¾ inch (20 mm) thickness per layer to a thickness equal to insulation on adjacent pipe. Finish with canvas or glass cloth covered with a seal coat of lagging adhesive.
 - 3) On pipe sizes 3 inches (80 mm) and over, apply mitered fiberglass insulation to a thickness equal to insulation on adjacent pipe. Fasten with wire mesh or galvanized wire. Point with insulating cement. Finish with ¼ inch (6 mm) of finishing cement and canvas or glass cloth covered with a seal coat of lagging adhesive.
 - 4) Finish with PVC cover. Seal cover joints with vapor barrier adhesive tape.
5. For piping covered with elastomeric insulation, cover fittings and specialties with same thickness mitered insulation, installed per manufacturers recommendations and requirements.

3.03 INSTALLATION

- A. Install insulation in a smooth, clean manner in accordance with the best accepted practices of the trade. Joints shall be tight and finished smooth. Cracked, chipped, and torn sections shall not be used in the work.
- B. Surfaces to be insulated shall be dry and free of loose scale, rust, dirt, oil or water when insulation is applied.
- C. Longitudinal seams shall be located where not visible where possible, or where least visible, and shall be secured with full adhesive and staples, to leave no openings in seam.
- D. Do not use scrap pieces of insulation where a full length section will fit.
- E. Recovering Jackets:
 1. Provide canvas recovering jackets on exposed indoor insulation throughout, including equipment rooms, pipe tunnels, janitor closets, and restrooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling space is not considered exposed.
 - a. Use pre-sized paper under recovering at uneven insulated surfaces.
 - b. Apply a finish coat of canvas adhesive over entire surface.
 2. Provide factory applied or field applied aluminum jackets on all outdoor installations, in manholes, pipe tunnels and wherever exposed to weather.
 - a. Moisture barrier on the underside of aluminum jacketing is not required where insulation is provided with a vapor barrier jacket.
 - b. Lap joint downward to shed water.
 - c. Finish circumferential joints with prefabricated aluminum or stainless steel straps and waterproof metal lap sealant.
 - d. Jackets shall be secured with stainless steel straps on 9 inch (230 mm) centers.
 - e. Factory fabricated jackets of equal thickness and construction and with longitudinal slip joints and aluminum butt straps may be used.
 - f. Valves and fittings shall be finished with factory or job fabricated jacketing as specified above.

3. Insulation which may be damaged by personnel access shall be calcium silicate with vapor barrier and covered with a 20 gauge (1 mm) galvanized steel jacket. Secure with galvanized bands on 8 inch (200 mm) centers.
- F. Fit insulation tightly against surface to which it is applied.
- G. Do not apply sealant or cement until all previous applications of adhesives and cement have thoroughly dried.
- H. Restore existing insulation and surface finishes disturbed or damaged during the course of the work to new condition.
- I. All required tests on piping shall be completed prior to application of insulation.
- J. Apply insulation so as to permit expansion or contraction of pipe lines without causing damage to insulation or surface finish.
- K. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.
- L. Pipe Hangers: Insulated piping shall be supported by hangers and metal protection shields to be installed with the piping. Provide a calcium silicate insert equal in length to insulation shield length. Insert shall be molded or shaped to fit the lower half of the pipe circumference for horizontal pipe, and the entire pipe circumference to vertical pipe. Inserts shall be of same thickness and outside contour as the adjoining insulation, and shall be sealed into it with coating compound, and covered with vapor barrier jacket. The use of protection saddles prefabricated to include the insert material and vapor barrier jacket will also be permitted.
- M. Insulation and vapor barriers shall be continuous through all sleeves and openings, except at fire walls and partitions where fire stops per Section PIPING SUPPORT shall be provided.
- N. Where insulation terminates for any reason, taper to pipe and finish with insulating cement.
- O. Terminate preformed pipe covering at a sufficient distance from valve flanges to permit removal of bolts.
- P. Insulation on flanges shall overlap adjacent pipe covering 2 inches (50 mm).
- Q. Pipeline strainers on low temperature piping shall be insulated in such a manner as to permit removal of strainer basket without disturbing insulation on the strainer body.
- R. Furnish premolded pipe insulation with extended leg when used on heat traced pipes.
- S. Install all insulation and accessories in accordance with the manufacturer's instructions.

3.04 FIELD QUALITY CONTROL

- A. Installers: Insulation shall be applied only by mechanics skilled at such work.
- B. Insulation Protection: Protection against dirt, water, chemical or mechanical damage before, during and after installation.
- C. Damage: Any such insulation or covering damaged prior to final acceptance of the Work shall be satisfactorily repaired or replaced.

- D. Cleanup: Upon completion of the Work, thoroughly clean all floors, walls, ceilings, equipment, and similar items of all adhesives, paints, cements, empty containers, scraps and other miscellaneous materials, leaving said surfaces in the same condition of cleanliness as they were found.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES AND ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies work required to provide plumbing systems.
1. Sections 33 14 13 and 33 14 19 take precedence over this Section. Precedence applies if there is a conflict between Sections and Drawings.
 2. In the event discrepancies exist between different plans, or between the plans and specifications and the Engineer is not so notified in writing before the date of the bid opening, the Engineer shall reserve the right to exercise sole arbitration authority.
- B. Unless noted otherwise on drawings, this section applies to systems within buildings and up to 30" outside of buildings.
- C. Section includes:
1. Domestic Water Distribution System (PW, HW)
 2. Service Water Distribution System (NPW)
 3. Rainwater Drain System (RWP)
 4. Plumbing Fixtures and Trim
 5. Plumbing Equipment
 6. Area Drain System (D)
 7. Water Heating System

1.02 QUALITY ASSURANCE

- A. References: All equipment and materials specified in this Section shall conform to the following references. In case of discrepancies between the referenced specifications and this section, the more stringent requirement shall prevail.

<u>Reference</u>	<u>Title</u>
ADA	Americans with Disabilities Act
ASME A112.6.1	Supports for Off-the-Floor Plumbing Fixtures.
ASME A112.18.1M	Plumbing Fixture Fittings
ASME A112.19.1M	Enameled Cast Iron Plumbing Fixtures
ASME A112.19.1M	Vitreous China Plumbing Fixtures
ASME A112.19.3M	Stainless Steel Plumbing Fixtures
ASME A112.19.5	Trim for Water-Closet Bowels, Tanks and Urinals
ASME B1.20.7	Hose Coupling Screw Threads
ASTM B251	Wrought Seamless Copper and Copper-Alloy Tube

AWWA C651	Disinfecting Water Mains
AWWA Manual 14	Recommended Practice for Backflow Prevention and Cross-Connection Control
CFR	Energy Conservation Act
IPC	International Plumbing Code

- B. Warranty. As specified in Section 11 00 00.
- C. Submittals: Provide the following information in accordance with Section 01 33 00 for review and approval:
 - 1. Manufacturer's standard published product data including catalog data and brochures specifying the quality standards, materials of fabrication, color/finish where applicable, equipment configuration, and instructions for installation and routine maintenance.
 - 2. Manufacturer's warranty.
 - 3. Electrical data and control and wiring diagrams for electric heaters.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide items of similar equipment and materials from same manufacturer to achieve standardization for appearance, maintenance, and replacement. All plumbing fixtures shall meet the requirements for water conserving fixtures under the 2015 IBC. It is the Contractor's responsibility to ensure fixture fit, finish, and performance.

2.02 ACCESSORIES

A. Traps

- 1. Traps for floor drains to be cast iron.

B. Floor Drains

- 1. Cast iron body and grate, flashing collar, and removable sediment bucket.
- 2. Manufacturers: Zurn Z-554 Model; Josam 32120 Model; J. R. Smith, Figure 2220.

C. Yard Cleanouts

- 1. Cast iron body and frame, square, adjustable, scoriated, nickel-bronze top.
- 2. Manufacturers: J. R. Smith, Figure 4023, Josam, 56010-22 Series.

D. Roof Jacks

- 1. Where piping passes through metal deck roofs or metal roofs, provide frost proof roof jack extending 12 inches up the pipe, and fitted with a double-threaded flashing for pipes 3 inches and smaller.
- 2. Manufacturers: Josam, No. 26400, J. R. Smith, Figure 1720.

E. Water Closet

1. Include water closet, seat, water supply valve, and all other necessary valves and fittings for a fully functional fixture.
 2. Water closet manufacturers: See Plumbing Fixture Schedule on Mechanical Drawing.
 3. Water closet seat manufacturers: See Plumbing Fixture Schedule on Mechanical Drawing.
- F. Restroom Sink
1. White, vitreous china. Chrome plated all brass 1-1/4" trap, supply and waste fitting, vandal-resistant aerator to limit flow to 0.5 gpm and self-closing valves. Include sink, water supply valves, faucet and valves, and all other necessary valves and fittings for a fully functional fixture.
 2. Sink manufacturers: See Plumbing Fixture Schedule on Mechanical Drawing.
 3. Faucet manufacturers: See Plumbing Fixture Schedule on Mechanical Drawing.
- G. Service Sink
1. Service sink shall be as specified in Plumbing Fixture Schedule on Mechanical Drawing.
 2. Faucet: Polished chrome plated cast brass faucet body with integral shanks, quarter turn ceramic disc cartridges and a 12" tubular brass swing spout. Furnished with a 2.2 GPM pressure compensating aerator (complying with ANSI A112.18.1 Standard for flow), 4" vandal-resistant color-coded metal wrist blade handles, mounting hardware and 1/2" NPSM coupling nuts for standard lavatory risers.
 3. Faucet manufacturers: See Plumbing Fixture Schedule, on Mechanical Drawing.
- H. Garbage Disposal
1. Stainless steel grind components with sink baffle, continuous disposer feed, and connection drain.
 2. Manufacturers: IN-SINK-ERATOR Model Essential XTR or engineer approved equivalent.
- I. Electric Water Heater
1. Point of use water heater, 5 gallon per minute capacity with change in temperature of 74°F.
 2. 54 kilowatt, copper/bronze element, 480 volts, 3 phase, maximum 65 Amps at 100% output, resettable thermostat, pressure relief connection. UL listed.
 3. Manufacturers: Hubbell Model TX054-6T4 Tankless or engineer approved equivalent.
- J. Electric Tempered Water Heater
1. Point of use water heater, 23 gallon per minute capacity with change in temperature of 34°F.
 2. 126 kilowatt, copper/bronze element, 480 volts, 3 phase, maximum 152 Amps at 100% output, user adjustable $\pm 3^\circ$ calibration feature, pressure relief connection. UL listed.
 3. Manufacturers: Hubbell Model ETX126-18T4 Tankless or engineer approved equivalent.

2.03 PIPE AND FITTINGS

A. Domestic Water Piping (PW, HW)

1. Above grade:
 - a. 2-1/2" and smaller: Type L hard-drawn copper tube with wrought- copper fittings.; low-liquidus/solidus solder, which does not contain lead or antimony, with a shear strength equal or greater than 10,000 psi. All-State Aquasafe or approved equal
2. Below grade:
 - a. 2-1/2 inches and smaller: Type K hard-drawn copper tube with wrought- copper fittings.
 - b. 3 inches and larger: Refer to Section 33 14 13.

B. Interior Sanitary Sewer (D and VTR)

1. Above grade: Galvanized steel pipe with cast-iron drainage fittings, or service weight cast-iron soil pipe with No-Hub fittings, or DWV copper pipe and fittings. No copper on urinal waste.
2. Below grade: Cast iron soil pipe with either hub-and-spigot (with neoprene compression gaskets and lubricant) or No-Hub joints, or DWV PVC pipe and fittings.
3. No-Hub couplings shall be of super-duty type such as Husky series 4000 or equivalent.

C. Interior Roof Drain and Overflow Drain (RWP) Above Grade

1. 30 foot head or less: Service weight cast iron, no-hub or hub and spigot type; or galvanized steel with galvanized cast iron drainage fittings and threaded joints.
2. Over 30 foot head: Schedule 40 galvanized steel pipe with galvanized cast iron drainage fittings and threaded joints; or schedule 40 grooved galvanized steel pipe joined with rigid couplings and gaskets designed for water service, molded of materials conforming to ASTM D-2000; or ductile iron, thickness 52 or ANSI/AWWA C150/A21.50-81, 350 psi pressure rating. Full lengths of pipe shall be utilized to greatest extent possible.
3. Below Grade: Sizes 2" to 20", service weight cast iron, hub and spigot type or sizes 12" and larger ductile cast iron with neoprene gasket joints.

2.04 MISCELLANEOUS PIPING SPECIALTIES

A. Rubber Water Hose

1. Provide a 50 foot length of 3/4-inch hose for each hose valve. Provide each length with brass male and female NST hose thread couplings to fit hose nozzles and hose valves specified.
2. Manufacturers: B. F. Goodrich, Boston Industrial Hose.

B. Hose Nozzles

1. Provide, for each hose valve, a 3/4-inch cast brass, adjustable, fog-straight stream type, and with female NST hose thread.
2. Manufacturers: Akron Brass, Style 1301; Potter Roemer, Figure 2971.

C. Pressure Gages: Refer to Section 33 14 14.

2.05 PIPE INSULATION

A. Insulation: Fibrous glass.

1. Applied to: Hot water and rain water piping.
2. Insulation: Rigid molded fiber glass pipe covering having a density of 4 lbs/cu. ft., in compliance with ASTM C 547, having a k-factor of approximately 0.24 @ 75°F (0.35 @ 24°C), and suitable for temperatures from -40°F to 450°F (-40 °C to 232°C). Minimum insulation thickness on the GAL2 piping insulation is 1 inch. Alternatively, submit calculations showing a reduced thickness is sufficient to meet the requirements of the specification.
3. Valve, Fitting and Flange Covers: Pre-molded PVC covers with fiber glass insert.
4. Jacket: Factory applied vapor barrier all-service type with adhesive held lap seams (field applied adhesive or self-sealing lap) and adhesive held lap seam butt strips.

B. Thickness

Item	Pipe Diameter	Insulation Thickness
All others	Up to 2 inches	1/2 inch
All others	2 - 6 inches	1 inch
All others	6 inches	1-1/2 inch

2.06 TEMPERING VALVES

A. Master tempering valve for hot water distribution

1. ASSE 1017 compliant down to 1 gpm minimum.
2. Positive shut off
3. Integral union check stops
4. Lead free
5. Corrosion resistant, bronze finish
6. Leonard Water Temperature Controls model TM-1520B-LF-DT or Engineer Approved Equal.

B. Tempering valve for lavatories

1. ASSE 1070 compliant, 4 gpm at 45 psi, to 0.5 gpm
2. Lead free
3. Tamper resistant cover, brass construction, integral checks with screens.
4. Powers LFe480 or Engineer Approved Equal

C. Tempering valve for eye washes

1. ASSE 1071 compliant, 1 gpm to 8.7 gpm at 30 psi.
2. Internal cold water bypass on loss of hot water.
3. Integral check stops, bronze construction, vandal resistant.

- 4. Haws Model 9201E or Engineer Approved Equal
- D. Tempering valve (Thermostatic Mixing Valve, TMV) in the Admin Building, refer to Plumbing Fixture Schedule on Drawing U-2.
- 2.07 SHOCK ABSORBERS
 - A. Stainless steel construction, shock absorbing air cushion. Comply with PDI standards.
 - B. Zurn Shoktrol or Engineer Approved Equal
- 2.08 ADA COMPLIANT UNDER LAVATORY PLUMBING COVERS
 - A. Molded PVC covers containing anti-microbial/anti-fungal and UV inhibitors with self-extinguishing flammability characteristics. Fastening system shall consist of tamper resistant, smooth non-abrasive snap locks.
 - B. P-Trap cover shall be one-piece cover designed with full rotation option, cover must have weep holes at lowest point for drainage and ventilation.
 - C. Valve and supply covers shall be one piece covers. Valve covers shall have removable cap for access to water shut-off, cap shall be able to be reassembled and secured. Cover must have weep holes at lowest point for drainage and ventilation.
 - D. Wheelchair offset strainer cover shall be one-piece cover designed with full rotation option and Velcro fasteners.
 - E. Acceptable products: Plumberex Specialty Products Inc. "Pro-Extreme" ADA compliant under-lav covers or engineer approved equal.

PART 3 EXECUTION

3.01 GENERAL

- A. All plumbing piping and fixtures shall be installed under the direct, on-site supervision of a journeyman plumber licensed by the State of Colorado. The ratio of plumbing apprentice- helpers shall not exceed two apprentice-helpers for each journeyman.
- B. Surround all underground plumbing with a minimum of 6" of "squeegee".

3.02 DOMESTIC WATER PIPING INSTALLATION

- A. Provide drip cocks so that the entire system can be drained. Provide manual air vents at high points in the system where air can be trapped.
- B. Provide fixture stops at all fixtures, hose bibbs, and equipment.
- C. Run all piping on warm side of building insulation. Pipe insulation is not considered freeze protection.
- D. Ream out all pipes when cuts are made.

- E. Provide water hammer arresters where required. Locate to be accessible or provide access panels.
- F. Provide vacuum breakers at all fixtures where hose connections can be made.
- G. Provide ball valves and unions on all lines to equipment for isolation and removal.
- H. Provide ball valves for isolation of branch lines. Provide ball valves in all domestic hot water and cold water supplies to plumbing fixture groups, for example, toilet room, break room, labs, and similar locations.
- I. Provide pipe hangers of the same material as the piping system or use coated hangers.
- J. Make solder joints between HW/IW copper tubing and fittings using low-liquidus/solidus solder which does not contain lead or antimony. All-state Aquasafe or approved equal.
- K. Joints between copper tubing and fittings for below-grade locations shall be silver brazed. Minimize the number of below-grade connections.
- L. Provide identification per Section 09 90 00.

3.03 SANITARY SEWER INSTALLATION

- A. Lay piping true to line and grade so that sewer will have smooth and uniform invert through- out its length. Grade piping by measuring with rod from overhead grade line set horizontal and held taut between grade bars to prevent sagging. Verify elevations of existing sewer before starting work.
- B. Collect all soil and waste piping, make connections to all fixtures, floor drains and equipment requiring waste service, extend piping as indicated on the drawings. Trap each fixture separately with an approved trap placed as near the fixture as possible, except fixtures which are indicated to have indirect connections.
- C. Make solder joints between copper tubing and fittings for soil, waste, and vent piping in above grade locations using 95 percent tin and 5 percent antimony solder.
- D. Provide floor clamps at each floor for uniform support of stacks.

3.04 FLOOR DRAIN INSTALLATION

- A. Set floor drains so that top will be slightly lower than surrounding floor.
- B. Flash all drains located in slabs above ground with 4 pounds per square foot sheet lead or chlorinated polyethylene (CPE) membrane manufactured by the Noble Company or approved equivalent. Extend flashing 24 inches on all sides.
- C. Provide deep-seal trap and trap primer port as specified on Drawings.

3.05 CLEANOUT INSTALLATION

- A. Provide cleanouts for sanitary and storm sewer systems. Cleanouts shall be full size except that maximum size shall be 4 inches.
- B. Install cleanouts at base of all vertical stacks, at ends of sewer mains, and at changes in direction of sewer mains. Install cleanouts in horizontal piping for interior sewers at a maximum spacing of

40 feet for piping 3 inches or smaller and 100 feet for piping 4 inches or larger; and of a maximum spacing of 100 feet for exterior sewers.

- C. Install cleanouts so that they are accessible by extending them through walls or floors.
- D. Lubricate cleanout plugs with non-hardening thread lubricant.
- E. Locate cleanouts to assure minimum disturbance to occupants and building operations. Do not install cleanouts in ceiling spaces or above 6 feet above finished floor.
- F. Coordinate locations at finished walls and floors with general contractor.
- G. For exterior cleanouts, extend cast-iron inspection pipe from sewer to cleanout at grade. Encase cleanout in 24-inch by 24-inch by 8-inch concrete block, finish flush with grade.

3.06 PLUMBING FIXTURE INSTALLATION

- A. Set water closets and other gasketed fixtures against brass or cast-iron closet flanges and provide joints between fixtures and flanges with neoprene gaskets.
- B. Assemble lavatory and sink wastes and traps with slip joints with lock nuts and rubber gaskets or with threaded joints on fixture side of trap. Do not use slip joints on sewer side of traps. Make sewer side connections with screwed trap nipples, compression fittings or solder joints.
- C. Provide a vacuum breaker at each hot and cold water service outlet to which a hose can be attached including janitor's faucets.
- D. Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers, and escutcheons.
- E. Provide approved wall carriers appropriate for the installation for wall mounted lavatories, urinals, and water closets. Coordinate depth of carriers with wall thickness.
- F. Provide in-wall bracing and blocking to securely anchor and support wall mounted fixture and flush valves.
- G. Set all fixtures level.
- H. Provide chrome plated anchor bolts and washers for all lavatories and china bolt caps for all floor mounted water closets.
- I. Remove labels, clean fixtures, and leave installation ready for use.
- J. Seal joints between fixtures and mounting surfaces with silicone sealant
- K. Mounting Heights
 - 1. Water closet:
 - a. Standard: 15 inches to top of bowl rim
 - b. Handicapped: 18 inches to top of seat
 - 2. Lavatory:
 - a. Standard: 34 inches to top of basin rim

3. Minimum fixture branch sizes shall be as follows:

Fixture	HW	CW	WASTE Inches	VENT
Lavatories (one waste FU)	1/2	1/2	1-1/4	1-1/4
Utility sink	1/2	1/2	2	1-1/2
Water closet (flush valve)	-	1	3	1-1/2
Floor drains	-	-	*	*
Hose bibbs	-	3/4	-	-

3.07 SHOCK ABSORBER INSTALLATION

- A. Provide shock arresters at all solenoid valves, quick-closing valves, and at each plumbing fixtures or battery of plumbing fixtures on cold water supply branches. Size and locations shall be in accordance with PDI (Plumbing and Drainage Institute) recommendations.
- B. Mount shock arresters as close to the line or quick-closing valve as possible. Remote mounting or nipple mounting in excess of 6 inches is not acceptable.
- C. Install shock arresters with full size ball valve and union from pipe to shock arrester.
- D. Install 12-inch by 12-inch minimum access panels centered on each shock arrester that is otherwise inaccessible.

3.08 REDUCED PRESSURE BACKFLOW PREVENTER INSTALLATION

- A. Locate valve where it will be visible and accessible for maintenance and at such location that dripping or discharge of water from relief vent will not create a nuisance or damage to finished surfaces. Maximum mounting height is 3'-0" above finished floor.
- B. Provide shutoff valve and strainer upstream of backflow preventer.
- C. Securely anchor backflow preventer.
- D. Provide funnel receptor for discharge and securely anchor near drain receptor.

3.09 FLASHING

- A. Flash vents passing through roof with 4 pounds per square foot sheet lead, or with material approved by roofing contractor, extending 12 inches on all sides, carried up around vent pipe over top and turned down in.

3.10 STERILIZATION

- A. Prior to placing the potable water system in operation but after all testing has been completed, the entire potable water system shall be filled with a solution containing not less than 50 PPM of available chlorine and allowed to stand 24 hours before flushing. During this period, a pressure of not less than 40 PSI shall be maintained on the system and all valves and faucets shall be opened and closed several times to assure chlorine reaches all parts of the system. The residual chlorine content shall not be less than 10 PPM after 24 hours.
- B. Following sterilization, thoroughly flush the system until the chlorine residual drops below 3 PPM.

- C. Have sample checked by local health department or testing agency. Include report in O & M manual.

3.11 ROOF DRAIN INSTALLATION

- A. Consult with the roofing applicator and set roof drains at the exact elevation required for proper drainage.
- B. Provide proper flashing clamps compatible with roofing system used.
- C. Use underdeck clamps.
- D. Insulate roof drain piping per related paragraphs contained herein.

3.12 WATER HEATER INSTALLATION

- A. Provide isolation valves and dielectric unions on both hot water and cold water lines.
- B. Pipe relief valve discharge to within four inches of the floor. Anchor end of pipe to adjacent surface.

3.13 PIPE TESTING

- A. Refer to Section 33 14 13.

3.14 FIELD TESTS

- A. Inspect and test installed fixtures and equipment for proper connections and operation.

3.15 ADJUSTING/CLEANING

- A. Clean drains. Replace fixtures and/or accessories damaged during shipment or construction. Test accessories for proper operation.

3.16 PIPE INSULATION

- A. Stagger longitudinal joints.
- B. Tightly butt the sections and seal longitudinal seams of vapor barrier jacket with vapor barrier lap adhesive in addition to the self-sealing feature.
- C. Seal circumferential end joints with butt strips of vapor barrier material and vapor barrier lap adhesive.
- D. Staples shall not be used.
- E. Seal pipe ends, valves, and fittings with vapor barrier coating.
- F. Jacket shall be free of pinholes or openings.
- G. Cover valves, fittings, flanges and specialties with pre-molded glass fiber covering having same thickness as adjacent insulation, or use job fabricated or precut insulation. Vapor barrier must be continuous throughout installation.

1. On pipe sizes 65 mm (2-2 inches) and under, apply insulating cement in successive layers not exceeding 20 mm (3/4 inch) thickness per layer to a thickness equal to insulation on adjacent pipe. Finish with canvas or glass cloth covered with a seal coat of lagging adhesive. Apply coat of vapor barrier coating.
2. On pipe sizes 80 mm (3 inches) and over, apply mitered fiberglass insulation to a thickness equal to insulation on adjacent pipe.
3. Fasten with wire mesh or galvanized wire. Point with insulating cement. Finish with 6 mm (1/4 inch) of finishing cement and canvas or glass cloth covered with a seal coat of lagging adhesive. Apply coat of vapor barrier coating.
4. Cover valves, fittings, flanges, and specialties at equipment, where insulation may be removed for maintenance, with flexible elastomeric insulation as specified.
5. Finish with PVC cover. Seal cover joints with vapor barrier coating or vapor barrier adhesive tape.
6. Where anchors are secured to piping to be insulated, the anchor shall be insulated same as piping for a distance not less than four times the insulation thickness, to prevent condensation. Insulation shall be vapor sealed as specified for fittings.

END OF SECTION

SECTION 23 00 00

BASIC HVAC REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.

1.02 SUMMARY

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements.
- B. Section includes General Provisions applicable to Division 23 HVAC.
 - 1. Provide all labor, equipment, and material necessary to complete the work as specified and as shown on the drawings.
 - 2. Provide supervision, coordination, tools, and accessories and appurtenances necessary or required to perform and accomplish the work.

1.03 SUBMITTALS

- A. Submit shop drawings, product data, and samples in accordance with Division 1 Sections.

1.04 QUALITY ASSURANCE

- A. Chemical and physical properties, design, and performance characteristics of all material and equipment, and methods of construction shall be in accordance with the following applicable codes, regulations, and standards. Current editions in effect 30 days prior to receipt of bids will apply.
 - 1. Air Conditioning, Heating, and Refrigeration Institute (AHRI)
 - 2. Air Movement and Control Association, Inc. (AMCA)
 - 3. American National Standards Institute (ANSI)
 - 4. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - 5. American Society of Mechanical Engineers (ASME)
 - 6. American Standard Code for Pressure Piping (ASCPP)
 - 7. American Society for Testing and Materials (ASTM)
 - 8. American Water Works Association (AWWA)
 - 9. Environmental Protection Agency (EPA)
 - 10. Factory Mutual Laboratories (FM)
 - 11. Manufacturer's Standards Institute (MSI)
 - 12. National Certified Pipe Welding Bureau (NCPWB)
 - 13. National Electrical Code (NEC)
 - 14. National Electrical Manufacturer's Association (NEMA)

15. National Fire Protection Association (NFPA)
 16. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 17. State of Colorado Energy Conservation Standards
 18. Underwriters' Laboratories, Inc. (UL)
 19. 2015 International Building Code (IBC)
 20. 2015 International Mechanical Code (IMC)
- B. Comply with applicable state, and federal codes, rules, and regulations. As a minimum requirement, codes, rules and regulations take precedence over the drawings and specifications. Where the requirements of the drawings and specifications exceed those of applicable codes, rules and regulations, the drawings and specifications shall govern.
- 1.05 PRODUCTS
- A. Material and equipment shall be new and free from defects.
- B. Install all material and equipment in accordance with the manufacturer's current published recommendations.
- C. Certain materials and equipment are specified by manufacturer and model or catalog number. Such specified items are the basis of design and establish a degree of quality, performance, and physical configuration. The Contractor shall be responsible for the quality, performance, and physical configuration of the work should he use products of a listed acceptable manufacturer in lieu of the specific product upon which the design is based.
- 1.06 DELIVERY AND STORAGE OF EQUIPMENT AND MATERIAL
- A. Make provisions for delivery and safe storage of equipment and materials.
- B. Make arrangements for the introduction into the building of equipment too large to pass through finished openings and spaces.
- 1.07 PROTECTION
- A. Protect all equipment, material, and completed work from damage. Repair or replace damaged items as necessary to establish conformance with requirements of the drawings and specifications.
- B. Protect equipment, material, and completed work until acceptance by Owner.
- C. Close open ends of work, and stored equipment and materials with temporary covers or plugs to prevent entry of foreign objects, dirt, water, or debris.
- 1.08 WARRANTIES
- A. Unless otherwise stated, all materials, equipment, and work described in Division 23 Specifications and HVAC construction documents shall be warranted for a minimum period of two years.
- B. Warranty period shall begin at time of start-up of equipment, or at the time of Owner acceptance for installation.

- C. Warranty of equipment shall be standard manufacturer's limited guarantee of quality and operation based on proper installation and normal use. Warranty of work shall include installation as described in construction documents, standard industry practices, and requirements described by manufacturers.
- D. Guarantee all equipment, materials, workmanship, and proper operation of equipment and apparatus for a period of one year from date of final acceptance.
- E. Repair or replace at no cost to Owner work which is judged defective by the Engineer or Owner during the guarantee period.

1.09 SUBSTITUTIONS

- A. Equipment and materials manufactured by any one of the manufacturers listed on the drawings or in the specifications will be acceptable, provided they meet the specified requirements and, where shown, physical configurations, sizes, etc. on the drawings.
- B. Where no manufacturer is listed, provide a standard product meeting the requirements of the drawings and specifications, and manufactured by a firm regularly engaged in the manufacture of such products.
- C. Requests prior to bid for approval of equipment or material not specified will be considered for this project. Request must be received seven days prior to bid date.

1.10 DEFINITIONS

- A. Provide: Furnish and install complete and ready for use.
- B. Contractor: Any Contractor performing work under Division 23 of the specifications.
- C. Shall, secure or other performance terms: Work shall be performed by the HVAC Contractor.

1.11 DRAWINGS AND SPECIFICATIONS

- A. HVAC drawings are diagrammatic in character and do not indicate every required offset, valve, fitting, accessory, or appurtenance.
- B. Review and consider all drawings and specifications relating to this project in preparation of bid.
- C. Drawings and specifications are complementary. Whatever is required by either the drawings or specifications shall be provided.
- D. Refer discrepancies between and within the drawings and specifications to the Engineer for resolution. In general, the more stringent requirements will take precedence.
- E. Do not scale drawings.

1.12 WORKMANSHIP

- A. Workmanship shall conform to the highest industry standard for each specific type of work.
- B. Perform work in accordance with standard commercial practices.

1.13 EXAMINATION OF SITE

- A. Visit site and ascertain existing conditions prior to submitting bid. Include in bid all considerations necessary to accomplish the work under the existing conditions.
- B. Additional charges will not be authorized due to the Contractor's failure to become familiar with the existing conditions.

1.14 PERMITS AND INSPECTIONS

- A. Secure and pay for all required permits and licenses.
- B. Pay all applicable royalties, inspection fees, and taxes.
- C. File necessary plans, prepare necessary documents, and obtain necessary approvals from the Authorities Having Jurisdiction.
- D. Upon completion of the work, furnish to Owner and Engineer a certificate of inspection and final approval from each authority having jurisdiction for inspection and approval of the work.

1.15 RESPONSIBILITY OF CONTRACTOR

- A. The Contractor is responsible for the complete installation and satisfactory operation of all work in accordance with requirements of the drawings and specifications.
- B. Include in bid all incidental, accessory, and appurtenant items required or necessary, even though not specified or indicated, to provide complete operating systems.
- C. The component parts of the installation shall function together as workable systems. Each system shall be left with all parts adjusted and in proper working order.

1.16 DELEGATED-DESIGN

- A. Engage a qualified professional engineer, to design duct hangers and duct supports for above-grade, exterior ducts (rooftop ductwork).
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- C. Delegated-Design Submittal: For above-grade exterior ductwork, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
 - 5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

- D. Structural Performance of Above-Grade, Exterior Ductwork: Ductwork, duct hangers, and duct supports shall withstand the effects of loads and stresses under conditions indicated.
 - 1. Wind Load: 120-mph, 3-second gust, exposure C.
- E. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
 - 1. Main wind-force-resisting exterior ductwork, duct hangers, and duct supports.

1.17 OPERATION AND MAINTENANCE MANUAL

- A. Furnish operation and maintenance manuals for equipment and systems installed under Division 23 of the specifications, in accordance with Division 1 within 90 days of system acceptance.

1.18 COORDINATION

- A. Coordinate project in accordance with Division 1 and the following:
- B. Examine each drawing and specification section. Report in writing to the Engineer all discrepancies within and between the documents. Additional cost made necessary by the Contractor's neglect or failure to report discrepancies shall be borne by the Contractor.
- C. Coordinate the work of each Division 23 Section with all other specification sections. Schedule work to ensure that the various parts fit together in an orderly sequence.
- D. Cooperate with each trade and assist in working out space allocations and minor construction details.
 - 1. When necessary to ensure efficient use of space and orderly construction sequences, prepare composite coordination drawings. Prepare drawings at a scale of 1/4-inch equals 1 foot 0 inches or larger. Submit drawings to Engineer for review.
 - 2. If Contractor installs work before coordinating with other trades and the work interferes with the work of other trades, the Contractor shall make necessary changes in his work to correct the condition. Additional charges will not be authorized because of the Contractor's failure to coordinate the work.
- E. Electrical components relating to HVAC work shall comply with Division 26.
- F. Coordinate equipment, HVAC and electrical work in accordance with the following schedule.

- I = Installer of equipment requiring electrical service
- H = HVAC Installer (Division 23).
- E = Electrical Installer (Division 26).
- C = Controls Installer (Division 23, Section 23 09 00). The portion of this task that involves connection of the item to the Controls Installer system shall be the responsibility of the Controls Installer.
- O = Owner

Item	Furnished By	Set in Place or Mounted By	Power Wired & Connected By	Control Wired and Connected By
HVAC Equipment Motors	H	H	E	-
Magnetic Motor Starters:				
Automatically controlled, with or without HOA switches	H	E	E	C
Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	H	H	E	C
Disconnect switches - when furnished as factory mounted equipment	H	H	E	M,C
Disconnect switches - field supplied and mounted	E	E	E	C
Control panels specified in Section 23 09 00	C	C	E	C
Control Power Transformers	C	C	-	-
Line Voltage Side	-	-	E	-
Low Voltage Side	-	-	C	-
Line voltage or low voltage control devices such as thermostats, freezestats, humidistats, actuators, relays, etc.	C	C	C	C
Factory installed/wired controls specified in Divisions 23	H	H	E	H,C
Duct mounted control devices such as temperature sensors and switches	C	C	-	C
Control Dampers	C	H	E	C

1.19 SCAFFOLDING, RIGGING, AND HOISTING

- A. Provide all scaffolding, rigging, and hoisting necessary to accomplish the work.
 - 1. Remove from premises when no longer needed.
- B. Provide necessary services to deliver, erect, place, and install all equipment and apparatus furnished.

1.20 DAMAGED SURFACES

- A. At completion of the work, all HVAC material and equipment furnished shall be inspected for damage.
 - 1. Repair damaged factory finishes to match adjacent, undamaged areas.
 - 2. Replace deformed metal cabinets, jackets, and enclosures with new items. Finish shall match similar undamaged items.

1.21 CLEAN UP

A. At completion of the work, check and thoroughly clean all equipment.

1. Clean coils and plenums.
2. Clean under, in, and around equipment.
3. Clean exposed surfaces of piping, ducts, and hangers.
4. Clean equipment cabinets and enclosures.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.

1.02 SECTION INCLUDES

- A. Basic materials and methods applicable to each Division 23 Section.

1.03 CONTENT SUMMARY

- A. Escutcheon Plates
- B. Hangers and Supports
- C. Sleeves and Inserts
- D. Supporting Steel
- E. Motors
- F. Starters

1.04 SUBMITTALS

- A. Comply with Division 01 sections.

PART 2 PRODUCTS

2.01 HANGERS AND SUPPORTS

- A. Hangers shall be of the same material as the mechanical system being supported.
- B. Thermal hanger inserts: High density, 100 psi, waterproofed calcium silicate encased in a 360-degree sheet metal shield with vapor barrier jacket. Calcium silicate shall be color coded indicating non-asbestos bearing composition.
- C. Thermal hanger shields: aluminum.
- D. Acceptable Manufacturers
 - 1. Hangers and supports
 - 2. B-line
 - 3. Michigan
 - 4. Fee and Mason

5. Grinnell
6. P.H.D.
7. Tolco
8. Unistrut
9. Mason Industries, Inc.
10. Thermal hanger shields
 - a. Pipe Shields, Inc.
 - b. Insulshield
 - c. Uni-Grip
 - d. Value Engineered Products, Inc.

2.02 MOTORS

- A. Motors shall be premium efficiency type.
- B. NEMA rated with tolerances for allowable electrical system voltage fluctuations.
- C. Electrical characteristics shall be as indicated for specific motors. Where characteristics are not indicated, provide motors with characteristics as follows:
 1. 1/2 horsepower and smaller: Single-phase
 2. 3/4 horsepower and larger: Three-phase
 3. Voltage rating:
 - a. Single-phase, 120/208V service: 115 volts
 - b. Three-phase, 120/208V service: 200 volts
 - c. Three-phase, 277/480V service: 460 volts
 4. Frequency rating: 60 hertz
- D. Bearings
 1. Ball or roller bearings with inner and outer shaft seals.
 2. Regreasable except permanently sealed where motor is normally inaccessible for regular maintenance.
 3. Sleeve type acceptable for fractional horsepower, light duty motorized equipment.
- E. Three-Phase Motors
 1. Squirrel cage type suitable for continuous and intermittent operation, Class B insulation, maximum of 40 degrees Centigrade temperature rise at full-load continuous operation.
 2. Corrosion-resistant cast iron yoke with integrally cast supporting feet, cast iron bearing housing with rabbeted fit to ensure proper alignment of rotating and electrical components, double-shielded ball type grease lubricated bearings with accessible grease inlet and outlet plugs in housing, inner bearing caps on both ends, die cast aluminum cage type rotor with integrally cast fan.
 3. Marked conduit, stainless steel nameplate.

- F. Power factor: 85 percent or higher for motors rated at more than 1,000 watts. Correct power factor with capacitors to at least 85 percent under load conditions.
 - 1. Power factor correction capacitors: UL listed non PCB, internally fused, three-phase, 60 hertz. Size based on manufacturer's recommendation for motor served.
- G. Overload Protection
 - 1. Built-in thermal overload protection for each leg of each phase.
 - 2. Internal sensing device suitable for signaling and stopping the motor at the starter.
- H. Acoustical
 - 1. Motors shall not exceed 80 db rating when running at their full speed and power range.
- I. Acceptable Manufacturers
 - 1. General Electric
 - 2. Gould
 - 3. Lincoln
 - 4. Louis Allis
 - 5. Reliance
 - 6. Westinghouse

2.03 STARTERS

- A. Manual Starters
 - 1. Fractional horsepower: 115 - 230 volts, single-phase, 2-pole, toggle type operator. Class-20 overload protection provided by trip-free melting alloy, manual reset. Only NEMA rated allowed.
 - 2. Integral horsepower: 600 volts, three-phase, maintained contact push-button operator. Class-20 or Class-10 overload protection provided by melting alloy or adjustable bimetallic overload relay, trip free, manual reset.
- B. Magnetic Starters:
 - 1. 600 volts, three-phase, transformer type pilot light in enclosure cover. Cadmium silver oxide, double break, weld resistant, replaceable power contacts. Molded type, 120 volt, 60 hertz, replaceable coil. Standard capacity, open type control transformer fused from line side where service exceeds 240 volt, with 120 volt fused secondary. Factory installed normally open, auxiliary holding contact. Provisions for installing additional auxiliary contacts without removing or disassembling starter. Factory connect contactor to overload relay and overload delay trip contact to coil. Only NEMA rated allowed.
 - a. Overload relay: Adjustable, direct heated, bimetallic type providing Class-10 protection on all three phases. Trip free operation, manual and automatic reset.
 - b. Under voltage protection.
 - c. Phase failure/phase reversal protection.
 - d. Hand-off-auto switch on cover for automatic control.

- e. Maintained contact push buttons for manual control.
 - 2. Required for motors 1/2 horsepower and larger and for smaller motors where interlock or automatic operation is required.
- C. Combination Starters
- 1. Magnetic starter as specified in B above combined with and factory wired to either a non-fused disconnected switch, a fused disconnect switch, or a molded case circuit breaker as indicated. Lock out provisions for switch or circuit breaker operator, defeatable interlock to prevent opening of enclosure when switch or circuit breaker is in the on position. Common enclosure for combination assembly. Only NEMA rated allowed.
 - a. Disconnect switch: In accordance with Division 26.
 - b. Circuit breaker: Molded case, 3 pole, with adjustable instantaneous magnetic trip. Interrupting rating shall be as required by electrical drawings and Division 26. Trip range shall allow proper motor starting and ampere rating shall provide proper short-circuit protection. Select unit based on manufacturer's recommendations for the motor application.
- D. Provide phase monitor and control relay integral with starter or as a separate unit for three-phase motors rated 1 horsepower and larger.
- 1. UL listed unit providing low voltage, phase loss, and phase reversal protection. Two to five second trip-time delay, factory set to 90 percent of rated line voltage. Provide one normally open and one normally closed, 10 amp, 240 volt auxiliary contact.
 - 2. Provide momentary-contact test button.
 - 3. Amprobe motor guard MG-1 or approved equivalent.
- E. Provide time delay relays to sequentially start motors in groups of 50 horsepower or less.
- F. Provide NEMA 1 enclosures with padlock ears for indoor general purpose use. Provide NEMA 3R enclosures for outdoor use and where specifically called for. Provide special purpose enclosures where indicated on drawings.
- G. Acceptable Manufacturers
- 1. Allen Bradley
 - 2. General Electric
 - 3. Westinghouse
 - 4. Square D
 - 5. S & S
 - 6. Cutler Hammer
- 2.04 ESCUTCHEON PLATES
- A. Split hinged type, chrome plated brass or stainless steel.

PART 3 EXECUTION

3.01 ACCESSIBILITY

- A. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include, but not be limited to, valves, traps, cleanouts, motors, controllers, and drain points. Minor deviations from drawings may be made to allow for better accessibility.
- B. Where required to assure accessibility, provide access doors. Minimum size is 20" x 20". Size to assure adequate access to service equipment.

3.02 CUTTING AND PATCHING

- A. Be responsible for the costs of cutting and patching for work under Division 23 caused by improper coordination or notification. Comply with the requirements of Division 1 Sections.
- B. Cutting: Coordinate and supervise cutting required. Notify Architect before any cutting, channeling, chasing or drilling. Use rotary type drill or other method as approved by the Architect. Holes cut with pneumatic hammer will not be accepted. Cutting of steel, wood or other main structural parts must be approved by architect prior to commencing cutting.
- C. Patching: Seal openings and repair and refinish any damage to building elements using skilled mechanics of trades involved in manner acceptable to Architect.

3.03 SUPPORTING STEEL

- A. Provide structural steel supports for HVAC equipment.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.

1.02 SUMMARY

- A. Section Includes: Identification of HVAC products installed under Division 23.

1.03 REFERENCES

- A. American National Standards Institute (ANSI).
 - 1. ANSI A13.1 "Scheme for the Identification of Piping Systems"
 - 2. ANSI Z53.1 "Safety Color Code for Marking Physical Hazards"
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

PART 2 PRODUCTS

2.01 IDENTIFICATION MATERIALS FOR EQUIPMENT

- A. Engraved Nameplates
 - 1. Laminated three-layer plastic with engraved black letters on light contrasting background color.
- B. Paint Stencils
 - 1. Of size and color per ANSI/ASME A13.1 using clean cut letters and oil base semigloss enamel paint.
 - 2. Paint material shall be manufactured by one of the following and be the best quality grade regularly manufactured for the application.
 - a. Benjamin Moore
 - b. Devoe
 - c. Glidden
 - d. Sherwin-Williams
 - e. Uni-Pro
 - f. Approved substitutions

3. Size of Legend and Letters for Stencils:

<u>Insulation or Pipe Diameter</u>	<u>Length of Color Field</u>	<u>Size of Letters</u>
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
Ductwork & Equipment	N/A	2-1/2"

- C. Pressure Sensitive Markers: Brady Type flexible vinyl film identification markers and tape, with legend, size and color coding per ANSI A13.1.

PART 3 EXECUTION

3.01 IDENTIFICATION OF PIPING AND EQUIPMENT

A. General

1. Provide identification for all HVAC equipment including controls of the various HVAC systems.
2. Use unit identifications as shown in the contract documents.

B. Methods for Identification as follows:

1. Engraved Nameplates:

- a. Attach nameplates with brass screws.
- b. Pressure-sensitive embossed labels are not acceptable.
- c. Nameplates shall bear the same identifying legend used on the Contract Documents.

2. Painted Stencils:

- a. Pipes and equipment to be stenciled shall first be wiped clean of dirt, dust, rust, grease and moisture.
- b. Prepare surfaces in accordance with paint manufacturer's instructions.
- c. Pipes and equipment shall be painted with required color code to a smooth hard surface in the area the stencil is to be applied.
- d. Stenciled markings shall be neatly performed with no overspray, drips, or other imperfections.
- e. Legend Letters and Color field size as specified for Paint Stencils in Part 2 of this Section.
- f. Paint application shall comply with paint manufacturer's instructions.

3. Pressure Sensitive Markers: Apply pressure sensitive markers in accordance with manufacturer's recommendations with complete wrap around. Marker adhesion will be tested for permanence. Any markers showing dog ears, bubbles, or other failings shall be replaced.

C. Label Colors and Legend

Classification	Color of Field	Letters	Legend
HVAC Equipment	White	Black	Per Dwgs

D. Controls

1. Magnetic starters and relays shall have nameplates or be stenciled to identify connecting or controlled equipment.
2. Automatic controls, control panels, and starters shall be clearly identified.
3. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches.

E. HVAC Equipment

1. HVAC Equipment shall have nameplates or be stenciled as to plan code number.

END OF SECTION

SECTION 23 05 93

HVAC TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.

1.02 SECTION INCLUDES

- A. Testing and balancing of environmental systems.
 - 1. Air distribution systems
 - 2. Equipment and apparatus connected to distribution systems

1.03 QUALITY ASSURANCE

- A. Qualifications of Contractor
 - 1. Independent testing and balancing firm specializing in testing and balancing of environmental systems with NEBB (National Environmental Balancing Bureau) certification.
 - 2. The firm shall have a Registered Professional Engineer or NEBB certified supervisor in charge of the work, must have a local office with resident personnel within 100 miles of the project, have an experience record of not less than five years in the mechanical contracting industry, and shall have been engaged in the TAB industry for a minimum of five years.
 - 3. All work must be done under the direct supervision of and the results attested to by the Registered Professional Engineer or NEBB certified supervisor. The Balancing Engineer shall be available to interpret all material found in the balance reports and shall represent the TAB firm at meetings.

1.04 STANDARDS

- A. Comply with the applicable procedures of the following:
 - 1. ASHRAE Systems Handbook, chapter on Testing, Adjusting, and Balancing.
 - 2. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.
 - 3. Accuracy of measurements shall be in accordance with the applicable measurement means as listed in the chapter on Measurement and Instruments in the ASHRAE Fundamentals Handbook.

1.05 PERFORMANCE REQUIREMENTS

- A. Allowable Tolerances

1. Tolerances of adjustment for air-handling systems: Plus or minus 5 percent for supply systems and plus or minus 10 percent for return and exhaust systems from information indicated on drawings.

1.06 STATUS OF SYSTEMS PRIOR TO BALANCING

- A. Air and water testing and balancing shall not begin until the systems have been completed and are in full working order.
- B. Outside temperature conditions shall be within a reasonable range of the design conditions.
- C. Put all heating, ventilating, and air conditioning systems and equipment into full operation and continue operation of the systems during each working day of testing and balancing. Preliminary testing, adjusting, and balancing requirements shall be ascertained prior to the commencement of work through a review of available plans and specifications for the project. In addition, observations at the site during construction shall be made to determine the location of required balancing devices and to determine that the devices are being installed properly for the need.
- D. The TAB contractor shall furnish all necessary tools, scaffolding, and ladders that are required and shall provide all required instruments, take all readings, and make all necessary adjustments.

1.07 COORDINATION

- A. The TAB contractor shall coordinate with work of other sections to make sure all items such as thermometer wells, pressure test cocks, and access doors are furnished and installed as required to allow tests and adjustments to be made as described in this section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEMPERATURE CONTROLS

- A. Inspect all temperature control systems for proper sequence of operation and approximate calibration. Report any deficiencies to the responsible contractor immediately.
- B. Check the physical operation of each operating piece of equipment.

3.02 ADJUSTING AND BALANCING

- A. Adjust and balance air systems. Check, adjust, and balance all systems to meet the design conditions and tabulate all information on acceptable forms. All systems shall be checked for proper performance during both heating and cooling. Provide coordination with controls installer to set all water and airflows, including outside air. Balancing and adjusting shall include the following:
 1. Air supply, return, and relief systems with air quantities for each air device; exhaust systems; air-handling units including supply, return, mixed, and outside temperatures and fan data including cfm, static pressure, fan rpm, motor running and full load amperage before and after final balance. Design cfm is based on filters being approximately 50 percent loaded with dirt. Pressure drop across filters during balancing shall be simulated to that condition. After balancing is completed, check motor amperage with the filters clean. Check and adjust outside and return air intakes so that the system will deliver

scheduled airflow quantities. Diffusion patterns shall be set to minimize objectionable drafts and noise, and assure coverage of space.

2. Sheaves shall be changed to fixed pitch and belts shall be changed as required to adjust the rpm of all fans so they handle specified air quantities. Sheaves and belts shall be provided by TAB contractor.
3. The pitot tube traverse method for determining cfm shall be used and recorded on all fans and reconciled with the inlet/outlet measurements.
4. Counterbalanced control dampers shall be adjusted to open as required to maintain control sequence as described on drawings.
5. Final air handling adjustments shall include the following:
 - a. Adjust rpm on belt drive fans. Include sheave and belt exchange to deliver airflow within limits of installed motor horsepower and mechanical stress limits of the fan. Determine the limiting fan tip speed before increasing rpm. Final fan speed setting shall allow for predicted filter loading and shall establish proper duct pressures for operation of zone cfm regulators.
 - b. Adjust rpm on direct drive fans. For motors with speed taps, set fan speed on tap which most closely approaches design cfm. Report tap setting on equipment data sheet as high, medium, or low.
 - c. Final balancing position of manual air duct dampers shall be plainly marked.
6. When deemed necessary by Owner or Mechanical Engineer, the TAB contractor shall run performance tests and shall read the report quantities in the presence of Owner and Mechanical Engineer for verification purposes. Tests shall be made until Owner is satisfied with the results being obtained. The operating mode of the system shall be the same for read back as it was during balancing. Any required rebalance of the system shall be performed without additional cost.

3.03 REPORT OF WORK

- A. Submit an electronic copy of the final testing and balancing report at least seven days prior to the Contractor's request for final inspection of the mechanical systems. All data shall be recorded on applicable reporting forms. The report shall include all operating data, a list of all equipment used in the testing and balancing work, method of balancing, altitude correction calculations, and shall be signed by the supervising engineer and affixed with his certification seal. Report shall contain the following information:
 1. Equipment data sheets listing make, size, serial number, rating, and operating data of all mechanical equipment including fans, pumps, motors, starters, and drives. Operating data shall include rotational speed, inlet and outlet pressures, pressure drop across filters, coils and other system components, and measured motor current and voltage.
 2. Manufacturer's grille, register, and diffuser data.
 3. Manufacturer's fan curve sheets indicating point of operation.
 4. Rpm drive sheave information (as installed and as changed), final belt number and size, fan nameplate information, motor nameplate information, and amperage and voltage input to all motors in all operating modes.
 5. Static pressure across each individual component of the system and the summarized system total.
 6. Design and final balanced cfm at each system terminal. Include the terminal size, reading orifice size, and velocities read to attain the cfm.

7. Total cfm required and final, for each fan system.
8. Percent and actual outside air under minimum damper position.
9. Thermal protection for all motors shall be recorded. Starter brand, model, enclosure type, installed thermal heaters and the rating of the heaters, required thermal heaters and the rating of the heaters if different than installed shall be recorded.
10. Make special note of any discrepancy between tabulated conditions and specified conditions and locate in a separate section of the report. Such items shall include missing items, non-functioning items, and items without final connections.
11. A reduced set of contract drawings shall be included in the report with all terminals clearly marked and all equipment designated.
12. Submit letter stating that the test and balance work is complete, and systems are ready for final commissioning.

END OF SECTION

SECTION 23 08 00
COMMISSIONING OF HVAC SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. The general commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 13 - Installation, Testing and Commissioning, with supplemental requirements pertinent to HVAC systems commissioning in this section.

1.02 SUMMARY

- A. This Section includes requirements for commissioning of HVAC systems and related subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 13 - Installation, Testing and Commissioning.

1.03 COMMISSIONED SYSTEMS

- A. Commissioning of all systems and equipment scheduled on drawing H-2 is part of the construction process. Documentation and testing of these systems, as well as training of the Town's Operation and Maintenance personnel is required.

1.04 SUBMITTALS

- A. The Contractor shall develop and submit an HVAC Commissioning Plan for review by the Engineer and Owner. The HVAC Commissioning Plan shall:
 - 1. Be developed by a registered design professional or approved agency.
 - 2. Include a narrative description of the activities that will be accomplished during each phase of HVAC Commissioning, including the personnel intended to accomplish each of the activities.
 - 3. List the specific equipment, appliances, or systems to be tested, and a description of the tests to be performed. Include Pre-Functional Checklists and Functional Test Procedures for included equipment.
 - a. Functional Tests shall include, but not be limited to, economizer controls.
 - 4. Identify measurable criteria for performance based on the Project Standards Report and individual sections of Division 23.
- B. Pre-Functional Checklists (completed). See 3.02, below.
- C. Functional Performance Test Reports (completed). See 3.04, below.
- D. HVAC Commissioning Report. See 3.05, below.
- E. Redline Markups of HVAC Drawings. See 3.07, below.

1.05 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this specification to the extent indicated by the reference thereto.
1. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 - a. 2019 ASHRAE Applications Handbook, Chapter 39, Testing, Adjusting, and Balancing
 - b. 2019 ASHRAE Applications Handbook, Chapter 44, HVAC Commissioning
 2. Associated Air Balance Council (AABC):
 - a. 2016 AABC National Standards for Total System Balance
 3. National Environmental Balancing Bureau (NEBB):
 - a. 2019 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
 - b. 2015 Procedural Standards for the Measurement of Sound and Vibration
 - c. 2019 Standard for Whole Building Technical Commissioning of New Construction
 4. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - a. 2006 HVAC Duct Construction Standard – Metal and Flexible Duct
 - b. 2005 HVAC Systems Testing, Adjusting and Balancing

PART 2 PRODUCTS (NOT USED)

PART 3 PART 3 - EXECUTION

3.01 CONSTRUCTION INSPECTIONS

- A. Commissioning of HVAC systems may require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall schedule HVAC systems inspections as required in the Commissioning Plan.

3.02 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing.
- B. Completed checklists shall be submitted to the Engineer and Owner for review.

3.03 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented as indicated.
- B. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing.

- C. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.04 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions.
- B. Detailed Systems Functional Performance Test Procedures will have been submitted and approved per paragraph 1.04, above.
- C. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests.
- D. The Contractor shall sign the test reports to verify tests were performed.

3.05 HVAC COMMISSIONING REPORT

- A. A preliminary report of the HVAC Commissioning results shall be submitted to the Engineer and Owner for review and approval.
- B. The HVAC Commissioning Report shall include:
 - 1. Copies of completed Pre-Functional Checklists.
 - 2. Copies of Functional Performance Test Results.
 - 3. Disposition of deficiencies found during testing including details of corrective measures used or proposed.
 - 4. Functional Performance Test Procedures that were used during the commissioning process, including the measurable criteria set forth in the HVAC Commissioning Plan.
- C. The Final HVAC Commissioning Report (picking up all exceptions noted on the preliminary report) shall be delivered to the building owner within 90 days of receipt of a certificate of occupancy.

3.06 TRAINING OF OWNER PERSONNEL

- A. Training of the Owner's Operation and Maintenance personnel is required.
- B. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems.
- C. Contractor shall submit training agendas and trainer resumes to Engineer and Owner for approval.
- D. The instruction schedule shall be coordinated with the Owner and Engineer.

3.07 RECORD DRAWINGS

- A. Reline markups of HVAC Contract Drawings (Re: Specification Section 01 78 39) shall be submitted within 90 days of system acceptance.

END OF SECTION

SECTION 23 09 00

HVAC TEMPERATURE CONTROLS

1.01 GENERAL

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section. Contractor shall review and adhere to all requirements of these documents.

1.02 SUMMARY OF WORK

- A. This Section includes control work for monitoring and controlling building HVAC Systems.
- B. Summary of Work
 - 1. Installation of field-installed components of control systems furnished with HVAC equipment so as to complete those systems to implement the monitoring and control sequences shown or referenced on the drawings.
 - 2. All required field wiring, conduit, and connections between all components of the automatic temperature control system as specified herein, and controlled devices.
 - 3. Coordination with HVAC equipment suppliers to assure full checkout, setup, any required field programming, and commissioning of the control systems furnished with the equipment so as to implement the monitoring and control sequences shown or referenced on the drawings.
 - 4. Demonstration of control systems to show successful implementation of monitoring and control sequences.
- C. Refer to Division 26 sections for the following; not of this section.
 - 1. Power supply wiring for power source to power connection on controls and/or unit control panels. This includes starters, disconnects, and required electrical devices, except where these items are specified as furnished or installed by manufacturer.
- D. The following electrical work done under this section shall comply with requirements of Division 26 sections:
 - 1. Control wiring and conduit between field installed controls, indicating devices and control panels.
 - 2. Cables and conductors, terminations and splices, cabinets, supports, seals, and other applicable requirements.
 - 3. Interlock wiring between electrically operated equipment units; and between equipment and field installed control devices.
- E. Provide demonstrations and instruction to the operating personnel of the controls provided under this section.

1.03 QUALITY ASSURANCE

- A. All programming work must be accomplished by experienced TC control programmer.
- B. Products, materials, equipment, installation, shop drawings, and systems to comply with the following Codes and Standards:

1. Electrical Standards: Where available electrical products shall have been tested, listed and labeled by UL.
 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electrical control systems.
 3. 2015 International Building Codes.
 4. NFPA.
- C. Products, materials, equipment, installation, shop drawings, and systems to comply with the following Codes and Standards:
1. Electrical Standards: Where available electrical products shall have been tested, listed and labeled by UL.
 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electrical control systems.
 3. International Building Codes.
 4. NFPA.
- 1.04 SUBMITTALS
- A. Submit Shop Drawings and Product Data including installation instructions for the following items in accordance with the Contract Documents.
- B. Shop Drawings: Shop drawings for each control system, containing the following information:
1. Damper schedule for all automatically actuated dampers.
 2. Schematic flow diagrams of systems showing fans, coils, dampers, and control devices.
 3. Each control device to be labeled with setting or adjustable range of control.
 4. All required electrical wiring to be indicated. Clean differentiation is required between portions of wiring that are factory installed and portions to be field installed.
 5. Details of faces of control panels, including labeling.
 6. Written description of sequence of control incorporating into the written sequence all functional devices using device code abbreviations or point number.
 7. Bill of materials, scheduling all items by using code abbreviations indicating quantity, manufacturer, manufacturer's code number, and full equipment descriptive literature.
- C. Product Data: Manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation, maintenance, troubleshooting, repair/replace, and startup instructions. Include complete parts list.
- D. Maintenance instructions and spare parts lists. This data, product data, and as built shop drawings shall be included in maintenance manuals.

PART 2 PRODUCTS

2.01 WIRING AND LOW VOLTAGE POWER

- A. All wiring shall be run in metallic conduit (flexible conduit shall be limited to 3 foot lengths maximum), tubing or raceways, as delineated in Division 26 sections. Exceptions: Wiring enclosed in Temperature Control panels.
- B. All control devices and panels containing low voltage power sources shall inherently comply with NEC class 2 requirements (current limiting) or shall be supplied with branch circuit fusing to limit control circuit current to NEC Class 2. All control transformers shall be of the inherent current limiting type or shall be installed with primary disconnect and overload protection.
- C. Shielded wire to have 100 percent overall shield of aluminum/polyester.
- D. The Contractor shall furnish and install TVSS surge protectors, Leviton 51010WM, or approved equal for incoming 120 VAC power to all controllers. Surge protectors furnished shall be UL 1449 listed.

2.02 TEMPERATURE SENSORS

- A. Space Temperature Sensors:
 - 1. Electronic temperature sensors may be platinum or nickel-iron RTD, or aged thermistors. Resistance change versus temperature shall be linear over the range of the application or compensated for non-linearity.
 - 2. ± 0.1 deg F repeatable; accurate to .5 deg F at 77 deg F.
 - 3. Shall have digital LCD display and setpoint adjustment override options. The setpoint adjustment shall be software limited by the DDC system to limit the amount of room adjustment.
 - 4. Shall have built-in port to allow connection of portable operator terminal to query and modify operating parameters on room level sensor.
 - 5. For application in the Chemical Room (RTU 1121 & 1122), space temperature sensors shall be listed for "Hazardous Locations".
- B. Duct Temperature Sensors
 - 1. $\pm 0.1^{\circ}\text{F}$, repeatable; accurate to 1.5% of range
 - 2. Averaging temperature sensors: Required in all applications where airflow area is greater than 4 sq. ft. unless specifically noted otherwise. Averaging sensors to be made of precision thermistor material. Minimum length of 12 ft. Sensing element shall fully cover entire area over which the temperature is to be averaged.
- C. Outside Air Temperature Sensors
 - 1. $\pm 2.0^{\circ}\text{F}$, repeatable; accurate to 2% of range.
 - 2. Shielded from sun and wind.

2.03 ROOM THERMOSTATS

- A. 24V with stages, modes, and programmability suitable to the application and to meet control sequence set forth on drawings.

2.04 LOW TEMPERATURE DETECTION THERMOSTATS (FREEZESTATS)

- A. Low temperature detection thermostats shall be dual pole type, having manual reset with 25' flexible sensing bulb to provide full duct coverage. Incremental type sensing bulb designed to operate actuating mechanism when any one foot section drops below set point. They shall have an isolated set of contacts for connection to alarm system.
- B. Manufacturer: Johnson Model A70HA-1 or approved equal.

2.05 AUXILIARY DEVICES - ELECTRIC

- A. Control relays shall be UL-listed, plug-in type with dust cover and an "energized" indication light. Contact rating, configuration, and coil voltage suitable for application. Provide diodes to limit back EMF on all DC relays and MOVs on AC. IDEC, or approved equal.
- B. Control transformers shall be UL-listed, Class 2 current-limiting type, or shall be furnished with overcurrent protection in both primary and secondary circuits for Class 2 service.
- C. Manual control switches shall be UL-listed for use in NEMA 1 enclosures with contact arrangement and rating suitable for application. Bat handle or knob actuator with nameplate clearly identifying function of each switch position.

2.06 ACTUATORS - ELECTRIC

- A. Electric actuators shall be either hydraulic or rotary (gear-train) type for two-position or modulating service as required by application. All electric actuators shall be UL-listed with NEMA 1 enclosures unless otherwise specified.
- B. Actuators shall be permanently lubricated; gear-train units shall be oil-immersed type or shall have permanently lubricated high-density polymer gears.
- C. Actuator housings shall be of sturdy construction. Terminals shall be push-on type, or screw type accepting up to #12 AWG wire.
- D. Ambient temperature range shall be at least 40 to 120 deg F, except actuators subjected to outdoor temperatures shall have an ambient range of -20 to 125 deg F minimum.
- E. Actuator size and rating shall be suitable for intended application. See drawings for sizes of dampers.
 - 1. Damper actuators shall be selected per manufacturer's recommendations to provide sufficient close-off force to effectively seal damper. Modulating actuators shall provide smooth modulating control under design flow and pressure conditions. Furnish a separate actuator for each damper section.
 - 2. Provide positive transmitters and/or end switches where specified.
 - 3. Actuators shall have a spring return to fail to the safe position. Actuators relying on batteries are not acceptable.
- F. Actuators shall be low voltage unless line voltage is required for component operation. Contractor is responsible for all wiring including line voltage actuation.

2.07 MOTORIZED CONTROL DAMPERS

- A. Motorized dampers shall be as follows:

1. Damper frames shall be galvanized steel hat channel.
2. Damper blades shall be heavy gage, extruded vinyl edge seal.
3. Damper shaft bearings shall be as recommended by manufacturer for application.
4. Modulating dampers shall provide a linear flow characteristic where possible.
5. Damper shall have a maximum air pressure drop of .06" at 650 feet per minute velocity.
6. Coordinate damper with other trades to ensure accessibility to actuator.
7. Damper shall be Greenheck VCD-23 or equal by one of the following manufacturers:
 - a. Ruskin
 - b. Pottorff
 - c. Nailor-Hart
 - d. Johnson Controls

2.08 DDC CONTROLLERS

- A. DDC Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the sequences of control shown on the drawings.
- B. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
- C. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- D. Isolation shall be provided at controller terminations, as well as field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
- E. In the event of the loss of normal power, there shall be an orderly shutdown of the DDC Controller to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
- F. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
- G. Should the DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local port.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical work and use electrical products complying with requirements of applicable Division - 26 sections of these specifications.

- B. Averaging Sensor Elements, Low Temperature Detection Elements
 - 1. The elements of averaging sensors shall be long enough to serpentine across the area served. The element shall cover the duct area completely and shall be equally spaced. Use copper radius clips at the bends and protect sensor elements at duct penetrations and other points of contact with poly tubing.
 - 2. Low temperature detection devices shall fully cover the coil face. Mount and protect elements as described above.
 - 3. Sense elements shall be located so as not to interfere with filter changing or other maintenance activities. The elements shall be mounted downstream of the coil served.
- C. Coordinate all work with balancer.
- D. Seal all penetrations into ducts or AHU housings airtight with an approved duct sealant.

3.02 IDENTIFICATION SYSTEM

- A. Wiring
 - 1. Tag with labeling tape or color code control wiring and tubing at each end, and junction points. Match the tagging or coding number indicated on the Shop Drawings. Wire bundles may be tagged if wire color coding is unique and indicated on shop drawings.
- B. Termination Strips
 - 1. Control Unit and control panel termination points shall be labeled to match shop drawings.
- C. Panel Mounted Control Devices
 - 1. Mark each panel mounted control device with engraved plastic laminate nameplates. Each name shall be unique and cross-referenced to control diagrams.
- D. Field Devices
 - 1. Each field device (including space temperature sensors) shall be labeled to match Shop Drawings and software point name. Labeling to be permanent and commercially available. Plastic Dymo tape and handwritten labels are not acceptable.
- E. All components shall be labeled as to function and the code used on the drawings. Labels shall be installed next to, not on, each remotely installed device. Label all equipment located in each enclosure. Label the relay as well as its base. Include labels for each input and output as well as for the controller itself. Label all enclosures as to the unit served and the controllers found inside. Label all remotely mounted enclosures containing relays or other devices as to what can be found inside. Labeling to be permanent and commercially available. Plastic Dymo tape and handwritten labels are not acceptable.

3.03 WIRING

- A. Installation of wiring shall comply with the requirements in Division 26.
- B. Communication Circuits

1. Cable shall not be installed closer than six feet from high power transformers. Cable not in conduit shall not be run parallel within six feet of electrical high power cables. For cable in conduit, this may be reduced to two feet.
 2. Tape all shield wiring where the insulation has been removed.
- C. Temperature Control Wiring
1. Temperature control wiring shall not be run in conduit with power wiring. Analog or communication wiring shall not be run in the same conduit which has highly inductive loads such as contactors or coils. All analog and communication wiring shall be shielded twisted pair.
- D. Splices
1. Splices in shielded cables shall consist of termination and the use of shielded cable couplers which maintain the integrity of the shielding.
- E. Wiring is to be concealed, except in mechanical rooms and areas where other conduit and piping are exposed. Wiring shall be routed in conduit. Where wires leave the conduit system, they shall be protected by a plastic insert. The use of power line carriers is not allowed.
- 3.04 LOW TEMPERATURE DETECTION THERMOSTATS
- A. The air handling systems shall have low temperature detection thermostats (set at 35°F) located in the discharge air duct. Element to be serpentine so that no area greater than 2 square feet is uncovered. When thermostat drops below set point, thermostat shall initiate sequence shown on drawings.
- 3.05 LIMIT AND SAFETY CONTROLS
- A. Temperature controls for limit and safety controls must function independently of the DDC system controls. This includes controls for coil low temperature detection and smoke detection.
- 3.06 WIRING OF CONTROL DEVICES BY OTHERS
- A. Control devices carrying full load current furnished by this Division and wired by Division 26, shall be located at the device being controlled, unless shown otherwise on the drawings, or mutual agreement is made between the contractors with no change in the contract price.
- 3.07 COMPLETION SERVICES
- A. Demonstration
1. At the completion of the work, provide training per Division 1. In addition, the Contractor shall be available for telephone consultation during the warranty period to answer questions from the operating staff concerning the control equipment. Such consultation shall be at no cost to Owner. Minimum instruction time shall be 4 hours which may be taken in several shorter meetings during the warranty period.

END OF SECTION

SECTION 23 11 23
HVAC NATURAL GAS PIPING

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.

1.02 SECTION INCLUDES

- A. Gas distribution system

1.03 CONTENT SUMMARY

- A. Pipe and fittings
- B. Valves
- C. Installation

1.04 SUBMITTALS

- A. Comply with Section 23 00 00.
- B. Product Data:
 - 1. Pipe/fittings
 - 2. Pressure regulators
 - 3. Valves

1.05 CODES AND REGULATIONS

- A. Comply with requirements, rules, and regulations of:
 - 1. International Plumbing Code (2012)
 - 2. International Fuel Gas Code (2012)
 - 3. Local plumbing codes and ordinances

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Interior, exposed or accessible:
 - 1. 1-1/2 inches and smaller:
 - a. Pipe: Schedule 40, ASTM A120.
 - b. Fittings: Threaded, malleable iron.

- c. Joint Seal: Rector seal or Teflon paste.
 - d. Unions: Black malleable iron, ground joint, bronze to iron seat, 150 pound class, ANSI B2.1 and ASTM A197.
- 2. 2 inches and larger:
 - a. Pipe: Schedule 40, ASTM A53, type S, Grade B.
 - b. Fittings: Butt weld ASTM A234.
 - c. Unions: Forged steel, weld-neck flange, 150 pound class, ANSI B16.5 and ASTM A105.
- B. Interior, concealed or in air plenums: All pipe and fittings shall be welded type.
- C. Exterior, above grade:
 - 1. Steel Pipe: ASTM A 53, black steel, Schedule 40, Grade B.
 - 2. Fittings:
 - a. Threaded:
 - 1) Malleable-Iron Threaded Fittings: ASME B16.3, Class 150
 - 2) Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - b. Welded:
 - 1) Wrought-Steel Welding Fittings: ASTM A 234 for butt welding and socket welding.
- D. Exterior, below grade:
 - 1. PE Pipe: ASTM D 2513, SDR 11.
 - 2. PE Fittings:
 - a. ASTM D 2683, socket-fusion type or
 - b. ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 - c. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53, black steel, Schedule 40, Grade B.

2.02 VALVES

- A. Manual Gas Shutoff Valves: One-piece, bronze ball valve with bronze trim, rated for gas service.

PART 3 EXECUTION

3.01 GAS PIPING INSTALLATION

- A. All gas distribution system work shall be in conformance with the requirements of NFPA 54-2002. This includes, but is not limited to, requirements for inspection, testing, purging, accessibility and shutoff valves.
- B. Use tapered couplings. Do not use thread protectors provided with piping.

- C. Welding shall be inspected for visual quality for approval of installation.
- D. Properly support all gas piping with approved methods.
- E. Provide gas cock at service connection to equipment.
- F. Provide union connection between equipment and gas cock.

3.02 PIPE TESTING

- A. Test all piping systems. Systems shall prove tight prior to concealment. Tests will be witnessed by the local authority having jurisdiction.
- B. Ensure that fixtures and equipment will not be damaged by test pressures. Valve-off or otherwise isolate fixtures and equipment that could be damaged by the test pressures.
- C. Valve off gas pressure regulators and gas burning equipment. Do not subject regulators and equipment to test.
- D. All hydrostatic tests shall be held for a minimum of eight hours without loss of pressure. All air tests shall be held for a minimum of one hour without loss of pressure.
- E. Test Procedures:
 - 1. Gas: 1-1/2 times the maximum working pressure, but not less than 3 psig.

END OF SECTION

SECTION 23 30 00
HVAC AIR DISTRIBUTION

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.

1.02 CONTENT SUMMARY

- A. Access doors
- B. Volume dampers
- C. Elbows and turning vanes
- D. Flexible connections
- E. Grilles, registers and diffusers
- F. HVAC ductwork
- G. Duct Liner
- H. Louvers
- I. Sealants

1.03 SUBMITTALS

- A. Comply with Division 01 Requirements.
- B. Product Data: Construction materials.
 - 1. Access panels
 - 2. Dampers
 - 3. Grilles, registers, diffusers: operational data at design conditions. Indicate NC, throws, pressure drop.
 - 4. Louvers: operational data at design conditions. Indicate pressure drop.
- C. Shop Drawings: dampers, grilles, registers, and diffusers, gravity hoods, louvers. Clearly indicate material for each item, weights, dimensions. Indicate installation type or style where applicable.

PART 2 PRODUCTS

2.01 ACCESS PANELS IN DUCTS AND EQUIPMENT

- A. Access panels shall consist of three, one piece stampings: the door frame, the door, and the pan. Space between door and pan shall be filled with 1/2-inch thick insulation. The door shall be hung with loose-pin hinges.
- B. Access panel sizes shall be as follows unless otherwise indicated on drawings:

Size of Duct to be Accessed Inches	Panel Size Inches	Metal Frame	Gauges of		Number of	
			Door	Pan	Hinges	Latches
6 - 8	6 x 8	24	26	28	2	1
10 - 12	10 x 12	22	24	28	2	1
12 - 16	12 x 16	20	24	28	2	2
18 and larger	16 x 24	20	22	28	3	2

- C. Access doors shall be fabricated in accordance with the details in the SMACNA duct manuals. Latches and hinges shall be equal to Ventlok of appropriate type and size.
- D. Acceptable Manufacturers
1. C. E. Sparrow Company.
 2. Hercules
 3. Kees
 4. Ventfabrics Inc

2.02 MANUAL VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards.
- B. Frame shall be 16 gauge, with 16 gauge blades.
- C. Material shall be the same as the duct in which the dampers are installed.
- D. Dampers shall have locking hand quadrants.
- E. Provide with Oilite bronze bearings.

2.03 ELBOWS AND TURNING VANES

- A. Elbows shall have radius equal to 1.5 times duct width wherever possible. Where necessary, mitered elbows may be used with turning vanes.
- B. Turning vanes shall be single-walled and formed to assure that any joint on one blade is equidistant from the same point on an adjacent blade. Construction of all turning vanes shall conform to SMACNA standards. Vanes longer than 36" shall be provided with intermediate supports. Edges of vanes shall be parallel with sides of elbow.
- C. Turning vanes shall be constructed of the same material as the duct in which they are installed.

2.04 FLEXIBLE CONNECTIONS

- A. Exposed to weather: Ventlon
- B. Not exposed to weather: Ventglas
- C. Acceptable Manufacturers
 - 1. Ventfabrics, Inc.

2.05 HVAC DUCTWORK

- A. Sheet metal used for general HVAC duct construction shall be aluminum.
- B. Ducts shall be constructed in accordance with the applicable SMACNA duct manuals. Gauge of metal, type of joint, and reinforcing shall be in accordance with SMACNA standards.
- C. Duct construction and installation shall be in accordance with the provisions of the International Mechanical Code.
- D. Factory-made air ducts shall be either Class 0 or Class 1 and meet UL 181.
- E. All rigid round and oval single-wall, spiral pipe and fittings shall be manufactured by a company whose primary business is the manufacture of spiral pipe and who has been in business for at least 10 years. All spiral pipe and fittings shall be manufactured by the same manufacturer.
- F. Round duct, fittings, and couplings shall be fabricated of the same material as the duct system to which they are attached.

2.06 DUCT LINER

- A. General:
 - 1. Duct liner shall comply with the requirements of NFPA 90A and the "Duct Liner Materials Standard" of the Thermal Insulation Manufacturers Association.
 - a. Square and rectangular duct liner:
 - 1) Flexible blanket with factory coated edges conforming to ASTM C1071.
 - 2) K value: 0.25 at 75 degrees Fahrenheit.
 - 3) Noise reduction coefficient: Minimum of 0.65 based on type-A mounting.
 - 4) Velocity rating: Minimum of 5000 feet per minute.
 - 5) Adhesive: UL listed waterproof type.
 - 6) Fasteners: Duct liner galvanized steel pins.
 - 7) Manville Permacote, Linacastic HP, or equal by Certain-teed or Owens Corning.
 - b. Duct Liner Schedule:

Application	Liner Thickness
Description	Inches
All rectangular outdoor supply and return duct	3

- c. Duct sizes shown on drawings are interior clear dimensions.

2.07 GRILLES, REGISTERS, AND DIFFUSERS

- A. Registers and diffusers shall have opposed blade dampers where scheduled. Dampers shall meet pressure rating of ductwork.
- B. Provide frames and mounting hardware appropriate to the installation.
- C. Acceptable Manufacturers
 - 1. Titus
 - 2. Nailor-Hart Industries
 - 3. Carnes
 - 4. Price
 - 5. Krueger
 - 6. Metal Aire

2.08 LOUVERS

- A. Frame
 - 1. Heavy gage extruded 6063-T5 aluminum.
 - 2. 4" x 0.081 in. nominal wall thickness.
- B. Blades
 - 1. Heavy gage extruded 6063-T5 aluminum.
 - 2. 0.081 in. nominal wall thickness.
 - 3. Drainable design blades positioned at 37 1/2 deg angle and spaced approximately 4" center to center.
- C. Features
 - 1. Components shall be factory assembled by the manufacturer.
 - 2. Capable of withstanding a wind load from a 100 mph wind.
 - 3. Finish: Integral Color Anodize AA-M10C22A42. Color shall be custom as selected by architect.
 - 4. 1/2-inch galvanized metal bird screen with removable frame mounted on inside.
 - 5. Sill Extensions: Provide manufacturers sill extension with integral end dams. See louver details on Architectural drawing. Provide sill extension to match specified louver finish & color.
 - 6. Provide manufacturer's standard anchor clips (angles) as required to comply with manufacturer's clip installation requirements.
- D. Acceptable Manufacturers

1. Greenheck
2. Ruskin
3. Pottorff
4. Airstream Products Company
5. Louvers & Dampers, Inc.
6. American Warming
7. United Air

2.09 SEALANTS

- A. Duct sealer shall be a metal-to-metal air pressure sealant which is flexible and self-curing.
- B. Sealant shall be water resistant and fire resistive when dry in accordance with NFPA 90.

PART 3 EXECUTION

3.01 DUCT FABRICATION AND INSTALLATION

- A. Exercise the utmost care to obtain a smooth surface inside of all ductwork, absolutely free from small fins, imperfect joints or other obstructions which cause noise and increase friction. Internal ends of slip joints shall be made in the direction of air flow. Ducts shall be securely attached to the building construction in an approved manner.
- B. All ducts and plenums shall be constructed in accordance with the IMC and applicable SMACNA duct manuals including gauge of metal, type of joint, and reinforcing.
- C. All ductwork shall be fabricated and installed so that no undue vibration or noise results. All joints shall be airtight with additional taping and caulking provided if necessary.
- D. Hang ducts with strap aluminum attached to bottom of ducts spaced not over five feet center-to-center and according to the SMACNA manual, or as required by the International Building Code, whichever is more stringent.
- E. Curved elbows shall have a center line radius equal to 1-1/2 times the duct width. Square elbows shall have turning vanes where indicated. Job fabricated turning vanes will not be accepted without prior approval. Elbows with square throat and radius heel are not acceptable.
- F. Provide dampers as necessary for proper adjustment and control of air distribution. All dampers shall have rigid bearings and locking quadrants which allow no rattling. All damper rods shall be marked to indicate the relative position of the damper blade with respect to the rod.
- G. Provide 1-inch angle collars for all exposed ducts passing through walls, ceilings, or floors. Anchor collars in position after installation is complete.
- H. Provide flexible connections at inlet and discharge connections of fans and air-handling equipment to prevent mechanical noises from being transmitted to connecting ductwork. Isolators shall be Class 0 or Class 1 and shall not exceed 10 inches in length but shall provide at least 1" slack.
- I. At all places where inside of duct will be visible through return air grilles, louvers, registers, or diffusers, paint normally visible inside portion of duct with flat black paint.

- J. Install hinged access panels on ductwork and housing to provide access to all parts of every automatic damper and turning vanes, and all other items requiring maintenance or inspection.
- K. Transitions in ductwork, for changing shapes and sizes, shall be made with angles not exceeding 20 degrees per side wherever possible. Indicate any deviation from this on shop drawings or obtain approval from Engineer.
- L. Where vertical ducts pass through floors, supporting angles shall be rigidly attached to ducts and to the floor. Angles shall be galvanized and of the approved sizes to properly support the ductwork. Supporting angles shall be placed on at least two sides of the duct.
- M. Where horizontal ducts pass through walls and vertical ducts pass through floors, opening shall be tightly sealed to provide a tight seal between duct and opening.
- N. All ducts passing through floor slabs shall be provided with 16-gauge galvanized sheet-metal sleeves, grouted in place, which extend two inches above the finished floor. The exposed top end of the sleeve shall be reinforced with a hemmed slip all around.
- O. Maintain fire ratings where ducts penetrate fire rated surfaces and assemblies. Sealants shall be UL listed.
- P. Ensure that work of other trades do not penetrate ducts. Piping, conduits and similar items shall not pass through ducts.
- Q. Provide supports for horizontal flexible ducts at maximum of 36 inches on center using a minimum 3/4-inch wide flat banding material. Joints and connections in flexible ducts shall be made with 1/2-inch wide positive locking steel straps. Length of flexible ducts shall not exceed 7 feet.
- R. Supply connections to terminal boxes shall be straight for a distance of at least 3 duct diameters.
- S. Ductwork Schedule: Ductwork shall be in accordance with the following:

Application	Ductwork Requirements	SMACNA Pressure Class (Pos. or Neg., Note 1)
1. Exterior Supply/Return ductwork	Lined sheet metal	2"
2. Interior Supply/Return ductwork	Unlined sheet metal	2"
2. Exhaust ductwork	Unlined sheet metal	2"

Note 1: Based on 1985 edition of SMACNA HVAC duct construction standards.

3.02 SEALING OF DUCTS

A. General

- 1. All ducts shall be sealed with sealant in accordance with SMACNA standards.
- 2. Metal surfaces to be joined shall be clean, dry, and grease free.
- 3. Apply a heavy brush coat of sealant to the interior metal surface of the duct slip joint, then interlock securely the duct sections and position into place.
- 4. Apply a heavy brush coat finish of sealant to the exterior metal surface duct joint or seam covering heads of lock joint screws. Ensure that all voids are completely filled to provide a continuous air pressure sealant.

5. Where ducts are subject to excessive vibration or mechanical abuse, the exterior joint finish shall consist of a heavy coat of brush applied sealant reinforced with 2-inch wide glass fabric. Press the reinforcing fabric into the wet sealant and cover with a second coat of brush applied sealant.

3.03 GRILLE, REGISTER, AND DIFFUSER INSTALLATION

- A. In moist areas, install grilles, registers, and diffuser with stainless steel fasteners.
- B. When installing grilles, registers, and diffusers in existing drop ceilings provide additional T-sections as required for a finished opening for the grille, register, or diffuser.

3.04 ACCESS PANELS

- A. Install access panels for inspection, maintenance, and cleaning of all automatic dampers, fire and smoke dampers, duct turning vanes, before and after all coils, and at other locations where equipment will require service.
- B. Access panels to fire dampers shall be labeled with letters not less than 1/2-inch in height reading "Fire Damper." For locations where access panels are insulated, provide identifying labels on the exterior of the insulation.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.
- B. Refer to all Division 23 sections for related information.

1.02 CONTENT SUMMARY

- A. Utility Set Exhaust Fan (EF 1170)
- B. Toilet Exhaust Fan (EF 1171)

1.03 SUBMITTALS

- A. Comply with Division 1.
- B. Product Data
 - 1. Fan operational data including fan curve or tables showing points of operation, horsepower rating, electrical information, and sound data.
 - 2. Controls and electrical information, wiring diagrams
 - 3. Construction materials
 - 4. Accessories
- C. Shop Drawings
 - 1. Submit unit dimensions, configurations, weights, connection sizes and locations, access doors, clearances, and installation diagrams, support and/or hanger types.
 - 2. Wall/roof opening requirements.

1.04 CODES, REGULATIONS AND STANDARDS

- A. Comply with the following:
 - 1. ANSI-AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. SMACNA - HVAC Duct Construction Standards.
 - 3. ANSI/UL 900 - Test Performance of Air Filter Units.
 - 4. AMCA 211 - Certified Ratings Program - Product Rating Manual for Fan Air Performance
 - 5. AMCA 311 - Method for Publishing Sound Ratings for Air Moving Devices.
 - 6. 2015 International Building Codes
 - 7. 2015 NEC - National Electric Code

PART 2 PRODUCTS

2.01 UTILITY SET EXHAUST FANS

A. General

1. Fan shall be a single width, single inlet backward inclined airfoil, belt driven centrifugal blower.
2. Fan shall be manufactured at an ISO 9001 certified facility.
3. Fan shall be listed by Underwriters Laboratories (UL/cUL 705) for US and Canada.
4. Fan shall bear the AMCA certified ratings seal for sound and air performance.

B. Construction

1. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners.
2. The scroll wrapper and scroll side panels shall be a minimum 12 gauge steel.
3. The entire fan housing shall have continuously welded seams for leak-proof operation and shall have a minimum 1 ½" outlet discharge flange.
4. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. Bearing support shall be minimum 10 gauge welded steel. Lifting eyes shall be provided for ease of installation.
5. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM.
6. Unit shall be shipped in ISTA certified transit tested packaging.

C. Coating

1. Steel fan components shall be coated with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

D. Wheel

1. Wheel shall be steel, non-overloading, centrifugal backward inclined, airfoil type.
2. Blades shall be continuously welded to the backplate and deep spun inlet shroud.
3. All sizes shall be keyed and securely attached to the fan shaft.
4. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.
5. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

E. Motor

1. Motor shall be NEMA design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase, and enclosure.

F. Blower Shaft

1. Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished.
2. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.

G. Bearings

1. Bearings shall be designed and tested specifically for use in air handling applications.
2. Construction shall be heavy duty regreasable ball or roller type in a cast iron pillow block housing and selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

H. Belts and Drives

1. Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
2. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

2.02 TOILET EXHAUST FAN (EF 1171)

A. General

1. Fan shall be inline mounted, direct driven, centrifugal exhaust fan.
2. Certifications:
 - a. Fan shall be manufactured by an ISO 9001 certified company.
 - b. Fan shall be listed by Underwriters Laboratories (UL 507) and UL listed for Canada (cUL507).
 - c. Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.
3. Construction:
 - a. The fan wheel housing and integral outlet duct shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation.
 - b. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod.
 - c. The inlet box shall be minimum 22 gauge galvanized steel.
 - d. The motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet.
 - e. A field wiring compartment with disconnect receptacle shall be standard.
 - f. To accommodate different mounting positions, an adjustable pre-punched mounting bracket shall be provided.
 - g. Unit shall be shipped in ISTA Certified Transit Tested Packaging.
4. Wheel:
 - a. Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin.
 - b. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.
5. Motor:

- a. Motor shall be totally enclosed, not ventilated (TENV) electronically commutated (EC) with permanently lubricated bearings, built-in thermal overload protection and disconnect plug.
 - b. Motor shall have an adjustable speed range from 500 to 1800 rpm. Motor shall be furnished at the specified voltage.
- 6. Acceptable Manufacturers:
 - a. Cook
 - b. Greenheck
 - c. Approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install to provide required clearances.
- B. Install in accordance with manufacturers printed instructions.
- C. Do not operate until ductwork is clean, filters are in place and bearings lubricated.
- D. Provide support system for fan and coordinate with Contractor.

3.02 STARTERS AND DISCONNECTS

- A. Contractor to verify requirements with Temperature Controls, Electrical, and manufacturer-provided equipment. Where devices are not furnished and/or mounted by manufacturer, coordinate installation and connections with other trades.

END OF SECTION

SECTION 23 75 00

CUSTOM PACKAGED OUTDOOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of and apply to this Section. Consult them for additional conditions and requirements.
- B. Refer to all Division 23 sections for related information.

1.02 CONTENT SUMMARY

- A. Custom Make-up Air Units (MAU 1101)
- B. Custom Gas-Electric Rooftop Units (RTU 1121, RTU 1122)

1.03 SUBMITTALS

- A. Comply with Division 1.
 - B. Product Data: Include manufacturer's technical data, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
 - C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
 - D. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which units will be attached.
 - E. Field quality-control test reports.
 - F. Operation and Maintenance Data: To include in emergency, operation, and maintenance manuals.
- ##### 1.04 CODES, REGULATIONS AND STANDARDS
- A. Comply with the following:
 - 1. ARI 410 Standard for Forced Circulation, Air Cooling and Air Heating Coils
 - 2. ARI 430 - Standard for Central Station Air Handling Units.
 - 3. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
 - 4. ANSI-AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

5. SMACNA - HVAC Duct Construction Standards.
6. ANSI/UL 900 - Test Performance of Air Filter Units.
7. AMCA 301 - Method for Publishing Sound Ratings for Air Moving Devices.
8. 2015 International Building Codes
9. 2015 NEC - National Electric Code

PART 2 PRODUCTS

2.01 MAKE-UP AIR UNIT (MAU 1101)

A. General:

1. Make-up air units (MAUs) shall be built to the level of quality as herein specified and to the description of the make-up air unit schedule.
2. Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for equivalent products must address these factors.
3. Make-Up Air units are to be shipped to the job in one piece, factory assembled. All equipment shall be factory tested prior to shipment. All equipment shall be pre-wired, and factory certified by an approved testing agency such as ETL-US prior to shipment.
4. Pre-wired Make-Up Air units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
5. All electrical circuits shall undergo a dielectric strength test and shall be factory tested and checked as to proper function.
6. The Make-Up Air units, and major components, shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.
7. Manufacturer shall have a fully implemented and auditable quality assurance program, equal to the ISO-9002 Quality Standard.
8. Units shall be equivalent to Engineered Air as the basis of design.

B. Casing:

1. Unit casing shall be of minimum 18-gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish exterior coat shall be two-part epoxy paint with clear top coat all exterior exposed surfaces, including the roof curb. All unprotected metal and welds shall be factory coated.
2. Continuous high-pressure sealant shall be provided between all panels.
3. All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant.

4. The unit casing shall be built with full double walled construction including a 22-gauge solid galvanized metal liner over all insulated areas including the unit underside.
5. Unit shall be provided with access doors to the following components: fan and motor, filters, damper and operator, access plenum and electrical / burner control compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
6. Access doors shall be provided with hinged access doors in welded steel frames. Doors shall be fully lined, come complete with bulb trim seal gasket and lever lock handles, operable from both sides. Hinged access doors shall open outwards.
7. Provide marine lights with glass globes with metal protective cage in each section provided with an access door. Lights shall be wired in EMT with liquid tight fittings conduit to a common switch all powered by a separate 120-volt power supply circuit by others.
8. Unit shall be internally insulated with 2-inches thick, 1-1/2 lb. / cu. ft., density insulation sandwiched between outer casing panels and inner metal liner panels for full double walled construction throughout including unit floor.
9. Unit casing shall be provided with reinforcing cross channels under floor to minimize deflection.
10. The following specialized construction and features for the make-up air handling unit shall be provided:
 - a. Inlet hood with birdscreen.
 - b. Solid-state control burner controller with adjustable minimum discharge set at 74°F.
 - c. TEFC Super-E belted fan motor with 1.15 service factor.
 - d. Blower assembly motor drives / belts with a 1.5 service factor.
 - e. Aluminum dampers and damper frames
 - f. Solid metal liner throughout. Two part epoxy coat exterior with clearcoat final finish plus interior exposed welds and non-galvanized steel components, excluding gas fired heat exchanger and aluminum dampers.
 - g. Coat fan shafts with chlorine resistant coating.
 - h. Gasket and/or caulk seal all opening between control panel and the air stream and at all wiring conduit entering and leaving the electrical / controls / burner compartments.
 - i. Make up air handling unit shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, hood on air intake with 1-inch galvanized inlet screen; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 2-inches with three break interlocking design; outer wall panels extend a minimum of 1/4-inch below the floor panel; drain trap(s) connections for field supply and installation of drain traps for casing floor drains.
 - j. Unit to be mounted on a roof curb and have drain trap connections for field supply and installation of drain traps for casing floors drainage. Unit floor to incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.
 - k. Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 28-inches high, and complete with wood nailer, neoprene sealing strip, and

fully welded "Z" bar with 1-inch upturn on inner perimeter, to provide a complete seal against the elements. Exposed surfaces of the roof curb to be factory painted with two part epoxy paint with the same finish as the unit exterior (RE: 09901). External insulation and flashing of the roof-mounting curb shall be provided under Division 7.

C. Supply Air Fan, Motor, and Drive:

1. Centrifugal fan shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. Fan and fan assembly shall be dynamically balanced during factory test run. Fan shaft shall be selected for stable operation at least 20% below the first critical RPM. Fan shaft shall be provided with a rust inhibiting coating.
2. Single low pressure forward curved fan shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.
3. Drives shall be adjustable on fan motors assembly. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
4. Fan motor assembly shall be factory installed, balanced, and tested at full rated load and speed prior to shipment.
5. Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly. Motor mounting shall be adjustable to allow for variations in belt tension.
6. Provide standard OSHA approved belt guard on belted drive assembly.
7. Fan-motor assembly shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single forward curve fan. Fan shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
8. Provide extended grease lines to access side cabinetry.
9. Fan motor shall TEFC (totally enclosed fan cooled) Super E high efficiency type.

D. Heating System:

1. General:
 - a. Heating section shall be indirect natural, gas fired approved for both sea level and high-altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority and carry the approval label of that authority as a complete operating package.
 - b. All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire operation.
 - c. Operating natural gas inlet pressure at unit manifold shall be 7-inches, wg minimum and up to 14-inches, wg maximum.
 - d. Gas fired unit shall be approved for operation in -40°F
2. Heat Exchanger/Burner Assembly
 - a. Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators and shall

be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1-inch of insulation between the outer cabinet and inner heat reflective galvanized steel liner. Blower location shall be engineered to improve the required air flow pattern around the heat exchanger. Using duct type furnaces and closed coupled blowers are not acceptable.

- b. High efficiency heat exchanger shall be tested and certified to ANSI/CSA standards to provide a minimum of 80% output efficiency throughout the entire modulating operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.
- c. The heat exchanger/burner assembly shall be a blow through positive pressure type. Unit shall incorporate the DJM burner control module and have an interrupted pilot ignition system to provide increased safety. Units using continuous or intermittent pilots are not acceptable.
- d. Flame surveillance shall be from the main flame after ignition not the pilot flame. The burner and gas train shall be in a cabinet enclosure. Atmospheric burners or burners requiring power assisted venting are not acceptable.
- e. The heat exchanger/burner assembly shall include 15:1 turndown for all input ranges from low to high fire. The high turn down heat exchanger/burner assembly minimum input shall be capable of controlling 6.7% of its rated input, excluding the pilot assembly, without on/off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from high to low fire.
- f. Factory testing of indirect fired gas heating section.
 - 1) Tests shall be performed after complete final unit assembly, just prior to shipping to job site. The tests shall be performed in accordance with the equipment standard that the gas heating section is certified.
 - 2) Heat exchanger shall be clocked with a dedicated calibrated gas meter to insure proper set up of the gas manifold.
 - 3) High and Low input flue gas combustion analysis using a calibrated combustion analyzer including O₂ and CO to provide proper air fuel ratio throughout the entire operating range.
 - 4) Heat Exchanger airflow pattern shall be tested to ensure uniform airflow across all parts of the heat exchanger.
 - 5) Once the equilibrium operating temperatures have been reached, the heat exchanger temperatures shall be checked to ensure that all surfaces are below 1075°F. Temperatures above this can lead to premature heat exchanger failure.
 - 6) Flue gas temperature and combustion analysis shall be performed. The heat exchanger efficiency shall be analyzed and must meet current requirements.
 - 7) High limit operational check shall be performed to ensure proper function at all normal airflows including loaded filters.
 - 8) If the unit is capable of or intended to operate at varying air flows, all of the above tests must be performed at high flow and low flow.
- g. Venting

- 1) Installation and venting provisions must be in accordance with CAN/CSA Standard B149.1, ANSI Z223.1-NFPA 54, and local authorities having jurisdiction. Field install the factory provided stainless steel "wedge vent" flue terminal.

h. Controls

- 1) Electronic DJM module (Modulating Fuel w/ Modulating Combustion Air) complete with proportional and integral control with discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Combustion air motor speed varies proportionally in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions. Combustion blower RPM shall be proved using a Hall Effect speed sensor.
- 2) Combustion efficiency of high efficiency heat exchangers shall increase by up to 1-2% from high fire to low fire while turning down on unit incorporating 15:1 turndown (HT Burner). Heat exchangers shall provide a minimum of 80% efficiency throughout the entire operating range.
- 3) DJM Burner Controller for heating only application unit shall include the following standard features:
 - a) Service analyzer with diagnostic lights for ease of set-up and service
 - b) Linear gas and combustion air flow obtained via a built in solid-state linear algorithm
 - c) -40°F minimum operating ambient temperature
 - d) Four air change pre-purge
 - e) Maintained purge to decrease temperature cycles
 - f) Post purge
 - g) Interrupted pilot
 - h) Self-check on start-up to make sure air proving and discharge air sensors are operating within design tolerances
 - i) Low fire start
 - j) Controlled burner start-up and shut down
 - k) Blower contactor that starts fan after burner prepurge
 - l) Damper contact that allows fan to start after damper opens, damper to close after fan stops, and damper to close on flame failure
 - m) Non-recycling auto by-pass low limit with alarm contacts and built-in sensor checking
 - n) Separate gas and air actuators independently controlled to give the correct air to fuel ratio though out the entire firing range.
- 4) Heating control function shall be per the sequence set forth on the drawings.
- 5) Controller for heating only application to incorporate integral auto bypass low limit feature.

- 6) Discharge air sensor shall be field mounted in supply ductwork by installing contractor.
- 7) Provide a make-up air reverse airflow high limit switch in series with the standard high limit switch mounted in the blower discharge.
- 8) Controls: Heating shall be disabled above an adjustable ambient temperature set point.
- 9) The controller shall attempt up to 3 ignition attempts in the event of loss of flame signal before disabling equipment operation.

E. Mechanical Cooling System

1. General

- a. The entire cooling package including fan controls, head pressure control, and all other miscellaneous controls and accessories shall be pre-wired and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination.
- b. Equipment shall operate down to 50°F (10°C) ambient temperature for mixed air and 58°F (14.4°C) ambient temperature for make-up-air applications. Where applicable, multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with TX valves, sight glass, liquid line filter-driers, and service ports fitted with Schrader fittings. Equipment shall have condensers designed for 15°F (8°C) liquid sub-cooling. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.
- c. Units shall be supplied with R-410A

2. Compressors:

- a. Compressors shall be hermetic scroll type set on resilient neoprene mounts.
- b. Compressors shall incorporate an internal or external pressure-limiting device to protect the compressor in the event of overpressure.
- c. Compressors shall be provided with a means of overload protection.
- d. External crankcase heaters shall be locked out during compressor operation.
- e. Compressors shall be located on the side of the unit in a service enclosure complete with hinged access doors c/w lever
- f. Units to have a minimum of three compressors.
- g. Provide hot gas bypass on the lead compressor to provide freeze protection in the event of low loads.

3. Air Cooled Condenser

- a. Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory pressure tested with air while immersed in an illuminated water tank.
- b. Condenser fans shall be direct drive propeller type arranged for vertical draw through airflow. Motors shall be weather resistant type with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted in a venturi for optimum efficiency with minimum noise level.

- c. Condenser fans shall be fully housed fan with protective screen and fluted blades for optimum efficiency with minimum noise level.
 - d. Condenser section to form an integral part of the unit.
4. Cooling Control
- a. The cooling controller shall be complete with proportional and integral control with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature.
 - b. The controller shall provide 6 stages of mechanical cooling.
 - c. The controller shall have built-in minimum run time and anti-cycle timers.
 - d. Mechanical cooling shall be disabled below a fixed low ambient temperature setpoint.
 - e. Cooling enable/disable shall be through controller demand.
 - f. When controller is in economizer mode, the mechanical cooling shall be enabled.
 - g. Electronic control shall have two stage electronic room control with free cooling.
 - h. Controls shall include compressor and condenser fan motor contactors, supply fan contactors and overload protection, control circuit transformer, cooling relays, ambient compressor lockout, anti-short-cycle and inter-stage timers, and automatic reset low pressure controls. Compressors over 6 tons (21 kW) shall be complete with manual reset high pressure controls. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

F. Filters:

- 1. Filter section shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.
- 2. Unit filter bank shall be designed so that the filter modules side / slide out of the unit. Side removal with 2-inch filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
- 3. Two-Inch Thickness Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Provide permanent re-usable metal enclosing frame for each filter. The filter media shall have a minimum efficiency of 30-35% on ASHRAE Standard 52.1-2013, and a minimum of MERV 8 per ASHRAE 52.2-2013.
- 4. Filter media shall meet UL 900 classification.
- 5. Provide filter bank with Dwyer 2000 magnehelic air filter gauge complete with static pressure taps and aluminum tubing all factory installed. Filter gauge to have a range of 0 to 2-inches, wg.
- 6. Since the filter gauge is being provided on an outdoor unit, it shall be mounted inside of a weatherproof enclosure with viewing window.

G. Dampers:

- 1. Damper frames shall be U-shaped extruded aluminum metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 1/2-inch aluminum shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.

2. Blades shall be low leak dampers with blade ends sealed with an adhesive backed foamed polyurethane gasketing. Interlocking blade edges shall include an all-weather PVC seal fastened with a positive lock grip and pliable overlap edges on both the entering and leaving air sides, with extruded aluminum blades and damper frame Ruskin CD-50.
3. Two position inlet dampers shall be parallel blade type.
4. Make-up air inlet damper control shall provide a two position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position.

H. Factory Supplied Controls/Wiring:

1. Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors, and terminals for the connection of external control devices or relays.
2. Gas fired unit shall also include high limit and combustion airflow switch.
3. Fire alarm circuit contact(s) shall be provided by others.
4. Factory installed and wired non-fused disconnect switch in NEMA 3 weatherproof configuration.
5. Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.
6. All control and main three phase power wiring outside the integral unit control panel of the unit to be in liquid tight flex conduit internally sealed wherever the wiring enters or exits the compartment.
7. Provide a factory installed clogged filter indication control dry contact as well as a terminalized factory mounted air proving switch dry contact for supply air fan on indication operation, all for use by others.
8. As an integral part of the burner controller module logic, provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure, this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.

I. Acceptable Manufacturers:

1. Engineered Air
2. Approved Equal

2.02 CUSTOM GAS-ELECTRIC ROOFTOP UNITS (RTUS 1121 & 1122)

A. General:

1. Custom Gas-Electric Rooftop Units (RTUs 1121 & 1122) shall be built to the level of quality as herein specified and to the description on the unit scheduled on the drawings.
2. Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for equivalent products must address these factors.

3. Units are to be shipped to the job in one piece, factory assembled. All equipment shall be factory tested prior to shipment. All equipment shall be pre-wired, and factory certified by an approved testing agency such as ETL-US prior to shipment.
4. Units shall be pre-wired and shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
5. All electrical circuits shall undergo a dielectric strength test and shall be factory tested and checked as to proper function.
6. The units, and major components, shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.
7. Units shall include supply and return fans and an economizer/mixing damper arrangement.
8. Manufacturer shall have a fully implemented and auditable quality assurance program, equal to the ISO-9002 Quality Standard.
9. Units shall be equivalent to Engineered Air as the basis of design.

B. Casing:

1. Unit casing shall be of minimum 18-gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish exterior coat shall be two-part epoxy paint with clear top coat all exterior exposed surfaces, including the roof curb. All unprotected metal and welds shall be factory coated.
2. Continuous high-pressure sealant shall be provided between all panels.
3. All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant.
4. The unit casing shall be built with full double walled construction including a 22-gauge solid galvanized metal liner over all insulated areas including the unit underside.
5. Unit shall be provided with access doors to the following components: fan and motor, filters, damper and operator, access plenum and electrical / burner control compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
6. Access doors shall be provided with hinged access doors in welded steel frames. Doors shall be fully lined, come complete with bulb trim seal gasket and lever lock handles, operable from both sides. Hinged access doors shall open outwards.
7. Provide marine lights with glass globes with metal protective cage in each section provided with an access door. Lights shall be wired in EMT with liquid tight fittings conduit to a common switch all powered by a separate 120-volt power supply circuit by others.
8. Unit shall be internally insulated with 2-inches thick, 1-1/2 lb. / cu. ft., density insulation sandwiched between outer casing panels and inner metal liner panels for full double walled construction throughout including unit floor.
9. Unit casing shall be provided with reinforcing cross channels under floor to minimize deflection.

10. The following specialized construction and features for the make-up air handling unit shall be provided:
- a. Inlet hood with birdscreen.
 - b. Solid-state control burner controller with adjustable minimum discharge set at 74°F.
 - c. TEFC Super-E belted fan motor with 1.15 service factor.
 - d. Blower assembly motor drives / belts with a 1.5 service factor.
 - e. Aluminum dampers and damper frames
 - f. Solid metal liner throughout. Two part epoxy coat exterior with clearcoat final finish plus interior exposed welds and non-galvanized steel components, excluding gas fired heat exchanger and aluminum dampers.
 - g. Coat fan shafts with chlorine resistant coating.
 - h. Gasket and/or caulk seal all opening between control panel and the air stream and at all wiring conduit entering and leaving the electrical / controls / burner compartments.
 - i. Unit shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, hood on air intake with 1-inch galvanized inlet screen; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 2-inches with three break interlocking design; outer wall panels extend a minimum of 1/4-inch below the floor panel; drain trap(s) connections for field supply and installation of drain traps for casing floor drains.
 - j. Unit to be mounted on a roof curb and have drain trap connections for field supply and installation of drain traps for casing floors drainage. Unit floor to incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.
 - k. Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 28-inches high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1-inch upturn on inner perimeter, to provide a complete seal against the elements. Exposed surfaces of the roof curb to be factory painted with two part epoxy paint with the same finish as the unit exterior. External insulation and flashing of the roof-mounting curb shall be provided under Division 7.

C. Supply and Return Air Fan, Motor, and Drive:

- 1. Centrifugal fan shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. Fan and fan assembly shall be dynamically balanced during factory test run. Fan shaft shall be selected for stable operation at least 20% below the first critical RPM. Fan shaft shall be provided with a rust inhibiting coating.
- 2. Single fans shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.
- 3. Drives shall be adjustable on fan motors assembly. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

4. Fan motor assembly shall be factory installed, balanced and tested at full rated load and speed prior to shipment.
5. Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly. Motor mounting shall be adjustable to allow for variations in belt tension.
6. Provide standard OSHA approved belt guard on belted drive assembly.
7. Fan-motor assembly shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single forward curve fan. Fan shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
8. Provide extended grease lines to access side cabinetry.
9. Fan motor shall TEFC (totally enclosed fan cooled) Super E high efficiency type.

D. Heating System:

1. General:
 - a. Heating section shall be indirect natural, gas fired approved for both sea level and high-altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority and carry the approval label of that authority as a complete operating package.
 - b. All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire operation.
 - c. Operating natural gas inlet pressure at unit manifold shall be 7-inches, wg minimum and up to 14-inches, wg maximum.
 - d. Gas fired unit shall be approved for operation in -40°F
2. Heat Exchanger/Burner Assembly
 - a. Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1-inch of insulation between the outer cabinet and inner heat reflective galvanized steel liner. Blower location shall be engineered to improve the required air flow pattern around the heat exchanger. Using duct type furnaces and closed coupled blowers are not acceptable.
 - b. High efficiency heat exchanger shall be tested and certified to ANSI/CSA standards to provide a minimum of 80% output efficiency throughout the entire modulating operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.
 - c. The heat exchanger/burner assembly shall be a blow through positive pressure type. Unit shall incorporate the DJM burner control module and have an interrupted pilot ignition system to provide increased safety. Units using continuous or intermittent pilots are not acceptable.
 - d. Flame surveillance shall be from the main flame after ignition not the pilot flame. The burner and gas train shall be in a cabinet enclosure. Atmospheric burners or burners requiring power assisted venting are not acceptable.

- e. The heat exchanger/burner assembly shall include 15:1 turndown for all input ranges from low to high fire. The high turn down heat exchanger/burner assembly minimum input shall be capable of controlling 6.7% of its rated input, excluding the pilot assembly, without on/off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from high to low fire.
- f. Factory testing of indirect fired gas heating section.
 - 1) Tests shall be performed after complete final unit assembly, just prior to shipping to job site. The tests shall be performed in accordance with the equipment standard that the gas heating section is certified.
 - 2) Heat exchanger shall be clocked with a dedicated calibrated gas meter to insure proper set up of the gas manifold.
 - 3) High and Low input flue gas combustion analysis using a calibrated combustion analyzer including O₂ and CO to provide proper air fuel ratio throughout the entire operating range.
 - 4) Heat Exchanger airflow pattern shall be tested to ensure uniform airflow across all parts of the heat exchanger.
 - 5) Once the equilibrium operating temperatures have been reached, the heat exchanger temperatures shall be checked to ensure that all surfaces are below 1075°F. Temperatures above this can lead to premature heat exchanger failure.
 - 6) Flue gas temperature and combustion analysis shall be performed. The heat exchanger efficiency shall be analyzed and must meet current requirements.
 - 7) High limit operational check shall be performed to ensure proper function at all normal airflows including loaded filters.
 - 8) If the unit is capable of or intended to operate at varying air flows, all of the above tests must be performed at high flow and low flow.
- g. Venting
 - 1) Installation and venting provisions must be in accordance with CAN/CSA Standard B149.1, ANSI Z223.1-NFPA 54, and local authorities having jurisdiction. Field install the factory provided stainless steel "wedge vent" flue terminal.
- h. Controls
 - 1) Electronic DJM module (Modulating Fuel w/ Modulating Combustion Air) complete with proportional and integral control with discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Combustion air motor speed varies proportionally in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions. Combustion blower RPM shall be proved using a Hall Effect speed sensor.
 - 2) Combustion efficiency of high efficiency heat exchangers shall increase by up to 1-2% from high fire to low fire while turning down on unit incorporating 15:1 turndown (HT Burner). Heat exchangers shall provide a minimum of 80% efficiency throughout the entire operating range.
 - 3) DJM Burner Controller for heating only application unit shall include the following standard features:

- a) Service analyzer with diagnostic lights for ease of set-up and service
 - b) Linear gas and combustion air flow obtained via a built in solid-state linear algorithm
 - c) -40°F minimum operating ambient temperature
 - d) Four air change pre-purge
 - e) Maintained purge to decrease temperature cycles
 - f) Post purge
 - g) Interrupted pilot
 - h) Self-check on start-up to make sure air proving and discharge air sensors are operating within design tolerances
 - i) Low fire start
 - j) Controlled burner start-up and shut down
 - k) Blower contactor that starts fan after burner prepurge
 - l) Damper contact that allows fan to start after damper opens, damper to close after fan stops, and damper to close on flame failure
 - m) Non-recycling auto by-pass low limit with alarm contacts and built-in sensor checking
 - n) Separate gas and air actuators independently controlled to give the correct air to fuel ratio though out the entire firing range.
- 4) Heating control function shall be per the sequence set forth on the drawings.
 - 5) Controller for heating only application to incorporate integral auto bypass low limit feature.
 - 6) Discharge air sensor shall be field mounted in supply ductwork by installing contractor.
 - 7) Provide a make-up air reverse airflow high limit switch in series with the standard high limit switch mounted in the blower discharge.
 - 8) Controls: Heating shall be disabled above an adjustable ambient temperature set point.
 - 9) The controller shall attempt up to 3 ignition attempts in the event of loss of flame signal before disabling equipment operation.

E. Mechanical Cooling System

1. General

- a. The entire cooling package including fan controls, head pressure control, and all other miscellaneous controls and accessories shall be pre-wired and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination.
- b. Equipment shall operate down to 50°F (10°C) ambient temperature for mixed air and 58°F (14.4°C) ambient temperature for make-up-air applications. Where applicable, multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with TX valves, sight glass, liquid line

filter-driers, and service ports fitted with Schrader fittings. Equipment shall have condensers designed for 15°F (8°C) liquid sub-cooling. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.

- c. Units shall be supplied with R-410A

2. Compressors:

- a. Compressors shall be hermetic scroll type set on resilient neoprene mounts.
- b. Compressors shall incorporate an internal or external pressure-limiting device to protect the compressor in the event of overpressure.
- c. Compressors shall be provided with a means of overload protection.
- d. External crankcase heaters shall be locked out during compressor operation.
- e. Compressors shall be located on the side of the unit in a service enclosure complete with hinged access doors c/w lever
- f. Units to have a minimum of three compressors.
- g. Provide hot gas bypass on the lead compressor to provide freeze protection in the event of low loads.

3. Air Cooled Condenser

- a. Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory pressure tested with air while immersed in an illuminated water tank.
- b. Condenser fans shall be direct drive propeller type arranged for vertical draw through airflow. Motors shall be weather resistant type with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted in a venturi for optimum efficiency with minimum noise level.
- c. Condenser fans shall be fully housed fan with protective screen and fluted blades for optimum efficiency with minimum noise level.
- d. Condenser section to form an integral part of the unit.

4. Cooling Control

- a. The cooling controller shall be complete with proportional and integral control with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature.
- b. The controller shall provide 6 stages of mechanical cooling.
- c. The controller shall have built-in minimum run time and anti-cycle timers.
- d. Mechanical cooling shall be disabled below a fixed low ambient temperature setpoint.
- e. Cooling enable/disable shall be through controller demand.
- f. When controller is in economizer mode, the mechanical cooling shall be enabled.
- g. Electronic control shall have two stage electronic room control with free cooling.
- h. Controls shall include compressor and condenser fan motor contactors, supply fan contactors and overload protection, control circuit transformer, cooling relays, ambient compressor lockout, anti-short-cycle and inter-stage timers, and automatic reset low pressure controls. Compressors over 6 tons (21 kW) shall

be complete with manual reset high pressure controls. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

- i. When controller is in economizer mode, minimum compressor runtime shall not force the OA damper closed until the leaving air temperature is less than 45 deg F.
- j. Provide Fault Detection and Diagnostics to monitor the following temperatures and statuses.
 - 1) OA temperature
 - 2) SA temperature
 - 3) RA temperature
 - 4) Free cooling available
 - 5) Economizer enabled
 - 6) Compressor enabled
 - 7) Heating enabled
 - 8) MA low limit cycle active
 - 9) Air temperature sensor failure
 - 10) Not economizing when the unit should be economizing
 - 11) Economizing when the unit should not be economizing
 - 12) Damper not modulating
 - 13) Excess OA

F. Filters:

- 1. Filter section shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.
- 2. Unit filter bank shall be designed so that the filter modules side / slide out of the unit. Side removal with 2-inch filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
- 3. Two-Inch Thickness Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Provide permanent re-usable metal enclosing frame for each filter. The filter media shall have a minimum efficiency of 30-35% on ASHRAE Standard 52.1-2013, and a minimum of MERV 8 per ASHRAE 52.2-2013.
- 4. Filter media shall meet UL 900 classification.
- 5. Provide filter bank with Dwyer 2000 magnehelic air filter gauge complete with static pressure taps and aluminum tubing all factory installed. Filter gauge to have a range of 0 to 2-inches, wg.
- 6. Since the filter gauge is being provided on an outdoor unit, it shall be mounted inside of a weatherproof enclosure with viewing window.

G. Dampers:

- 1. Damper frames shall be U-shaped extruded aluminum metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 1/2-inch aluminum shall turn in

nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.

2. Blades shall be low leak dampers with blade ends sealed with an adhesive backed foamed polyurethane gasketing. Interlocking blade edges shall include an all-weather PVC seal fastened with a positive lock grip and pliable overlap edges on both the entering and leaving air sides, with extruded aluminum blades and damper frame Ruskin CD-50.
3. Two position inlet dampers shall be parallel blade type.
4. Make-up air inlet damper control shall provide a two position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position.

H. Factory Supplied Controls/Wiring:

1. Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.
2. Gas fired unit shall also include high limit and combustion airflow switch.
3. Fire alarm circuit contact(s) shall be provided by others.
4. Factory installed and wired non-fused disconnect switch in NEMA 3 weatherproof configuration.
5. Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.
6. All control and main three phase power wiring outside the integral unit control panel of the unit to be in liquid tight flex conduit internally sealed wherever the wiring enters or exits the compartment.
7. Provide a factory installed clogged filter indication control dry contact as well as a terminalized factory mounted air proving switch dry contact for supply air fan on indication operation, all for use by others.
8. As an integral part of the burner controller module logic, provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure, this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.

I. Acceptable Manufacturers:

1. Engineered Air
2. Approved Equal

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Coordinate location assure straight duct connections.
- B. Install unit to provide required clearances.

C. Install according to manufacturer instructions.

3.02 STARTERS AND DISCONNECTS

A. Contractor to verify requirements with Temperature Controls, Electrical, and manufacturer-provided equipment. Where devices are not furnished and/or mounted by manufacturer, coordinate installation and connections with other trades.

END OF SECTION

SECTION 23 80 00

DECENTRALIZED HVAC EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes:

- 1. Packaged Rooftop Air Conditioning Units with Electric Heat (RTU 1110)
- 2. Packaged Rooftop Air Conditioning Units with Gas Heat (RTU 1120)
- 3. Electric Baseboard Heaters (EBB 1145 & 1146)

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

- B. Shop Drawings

- 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 2. Include diagrams for power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

- 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Maintenance schedules and repair part lists for motor, coil, integral controls, and filter.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 PRODUCTS

2.01 PACKAGED ROOFTOP AIR CONDITIONING UNITS WITH ELECTRIC HEAT (RTU 1110)

A. General:

1. The units shall be convertible airflow.
2. The operating range for mechanical cooling shall be between 115°F and 0°F.
3. Cooling performance shall be rated in accordance with ARI testing procedures.
4. All units shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory.
5. Wiring internal to the unit shall be colored and numbered for simplified identification.
6. Units shall be UL listed and labeled, classified in accordance for Central Cooling Air Conditioners.
7. Minimum Efficiency (SEER) = 15.

B. Casing

1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel.
2. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish.
3. Units surface shall be tested 672 hours in a salt spray test in compliance with ASTM B117.
4. Cabinet construction shall allow for all maintenance on one side of the unit.
5. Service panels shall have lifting handles and be removed and reinstalled by removing two fasteners while providing a water and air tight seal.
6. All exposed vertical panels and top covers in the indoor air section shall be insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material. The base of the unit shall be insulated with 1/8", foil-faced, closed-cell insulation. All insulation edges shall be either captured or sealed.
7. The unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 1 1/8" inch high downflow supply/return openings to provide an added water integrity precaution if the condensate drain backs up.
8. The base of the unit shall have provisions for forklift and crane lifting, with forklift capabilities on three sides of the unit.

C. Hinged Access Doors

1. Sheet metal hinges shall be provided on the Filter/Evaporator, Supply Fan/Heat, and the Compressor/Control Access Doors.

D. Unit Top

1. The top cover shall be one piece construction or, where seams exist, it shall be double-hemmed and gasket-sealed. The ribbed top adds extra strength and enhances water removal from unit top.

E. Filters

1. Filters shall be 2-inch MERV 8 pleated.

F. Compressors

1. All units shall have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps.
2. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors.

G. Evaporator and Condenser Coils

1. Evaporator coils shall be internally finned, 5/16" copper tubes mechanically bonded to a configured aluminum plate fin.
2. Condenser coils shall be microchannel type.
3. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 600 psig. The assembled unit shall be leak tested to 465 psig. The condenser coil shall have a patent pending 1+1+1 hybrid coil designed with slight gaps for ease of cleaning.
4. A plastic, dual-sloped, removable, and reversible condensate drain pan with through-the-base condensate drain shall be provided.

H. Tool-less Hail Guards

1. Tool-less, hail protection quality coil guards shall be provided for condenser coil protection.

I. Outdoor Fans

1. The outdoor fan shall be direct-drive, statically and dynamically balanced, draw-through in the vertical discharge position.
2. The fan motor shall be permanently lubricated and shall have built-in thermal overload protection.

J. Indoor Fan

1. Indoor fan shall be a FC centrifugal type with a multispeed, direct drive motor.
2. Motor shall be thermally protected.
3. Indoor fan motor shall meet the U.S. Energy Policy Act of 1992 (EPACT).

K. Controls

1. Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring.
2. Unit shall provide an external location for mounting a fused disconnect device.
3. Unit shall be equipped with microprocessor controls providing for to produce the control sequence set forth on the drawings.
4. The centralized microprocessor shall provide anti-short cycle timing and time delay between compressors.

5. When unit is in economizer mode, minimum compressor runtime shall not force the OA damper closed until the leaving air temperature is less than 45 deg F.
6. Provide Fault Detection and Diagnostics to monitor the following temperatures and statuses.
 - a. OA temperature
 - b. SA temperature
 - c. RA temperature
 - d. Free cooling available
 - e. Economizer enabled
 - f. Compressor enabled
 - g. Heating enabled
 - h. MA low limit cycle active
 - i. Air temperature sensor failure
 - j. Not economizing when the unit should be economizing
 - k. Economizing when the unit should not be economizing
 - l. Damper not modulating
 - m. Excess OA

L. Refrigerant Circuits

1. Each refrigerant circuit shall have a thermal expansion valve, service pressure ports, and refrigerant line filter driers.
2. An area shall be provided for replacement suction line driers.

M. Phase monitor

1. A phase monitor shall provide 100% protection for motors and compressors against problems caused by phase loss, phase imbalance, and phase reversal. Phase monitor shall be equipped with an LED that provides an ON or FAULT indicator. The module shall automatically reset from a fault condition.

N. Electric Heaters

1. Electric heat modules shall be factory installed within the basic unit.
2. Electric heater elements shall be constructed of heavy-duty nickel chromium elements internally delta connected for 240 volt, wye connected for 480 and 600 volt.
3. Staging shall be achieved through the unit controller.
4. Each heater package shall have automatically reset high limit control operating through heating element contactors. All heaters shall be individually fused from the factory, where required, and shall meet all NEC and CEC requirements.
5. Power assemblies shall provide single point connection. Electric heat modules shall be UL listed or CSA certified.

O. Economizer

1. A Low Leak Economizer Feature shall be provided with barometric relief.

2. The assembly shall include a fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug, spring return actuator and fixed dry bulb control.
3. The barometric relief shall provide a pressure operated damper that shall be gravity closing and shall prohibit entrance of outside air during the equipment off cycle.

P. Acceptable Manufacturers:

1. Trane
2. Approved Equal

2.02 PACKAGED ROOFTOP AIR CONDITIONING UNITS WITH GAS HEAT (RTU 1120)

A. General

1. All units shall be factory assembled, piped, internally wired and fully charged with refrigerant. All units shall be designed to operate at outdoor ambient temperatures as high as 115°F. Cooling capacities shall be rated in accordance with A.H.R.I. standards. The heating/cooling unit design is certified to ANSI 221.47/CSA2.3, specifically for outdoor applications using natural gas or propane. All units shall be designed for outdoor rooftop or ground level installation. Unit casing is constructed of heavy gauge, galvanized steel and painted with a weather-resistant powder paint.
2. Unit shall be shipped for horizontal application, convertible to downflow.
3. Minimum Efficiency (SEER) = 15.

B. Casings

1. All panels shall be heavy gauge steel, gasketed and insulated. Foil-faced insulation shall be in the heat exchanger section. Foil-faced insulation shall be in the evaporator section. Base pan shall be heavy gauge steel. WEATHERGUARD™ exterior corrosion resistant screws shall be used for added resistance to rust and corrosion.

C. Controls

1. Refrigeration cycle controls shall include condenser fan, evaporator fan and compressor contactors. Compressors shall be equipped with a combination internal winding thermostat/current overload. Internal high pressure relief shall also be provided.
2. When unit is in economizer mode, minimum compressor runtime shall not force the OA damper closed until the leaving air temperature is less than 45 deg F.

D. Refrigeration System

1. Compressors:
 - a. Compressor shall be two-stage with internal over temperature and pressure protection.
 - b. Total dipped hermetic motor.
 - c. Centrifugal oil pump.
2. Evaporator Coil:
 - a. All aluminum micro channel, extruded tubes, mechanically bonded to aluminum fins and factory pressure and leak tested at 480-650 psig.

- b. Unit shall have TXV to control refrigerant flow.
- 3. Condenser Coil:
 - a. The Spine Fin™ condenser coil shall be continuously wrapped, corrosion resistant all aluminum with minimum brazed joints.
 - b. This coil is 3/8 inch OD seamless aluminum tubing glued to a continuous aluminum fin.
 - c. Coils shall be lab tested to withstand 2,000 pounds of pressure per square inch.
 - d. The outdoor coil shall be protected on all four sides by louvered panels.
- 4. Indoor Air Fan:
 - a. Direct-drive, forward-curved, centrifugal wheel in a Composite Blower housing.
 - b. Motor shall have thermal overload protection, and permanently lubricated motor bearings.
 - c. Motor/blower assembly shall be isolated from the unit with rubber mounts.
- 5. Condenser Fan:
 - a. Direct-drive, draw through propeller type.
 - b. Weather-proofed permanent split capacitor fan motor shall have built-in thermal overload and permanently lubricated motor bearings.
- 6. Low Ambient Accessory:
 - a. Provide to enable refrigerant system operation down to 0°F ambient condition.
- E. Gas-Fired Heating System:
 - 1. Unit shall include completely assembled, wired and piped gas fired heating systems within the unit.
 - 2. Design shall be certified by UL, specifically for outdoor application.
 - 3. Threaded gas connection on the unit.
 - 4. Electronic Ignition System
 - 5. Flame sensor shall prove flame to keep the main burners on. Should a loss of flame occur, the main valve shall close and the spark recur within 0.8 second.
 - 6. When the thermostat is satisfied, main burner is extinguished.
 - 7. A forced combustion blower shall insure flame stability under varying wind conditions.
 - 8. Heat Exchanger shall have stainless steel tubes with a free floating design.
 - 9. Burners shall be stainless steel. Multi-port inshot.
- F. Accessories
 - 1. Roof Curb—The roof curb shall be designed to mate with the unit and provide support and complete weather-tight installation when properly installed. Curb shall ship knocked down for field assembly, and include wood nailer strips.
 - 2. Modulating Economizer—This accessory shall be field installed and be composed of the following items: 0-100% fresh air damper, damper drive motor fixed dry bulb control, and low voltage polarized plug for electrical connections.

3. A barometric relief damper shall be provided with the economizer and provide a pressure operated damper that shall be gravity closing and prohibit entrance of outside air on equipment "off" cycle.
- G. Acceptable Manufacturers:
1. Trane
 2. Approved Equal
- 2.03 ELECTRIC BASEBOARD HEATERS (EBB 1145 & 1146)
- A. Enclosure:
1. Shall be fabricated of 20-gauge steel body with 20-gauge front panel and welded junction box, with a built-in wireway with factory installed wiring.
 2. Removal of the front panel shall provide unobstructed access to the element area and terminal boxes.
- B. Heating Elements:
1. Shall be constructed of nickel chromium heating element wire, embedded in magnesium oxide, and enclosed in a stainless steel sheath for maximum strength and corrosion resistance.
 2. Aluminum fins shall be pressure bonded to the sheath.
 3. The elements shall be center anchored and float freely on each end in high temperature nylon bushings.
- C. Over-temperature Protection:
1. An automatic reset thermal overheat protector shall run the length of the heater turning the unit off in the event an overheating situation should occur.
 2. The protector shall automatically reset after the unit has cooled down.
- D. Heating Lengths and Voltages:
1. Heater lengths, voltages, and wattage capacities shall be as indicated on the plans.
- E. Finish:
1. All heaters and trim accessories shall have either a white or almond epoxy/polyester powder paint finish. The finish shall accept any interior paint.
- F. Mounting:
1. Two rows of oblong mounting holes with center marks shall be provided for ease of installation.
 2. Heaters may be mounted flush on any floor surface.
- G. Adjustable Thermostat:

1. Shall be built into the system. For EBB 1145, an additional supervisory thermostat shall be furnished and installed under Electrical Scope to shut off the heater when the Outside Air Temperature rises above 45 deg F.
- H. Average Watt Density shall be 275 W/ft (900 W/m) maximum.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer instructions.
- B. Install unit to provide required clearances.
- C. Provide support system for equipment.

3.02 STARTERS AND DISCONNECTS

- A. Verify requirements among Temperature Controls, Electrical, and manufacturer-provided equipment. Where devices are not furnished and/or mounted by manufacturer, coordinate installation and connections with other trades.

3.03 UNIT HEATER INSTALLATION

- A. Use manufacturer provided vent/combustion air termination assemblies; comply with manufacturer's requirements for vent and combustion air installation.
- B. Use manufacturer's mounting brackets and secure to building. Where called out on drawings, mount equipment at heights indicated.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. General: This section specifies several categories of provisions for electrical work, including the following:
 - 1. Certain adaptive expansions of requirements specified in Division 1.
 - 2. General performance requirements within the electrical system as a whole.
 - 3. General work to be performed as electrical work because of its close association.
- B. Drawings: Examine all drawings relating to the project. Include all work, materials, and equipment mentioned or shown as being provided under this division. Refer to all Drawings and details in coordinating and completing the work. Study all Drawings to determine any conflicts with ordinances and statutes. Report any discrepancies, conflicts, or omissions; accomplish work required for conformance and/or completion.
- C. Specifications: Examine all specification divisions relating to the project. Include all work, materials, and equipment mentioned as being provided under this division. Study all specifications to determine any conflicts with ordinances and statutes. Report any discrepancies, conflicts, or omissions; accomplish work as required for conformance and/or completion.

1.03 COORDINATION WITH ELECTRICAL WORK

- A. General: Refer to the Division 1 sections for general coordination requirements applicable to the entire Work. It is recognized that the Drawings are diagrammatic in showing certain physical relationships that must be established within the electrical work, and in its interface with other work including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Contractor.
 - 1. Provide offsets, transitions, fittings, and accessories that may be required but have not been shown because of the small scale of the Drawings.
 - 2. Verify all voltages and connection requirements for equipment furnished by others and wired under this contract.
 - 3. Arrange electrical work in a neat, well organized manner with conduit and similar services running parallel with primary lines of the building construction, and with a minimum 7' - 0" overhead clearance where possible.
 - 4. Locate operating and control equipment properly to provide easy access and arrange entire electrical work with adequate access for operation and maintenance. Final

locations of electrical control and safety devices shall be approved by the Engineer prior to installation.

5. Advise other trades of openings required in their work for the subsequent installation of large units of electrical work (equipment).
6. Installation details are included in the Drawings to describe the specific installation practices to be followed as work of this contract. Although the details are not specifically referenced from the Drawings, the installation practices described by each detail shall be applied as generally described by the title of the detail.

1.04 QUALITY ASSURANCE, STANDARDS, DEFINITIONS, AND SYMBOLS

- A. General: Refer to Division 1 for general administrative/procedural requirements related to compliance with codes and standards. At a minimum, materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards, and utility company regulations. In the event of conflict between codes, state laws, local ordinances, industry standards, utility company regulations, and the contract documents, the most stringent of these shall govern the requirements to be satisfied.
- B. Standards: This division contains references to the following standards issuing organizations. Where a specific standard is referenced in these specifications, the standard shall be considered part of this division as specified and modified. Unless otherwise specified, references to standards shall mean the standard in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced standards have been discontinued by the issuing organization, references to those standards shall mean the replacement standards issued or otherwise identified by that organization or, if there are no replacement standards, the last version of the standard before it was discontinued. Where standards dates are referenced, references to those standards shall mean the specific standard version associated with that date, whether or not the standard has been superseded by a version with a later date, discontinued or replaced.

<u>Reference</u>	<u>Standards Organization</u>
ANSI Standards	American National Standards Institute
ASTM Standards	American Society of Testing Materials
IEEE Standards	Institute of Electrical and Electronic Engineers
ICEA Standards	Insulated Cable Engineers Association
NECA Standards	National Electrical Contractors Association
NEMA Standards	National Electrical Manufacturers Association
NFPA Standards	National Fire Protection Association
NFPA 70	National Electrical Code (NEC)
OSHA Standards	Occupational Safety and Health Act
UL Standards	Underwriters' Laboratories

C. Definitions

1. Elementary or Schematic Diagram: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
2. One-line Diagram: A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

3. Block Diagram: A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.
 4. Wiring or Connection Diagram: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly.
 5. Interconnection Diagram:
 - a. Interconnection diagrams shall show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams that interface to the interconnection diagrams.
 - b. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable. Wire identification shall be shown as actually installed.
 - c. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified in the equipment complete with individual terminal identification.
 6. Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one that shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.
- D. Identification of Listed Products: Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.
1. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.
- E. Symbols: Except as otherwise indicated, refer to the symbols legend on the Drawings for definitions of symbols used on the Drawings to show electrical work.

1.05 ELECTRICAL COMPLIANCE SUBMITTALS

- A. General: Electrical compliance submittals shall be prepared and submitted in accordance with the Conditions of Contract, Division 1 Specification Sections, and this specification section. The types of submittals required for electrical work are defined herein. Refer to each Division 26 specification section for detailed requirements for submittal content. Administrative submittals are specified elsewhere in the Contract Documents.
- B. Electronic Submittals: Each submittal shall be prepared as an electronic file and shall be prepared in accordance with the following requirements.
1. Each submittal shall be an electronic file in the Adobe Acrobat Portable Document Format (PDF). The latest version of Adobe Acrobat available at the time of execution of the Agreement shall be used in preparation of the submittals.

2. PDF files shall be created from the native digital form of the document. Scanned images are not acceptable.
 - a. Materials not available in original digital format shall be scanned into digital format and cleaned to remove smudges, fingerprints, artifacts, and other extraneous marks. All scanned documents shall be processed by an optical character recognition (OCR) application to make the document searchable. The original scanned image shall be retained with the file.
 - b. Text shall be searchable and shall appear and paginated as it would in hardcopy.
3. Submittals shall be organized with internal bookmarking using the Adobe Acrobat bookmarking utility. Bookmarking within the document shall be organized as follows:
 - a. Each section and individual documents within the section shall be bookmarked.
 - b. Each manufacturer's manual, catalog, or other published document shall be bookmarked using the title of the document.
 - c. Contractor prepared forms such as transmittal forms, motor data forms, and the like shall be bookmarked.
 - d. Bookmarks shall be organized in a hierarchical structure as required to represent the purpose of the individual documents and their association to each other.
 - e. Documents representing specific pieces of equipment such as performance curves and analyses, motor characteristics, dimension and assembly drawings, etc., shall be organized and bookmarked for each piece of equipment.
 - f. Bookmarks shall be collapsed to the top level bookmarks and be visible when the file is opened.
 - g. Bookmarks zoom level shall be set to "Fit Page".
4. PDF files shall be set to open with the following Initial View settings:
 - a. Navigation Tab: Bookmarks Panel and Page.
 - b. Page Layout: Single Page.
 - c. Magnification: Fit Page.
5. General information shall be added to each PDF file including title, subject, author, and keywords.
6. PDF files submitted for review may be secured; however, the following actions within Adobe Acrobat shall be permitted by the reviewer.
 - a. Printing.
 - b. Content copying or extraction.
 - c. Content copying for accessibility.
 - d. Commenting.
7. PDF files submitted as final documents shall be unsecured, unencrypted, and not password protected.
8. PDF files shall be configured to print legibly at either 8-1/2 inch x 11-inch or 11-inch by 17-inch paper sizes. No other paper sizes shall be permitted.
9. New electronic files shall be prepared for each resubmittal.
10. Each electronic submittal shall also include a copy of the Contractor's transmittal form.
11. Contractor authorizes the Engineer to reproduce and/or redistribute each file as many times as necessary for the project.

- C. Content: Electrical compliance submittals shall include the following information.
1. Shop Drawings: Project shop drawings and other data prepared specifically for fulfillment of the project requirements. Shop drawings include fabrication, layout, wiring diagrams, erection, setting, coordination and similar drawings and diagrams, and include performance data associated therewith, including weights, capacities, speeds, outputs, consumptions, efficiencies, voltages, amperages, cycles, phases, noise levels, operating ranges, and similar information.
 2. Manufacturer's Data: Product manufacturer's standard printed product information, including (as applicable) promotional brochures, product specifications, installation instructions and diagrams, statements of compliance with standards, performance charts or curves, and similar information concerning the standard portions of the manufacturer's products.
 3. Certifications: Written statements, either standard printed forms or specifically prepared text, executed specifically for the project application by an authorized officer of the contracting firm, manufacturer, or other firm as designated, certifying (to the best of his knowledge) to compliance with the requirements as specified.
 4. Specification Conformance: Each electrical submittal shall include a copy of the applicable specification section, inclusive of all addendum updates, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
- D. Submittal Presentation: All submittals shall be in digital format and transmitted electronically. Digital submittals shall be assembled as a single portable document format (.PDF) file, including a cover sheet, indexed by item and cross-referenced to the appropriate specification paragraph. Catalog cuts shall be edited to explicitly show the items, model numbers, and information that applies to the equipment being furnished.
- E. Partial, incomplete or illegible submittals will be returned to the Contractor without review for re-submittal.

1.06 INSTRUCTION MANUALS

- A. General: Submittals shall be in accordance with Conditions of Contract and Division 1 Specification Sections and the requirements of this specification section. Instruction Manuals shall be submitted complete prior to commencing any training; partial or incomplete data shall not be accepted.
- B. Electronic Submittals: Each submittal shall be prepared as an electronic file in accordance with paragraph 1.05 B.
- C. Content: Instruction Manuals shall include the following information.

1. Contact Information: Instruction Manuals shall include the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts.
2. Manufacturer's Product Warranties: Manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits.
3. User Manuals: The written instructions by the manufacturer, fabricator, or installer of equipment or systems, detailing the procedures to be followed by the Owner in configuration, operation, control, and shutdown of each operating item of the equipment and each electrical system.
4. Maintenance Manuals: The compiled information provided for the Owner's maintenance and troubleshooting of each system of operating equipment, including lubrication, emergency control, parts replacement, spare parts inventory recommendation, listing of tools and accessories needed for maintenance, and similar instructions.
5. Guarantees: The Contractor's specific signed commitment (including countersignature by others as required) to the Owner that acts of restitution will be performed when and if electrical work fails within certain operational conditions and time limits.
6. Certifications: Written statements, either standard printed forms or specifically prepared text, executed specifically for the project application by an authorized officer of the contracting firm, manufacturer, or other firm as designated, certifying the equipment installation, configuration, and startup is in compliance with the manufacturer's recommendations and the project requirements.
7. Test Reports: The results of all specified factory and field tests shall be included with the Instruction Manuals.
8. Startup Reports: Equipment manufacturer's field startup reports shall be included with the Instruction Manuals.
9. Configuration Data: A written record documenting the setup and configuration of each system that is software, hardware, or firmware configurable in the field shall be included in the Instruction Manual. All configuration parameters, jumpers, switch settings, etc., shall be recorded.
10. As-Built Control Wiring Diagrams and Assembly Drawings: As-built control diagrams and assembly drawings shall be provided in appropriately sized binders. Drawings shall not be folded or otherwise reduced in size for assembly in the instruction manual binder. As-built drawings shall be organized by facility or location.

1.07 DRAWINGS

- A. Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 11 inch by 17 inch paper complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing. Drawings shall be prepared on a computer-aided drafting (CAD) system. All CAD drawing files shall be converted to .DWG file format. All CAD drawing files shall be updated to reflect final as-constructed conditions.

1.08 PROJECT/SITE CONDITIONS

- A. Environmental Conditions: Refer to Section 01 81 16 for information regarding environmental conditions for the project.

- B. Area Classifications: For the purpose of delineating the basic electrical construction materials and installation requirements for this project, areas of the project have been classified on the Drawings as defined below. Electrical work within these areas shall conform to the requirements described below as well as the referenced code requirements.
1. Architectural: All architecturally finished spaces including offices, laboratories, reception areas, conference rooms, kitchens, lobbies, and similar spaces. No area classification is indicated on the Drawings for this type of space.
 2. General Purpose (NEMA 1): Areas requiring general purpose, NEMA 1, construction include indoor non-process areas typically environmentally controlled areas such as electrical rooms.
 3. Outdoors and Process Areas (NEMA 4X): Areas requiring corrosion resistant, NEMA 4X, construction include all process areas and all equipment installed outdoors (unless otherwise noted). Process areas typically contain wastewater, chemicals, or sludge pumping or piping systems and are subject to spills and wash down. Corrosive process areas shall also include those areas containing chemicals.
 4. Utility and Mechanical Areas (NEMA 12): Areas requiring drip-proof, NEMA 12, construction include indoor support system areas and are not typically subject to spills, direct wash down, or corrosive chemicals under normal operating conditions.
 5. Hazardous Areas (NEMA 7): Areas classified as hazardous locations in accordance with NFPA 70, Article 500 requiring explosionproof construction.
- C. Construction Materials: Construction materials required for each area classification are listed in Table 26 05 00-A, appended to the end of this specification section. Refer to the individual specification section for each component for material composition and installation practices.
- D. Seismic: Electrical equipment and supports shall be braced in accordance with the International Building Code and all local and state amendments and/or modifications to the IBC unless otherwise noted.

1.09 STORAGE, DELIVERY, AND HANDLING OF MATERIALS AND EQUIPMENT

- A. Delivery: Deliver electrical materials and equipment properly packaged. Utilize factory fabricated containers or wrappings for materials and equipment which protect materials and equipment from damage. Inspect materials and equipment to ensure that no damage has occurred during shipment.
- B. Storage: Store electrical materials and equipment indoors in original packaging in areas specifically designated for equipment storage. Protect equipment and materials from construction traffic and debris.
- C. Handling: Handle electrical materials and equipment carefully to prevent physical damage to materials and equipment. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which could damage the materials and equipment contained therein. Do not install damaged materials or equipment; remove from site and replace damaged materials and equipment with new.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

2.02 CUTTING AND PATCHING

- A. Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of electrical work. Except as individually authorized by the Construction Manager, cutting and patching of electrical work to accommodate the installation of other work is not permitted.

2.03 EXCAVATING FOR ELECTRICAL WORK

- A. General: The work of this article is defined to include whatever excavating and backfilling is necessary to install the electrical work. Coordinate the work with other excavating and backfilling in the same area, including dewatering, flood protection provisions, and other temporary facilities. Coordinate the work with other work in the same area, including other underground services (existing and new), landscape development, paving, and floor slabs on grade. Coordinate with weather conditions and provide temporary facilities needed for protection and proper performance of excavating and backfilling.
 - 1. General Standards: Except as otherwise indicated, comply with the applicable provisions of Division 1 for electrical-work excavating and backfilling. Refer instances of uncertain applicability to the Construction Manager for resolution before proceeding.
 - 2. Replacement of Other Work: Where it is necessary to remove and replace landscape work, pavement, flooring, and similar exposed finish work, engage the original installer to install the replacement work, except where work existed prior to the work of this Contract. In such case, engage only experienced and expert firms and tradespersons to replace the work.

2.04 CONCRETE FOR ELECTRICAL WORK

- A. General: The work of this article is defined to include whatever concrete work is necessary or shown specifically to install the electrical work; but excluding equipment base grouting. Coordinate the work with other work, particularly other concrete work and accessories.
 - 1. General Standards: Except as otherwise indicated, comply with applicable provisions of Division 03 sections for electrical work concrete, including formwork, reinforcement, mix design, materials (use mix designs and materials accepted for Division 3 work where possible), admixtures, curing, protecting, testing, submittals and other requirements of the concrete work. Refer instances of uncertain applicability to the Construction Manager for resolution before proceeding.
- B. Classes and Applications: Except as otherwise specified in Division 03 sections or specifically detailed on the Drawings, provide strength classes as follows, with the following cement content and water/cement ratios; for the indicated applications and similar applications:
 - 1. 3000 psi Class: 500 pounds cement per yard (5.25 sacks); 0.58 water/cement ratio. Provide 3000 class for miscellaneous underground structural concrete, reinforced encasement, block type foundations (with smallest dimension at least 0.2 times largest dimension), curbs, pads, and similar structural support work.

2. Rough Grouting Class: 565 pounds cement per yard (6.0 sacks); 0.6 water/cement ratio; adjust aggregate sizes to facilitate placement. Use for rough grouting, not for setting equipment bases.
3. Concrete for conduit encasement shall have red oxide dye brushed into the top surface.

2.05 RUBBER MATS

- A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each piece of electrical equipment located indoors. The mat length shall be as required to cover the full length of each enclosure and be a single piece. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D 178 J6-7 for Type 2, Class 2 insulating matting.

2.06 MAINTENANCE MATERIALS

- A. Extra stock of spare parts, materials, replacement units, accessories, adjustment devices, and similar items as designated, for the Owner's initial use in maintaining the electrical equipment and systems in continued operation. Maintenance materials shall be furnished where specified in each equipment specification.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions in which equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 GENERAL

- A. Coordinate equipment installation work with electrical raceway and wire/cable work, as necessary for proper interface. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

3.03 RECORD DOCUMENTS

- A. Record documents refer to those documents maintained and annotated by the Contractor during construction, and include record drawings in accordance with Division 01 sections, and the following additional schedules, lists, and drawings:
 1. Submittal drawings including wiring and interconnection diagrams, layout drawings, rough-in drawings, etc.
 2. Submittal equipment schedules and lists.

Table 26 05 00-A

Component	Area Classification					
	Architectural	NEMA 1	NEMA 4X ¹	NEMA 7 ¹	NEMA 4/12 ¹	Outdoors ¹
Rigid Conduit (exposed)	NA	GRS	PGRS	PGRS	GRS	GRS
Rigid Conduit (concealed) ⁴	EMT	GRS	GRS	GRS	GRS	N/A
Flexible Conduit ⁵	FMC	LFMC	LFMC	LFMC	LFMC	LFMC
Support Systems	Galvanized Steel	Galvanized Steel	Stainless Steel	Galvanized Steel	Galvanized Steel	Galvanized Steel
Fastening Hardware and Hanger Rods	Cadmium Plated Steel	Cadmium Plated Steel	Stainless Steel	Stainless Steel	Cadmium Plated Steel	Stainless Steel
Control Stations ^{2,3}	Gasketed Steel	Gasketed Steel	Stainless Steel	Non-metallic or Steel	Steel	Stainless Steel
Enclosures ^{2,3}	Painted Steel	Painted Steel	Stainless Steel	Steel	Painted Steel	Stainless Steel
Receptacles ²						
Surface	NA	General	WP	XP	WP	WP
Recessed	General	General	WP	N/A	WP	N/A
Switches ²						
Surface	NA	General	WP	XP	WP	WP
Recessed	General	General	WP	N/A	WP	N/A

Table A Notes:

1. Enclosures, device boxes, control stations, and raceway systems shall be mounted with 1/4-inch (minimum) air space between the electrical system and supporting structure.
2. Conduit terminations to control stations, enclosures, and device boxes in NEMA 4X, 7, and 12 areas shall be made through threaded hubs.
3. Control station and enclosure NEMA sealing ratings shall meet or exceed the rating designated by the area classification.
4. Conduit encased in concrete duct bank or beneath slab on grade shall be rigid nonmetallic conduit in accordance with Specification 26 05 43.
5. Conduit concealed in concrete walls shall be raceway type RMC.
6. Flexible conduit shall be utilized for final connections to equipment.

Legend:

GRS Galvanized Steel Rigid Metal Conduit
 LFMC Liquidtight Flexible Metal Conduit
 PVC Rigid Polyvinyl Chloride
 P-GRS PVC coated Galvanized Steel Rigid Metal Conduit
 WP Weatherproof
 XP Explosionproof
 N/A Not applicable

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems
 - 2. Section 26 05 83, Low Voltage Wiring Connections
- C. This section is a Division 26 section and is part of each specification section referencing wires and cables specified herein.

1.02 SUMMARY

- A. This section specifies wires and cables rated 600 volts used for power, lighting, receptacle, signal, and control circuits.
- B. Extent, location, and details of wire and cable work are indicated on Drawings and in schedules.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Catalog cuts showing general information for all wires and cable.
 - 2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. NEMA/ICEA Compliance: Provide components that comply with the following standards:
 - a. WC-70 - Non-Shielded Power Cables Rated 2000 V or Less
3. UL Compliance: Provide components that are listed and labeled by UL under the following standards:
 - a. UL Standard 44 - Thermoset-Insulated Wires and Cables
 - b. UL Standard 83 - Thermoplastic-Insulated Wires and Cables
 - c. UL Standard 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - d. UL Standard 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
4. IEEE Compliance: Provide components that comply with the following standard:
 - a. IEEE Standard 82 - Test procedures for Impulse Voltage Tests on Insulated Conductors
 - b. IEEE Standard 802.3 – Carrier Sense Multiple Access with Collision Detection Access Method and Physical Layer Specifications
5. TIA/EIA Compliance: Provide components that comply with the following standards:
 - a. TIA 568-D - Commercial Building Telecommunications Cabling
 - b. TIA 606 - The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - c. TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications
 - d. TIA 1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling
 - e. TIA 568-D.0 – Generic Telecommunications Cabling for Customer Premises
 - f. TIA 568-D.1 – Commercial Building Telecommunications Cabling Standard
 - g. TIA 568-D.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard

- B. BICSI Registration: A registered Building Industry Consulting Service International (BICSI) Technician shall supervise and/or conduct all copper and fiber optic voice and data equipment and cabling, design, configuration, installation and testing work.

PART 2 PRODUCTS

2.01 GENERAL

- A. General requirements for conductors and cables specified in this section are listed in the Cable Specification Sheets at the end of this section.

- B. Cable Specification Sheets: The following Cable Specification Sheets are included in this section:

1. CORD
2. STP/6
3. STP/W
4. THWN
5. TSP/TST
6. UTP
7. VFD
8. XHHW-2

- C. Conductor and Cable Size: Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified in paragraph 26 05 19-2.03.

2.02 COLOR CODING

- A. Control Conductors: Single-conductor control conductors shall have the following colors for the indicated voltage:

<u>Application</u>	<u>120 volt</u>
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Foreign Voltage (DC)	Blue/White
Foreign Voltage (AC)	Yellow
Power (DC)	Blue
Control (DC)	Violet

- B. Power Conductors: Single-conductor power conductors shall have the following colors for the indicated voltage:

<u>Application</u>	<u>480 volt</u>	<u>240/208/120 volt</u>
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	White	White

- C. Signal Conductors: Unless otherwise specified, signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor shall be numbered.
- D. UPS Conductors: Conductor colors for 120 volt AC uninterruptible power supply systems shall be red with white tracer for phase conductor and gray for neutral conductor.
- E. Taping: Cables sized No. 4 AWG and larger may be black with colored 3/4 inch vinyl plastic tape applied at each cable termination and in pull boxes, handholes and manholes. Tape shall be wrapped with 25 percent overlay to provide 3 inches (minimum) of coverage.

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. General

1. Minimum conductor size shall be 12 AWG for power and lighting circuits and 14 AWG for control circuits.
2. Provide solid conductors for lighting and receptacle circuits 10 AWG and smaller.
3. Provide stranded conductors for sizes 8 AWG and larger. All conductors used for control, signal, and indication shall be stranded.
4. Conductor insulation shall be selected based on the conductor application in accordance with the following:
 - a. Cable Specification Type THWN:
 - 1) Power (≤ 240 volts AC) including lighting, receptacle, and appliance circuits.
 - 2) AC control circuits.
 - 3) DC power and control circuits.
 - b. Cable Specification Type XHHW-2:
 - 1) 480 volt AC power circuits.

2.04 SIGNAL CABLES

- A. General: Signal cable shall be provided for instrument signal transmission and other circuits as specified. Circuit shielding shall be provided in addition to cable shielding. Single circuit signal cable shall be provided in accordance with cable specification, Type TSP/TST unless otherwise specified.
- B. Communication, Paging, and Security System Cables: Communication, paging, and security system cables shall be as specified in their respective specification sections.

2.05 PORTABLE CORD

- A. General: Where required, portable cord shall be provided in accordance with cable specification Type CORD unless otherwise specified. Cords shall contain an equipment grounding conductor.

PART 3 EXECUTION

3.01 GENERAL

- A. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Soapstone, talc or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed.
- B. Where wire or cable exits a raceway, a wire or cable support shall be provided.
- C. Where flat bus bar connections are made with unplated bar, the Contractor shall scratch-brush the contact areas. Bolts shall be torqued to the bus manufacturer's recommendations.

3.02 600 VOLT WIRE AND CABLE

- A. Conductors in panels and electrical equipment, No. 6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct. Conductors crossing hinges shall be bundled into groups not exceeding 12 and enclosed in nylon spiral wrap to protect from chafing when the hinged member is moved.
- B. Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box. Amount of slack shall be equal to largest dimension of the box. Where plastic panel wiring duct is provided for wire runs, lacing is not required. Plastic panel wiring duct shall not be used in manholes and handholes.
- C. Stranded conductors shall be terminated as described in paragraph 26 05 19-2.6, except where terminals will not accept such terminations. In these cases, the conductors shall be terminated directly on the terminal block. Compression lugs and connectors shall be installed using manufacturer's recommended tools.
- D. Raceway fill limitations shall be as defined by NEC and the following:
 - 1. Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC. However, lighting and receptacle circuits shall not be in conduits with power, signal, or control conductors.
- E. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems.
- F. Solid wire shall not be lugged nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.
- G. Branch and feeder circuits shall not be configured with a common neutral unless approved by the Construction Manager.
- H. Cables larger than No. 6 AWG which hang from vertical connections shall be supported from the structure within 2 feet of the connection.

3.03 SIGNAL CABLE

- A. Circuits shall be run as individually shielded twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever 3 wire circuits are required. Terminal blocks shall be provided at instrument cable junctions, and circuits shall be identified at such junctions unless otherwise specified. Signal circuits shall be run without splices between instruments, terminal boxes, or panels. Signal cable terminations shall be prepared as indicated on the Drawings.
- B. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables.
- C. Common ground return conductors for two or more circuits are not acceptable.

- D. Unless otherwise specified, shields shall be bonded to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.
- E. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run.
- F. Terminal boxes shall be provided at instrument cable splices. If cable is buried or in raceway below grade at a splice, an instrument stand shall be provided as specified with terminal box mounted approximately 3 feet above grade.
- G. Cable for paging, telephone, communication, and security systems shall be installed and terminated in compliance with the manufacturer's recommendations.

3.04 PORTABLE CORD

- A. General: Portable power cords feeding permanent equipment, such as pendant cords feeding motors for pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with the use of terminals. In-line taps and splices shall be used only where specified. Cable shall not be allowed to drape on ground, walkway surface, or roof, as applicable. Where cord is longer than required for connection of power, provide cable management to ensure that cable installation is clean and that cable will not come into contact with deleterious materials which may cause degradation of outer jacket.

3.05 VFD CABLE

- A. VFD cables shall be provided for all 480 volt AC motor feeder applications deriving power from the load side of a VFD motor controller.

3.06 DATA COMMUNICATION CABLE

- A. General: Horizontal wiring shall be routed using the "home run" methodology with no intermediate transition points between the communication equipment racks and the specified communication outlet or termination equipment. All cabling shall be free of bridges, splices, and taps from the homerun's origin at the communication equipment rack or control panel to the termination at the specified data or voice communications outlet or patch panel. Additionally, each horizontal wiring run shall be terminated as a "straight through" connection with no transposition of pairs.
- B. Cables shall be installed in conduit.
- C. The following cable types shall be provided in the designated applications:
 - 1. Type STP/6: Serving devices in power distribution equipment such as motor control centers and switchboards.
 - 2. Type STP/W: Installed in conduit below grade or in slab.
 - 3. Type UTP: Installed in conduit above grade serving any type device except those located in power distribution equipment.

3.07 TESTING

- A. General: The Contractor shall test conductors, wire, and cable in accordance with Section 26 08 00.
- B. Data Communications Cable Testing:
 - 1. Cable Tests: All communications cable systems shall be tested in accordance with TIA 568. Tests shall include a basic link test for each communications circuit. All testing shall be conducted with Level II field tester. The following tests shall be conducted:
 - a. Wire Map
 - b. Cable Length
 - c. Propagation Delay
 - d. Delay Skew
 - e. DC Loop Resistance
 - f. DC Resistance Unbalanced
 - g. Insertion Loss
 - h. Near-End Crosstalk (NEXT)
 - i. Power Sum NEXT
 - j. Attenuation to Crosstalk Ratio Far End
 - k. Power Sum Attenuation to Crosstalk Ratio Far End
 - l. Return Loss

3.08 DATA COMMUNICATION CABLE DOCUMENTATION

- A. As-Built Documentation: As-built documentation shall be provided which details the final installed configuration of the data and voice communication systems. Documentation shall be prepared in accordance with Specification 26 05 00. Documentation shall include plan drawings indicating the communication outlet location and labeling, cable labeling and routing, and communication rack locations.
- B. Cabling System Test Results: A test report shall be generated in accordance with the requirements of TIA 568 and shall be submitted to the Construction Manager. The test report shall indicate the measured result and the pass/fail determination of each test.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	CORD
Description:	Portable Cord: 10 AWG and smaller, UL listed, type SOOW; larger than 10 AWG, UL listed, type G
Voltage:	600 volts
Conductor Material:	Bare copper with Class K stranding per ASTM B174. Conductors shall be coated except ground conductors may be uncoated.
Conductor Insulation:	Insulation shall be ethylene propylene diene monomer (EPDM) thermoset rubber and rated for continuous operation at 90 degrees C dry, 75 degrees C wet.
Outer Jacket:	Chlorinated polyethylene elastomers (CPE) thermoset rubber.
Manufacturer(s):	Okonite, Southwire; or approved equivalent
Execution:	
Application:	As specified, shown on the Drawings, and as required and approved for use during construction for temporary power feed to equipment.
Installation:	Install in accordance with paragraph 26 05 19-3.04.
Testing:	Test in accordance with paragraph 26 05 19-3.07.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	STP/6
Description:	Industrial grade, four (4) shielded solid copper core pairs, 24 AWG, category 5e.
Voltage:	600 volts
Conductor Material:	Bare annealed copper
Insulation:	Polyolefin, bonded pairs.
Shield:	Overall foil shield with 24 AWG drain wire.
Jacket:	Polyvinyl chloride with sequential meter markings.
Jacket Color:	Teal
Data Speed:	100 megabytes per second in accordance with IEEE 802.3 standards.
Manufacturer(s):	Belden DataTuff 7958A; or approved equivalent.
Execution:	
Application:	Data communication installed in conduit indoors above grade serving devices located in 480 volt AC power distribution equipment.
Installation:	Install in accordance with paragraph 26 05 19-3.06.
Testing:	Test in accordance with paragraph 26 05 19-3.07.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	STP/W
Description:	Industrial grade, four (4) shielded solid copper core pairs, 24 AWG, category 5e.
Voltage:	300 volts
Conductor Material:	Bare annealed copper in accordance with ASTM B8
Insulation:	Polyolefin
Shield:	Overall foil shield with 24 AWG drain wire.
Jacket:	Low density polyethylene inner and outer jacket. Outer jacket color shall have sequential meter markings.
Jacket Color:	Black
Water Resistance:	Polymer gel water block
Data Speed:	100 megabytes per second in accordance with IEEE 802.3 standards.
Manufacturer(s):	Belden DataTuff 2137A; or approved equivalent.
Execution:	
Application:	Data communication installed in conduit below grade or in slab.
Installation:	Install in accordance with paragraph 26 05 19-3.06.
Testing:	Test in accordance with paragraph 26 05 19-3.07.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	THWN
Description:	Single conductor, feeder, branch, and control circuit cable.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Insulation:	THWN/THHN/MTW tri-rated, 90 degree C dry, 90 degree C wet, polyvinyl chloride (PVC) per UL 83.
Jacket:	Nylon
Flame Resistance:	UL 1685
Manufacturer(s):	General Cable, Okonite, Southwire; or approved equivalent.
Uses Permitted:	Power (\leq 240 volt AC), lighting, receptacle, control, and appliance circuits.
Execution:	
Application:	240 volt AC and less power and control circuits. DC power and control circuits. Suitable for installation in raceway and cable tray (1/0 AWG and larger).
Installation:	Install in accordance with paragraph 26 05 19-3.02.
Testing:	Test in accordance with paragraph 26 05 19-3.07.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	TSP/TST
Description:	Single twisted, shielded pair or triad, 18 AWG, instrumentation and signal cable, UL listed
Voltage:	300 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Insulation:	19 mil, 90 degree C, polyvinyl chloride (PVC) with 4 mil nylon conduit or jacket
Lay:	Twisted on a 2-inch lay
Shield:	100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned 20 AWG copper drain wire
Jacket:	37 mil Polyvinyl chloride (PVC)
Flame Resistance:	UL 1277
Manufacturer(s):	Belden 9138/9365, Okonite; or approved equivalent
Execution:	
Application:	Analog signal circuits. Suitable for installation in raceway and cable tray and for installation in raceway below grade.
Installation:	Install in accordance with paragraph 26 05 19-3.03.
Testing:	Test in accordance with paragraph 26 05 19-3.07.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	UTP
Description:	Industrial grade, four (4) shielded solid copper core pairs, 24 AWG, category 5e.
Voltage:	300 volts
Conductor Material:	Bare annealed copper
Insulation:	Polyolefin, bonded pair
Jacket:	Polyvinyl chloride with sequential meter markings.
Jacket Color:	Black
Data Speed:	100 megabytes per second in accordance with IEEE 802.3 standards.
Manufacturer(s):	Belden DataTuff 7922A; or approved equivalent.
Execution:	
Application:	Data communication installed in conduit below grade or in slab.
Installation:	Install in accordance with paragraph 26 05 19-3.06.
Testing:	Test in accordance with paragraph 26 05 19-3.07.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	VFD
Description:	Shielded 3 conductor cable assembly with 3 symmetrical bare ground conductors.
Voltage:	600 volts
Conductor Material:	Rope-lay stranded annealed copper conductors in accordance with ASTM B3 and B172.
Insulation:	XHHW-2, 90 degree C cross linked polyethylene; wet and dry locations.
Shield:	Helically applied copper tape; 25 percent overlap
Jacket:	Thermoplastic chlorinated polyethylene
Ground:	3 symmetrical bare copper conductors
Flame Resistance:	UL 1685, IEEE 1202
Manufacturer(s):	Southwire Halo Flex, Belden or approved equivalent.
Execution:	
Application:	480 volt AC motor feeder circuits on the load side of a variable frequency drive.
Installation:	Install in accordance with paragraph 26 05 19-3.05.
Testing:	Test in accordance with paragraph 26 05 19-3.07.

LOW VOLTAGE CABLE SPECIFICATION SHEET

Cable System Type:	XHHW-2
Description:	Single conductor, service and feeder circuit cable.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Insulation:	XHHW-2, 90 degree C dry, 90 degree C wet/dry, abrasion, moisture, heat and sunlight resistant, cross-linked polyethylene per UL 44.
Flame Resistance:	UL 1685
Manufacturer(s):	General Cable, Okonite, Southwire; or approved equivalent.
Uses Permitted:	480 volt AC power circuits.
Execution:	
Application:	480 volt AC and less power circuits. Suitable for installation in raceway and cable tray (1/0 AWG and larger).
Installation:	Install in accordance with paragraph 26 05 19-3.02.
Testing:	Test in accordance with paragraph 26 05 19-3.06.

END OF SECTION

SECTION 26 05 25

FIBER OPTIC CABLE SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies fiber optic cabling systems for voice and data communication systems.
- B. Extent, location, and details of fiber optic cable work are indicated on Drawings and in schedules.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's product data for all cabling systems and termination systems.
 - 2. Data sheets for each cable type including the cable manufacturer's product number and definitions for full development of the product number.
 - 3. Cable manufacturer's installation instructions.
 - 4. Cable interconnection diagrams identifying each point of termination for every fiber in each cable.
 - 5. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. NEMA/ICEA Compliance: Provide components that comply with the following standards:

- a. ICEA S-87-640 - Optical Fiber Outside Plant Communications Cable
- 3. TIA Compliance:
 - a. TIA-472D000 - Fiber Optic Communications Cable for Outside Plant Use
 - b. TIA-526-14 - OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - c. TIA-568.1 - Optical Fiber Cabling Components Standard
 - d. TIA-590 - Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant
 - e. TIA/EIA-598 - Optical Fiber Cable Color Coding
 - f. TIA/EIA-604-3 - Fiber Optic Connector Intermateability Standard (FOCIS), Type SC and SC-APC, FOCIS-3
- 4. UL Compliance: Provide components that are listed and labeled by UL under the following standards:
 - a. UL Standard 44 - Thermoset-Insulated Wires and Cables
 - b. UL Standard 83 - Thermoplastic-Insulated Wires and Cables
 - c. UL Standard 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - d. UL Standard 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

PART 2 PRODUCTS

2.01 GENERAL

- A. General requirements for conductors and cables specified in this section are listed in the Fiber Optic Cable Specification Sheets at the end of this section.
- B. Cable Specification Sheets: The following Cable Specification Sheets are included in this section:
 - 1. MULTIMODE, BACKBONE
- C. Fiber Count: Fiber count for each fiber optic cable application shall be as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which fiber optic cabling systems are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 FIBER OPTIC CABLE INSTALLATION

- A. General: All fiber optic cables shall be installed in conduit unless otherwise noted and without splices between termination points. Fiber optic cables shall be installed in accordance with the cable manufacturer's instructions.
- B. Identification: Each fiber optic cable and each fiber strand therein shall be labeled with machine printed labels at each end.
- C. Connectorization: Fiber optic cables shall be terminated using an epoxy glue and polish process. Cables connected directly to the fiber optic transceiving equipment shall be provided with breakout kits.
- D. Cable Distribution Panels: Cable distribution panels shall be installed as indicated on the Drawings at each termination point. All incoming fiber optic cables shall be terminated at the distribution panel. Patch cables shall be used to extend the fiber optic circuit from the distribution panel to the fiber optic transceiver.
- E. Cables larger than No. 6 AWG which hang from vertical connections shall be supported from the structure within 2 feet of the connection.

3.03 OPTICAL TESTS

- A. All fiber optic cable systems shall be tested in accordance with the following:
 - 1. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer.
 - 2. Perform connector and splice integrity test using an optical time domain reflectometer.
 - 3. Perform cable attenuation loss measurement with an optical power loss test set.
 - 4. Perform connector and splice attenuation loss measurement from both ends of the fiber optic cable with an optical power loss test set.
- B. Test Results:
 - 1. The optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
 - 2. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations and the requirements of this specification.

3.04 DOCUMENTATION

- A. As-Built Documentation: As-built documentation shall be provided which details the final installed configuration of the fiber optic cabling systems. Documentation shall include plan drawings indicating the cable labeling and routing, and termination locations.
- B. Cabling System Test Results: A test report shall be generated in accordance with the requirements of TIA/EIA TSB 67 and shall be submitted to the Construction Manager. The test report shall indicate the measured result and the pass/fail determination of each test.

FIBER OPTIC CABLE SPECIFICATIONS SHEET

Cable System Type:	MULTIMODE, BACKBONE
Description:	Tight buffered, indoor/outdoor rated multimode fiber optic cable with the number of fibers as indicated on the Drawings
Core/Clad Diameter:	62.5/125 microns
Subcable Jacket:	Core-Locked™ PVC
Outer Jacket:	Core-Locked™ PVC
Strength Member:	Aramid (Kevlar)
Operating Temperature:	-20 to 65 degrees C
Numerical Aperture:	.275
Maximum Attenuation:	3.0 dB/km at 850 nm
Minimum Bend Radius:	10 x cable diameter
Manufacturer(s):	Optical Cable Corporation, BX Series; or approved equivalent
Execution:	
Application:	As specified, shown on the Drawings, and as required and approved for use during construction for temporary power feed to equipment.
Installation:	Install in accordance with paragraph 26 05 19-3.04.
Testing:	Test in accordance with paragraph 26 05 19-3.05.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies the system for grounding electrical equipment, exposed non-energized metal surfaces of equipment, and metal structures.
- B. Extent, location, and details of grounding work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's data on grounding equipment and devices.
 - 2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of grounding equipment and materials of types and ratings required, whose products have in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for this project.
- C. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.

2. IEEE Compliance: Provide components that comply with the following standards:
 - a. IEEE Std. 81 - Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, Guide for
 - b. IEEE Std. 141 - Electrical Power Distribution for Industrial Plants
 - c. IEEE Std. 242 - Protection and Coordination of Industrial and Commercial Power Systems
3. UL Compliance: Comply with requirements of UL and UL standards pertaining to grounding equipment and devices. Provide products that have been UL-listed and labeled.

PART 2 PRODUCTS

2.01 GENERAL

- A. Except as otherwise indicated, provide each electrical grounding system indicated, with assembly of materials including, but not necessarily limited to, cable/wire, connectors, terminals (solderless lugs), grounding rods/electrodes, bonding jumper braid, and other items and accessories needed for a complete installation. Where more than one type meets indicated requirements, selection is Installer's option. Where material or component are not otherwise indicated, comply with NEC, NEMA, and established industry standards for applications indicated.

2.02 CABLE

- A. General: Ground cable shall be annealed bare copper, concentric stranded as specified. If cable sizes are not specified, the minimum sizes shall be as follows:

600V Switchgear and Switchboards	4/0 AWG
600V Motor Control Centers	4/0 AWG
Duct banks	4/0 AWG
Site Grounding	4/0 AWG
Lightning Arresters	4/0 AWG
Structural Steel in Building Footings	4/0 AWG
Cable Tray	2/0 AWG
480VAC Distribution Panelboards	2 AWG
Lighting Panels	2 AWG
Exposed Metal	2 AWG
480V Dry Type Transformers	2 AWG
Process Control Panels	2 AWG

2.03 GROUND RODS

- A. General: Ground rods shall be copper covered steel, 3/4-inch diameter and 10 feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

2.04 CONNECTORS

- A. Below Grade Connectors

1. Exothermic Connectors: Exothermic connections shall be made using Cadweld process or approved equivalent.

B. Above Grade Connectors

1. Ground Bars and Pads: Two-hole compression type lugs using tin-plated copper or copper alloy hardware.

2.05 GROUND CLAMPS

- A. Cable to Pipe Ground Clamp: Burndy GAR Series or approved equivalent.

2.06 GROUND BAR

- A. General: Ground bar shall be 1/4" x 2" x 24" tin plated copper bus with pre-drilled holes, stainless steel mounting brackets and insulators. Ground bar assembly shall be designed for wall mounting. Ground bar hole pattern shall be suitable for termination of 2-hole lugs. Ground bar shall be as manufactured by Harger, Type GBI or approved equivalent.

2.07 GROUND WELL

- A. General: Ground well shall be 14-inch diameter, 10-inch nominal throat, minimum 12-inches deep, concrete ground rod box with a cast iron traffic cover. Cover shall be provided with a legend in raised letters reading "Ground".

PART 3 EXECUTION

3.01 INSTALLATION OF GROUNDING SYSTEMS

- A. Embedded and buried ground connections shall be made by exothermic connector and mold.
- B. Exposed ground connections to equipment and in ground wells shall be made by bolted clamps unless otherwise specified. No solder shall be used in any part of the ground circuits.
- C. Embedded ground cables and fittings shall be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement. As each part of the grounding system which is laid below finished grade is completed, the Engineer shall be notified 2 hours prior to back-filling.
- D. All grounding conductors for equipment located indoors shall be run in PVC conduit to accessible ground grid connections. All ground grid conductors under concrete shall be sleeved with PVC conduit.
- E. Grounding conductors that are extended beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Minimum extension shall be 3 feet.
- F. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by conduit, or terminated in a flush grounding plate. Exposed grounding conductors shall be supported by non-corrosive metallic hardware at 4 foot intervals or less. Grounding conductors for future equipment shall be terminated using a two-hole copper flush mounted grounding plate, Cadweld, or approved equivalent.
- G. Ground conductors, except signal conductor shields, entering enclosures shall be bonded together to the enclosure if it is metallic and to metallic raceways within or terminating at the enclosure. Prior to making ground connections or bonds, the metal surface at the point of connection shall be cleaned.

- H. Furnish and install ground access wells to access the ground grid and for removable ground grid splices. Ground wells shall be installed at the locations indicated on the Drawings and in accordance with the following:
 - 1. Connection between building ground grids
 - 2. Connection between building ground grids and service entrance equipment.
- I. The building perimeter ground conductor shall be located 3 feet to 6 feet from outside face of building footing and a minimum of 30 inches below finished grade.
- J. Exothermic and bolt-on lugs shall be used in accordance with manufacturer's recommendations.

3.02 RACEWAY GROUND

- A. Metallic conduits shall be installed to provide a continuous ground path. Metallic conduits shall be bonded using insulated grounding bushings. All raceway circuits shall include a ground conductor.
- B. Grounding bushings shall be connected to the grounding system using conductors sized in compliance with NFPA 70. Conductor shall be connected to each section or fitting using a carriage bolt and clamp or other electrical fittings for the purpose.

3.03 EQUIPMENT AND ENCLOSURE GROUND

- A. Electrical equipment and power distribution equipment shall be connected to the grounding system. Equipment with an internal ground bus exceeding 5 feet in length shall be connected to the grounding system at separate points from each end of the bus. Cables shall be sized as specified.
- B. Non-electrical equipment with metallic enclosures shall be connected to the grounding system.

3.04 GROUNDING SYSTEM TESTS

- A. Grounding systems shall be tested in accordance with specification Section 26 08 00.
- B. A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted test data shall be considered inadequately grounded. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm or less requirement. Ground rods required over that specified or indicated will be paid for as extra work. Use of salt, water, or other chemical compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. This section is a Division 26 Common Work Results for Electrical section and is part of each specification section referencing electrical raceways, fittings, and supports specified herein.

1.02 SUMMARY

- A. This section specifies the furnishing and installation of hangers and supports for electrical systems including but not limited to the following:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Firestopping and accessories relating to electrical work.
 - 7. Equipment bases and supports.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's product data for all hanger and support systems and accessories.
 - 2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. MFMA Compliance: Comply with the latest revision of MFMA Standards Publication Number MFMA-3, "Metal Framing Standards Publication".
3. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide hanger and support products and components which have UL-listed and labeled.
4. Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.
5. Stainless steel bolted framing parts shall be stamped to identify the material. Material certification sheets and test reports must be made available by the manufacturer upon request.

B. Performance Requirements

1. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for each application, with a minimum structural safety factor of five times the applied force.

PART 2 PRODUCTS

2.01 SLOTTED FRAMING CHANNEL

A. General: Strut shall be 1-5/8 inches wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the Drawings.

B. Materials and Finish: Material and finish specifications for each strut type are as follows:

1. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633 (SC3 for fittings, SC1 for threaded hardware) for indoor use only. For outdoor use, all fittings and hardware shall be stainless steel Type 304.
2. Epoxy Painted: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS Grade 33, then painted with water born epoxy applied by a cathodic electro-deposition process. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).
3. Pre-galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 SS, Grade 33, and mill galvanized in accordance with coating

designation G90. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).

4. Hot-dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 304 or chromium zinc ASTM F1136 Gr. 3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.
5. Stainless Steel: All strut, fittings and hardware shall be made of AISI Type 304 stainless steel as indicated.

2.02 CONDUIT SUPPORTS

- A. Conduit clamps, straps, supports, etc., shall be steel or malleable iron.
- B. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.
- C. Bar joist conduit/box hangers: Spring Steel Clips with Snap-Close Clamps (Conduit Supports): Conduit clamps shall pivot a full 360 degrees and shall snap close around the conduit. Push-in type conduit clamps are not allowed. Spring clips shall require a hammer to install onto supporting surface.
- D. Stud wall applications: Spring Steel Clips with Push-in or Snap-Close Conduit Clamps (Conduit Supports): Conduit clamps shall pivot a full 360 degrees. Spring clips shall require a fastener to install onto stud.
- E. Box/conduit hanger with rod/wire clip (a.k.a. antlers): One assembly provides support for electrical box and conduit from drop wire or rod. Conduit clamps shall snap close around the conduit.
- F. Spring Steel Clip products shall be provided with corrosion resistance and be warranted against failure from corrosion for a period of ten (10) years from date of manufacture.

2.03 THREADED ROD

- A. Minimum sized threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and 1/4" for single conduits 1" and smaller.

2.04 HARDWARE

- A. Corrosion resistant, or as noted for each product above.

2.05 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

- A. General: Items for fastening electrical items or their supports to building surfaces include the following.
 1. Capacities: Provide materials and installed systems with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used, plus 100% safety factor.

2. Adverse and/or Corrosive Environment Areas: Provide stainless steel anchors.
3. Mechanical-Expansion Anchors in Dry Conditioned Areas: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement Provide stainless steel anchors where located in areas subject to moisture or corrosion.
4. Drop-In Anchors: AISI Type 303 stainless steel, drop-in, shell or flush type.
5. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
6. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
7. Through Bolts: Steel structural type, hex head, and high strength. Comply with ASTM A 325.
8. Toggle Bolts: All-steel galvanized springhead type, minimum 3/16" x 4".
9. Hanger Rods: Threaded steel, Galvanized steel rods; 1/2" minimum diameter.
10. Clevis hangers: For supporting rigid metal conduit; galvanized steel; with 1/2" minimum diameter hole for round steel rod.
11. Galvanized steel rod reducing couplings: 1/2" x 5/8" minimum.
12. Galvanized steel clamps: 1/2" minimum rod size; Galvanized steel clamps: Minimum 1-1/4" x 3/16" stock; minimum 3/8" cross bolt; minimum flange width 2".
13. Hexagon nuts: Galvanized steel.
14. Expansion anchors: Minimum 1/2".

- 2.06 2.22 SUPPORTS
- 2.07 CONTRACTOR SHALL PROVIDE STRUT CHANNELS, FITTINGS, STANCHIONS, CLAMPS, HANGERS, AND REQUIRED
- 2.08 HARDWARE TO SUPPORT ALL CONDUIT AND EQUIPMENT, AS SHOWN ON THE DRAWINGS AND SPECIFIED HEREIN,
- 2.09 AND AS REQUIRED. REFER ALSO TO EARTHQUAKE RESTRAINT PROVISIONS OF SECTION 11005.
- 2.10 A. STRUT CHANNEL SUPPORTS
- 2.11 1. UNLESS INDICATED OTHERWISE ON THE DRAWINGS, STRUT CHANNEL SHALL BE SINGLE STRUT
- 2.12 TYPE, 1-5/8" X 1-5/8", 12 GAUGE HOT DIPPED GALVANIZED STEEL WITH 9/16" DIAMETER
- 2.13 BOLT HOLES ON 1-7/8" CENTERS.
- 2.14 2. WHERE INDICATED ON THE DRAWINGS, STRUT CHANNEL SHALL BE SINGLE STRUT TYPE, 1-5/8"
- 2.15 X 1-5/8", HEAVY DUTY, FIBERGLASS (VINYLESTER) WITH 1" X 7/16" BOLT HOLES ON 2"
- 2.16 CENTERS.
- 2.17 3. WHERE INDICATED ON THE DRAWINGS, STRUT CHANNEL SHALL BE SINGLE STRUT TYPE, 1-5/8"
- 2.18 X 1-5/8", TYPE 304 STAINLESS STEEL WITH 9/16" BOLT HOLES ON 1-7/8" CENTERS.
- 2.19 4. WHERE INDICATED ON THE DRAWINGS, STRUT CHANNEL SHALL BE SINGLE STRUT TYPE, 1-5/8"
- 2.20 X 1-5/8", 12 GAUGE, PVC COATED PRE-GALVANIZED STEEL, WITH 9/16" BOLT HOLES ON 1-
- 2.21 7/8" CENTERS. PVC COATING SHALL BE AS SPECIFIED HEREIN FOR PVC COAT RIGID METAL
- 2.22 CONDUIT.
- 2.23 5. DEEP STRUT OR DOUBLE STRUT CHANNEL SHALL BE PROVIDED WHERE REQUIRED FOR THE
- 2.24 SUPPORT LOAD OR CONFIGURATION.
- 2.25 6. STRUT CHANNEL SUPPORTS SHALL BE FURNISHED WITH ALL FITTINGS REQUIRED FOR A PARTICULAR
- 2.26 SUPPORT CONFIGURATION, INCLUDING: CONDUIT CLAMPS, FLAT PLATE FITTINGS, ANGLE FITTINGS,

- 2.27 90° FITTINGS, BRACE FITTINGS, ZEE FITTINGS, "U" FITTINGS, WING FITTINGS, AND POST BASES.
- 2.28 BASIC ELECTRICAL MATERIALS AND METHODS
- 2.29 SECTION 16050 – 33
- 2.30 7. STRUT CHANNEL FITTINGS AND FASTENERS SHALL BE FABRICATED FROM THE SAME MATERIAL AND
- 2.31 RECEIVE THE SAME COATING, AS SPECIFIED FOR THE STRUT CHANNEL.
- 2.32 8. STRUT CHANNELS, FITTINGS, AND FASTENERS SHALL BE AS MANUFACTURED BY POWER-STRUT,
- 2.33 UNISTRUT, OR EQUAL.
- 2.34 B. ONE-HOLE CLAMPS
- 2.35 CLAMPS SHALL BE MALLEABLE IRON, HOT DIPPED GALVANIZED, AND EQUIPPED WITH CLAMP-BACKS.
- 2.36 CLAMPS SHALL BE AS MANUFACTURED BY CROUSE-HINDS, THOMAS & BETTS, APPLETON, OR EQUAL.
- 2.37 C. BEAM CLAMPS
- 2.38 CLAMPS SHALL BE MALLEABLE IRON, HOT DIPPED GALVANIZED, RIGHT ANGLE AND PARALLEL TYPES.
- 2.39 CLAMPS SHALL BE AS MANUFACTURED BY CROUSE-HINDS, THOMAS & BETTS, APPLETON, OR EQUAL.
- 2.40 D. U-BOLTS
- 2.41 U-BOLTS SHALL BE HEAVY-DUTY STEEL, ELECTRO-GALVANIZED AND EQUIPPED WITH TWO HEX STEEL
- 2.42 NUTS. U-BOLTS SHALL BE AS MANUFACTURED CROUSE-HINDS, EFCOR, KINDORF, OR EQUAL.
- 2.43 E. CONDUIT HANGERS
- 2.44 CONDUIT HANGERS SHALL BE HEAVY GAUGE FORMED STEEL, GALVANIZED AND EQUIPPED WITH
- 2.45 CARRIAGE BOLTS, 1/4-INCH (MINIMUM) RODS AND NUTS. CONDUIT HANGERS SHALL BE AS
- 2.46 MANUFACTURED BY KINDORF, APPLETON, OR EQUAL.
- 2.47 F. LIGHTING FIXTURE HANGERS
- 2.48 FIXTURE HANGERS SHALL BE CAST IRON ALLOY, CUSHION TYPE, AND EQUIPPED WITH OUTLET BODY AND

- 2.49 COVER FOR FIXTURE WIRING. FIXTURE HANGER SHALL PERMIT THE FIXTURE TO SWING 20° FROM
- 2.50 PERPENDICULAR IN ANY DIRECTION. FIXTURE HANGERS SHALL BE CROUSE-HINDS TYPE ALT, APPLETON
- 2.51 TYPE ALT, OR EQUAL.
- 2.52 G. FASTENERS AND ANCHORS
- 2.53 1. FASTENERS AND ANCHORS SHALL BE PROVIDED TO SECURELY MOUNT ALL EQUIPMENT AND
- 2.54 MATERIALS.
- 2.55 2. UNLESS SPECIFIED OTHERWISE, ALL FASTENERS AND ANCHORS SHALL BE CONSTRUCTED OF TYPE
- 2.56 304 STAINLESS STEEL.
- 2.57 BASIC ELECTRICAL MATERIALS AND METHODS
- 2.58 SECTION 16050 – 34
- 2.59 3. STAINLESS STEEL ANCHORS SHALL BE PROVIDED FOR SECURING EQUIPMENT AND SUPPORTS TO
- 2.60 MASONRY AND CONCRETE WALLS, CONCRETE FOUNDATIONS, AND CONCRETE FLOORS. STAINLESS
- 2.61 STEEL ANCHORS SHALL BE WEDGE ANCHORS, SLEEVE ANCHORS, OR EPOXY ANCHORS, AS
- 2.62 MANUFACTURED BY RED HEAD, HILTI, OR EQUAL.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION

- A. General: It is recognized that the raceway requirements indicated on the contract drawings are diagrammatic in showing certain physical relationships which must be established within the electrical work, and its interface with other work including utilities, and mechanical and structural work and that such establishment is the exclusive responsibility of the Contractor. Contractor shall provide offsets, transitions, boxes, fittings and accessories which may be required but have not been shown because of the small scale of the Drawings.

- B. Raceway Types: Unless otherwise specified, application of raceway types shall be in accordance with paragraph 26 05 00-1.07 of these Specifications. General requirements for raceway installation shall be in accordance with Table A appended to the end of this specification section and as specified herein. Unless otherwise specified, in paragraph 26 05 00-1.07, unscheduled conduit shall be galvanized, rigid steel, raceway type GRS.
- C. Rough-in Dimensions: Use roughing-in dimensions of electrically operated or controlled equipment furnished by equipment supplier. Set conduit and boxes for connection to units only after receiving and reviewing dimensions and coordinating locations with other trades.

3.03 CONDUIT

- A. General: The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes. Pull boxes shall be provided in conduit runs to limit the maximum conduit run to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.
- B. Conduit Raceway Sizes: Minimum conduit size shall be $\frac{3}{4}$ inch for exposed and 1 inch for embedded or concealed raceways. The size and type of conduit shall be as specified herein and as indicated on the Drawings.
 - 1. Conduit sizes indicated on the Drawings are the minimum size permitted for exposed applications. Conduit sizes shall be increased as necessary to the minimum specified size for embedded applications.
 - 2. Any conduit or raceway system for which a trade size is not indicated on the Drawings shall be sized by the Contractor in accordance with the Annex C of the NEC and shall be subject to the minimum sizes specified herein.
- C. Indoor and Outdoor Conduit Systems: In general, conduit inside structures shall be installed in accordance with the requirements of Table 26 05 33-A, unless otherwise specified or indicated on the Drawings. Unless otherwise indicated on the Drawings, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein. Conduit installation shall conform to the requirements of the Raceway Specification sheets and the following:
 - 1. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.
 - 2. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.
 - 3. Exposed conduit shall be installed on supports spaced not more than 10 feet apart.
 - 4. Where three or more conduits are installed in a parallel run, they shall be spaced out from the wall using framing channel.
 - 5. Where conduits are suspended from the ceiling, support systems shall comply with the requirements of this specification.
 - 6. Conduit rack supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.
 - 7. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degree C.
 - 8. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, conduits shall be placed under the reinforcement.

9. Conduit shall be routed clear of structural openings and indicated future openings.
 10. Conduits through roofs or metal walls shall be flashed and sealed watertight.
 11. Conduit shall be neatly grouted into any openings cut into concrete and masonry structures. Apply anti-seize compound to cap and plug threads prior to installation.
 12. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.
 13. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.
 14. Concealed conduit stub-up locations shall be determined from the manufacturer's shop drawings.
 15. Concealed conduit for future use shall be terminated in equipment or by galvanized couplings plugged flush with structural surfaces.
 16. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.
 17. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.
 18. All conduits that enter enclosures shall be terminated by fittings which ensure that the NEMA sealing rating of the enclosure is not affected or changed.
 19. Underground metallic or nonmetallic conduit which turns out of concrete, masonry or earth shall be connected to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.
 20. Conduit across structural joints where structural movement is allowed shall have a bonded, weathertight expansion and deflection fitting of that conduit size.
 21. Conduit shall not be installed exposed on the exterior of buildings without approval of the Construction Manager.
 22. No conduit shall be exposed in water chambers unless so indicated on the Drawings.
 23. Concrete conduit curbs shall be provided for all conduits that turn up vertically through concrete floor slabs. Curbs shall not be required in areas designated as NEMA 1.
- D. Sealing of Conduit: Conduits passing from a hazardous or corrosive area into a nonhazardous or noncorrosive area, or between Class 1, Division 1 area and Class 1, Division 2 area, or between areas of different ambient temperatures (indoors to outdoors) shall be provided with a sealing fitting which shall be located at the boundary in accordance with NEC.
- E. Conduit Separation: Signal, data, network, and communications conduits shall be separated from AC power and control circuits. The separation shall be 12 inches for metallic conduits and 24 inches for nonmetallic conduits.
- F. Corrosion Protection: One of the following corrosion protection methods shall be used for metal conduit below grade in direct contact with earth or concrete. Corrosion protection shall extend 6-inches minimum beyond the limits of where the conduit contacts earth or concrete.
1. Half-lapped corrosion protection tape. Tape shall be 3M Scotchrap 51 applied in conjunction with 3M Scotchrap Pipe Primer.
 2. Two coats of thixotropic coal tar paint.
 3. Factory-coated PVC rigid steel conduit.

3.04 WIREWAYS

- A. Wireways shall be installed in with the manufacturer's instructions.
- B. Wireway manufacturer's fittings and hangers shall be provided for supporting and fastening wireways to surfaces. Wireways shall be mounted plumb and level.
- C. Wireway covers shall operate freely without binding.
- D. All wireway ends and unused conduit openings shall be closed.

Table 26 05 33-A

Location	Application/Installation Condition
Architecturally finished spaces - offices, restrooms, control rooms, etc.	Concealed in walls and ceiling spaces
General purpose, NEMA 1, process or utility spaces	Receptacle and light switch circuits concealed All other systems exposed
NEMA 4X and NEMA 12 process areas	Exposed
NEMA 7 hazardous Spaces	Exposed
Exterior surfaces of new structures	Concealed
Water containing structures	Per requirements of the Drawings

RACEWAY SPECIFICATION SHEETS

Raceway Type:	EMT
Description:	Electrical Metallic Tubing
Compliance:	ANSI C80.3, UL 797
Finish:	Electrogalvanized steel
Minimum size:	3/4 inch
Fittings:	Compression type. Fittings for EMT inside concrete block (CMU) walls shall be concrete-tight.
Boxes:	Electrogalvanized sheet steel. NEMA Class 1 stamped or form-bent steel with screw covers.

RACEWAY SPECIFICATION SHEETS

Raceway Type:	FMC
Description:	Flexible Metal (Steel) Conduit
Application:	Final connection to equipment subject to vibration or adjustment, for use with EMT only.
Compliance:	UL 1
Construction:	Spirally wound galvanized steel strip with successive convolutions securely interlocked.
Minimum Size:	1/2 inch
Fittings:	Compression type

RACEWAY SPECIFICATION SHEETS

Raceway Type:	GRS
Description:	Rigid Metal (Steel) Conduit
Compliance:	ANSI C80.1, UL 6
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Manufacturers:	Allied Tube and Conduit Corp., Wheatland Tube Co., or approved equivalent.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	
Hubs:	Zinc die cast two-piece body with insulated throat, bonding locknut, and grounding terminal provisions. The hubs shall utilize a neoprene "O" ring and shall provide a watertight connection.
Unions:	Electrogalvanized ferrous alloy type UNF, UNY, Appleton Crouse-Hinds, or approved equivalent. Threadless or split fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA 12 welded steel 6 inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight.
Outdoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA 4X stainless steel for 6 inches square and larger.
Corrosive:	NEMA 4X stainless steel or nonmetallic.
Hazardous:	NEMA Class 7 cast ferrous.
Elbows:	
(3/4" thru 1-1/2")	Factory fabricated or field bent.
(2" thru 6")	Factory fabricated only.
Conduit Bodies:	
(3/4" thru 4")	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
(5" and 6")	Electrogalvanized iron or cast iron box.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
	Manufacturers: Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or approved equivalent.
Installation:	Rigid steel conduit shall be made up tight and without thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs.
	Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.
	Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

RACEWAY SPECIFICATION SHEETS

Raceway Type:	LFMC
Description:	Liquidtight Flexible Steel Conduit
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 360
Construction:	Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum Size:	3/4 inch
Fittings:	Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90 degree fittings shall be used where applicable.
Installation:	The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.

RACEWAY SPECIFICATION SHEETS

Raceway Type:	PGRS
Description:	Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated.
Compliance:	ANSI C80.1, UL 6, and ETL PVC coating adhesion verification PVC-001.
Finish:	Hot-dip galvanized rigid steel conduit, to which a minimum 40-mil thick PVC coating has been bonded to the outside of the conduit. A 2-mil coat of urethane coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Similarly coated to the same thickness as the conduit and provided with type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company.
Hubs:	Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded and made of cast ferrous alloy. Hubs shall have the same PVC coating as the conduit. The hub shall have an insulating grounding bushings. The hubs shall utilize a neoprene "O" ring and shall provide a watertight connection.
Boxes:	
Nonhazardous:	NEMA Class 4X stainless steel or nonmetallic.
Hazardous:	NEMA Class 7 cast ferrous.
Corrosive:	NEMA 4X stainless steel or nonmetallic.
Elbows:	Elbows shall be factory made and coated.
Manufacturers:	Robroy Industries, Ocal Blue by Thomas and Betts, or approved equivalent.
Installation:	<p>Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the conduit manufacturer. All conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer's recommendations. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.</p> <p>PVC coated conduit shall be supported away from the structure using PVC coated conduit wall hangers or PVC coated conduit mounting hardware.</p>

RACEWAY SPECIFICATION SHEETS

Raceway Type:	PVC4
Description:	Rigid Nonmetallic Conduit, heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.
Compliance:	
Conduit:	NEMA TC2, UL 651
Fittings:	NEMA TC3, UL514b
Construction:	Schedule 40, high-impact, polyvinylchloride (PVC)
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased
Fittings:	PVC solvent weld type
Boxes:	
Indoor:	NEMA Class 4, nonmetallic
Outdoor:	NEMA Class 4X, nonmetallic
Corrosive:	NEMA Class 4X, nonmetallic
Installation:	In accordance with NEC Article 347. Field bending shall not be permitted.

RACEWAY SPECIFICATION SHEETS

Raceway Type:	PVC8
Description:	Rigid Nonmetallic Conduit, extra heavy wall thickness for direct bury, concrete encasement or surface mounting.
Compliance:	
Conduit:	NEMA TC2, UL 651
Fittings:	NEMA TC3, UL514b
Construction:	Schedule 80, high-impact, polyvinylchloride (PVC)
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased
Fittings:	PVC solvent weld type
Boxes:	
Indoor:	NEMA Class 4, nonmetallic
Outdoor:	NEMA Class 4X, nonmetallic
Corrosive:	NEMA Class 4X, nonmetallic
Installation:	In accordance with NEC Article 347. Field bending shall not be permitted. PVC conduit shall have bell ends where terminated at walls.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND FITTINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems
- C. This section is a Division 26 Common Work Results for Electrical section and is part of each specification section referencing electrical raceways, fittings, and supports specified herein.

1.02 SUMMARY

- A. This section specifies the furnishing and installation of electrical conduits, wireways, fittings and accessories.
- B. Extent, location, and details of raceway work are indicated on Drawings and in schedules.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's product data for all raceway, conduit, and cable tray systems and accessories.
 - 2. Raceway and Conduit Shop Drawings: Provide shop drawings including dimensioned plan and elevation views for the following conduit and raceway installations.
 - a. Conduit Routing Plans: Conduit routing plans indicating the size, routing, and dimensions of conduits and raceway systems.
 - 3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested

deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. NEMA Compliance: Comply with applicable requirements of NEMA Standards publications pertaining to raceways, conduits, and cable trays.
3. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have UL-listed and labeled.

PART 2 PRODUCTS

2.01 GENERAL

- A. General requirements for raceway systems and related components specified in this section are listed in the Raceway Specification Sheets at the end of this section. The type of raceway to be used for any given area and application shall conform to the requirements of paragraph 26 05 33-3.02 in this section.
- B. Raceway Specification Sheets: The following Raceway Specifications Sheets are included in this section.
1. GRS
 2. LFMC
 3. PGRS
 4. PVC4
 5. PVC8

2.02 WIREWAY

- A. Hinged Cover Wireway: Hinged cover wireway shall be constructed of 14 gauge steel with continuously welded seams and integral mounting brackets. All edges shall be finished to prevent damage to wiring. Cover shall have a continuous hinge with screw clamps and a fixed oil-resistant gasket. Minimum cross-sectional dimensions shall be 4-inches by 4 inches and minimum length shall be 12 inches.
1. NEMA 12 Wireway: Wireways for installation in areas designated NEMA 1 or NEMA 12 shall be of carbon steel construction, have integral mounting brackets, and shall have an ANSI 61 grey powder coat interior and exterior finish. Wireway sealing rating shall be NEMA 12.
 2. NEMA 4X Wireway: Wireways for installation in areas designated NEMA 4X shall be feed-through type with flanged ends. Wireways including flanges and all accessories shall be of Type 304 stainless steel construction with a smooth brushed finish. Flanges shall be 10-gauge construction. Wireways shall be furnished with accessories such as closure plates and hangers suitable for each application. All accessories shall be by the manufacturer of the wireway.

2.03 FITTINGS

- A. Bulkhead Hub Fitting: Bulkhead fitting shall be three-piece coupling with thermoplastic insulating throat, nitrile sealing ring and tapered female threads. Hub body and locknut shall be of zinc or copper free aluminum construction.
- B. Seal Fittings: Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type, UL listed for explosionproof sealing fittings. Sealing compound shall be non-hardening type for corrosive areas. Seal fitting and sealing compound shall be as manufactured by Appleton, Crouse-Hinds, or approved equivalent.
- C. Expansion/Deflection Couplings: Expansion/deflection conduit couplings shall be designed to couple two sections of conduit subject to longitudinal movement, axial expansion, and/or angular or parallel misalignment.
 - 1. For use with rigid metal conduit; trade sized ½" through 4".
 - 2. Weatherproof and approved for indoor and outdoor applications. UL listed for wet locations.
 - 3. Ground continuity through the fitting; no external bonding jumper required.
 - 4. Materials of construction:
 - a. Body: Electrogalvanized steel.
 - b. Reducer and Gland Nut: Galvanized iron alloy.
 - c. Hubs: Galvanized iron alloy.
 - d. Packing: PTFE composite.
 - e. Gasket: Vellum.
 - f. Ground Springs: Galvanized phosphor bronze.
 - g. Deflection Fitting:
 - 1) Outer Jacket: Molded neoprene.
 - 2) Jacket Clamps: Stainless steel.
 - 3) Inner Sleeve: Neoprene polyester fabric with steel coil.
 - 5. Manufacturer: Crouse-Hinds XJGD or approved equivalent.

2.04 INNER DUCT

- A. Genera: Inner duct shall be a fabric inner duct system.
 - 1. 4-cell inner duct for 2-inch and 4-inch conduit applications.
 - 2. Max Cable Diameter Per Cell:
 - a. 2-inch Conduit: 0.85 inch
 - b. 4-inch Conduit: 1.5 inch
 - 3. Resistant to ground chemicals and petroleum products.
 - 4. Pre-lubricated to reduce friction during inner duct and cable installation.
 - 5. Pre-installed color-coded 1250 pound pull tape/rope in each cell of the inner duct.

- B. Manufacturer: Inner duct shall be MaxCell Edge or approved equivalent.

2.05 MISCELLANEOUS RACEWAY SYSTEM ACCESSORIES

- A. Pull Line: Pull line shall be flat 1/4-inch wide polyester with sequential footage markings. Pull line shall have a minimum tensile strength of 1200 pounds.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION

- A. General: It is recognized that the raceway requirements indicated on the contract drawings are diagrammatic in showing certain physical relationships which must be established within the electrical work, and its interface with other work including utilities, and mechanical and structural work and that such establishment is the exclusive responsibility of the Contractor. Contractor shall provide offsets, transitions, boxes, fittings, and accessories which may be required but have not been shown because of the small scale of the Drawings.
- B. Raceway Types: Unless otherwise specified, application of raceway types shall be in accordance with paragraph 26 05 00-1.07 of these Specifications. General requirements for raceway installation shall be in accordance with Table A appended to the end of this specification section and as specified herein. Unless otherwise specified, in paragraph 26 05 00-1.07, unscheduled conduit shall be galvanized, rigid steel, raceway type GRS.
- C. Rough-in Dimensions: Use roughing-in dimensions of electrically operated or controlled equipment furnished by equipment supplier. Set conduit and boxes for connection to units only after receiving and reviewing dimensions and coordinating locations with other trades.

3.03 CONDUIT

- A. General: The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes. Pull boxes shall be provided in conduit runs to limit the maximum conduit run to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.
- B. Conduit Raceway Sizes: Minimum conduit size shall be 3/4 inch for exposed and 1 inch for embedded or concealed raceways. The size and type of conduit shall be as specified herein and as indicated on the Drawings.
 - 1. Conduit sizes indicated on the Drawings are the minimum size permitted for exposed applications. Conduit sizes shall be increased as necessary to the minimum specified size for embedded applications.
 - 2. Any conduit or raceway system for which a trade size is not indicated on the Drawings shall be sized by the Contractor in accordance with the Annex C of the NEC and shall be subject to the minimum sizes specified herein.

C. Indoor and Outdoor Conduit Systems: In general, conduit inside structures shall be installed in accordance with the requirements of Table 26 05 33-A, unless otherwise specified or indicated on the Drawings. Unless otherwise indicated on the Drawings, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein. Conduit installation shall conform to the requirements of the Raceway Specification sheets and the following:

1. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.
2. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.
3. Exposed conduit shall be installed on supports spaced not more than 10 feet apart.
4. Where three or more conduits are installed in a parallel run, they shall be spaced out from the wall using framing channel.
5. Where conduits are suspended from the ceiling, support systems shall comply with the requirements of this specification.
6. Conduit rack supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.
7. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90-degree C.
8. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, conduits shall be placed under the reinforcement.
9. Conduit shall be routed clear of structural openings and indicated future openings.
10. Conduits through roofs or metal walls shall be flashed and sealed watertight.
11. Conduit shall be neatly grouted into any openings cut into concrete and masonry structures. Apply anti-seize compound to cap and plug threads prior to installation.
12. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.
13. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.
14. Concealed conduit stub-up locations shall be determined from the manufacturer's shop drawings.
15. Concealed conduit for future use shall be terminated in equipment or by galvanized couplings plugged flush with structural surfaces.
16. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.
17. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.
18. All conduits that enter enclosures shall be terminated by fittings which ensure that the NEMA sealing rating of the enclosure is not affected or changed.
19. Underground metallic or nonmetallic conduit which turns out of concrete, masonry or earth shall be connected to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.
20. Conduit across structural joints where structural movement is allowed shall have a bonded, weathertight expansion and deflection fitting of that conduit size.

21. Conduit shall not be installed exposed on the exterior of buildings without approval of the Construction Manager.
 22. No conduit shall be exposed in water chambers unless so indicated on the Drawings.
 23. Concrete conduit curbs shall be provided for all conduits that turn up vertically through concrete floor slabs. Curbs shall not be required in areas designated as NEMA 1.
- D. Sealing of Conduit: Conduits passing from a hazardous or corrosive area into a nonhazardous or noncorrosive area, or between Class 1, Division 1 area and Class 1, Division 2 area, or between areas of different ambient temperatures (indoors to outdoors) shall be provided with a sealing fitting which shall be located at the boundary in accordance with NEC.
- E. Conduit Separation: Signal, data, network, and communications conduits shall be separated from AC power and control circuits. The separation shall be 12 inches for metallic conduits and 24 inches for nonmetallic conduits.
- F. Corrosion Protection: One of the following corrosion protection methods shall be used for metal conduit below grade in direct contact with earth or concrete. Corrosion protection shall extend 6-inches minimum beyond the limits of where the conduit contacts earth or concrete.
1. Half-lapped corrosion protection tape. Tape shall be 3M Scotchrap 51 applied in conjunction with 3M Scotchrap Pipe Primer.
 2. Two coats of thixotropic coal tar paint.
 3. Factory-coated PVC rigid steel conduit.

3.04 WIREWAYS

- A. Wireways shall be installed in with the manufacturer's instructions.
- B. Wireway manufacturer's fittings and hangers shall be provided for supporting and fastening wireways to surfaces. Wireways shall be mounted plumb and level.
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Exterior surfaces of new structures	Concealed
Water containing structures	Per requirements of the Drawings

RACEWAY SPECIFICATION SHEETS

Raceway Type:	GRS
Description:	Rigid Metal (Steel) Conduit
Compliance:	ANSI C80.1, UL 6
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Manufacturers:	Allied Tube and Conduit Corp., Wheatland Tube Co., or approved equivalent.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	
Hubs:	Zinc die cast two-piece body with insulated throat, bonding locknut, and grounding terminal provisions. The hubs shall utilize a neoprene "O" ring and shall provide a watertight connection.
Unions:	Electrogalvanized ferrous alloy type UNF, UNY, Appleton Crouse-Hinds, or approved equivalent. Threadless or split fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA 12 welded steel 6 inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight.
Outdoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA 4X stainless steel for 6 inches square and larger.
Corrosive:	NEMA 4X stainless steel or nonmetallic.
Hazardous:	NEMA Class 7 cast ferrous.
Elbows:	
(3/4" thru 1-1/2")	Factory fabricated or field bent.
(2" thru 6")	Factory fabricated only.
Conduit Bodies:	
(3/4" thru 4")	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
(5" and 6")	Electrogalvanized iron or cast iron box.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
	Manufacturers: Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or approved equivalent.
Installation:	Rigid steel conduit shall be made up tight and without thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs.
	Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.
	Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

RACEWAY SPECIFICATION SHEETS

Raceway Type:	LFMC
Description:	Liquidtight Flexible Steel Conduit
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 360
Construction:	Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum Size:	3/4 inch
Fittings:	Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90 degree fittings shall be used where applicable.
Installation:	The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.

RACEWAY SPECIFICATION SHEETS

Raceway Type:	PGRS
Description:	Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated.
Compliance:	ANSI C80.1, UL 6, and ETL PVC coating adhesion verification PVC-001.
Finish:	Hot-dip galvanized rigid steel conduit, to which a minimum 40-mil thick PVC coating has been bonded to the outside of the conduit. A 2-mil coat of urethane coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Similarly coated to the same thickness as the conduit and provided with type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company.
Hubs:	Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded and made of cast ferrous alloy. Hubs shall have the same PVC coating as the conduit. The hub shall have an insulating grounding bushings. The hubs shall utilize a neoprene "O" ring and shall provide a watertight connection.
Boxes:	
Nonhazardous:	NEMA Class 4X stainless steel or nonmetallic.
Hazardous:	NEMA Class 7 cast ferrous.
Corrosive:	NEMA 4X stainless steel or nonmetallic.
Elbows:	Elbows shall be factory made and coated.
Manufacturers:	Robroy Industries, Ocal Blue by Thomas and Betts, or approved equivalent.
Installation:	<p>Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the conduit manufacturer. All conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer's recommendations. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.</p> <p>PVC coated conduit shall be supported away from the structure using PVC coated conduit wall hangers or PVC coated conduit mounting hardware.</p>

RACEWAY SPECIFICATION SHEETS

Raceway Type:	PVC4
Description:	Rigid Nonmetallic Conduit, heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.
Compliance:	
Conduit:	NEMA TC2, UL 651
Fittings:	NEMA TC3, UL514b
Construction:	Schedule 40, high-impact, polyvinylchloride (PVC)
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased
Fittings:	PVC solvent weld type
Boxes:	
Indoor:	NEMA Class 4, nonmetallic
Outdoor:	NEMA Class 4X, nonmetallic
Corrosive:	NEMA Class 4X, nonmetallic
Installation:	In accordance with NEC Article 347. Field bending shall not be permitted.

RACEWAY SPECIFICATION SHEETS

Raceway Type:	PVC8
Description:	Rigid Nonmetallic Conduit, extra heavy wall thickness for direct bury, concrete encasement or surface mounting.
Compliance:	
Conduit:	NEMA TC2, UL 651
Fittings:	NEMA TC3, UL514b
Construction:	Schedule 80, high-impact, polyvinylchloride (PVC)
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased
Fittings:	PVC solvent weld type
Boxes:	
Indoor:	NEMA Class 4, nonmetallic
Outdoor:	NEMA Class 4X, nonmetallic
Corrosive:	NEMA Class 4X, nonmetallic
Installation:	In accordance with NEC Article 347. Field bending shall not be permitted. PVC conduit shall have bell ends where terminated at walls.

END OF SECTION

SECTION 26 05 34

BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 00, Common Work Results for Electrical Work
 - 2. Section 26 05 33, Raceways and Fittings
 - 3. Section 26 05 53, Identification for Electrical Systems

1.02 SCOPE OF WORK

- A. The scope of work under this Section includes furnishing and installing all pull boxes, junction boxes, and device boxes.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
- B. Product Datasheets
 - 1. Layout Drawings for all boxes larger than standard receptacle boxes.
 - 2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Codes and Standards:

1. UL Compliance
 - a. UL 514A, Metallic Outlet Boxes
 - b. UL 514C, Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers
 - c. UL 50, Enclosures for Electrical Equipment, Non-environment Considerations
 - d. UL 50E, Enclosures for Electrical Equipment, Environmental Considerations
 - e. UL 1203, Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations
2. NEMA Compliance
 - a. NEMA 250, Enclosures for Electrical Equipment

1.05 HANDLING AND STORAGE

- A. Follow manufacturer's recommendations regarding handling and storage at all times prior to placing the devices in service.

PART 2 PRODUCTS

2.01 PULL AND JUNCTION BOXES

A. General

1. All pull and junction boxes shall be UL listed and labeled.
2. Pull and junction boxes shall not be provided with eccentric or concentric knockouts.
3. Pull and junction boxes mounted embedded in concrete shall be UL listed for embedment.
4. Where metallic boxes are used, they shall be of all welded construction. Tack welded boxes are not acceptable.

B. Pull Boxes

1. All pull boxes shall be provided with a matching gasketed cover. For covers with dimensions of 24 inches by 24 inches or less, the cover shall be held in place by machine screws. Other screw types are not acceptable. For covers with dimensions greater than 24 inches by 24 inches, the cover shall be hinged and held in place by screw-operated clamp mechanisms. Hinge pins shall be removable. Clamp mechanism material of construction shall match that of the associated box.
2. Pull boxes shall not have any wire terminations inside, other than those for grounding/bonding. A ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the pull box (minimum of two) shall be provided as spare terminations. Boxes requiring any other wire terminations shall be furnished and installed in accordance with the requirements for junction boxes herein.
3. Pull boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC

4. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:
 - a. Power wiring
 - b. AC Control wiring
 - c. DC Control wiring
 - d. Instrumentation wiring

C. Junction Boxes

1. Junction boxes used for lighting and receptacle circuits only shall be provided with a matching gasketed cover held in place by machine screws. Other screw types are not acceptable.
2. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with a hinged, gasketed cover. Hinge pins shall be removable. Cover shall be held in place by screw-operated clamp mechanisms. Clamp mechanism material of construction shall match that of the associated box.
3. Barriers shall be provided in junction boxes to isolate conductors and terminal blocks of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:
 - a. Power wiring
 - b. AC control wiring
 - c. DC control wiring
 - d. Instrumentation wiring
4. Junction boxes used for lighting and receptacle circuits only shall be allowed to have screw-on (wire nut) type connectors for wire terminations/junctions.
5. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with terminal strips, consisting of the necessary number of screw type terminals. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected. Terminal block minimum rated ampacity shall be 10 amperes. Terminal strips shall be rated for the voltage of the circuits connected. A separate ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the junction box (minimum of two) shall be provided as spare terminations. When barriers are provided within the box, separate terminal strips shall be provided in each barrier area. Terminals shall be lettered and/or numbered to conform to the wiring labeling scheme in place on the project.
6. Junction boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC. Terminal blocks (including spare terminals) shall be considered when sizing the junction box.

- D. Enclosure Types and Materials: Unless otherwise noted, pull and junction box sealing rating and materials of construction shall be in accordance with paragraph 26 05 00-1.08.

2.02 OUTLET BOXES

A. General

1. Device boxes shall be provided with device plates appropriate for the wiring device installed inside. Reference Section 26 27 26, Wiring Devices, for device box trim requirements. An appropriate device box trim is required to achieve the NEMA rating of the device boxes as specified herein.
2. Unless otherwise noted, pull and junction box sealing rating and materials of construction shall be in accordance with paragraph 26 05 00-1.08.

B. Surface Mount Device Boxes

1. Device boxes shall be the deep type, no less than 2.5 inches deep.
2. Device boxes shall be provided in single or multi-gang configuration as required, sized in accordance with the requirements of the NEC.
3. Device boxes shall be provided with integral threaded conduit hubs mounted external to the box. Boxes with threaded conduit hubs mounted internal to the box or as a part of the box wall are not acceptable.

C. Flush Mount Device Boxes

1. Device boxes shall be no less than 2-1/8 inches deep, and 4-11/16 inches square. Boxes shall be UL listed and labeled. Pre-punched single diameter conduit knockouts are acceptable; however, concentric and eccentric knockouts are not acceptable.
2. Device boxes mounted flush in CMU walls shall be made of galvanized, tack welded steel, and suitable for installation in masonry walls. Sectional type boxes are not acceptable for this application.
3. Device boxes mounted flush in gypsum walls shall be made of galvanized pressed steel. Tack welded boxes are not acceptable for this application. Sectional type boxes are not acceptable for this application.
4. Device boxes mounted cast into concrete shall be concrete tight and shall be made of galvanized steel.

2.03 SPECIALTY BOXES

A. Cable Access Box: Cable access box shall consist of a standard single gang device box, a cable access strap, and a device plate. Cable access box shall provide cable entry to a raceway system.

1. Device: As specified in this Section.
2. Wall Plate: As specified in Section 26 27 26.
3. Cable Strap: Legrand On-Q Cable Access Strap, Part Number WP1014WHV1 or approved equivalent.

B. Audio/Video (AV) In-Wall Accessory Box: AV in-wall accessory box shall designed for flush mounting in a stud wall and house the necessary utilities to serve a wall-mount video monitor. Box features shall be as manufactured by Peerless-AV, Model IBA2AC-W or approved equivalent. Box shall have the following features.

1. Box Interior Dimensions: 9.6"H 13.1"W x 3.75"D.
2. Construction: Cold-rolled steel.
3. Finish: White scratch resistant fused epoxy.

4. Integral 125V, 15 ampere duplex receptacle with device box and device plate and cable access plate mounted in the bottom panel of the box.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pull and Junction Boxes

1. Pull boxes and junction boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Box penetrations for conduits shall be made with a punch tool, and penetrations shall be of the size required for the conduit entry and/or hub. Oversized penetrations in boxes are not acceptable.
4. Watertight conduit hubs shall be provided for boxes where a NEMA 4X enclosure rating is specified. Refer to Section 26 05 33 for conduit hub requirements.
5. Pull and junction boxes may be installed flush mounted in gypsum, concrete or CMU walls where appropriate provided that covers are easily removed or opened.
6. Pull and junction boxes shall be provided in the enclosure type and material of construction required for the area in which it is installed.

B. Device Boxes

1. Device boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Flush mounted device boxes shall be arranged and located so that tile and grout lines fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.
4. Device boxes shall be flush mounted in NEMA 1 finished areas.
5. For the below-named items, mounting heights from finished floor, or finished grade to top is applicable, depending on the type of wiring device to be installed in the device box. Mounting heights above finished floor or operating platform for device boxes shall be as follows, unless otherwise specified herein, indicated on the Drawings.
 - a. Light switches: 48 inches
 - b. Receptacles, NEMA 1 areas: 16 inches
 - c. Receptacles, NEMA 4, 7, 12 areas: 48 inches
 - d. Receptacles, outdoor locations: 24 inches

3.02 ADJUSTING AND CLEANING

- A. Adjust covers insure proper mechanical operation and seating and to permit full operating range.

- B. Electrical boxes shall be clean and free from building materials, dirt, and debris.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. This section is a Division 26 section and is part of each specification section referencing wires and cables specified herein.

1.02 SUMMARY

- A. This section specifies the furnishing and installation of electrical conduits, ducts, fittings and accessories for underground applications.
- B. Extent, location, and details of duct raceway work are indicated on Drawings and in schedules.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's product data for all raceway, conduit, and accessories.
 - 2. Raceway and Conduit Shop Drawings: Provide shop drawings including dimensioned plan and elevation views for the following conduit, and raceway installations.
 - a. Underground duct banks indicating cross section, fill, routing, depth, and manhole/handhole locations.
 - b. Below grade duct bank penetrations through structural footings and walls.
 - c. Conduit Routing Plans: Conduit routing plans indicating the size, routing, and dimensions of conduits and raceway systems.
 - 3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. NEMA Compliance: Comply with applicable requirements of NEMA Standards publications pertaining to raceways and ducts.
3. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have UL-listed and labeled.

PART 2 PRODUCTS

2.01 GENERAL

- A. General requirements for raceway systems and related components specified in this section are listed in the Raceway Specification Sheets at the end of this section.
- B. Raceway Specification Sheet: The following Raceway Specifications Sheet are included in this section.
 1. PVC4

2.02 CONCRETE ENCASED DUCT BANKS

- A. General: Concrete used for duct banks shall be as specified in Section 26 05 00.

2.03 MISCELLANEOUS RACEWAY SYSTEM ACCESSORIES

- A. Pull Line: Pull line shall be in accordance with specification 26 05 33.
- B. Underground marking tape shall be for location and early warning protection of buried power, control, and communications utilities. Marking tape shall be OSHA approved. Tape shall be detectable by a pipe/cable locator or metal detector from above the undisturbed ground.
 1. Tape shall be nominally 6 inches wide constructed of 5 mil thick polyester plastic with an aluminum foil backing. Tape color shall be red in accordance with APWA (American Public Works Association). A warning shall be imprinted in black ink continuously along the length with message reading similar to "CAUTION: BURIED ELECTRIC LINE BELOW." Tape shall be as manufactured by Seton or approved equivalent.
- C. Conduit Spacers: Conduit spacers shall be non-metallic, non-corrosive, non-conductive saddle type designed to relieve concrete-encased raceway systems of both horizontal and vertical stresses.
 1. Vertical and horizontal interlocking.
 2. Suitable for concrete encasement.
 3. Integral molded reinforcing bar holder.
 4. Accommodate 1-1/2 inch through 4 inch diameter conduit.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION

- A. General: It is recognized that the raceway requirements indicated on the contract drawings are diagrammatic in showing certain physical relationships which must be established within the electrical work, and its interface with other work including utilities, and mechanical and structural work and that such establishment is the exclusive responsibility of the Contractor. Contractor shall provide offsets, transitions, boxes, fittings and accessories which may be required but have not been shown because of the small scale of the Drawings.

3.03 CONDUIT

- A. General: The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes. Pull boxes shall be provided in conduit runs to limit the maximum conduit run to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.
- B. Conduit Raceway Sizes: Minimum conduit size shall be 1 inch. The size and type of conduit shall be as specified herein and as indicated on the Drawings.
 - 1. Conduit sizes indicated on the Drawings are the minimum size permitted for exposed applications. Conduit sizes shall be increased as necessary to the minimum specified size for embedded applications.
 - 2. Any conduit or raceway system for which a trade size is not indicated on the Drawings shall be sized by the Contractor in accordance with the Annex C of the NEC and shall be subject to the minimum sizes specified herein.
- C. Underground Conduit Systems: All excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:
 - 1. All underground conduits not indicated otherwise on the Drawings shall be concrete encased. All concrete encasement shall be reinforced.
 - a. Underground conduits serving site lighting systems shall not require reinforcement.
 - 2. Underground conduits shall be installed with manufactured plastic interlocking conduit spacers with integral molded reinforcing bar holder. Spacers shall be anchored to reinforcing bars to prevent movement during the concrete pour.
 - 3. Concrete encased conduit shall have minimum concrete thickness of 2 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches over reinforcing.
 - 4. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.
 - 5. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere.

6. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads shall be protected.
 7. Underground conduits and conduit banks shall have 2 feet minimum earth cover except where indicated otherwise.
 8. Underground conduit banks through building walls shall be cast in place or concreted into boxouts with waterstops on all sides of the boxout. Waterstops shall be as specified in the 03 30 00 Cast-in-Place Concrete specification section.
 9. Conduits not encased in concrete and passing through walls which have one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.
 10. Provide PVC conduit with bell ends where duct banks terminate at walls, manholes, or handholes. Install bell ends flush with finished concrete.
 11. Conduits shall be thoroughly swabbed on the inside, immediately upon completion of pouring concrete. After the concrete has set, and before backfilling, a mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, shall be pulled through each conduit. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.
 12. All spare raceways shall be provided with a pull line with adequate spare length at both ends to facilitate conductor pulling.
 13. Duct banks shall be sloped away from building to manholes and handholes.
 14. Slope duct banks uniformly 1/4-inch per 10 feet between manholes and handholes or in both directions from a high point midway between manholes/handholes.
- D. Conduit Separation: Conduit separation shall be in accordance with specification 26 05 33.
- E. Underground Marking Tape: Underground marking tape shall be installed 18-inches above the conduit or conduit bank the tape is intended to protect. Where the protected conduit bank exceeds 36-inches in width another tape shall be installed at every interval of 30 inches across the width of the conduit bank.

RACEWAY SPECIFICATION SHEET

Raceway Type:	PVC4
Description:	Rigid Nonmetallic Conduit, heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.
Compliance:	
Conduit:	NEMA TC2, UL 651
Fittings:	NEMA TC3, UL514b
Construction:	Schedule 40, high-impact, polyvinylchloride (PVC)
Minimum size:	1 inch
Fittings:	PVC solvent weld type
Installation:	In accordance with NEC Article 347. Field bending shall not be permitted.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. This section is a Division 26 section and is part of each specification section referencing identification for electrical systems.

1.02 SUMMARY

- A. This section specifies products and methods that shall be used in the identification of electrical systems.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Nameplate schedule specifying the dimensions, color, font size and type, and wording for each nameplate.
 - 2. Manufacturer's literature for the following:
 - a. Wire and cable identification products.
 - b. Raceway markers.
 - c. Underground warning tape.

PART 2 PRODUCTS

2.01 NAMEPLATES

- A. General
 - 1. Nameplates shall be made from 3/32-inch-thick 2-ply laminated phenolic plastic with chamfered edges. Nameplates shall have white backgrounds with black letters unless otherwise specified.
 - 2. Nameplates shall be sized as required to accommodate the specified legends.
 - 3. Lettering shall be engraved block style characters.
 - 4. Character Height:
 - a. Identification: The top line of the nameplate shall be the identification line and the most prominent on the nameplate. The height of the characters used in the identification line shall be 1/2 inch with the exception of control station nameplates on which the height of all characters shall be 3/16 inch.

- b. Information: The lines beneath the identification line shall be the information lines. The height of characters in the information lines shall be 5/16 inch.

B. Legends: The following examples describe the nameplate legends for common equipment. Legends for equipment nameplates other than one of the examples below shall be approved by the Engineer. Equipment descriptions, tag numbers, circuit designations, etc. shall be as shown on the Drawings.

1. Panelboards:

PANELBOARD LP3010
208/120V, 3 PH
SERVED FROM: DP4010-2, 4, 6

2. Switchgear/Switchboards/Motor Control Centers:

SWITCHBOARD SWB3010
480V, 3 PH
SERVED FROM: SWG3000

3. Transfer Switches:

MANUAL TRANSFER SWITCH
MTS3010
480, 3 PH
SOURCE A: MCC4010A
SOURCE B: MCC4010B

4. Disconnect Switches:

RAS PUMP 4
DS4314
480V, 3 PH
SERVED FROM: MCC4010A

5. Transformers:

TRANSFORMER TFR3010

PRIMARY: 480V, 3 PH

SECONDARY 208/120V, 3 PH

SERVED FROM: MCC4010A

6. Motor Controllers:

RAS PUMP 4

VFD4314

480V, 3 PH

Served From: MCC4010A

7. Control Panels:

AREA CONTROL CENTER

ACC3010

SERVED FROM: LP3010-2, 4,

8. Control Stations:

RAS PUMP 4

CS4314

9. Motors:

RAS PUMP 4

P4314

480V, 3 PH

SERVED FROM: MCC4010A

2.02 WIRE AND CABLE IDENTIFICATION

- A. General: Each power, control, and signal conductor with the exception of lighting and receptacle power conductors shall be identified at each terminal to which it is connected. Roadway lighting circuits shall be tagged identifying the panelboard and circuit from which it is served. All conductors, including spares, shall be identified. Conductors size No. 10 AWG or smaller shall have identification sleeves.
- B. Markers: The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The characters shall be 1/8 inch high (minimum). Sleeves shall be white tubing sized to fit the conductor insulation. The sleeves shall be shrunk to fit the conductor with hot air after installation. They shall be TMS Thermofit Marker System by Raychem Co., sleeve style wire marking system by W.H. Brady Co., or approved equivalent.

2.03 RACEWAY IDENTIFICATION

- A. General: Raceways shall be permanently identified with raceway markers as specified herein.
- B. Raceway Markers:
 - 1. Material: 20-gauge, 304 stainless steel
 - 2. Shape: Round, 1.5-inch diameter
 - 3. Engraving: Laser engraving with blank ink fill
 - 4. Attachment: 3/16-inch diameter top hole and 316 stainless steel wire with zinc clamp

2.04 UNDERGROUND WARNING TAPE

- A. Underground marking tape shall be for location and early warning protection of buried power, control, and communications utilities. Marking tape shall be OSHA approved. Tape shall be detectable by a pipe/cable locator or metal detector from above the undisturbed ground.
 - 1. Tape shall be nominally 6 inches wide constructed of 5 mil thick polyester plastic with an aluminum foil backing.
 - 2. Tape color shall be red in accordance with APWA (American Public Works Association).
 - 3. A warning shall be imprinted in black ink continuously along the length with message reading similar to "CAUTION: BURIED ELECTRIC LINE BELOW." Tape shall be as manufactured by Seton or approved equivalent.
- B. Manufacturer: Tape shall be as manufactured by Seton or approved equivalent.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 NAMEPLATES

A. General

1. Provide a nameplate for each piece of electrical equipment, control panel, control station, motor, etc.
2. Provide nameplates of identical style, color, and material throughout the facility.

B. Installation

1. Nameplates shall be attached to equipment with a waterproof epoxy-based cement.
2. Nameplates shall be aligned and level or plumb to within 1/64-inch over the full length of the nameplate.

3.03 WIRE AND CABLE IDENTIFICATION

A. All power, control and signal conductors shall be identified at each connection terminal; in pull boxes, manholes, and handholes; and at splice points. Conductors shall be identified with identical numbers at both ends. Conductor tag numbers shall consist of the equipment number followed by a dash followed by the conductor number specified on the submittal drawings or control diagram.

B. Conductors which are in parallel or in series between equipment shall have the same conductor number. Neutral conductors shall have the same conductor number. Wherever possible, the conductor number shall be the same as the terminal to which it connects.

C. Conductor Identification Example

Example: P1201 - L1

Where:

P1201	Equipment number
L1	Conductor number

D. Installation

1. Apply wire and cable markers prior to wire and cable termination.
2. Tubing markers shall be shrunk using a heat gun approved for the application.
3. Marker legends shall face the open panel or enclosure and shall read from left to right or top to bottom.
4. Markers shall be positioned 1/8 inch from the point where the insulation or jacket has been removed for termination.

3.04 RACEWAY IDENTIFICATION

A. General

1. Conduits shall be provided with a raceway marker at each termination point in the following applications:
 - a. Homerun conduits from field devices or equipment to panelboards, switchgear, motor control centers, or control panels.

- b. Conduits that any portion of which are concealed.
 - c. Conduits that pass from one space to another through walls, floors, or ceilings.
- 2. Legends: Legends on raceway markers shall include the following information:
 - a. Line 1: Raceway number as defined herein.
 - b. Line 2: Source equipment designation.
 - c. Line 3: Destination equipment designation.
- B. Contractor shall assign raceway numbers in accordance with the following system. Prefixes shall be followed by the equipment tag number.

<u>Raceway Prefix</u>	<u>Raceway Function</u>
C	Control
H	Power above 600V
I	Instrumentation
P	Power 120V to 600V
S	Low level signal (less than 90 volt communication or less than 30 volt instrumentation)
X	Spare

Example: Raceway number: P2101A

where:

P	=	conduit contains power
2101	=	unique equipment number
A	=	letter to distinguish from other raceways to same equipment

- C. Letter Suffix: Where there is more than one raceway to a particular piece of equipment, a letter suffix shall be added to distinguish the raceways.
- D. Lighting and Receptacle Branch Circuits: Conduit tags for conduits containing lighting and receptacle branch circuit conductors shall identify the associated panelboard designation.

3.05 UNDERGROUND WARNING TAPE

- A. Install warning tape 18 inches below finished grade along the full length of the conduit or conduit bank the tape is intended to protect.
- B. Where the protected conduit bank exceeds 24-inches in width another tape shall be installed at every interval of 18 inches across the width of the conduit bank.

END OF SECTION

SECTION 26 05 73

POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. General: This section specifies that the Contractor conduct the following power system studies for the electrical power distribution system.
 - 1. Short Circuit Study: Provide a complete short circuit study, equipment interrupting or withstand evaluation, and a protective device coordination study for the electrical power distribution system serving the wastewater treatment facility. The studies shall include all portions of the electrical power distribution system from the utility primary service drop through and including the 480 volt bus.
 - 2. Protective Device Coordination Study: A protective device coordination study shall be performed to determine proper selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and circuit breaker trip characteristics and settings. Study shall include coordination with upstream utility devices.
 - 3. Flash Hazards Analysis: A flash hazard analysis shall be conducted to determine the arc-flash incident energy at all power distribution and control equipment and to establish the flash protection boundary for said equipment. The scope of the analysis shall also include the preparation and installation of warning labels for all power distribution and control equipment.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. The reports specified in paragraph 26 05 73-2.01. The report shall be approved by the Construction Manager prior to releasing any power distribution equipment for manufacture.
 - 2. Sample of the arc flash hazard warning label.
 - 3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be

accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Qualifications: The studies shall be performed, sealed, and signed by a professional engineer registered in the State of Colorado. The individual responsible for performing the studies and preparing the reports shall be an employee of the independent testing firm specified in Section 26 08 00 and shall have a minimum of ten (10) years experience in power system analysis.
- B. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. Institute of Electrical and Electronic Engineers (IEEE) Compliance: Study and analysis procedures shall comply with the following standards:
 - a. IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants
 - b. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - c. IEEE 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis.
 - d. IEEE 1584 - Guide for Performing Arc Flash Hazard Calculations
 - 3. National Fire Protection Association (NFPA) Compliance: Study and analysis procedures shall comply with the following standards:
 - a. NFPA 70E - Electrical Safety in the Workplace

PART 2 PRODUCTS

2.01 REPORT

- A. General: The product shall be a certified report summarizing the short circuit, protective device coordination, and arc flash hazard studies and provide conclusions and recommendations which may affect the integrity of the entire electric power distribution system.
- B. Short Circuit Analysis: The short circuit analysis shall be performed with the aid of a digital computer program and shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010. Short circuit interrupting and momentary duties shall be determined for an assumed three phase bolted fault at each pad-mounted transformer primary and secondary terminals, low voltage switchgear and switchboard, motor control centers and distribution panelboards. A ground fault current study shall be provided for the same system areas.

Normal system operating method, alternate operation, standby power operation, and operations which could result in maximum fault conditions shall be thoroughly addressed in the study. The study shall assume all motors operating at rated voltage with the exception that motors identified as standby shall not be included as fault current sources. Power distribution equipment bus impedance shall be assumed zero. The study shall be based on actual equipment data.

1. Content: The short circuit study shall include the following information:
 - a. The equipment manufacturer's published information used to prepare the study.
 - b. Assumptions made during the study.
 - c. Identification of calculation methods employed in the study.
 - d. One-line diagram of the power distribution system. The following information shall be either indicated on the one-line diagram or tabulated within the report:
 - 1) Location and function of each protective device in the system.
 - 2) Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
 - 3) Power, voltage ratings, impedance, and primary and secondary connections of all transformers.
 - 4) Type, manufacturer, and ratio of all instrument transformers energizing each relay.
 - 5) Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.
 - 6) Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.
 - 7) All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
 - e. Tabulation of all data used as input to the report including cable impedances, source impedances, equipment ratings, etc.
 - f. Fault current calculations including a definition of terms and guide for interpretation of computer-generated results.
 - g. Tabulation of results at each bus including fault impedance, X/R ratios, asymmetry factors, motor and generator contributions, short circuit kVA and symmetrical and asymmetrical fault currents.
 - h. Evaluation of results including a tabulation of equipment short circuit interrupt and withstand ratings and available fault currents at each device.
 - i. Conclusions and recommendations.
 2. Utility System Impedance: Contractor shall be responsible for obtaining system impedance information from utility company. Actual transformer impedances and fault currents shall be used in the study unless a more conservative approach is taken. Regardless of the approach proposed, the utility impedance data shall be provided in the study.
 3. Preliminary Report: A preliminary short circuit analysis shall be submitted prior to final acceptance of the power distribution equipment submittals. The preliminary short circuit analysis shall be based on the actual utility system impedance but may neglect impedance of the bus and cable systems of the plant power distribution system.
- C. Protective Device Coordination Study: A protective device coordination study shall be conducted in accordance with the National Electrical Code and the recommendations of IEEE Standard 399 to select and to verify the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and circuit breaker trip characteristics and settings. The coordination study shall include all voltage classes

of equipment from the utility's incoming line protective device down to and including the main device of each 208-volt AC panelboard.

1. Content: The protective device coordination study shall include time-current curve sets graphically indicating the coordination proposed for the system. Time-current curves shall be plotted on full-size, 5-cycle, log-log graph paper with a maximum of eight protective devices per plot. Device time-current characteristics shall be based on the published time-current curves for the equipment manufacturer proposed for use on this project. The coordination study time-current plots shall, at a minimum, include the following:
 - a. Time-current curve for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.
 - b. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Reasonable coordination intervals and separation of characteristic curves shall be maintained
 - c. Time-current curves and points for cable and equipment damage and symmetrical and asymmetrical fault currents.
 - d. Circuit interrupting device operating and interrupting times.
 - e. Maximum fault values.
 - f. Transformer full load currents, magnetizing inrush current, and ANSI withstand parameters.
 - g. Motor starting curves.
 - h. Pertinent generator characteristics.
 - i. Sketch of bus and breaker arrangement.
 - j. Tabulation of all device settings including tap, time dial, pickup, instantaneous, and time delay settings.
 - k. Conclusions and recommendations pertinent to final system coordination and selectivity.
 - l. Discrepancies, problem areas, or inadequacies shall be clearly identified.
- D. Flash Hazard Analysis: A flash analysis shall be conducted in accordance with the recommendations of IEEE Standard 1584 and NFPA 70E. The flash analysis shall address all power distribution and control equipment with potential to produce an arc flash when energized. The flash hazard analysis shall include the following:
 1. Calculation of the flash protection boundary.
 2. Calculation of the arc-flash incident energy.
 3. Preparation and installation of all required warning labels. Warning labels shall be in accordance with the latest ANSI Z535.4 standards and shall minimally identify the equipment by type and designation, the arc flash boundary, and the type of personal protective equipment required.
 4. Identify the required personal protective equipment with arc rating to provide adequate protection for personnel working on or near energized equipment or conductors.

PART 3 EXECUTION

3.01 DATA COLLECTION

- A. The Contractor shall be responsible for obtaining and verifying all data required in preparation of the studies.

3.02 FIELD SETTINGS

- A. The results of the approved short circuit and protective device coordination study shall establish the final field settings for all protective devices. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.

END OF SECTION

SECTION 26 05 83

LOW VOLTAGE WIRING CONNECTIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. This section is a Division 26 section and is part of each specification section referencing wiring connections for low voltage systems.

1.02 SUMMARY

- A. This section specifies products and methods that shall be used for wire termination and splicing on electrical systems rated 600 volts and less.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's literature for the following:
 - a. Wire and cable identification products.
 - b. Variable frequency drive shielded cable termination kits.
 - c. Motor connection kits.

PART 2 PRODUCTS

2.01 SPLICING AND TERMINATING MATERIALS

- A. General: Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper.
- B. Connectors for power cables sizes No. 10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-spade terminals.
- C. Signal and Control Conductors: Signal and control conductors connected to terminal blocks, process controller input/output systems, and field devices and instruments shall be terminated with crimp-type locking-spade or ring lugs.
- D. Bus Taps: Bus tap connectors for wire sizes No. 8 AWG and larger shall be compression lugs. Lugs shall have the required bolt pattern and bolt size as required to accommodate the associated equipment terminals.
 - 1. One-hole lugs shall be used for conductor sizes No. 3/0 AWG and smaller.
 - 2. Two-hole lugs shall be used for conductor sizes No. 4/0 AWG and larger.

- E. In-line Splices: In-line splices and taps shall be used only where specified, or by written consent of the Engineer. When used, they shall be of the same construction as other connectors. Splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or approved equivalent. Splice shall be covered with a heat-shrinkable sleeve or boot.

2.02 VARIABLE FREQUENCY DRIVE (VFD) SHIELDED CABLE TERMINATIONS

- A. VFD Shielded Cable Shield Termination Kits: VFD shielded cable shield termination kits shall consist of the following components and be of a single manufacturer.
 - 1. Conducting copper foil tape conforming to UL 510.
 - 2. Flexible tinned copper braid bonding strap with attached lug.
 - 3. Constant force spring providing 360 degrees of electrical contact with the cable shield.
- B. Manufacturer: Shield termination kits shall be as manufactured by Southwire Spec 85451 or approved equivalent.

2.03 MOTOR CONNECTIONS

- A. Motor Connection Kits: Motor connection kits shall be insulated quick disconnect type. Motor connection kits shall consist of the following:
 - 1. Quick Disconnect Taps:
 - a. High conductivity tin-plated cast copper male and female quick disconnect taps.
 - b. Disconnect taps shall have integral conductor barrel to be compression fitted to the motor feeder and motor lead conductors.
 - c. Female tap shall have beryllium copper interface band.
 - 2. Insulating Boots: Thermoplastic elastomer insulating boots and cable ties to secure the boots over the disconnect taps.
- B. Manufacturer: Quick disconnect motor connection kits shall be ABB Color-Keyed Compression Connector System or approved equivalent.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 SPLICING AND TERMINATIONS

- A. Splices shall only be permitted by approval of the Engineer.
- B. Wire nuts shall not be permitted.
- C. Compression lugs shall be applied with tools specifically designed for that purpose and approved by the compression lug manufacturer.

3.03 SHIELDED VFD CABLE TERMINATIONS

- A. VFD cables shall be terminated with the specified shield termination kit. Shield termination kits shall be applied in accordance with the cable and termination kit manufacturer's instructions.
- B. VFD cable shields shall be terminated at each cable termination point as follows:
 - 1. VFD Termination: Shield bonding strap shall be terminated at the VFD manufacturers designated termination point within the VFD enclosure.
 - 2. Motor Termination: Shield bonding strap shall be terminated on the ground lug in the motor conduit box.
 - 3. Disconnect Switch Termination: Shield bonding straps shall be bolted together. The entire length of the bonding straps shall be insulated with a heat shrink sleeve to isolate the shield from ground within the disconnect enclosure.
- C. VFD cable ground conductors shall be terminated at each cable termination point by splicing a bare copper pigtail to the three symmetrical ground conductors in the cable using compression connectors. The ground pigtail shall be terminated on the associated equipment ground using a properly sized ground lug. The pigtail size shall not be smaller than the NEC required minimum equipment grounding conductor.

3.04 MOTOR CONNECTIONS

- A. Motor connection kits shall be installed in complete conformance with the motor connection kit manufacturer's instructions.
- B. Motor connections shall be made with the tool and die approved by the motor connection kit manufacturer.

3.05 FIELD QUALITY CONTROL

- A. All splices and terminations are subject to inspection by the Construction Manager prior to and after insulating.

END OF SECTION

SECTION 26 05 85

ELECTRICAL EQUIPMENT INSTALLATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. Equipment furnished in accordance with the following specifications applies to Work of this Section:
 - 1. Specification 26 24 16, Panelboards
 - 2. Specification 26 24 19, Motor Control Centers.
 - 3. Specification 26 29 23, Variable Frequency Drives
 - 4. Specification 40 67 00, Panels
- C. This section is a Division 26 section and is part of each specification section referencing control panel or other electrical equipment installation.

1.02 SUMMARY

- A. This section specifies the installation of electrical and control equipment furnished as Work of other specifications sections including the following:
 - 1. Panelboards
 - 2. Motor control centers
 - 3. Variable frequency drives
 - 4. Control panels and area control centers
 - 5. Control panels or related electrical equipment furnished as work of other specification sections.
- B. Extent, location, and details of equipment installation work are indicated on Drawings.

1.03 QUALITY ASSURANCE

- A. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects utilizing motor control centers similar to those required for this project.
- B. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. NECA Standards

- a. NECA 1 - Good Workmanship in Electrical Construction
- b. NECA 402 - Recommended Practice for Installation and Maintaining Motor Control Centers

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 GENERAL

- A. Coordinate equipment installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- C. Cables larger than No. 6 AWG which hang from their vertical connections shall be supported from the structure within 2 feet of the connection.

3.03 INSTALLATION OF FREESTANDING EQUIPMENT

- A. Install equipment at the locations indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. The floor upon which the freestanding equipment is installed shall be smooth and level (within 1/8 inch per three feet in any direction).
- C. Field cabling associated with freestanding electrical equipment shall be bundled in vertical wireways or designated wiring chase or compartment. Wiring serving more than one unit (circuit breaker, motor controller, control device, etc) shall not be bundled together. Control wiring shall not be bundled with power wiring.

3.04 INSTALLATION OF WALL-MOUNTED EQUIPMENT

- A. Install equipment at the locations indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Equipment mounting height shall be 72 inches above finished floor to top of equipment enclosure.
- C. Equipment enclosure shall be mounted on u-channel supports anchored to associated wall.

3.05 CONDUIT ENTRY AND TERMINATIONS

A. General

1. Conduits shall be terminated on equipment enclosures in manufacturer designated locations.
2. Conduits extending from underground duct banks and terminated in the bottom of electrical equipment enclosures shall be sealed with a foam duct sealant.
3. All conduits shall be fitted with a grounding hub or threaded grounding bushing. A bare #8 AWG ground conductor shall bond the conduit hub/bushing to the ground bar/lug in the associated electrical equipment.

B. Switchboards, Switchgear, and Motor Control Centers

1. Top Conduit Entries:
 - a. Structure top plates shall be removed before being cut to accommodate conduit entry. Lifting angles removed to facilitate the removal of the top plate shall be reinstalled after the top plate has been reinstalled.
 - b. Conduits shall be terminated above the structure vertical wireway when space permits.
 - c. Conduits shall not interfere with the operation of the arc flash mitigation pressure relief venting system.
2. Bottom Conduit Entries:
 - a. Conduits stubbed up beneath the equipment shall be no higher than 2 inches above the surface upon which the equipment is mounted and shall be clear of the horizontal ground bus or other structural elements.

C. Control Panels

1. Top Conduit Entries: Conduit entries shall not be permitted in the top of control panel enclosure without approval of the Engineer.

3.06 GROUNDING

- A. Provide equipment grounding connections to equipment as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.07 FIELD QUALITY CONTROL

- A. Field inspection and testing of equipment shall be completed prior to energizing the equipment.
- B. Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

3.08 HOUSEKEEPING

- A. General: Electrical equipment shall be protected from dust, water, and damage during the construction period. Electrical equipment including motor control centers, motor controllers, panelboards, switchgear, and buses shall be wiped free of dust and dirt on the outside and kept dry.

- B. Upon completion of the work, remove all litter, waste material, unused materials, and Contractor's tools and equipment from the job site.
- C. Remove all construction debris, packing materials, shipping labels, etc., from the interior and exterior of the equipment. Thoroughly clean and remove construction markings from interior surfaces.
- D. Clean exterior surfaces of equipment of all construction debris and markings and leave the equipment in an unblemished condition. Touch-up scratched or marred surfaces to match original finish.
- E. Clean all equipment filters in accordance with the manufacturer's instructions.

3.09 ADJUSTING

- A. Adjust operating mechanisms, enclosure doors, device cover plates, etc., for free mechanical movement.

END OF SECTION

SECTION 26 08 00
ELECTRICAL TESTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 73, Power System Studies

1.02 SUMMARY

- A. This section specifies the acceptance testing of electrical materials, equipment and systems. Contractor shall provide all labor, tools, material, power and other services necessary to provide the specified tests. Contractor shall engage the services of an independent electrical testing firm, hereinafter referred to as "Testing Organization", to conduct and perform the inspection and test procedures specified herein.
- B. The Testing Organization shall also be engaged to conduct the power system studies required by Specification 26 05 73.

1.03 QUALITY ASSURANCE

- A. References: This section contains references to the InterNational Electrical Testing Association (NETA), ATS-2021: Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems, copyright 2021; hereinafter referred to as "ATS". It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of said document, the requirements of this section shall prevail.
- B. Safety Requirements
 - 1. Safety and Precautions: This specification does not include specific safety procedures. It is recognized that tests and inspections set forth by this specification may be potentially hazardous. Consequently, individuals performing these tests must be capable of conducting these tests in a safe manner and with complete knowledge of the hazards involved. Each person involved in this project must be provided with and use appropriate personal protective equipment.
 - 2. Safety practices that shall be followed include, but are not limited to, the following:
 - a. Occupational Safety and Health Act.
 - b. Accident Prevention Manual for Industrial Operations, National Safety Council.
 - c. Applicable state and local safety operating procedures.

- d. Owner's safety practices.
 - e. Section 5 of ATS
- C. Procedural Requirements: All testing work shall be performed in accordance with the following codes and standards except as specified otherwise herein:
 - 1. Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems, ANSI/NETA ATS.
 - 2. Standard for Certification of Electrical Testing Personnel, ANSI/NETA ETT-2022.
 - 3. National Electrical Code, ANSI/NFPA 70.
 - 4. Recommended Practice for Electrical Equipment Maintenance, ANSI/NFPA 70B.
 - 5. Electrical Safety Requirements for Employee Workplaces, NFPA 70E.
- D. Testing Organization Qualifications. The Testing Organization proposing to perform the work of this specification section shall meet or exceed the following qualifications.
 - 1. Full compliance with Section 3 of ATS.
 - 2. Testing Organization shall have been the independent electrical testing firm of record for a minimum of five (5) projects in the past two years similar in scope, size, and types of electrical equipment and systems.
 - 3. The Testing Organization's project manager assigned to this project shall hold a current Level IV certification in electrical testing.
 - 4. The Testing Organization shall have an engineering staff meeting the qualifications of Specification 26 05 73-1.04A to conduct the specified power system studies.
 - 5. The Testing Organization field technicians shall have the specified NETA certification. Assistants or apprentices assigned to the Project shall not exceed a ratio of one apprentice for every two certified technicians.

1.04 APPLICATION

- A. Requirements for testing in accordance with this section are specified in this and other sections of Division 26. Where testing in accordance with this section is required, the required tests, including correction of defects when detected as a result of the testing activities, and subsequent retesting, shall be completed prior to energization of material, equipment or systems.

1.05 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Pre-Test Submittals:
 - a. Documentation to demonstrate compliance with specification 26 08 00-1.03 D including resumes and evidence of certification for testing personnel.
 - b. Tabulation of all equipment to be tested as work of this project with cross reference to applicable ATS Inspection and Test Procedures. Where ATS offers the Testing Organization multiple inspection or testing methods, the proposed method of choice shall be identified.
 - c. Examples of test report forms for all specified tests including deficiency report forms.
 - d. Preliminary test schedule.

2. Test Submittals:
 - a. Deficiency reports.
 3. Post-Test Submittals:
 - a. Final test report.
- B. Submittal Presentation: A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration. Submittal data shall be assembled in folders or three-ring binders or delivered electronically. Each folder or binder shall contain a cover sheet, indexed by item and cross-referenced to the appropriate specification paragraph. Catalog cuts shall be edited to show only the items, model numbers, and information that applies to the equipment being furnished.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT AND MATERIALS

- A. General: Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.
- B. NETA Compliance: Test equipment shall be in complete compliance with ATS, Paragraphs 5.2 and 5.3.

PART 3 EXECUTION

3.01 GENERAL

- A. Scope: Electrical testing shall be comprised of test procedures that shall be conducted by the installing contractor and test procedures that shall be performed by the Testing Organization. All inspections and tests shall be performed in strict conformance with the electrical acceptance test specifications in paragraphs 26 08 00-3.02 and 3.03.
 1. Installing Contractor Tests: The test procedures to be conducted by the installing contractor are defined as those tests specified in paragraph 26 08 00-3.04 C.
 2. Testing Organization Tests: Tests specified in paragraphs 26 08 00-3.02 and 3.04 B shall be conducted and performed by the Testing Organization meeting the qualification requirements of this specification. The types of equipment and/or systems to be inspected and tested shall be as specified in paragraph 26 08 00-3.04.

3.02 NETA ATS TEST REQUIREMENTS

A. Modifications to NETA ATS Test Requirements: NETA ATS shall be modified as described below and included as part of this section of the specifications.

1. ATS, Section 4, paragraph 4.1 shall be changed to read as follows: "The Contractor shall provide the Testing Organization ..."
2. ATS, Section 4, paragraph 4.1.1 shall be changed to read as follows: "The Contractor shall be responsible for power systems study work in accordance with Section 26 05 73. The Contractor shall provide the Testing Organization with a copy of approved power system studies."
3. ATS, Section 4, paragraph 4.2.3 shall be changed to read as follows: "Notification to the Owner's representative 30 days prior to commencement of any testing."
4. ATS, Section 4, paragraph 4.2.4 shall be changed to read as follows: "Deficiency reports shall be provided to the Owner's representative at the end of each day of testing."
5. ATS, Section 4, paragraph 4.2.5 shall be appended with the following: "A copy of all test results shall be submitted to the Owner's representative at the end of each day of testing."
6. ATS, Section 5, paragraph 5.4.3 shall be changed to read as follows: "The Testing Organization shall furnish six (6) copies of the complete report to the Owner's representative no later than 30 days after completion of all testing activities."
7. ATS, Section 6 shall be deleted in its entirety.
8. ATS, Section 7, paragraph 7.16.1.1.1.6 shall be changed to read as follows: "Verify the setting of the solid-state overload relay is correct for its application. Record the overload relay trip and time delay settings."

B. Optional Inspection and Test Procedures: Inspection and test procedures identified as "optional" in Sections 7 and 9 of ATS shall not be required as work of this specification except as specified below:

1. Perform all tests and inspections required by the paragraphs:
 - a. Section 7, paragraph 7.1.2.4.
 - b. Section 7, paragraph 7.2.1.1.2.3.
 - c. Section 7, paragraph 7.6.1.1.2.4.
 - d. Section 7, paragraph 7.6.1.1.2.9.
 - e. Section 7, paragraph 7.6.1.2.2.4.
 - f. Section 7, paragraph 7.6.1.2.2.9.
 - g. Section 7, paragraph 7.6.3.1.11.
 - h. Section 7, paragraph 7.6.3.2.3.
 - i. Section 7, paragraph 7.6.3.2.8.
 - j. Section 7, paragraph 7.6.3.2.9.
 - k. Section 7, paragraph 7.14.2.3.
 - l. Section 7, paragraph 7.15.1.2.13.
 - m. Section 7, paragraph 7.16.1.1.1.6.
 - n. Section 7, paragraph 7.16.1.1.2.3.

- o. Section 7, paragraph 7.16.1.2.2.4.
- p. Section 7, paragraph 7.17.2.4.
- q. Section 7, paragraph 7.22.1.2.5.
- r. Section 7, paragraph 7.22.3.2.2.
- s. Section 9, paragraph 9.1.3.

3.03 TEST DOCUMENTATION

- A. Inspection and Test Procedures Documentation: Detailed description of the proposed inspection and test procedures to be performed by the Testing Organization shall be prepared and submitted in accordance with paragraph 26 08 00-1.05. The inspection and test description shall also identify the test equipment required for each test.
- B. Test Report Forms: Test report forms shall be prepared for all test procedures as specified herein. Test report forms which appropriately and completely address the ATS test procedures shall include, but not by way of limitation, the following information:
 - 1. Electrical equipment description.
 - 2. Electrical equipment identification number.
 - 3. Electrical equipment location.
 - 4. Electrical equipment nameplate data.
 - 5. Electrical equipment settings.
 - 6. Time and date of test.
 - 7. Ambient conditions at time of test.
 - 8. Inspection checklist and results.
 - 9. Test results.
 - 10. Test equipment used.
 - 11. Remarks regarding test procedure or results, unusual or noteworthy observations, etc.
 - 12. Name and signature of testing personnel.
 - 13. Name and signature of test witness.
- C. Equipment Reference: The equipment descriptions and tag numbers indicated in these construction documents shall be used on test forms and reports to reference the equipment and systems under test.
- D. Deficiency Reports: Deficiency reports shall be prepared to identify and document all deficiencies in any system, material, equipment, or workmanship observed or detected during the acceptance testing activities.

3.04 EQUIPMENT TESTING

- A. General: The inspection and test procedures described by ATS, Section 7 shall establish the minimum requirements for electrical equipment inspection and testing. Additional test procedures, beyond the scope of ATS, Section 7, are defined herein and shall be conducted as specified.

B. Testing Organization Tests: The following types of equipment and/or systems shall be inspected and tested by the Testing Organization, as applicable to the project.

1. Medium voltage switchgear including vacuum circuit breakers, surge arresters, protective relaying, and control equipment.
2. Pad-mount liquid-filled transformers.
3. Low voltage, three pole power circuit breakers and solid-state trip units.
4. Low voltage, three pole, insulated and molded case circuit breakers and motor circuit protectors rated 100 amperes and greater. Circuit breakers and motor circuit protectors in adjustable frequency drives and solid-state reduced voltage motor controllers in accordance with these rating requirements.
5. Low voltage switchgear, switchboards, and panelboards.
6. Motor control centers including all motor starters. All motor starters of this project include solid-state overload relays. Injection testing of overload relays shall not be required.
7. Individually enclosed motor controllers including adjustable frequency drives.
8. Grounding systems.
9. Ground fault protection systems.
10. AC induction motors, 50 horsepower and larger.
11. Medium voltage cable systems including partial discharge testing.
12. Instrument transformers and metering systems.
13. Standby engine generator sets.
14. Automatic and manual transfer switches.
15. Surge protection devices located in power distribution equipment.
16. Dry type transformers, 30 kVA and larger.
17. Thermographic surveys shall be performed on the following equipment:
 - a. Medium voltage AC power distribution and control equipment.
 - b. Individually enclosed motor controllers including adjustable frequency drives and full and reduced voltage motor controllers.
 - c. Low voltage AC power distribution and control equipment including dry-type transformers and panelboards.

C. Installing Contractor Tests: The following types of equipment and/or systems shall be inspected and tested by the installing contractor.

1. Insulation Resistance Tests: Insulation resistance tests shall be performed on the following types of equipment or systems. Insulation resistance measurements shall be recorded on test report forms in compliance with specification 26 08 00-3.03 B.
 - a. Low Voltage (600 volt maximum) Power and Control Conductors and Cables: Insulation resistance tests shall be performed on all circuits 120 volts and above except interior lighting and 120 volt receptacle circuits.
 - 1) Power and control conductor and cable insulation tests shall be performed in accordance with ATS, Paragraph 7.3.2. Tests may be conducted with motors and other equipment connected, except that solid-state equipment shall be disconnected unless the equipment is

normally tested by the manufacturer at voltages in excess of 1000 volts DC.

- 2) The ambient temperature at which insulation resistance is measured shall be recorded on the test form.
- 3) Test results shall be evaluated against the results for cables of same type and length. Test results of less than 50 megohms shall be investigated.

b. Signal Cables: All analog signal cables shall be tested as specified herein.

- 1) The loop resistance of each signal pair or triad shall be measured. Any pair or triad exhibiting a loop resistance of less than or equal to 50 ohms shall be deemed satisfactory. For pairs with greater than 50 ohm loop resistance, the Contractor shall calculate the expected loop resistance considering loop length and intrinsic safety barriers if present. Loop resistance shall not exceed the calculated value by more than 5 percent.
- 2) Each shield drain conductor shall be tested for continuity. Shield drain conductor resistance shall not exceed the loop resistance of the pair or triad.
- 3) Each conductor (signal and shield drain) shall be tested for insulation resistance with all other conductors in the cable grounded.
- 4) Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500 volt megohmmeter shall be used for insulation resistance measurements.

2. Low Voltage Motor Tests:

- a. Installed Motor Test, Motors Less than 50 Horsepower: The Installed Motor Test Form, 26 08 00-A, appended to end of this specification section, shall be completed for each motor after installation. Motors shall be tested and inspected in accordance with ATS, Paragraph 7.15.1.
- b. Insulation Tests (At Delivery): Motors 50 horsepower and larger shall have their insulation resistance measured and recorded at the time of delivery.
- c. Motor Current Imbalance, Motors Less than 50 Horsepower: Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system. Current imbalance shall be based on the lowest measured value.
 - 1) Under 5 horsepower: 25 percent
 - 2) 5 horsepower and above: 10 percent
- d. Motors rated 120-volt AC shall not be required to be tested.

3. Power and Convenience Receptacles: 120-volt AC power and convenience receptacles shall be tested for the following conditions.

- a. Correct wiring
- b. Open ground connection
- c. Reverse polarity
- d. Open hot connection

- e. Open neutral connection
 - f. Hot on neutral
 - g. Hot and ground reversed with open hot
 - h. Ground fault interruption
4. Functional Checkout and Testing: Functional testing shall be performed in accordance with the requirements of this specification. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energization of equipment, all system component tests shall be completed, and the Contractor shall perform a functional checkout of the control circuit. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. The Contractor shall submit a description of his proposed functional test procedures thirty (30) days prior to the performance of functional checkout.

3.05 TEST VALUES

- A. Minimum acceptable test values shall be as specified in this specification and ATS. Where acceptable test values are not specified, the equipment manufacturers recommended test values shall be used.

3.06 EQUIPMENT ACCEPTANCE

- A. An acceptance sticker shall be placed on each equipment item that successfully passes all inspection and test procedures. Acceptance stickers shall not be placed on any equipment item until all identified deficiencies have been corrected by the Contractor and verified by the Testing Organization. The sticker shall indicate the Testing Organization's name, the initials of the person who conducted the inspection and test, the date of the test, and the recommended date of retest.

3.07 TEST REPORT

- A. General: The final test report shall be submitted in accordance with paragraph 26 08 00-1.05.
- B. Report Content: In addition to the requirements of ATS, Paragraph 5, the test report shall include the following documents and information.
- 1. Results of all tests conducted by the Installing Contractor.
 - 2. A document shall be prepared that provides a comprehensive list of all system deficiencies and non-compliant test results identified during the course of the testing activities conducted by the Testing Organization. This document shall also describe the resolution of each issue and the date on which the final inspection or test was conducted. The Testing Organization shall prepare on company letterhead a signed cover letter attesting to successful resolution of each outstanding issue. The cover letter shall be included in the test report with the list of deficiencies.
 - 3. Final power system studies.
- C. Report Organization: The test report shall be generally organized with the following major headings. A table of contents and corresponding individual tab dividers shall be provided to support the report organization.
- 1. Summary of the project
 - 2. Testing Organization Testing and Results

- a. Description of test procedures and test equipment
 - b. Summary of equipment tested
 - c. Test results organized by equipment item or system
 - d. Analysis and recommendations of test results
- 3. Comprehensive list of system deficiencies and non-compliant test results.
- 4. Power system studies organized by study type.
- 5. Installing Contractor Testing and Results
 - a. Summary of equipment tested
 - b. Test results organized by equipment item or system
- D. Submittal Schedule: The final test report shall be submitted on or before the project Substantial Completion date.

END OF SECTION

Form 26 08 00-A
Installed Motor Test Form

Driven Equipment Number: _____ Date of Test: _____

Driven Equipment Description: _____

Driven Equipment Location: _____

Insulation Resistance
Phase-to-Ground
(megohms)

Phase A: _____ Phase B: _____ Phase C: _____

Full Load Current and Voltage Measurements

Full Load Amps	Voltage
Phase A _____	Phase AB _____
Phase B _____	Phase BC _____
Phase C _____	Phase CA _____

Current Imbalance (percent): _____

Motor Nameplate Markings

Manufacturer: _____ Manufacturer Type: _____

Frame: _____ Horsepower: _____ Service Factor: _____

Volts: _____ Phase: _____ Temperature Rating: _____ °C

Full Load Amps: _____ Frequency: _____ Efficiency: _____ %

Time Rating: _____ Code Letter: _____

RPM: _____ Design: _____

Other Markings:

SECTION 26 21 00
SERVICE ENTRANCE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. Equipment furnished in accordance with the following specifications applies to Work of this Section:
 - 1. Specification 26 05 19, Low Voltage Conductors and Cables
 - 2. Specification 26 05 26, Grounding
 - 3. Specification 26 05 43, Underground Ducts and Raceways
 - 4. Specification 26 05 53, Identification for Electrical Systems
 - 5. Specification 26 05 83, Low Voltage Wiring Connections

1.02 SUMMARY

- A. This section specifies service entrance equipment including metering facilities, precast mounting pads and cable trays, and service laterals.
- B. Extent, location, and details of service entrance work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's product data indicating equipment specifications and construction features including all optional equipment and features proposed.
 - 2. Electrical ratings:
 - a. Bus configuration and ratings.
 - b. Short circuit withstand ratings.
 - 3. Dimensioned plan and elevation drawings including unit weight.
 - 4. Equipment installation instructions.

1.04 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.

2. UL Compliance: Provide components that are listed and labeled by UL and comply with applicable UL standards.
3. Utility Company Standards: Comply with applicable construction and installation requirements of the local utility company standards for service entrance work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver service entrance equipment and components properly packaged. Utilize factory fabricated containers or wrappings for service entrance equipment and components which protect equipment from damage. Inspect equipment to ensure that no damage has occurred during shipment.
- B. Store service entrance equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
- C. Handle service entrance equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which could damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.06 SEQUENCING AND SCHEDULING

- A. Coordinate with the local utility company, other trades, and other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of service entrance work with other work.
- B. The Contractor shall be responsible for contacting the local utility company and coordinating the construction of the power distribution facilities with the work of this Contract. The Contractor shall coordinate scheduling with the local utility company to ensure that the work of the local utility company is not impeded by the work of the Contractor.
- C. The costs accrued by the local utility company for construction and commissioning of the power distribution facilities shall be paid directly by the Owner with the exception that all costs incurred as a result of delays due to the Contractor's performance shall be paid for by the Contractor at no additional cost to the Owner.
- D. The Contractor shall be responsible for submitting service entrance equipment submittals to the local utility company to ensure compliance with applicable utility company guidelines.

PART 2 PRODUCTS

2.01 SERVICE ENTRANCE EQUIPMENT

- A. General: Provide service entrance equipment and accessories of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation and as specified herein. All service entrance equipment and accessories shall be in full compliance with the local utility company requirements.
- B. Secondary Connection Cabinet: Secondary connection cabinet shall be a freestanding, pad-mounted enclosure assembly complete with electrical bussing to accommodate the installation of

utility company current transformers. The secondary connection cabinet shall have the following features and be as manufactured by American Midwest Power or approved equivalent.

1. Compliance:
 - a. Cabinets shall be ETL listed and labeled per UL 1773, Standard for Safety Termination Boxes.
 - b. Utility Company Compliance: The service connection cabinet shall comply with all requirements of the local utility company.
2. Ratings:
 - a. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current 85,000 amperes symmetrical at rated voltage without cable lashing.
 - b. Voltage: 600 volts AC, 3 phase, 4 wire
 - c. Amperage: Rating to be as indicated on the Drawings.
3. Bus Bar Supporting Structure: Bus bar supporting structure shall be bolted to the cabinet framework such that any phase bus bar can be relocated vertically as required to meet the application requirements.
4. Bus Bars:
 - a. Bus bars shall be electrical grade tin-plated 6101T65 aluminum in compliance with ASTM specification B317.
 - b. Bus bars shall be supported using double glastic stand-off insulators.
 - c. Bus current density shall be 750 amperes per square inch maximum.
 - d. Bus bars shall have 5 sets of 9/16 inch square holes spaced on-center 2" horizontally and 1.75" vertically.
 - e. Neutral bus shall have a neutral lug suitable for termination of one #12 AWG solid conductor through two #10 AWG stranded conductors for metering the neutral conductors.
 - f. The phase arrangement on three-phase installations shall be A, B, C front-to-back, top-to-bottom, left-to-right when viewed from the front of the equipment.
5. Bus Links:
 - a. Cabinet shall be provided with a removable bus section to accommodate window-type current transformers. The removable bus section shall be twelve (12) inch minimum length and five (5) inch maximum width with an enclosed screw type compression terminal to accommodate a minimum #12 AWG metering potential conductor on the line side of the bus.
 - b. The installation height of the current transformers shall be between two feet minimum to six feet maximum measured from the center of the current transformers to the bottom of the cabinet.
6. Wiring Terminations
 - a. Mechanical-type terminals shall be provided for all load side conductor terminations and be suitable for copper or aluminum cable rated for 75 degrees Centigrade.
7. Enclosure:
 - a. Outdoor enclosure shall meet applicable NEMA 3R UL requirements.

- b. Enclosure shall have a cross checked reinforced roof.
- c. The enclosure shall be provided with galvanized pan formed side and rear covers bolted to the frame with tamperproof zinc plated bolts.
- d. Doors over utility current transformer provisions shall have continuous hinges and provisions for padlocking.
- e. Door hinge shall be on the side of the cabinet opposite the utility transformer.
- f. Doors shall have a wind catch for holding the door in the open position.
- g. All exterior and non-galvanized interior steel surfaces of the service connection cabinet shall be properly cleaned and provided with an oven baked polyester powder coating paint applied electro-statically. Color and finish of the cabinet shall be transformer green.

2.02 RACEWAY SYSTEMS

- A. Provide raceways complying with Specification 25 05 43.
- B. Precast Cable Tray Vault:
 - 1. General: Cable tray vault shall be a two piece precast concrete vault constructed in full compliance with the local utility requirements. Cable tray vault shall be as detailed on the Drawings and have the following features:
 - a. Two piece construction consisting a the vault body and lid.
 - b. Both the vault body and lid shall have integral swift lift anchors.
 - c. Vault body shall have 4-inch diameter drain holes in bottom slab.
 - d. Lid shall have blockouts for cable passage from cable tray space in the vault to the the pad-mounted equipment above.
 - 2. Manufacturer: Cable tray vault shall be as manufactured by Oldcastle Infrastructure; lid model number 1801455 and vault model number 1801450, or approved equivalent.

2.03 PRECAST CONCRETE EQUIPMENT PAD

- A. General: Precast concrete equipment pads shall be single piece concrete construction sized and rated as required to support and anchor the associated pad-mounted equipment. Equipment pads shall have the following features:
 - 1. Constructed of 5000 psi (28 day compressive strength) reinforced concrete
 - 2. 4" height with 1" chamfered perimeter edge
 - 3. Embedded 3/4" threaded lifting inserts (2 minimum)
 - 4. Embedded 5/8" threaded anchor inserts at pad-mount equipment anchor points (4 minimum)
 - 5. Center opening sized as required to permit full access to the pad mounted equipment.

2.04 TRENCH AND BACKFILL

- A. Trench and backfill for direct bury raceway systems shall be as detailed on the Drawings and in conformance with the requirements of the local utility company.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which service entrance equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF SERVICE ENTRANCE EQUIPMENT

- A. Install service entrance equipment as indicated, in accordance with equipment manufacturer's written instructions, local utility company service requirements, and with recognized industry practices, to ensure that service entrance equipment fulfills the requirements. Comply with applicable installation requirements of NEC and NEMA standards.
- B. The Contractor shall familiarize himself with all applicable provisions of the local utility company electric service requirements prior to commencing any service entrance equipment work.
- C. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

3.03 RACEWAYS

- A. All raceway systems shall be installed in accordance with the requirements of Specification 26 05 43 and the local utility guidelines where applicable.

3.04 FIELD QUALITY CONTROL

- A. Prior to energization of service entrance equipment check accessible connections for compliance with manufacturer's torque tightening specifications.
- B. Prior to energization, check circuitry for electrical continuity and for short circuits

3.05 GROUNDING

- A. Provide equipment grounding connections for service entrance equipment as indicated on the Drawings and as required by the local utility company. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.06 GROUNDING

- A. Provide equipment grounding connections to equipment as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.07 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. All equipment shall be cleaned in accordance with the requirements of Specification 26 05 00.

END OF SECTION

SECTION 26 22 13

LOW-VOLTAGE DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

- 1. Section 26 05 53, Identification for Electrical Systems

1.02 SUMMARY

- A. This section specifies dry-type transformers rated 600 volts and less used for power distribution, lighting, and control purposes.
- B. Extent, location, and details of dry-type transformer work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Dimensioned outline drawings.
 - 2. Manufacturer's catalog data indicating equipment specifications and features.
 - 3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. UL Compliance: Provide products that are listed and labeled by UL under the following standards:
 - a. ANSI/UL 506 - Specialty Transformers
3. NEMA Compliance: Provide products that comply with the following standards:
 - a. NEMA ST20 - Dry-Type Transformers for General Application
 - b. NEMA TP1 - Guide for Determining Energy Efficiency for Distribution Transformer
4. IEEE Compliance: Provide products that comply with the following standards:
 - A. ANSI/IEEE - General Requirements for Dry-Type Distribution and Power Transformers C57.12.01
5. Transformers shall meet the requirements of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment"

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 1. Cutler-Hammer
 2. General Electric Co.
 3. Square D Company

2.02 INSULATION

- A. Transformers 15 kVA and above shall have a Class 220 insulation system in accordance with NEMA ST20. Transformers 2 kVA and less shall be designed not to exceed 80 degrees C temperature rise. Transformers 3 kVA and greater shall be designed not to exceed 115 degree C temperature rise.

2.03 COILS

- A. Transformer coils shall be copper or aluminum. Transformer coils 15 kVA and above shall be impregnated with varnish. Transformer coils 10 kVA and below shall be encapsulated.

2.04 WINDING CONFIGURATION

- A. Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified. Provisions shall be made to permit separate grounding of the neutral conductor and the enclosure. Single-phase transformers shall be the four winding type.

2.05 TRANSFORMER TAPS

- A. Transformers 15 kVA and above shall be provided with two 2 1/2 percent full capacity taps above nominal voltage and four 2 1/2 percent full capacity taps below nominal voltage on the primary

winding. Transformers 10 kVA and below shall be provided with two 2-1/2 percent full capacity taps above nominal voltage and two 2-1/2 percent full capacity taps below nominal voltage on the primary winding.

2.06 TERMINAL COMPARTMENTS

- A. Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for the cable specified.

2.07 ENCLOSURES

- A. Transformers rated 15 kVA and smaller shall be provided with weatherproof, nonventilated enclosures. Indoor transformers rated greater than 15 kVA shall be provided with drip proof, ventilated enclosures. Outdoor transformers shall have weatherproof enclosures.

2.08 MOUNTING

- A. Transformers 15 kVA and below shall be suitable for wall mounting. Transformers 30 kVA and larger shall be floor mounting type except where indicated on the Drawings. If indicated as such on the Drawings, transformers 30 kVA and larger shall be provided with wall mounting brackets designed by the transformer manufacturer to support the transformer when supported from the wall.

2.09 TRANSFORMERS FOR NON-LINEAR LOADS

- A. Where designated on the Drawings as "K-Factor" transformers, transformers shall be UL listed as suitable for non-sinusoidal current loads with a K factor not to exceed 13. K factor transformers, in addition to the requirements for general purpose transformers specified herein, shall comply with the following:
 - 1. An electrostatic shield consisting of a single turn of copper or aluminum shall be placed between the primary and secondary winding and grounded to the transformer core.
 - 2. Transformer neutral conductor shall be rated to carry 200 percent of normal phase current.
 - 3. Transformers shall be specifically designed to supply circuits with a harmonic profile equal to or less than a K-factor of 13 as described below without exceeding 115 degree C temperature rise.

<u>Harmonic</u>	<u>K-13</u>
Fundamental	100%
3rd	70%
5th	42%
7th	5.0%
9th	3.0%
11th	3.0%
13th	1.0%
15th	0.7%
17th	0.6%

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which transformers are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated on the Drawings, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Transformers shall be installed on vibration isolation pads.
- D. Provide properly wired electrical connections for transformers within enclosures.
- E. Transformer enclosures and neutrals shall be bonded together and grounded.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

3.03 GROUNDING

- A. General: Provide grounding connections to transformers as indicated. Transformers shall be grounded as separately derived systems in accordance with the National Electrical Code, NFPA 70. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.04 FIELD QUALITY CONTROL

- A. General: Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

3.05 ADJUSTING AND CLEANING

- A. Touch-up scratched or marred surfaces to match original finish.

3.06 TESTING

- A. General: Transformers shall be field acceptance tested in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems
 - 2. Section 26 05 85, Electrical Equipment Installation
 - 3. Section 26 43 13, Surge Protective Devices

1.02 SUMMARY

- A. This section specifies panelboards for lighting and power distribution.
- B. Extent, location, and details of panelboard work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Panelboard arrangement and configuration data including the quantity, type, and rating of main and branch devices. Arrangement data shall also include a directory of circuits, which shall feature the name, ampacity and number of poles for each circuit in the panelboard.
 - 2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of panelboards and enclosures of types, sizes, and ratings required, whose products have in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects utilizing panelboards similar to those required for this project.
- C. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. UL Compliance: Provide products that are listed and labeled by UL under the following standards:
 - a. UL Std. 67 - Electric Panelboards
 - b. UL Std. 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures
 - c. UL 50 - Cabinets and Boxes
 - 3. NEMA Compliance: Provide products that comply with the following standards:
 - a. NEMA Std 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
 - b. Publication No. PB 1 - Panelboards
 - c. Publication No. PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Eaton
 - 2. General Electric Co.
 - 3. Schneider Electric

2.02 ARRANGEMENT AND CONSTRUCTION

- A. General
 - 1. Assembly: Panelboard interiors shall be completely factory assembled with individually mounted bolt-on devices. Panelboard interiors shall be designed such that individual switching and protective devices can be removed without disturbing adjacent units and without removing the main bus connectors.
 - 2. Enclosures: Panelboard enclosures shall comply with the following.
 - a. Panelboard enclosures shall be sized to provide wire bending space in compliance with the requirements of NFPA 70. Gutter space shall be provided on all sides of the panelboard interior to permit marshalling and connection of

branch circuit wiring. Oversized panelboard enclosures shall be provided where indicated on the Drawings.

- b. Trims for panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. The panelboard trim door-in-door style having a removable hinge assembly, in addition to the door hinge, that allows access to live parts inside the enclosure without the need to remove the trim. Both hinged trim and trim door shall utilize three-point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab.
- c. Unless otherwise noted, panelboard enclosure sealing rating and materials of construction shall be in accordance with schedules and paragraph 26 05 00-1.07.
- d. A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the panelboard door.

- B. General Purpose (NEMA 1) Construction: Panelboard assembly shall consist of a galvanized back box, interior deadfront panel, and front trim and hinged door. The panelboard trim piece shall be provided concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring loaded door pulls. Panelboard trim piece shall not be removable with doors in the locked position. All panelboard locks shall be keyed alike. Panelboard mounting shall be as indicated in the panelboard schedule on the Drawings. Panelboard trim shall have a gray, baked enamel finish.
- C. Dripproof (NEMA 12) Construction: Panelboard assembly shall consist of a NEMA 12 enclosure with an interior deadfront panel. Enclosure shall be 14 gauge, minimum, sheet steel construction with continuous hinge, door clamps, and padlocking hasp and staple. Interior deadfront panel shall prevent access to live parts with the panel in place. Panelboard enclosure shall be suitable for surface mounting and shall have a gray, baked enamel finish.
- D. Watertight, Corrosion-Resistant (NEMA 4X) Construction: Panelboard assembly shall consist of a NEMA 4X enclosure with an interior deadfront panel. Enclosure shall be 14-gauge, minimum, stainless steel construction with stainless steel continuous hinge, door clamps, and padlocking hasp and staple. Interior deadfront panel shall prevent access to live parts with the panel in place. Panelboard enclosure shall be suitable for surface mounting.

2.03 BUS

- A. Bus shall be tin-plated copper and shall have current ratings as shown on the panelboard schedules, sized in accordance with UL 67. Ratings shall be determined by temperature rise test. Minimum bus size shall be 100 amperes.
- B. Panel minimum integrated short circuit rating shall be as shown on the panelboard schedules, and shall be equal to or greater than the short circuit interrupting rating of the lowest rated device in the panel, but in no case less than 65,000 amps for 480 (phase to phase) VAC panels and 22,000 amps for panels at 240/208 (phase to phase) VAC panels.
- C. Panelboards shall be provided with a separate ground bus and full capacity neutral bus unless specified otherwise.
- D. Where indicated on the Drawings, panelboards shall be provided with the following:
 - 1. Isolated ground bus.
 - 2. 200 percent rated neutral bus.

2.04 CIRCUIT BREAKERS

- A. Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers shall have a minimum interrupting current rating as shown on the panelboard schedules.
- B. Circuit breakers shall be bolt-on type. Circuit breakers shall be listed in accordance with UL 489 for the service specified. Circuit breakers load terminals shall be solderless connectors.
- C. All circuit breakers feeding receptacles and where otherwise noted on the Drawings shall be provided with an integral ground fault circuit interrupter (GFCI). Ground fault circuit interrupting circuit breakers shall occupy no more panelboard mounting space than a standard circuit breaker.
- D. Circuit breakers shall be provided with manufacturer- furnished, machine-printed, circuit number labels on the deadfront of the panelboard to individually identity each panelboard circuit.

2.05 SURGE PROTECTIVE DEVICES

- A. Where shown on the Drawings, panelboards shall be provided with Type 1 or Type 2 surge protective devices. Surge protection devices shall be factory installed by the panelboard manufacturer and shall be connected to the panelboard using a direct bus connection. Cable connections between the surge protection device and the panelboard bus shall not be permitted.
- B. Surge protection devices shall be as specified in Specification 26 43 13.

2.06 ACCESSORIES

- A. Padlockable Handle Hasp: Where indicated on the Drawings, circuit breakers shall be provided with a permanently installed padlockable handle hasp. Padlockable handle hasp shall allow the circuit breaker to be locked in the open position.
- B. Conduit Cover: Panelboards shall be provided with a conduit cover fabricated of sheet steel and finished to match the panelboard. Conduit covers shall be the full width of the panelboard and extend to the floor or ceiling as indicated.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which panelboards are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF PANELBOARDS

- A. Install panelboards as indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate panelboard installation work with electrical raceway and wire/cable work, as necessary for proper interface.

- C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.
- D. Provide properly wired electrical connections for panelboards within enclosures.
- E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

3.03 PANELBOARD DIRECTORIES

- A. The Contractor shall maintain in each panelboard, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses.
- B. Final directories shall be typewritten with circuit designations and circuit locations conforming to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

3.04 GROUNDING

- A. General: Provide equipment grounding connections to panelboard enclosures as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.05 FIELD QUALITY CONTROL

- A. General: Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

3.06 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.07 TESTING

- A. General: Panelboards shall be field acceptance tested in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems
 - 2. Section 26 43 13 Surge Protective Devices.
 - 3. Section 26 29 23, Variable Frequency Drives.

1.02 SUMMARY

- A. This section specifies freestanding, factory-assembled 600-volt motor control centers.
- B. Extent, location, and details of motor control center work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Drawings shall be prepared to present the following information.
 - a. Motor control center elevations showing dimensional information including details such as, but not limited to, the following:
 - 1) Motor control center height (less any removable lifting angles or eyes).
 - 2) Motor control center width.
 - 3) Motor control center depth.
 - 4) Location of shipping splits and shipping split weight.
 - 5) Overall structure weight.
 - b. Structure descriptions showing the following:
 - 1) Bus ratings.
 - 2) Enclosure ratings.
 - 3) Short-circuit withstand and interrupt ratings.
 - 4) Other information as required for approval.
 - c. Conduit locations.

- d. Required bus splices.
 - e. Unit descriptions including starter sizes, circuit breaker frame sizes, circuit breaker continuous ampere and trip ratings, pilot devices, etc.
 - f. Nameplate information.
 - g. Elementary connection and interconnection diagrams in accordance with NEMA ICS and NFPA standards.
2. Manufacturer's product data indicating equipment specifications and construction features including all optional equipment and features proposed.
 3. Time current curves for all protection devices.
 4. Installation Instructions: Provide a copy of the manufacturer's installation instructions that includes the following.
 - a. Receiving, handling, and storage instructions.
 - b. General description for reading nameplate data, serial numbers, UL markings and short circuit ratings.
 - c. Installation procedures including splicing procedures.
 - d. Conduit and cable installation.
 - e. Installing and removing plug-in units.
 - f. Operation of operator handles and unit interlocks.
 - g. Checklist before energizing.
 - h. Procedure for energizing equipment.
 - i. Maintenance procedures.
 5. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. UL Compliance: Provide products which are listed and labeled by UL under the following standards:
 - a. UL 845 – Standard for Safety for Motor Control Centers
3. NEMA Compliance: Provide products which comply with the following standards:

- a. NEMA ICS 1 - General Standards for Industrial Controls and Systems
- b. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies
- c. NEMA ICS 3 - Industrial Systems
- d. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Variable Speed Drive Systems
- e. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- f. NEMA ICS 18 - Industrial Control and Systems: Motor Control Centers
- 4. ANSI Compliance: Provide products which comply with the following standards:
 - a. ANSI/IEEE C57.13 - Requirements for Instrument Transformers
- 5. ODVA Conformance: Provide EtherNet/IP network system components that have been conformance tested in accordance with ODVA requirements and manufactured by companies that have been authorized to use ODVA technology and are compliant with the applicable ODVA Terms of Usage Agreement(s).
- B. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of motor control centers with other components of the facility process control system.
- C. Manufacture and Assembly: Motor control centers shall be manufactured and assembled by the motor control center manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001. No alterations of the motor control center shall be permitted after the motor control center has left the manufacturer's facility unless directed and supervised by the motor control center manufacturer or otherwise approved by the Engineer.

1.05 DOCUMENTATION

- A. General: The motor control center manufacturer shall provide complete "as-constructed" documentation for all motor control centers in conformance with NEMA Standard ICS-2-322.08, Class IIS-B for special wiring drawings of internal and external items.
- B. Motor control center documentation shall include a comprehensive schedule of unit devices, layout drawings, and unit elementary diagrams. Unit elementary wiring diagrams shall indicate numbered terminal points and wiring within the unit, device designations, conductor insulation color code, and all interconnections to other units within the motor control center and to the first level of remote equipment, devices, and field instruments. A unique individual elementary diagram shall be prepared and provided for each unit.
- C. Designation of terminals and electrical devices shall be in accordance with the Drawings. Interfaces to systems and equipment provided as work of other sections of this specification shall be fully coordinated and indicated on the elementary diagrams.
- D. A detailed Ethernet network table and Ethernet network diagram specifying IP addresses, subnet masks, device locations, cable label details, and 24V DC capacities shall be provided.
- E. Motor control center documentation shall be prepared on a computer-aided drafting (CAD) system. All CAD drawing files not in .DWG format shall be converted to .DXF file format and submitted to the Engineer on CD-ROM media. All CAD drawing files shall be updated to reflect the final as constructed condition of the motor control centers.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. General: Motor control center shipping splits shall be as required to ensure entry into the space where the motor control centers will be installed.
- B. Delivery: Motor control centers shall be shipped with removable, external lifting angles mounted on top and shall extend the width of the shipping split.
- C. Storage: Store motor control centers in a well-ventilated space protected from weather, moisture, soiling, extreme temperatures, and humidity.
- D. Handling: Handle motor control centers carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new. Motor control centers shall be protected from dirt, water, construction debris and traffic at all times.

1.07 ENVIRONMENTAL CONDITIONS

- A. General: All motor control center components shall be rated for continuous operation in the configuration specified for the environmental conditions as described in Specification 01 81 16.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. General: Motor control centers shall comply with ANSI/NEMA ICS 18, Motor Control Centers, and UL 845. Motor control centers and all internal components shall be suitable to serve the loads specified under the conditions specified.
- B. Factory Testing: Motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities. All major components shall have been individually design tested and guaranteed by the manufacturer. The manufacturer of the motor control center shall be the manufacturer of the major components contained therein, such as motor starters, control components, etc.
- C. Manufacturers: The motor control centers specified in this section shall be the product of a single manufacturer. Motor control centers are specified on the basis of the following products for function and quality. The arrangement, dimensions, and characteristics of the equipment specified under this section are based on the named manufacturer. Other manufacturer's products will not be considered if the products do not have the ratings, features and functions specified herein. Supply products modified as necessary by the manufacturer to provide the specified features and to meet specified operating conditions.

- 1. Allen-Bradley, Centerline 2100

2.02 APPLICATION

- A. General: Motor control centers shall be rated 600 volts, 60 hertz, 3 phase, 3- or 4 wire as specified and shall be suitable for operation at the specified voltages and short circuit capacities indicated on the Drawings.

2.03 STRUCTURE

- A. General: Motor control centers shall be totally enclosed, deadfront, freestanding assemblies. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units.
- B. Vertical Sections
 - 1. Each section shall be 90 inches high by 20 inches wide (minimum) by 20 inches deep unless otherwise noted on the Drawings.
 - 2. There shall be a minimum of 72 inches of vertical compartment mounting space arranged to accommodate any combination of control and/or feeder units in 6-inch nominal increments. Unit guide rails shall be provided. Compartments shall have pan-type doors with a minimum of two quarter-turn, spring-loaded, hold-down latches and neoprene gaskets.
 - 3. Vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block.
- C. Horizontal Wireways
 - 1. Horizontal wireways shall be located at the top and bottom of the motor control center.
 - 2. Horizontal wireways shall be a minimum of 6 inches in height and extend the full depth of the vertical section.
 - 3. Horizontal wireways shall be continuous across the length of the motor control center, except where access needs to be denied due to electrical isolation requirements.
 - 4. The horizontal wireways shall be isolated from the power bus.
 - 5. The horizontal wireways shall have removable covers held in place by captive screws.
- D. Vertical Wireways: Each standard vertical section shall be equipped with a full height vertical wireway, independent of the plug-in units.
 - 1. Vertical wireway shall be isolated from the vertical and horizontal buses.
 - 2. Vertical wireway shall be covered with a hinged and secured door.
 - 3. Wireway tie bars shall be provided.
 - 4. Isolation between the wireway and units shall be provided.
- E. Structure Mounting Accessories: Bottom channel sills shall be mounted front and rear of the vertical sections extending the full length of the motor control center lineup.

2.04 ENCLOSURE

- A. Motor control centers enclosures shall have NEMA sealing ratings indicated on the Drawings.
- B. Each section shall be equipped with two full metal side sheets to isolate each vertical section and mitigate the fault propagation between sections.
- C. Removable end plates on each end of the motor control center shall cover all horizontal bus and horizontal wireway openings.

- D. Insulating sheets shall be provided on the inside of end closing plates for horizontal bus openings to help prevent burn-through of the end closing plate in the event that an internal arcing fault occurs in the horizontal bus compartment.

2.05 BUS

- A. General: All bussing shall be tin-plated copper with bolted connections between vertical and horizontal bus bars. Access for tightening these connections shall be from the front, without the need for tools on the rear of the connection. Insulated horizontal and vertical bus barriers shall be provided. Barriers shall be fabricated from high-strength, glass-filled polyester resin. Unless otherwise specified, the bus shall be braced to withstand a fault current of 65,000 amperes, RMS, symmetrical. Bus structure shall have provisions for accommodating future bus extensions.
- B. Horizontal Bus: The ampacity of the main horizontal bus shall be as indicated on the Drawings and in no case less than 600 amperes continuous.
- C. Vertical Bus
 - 1. The vertical bus shall have an effective rating of 600 amperes continuous. If a center horizontal bus construction is utilized, then the rating shall be 300 amperes above and below the horizontal bus for an effective rating of 600 amperes. If a top or bottom mounted horizontal bus is utilized, then the full vertical bus shall be rated for 600 amperes.
 - 2. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases from passing from one phase to another.
 - 3. The vertical bus shall include a shutter mechanism to provide complete isolation of the vertical bus when a unit is removed.
- D. Neutral bus shall be provided where indicated on the Drawings. The horizontal neutral bus shall be rated one half the rating of the main horizontal unless otherwise specified. Each vertical section shall be equipped with a neutral bus when a horizontal neutral bus is provided.
- E. Ground Bus
 - 1. Provide a ground bus system consisting of a horizontal ground bus connected to vertical ground buses mounted in each section.
 - 2. Provide a 1/4-inch by 2-inch tin-plated copper horizontal ground bus mounted in the bottom of the motor control center unless otherwise specified in the Drawings.
 - 3. Provide pressure-type mechanical lugs mounted on the ground bus at each end of the motor control center.
 - 4. Provide a unit ground stab on all unit inserts. The ground stab shall establish unit insert grounding to the vertical ground bus before the plug-in power stabs engage the power bus. The grounding shall be maintained until after the plug-in power stabs are disengaged.
 - 5. Provide a copper vertical-unit load ground bus in each section that can accommodate plug-in units.
 - 6. Provide a unit load connector on all units that require load wire connections. The load connector shall provide a termination point for the load ground conductor at the unit.

2.06 WIRING

- A. General: Motor control centers shall be provided with NEMA Class IIS, Type B wiring. All starter units shall have terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller. Motor control centers shall be provided with all necessary interconnecting wiring and interlocking. Provide elementary and connection diagrams for each starter unit and an interconnection diagram for the entire motor control center.
- B. Power Wire: Power wire shall be copper 90 degrees C "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded.
- C. Control Wire: Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C and UL listed for panel wiring.
- D. Terminations and Cable Connections
 - 1. Terminals: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.
 - 2. Cable Connectors: Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 KCM, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors.
 - 3. Incoming Cable Termination: Incoming cable shall terminate within the motor control center on a main lug or main breaker termination point as indicated on the Drawings. Main lug terminations shall be UL listed for the type and size of cables indicated on the Drawings. The lugs shall be compression type with anti-turn feature.
- E. Conductor Labeling: Each power, control and signal conductor within the motor control center unit shall be identified at each termination by number or letter or combination thereof and shall correspond with the elementary diagram prepared for the unit. Markers used for identification shall meet the requirements of Section 26 05 53.

2.07 UNIT INFORMATION

- A. The minimum compartment height shall be 6.5 inches and this shall be considered one-half space factor.
- B. NEMA Size 5 FVNR starters and below shall be provided as plug-in units.
- C. Plug-In Units:
 - 1. Plug-in units shall consist of a unit assembly, unit support pan, and unit door.
 - 2. Unit support pan shall be provided for support and guiding units.
 - a. Unit support pans shall remain in the structure when the unit is removed to provide isolation between adjacent units.
 - b. A service position shall be provided for plug-in units that allows for the unit to be supported but disengaged from the bus. The unit shall be capable of being padlocked in the service position.
 - 3. Power Stabs:
 - a. Unit stabs for engaging the power bus shall be tin-plated copper and provided with stainless back-up springs to provide and maintain a high-pressure, 4-point connection to the vertical bus.

- b. Wiring from the unit disconnecting means to the plug-in stabs shall not be exposed on the rear of the unit. A separate isolated pathway shall be provided for each phase to minimize the possibility of unit fault conditions reaching the power bus system.
 - c. Power cable termination at the plug-in stab shall be a maintenance-free crimp type connection.
- 4. Withdrawable Power Stabs: Plug-in units shall have the capacity of withdrawing the power stabs, allowing the primary voltage to be disconnected with the unit door closed.
 - a. The withdrawable assembly shall accept a standard 1/4' hex-style drive socket.
 - 1) A complete power engagement shall occur when turning the mechanism 1/4 turn in clockwise direction.
 - 2) Complete power disengagement shall occur when turning the mechanism 1/4 turn in counter-clockwise direction.
 - b. The withdrawable stabs design shall include a set of stab assembly-mounted shutters.
 - 1) Shutters shall automatically open before the power stabs can extend and connect to the vertical bus.
 - 2) Shutters shall close as soon as the power stabs are disconnected from the vertical bus and are completely inside the stab housing.
 - 3)
 - c. The withdrawable stabs design shall include the following interlock mechanisms.
 - 1) A through-the-door mechanism shall allow the unit to be locked in the 'Power Stabs Disconnected' position.
 - a) This mechanism shall be such that it can be padlocked to prevent the connection of the stabs to the vertical bus even when the unit is inserted into the vertical section.
 - b) Unit door shall be capable of opening with the padlock and lockout engaged.
 - 2) Unit disconnect handle must be in the OFF position (load side of the disconnect device removed from line power) before the stabs can be disconnected from the vertical bus.
 - a) Mechanism shall also allow the removal of the unit from the vertical section but only after the disconnect handle has been turned OFF and the power stabs have been disconnected from the vertical bus.
 - b) Unit stabs have to be disconnected (withdrawn) before the unit can be re-inserted into the vertical section.
 - d. The withdrawable stabs design shall include the following feedback mechanisms that are verifiable with the unit door closed.
 - 1) A two-position indication system shall be provided (Power Stabs Connected/Disconnected) and shall be visible from the door.
 - a) Connected with Red Indication: Primary voltage stabs fully engaged and connected to the vertical bus.
 - b) Disconnected with Green Indication: Primary voltage stabs fully disconnected from the vertical bus.

- 2) A set of test points shall be located on the front of the unit for identification of the following:
 - a) Power Stabs Position: A positive continuity check between these test points shall verify that all three power stabs have been disconnected from the vertical bus and completely withdrawn inside the stabs housing.
 - b) Stab-Mounted Shutter Position: A positive continuity check between these test points shall verify that the shutters are closed, meaning that all three power stabs have been disconnected and withdrawn inside the stab housing.
- e. Withdrawable power stabs with door closed mechanism shall not increase the original unit height design so total space in the motor control center is optimized.

D. Disconnect Handle:

1. Plug-in units shall be provided with a heavy-duty, non-conductive, industrial duty, flange mounted handle mechanism for control of each disconnect switch or circuit breaker.
2. The disconnect handle may pivot in the vertical or horizontal plane.
3. The on-off condition shall be indicated by the handle position, red and green color indicators with the words ON and OFF, and the international symbols 1 and 0 along with a pictorial indication of the handle position.
4. Handles shall be capable of being locked in the OFF position with up to three padlocks.
5. Plug-in units shall be provided with interlocks per NEMA and UL requirements. Interlocks shall be provided for the following:
 - a. Prevention of unit insertion or withdrawal with the disconnect handle in the ON position.
 - b. Prevention of the unit door from being opened when the disconnect handle is in the ON position.
 - 1) A feature for intentionally defeating this interlock by qualified personnel shall be provided.
 - c. Prevention of the disconnect switch from being moved to the ON position if the unit door is open.
 - 1) A feature for intentionally defeating this interlock by qualified personnel shall be provided

E. Doors

1. Each unit shall be provided with a removable door mounted on removable pin-type hinges.
2. The unit doors shall be capable of being opened at least 110 degrees.
3. The unit doors shall be removable from any location in the motor control center without disturbing any other unit doors.
4. The unit door shall be fastened to the structure so it can be closed to cover the unit space when the unit is removed.
5. The unit doors shall be held closed with quarter-turn latches.
6. Unit door latches shall be provided with arc resistant latches to help keep the door latched in the event that an internal arcing fault occurs.

2.08 MAIN AND FEEDER BRANCH CIRCUIT PROTECTION

- A. General: Main and feeder tap units shall consist of circuit breakers, as specified herein and as scheduled on the Drawings.
- B. Molded Case Circuit Breakers: Main and feeder circuit protective devices, as indicated on the Drawings, shall be molded case circuit breakers providing complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where applicable, be current limiting. Main circuit breakers shall be UL listed for applications at 100 percent of their continuous ampere rating in their intended enclosure. Circuit breakers shall be provided in accordance with the following requirements:
 - 1. Circuit breakers shall be operated by a toggle type handle and shall have a quick make, quick break over center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be clearly indicated by handle position. Contacts shall be non welding silver alloy and arc extinction shall be accomplished by means of de-ionizing arc chutes.
 - 2. Circuit breaker interrupting capacities shall be as specified and provide the motor control center minimum integrated equipment withstand rating indicated on the Drawings.
 - 3. Breakers rated less than 600 amperes shall be thermal magnetic trip with inverse time current characteristics.
 - 4. Feeder breakers with frame size 600 amperes and greater and all main circuit breakers shall be provided with a solid-state trip unit complete with built in current transformers and flux transfer shunt trip. Breakers shall utilize interchangeable rating plugs to establish the continuous trip rating of the circuit breaker as indicated on the Drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that a breaker cannot be closed and latched with the rating plug removed. Where indicated on the Drawings, circuit breaker trip units shall have the following time-current curve shaping adjustments:
 - a. Adjustable long time pick-up and delay.
 - b. Adjustable short time pick-up and delay with selective curve shaping.
 - c. Adjustable instantaneous pick-up.
 - 5. Each motor control center main breaker shall be provided with built in ground fault protection with adjustable pick up rating not exceeding 1000 amperes and ground fault time delay adjustable from 0.1 to 0.5 seconds.

2.09 MOTOR STARTERS

- A. General: Motor starter units shall be combination type with motor circuit protector, contactor, and overload protection. Specific features such as two speed, reversing, and reduced voltage starters shall be as specified on the Drawings. The starter units shall be NEMA-style and have a minimum combination UL listed short circuit interrupt rating of 65,000 amps RMS, symmetrical or higher as specified on the Drawings.
- B. Motor Circuit Protectors: Motor circuit protectors shall provide adjustable magnetic protection and be provided with pin insert or other means to stop magnetic adjustment at 1300% motor nameplate full load current to comply with NEC requirements. All combination starter units shall have a "tripped" position on the unit disconnect and a push to test button on the motor circuit protector. Motor circuit protectors shall include transient override feature for motor inrush current. Motor circuit protectors shall be sized by the motor control center manufacturer to serve the load indicated on the Drawings.

- C. Contactors: Unless otherwise specified, contactors shall be full voltage, 3-pole, 600-volt AC, NEMA size 1 minimum. Contactors shall meet applicable NEMA and UL requirements. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools. Reversing, multispeed, and reduced voltage starters shall have additional contactors, overload relays, and auxiliary relays as required, and shall have mechanically interlocked contactor coils to prevent simultaneous engagement.
- D. Overload Relays:
1. Motor starter units shall have an electronic overload relay that incorporates the following features:
 - a. Built-in EtherNet/IP communication interface.
 - b. LEDs for status indication.
 - c. Test/Reset button.
 - d. Selectable trip of NEMA Class 5 to 30. Unless indicated, the trip class shall be set for NEMA Class 20 operation.
 - e. Four inputs and two outputs.
 - f. Protective functions:
 - 1) Functions shall provide a programmable trip level, warning level, time delay, and inhibit window.
 - 2) Protective functions shall include Thermal overload, Phase loss, Stall, Jam, Underload, Current imbalance, Remote trip, and PTC thermistor input.
 - g. Current monitoring functions shall include phase current, average current, full load current, current imbalance percent, and percent thermal capacity utilized.
 - h. Diagnostic information shall include device status, warning status, time to reset, trip status, time to overload trip, and history of last five trips.
 - i. Preventative maintenance information shall include Allowable starts per hour, required Time between starts, Starts counter, Starts available, Time until next start, total operating hours, and elapsed operating time.
 - j. Overload relay shall include an on-board logic processor to allow basic logic to be performed within the overload relay based on network data and the status of the inputs to the overload relay.
 - k. The overload relay shall support the following CIP messaging types: Polled I/O messaging, Change-of-state/cyclic messaging, Explicit messaging, Group 4 offline node recovery messaging, and Unconnected Message Manager (UCMM).
 - l. The overload relay shall provide the following functions to minimize network configuration time: Full parameter object support, Configuration consistency value, and Add-on Profile.
 2. Units housing overload relays shall have a reset push button mounted on the unit door.
 3. Overload relay shall be Allen-Bradley E300 or approved equivalent. Overload relay shall be of the same manufacturer as the motor control center.
- E. Control Transformers: Control transformers, where indicated on the Drawings, shall be rated 480/240-120V, single phase, 2 wire, 60 Hz. The transformer shall be sized for the load it serves plus fifty percent spare capacity. Each control transformer shall be provided with time-delay, slow-

blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters. Fuse holders for primary and secondary fuses shall be fuse clips with full barriers between fuses.

- F. Terminal Blocks: Terminal blocks shall be screw type rated 600 volts; 20 amperes for control wiring and 30 amperes (minimum) for power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.10 VARIABLE FREQUENCY DRIVES

- A. General: Variable frequency drives (VFDs) shall be as specified in Section 26 29 23.
- B. Assembly: Each VFD system including all ancillary devices and equipment shall be contained in a single motor control center unit. VFD display and programming panel shall be flush mounted on the unit door and shall be visible and operable without opening the door.

2.11 SOLID STATE REDUCED VOLTAGE STARTERS

- A. General: Solid state reduced voltage starters (RVSS) shall be as specified in Section 26 29 14.
- B. Assembly: Each RVSS system including all ancillary devices and equipment shall be contained in a single motor control center unit. RVSS display and programming panel shall be flush mounted on the unit door and shall be visible and operable without opening the door.

2.12 DRY TYPE LIGHTING TRANSFORMERS

- A. General: Where shown on the Drawings, dry type lighting transformers shall be provided integral to the motor control center assembly and installed in an individual compartment. Transformers shall be provided in accordance with Section 26 22 13.
 - 1. Requirements of this specification section shall override corresponding requirements in the referenced transformer specification.
- B. Provide control and lighting transformers as shown on Drawings. The rating shown on the drawings shall be the minimum acceptable full capacity rating.
- C. The insulation shall be 180 °C insulation with 80 °C rise.
- D. Provide a circuit breaker with thermal magnetic trip for primary protection.
- E. The primary circuit breaker compartment and transformer compartment shall be interlocked together and factory wired together.
- F. Unit construction shall be dependent on the motor control center NEMA enclosure type.
 - 1. Units in a NEMA Type 1 enclosure shall be provided with vented doors.
 - 2. Units in a NEMA Type 1 enclosure with gasketed doors shall be provided with filters over the vent openings.
 - 3. Units in a NEMA Type 12 enclosure shall be provided with a non-vented door. If transformer derating is required, then the transformer shall be upsized to provide equivalent rating as shown on the Drawings.

- G. Power transformers that are specifically designed for use in motor control centers and for use with motor control circuits are exempt from NEMA TP-1 energy efficient requirements.

2.13 DISTRIBUTION AND LIGHTING PANELBOARDS

- A. General: Where shown on the Drawings, distribution and lighting panelboards shall be provided integral to the motor control center assembly and installed in an individual compartment. Distribution and lighting panelboards shall be provided in accordance with Section 26 24 19.

2.14 ETHERNET/IP NETWORK

- A. General: Motor control centers shall be provided with an integral Ethernet network to support EtherNet/IP communications between devices housed in the motor control center and an external process control system network. Each motor control center shall have Ethernet wiring and network switches incorporated into its design.

1. The motor control center shall have Ethernet cabling incorporated throughout each vertical section.
2. Each motor starter, AC drive, and soft starter unit in the motor control center shall be supplied with a means to communicate via EtherNet/IP network.
3. Plug-in units should be able to move around without impacting the network.
4. Maintenance activities should be able to be performed without impacting the network.

- B. Ethernet Cabling:

1. Ethernet Cable Ratings: Ethernet cable shall be shielded category 5e 600V UL PLTC rated.
2. Ethernet switch-to-device labels shall be located on both ends of the cable to specify where the cable is connected on both ends.
3. Layout:
 - a. An industrial Ethernet cable shall be routed from the Ethernet switch directly to the EtherNet/IP device in each unit.
 - b. Ethernet cable through the motor control center section shall be routed from the top or bottom wireways. To prevent accidental mechanical damage during motor control center installation, the cable shall be located behind barriers to isolate the cable from the unit space and wireways.
 - c. The industrial Ethernet cable shall be secured to vertical wireway tie bars.

- C. Industrial Ethernet Switches:

1. The motor control center shall have managed industrial Ethernet switch(s) with ports to connect each EtherNet/IP enabled device
2. Ethernet Switches shall be provided with spare ports to accommodate network expansion and future plug-in unit inserts
3. The managed industrial Ethernet switch shall deliver optimal network security, network resiliency (if needed), and flexibility. The functionality should include port based control/prioritization, switch-level ring support, VLAN segmentation, and other Layer-2 switch features

4. The managed industrial Ethernet switch shall have the ability to include, if needed, Gigabit ports, CIP Sync functionality, Network Address Translation (NAT), and an Industrial SD Card
 5. The managed industrial Ethernet switch shall include redundant terminal blocks for connection of external 24V DC power supply.
- D. Industrial Ethernet Switch Layout: The managed industrial Ethernet switch(s) shall be mounted in a fixed-mount, unit in the motor control center.
1. The fixed-mount switch unit shall be located at the top of a vertical section.
 2. Industrial Ethernet cabling shall connect each switch to one another in a linear topology
 3. The switch unit shall be provided with a locking latch.
 4. The switch unit shall be provided with a door mounted viewing window.
- E. Power Supplies:
1. 24 volt DC power supplies shall be provided integral to the motor control center to support active network components that require 24 volt DC utilization voltage.
 2. Power supply output shall be rated 8 amperes, 24 volt DC.
 3. The power supply unit shall be provided with a buffer module to provide a minimum of 500 ms ride-through at full load.
 4. Power supplies shall be mounted in a fixed mount unit in the motor control center.
 5. Power supplies shall be configured to accept an external 120 volt AC power source. Each power supply unit shall have a circuit breaker disconnect to isolate the external 120 volt AC power source from the power supply.
 6. Power supply unit door shall be provided with a yellow nameplate warning of the presence of an external power source.
- F. EtherNet/IP Interface for Motor Starter Units: Electronic overload relays provided with each motor starter unit shall incorporate an integral EtherNet/IP communication interface to allow for communications between the motor starter unit and the EtherNet/IP network.
- G. EtherNet/IP Interface for Adjustable Frequency AC Drives and Solid-State Reduced Voltage Motor Controllers: The EtherNet/IP communication interface shall be supplied to allow for communication between the solid-state component and the Ethernet network.
- H. EtherNet/IP Interface for Other Units:
1. Provide an EtherNet/IP interface for other units as indicated on the Drawings.
 2. Refer to the wiring diagrams on the Drawings for points to be monitored.
- I. Programming:
1. The motor control center manufacturer shall load the IP Address and subnet mask into each unit and Ethernet switch.
 2. The IP Address shall be as indicated on the Drawings or as provided by the Construction Manager.
 3. The motor control center manufacturer shall test the MCC to ensure that each unit communicates properly prior to shipment.

4. The motor control center manufacturer shall provide a disk containing applicable electronic data sheet (EDS) files for the EtherNet/IP devices.
5. All firmware will be provided with the same revision level of firmware across all similar intelligent electronic devices including the following.
 - a. Overload relays.
 - b. Variable frequency drives.
 - c. Ethernet network switches.
 - d. Power monitors.
 - e. Reduced voltage starters.

2.15 POWER METERING

- A. Motor control centers shall be provided with a power metering unit where indicated on the Drawings.
- B. Power metering unit shall include the following:
 1. Fusible disconnect with fuses.
 2. Current transformers shipped loose to be field installed on the incoming power conductors.
 3. Solid state power monitor.
- C. Power Monitor:
 1. Power monitors shall be capable of displaying the following:
 - a. Line current for all three phases with plus or minus 0.2 percent full-scale accuracy.
 - b. Average three phase current with plus or minus 0.2 percent full-scale accuracy.
 - c. Line-to-neutral and line-to-line voltage with plus or minus 0.2 percent of full-scale accuracy.
 - d. Current and voltage unbalance.
 - e. Real, reactive, apparent, and true power with plus or minus 0.4 percent full-scale accuracy.
 - f. KWh, KVARh, and kVAHnet.
 - g. True RMS to the 45th harmonic.
 - h. Frequency at plus or minus 0.5%.
 - i. Power factor at plus or minus 0.4%.
 2. Power monitors shall include min/max logs and trend logs with up to 45,867 data points.
 3. Power monitors shall be capable of performing distortion analysis with THD, Crest Factor (I, V) and Distortion power factor.
 4. The power monitor shall include EtherNet/IP communication module.
 5. Power monitors shall include two form-C relays.
 6. Power monitor shall be provided with a display module mounted in the unit door. Display module shall have a 4-inch diagonal touch screen with function keys. The display

module shall interface with the power monitor via the Ethernet/IP network. The display module shall provide an interface to the power data derived from the power monitor including voltage, current, frequency, power, power quality and energy demand as well as access to the power monitor setup and configuration parameters.

7. Power monitors shall be Allen-Bradley PowerMonitor 5000 unit or approved equivalent.
- D. Unit Configuration: Power metering shall be mounted in a fixed mount unit with the following features.
1. Power monitor potential taps shall be connected to the load side of the unit disconnect switch.
 2. Current transformer circuits shall be terminated on shorting disconnect terminal blocks within the unit.
 3. Door-mounted display module.
 4. Power monitor shall be configured to accept an external 120 volt AC power source. The power monitor unit shall have a circuit breaker disconnect to isolate the external 120 volt AC power source from the power supply.
 5. Power monitor unit door shall be provided with a yellow nameplate warning of the presence of an external power source.

2.16 MISCELLANEOUS

- A. Control Devices: Control devices such as pushbuttons, selector switches, and indicating lights shall be mounted on the unit compartment door. The control devices shall comply with the requirements of Section 40 67 61.
- B. Nameplates: Nameplates shall be provided in accordance with Section 26 05 53 and the following.
1. Master Nameplate: A master nameplate identifying the motor control center tag number and power source shall be located on the top horizontal wireway. Lettering height shall be 0.5 inch minimum.
 2. Unit Nameplates: Unit nameplates shall be provided on each unit door.
- C. EtherNet/IP Network Node Address Identification: Each unit shall have a label showing the IP Addresses for the devices within it.
1. Card Holder: A rigid clear plastic card holder shall be mechanically fastened to the lower front right hand corner of each unit door.
 2. Cards with machine-printed text across the top of the card reading "Ethernet/IP Address" shall be provided in each card holder. Space shall be provided below the text to permit the addition of an adhesive label (1/4-inch high minimum) representing the EtherNet/IP address associated with the unit.
 3. Provide ten (10) spare cards with each motor control center.
- D. Load Identification: Each motor control center motor controller unit shall be provided with a machine-printed card listing the following information. The load identification card shall be installed in a clear adhesive sleeve attached to the inside surface of the compartment door. Provide 10 spare cards and sleeves for each motor control center.
1. Description and location of load served.

2. Load data including nameplate amperes, voltage, and power rating of load served. Units serving motor loads shall also indicate motor nameplate data including service factor, design letter, kVA code letter, power factor, efficiency, etc.
3. Overload relay settings or heater element number.
4. Final motor circuit protector setting.

2.17 SURGE PROTECTIVE DEVICES

- A. General: Surge protective devices shall be provided integral to the motor control center assembly and installed in an individual compartment. SPD shall be Type 1. Surge protective devices shall be provided in accordance with Section 26 43 13.

2.18 MOTOR CONTROL CENTER ASSEMBLY AND UNIT CONFIGURATION

- A. General: Each motor control center shall be provided with the number and type of unit devices as indicated on the Drawings. Each motor control center unit device, including main overcurrent protection units, motor starters, feeder taps, and power metering systems, shall be configured as specified herein and as indicated on the Drawings. Each unit device shall be provided with all ancillary components specified and as indicated on the Drawings to form a complete operational unit. Motor control center elevations as shown on the Drawings are to be considered typical. Manufacturer's motor control center elevation drawing shall be submitted for approval prior to motor control center fabrication.
- B. Arrangement: The Contractor shall arrange the specified unit devices within the motor control center structure in accordance with the requirements of this specification. The final motor control center arrangement shall address all requirements for future mounting space and unit device minimum space requirements as specified herein.
 1. Vertical Sections: Each motor control center assembly shall be comprised of the number of vertical sections indicated on the Drawings. The Contractor shall notify the Engineer if the motor control center footprint is different than that indicated on the Drawings.
 2. Motor Starter Unit Mounting Space: Motor starter device units consisting of unit assembly, unit support pan, and unit door assembly shall be sized to house all specified components on the back panel of the unit assembly.
 3. Variable Frequency Drive Mounting Space: Mounting space for VFD units shall be a minimum 36 inches vertical mounting space.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Motor control centers shall be installed in accordance with the requirements of Section 26 05 85 and as indicated on the Drawings.

3.02 LOAD IDENTIFICATION LABELS

- A. Each motor control center feeder and starter unit shall be provided with a completed load identification label. Application data shall be machine printed on the label.

3.03 SETTINGS AND ADJUSTMENTS

- A. The static tripping devices shall be adjusted to the settings specified in the coordination study in Section 26 05 73 prior to energizing the motor control center.
- B. The motor circuit protectors shall be adjusted to the lowest setting not causing false tripping.
- C. The overload protection system shall be adjusted in accordance with the manufacturer's instructions based on the actual full load amperes and service factor of the motor connected to the starter.

3.04 TESTING

- A. Factory Testing: EtherNet/IP network shall be factory tested to verify the network wire map and confirm all nodes on the network are fully functional.
- B. Field Acceptance Testing: Each motor control center, including circuit breakers, motor starters, adjustable frequency drives, harmonic filters, and surge suppression systems shall be field acceptance tested in accordance with Section 26 08 00.

3.05 TRAINING

- A. The Contractor shall provide the services of a factory-trained instructor for the purpose of training the Owner's personnel in the proper operation and maintenance of the motor control centers. Training shall consist of not less than 4 hours of field instruction in the operation, testing, troubleshooting, and maintenance of the motor control centers in accordance with Section 01 79 00.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies wiring devices consisting of receptacles, plugs, switches and appurtenances.
- B. Extent, location, and details of wiring device work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Catalog cuts for each type of product specified.
 - 2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

PART 2

PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Crouse-Hinds Co.
2. Hubbell Inc.
3. Pass and Seymour Inc.

2.02 GENERAL

- A. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD 1. Devices shall contain provisions for back wiring and side wiring with captively held binding screws. Wiring device color shall be white, unless otherwise specified.

2.03 RECEPTACLES AND PLUGS

- A. General: Receptacles shall be grounding type.

- B. 120 Volt Receptacles:

1. General: 120-volt AC general purpose receptacles shall be heavy-duty simplex or duplex, as indicated on the Drawings, rated 20 ampere, NEMA 5-20R and shall accept NEMA 5-15P and 5-20P plug caps. Receptacles shall be heavy-duty, decorator, specification grade, as manufactured by Pass and Seymour 26352W or equivalent.
 - a. Color:
 - 1) Wall-Mounted: White
 - 2) Surface Raceway Mounted: Color to match surface raceway.
2. Industrial, NEMA 12 and NEMA 4X: Receptacles shall be extra heavy-duty, corrosion, dust, and moisture resistant, industrial specification grade, NEMA 5-20R. Receptacle features shall include impact resistant nylon face and body, oversized #10 terminal and ground screws, and integral circuit label. Color shall be yellow. Receptacles shall be Pass and Seymour CR6307 or equivalent.
3. Industrial, NEMA 1: Receptacles shall be extra heavy-duty, industrial specification grade, NEMA 5-20R. Receptacle features shall include nickel-plated straps and contacts, impact resistant nylon face and body, oversized #10 terminal and ground screws, and integral circuit label. Color shall be gray. Receptacles shall be Pass and Seymour 5362A or equivalent.
4. Industrial, NEMA 7: Receptacles shall be extra heavy-duty, industrial specification grade, NEMA 5-20R and approved for use in Class I, Group D (methane) areas. Receptacle shall be dead front with a hinged cover. Receptacle housing and spring door shall be die cast copper-free aluminum with stainless steel cover hinge pin and spring. Receptacle shall not accept standard NEMA receptacles that could cause an arc in hazardous areas. Receptacle shall have a tagout hole in the receptacle cover to allow for lockout/tagout. Crouse-Hinds Arc-Gard or approved equal.
5. Isolated Ground: Isolated ground receptacles shall have an isolated equipment ground contact and shall be 120-volt AC, duplex, rated 20 ampere, NEMA 5-20R. Isolated ground receptacles shall have a marking on the face of the receptacle to indicate the

isolated ground configuration. Isolated ground receptacles shall be Pass and Seymour IG6300 or equivalent.

6. Ground Fault Interrupting: Ground fault interrupting (GFI) receptacles shall be duplex, 20 amp, NEMA 5-20R and shall accept NEMA 5-15P and 5-20P plug caps. GFI receptacles shall be provided where shown on the Drawings. GFI receptacles shall be UL listed and have provisions for testing and resetting.
 - a. Outdoor Installation: GFI receptacles shall be weather-resistant as manufactured by Pass and Seymour, DuraShield Series, Leviton, WR SmartlockPro Series or equivalent.
 - b. Indoor Installation: GFI receptacles shall be specification grade, decorator style as manufactured by Pass and Seymour, Leviton, or equivalent.
- C. Special Purpose Receptacles: Special purpose receptacles shall be flush-mounted and of the NEMA configurations and ratings indicated on the Drawings or as required for the connected equipment. Special purpose receptacles shall be Pass and Seymour or equivalent.
- D. Angle Plugs: Angle plugs shall be field adjustable to four positions and shall be rated 120-volt AC, 20 ampere. Angle plugs shall be Pass and Seymour, 5366 or equivalent.

2.04 SWITCHES

- A. General Purpose: General purpose switches shall be quiet AC toggle type, specification grade, 20 ampere minimum. Switches shall be provided as single pole, three-way, and four-way as indicated on the Drawings for each application. Switches shall be Pass and Seymour PS20AC or equivalent.
- B. Motor Rated Switches: Motor rated switches shall be 120-volt AC horsepower rated toggle type. Switches shall have oversized silver contacts and shall be as manufactured by Pass and Seymour PS20AC2-HP or equivalent.

2.05 DEVICE PLATES

- A. General: Device plates shall be provided for all switches and receptacles. Device plates, unless otherwise specified, shall be made of sheet steel, zinc electroplated with chrome finish as manufactured by Crouse-Hinds, Leviton or equivalent.
- B. Architecturally Finished Spaces
 1. Device plates shall white nylon unless noted otherwise.
 2. HVAC Equipment Disconnects: Device plates shall be stainless steel and laser engraved with legends as indicated on the Drawings.
- C. While-In-Use Receptacle Covers: While-in-use receptacle covers shall be heavy duty hinged covers that completely cover the receptacle and shall be UL listed suitable for wet locations while in use. While-in-use covers shall aluminum construction. Covers shall be selected for vertical or horizontal mounting orientation as the application dictates. Hinged covers shall be latching type with cord ports and padlock attachment. Color shall be gray. While-in-use covers shall be as manufactured by Leviton Model IUM1V/H or equivalent.
- D. Weatherproof Switch Covers: Weatherproof switch cover plates shall be die-cast aluminum construction with an integral wing type handle external operating mechanism and padlock hasp. Switch plate/operating mechanism shall be Crouse-Hinds DS185 or equivalent.

2.06 DEVICE BOXES

- A. Surface Mounted: All surface mounted devices including receptacles and switches shall be mounted in FD type mounting boxes. Boxes shall be cast malleable iron with integral ground lug, tapered threaded hubs, and mounting lug.

2.07 COMMUNICATION OUTLETS

- A. Workstation Communication Outlet (Architectural Spaces): Workstation communication outlets shall be of a modular design consisting of a 2-port, single gang, high impact thermoplastic faceplate and two (2) category 6 data grade RJ45 jacks. RJ45 jacks shall be of high impact thermoplastic construction and shall have an integral 110 IDC (insulation displacement connection) block with tin lead plated contacts. RJ45 jack contacts shall be beryllium copper with minimum 50 micro-inch gold plating. Faceplate color shall be white and shall be provided with screw covers and machine printed labels. RJ45 jacks shall be color coded to indicate data or voice communications and shall accept a machine-printed termination position label. Communications outlets shall be as manufactured by Hubbell Premise Wiring, FPL Series Faceplates and 5110 Series jacks, or approved equivalent.
- B. Industrial Communication Outlet: Industrial communication outlets shall consist of a female to female RJ45 bulkhead category 6 connector in an IP68 high impact polycarbonate device box suitable for wall mounting. The bulkhead connector shall have a threaded cable coupling on the IP68 rated side and provided with a threaded dust cap. Device box shall be provided with a gasket cover with knockouts compatible with the specified bulkhead connector.
 - 1. Bulkhead connector shall be as manufactured by Tripp-Lite, Model N206-BC01-IND or approved equivalent.
 - 2. Device box shall be as manufactured by Tripp-Lite, Model N206-SB01-IND or approved equivalent.

PART 3 EXECUTION

3.01 INSTALLATION OF WIRING DEVICES AND ACCESSORIES

- A. Receptacles and switches shall be applied in accordance Table 26 05 00-A.
- B. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- C. Coordinate with other Work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other Work.
- D. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- E. Install wiring devices after wiring work is completed.
- F. Install wiring devices and device plates after painting work is complete.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with

tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

- H. Each receptacle branch circuit shall be provided with a dedicated neutral conductor. Common neutrals shall not be permitted.
- I. All permanently connected, contractor-furnished, plug and cord connected equipment shall be field-fitted with an angle plug.
- J. Wiring device mounting heights (to bottom of device) shall be as specified herein unless indicated otherwise on the Drawings:

<u>Device Type</u>	<u>Area</u>	<u>Mounting Height</u>
Receptacle	Process areas	48 inches above finished floor
Receptacle	Architectural, utility, and electrical	18 inches above finished floor
Switches	All	48 inches above finished floor

3.02 PROTECTION

- A. General: Protect installed components from damage. Replace damaged items prior to final acceptance.

3.03 FIELD QUALITY CONTROL

- A. Subsequent to energizing, test wiring devices and demonstrate compliance with requirements, operating each operable device.
- B. Receptacles shall be tested in accordance with Specification 26 08 00.

END OF SECTION

SECTION 26 28 18

SAFETY DISCONNECT SWITCHES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems

1.02 SUMMARY

- A. This section specifies safety disconnect switches.
- B. Extent, location, and details of safety disconnect switch work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Product data sheets for each size and type of safety disconnect switch.
 - 2. Dimensioned outline drawing.
 - 3. Conduit entry/exit locations.
 - 4. Switch ratings including short circuit rating, voltage, and continuous current.
 - 5. Fuse ratings and types.
 - 6. Cable terminal sizes.
 - 7. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. UL Compliance: Provide devices which are listed and labeled by UL and comply with applicable UL standards including the following.
 - a. UL 98 Enclosed Switches
3. NEMA Compliance: Provide components which comply with the following standards:
 - a. NEMA 250 Enclosures for Electrical Equipment (1,000 volts maximum)
 - b. NEMA KS 1 Enclosed Switches

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Eaton, Cutler-Hammer
2. General Electric Co.
3. Schneider Electric, Square D Co.

2.02 SAFETY DISCONNECT SWITCHES

- A. General: Safety disconnect switches shall be heavy-duty, safety type unless otherwise specified. Switches shall be as shown with the following ratings.

1. 30 to 1200 amperes
2. 600 volts AC.
3. 2, 3, 4 and 6 poles.
4. Fusible and non-fusible.
5. 100 percent load break and load make rated.
6. Single throw.

- B. Construction: All disconnect switches shall have the following features.

1. Switch blades and jaws shall be visible and plated copper.
2. Switches shall have a red handle that is easily pad-lockable with three 3/8-inch shank locks in the OFF position.
3. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position. Defeater mechanism shall be front accessible.
4. Switches shall have deionizing arc chutes.
5. Switch assembly and operating handle shall be an integral part of the enclosure base.

6. Switches rated 30 to 600 amperes shall have reinforced fuse clips.
 7. Mechanical lugs suitable for aluminum or copper conductors.
 8. Ground lug.
 9. Switch blades shall be readily visible in the "ON" and "OFF" position.
 10. Switch operating mechanism shall be non-teasable, positive quick-make/quick-break type.
 11. Fusible switches shall be suitable for service entrance equipment.
 12. Switches shall have line terminal shields.
 13. Switches shall be suitable for systems capable of 200 kA at 480 volt with Class J, L, R, or T fusing.
 14. Embossed or engraved ON-OFF indication shall be provided.
 15. Double-make, double-break switch blade feature shall be provided.
 16. Fuse pullers shall be provided on all switches through 200 amperes.
- C. Enclosures: Unless otherwise noted, safety disconnect switch enclosure sealing rating and materials of construction shall be in accordance with paragraph 26 05 00-1.8 and the following.
1. NEMA 1, 4, and 12 enclosures shall be painted steel construction. Paint color shall be ANSI 61 gray.
 2. NEMA 4X enclosures shall be 316 stainless steel construction.
- D. The following factory-installed options shall be provided when specified.
1. Pad-lockable in the ON position. Padlock provisions shall accept one 3/8-inch shank padlock.
 2. 1 normally open, 1 normally closed auxiliary contact indicating the switch position.
 3. Solid neutral assembly.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which panelboards are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION

- A. Install safety disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate safety disconnect switch installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

- D. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

3.03 GROUNDING

- A. General: Provide equipment grounding connections to safety disconnect switches as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.04 FIELD QUALITY CONTROL

- A. General: Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

3.05 ADJUSTING AND CLEANING

- A. Adjust and lubricate operating mechanisms for free mechanical movement.
- B. Adjust doors and door interlocks to insure proper mechanical operation and full operating range.
- C. Touch-up scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 26 29 14

REDUCED VOLTAGE SOLID STATE (RVSS) MOTOR CONTROLLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems
 - 2. Section 26 24 19, Motor Control Centers
 - 3. Section 40 67 61, Operator Control Devices
- C. Reduced Voltage Solid State Motor Controller Summary, Table 26 29 14-A, appended to the end of this specification section applies to Work of this Section.

1.02 SUMMARY

- A. This section specifies low reduced-voltage solid state motor controller systems. The RVSS controller system shall be a factory engineered and integrated system including RVSS controller, contactors, control and protective equipment and accessories as necessary to provide the specified functions.
- B. Table 26 29 14-A, Reduced Voltage Solid State Motor Controller Summary, appended to the end of this section provides a schedule of all RVSS motor controllers to be provided as Work of this project.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's catalog data indicating equipment specifications and construction features including all optional equipment and features proposed.
 - 2. Unit descriptions including amperage ratings, enclosure ratings, circuit breaker frame sizes, fault ratings, breaker continuous amperage ratings, etc., as required for approval.
 - 3. Outline dimensions, weight, conduit routing and termination locations, and foundation requirements for all assemblies.
 - 4. Elementary connection and interconnection diagrams in accordance with JIC EMP 1 and NEMA ICS standards. Diagrams shall indicate the interconnection of all controller components including door-mounted control devices and the function and identification of all field terminals.

5. Dimensioned layout drawings indicating equipment layout on the controller enclosure door and interior equipment mounting panel. Layout drawings shall include an engraving legend for all panel nameplates.
6. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. IEEE Compliance: Provide products which comply with the following standards:
 - a. IEEE C587 – Recommended Surge Threshold
3. NEMA Compliance: Provide products which comply with the following standards:
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
 - b. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies
 - c. NEMA ICS 3 - Industrial Systems
4. ODVA Conformance: Provide EtherNet/IP network system components that have been conformance tested in accordance with ODVA requirements and manufactured by companies that have been authorized to use ODVA technology and are compliant with the applicable ODVA Terms of Usage Agreement(s).
5. Underwriters Laboratories: Provide products which comply with the following standards:
 - a. UL 508C - Power Conversion Equipment

B. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of RVSS motor controllers with other components of the facility process control system.

C. Manufacture and Assembly: RVSS motor controllers shall be manufactured by the RVSS manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001. RVSS motor controllers shall be completely factory wired and assembled and tested in the specified enclosure system by the manufacturer of the RVSS.

D. Commissioning and Training: RVSS motor controllers shall be inspected and commissioned by a field service engineer in the direct employment of the RVSS manufacturer. RVSS motor controller operation and maintenance training shall be conducted by a factory-trained instructor in the direct employment of the RVSS manufacturer.

1.05 SPARE MATERIALS

- A. Provide one (1) set of three (3) of each size power fuse utilized.
- B. Provide five (5) minimum of each size primary and secondary control power fuses.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Manufacturers: RVSS motor controllers specified in this Specification and Specification 26 24 19 shall be the product of a single manufacturer. RVSS motor controllers and motor control centers shall be products of the same manufacturer. RVSS motor controllers are specified on the basis of the following products for function and quality. Supply products modified as necessary by the manufacturer to provide the specified features and to meet specified operating conditions.

- 1. Allen-Bradley, SMC Flex Smart Motor Controllers

2.02 RATINGS

- A. The RVSS controller shall accept an input voltage from 200V to 480V AC three-phase plus 10 percent or minus 15 percent.
- B. The RVSS controller shall have a minimum short circuit current rating of 65 kA when protected with a type CC/J/L fuses (up to 600V).
- C. Sizing: RVSS controller nominal rated output shall be as required to continuously drive the specified motor load under the conditions specified herein.
 - 1. The ampere rating of the controller, derated in accordance with the controller manufacturer's published guidelines for the project environmental conditions specified herein and the mounting and enclosure requirements specified, shall exceed the associated motor nameplate full load current rating.
- D. Environmental Ratings
 - 1. Storage ambient temperature range: -50 to 70°C.
 - 2. Operating ambient temperature range: -30 to 50°C.
 - 3. The relative humidity range: 5 to 95 percent non-condensing.
 - 4. Operating elevation: up to 2000 meters.

2.03 RVSS CONTROLLER UNIT DESIGN

- A. The open-type controller device shall be modular, consisting of a power structure and a logic component.
- B. Power Structure:
 - 1. The family of devices must be available from 1...1250 A in a line connection.
 - 2. The power structure shall include an electro-mechanical SCR bypass device.

3. The power structure shall include built-in 3-phase current monitoring and overload protection.
4. The power structure shall consist of three power poles with integral heatsinks.
5. The power poles shall be modular in design to facilitate replacement.
6. Back-to-back SCR pairs shall be the only power switching semiconductor means acceptable.
7. SCRs shall have the following minimum repetitive peak inverse voltage ratings.
 - a. 1400V for units rated 200...480V
 - b. 1600V for units rated 200...600V
 - c. 1800V for units rated 230...690V
8. SCRs shall have built in temperature monitoring sensors.

C. Logic Component

1. The logic component shall be a self-contained control module, compatible with the full range of power structures. The control module shall mount directly to the power structure.
2. The control module shall provide digital microprocessor control and supervision of all controller operation, including pulse firing of the SCRs.
3. The control module shall consist of the following.
 - a. Self-tuning power supply accepting control power input from 100...240V AC or 24V AC/DC, 50/60 Hz.
 - b. Logic control circuitry incorporating a latch circuit for three-wire control.
 - c. SCR firing circuitry that incorporates an RC snubber network to prevent false firing.
 - d. Input/output circuitry.
 - e. Digital programming keypad.
 - f. Backlit LCD display with multi-lingual capabilities.
 - g. DPI communication port.
4. The control terminals shall have the following characteristics.
 - a. The control terminal wiring connector shall be easily accessible and located on the front top of the device.
 - b. The terminals shall be UL rated for 300V, 10 A maximum.
 - c. The terminals shall be UL Recognized to accept a maximum of two (2) wires rated #8...#14 AWG.
5. The control module shall be easily removed from the power structure, without the need to disassemble associated printed circuit board assemblies.

2.04 RVSS CONTROLLER UNIT MODES

A. Starting Modes

1. Soft Start with Selectable Kickstart
 - a. Programmable initial torque value of 0 to 90 percent of locked rotor torque.

- b. Programmable acceleration ramp time from 0...30 seconds.
 - c. A selectable kickstart, or boost, shall be provided at the beginning of the voltage ramp. The kickstart shall provide a current pulse of 550 percent of the full load current. The kickstart time shall be adjustable from 0 to 2 seconds.
 - d. Current limit start.
 - e. Provides means of limiting the maximum starting current.
 - f. Adjustable from 50 to 600 percent of motor full load current.
 - 2. Full-Voltage Start
 - a. Provides across the line starting.
 - b. Ramp time shall be less than 0.25 seconds.
 - 3. Dual Ramp Start
 - a. Provides two (2) separate start profiles with separately adjustable ramp times and initial torque, settings.
 - b. Programmable acceleration times from 0 to 30 seconds.
 - c. Current limit level programmable from 50 to 600 percent full load current.
 - d. Programmable initial torque values from 0 to 90 percent of locked rotor torque.
- B. Stopping Modes
- 1. Soft stop
 - a. The soft stop option shall provide a voltage ramp-down for an extended motor stopping time.
 - b. Soft stop shall be initiated by a dedicated Soft Stop input. A coast-to-rest stop shall still be possible with a separate stop input.
 - c. Programmable voltage ramp down time from 0 to 60 seconds.
 - d. The load shall stop when the motor voltage drops to a point where the load torque is greater than the motor torque.
 - 2. Preset Slow Speed
 - a. Provides a slow speed for applications requiring a slow speed.
 - b. The Preset Slow Speed option shall provide two jog speeds in the forward direction: high (15 percent of base speed) and low (7 percent of base speed).
 - c. The Preset Slow Speed option shall provide two jog speeds in the reverse direction: high (20 percent of base speed) and low (10 percent of base speed). Reverse operation of the motor shall be available in the jog mode without the use of a reversing contactor.
 - d. The starting current for the slow speed operation shall be user adjustable from 0 to 450 percent of the motor's full load current rating.
 - e. The running current for the slow speed operation shall be user adjustable from 0 to 450 percent of the motor's full load current rating.

2.05 RVSS CONTROLLER UNIT FEATURES

A. LCD Display

1. An alphanumeric, backlit LCD display shall be provided for controller set-up, diagnostics, status and monitoring. The display shall be four-line, 16 characters minimum.
 2. Digital parameter adjustment shall be provided through a keypad. Analog potentiometer adjustments are not acceptable.
- B. Overload Protection
1. RVSS shall meet applicable standards as a motor thermal protective device.
 2. RVSS shall utilize three-phase current sensing. The use of two current transformers shall be unacceptable.
 3. Selectable trip classes of 10, 15, 20, and 30 shall be provided as standard.
 4. Electronic thermal memory shall provide enhanced motor protection.
- C. Digital Inputs and Outputs
1. A minimum of four (4) auxiliary contacts shall be provided for customer use.
 2. The contacts shall be rated for 240V AC maximum.
 3. Contact configuration shall be programmable and contain the following configurations:
 - a. Normal Operation (N.O. or N.C.)
 - b. Up-to-Speed indication (N.O. or N.C.)
 - c. External bypass
 - d. Fault indication (N.O. or N.C.)
 - e. Alarm indication (N.O. or N.C.)
 - f. Network controlled output (N.O. or N.C.)
- D. Communication Ports
1. A DPI serial communication port shall be provided as standard.
 2. An Ethernet/IP communication protocol interface module shall be provided.
- E. Monitoring: The RVSS controller shall provide the following motor and/or power system monitoring functions indicated through the optional LCD display.
1. Three-phase current.
 2. Three-phase voltage.
 3. Power in kW.
 4. Power usage in kWh or MWh.
 5. Power factor.
 6. Motor thermal capacity usage
 7. Elapsed time
- F. Protection and Diagnostics
1. Pre-start line fault advising of shorted SCR or missing load connection with phase indication.

2. Running line fault advising power loss, shorted SCR, or missing load connection.
3. Pre-start power loss with phase indication.
4. Over temperature.
5. Open gate with phase indication.
6. The following programmable protection shall be provided as standard with the controller.
 - a. Overload
 - b. Underload
 - c. Undervoltage
 - d. Overvoltage
 - e. Voltage unbalance
 - f. Phase reversal
 - g. Stall
 - h. Jam
 - i. Excessive starts per hour
7. When fault conditions are detected, the controller shall inhibit starting or shutting down SCR pulse firing.
8. Fault diagnostics shall be indicated in descriptive text on the LCD display. The exclusive use of fault codes is unacceptable.
9. An auxiliary contact that is user programmable for fault indication shall be provided for customer use.

G. Human Interface Module (HIM)

1. Provide a door mounted human interface module with integral display and sealed membrane programming keys.
2. The display shall show operating conditions, adjustments and fault indications.
3. The display shall be backlit LCD and shall consist of four lines of 16 alphanumeric characters.

H. Transient Protection Modules

1. RVSS shall be provided with transient protection consisting of separately mounted protective modules.
2. Protective modules shall consist of metal oxide varistors (MOVs) in combination with capacitors to protect the power components from electrical transients and electrical noise. The capacitors shall be provided to shunt noise energy away from the controllers electronics.
3. The MOVs and capacitors shall be encapsulated in a clear material for easy inspection.
4. The protective modules shall be mounted so that they will not cause damage to the power components upon absorbing an electrical transient.
5. The MOVs shall be rated for a minimum of 220 joules.

I. Input Circuit Breaker

1. Provide a door interlocked thermal magnetic circuit breaker disconnect.
 2. Operator Handles
 - a. Provide flange mounted operator handles for free standing units.
 - b. Through the door operating handles are acceptable for wall mounted and motor control center units.
 3. Handles shall be padlockable.
- J. Control Power Transformer: Fused control power transformer rated to serve the RVSS control power requirements plus 50 VA spare capacity. Control power transformer shall provide control and operating power for RVSS control systems and specified peripheral systems. Control and power circuits shall be individually fused.

2.06 CONSTRUCTION

- A. Enclosure: Where specified, motor controllers shall be fully assembled in an industrial enclosure complying with the following.
1. NEMA 12 enclosure for indoor use to provide a degree of protection against dust, falling dirt and dripping non-corrosive liquids. They shall be designed to meet drip, dust and rust resistance tests. No ventilation openings shall be allowed.
 2. Enclosures shall be designed for wall mounting and shall be sized to allow adequate convection cooling to limit the interior temperature to less than the RVSS specified maximum limits.
 3. Paint:
 - a. Exterior: ANSI 49 Gray
 - b. Interior: White
 4. Equipment within the enclosure shall be arranged for entry of incoming power line and load cables as required for each application.
 5. UL label.
 6. Door-mounted operator control devices as indicated on the Drawings.
- B. Motor Control Center Mounting: RVSS controllers designated for installation in a motor control center shall be fully assembled in a single motor control center unit in accordance with Specification 26 24 19.
- C. Wiring
1. Power and Control Wire: Power wire shall be copper 90 degrees C "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG, stranded.
 2. Identification: All power, signal, control and communication wiring shall be uniquely identified and provided with labels in accordance with Specification 26 05 53.
- D. Terminations and Cable Connections
1. Terminals: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated. All control wiring shall be terminated on separate terminal blocks within the controller enclosure.
 2. Power Cable Connectors:

- a. Power cable connectors for use with stranded copper wire, sizes as required for each application, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be box lug type rated for use with copper conductors.
 - b. Motor feeder cables shall terminate directly on the controller load terminals. Termination lugs shall have adequate dedicated space for the type and size of conductors indicated on the Drawings. The lugs shall be compression type with anti-turn feature.
- E. Control Devices: Control devices such as pushbuttons, selector switches, and indicating lights shall be mounted on the unit compartment door. The control devices shall comply with the requirements of Section 40 67 61.

2.07 SOFTWARE

- A. Add-on Profile (AOP): RVSS motor controllers shall be provided with an AOP or equivalent that integrates the RVSS as a module in the PLC programming environment. The AOP shall facilitate the integration of RVSS configuration parameters and tag data into the PLC program without the need to map data or create tags. Tag data shall include control tags for RVSS start/stop control and tags for monitoring RVSS operating, alarm, and diagnostic conditions.
- B. Electronic Data Sheet (EDS): RVSS shall be provided with an EDS file in compliance with the ODVA specification.

PART 3 EXECUTION

3.01 INSTALLATION OF RVSS MOTOR CONTROLLERS

- A. RVSS motor controllers shall be installed in accordance with the requirements of Section 26 05 85 and as indicated on the Drawings.

3.02 FIELD QUALITY CONTROL

- A. General: Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- B. Configuration and Startup:
 - 1. Provide the services of a qualified factory-trained manufacturer's representative to assist the installing contractor with the installation, configuration and startup of each RVSS motor controller.
 - 2. The manufacturer's representative shall inspect the installation of each RVSS motor controller and configure each RVSS for operation under the specified conditions.
 - 3. The manufacturer's representative shall conduct the initial startup and operation of each RVSS motor controller.
- C. Certification: A factory-trained manufacturer's representative shall certify in writing that each RVSS motor controller has been installed, configured, and tested in accordance with the manufacturer's recommendations.

3.03 TESTING

- A. General: Each RVSS motor controller shall be field acceptance tested in accordance with Section 26 08 00.

3.04 TRAINING

- A. The Contractor shall provide the services of a factory-trained instructor for the purpose of training the Owner's personnel in the proper operation and maintenance of the RVSS motor controllers. Training shall consist of not less than 4 hours of field instruction in the operation, testing, troubleshooting, and maintenance of the RVSS motor controllers in accordance with Section 01 79 00.

3.05 RVSS CONTROLLER SUMMARY

- A. The Reduced-Voltage Motor Controller Summary, Table 26 29 14-A, is appended to the end of this specification section. The entries in the summary are defined as follows:
1. Controller Number: Unique identification number assigned to the controller.
 2. Equipment Number: Identifies the driven equipment associated with the controller.
 3. Description: Description of the driven equipment associated with the controller.
 4. Motor/HP: Nominal horsepower rating of the motor to be furnished with the driven equipment.
 5. Motor/RPM: Synchronous speed of the motor to be furnished with the driven equipment.
 6. Control Diagram: Identifies the control diagram associated with the controller.
 7. Mounting/Enclosure Rating:
 - a. If a motor control center designation is provided in this entry, the RVSS motor controller shall be factory installed in the identified motor control center.
 - b. Otherwise this entry will define the mounting type and provide an associated NEMA sealing rating for the enclosure if the mounting type requires an enclosure.
 - 1) Wall: RVSS motor controller shall be installed in a wall-mount enclosure system.
 - 2) Freestanding: RVSS motor controller shall be installed in a freestanding enclosure system.
 - 3) Open: RVSS motor controller shall be provided as an open chassis assembled on mounting panel suitable for installation in a third-party enclosure.
 8. Notes: Provides additional reference information.

END OF SECTION

Table 26 29 14-A
RVSS Motor Controller Summary

RVSS Number	Equip Number	Description	Motor		Control Diagram	Mounting/ Enclosure Rating	Notes
			HP	RPM			
RVSS 3810	B 3810	AIR SCOUR BLOWER 1	75	1800	E-301B	MCC9000	
RVSS 3820	B 3820	AIR SCOUR BLOWER 2	75	1800	E-301B	MCC9000	

SECTION 26 29 23

VARIABLE FREQUENCY DRIVES (VFD)

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems
 - 2. Section 26 24 19, Motor Control Centers
 - 3. Section 40 67 61, Operator Control Devices
- C. Variable Frequency Drives Summary, Table 26 29 23-A, appended to the end of this specification section applies to Work of this Section.

1.02 SUMMARY

- A. This section specifies low voltage variable frequency drive (VFD) systems. The VFD system shall be a factory engineered and integrated system including incoming line reactors, rectifier, inverter, control circuitry, protective equipment, output filters and accessories as necessary to provide the specified functions and assembled in an individual enclosure. VFDs shall employ pulse width modulated inverter technology and shall be the product of single manufacturer.
- B. Table 26 29 23-A, Variable Frequency Drives Summary, appended to the end of this section provides a schedule of all VFDs to be provided as Work of this project.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Manufacturer's catalog data indicating equipment specifications and construction features including all optional equipment and features proposed.
 - 2. Unit descriptions including amperage ratings, enclosure ratings, circuit breaker frame sizes, fault ratings, breaker continuous amperage ratings, etc., as required for approval.
 - 3. Outline dimensions, shipping section dimensions, weight, conduit routing locations, and foundation requirements for all assemblies.
 - 4. Elementary connection and interconnection diagrams in accordance with JIC EMP 1 and NEMA ICS standards. Diagrams shall indicate the interconnection of all VFD components including door-mounted control devices and the function and identification of all field terminals.

5. Dimensioned layout drawings indicating equipment layout on VFD enclosure door and interior equipment mounting panel. Layout drawings shall include an engraving legend for all panel nameplates.
6. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. IEEE Compliance: Provide products which comply with the following standards:
 - a. IEEE 519 - Recommended Practices for Harmonic Control in Electrical Power Systems
3. NEMA Compliance: Provide products which comply with the following standards:
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
 - b. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies
 - c. NEMA ICS 3 - Industrial Systems
 - d. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Variable Speed Drive Systems
4. ODVA Conformance: Provide EtherNet/IP network system components that have been conformance tested in accordance with ODVA requirements and manufactured by companies that have been authorized to use ODVA technology and are compliant with the applicable ODVA Terms of Usage Agreement(s).
5. Underwriters Laboratories: Provide products which comply with the following standards:
 - a. UL 508C - Power Conversion Equipment

B. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of VFDs with other components of the facility process control system.

C. Manufacture and Assembly: VFDs shall be manufactured by the VFD manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001. VFDs shall be completely factory wired and assembled and tested in the specified enclosure system by the manufacturer of the VFD.

D. Commissioning and Training: VFDs shall be inspected and commissioned by a field service engineer in the direct employment of the VFD manufacturer. VFD operation and maintenance

training shall be conducted by a factory-trained instructor in the direct employment of the VFD manufacturer.

1.05 SPARE MATERIALS

- A. Provide one (1) set of three (3) of each size power fuse utilized.
- B. Provide five (5) minimum of each size primary and secondary control power fuses.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. General: VFD systems shall convert 480-volt, 60 hertz nominal input power to a suitable voltage and frequency to cause a standard squirrel-cage induction motor to run at a speed proportional to an external reference signal. VFDs and all internal components shall be suitable to serve the loads specified under the conditions specified.
- B. Manufacturers: VFDs specified in this Specification and Specification 26 24 19 shall be the product of a single manufacturer. VFDs and motor control centers shall be products of the same manufacturer. VFDs are specified on the basis of the following products for function and quality. Supply products modified as necessary by the manufacturer to provide the specified features and to meet specified operating conditions.

- 1. Allen-Bradley, PowerFlex 753

2.02 VARIABLE FREQUENCY DRIVES

- A. Input Power
 - 1. VFDs shall be self-adjusting to accept an input voltage range between 380 volts AC to 480 volts AC, three phase, ± 10 percent.
 - 2. Displacement Power Factor: 0.95 or better at rated load and nominal line voltage over the entire speed range.
 - 3. Efficiency: Efficiency including control power supplies, control circuits and cooling fans shall be 96.5 percent minimum at full speed and motor load at nominal line voltage.
- B. Sizing: VFD nominal rated output shall be as required to continuously drive the specified the motor load under the conditions specified herein.
 - 1. Variable Torque (Normal Duty): VFD shall be rated to provide 110 percent overload capability for up to one minute and 150 percent for up to three seconds.
 - 2. Constant Torque (Heavy Duty): VFD shall be rated to provide 150 percent overload capability for up to one minute and 180 percent for up to three seconds.
 - 3. The ampere rating of the VFD, adjusted in accordance with the VFD manufacturer's published guidelines for the environmental conditions specified in Section 01 81 16 and the mounting and enclosure requirements specified herein, shall exceed the associated motor nameplate full load current rating.
 - 4. Speed Range: VFDs shall be rated to operate the specified load to a maximum speed of 60 hertz unless otherwise indicated in Table 26 29 23-A.

- C. The VFD shall remain on line and operate without damage to either the VFD or its connected load during a supply power dip of 20 percent of nominal.
- D. Circuit Breaker Disconnect and Line Fuses: A door-interlocked molded case circuit breaker disconnect with flanged-mounted, lockable operating means shall be provided. Fast-acting drive branch circuit fusing shall be provided for protection against internal faults and as a backup for external load faults. Load faults shall normally be cleared by the inverter assembly.
- E. Rectifier: The rectifier shall consist of a full wave, 3 phase, diode bridge or SCR bridge rectifier to convert the incoming fixed voltage/frequency to a fixed DC voltage. A DC link choke shall be provided on the DC bus to mitigate harmonics.
- F. Inverter: Inverter section shall consist of latest generation insulated gate bipolar transistors.
- G. Control Power Transformer: Fused control power transformer rated to serve the VFD control power requirements plus 100 VA spare capacity. Control power transformer shall provide control and operating power for VFD control systems and specified peripheral systems. Control and power circuits shall be individually fused.
- H. Wiring
 - 1. Power Wire: Power wire shall be copper 90 degrees C "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG, stranded.
 - 2. Control Wire: Control and signal wiring in the VFD that connects external wiring to the VFD shall be twisted shielded pairs and shall be separated from any VFD wiring that may contain voltage and/or current harmonics inherent in inverter operation by not less than 4 inches except at 90-degree crossings.
 - 3. Identification: All power, signal, control and communication wiring shall be uniquely identified and provided with labels in accordance with Section 26 05 53.
- I. Terminations and Cable Connections
 - 1. Terminals: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated. All control wiring shall be terminated on separate terminal blocks within the VFD enclosure.
 - 2. Cable Connectors:
 - a. Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 kcmil, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors.
 - b. Motor feeder cables shall terminate directly on the VFD load terminals. Termination lugs shall have adequate dedicated space for the type and size of conductors indicated on the Drawings. The lugs shall be compression type with anti-turn feature.
- J. Control Devices: Control devices such as pushbuttons, selector switches, and indicating lights shall be mounted on the unit compartment door. The control devices shall comply with the requirements of Section 40 67 61.

K. Protective Features

1. Overcurrent Protection: The VFD system shall provide electronic current limit protection. Current limit shall be accurate to within 1.0 percent and shall smoothly limit motor speed at whatever value is necessary to limit motor current to that value.
2. VFD shall provide electronic motor overload protection tested in accordance with UL Standard 991 to meet the requirements of the National Electrical Code. Overload protection shall be speed sensitive and variable for motors with speed ranges of 2:1, 4:1, and 10:1.
3. Short Circuit Protection: The VFD shall be fully protected against load faults. Bolted faults, phase to phase or phase to ground shall not damage the unit. Fault protection shall be based on a power source short circuit capacity of 65,000 amperes RMS symmetrical at the VFD power input terminals. Any impedance or other current limiting devices necessary to meet this requirement shall be provided as part of the VFD system. Any additional losses caused by current limiting devices shall be included in the efficiency calculation for the VFD system.
4. Line Voltage: The VFD shall be protected against high and low line voltage on one or more phases. VFD shall be provided with phase-to-phase and phase-to-ground metal oxide varistor (MOV) transient surge protection.
5. Internal Faults: The VFD shall incorporate an internal fault monitoring system to detect malfunctions. This system shall be designed to protect the VFD from transient and sustained faults and to limit damage that may be caused by these faults.

L. Fault/Diagnostic Annunciator: The VFD shall be provided with a fault/diagnostic message annunciation system which shall indicate the cause of any shutdown. Annunciator shall identify the first fault in those cases where multiple faults occur between manual or automatic resets and shall be visible without opening the VFD cabinet. Annunciator shall present all diagnostic and fault information. As a minimum, the following faults shall be annunciated:

1. Power loss.
2. Undervoltage.
3. Overvoltage.
4. Motor overload.
5. Heat sink overtemperature.
6. Maximum retries.
7. Phase-to-phase and phase-to-ground faults.

M. Programmable VFD Features: VFD control logic shall be microprocessor-based for control of drive control logic functions and drive operating parameters including frequency, voltage and current. Drive setup and operating parameters shall be digitally programmable from the VFD display and programming panel located on the enclosure door. All setup and operating parameters shall be stored in nonvolatile memory (EEPROM). Programmable features shall include the following:

1. Minimum/maximum output frequency limits.
2. Independent timed linear acceleration and deceleration functions, 0 to 600 seconds.
3. Configuration of volts per hertz for squared, cubed, straight line or full custom patterns.
4. Current limit from 20 to 160 percent of constant torque rating. Current limit shall be active for all VFD states; accelerating, constant speed, and decelerating. The VFD

control logic shall employ proportional-integral regulation for smooth transition in and out of current limit.

5. Variable carrier frequency (2 to 8 kHz) and three bands of critical frequency avoidance lockout with variable bandwidth and center frequency.
6. Speed regulation modes including:
 - a. Open loop.
 - b. Slip compensation with 0.5 percent speed regulation.
 - c. Droop-negative slip compensation.
 - d. Traverse function.
 - e. Phase lock loop.
 - f. Closed loop encoder feedback with 0.1 percent speed regulation.
7. DC boost function providing a selectable range for offsetting motor losses at low frequency operation. DC boost shall be current regulated and shall automatically adjust, on each start, to motor temperature and load changes. Variable from 15 percent to 120 percent of drive current rating.
8. Selectable automatic restart following restoration of power following an outage.
9. Selectable automatic fault reset and restart up to nine fault occurrences.
10. Flying start providing the capability to start into a spinning motor without tripping.

N. Control Interface

1. Human Interface Module (HIM): The VFD system shall be provided with a removable, door-mounted HIM consisting of an alphanumeric, backlit LCD display and sealed keypad to facilitate viewing and programming of drive setup and operating parameters including drive fault annunciation. The HIM shall be removable under power without causing a drive fault and be visible and operable without opening the enclosure door. As a minimum the following operating parameters shall be displayed on the HIM:
 - a. Output voltage.
 - b. Output current.
 - c. Output frequency.
 - d. Power demand, kilowatts.
 - e. Elapsed time.
2. Operator Control Devices: Operator control devices shall be provided on the front door of the VFD enclosure. The operator control devices shall be discrete, industrial-grade operator interface components or, alternatively, the same functions may be provided through the display and programming panel. The operator control functions shall be as indicated on the Drawings and include the following:
 - a. Hand-Off-Remote Selector Switch
 - b. Start-Stop Pushbutton
 - c. Drive Reset Pushbutton
 - d. Drive Ready Indicator
 - e. Drive Run Indicator
 - f. Overtemperature Fault Indicator

- g. Overtemperature Fault Reset Pushbutton
 - h. Drive Output Frequency Control
 - i. The control devices shall be front mounted on the VFD enclosure between 36 inches and 72 inches above the floor.
3. Data Communication Interface: VFD shall be provided with an ethernet interface to permit data communication via an EtherNet/IP network to both the VFD and any ancillary EtherNet/IP-ready devices located in the VFD enclosure. The data communication interface shall permit discrete transfer of operating and speed control commands to the VFD as well as return the VFD operating status. All VFD programmable setup parameters shall be read and write accessible through the communication interface. The data communication interface shall derive required operating power from the VFD system or communications link. No external power source shall be required.
 4. Hardwire Control Interface: VFD hardwire control interface shall be rated for 120 volt AC operation. Inputs shall be programmable to configure the VFD for standard 3-wire, 2-wire, and serial operation requirements. The control interface provided for fixed VFD functions shall be optically isolated from the VFD control logic and shall require 10 mA of power per input.
 - a. The external hardwire control and monitoring interface shall conform to the control diagrams presented in the E-series Drawings and to the requirements specified herein. Each engineered VFD system shall be provided with a specific hardwire interface to establish the specified control interlocks with associated support systems and to control and communicate additional VFD operation parameters not accessible through the VFD serial communication interface or the VFD fixed function interface.
 - b. Hardwire interface functions shall include, but not by way of limitation, the following:
 - 1) Six (6) discrete 120VAC inputs
 - 2) One (1) PTC thermistor input circuit
 - 3) One (1) 24VDC source power for field devices
 - 4) Two (2) analog inputs
 - 5) Two (2) analog outputs
 - 6) Two (2) Form C 120VAC relay circuits with separate common terminal for each relay

O. Software

1. Add-on Profile (AOP): VFD shall be provided with an AOP or equivalent that integrates the VFD as a module in the PLC programming environment. The AOP facilitate the integration of VFD configuration parameters and tag data into the PLC program without the need to map data or create tags. Tag data shall include control tags for VFD start/stop control , speed control, direction control and tags for monitoring VFD operating, alarm, and diagnostic conditions.
2. Electronic Data Sheet (EDS): VFD shall be provided with an EDS file in compliance with the ODVA specification.

2.03 AC LINE REACTORS

- A. The VFD shall be provided with 3 percent impedance, AC series line reactors for protection against spikes and surges without the requirement for an external isolation transformer. Series

line reactors shall be provided on the input power source to the VFD rectifier downstream of the VFD disconnect switch and shall be mounted in the VFD compartment. Reactors shall be rated for a minimum of the full current rating of the VFD and for the voltage being utilized.

2.04 OUTPUT FILTERS

- A. General: VFD shall be provided with a 600-volt AC, 3 phase low pass filter designed to protect an electric motor from voltage spiking on the output of PWM VFDs. The dampened, low pass filter shall consist of a gapped, three phase, iron core inductor; AC-rated, polypropylene capacitors; and wire-wound resistors. The filter shall be rated for application at a maximum fundamental system frequency of 60 hertz at nominal system voltages up to 600-volt AC. The filter shall operate at a maximum carrier frequency of 8k hertz at 40 percent of fundamental voltage. The output filter shall be rated for full load operation at an ambient temperature of 40 degrees C. Output filter shall be ampere rated for the load served and shall be installed on the output side of the inverter in the VFD enclosure. Output filters shall be UL recognized and shall be as manufactured by Trans-Coil, Inc., Model V1K Motor Protection Filter or approved equivalent.

PART 3 EXECUTION

3.01 INSTALLATION OF VARIABLE FREQUENCY DRIVES

- A. VFDs shall be installed in accordance with the requirements of Section 26 05 85 and as indicated on the Drawings.

3.02 FIELD QUALITY CONTROL

- A. General: Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- B. Configuration and Startup:
 - 1. Provide the services of a qualified factory-trained manufacturer's representative to assist the installing contractor with the installation, configuration and startup of each VFD.
 - 2. The manufacturer's representative shall inspect the installation of each VFD and configure each VFD for operation under the specified conditions.
 - 3. The manufacturer's representative shall conduct the initial startup and operation of each VFD.
- C. Certification: A factory-trained manufacturer's representative shall certify in writing that each VFD system has been installed, configured, and tested in accordance with the manufacturer's recommendations.

3.03 TESTING

- A. General: Each VFD shall be field acceptance tested in accordance with Section 26 08 00.

3.04 TRAINING

- A. The Contractor shall provide the services of a factory-trained instructor for the purpose of training the Owner's personnel in the proper operation and maintenance of the VFDs. Training shall consist of not less than 4 hours of field instruction in the operation, testing, troubleshooting, and maintenance of the VFDs in accordance with Section 01 79 00.

3.05 VARIABLE FREQUENCY DRIVES SUMMARY

A. The Variable Frequency Drives Summary, Table 26 29 23-A, is appended to the end of this specification section. The entries in the drives summary are defined as follows:

1. VFD Number: Unique identification number assigned to the VFD.
2. Equip Number: Identifies the driven equipment associated with the VFD.
3. Description: Description of the driven equipment associated with the VFD.
4. Motor/HP: Nominal horsepower rating of the motor to be furnished with the driven equipment.
5. Motor/RPM: Synchronous speed of the motor to be furnished with the driven equipment.
6. Load Type: Load characteristic of the driven equipment.
 - a. Variable Torque: VFD rating shall be Normal Duty.
 - b. Constant Torque: VFD rating shall be Heavy Duty.
7. Control Diagram: Identifies the control diagram associated with the VFD.
8. Mounting/Enclosure Rating:
 - a. If a motor control center designation is provided in this entry, the VFD shall be factory installed in the identified motor control center.
 - b. Otherwise this entry will define the mounting type and provide an associated NEMA sealing rating for the enclosure if the mounting type requires an enclosure.
 - 1) Wall: VFD shall be installed in a wall-mount enclosure system.
 - 2) Freestanding: VFD shall be installed in a freestanding enclosure system.
 - 3) Open: VFD shall be provided as an open chassis assembled on mounting panel suitable for installation in a third-party enclosure.
9. Notes: Provides additional reference information.

END OF SECTION

Table 26 29 23-A
Variable Frequency Drives Summary

VFD Number	Equip Number	Description	Motor		Load Type	Control Diagram	Mounting/ Enclosure Rating	Notes
			HP	RPM				
VFD 1095	P 1095	RAW WATER RAPID MIXER	1	1800	VARIABLE TORQUE	E-302B	MCC9000	
VFD 3410	P 3410	BACKWASH WATER SUPPLY PUMP 1	60	1200	VARIABLE TORQUE	E-300A	MCC9000	
VFD 3420	P 3420	BACKWASH WATER SUPPLY PUMP 2	60	1200	VARIABLE TORQUE	E-300A	MCC9000	

SECTION 26 32 13

DIESEL ENGINE DRIVEN GENERATOR SETS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 26 05 53, Identification for Electrical Systems
 - 2. Section 26 36 23, Automatic Transfer Switches

1.02 SUMMARY

- A. This section specifies diesel engine driven generator sets rated 600 volts and includes the following:
 - 1. Engine generator assembly.
 - 2. Diesel engine.
 - 3. Diesel fuel-oil system.
 - 4. Control and monitoring systems.
 - 5. Generator overcurrent and ground fault protection.
 - 6. Alternator, exciter, and voltage regulator.
 - 7. Load bank.
 - 8. Outdoor engine generator enclosure.
 - 9. Vibration isolation devices.
 - 10. Finishes.
- B. Extent, location, and details of diesel engine driven generator set work is indicated on Drawings.

1.03 DEFINITIONS

- A. ECM: Engine control module.
- B. EPS: Emergency power supply.
- C. EPSS: Emergency power supply system.

- D. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.

1. Product Data:

- a. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- b. Thermal damage curve for generator.
- c. Time-current characteristic curves for generator protective device.
- d. Fuel consumption in gallons per hour at 0.8 power factor at 50, 75, and 100 percent of generator capacity.
- e. Generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
- f. Airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor at 104 degrees Fahrenheit cooling system rating. Provide radiator air flow restriction data for ambient rating.
- g. Generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

2. Shop Drawings:

- a. Plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
- b. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- c. Fluid drain ports.
- d. Vibration Isolation Base Details: Detail including anchorages and attachments to structure and to supported equipment. Include base weights.
- e. Diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

3. Informational Submittal Data:

- a. Qualification Data: For equipment manufacturer.
- b. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.
 - 1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2) Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight, including supplied enclosure, silencer, subbase-mounted fuel tank, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.

- 3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- c. Source Quality-Control Reports: Including, but not limited to, the following:
 - 1) Certified Summary of prototype-unit test report.
 - 2) Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3) Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 - 4) Report of sound generation.
 - 5) Report of exhaust emissions showing compliance with applicable regulations.
 - 6) Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- d. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight.
4. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.05 MAINTENANCE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 2. Replaceable Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 4. Tools: Each tool listed by part number in operations and maintenance manual.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 1. ISO 9001 certified for design, development, production and service complete product line.
 2. Produced this type of equipment for a period of at least 10 years.
 3. Actively maintaining a 24-hour parts and service organization regularly engaged in maintenance contract programs to perform preventive maintenance and service on

equipment similar to that specified. Manufacturer shall maintain a service center within 200 miles of the project site.

4. Furnish a service agreement that includes system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and functional tests performed on all systems.
5. Engine-driven generator assembly furnished by a single manufacturer, responsible for design, coordination, and testing of the complete system.

B. Codes and Standards

1. Comply with the following American National Standards Institute (ANSI) standards:
 - a. ANSI B11.19, Performance Requirements For Risk Reduction Measures: Safeguarding And Other Means Of Reducing Risk.
2. Comply with the following National Electrical Contractors Association (NECA) standards for installation:
 - a. NECA Standard 1, Good Workmanship in Electrical Construction
 - b. NECA Standard 404, Standard for Installing Generator Sets
3. Comply with the following National Fire Protection Association (NFPA) standards:
 - a. NFPA 30, Flammable and Combustible Liquids Code
 - b. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
 - c. NFPA 70, National Electrical Code.
 - d. NFPA 110, Emergency and Standby Power Systems.
4. Provide products which are listed and labeled by UL Solutions under the following standards:
 - a. UL 2200, Stationary Engine Generator Assemblies.

1.07 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
1. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Warranty coverage of less than 500 hours a year operation will not be accepted. Submittals received without written warranties as specified will be rejected in their entirety.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
1. Caterpillar Inc, Electric Power Division.
 2. Cummins Power Division.
 3. Kohler Power Systems
- B. Source Limitations: Obtain packaged engine generators and auxiliary components from a single source from a single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Engine generator housing, subbase fuel tank, engine generator, batteries, battery racks, silencers, sound attenuating equipment, accessories, and shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
- B. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.
- C. Noise Emission:
1. Maximum exhaust isolated sound pressure emitted by engine generator 96.2 dBA at a distance of 23 feet while operating at 100 percent load and including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
 2. Maximum sound pressure emitted by engine generator within sound-attenuating enclosure of 76 dB(A) at a distance of 23 feet while operating at 100 percent load and including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- D. Environmental Conditions: Engine generator system to withstand the environmental conditions specified in Section 01 81 16 without mechanical or electrical damage or degradation of performance capability.
- E. ENGINE GENERATOR ASSEMBLY DESCRIPTION
1. Factory-assembled and -tested, liquid-cooled engine, with brushless generator and accessories.
 2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 3. Power Rating: Standby.
 4. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.
 5. EPSS Class: Engine generator to be classified as a Class 24 in accordance with NFPA 110.
 6. Tank Capacity Run Hours: 24 hours.
 7. Nameplate Rating: 800 kW.

8. Power Factor: 0.8, lagging.
9. Frequency: 60 Hz.
10. Voltage: 480 volts AC.
11. Phase: Three-phase, four-wire, wye.
12. Governor: Adjustable isochronous, with speed sensing.
13. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
14. Capacities and Characteristics:
 - a. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries,
 - b. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of the component.

F. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease and meets ISO8528-5, Class G2 for standard loads. Voltage to recover and remain within the steady-state operating band within six seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Transient Frequency Performance: Less than 10 percent variation for 50 percent step-load increase or decrease and meets ISO8528-5, Class G2 for standard loads. Frequency to recover and remain within the steady-state operating band within five seconds.
5. Output Waveform: At no load, harmonic content measured line to line or line to neutral may not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined in accordance with NEMA MG 1, may not exceed 50.
6. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system to supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
7. Start Time:
 - a. Comply with NFPA 110, Type 10 system requirements

2.03 DIESEL ENGINE

- A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.
- B. Rated Engine Speed: 1800 rpm.
- C. Minimum Standby Load Factor Rating: 85 percent.
- D. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to particles that may damage engine per manufacturer's written instructions while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit to be capable of full flow and is designed to be fail-safe.
 3. Closed Crankcase Ventilation: System: Prevents crankcase oil vapor from draining or escaping the engine.
 4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Jacket Coolant Heater: Electric-tank type, factory installed in coolant jacket system. Comply with UL 499.
- F. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.
1. Modular radiator cores for ease of maintenance, repair, or replacement.
 2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 3. Size of Radiator: Adequate to contain expansion of total system coolant to 110 percent of capacity.
 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 6. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant material.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 215 deg F (102 deg C), and noncollapsible under vacuum.
- G. Muffler/Silencer:
1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 - a. Minimum sound attenuation of 25 dB at 500 Hz.
- H. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- I. Starting System: 24-V dc electric, with negative ground.
1. Redundant Starting System: Supply with redundant starting motor, battery, and battery charger fully independent from the main starting system. Generator controls to alternate between starting systems six times before entering a fault condition. Best battery system is not an acceptable alternative.
 2. Cranking Cycle: As required by NFPA 110 for system level specified.

3. Battery: Lead acid with capacity within ambient temperature range specified in "Performance Requirements" article to provide specified cranking cycle at least twice without recharging.
4. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
5. Battery Heater: Thermostatically controlled heater to be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and continuous rating per manufacturer's standard.

J. Battery Charger:

1. Source Limitations: Obtain battery charger from engine-driven generator manufacturer.
2. UL Compliance: Comply with UL 1236 for Category BBHH.
3. CE Certified.
4. NFPA Compliance: Comply with NFPA 110.
5. Environmental Conditions: Battery charger to withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - a. Ambient Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C) with full charger output available up to 122 deg F (50 deg C).
 - b. Relative Humidity: 0 to 95 percent.
 - c. Altitude: Meets full performance requirements from sea level to 5000 ft. (1600 m). Chargers installed at higher altitudes may automatically derate output power to prevent overheating of internal components but remain operable.
6. Charger Operation: Current-limited, constant-voltage, automatic-boost-type charger designed for lead-acid batteries with the following features:
 - a. Automatic three-stage charge cycle for up to three independent batteries simultaneously per charger.
 - b. Output Voltage Regulation: Charger regulates output to within plus or minus 0.5 percent of manufacturer-provided voltage settings despite variations of input voltage, input frequency, and output current.
 - c. Battery Thermal Compensation: Battery temperature compensation with adjustable slope, factory set at minus 0.18 percent per degree C, and equipped for sensing battery temperature.
 - d. AC Input: Charger operates from any 45- to 65-Hz ac source with voltage ranging from 105- to 264-V rms.
7. LCD Digital Display: AC input voltmeter, DC output voltmeter, and ammeter (1 percent accuracy).
8. LED Lamp Indicators: Current limit, AC ON, and charger fail.
9. Charger Fail Alarm Contact: Voltage-free (dry type) form "C" output.
10. Charger Enclosure: NEMA 250, Type 1, wall mounted and rated for generator duty with charger enclosure vibration resistance.

2.04 DIESEL FUEL-OIL SYSTEM

- A. Piping: Fuel-oil piping to be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel may not be used in the fuel-oil system.
- B. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.
- C. Fuel Filtering: Remove water and contaminants larger than 1 micron.
- D. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- E. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Complying with UL 142 and including the following features:
 - 1. Steel Channel Support System: Reinforced steel box channel for generator support. Full height gussets at either end of channel and at generator mounting locations.
 - 2. Fuel Level Gauge: Direct-reading, UL-listed, magnetic fuel level gauge with a hermetically sealed, vacuum-tested dial.
 - 3. Low-Fuel Alarm Contact: Float-type switch for remote or local annunciation of a low-fuel-level condition.
 - 4. Fill Tube: 2-inch NPT opening with lockable cap.
 - 5. Leak detection in interstitial space.
 - 6. Vandal-resistant fill cap.
 - 7. Fill-pipe spill containment, minimum capacity 5 gal. (19 L).
 - 8. Emergency inner- and outer-tank UL-listed relief vents sized in accordance with American Petroleum Institute Standard No 2000 with an opening pressure of 0.5 psig (3.5 kPa) and full opening pressure of 2.5 psig (17 kPa).
 - 9. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.05 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the Automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the On position, engine generator starts. The Off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Comply with UL 6200.
- C. Configuration:
 - 1. Operating and safety indications, protective devices, basic system controls, and engine gauges to be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method to isolate the control panel from engine generator vibration. Panel must be powered from the engine generator battery.

D. Control and Monitoring Panel:

1. Digital engine generator controller with integrated 12-inch graphical touch screen TFT display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Controller Face Ingress Protection: IP 65.
3. Operating Temperature: Minus 40 to plus 158 deg F.
4. Maximum Operating Humidity: 95 percent non-condensing.
5. Corrosion Resistant: Tested in accordance with ASTM B117 (salt spray test).
6. Controller Features:
 - a. Mode Selector: Allowing selection of one of the following modes:
 - 1) Off/Reset: Prohibits the generator from starting and resets shutdowns. In this mode controller does not respond to remote start and stop commands.
 - 2) Manual: Allows user to locally start and stop to operate the generator. In this mode controller does not respond to remote start and stop commands.
 - b. Auto: Allows generator to start and stop based on remote commands. In this mode generator does not respond to manual start and stop commands.
7. Emergency Stop Switch: Latch-type remote stop switch, red in color with mushroom-type head. Depressing stop button will immediately stop the generator set and lock out any automatic remote starting.
8. Audible Alarm: Horn sounds for specific warning and shutdown conditions.
9. Alarm Silence/Lamp Test Pushbutton: Silences audible alarm when depressed. All controller indicating lights are simultaneously illuminated while actuated.
10. Fault Light: LED indicating abnormal conditions:
 - a. Yellow: Active warning condition or mode selector switch not in automatic.
 - b. Red: Active shutdown condition.
11. Real-time clock and calendar for time stamping events.
12. Load Management:
 - a. Programmable outputs to command the connect and disconnect of loads based on system state:
 - 1) Loads connected based on available capacity.
 - 2) Loads disconnected at system startup.
 - 3) Loads disconnected based on a maximum kW setting or under frequency setting.
 - b. Support up to 16 load steps.
13. Engine Control Features:
 - a. Programmable engine start delay.
 - b. Programmable engine cool-down delay.
 - c. Programmable warm-up delay based on time or engine temperature.
 - d. Programmable idle speed.

- e. Programmable cyclic cranking with adjustable on time, off time, and number of cycles.
- 14. Event Logging:
 - a. Maintain record of a minimum of 1,000 events with date and time locally for warning and shutdown faults.
 - b. Event log easily available for download onto USB storage device or PC.
 - c. Event Snapshot: Capture 15 seconds of critical data around the time of a fault or warning. Data to be viewable on the controller and downloadable.
- 15. Data Logging: Capable of time-based recording of customized parameters.
 - a. Parameters selectable from all monitored parameters.
 - b. Sample period configurable from one second to one day.
 - c. Collected data stored on USB storage device plugged into the control panel.
- 16. Minimum of three user access levels.
- 17. Password protection to prevent unauthorized modification to system parameters.
- 18. Customizable Interface:
 - a. Overview Screen: Dedicated screen allowing user to display up to 16 parameters for immediate access.
 - b. Favorites: User customizable menu set up for enhanced usability.
- E. Monitoring Instruments: Accessible through the digital engine generator controller and viewable during operation.
 - 1. Engine-coolant temperature.
 - 2. Battery voltage.
 - 3. Running-time meter.
 - 4. Engine speed.
 - 5. Oil pressure.
 - 6. Fuel level (with optional sensor).
 - 7. Fuel pressure.
 - 8. Fuel consumption rate.
 - 9. Crankcase pressure.
 - 10. Oil temperature.
 - 11. Coolant level.
 - 12. Coolant pressure.
 - 13. Common rail fuel pressure.
 - 14. Fuel temperature.
 - 15. Intake air temperature.
 - 16. Exhaust temperature (with optional sensor).
 - 17. Charge air pressure.
 - 18. Charge air temperature.

19. Ambient temperature.
 20. AC output voltage including all phase-to-phase and phase-to-neutral quantities, 0.25 percent accuracy.
 21. AC output current for each phase, 0.25 percent accuracy.
 22. AC frequency, 0.25 percent accuracy.
 23. Power factor total and per phase with leading/lagging indication.
 24. kW total and per phase, 0.5 percent accuracy.
 25. kVARS total and per phase, 0.5 percent accuracy.
 26. kVA total and per phase, 0.5 percent accuracy.
 27. kW hours.
 28. Generator duty level (actual kW loading divided by kW nameplate).
- F. Service Data: Stored in the controller and available for display.
1. Generator model number and serial number.
 2. ECM serial number.
 3. Alternator part number.
 4. Engine model number and serial number.
 5. Controller serial number and firmware version.
- G. Operational Records: Stored in controller beginning at system startup.
1. Total run-time hours.
 2. Total loaded hours.
 3. Total unloaded hours.
 4. Total kW hours.
 5. Controller hours.
 6. Controller run-time hours.
 7. ECM run-time hours.
 8. Number of starts.
 9. Number of crank attempts.
 10. Last crank duration.
 11. Last start runtime duration.
 12. Last start date and time.
 13. Last stop date and time.
- H. Maintenance Records: Stored in controller beginning at system startup, user resettable to zero.
1. Total run-time hours since last maintenance.
 2. Total loaded hours since last maintenance.
 3. Total unloaded hours since last maintenance.

4. Total kW hours since last maintenance.
- I. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:
1. Mode selector switch not in automatic position.
 2. Overcrank shutdown.
 3. Low lubricating-oil pressure warning.
 4. Low lubricating-oil pressure shutdown.
 5. Low coolant temperature warning.
 6. High engine temperature warning.
 7. High engine temperature shutdown.
 8. Overspeed shutdown.
 9. High fuel level warning.
 10. Low fuel main tank.
 - a. Low-fuel-level alarm to be initiated when the level falls below that required for operation for duration required for the indicated EPSS class.
 - b. Critically low-fuel-level warning.
 11. Coolant low-level shutdown device.
 12. Coolant high-temperature warning.
 13. Coolant high-temperature shutdown.
 14. ECM Digital Trouble Codes warnings.
 15. ECM Digital Trouble Codes shutdown.
 16. Loss of ECM Communications shutdown.
 17. ECM mismatch shutdown.
 18. Battery high-voltage warning.
 19. Battery-charger malfunction warning.
 20. Battery low-voltage warning.
 21. Remote manual stop shutdown.
 22. Local manual stop shutdown.
 23. Alternator protection shutdown.
 24. Overcurrent warning.
 25. Overcurrent shutdown.
 26. Under frequency warning.
 27. Under frequency shutdown.
 28. Over frequency warning.
 29. Over frequency shutdown.
 30. Over power warning.
 31. Over power shutdown.

- 32. Under voltage warning.
 - 33. Under voltage shutdown.
 - 34. Over voltage warning.
 - 35. Over voltage shutdown.
 - 36. User-defined input warning.
 - 37. User-defined input shutdown.
 - 38. No oil pressure signal shutdown.
 - 39. No speed sensor signal shutdown.
 - 40. Fail-to-start/shutdown.
- J. Supporting Items: Sensors, transducers, terminals, relays, and other devices located on engine or generator unless otherwise indicated.
 - K. Remote Emergency-Stop Switch: Wall mounted unless otherwise indicated. Push button must be permanently labeled and protected from accidental operation.
 - L. Start Signal Wiring Integrity Monitor: UL-listed modular system to monitor condition of generator remote start circuit(s), annunciate faults, and start generator in accordance with NFPA 70, Article 700.10(D)(4).
 - 1. Output Contacts: Two form "C" contacts, one for engine start and one for start circuit alarm.

2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices to be coordinated to optimize selective tripping when a short circuit occurs.
 - 1. Overcurrent protective devices for the entire EPSS to be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices considers both utility and EPSS as the voltage source.
 - 2. Overcurrent protective devices for the EPSS to be accessible only to authorized personnel.
- B. Generator Overcurrent Protective Device:
 - 1. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:
 - a. Tripping Characteristics:
 - 1) Adjustable long-time delay pickup and time
 - 2) Adjustable short-time delay pickup and time
 - 3) Adjustable instantaneous pickup
 - 4) Adjustable ground fault current pickup and time.
 - b. Trip Settings: Selected to coordinate with generator thermal damage curve.
 - c. Mounting: Adjacent to, or integrated with, the control and monitoring panel.

2.07 ALTERNATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Maximum Temperature Rise: 105° Centigrade at full load over 40° Centigrade ambient.
- C. Drive: Alternator shaft to be directly connected to engine shaft. Exciter to be rotated integrally with alternator rotor.
- D. Electrical Insulation: Class H.
- E. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- F. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- G. Construction to prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation.
- H. Enclosure: Drip-proof.
- I. Voltage Regulator: Microprocessor-based, high-speed digital voltage regulator, separate from exciter, with three-phase, true RMS sensing, providing performance as specified.
 - 1. Maintain steady-state voltage within 0.25 percent from no load to full load.
 - 2. Adjusting Feature on Control and Monitoring Panel: Provide plus or minus 10 percent adjustment of output-voltage operating band.
- J. Alternator Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

2.08 OUTDOOR ENGINE GENERATOR ENCLOSURE

- A. Description:
 - 1. Vandal-resistant, sound-attenuated, weatherproof aluminum housing with 0.125-inch-thick walls; wind resistant. Multiple panels to be lockable and provide adequate access to components requiring maintenance, minimum two doors per side. Access to controller and main line circuit breaker in accordance with NFPA 70. Panels to be removable by one person without tools. Instruments and control to be mounted within enclosure.
 - 2. Prefabricated or pre-engineered, aluminum-clad, integral structural-steel-framed, walk-in enclosure; erected on concrete foundation.
- B. Source Limitations: Obtain enclosure from engine-driven generator manufacturer.
- C. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph.
- D. Minimum Snow Load Rating: 70 psf (33.5 kPa).

- E. Sloped roof to prevent pooling.
- F. Stainless steel latches, hinges, and hardware on external panels of enclosure.
- G. Access doors and panels rubber sealed to prevent water intrusion and minimize noise.
- H. Hinged Doors: Lockable; keyed alike with recessed locks.
- I. External, weatherproof, recessed-mounted emergency stop pushbutton.
- J. Load Center: 100 A, three-phase, 120/208 volt AC, 12 space with main circuit breaker.
- K. Convenience Outlets: Two 20 A, 125 V ac, GFCI-protected duplex receptacles.
- L. AC Lighting: Provide weather-resistant LED lighting with 30 footcandle average maintained illuminance with control switches at each access door.
- M. DC Lighting: Provide weather-resistant LED lighting, powered from starting battery on fused circuit with 0-60 minute "No-Lock-On" timer.
- N. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- O. Insulation Flammability Classification: UL 94 HF1.
- P. Muffler Location: Complete exhaust system located within enclosure.
- Q. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits.
 - 1. Inlet Plenum: Vertically louvered and acoustic-lined plenum, constructed from a minimum of 0.125-inch-thick formed heavy-duty aluminum panels.
 - 2. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers limiting entry of rain and snow.
 - 3. Outlet Plenum: Acoustic-lined plenum, constructed from a minimum of 0.125-inch-thick formed heavy-duty aluminum panels with 90-degree angle to discharge air up.
 - 4. Automatic Dampers: Motorized, aluminum dampers at engine cooling-air inlet and discharge. Dampers to be closed to reduce enclosure heat loss in cold weather when unit is not operating.
 - 5. Ventilation: Provide temperature-controlled, wall-mounted exhaust fan interlocked to prevent operation when engine is running.
- R. Catwalk: Full-length catwalk with stairs and railings for access to all doors along both sides level with the bottom of the enclosure is required for maintenance. Treads to be slip-resistant. Comply with 29 CFR 1910.23.

2.09 VIBRATION ISOLATION DEVICES

- A. Elastomeric Vibration Isolators: Oil- and water-resistant elastomer neoprene or natural rubber, molded with a nonslip pattern and baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment. Compliant with ISO 8528.

- B. Provide vibration isolation and flexible connectors for piping, exhaust shroud, and ductwork.
- C. Vibration isolation devices may not be used to accommodate misalignments or to make bends.

2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Heavy-duty, high-durability, fade-, scratch- and corrosion-resistant finish achieved through a multi-stage finishing process from the genset manufacturer including:
 - 1. Pre-cleaning: Enclosure components and skid cleaned with a two-stage alkaline cleaning process to remove grease, grit, and grime from parts then subjected to a Zirconium-based conversion coating process to prepare the metal for electrocoat adhesion.
 - 2. Primer: All enclosure parts to receive 100 percent epoxy primer electrocoat with high-edge protection.
 - 3. Finish Coating: Powder baked paint for superior finish, durability, and appearance.
 - 4. Minimum Enclosure Corrosion Resistance: 3000 hours salt spray test in accordance with ASTM B117.
 - 5. Electrocoat for fading and abrasion resistance.
- B. Subbase Tank: Polyurea-texturized rubber coating for corrosion protection and adequate surface grip from the genset manufacturer.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test generator, exciter, and voltage regulator as a unit.
 - 2. Load Test: 25, 50, 75 and 100 percent rated load.
 - 3. Single-step load pickup.
 - 4. Safety shutdown.
 - 5. Overcrank.
 - 6. Locked rotor.
 - 7. Mechanical Readings: Oil pressure, ambient temperature, and coolant temperature.
 - 8. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 9. Maximum power.
 - 10. Voltage regulation.
 - 11. Transient and steady-state governing.
 - 12. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

13. Report factory test results within 10 days of completion of test.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which transformers are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF DIESEL ENGINE DRIVEN GENERATOR SETS

- A. Installation shall comply with all applicable standards referenced in paragraph 1.06 B.
- B. Complying with packaged engine generator set manufacturer's written instructions and alignment instructions.
- C. Equipment Mounting:
 1. Install engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 2. Coordinate size and location of concrete bases for engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Install packaged engine generator set to provide access, without removing connections or accessories, for periodic maintenance.
- E. Install electrical devices furnished by packaged engine generator set manufacturer but not specified to be factory mounted.
- F. The engine lubrication oil and coolant shall be provided by the supplier of the generator set for operation under the specified environmental conditions as recommended by the manufacturer.
- G. Contractor shall provide all fuel required for system testing. The fuel tank shall be filled at the successful completion of all acceptance tests

3.03 GROUNDING

- A. General: Provide grounding connections to engine generator sets as indicated. Generators shall be grounded as separately derived systems in accordance with the National Electrical Code, NFPA 70. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.04 IDENTIFICATION

- A. Identify system components in accordance with Section 26 05 53, Identification for Electrical Systems.

- B. Install a sign indicating the generator is installed as a separately derived source per NFPA 70.

3.05 FIELD QUALITY CONTROL

- A. General: Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

3.06 ADJUSTING AND CLEANING

- A. Touch-up scratched or marred surfaces to match original finish.

3.07 TESTING

- A. General: Packaged engine generator sets shall be field acceptance tested in accordance with Section 26 08 00.
- B. All tests and inspections shall be conducted with the assistance of factory-authorized service representative.

3.08 MAINTENANCE SERVICE

- A. The supplier shall include in the base price, a one-year service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing the engine generator set.
- B. This agreement shall include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Manufacturer's recommended routine preventive maintenance including the following:
 - 1. All engine and electrical systems maintenance as recommended by the service manual.
 - 2. All electrical controls maintenance and calibrations as recommended by the manufacturer.
 - 3. Inspection and maintenance of all auxiliary equipment furnished as a part of the emergency systems.
- C. The supplier shall guarantee emergency service.
- D. All expendable maintenance items are to be included in this agreement.
- E. Parts to be manufacturer's authorized replacement parts and supplies:

3.09 TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

- 1. Section 26 05 53, Identification for Electrical Systems

1.02 SUMMARY

- A. This section specifies 600 volt and less service entrance rated automatic transfer switches having the ratings, features/accessories and enclosures as specified herein and as shown on the Drawings.
- B. Extent, location, and details of automatic transfer switch work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Front view and plan view of the assembly
 - 2. Wiring diagrams.
 - 3. Conduit space locations within the assembly.
 - 4. Assembly ratings including:
 - a. Voltage rating
 - b. Continuous current rating
 - c. Withstand and closing ratings
 - 5. Cable terminal sizes
 - 6. Product data sheets.
 - 7. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify

compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards: Automatic transfer switches shall be designed, manufactured and tested in accordance with the latest applicable edition of the following standards.

1. NFPA Compliance:
 - a. NFPA 70, National Electrical Code.
 - b. NFPA 110, Emergency and Standby Power Systems
2. UL Compliance:
 - a. UL 1008, Standard for Safety, Transfer Switch Equipment.
 - b. UL 991, Standards for Tests for Safety-Related Controls Employing Solid State Devices.
3. NEMA Compliance:
 - a. NEMA ICS 10 – Electromechanical AC Transfer Switch Equipment.
4. IEEE Compliance:
 - A. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems.

B. Manufacturer's Qualifications:

1. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
2. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
4. Provide Seismic tested equipment as follows:
 - a. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
 - 1) The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.
5. The manufacturer of the automatic transfer switch shall have a national service organization that is available throughout the contiguous United States and is available on call 24 hours a day, 365 days a year.

C. Factory Testing

1. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 - a. Insulation check to ensure the integrity of insulation and continuity of the entire system.
 - b. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards.
 - c. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances.
 - d. Electrical tests to verify the complete electrical operation of the switch and to set up time delays and voltage sensing settings of the logic.
2. The manufacturer shall provide a certified copy of factory test reports.
3. Transfer switch shall include a label indicating order number, catalog number and date.

1.05 REGULATORY REQUIREMENTS

- A. Provide a UL1008 certificate of compliance for the transfer switches furnished under this section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions.
- B. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- C. Equipment being stored prior to installation shall be maintained in a clean and dry condition. If stored outdoors, indoor equipment shall be covered and heated, and outdoor equipment shall be heated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 1. Eaton, Magnum Breaker Based Automatic Transfer Switch with ATC-900 Controller
 2. Schneider Electric, ASCO Power Technologies

2.02 RATINGS AND CONFIGURATION

- A. Transfer switch shall be listed for use as service entrance equipment on the normal source only in accordance with UL 1008.
- B. The transfer switch shall have equal 3 cycle withstand; closing and interrupting ratings of 100 kAIC at 480 volts and a 30-cycle short-time withstand rating of 85 kAIC at 480 volts.
- C. The transfer switch shall be 100 percent equipment rated for continuous duty as shown on the Drawings and shall conform to the applicable requirements of UL 1008 for emergency system total load.

- D. The voltage rating of the transfer switch shall be no less than the system voltage rating. The continuous current rating of the transfer switch shall be no less than the maximum continuous current requirements of the system.
- E. The automatic transfer switches shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed

2.03 CONSTRUCTION

- A. Transfer switches shall be UL 1008 listed for application in their intended enclosures at 100% of continuous ampere rating and shall meet or exceed UL 1008 endurance test criteria to include rate of operation and number of operation cycles.
 - 1. The transfer switch shall be designed and intended for switching the load connection between two power sources.
 - 2. The transfer switch shall include electrical and mechanical interlocks to prevent unintentional paralleling of the power sources.
 - 3. The transfer switch shall be of double throw construction and the dual electrical operators shall be equipped with a reliable two-step stored energy mechanism to charge the closing springs. The closing springs shall be capable of being charged electrically or manually. The closing of the main contacts shall automatically charge the opening springs to ensure quick-break operation. After closing the main contacts, the closing springs shall be capable of being re-charged.
 - 4. The transfer switch shall include a mechanical coupling to facilitate completion of an open in-phase transition such that any inrush current is equal to or less than normal starting current for inductive loads.
 - 5. The transfer switch main contacts shall be of silver composition, electrically operated and mechanically held in position. Inspection of the main contacts shall be possible from the front of the transfer switch without major disassembly.
 - 6. The transfer switch shall include removable arc chutes, housed within an arc chamber constructed of high-dielectric high-strength material, that are mounted over each set of main contacts. Arc chutes shall be constructed of metal plates and a baffle cover designed to extinguish an electrical arc and protect the main contacts.
 - 7. The transfer switch shall include pushbutton controls, mounted on the power switch device, to perform manual operation with an electrical load connected.
 - 8. The transfer switch shall provide colored mechanical indication of main contact position (open, closed), mounted on the power switch device, for source 1 and source 2.
 - 9. The transfer switch shall provide colored mechanical indication of closing spring charge state (charged, discharged), mounted on the power switch device, for source 1 and source 2.
- B. Power Case Switching Device:
 - 1. Switches shall be floor mount construction utilizing fixed-mount power circuit breakers as specified herein.
 - 2. Ratings shall be as indicated on the Drawings and as specified herein. All breakers shall be UL listed for application in their intended enclosures for 100 percent of their continuous ampere rating. Breakers shall be electrically operated.
 - 3. Emergency source power circuit breaker shall not be provided with a trip unit.
 - 4. Power switching devices shall be four pole.

- C. The switching panel shall consist of completely enclosed contact assemblies and a separate control and transformer panel. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.
- D. Transfer switches shall be open delayed transition type with load voltage decay and operate with a time delay in the neutral position.
- E. Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically locked in position in both normal and emergency positions. A neutral position shall not be possible under normal electrical operation.
- F. Transfer switches shall be capable of being operated manually under full rated load conditions. Manual operation shall be accomplished by a permanently attached manual operator, or by integrally mounted pushbuttons. Removable manual operating handles, and handles that may move in the event of an electrical operation during the manual operation, are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.
- G. The fourth pole for switching the neutral shall be fully rated with equal withstand, closing and interrupting ratings to the power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.
- H. The transfer switch shall have a multi-tap voltage selection plug for ease of voltage adjustment in the field.
- I. Transfer switch applied as service entrance equipment shall be provided with over-current trip units and a service entrance label. A key-operated selector switch shall be provided to disconnect the power supplies. Indicators shall be provided to show the availability of each source as well as breakers in a disconnected position. Provide a neutral-to-ground main bonding jumper to meet UL service entrance requirements. Ground fault protection shall be provided in accordance with NEC Article 230-95.
- J. For safety and serviceability, a continuous steel barrier shall be provided between the power conductor connections and the electrical control components including the automatic controller, control power transformer, relays, user controls, and indication lights. Together, the continuous steel barrier and enclosure front door shall form an isolated control compartment.

2.04 POWER CIRCUIT BREAKERS

- A. Circuit breakers shall be provided in fixed mount configuration. Circuit breakers shall be Eaton Magnum DS Power Circuit Breaker or approved equivalent.
- B. All breakers shall be UL listed for application in their intended enclosures for 100 percent of their continuous ampere rating.
- C. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standard. The breaker shall carry a UL label.
- D. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.
- E. Circuit breakers shall be electrically operated.

- F. Electrically operated breakers shall be complete with 120-volt AC motor operators. The charging time of the motor shall not exceed 6 seconds.
- G. Circuit breakers shall have integral handles on the side of the breaker to facilitate lifting.
- H. Circuit breakers shall have a closing time of not more than 3 cycles.
- I. Circuit breaker primary contacts shall have an easily accessible wear indicator to indicate contact erosion.
- J. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage.
- K. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.
- L. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker.
- M. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is tripped or opened.
- N. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.
- O. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

2.05 CIRCUIT BREAKER TRIP UNITS

- A. Unless otherwise specified, each power circuit breaker shall be equipped with a solid state tripping system consisting of three current sensors, microprocessor-based trip device and flux transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor based technology to provide the basic adjustable time current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip ratings of each circuit breaker. The trip unit shall be Eaton type Digitrip RMS 1150+ or approved equivalent.
- B. The trip unit shall have an information system that provides LED's to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A trip reset button shall be provided to turn off the LED indication after an automatic trip.
- C. The trip unit shall be provided with a display panel, including a representation of the time/current curve of the trip unit, that indicates the protection function settings. The unit shall be continuously self checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

- D. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.
- E. Trip unit shall have selectable thermal memory for enhanced circuit protection.
- F. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
1. All circuit breakers shall have adjustments for long delay pick-up and time.
 2. All circuit breakers shall have individual adjustments for short delay pick-up and time and include I2t settings.
 3. Feeders shall have an adjustable instantaneous pick-up.
 4. Circuit breakers, where indicated on the Drawings shall have individually adjustable ground fault current pick-up and time, and include I2t settings or ground alarm only.
- G. An adjustable high load function shall be provided to avoid nuisance alarms.
- H. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.
- I. The trip unit shall include a power/relay module which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. Internal relays shall be programmable to provide contacts for remote indication.
- J. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize an LED to indicate the battery status.
- K. The trip unit shall have a display showing phase, neutral, ground and high load current. The accuracy of these readings shall be ± 2 percent of full scale.
- L. Metering display accuracy of the complete system, including current sensors, auxiliary current transformers, and the trip unit, shall be ± 1 percent of full scale for current values. Metering display accuracy of the complete system shall be ± 2 percent of full scale for power and energy values
- M. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the power relay module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.
- N. The unit shall be capable of monitoring the following data:
1. Instantaneous value of phase, neutral and ground current
 2. Instantaneous value of line-to-line voltage
 3. Minimum and maximum current values
 4. Watts, VARs, VA, Watt-hours, VAR-hours, and VA hours.

- O. The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit's alphanumeric display panel.
- P. The trip unit shall display the following power quality values: crest factor, power factor, percent total harmonic distortion, and harmonic values of all phases through the 31st harmonic.
- Q. The display for the trip units shall be LED display.
- R. Programming may be done via a keypad at the faceplate of the unit or via the communication network.
- S. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pickup adjustment shall be dependent on the long delay setting.
 - 1. Programmable long-time setting.
 - 2. Programmable long-time delay with selectable I²T or I⁴T curve shaping.
 - 3. Programmable short-time setting.
 - 4. Programmable short-time delay with selectable flat or I²T curve shaping, and zone selective interlocking.
 - 5. Programmable instantaneous setting.
 - 6. Programmable ground fault setting trip or ground fault setting alarm.
 - 7. Programmable ground fault delay with selectable flat or I²T curve shaping.
- T. The trip unit shall offer a three-event trip log that will store the trip data, and shall time and date stamp the event.
- U. The trip unit shall be equipped to permit communication via the electrical monitoring and control system network.
- V. The trip unit will also have the option of the following advanced features integral to the trip unit:
 - 1. Adjustable undervoltage release.
 - 2. Adjustable overvoltage release.
 - 3. Reverse load and fault current.
 - 4. Reverse sequence voltage.
- W. The trip unit shall utilize ARMs (Arc Flash Reduction Maintenance System) technology. The ARMs technology shall be provided in a system that shall reduce the trip unit instantaneous pickup value when activated. The ARMs device shall not compromise breaker phase protection even when enabled. Once the ARMs unit is disabled, the recalibration of trip unit phase protection shall not be required. Activation and deactivation of the ARMs Technology trip setting shall be accomplished without opening the circuit breaker door and exposing operators to energized parts. The ARMs technology shall provide a clearing time of 0.04 seconds, adjustable with a minimum of five settings ranging from 2.5X to 10X of the sensor value.
 - 1. The ARMs technology shall be enabled via a switch on the trip unit. It shall also provide confirmation of protection via a blue LED indicator.
 - 2. The ARMs technology shall be provided with remote "enable/disable" control and confirmation of protection via an IR communication link.

2.06 MICROPROCESSOR-BASED AUTOMATIC TRANSFER CONTROLLER

- A. The microprocessor-based automatic transfer controller shall be door mounted and shall provide the operator with an overview of the transfer switch status, parameters, and diagnostic data. Control power input range shall be from 65 volts AC to 160 volts AC RMS 50/60 Hz. The controller shall be listed under UL Standard 1008 and shall be Eaton type ATC-900 or approved equivalent.
- B. The automatic transfer controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller.
- C. The controller display shall be UV resistant and include a 4.3 inch Color TFT (480x272), backlit display. The controller shall be capable of displaying transfer switch status, parameters, and diagnostic data. All set point parameters shall be password protected and programmable using the controller keypad, USB port, or remotely using serial port access. Limited abbreviations or codes shall be used for transfer switch functions.
- D. The controller shall include a mimic bus display consisting of six (6) individual LED's (3mm) for indicating the following:
1. Availability status of source 1.
 2. Availability status of source 2.
 3. Connection status of source 1.
 4. Connection status of source 2.
 5. Source 1 preferred.
 6. Source 2 preferred.
- E. Voltage and Frequency Sensing: The controller shall have a voltage range of 0-790 volts (50/60 Hz) and an accuracy of ± 1 percent of the reading and a frequency range of 40-70 Hz and an accuracy of ± 0.3 Hertz.
- F. Voltage and frequency dropout and pickup parameters shall be set as a percentage of the nominal voltage as indicated in the table below.

Setpoint	Sources	Dropout (DO) (percent)	Pickup
Undervoltage	Source 1 and 2	70 – 97	(DO + 2%) - 99%
Overvoltage	Source 1 and 2	105 – 110	103% - (DO – 2%)
Underfrequency	Source 1 and 2	90 – 97	(DO + 1Hz) – 99%
Overfrequency	Source 1 and 2	103 – 105	101% - (DO – 1Hz)
Voltage Unbalance	Source 1 and 2	5 – 20	(UNBAL DO% - 2) – 3%

- G. The normal and emergency sources shall include phase reversal protection. The preferred rotation is programmable as ABC or CBA.
- H. Timing Functions: The controller shall have the following timing features. All delays shall be field adjustable from the controller without the use of special tools.

1. A time delay on transfer to source 2, adjustable from 0 to 166 minutes.
2. A time delay to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.
3. A time delay on retransfer from source 2 to source 1, adjustable from 0 to 166 minutes.
4. A time delay after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 166 minutes.
5. A time delay for engine failure to start, adjustable 0- 60 seconds.
6. A time delay for the neutral position, adjustable from 0 to 120 seconds.
7. A time delay shall be provided for voltage unbalance, adjustable from 10 to 30 seconds.

I. Additional Features: The transfer controller shall be equipped with the following features.

1. One Form C contact for closure of the generator start circuit. The contacts shall be rated 5 amperes at 250 volts AC and 5 amperes at 30 volts DC.
2. Programmable engine exerciser, selectable as disabled, 7, 14, or 28 day interval, or by calendar date. Run time shall be adjustable for 0-600 minutes, with or without load. Transfer time delays shall also be independently programmable for test events.
3. The controller shall include a keypad pushbutton to initiate a system test.
4. The controller shall include 4 user-configurable outputs rated for 10 amperes at 250 volts AC and 10 amperes at 30 volts DC. Each input shall be user-configurable for one of the following functions.
 - a. Source 1 connected.
 - b. ATS in test.
 - c. ATS not in automatic mode.
 - d. General alarm indication for failure to transfer, mechanical fault, or electrical fault.
 - e. Engine test aborted.
 - f. Engine cool down in progress.
 - g. Engine start contact status.
 - h. Emergency inhibit on.
 - i. Load sequence: Output used to signal select loads to disconnect prior to transfer and reconnect 0-120 seconds after transfer. Loads are reconnected sequentially.
 - j. Selective load shed: Output used to shed low priority loads when the load reaches a programmed threshold value. A load shed and load restore set point (measured in kW) are associated with this feature.
 - k. Pre and/or post transfer signal: A pre and or post transfer time delay output adjustable from 0-120 seconds.
5. Individual Form C relays contacts to indicate each of the following conditions. Contacts shall be rated 10 amperes, 1/3-horsepower at 250 volts AC and 10 amperes at 30 volts DC.
 - a. Transfer switch in Source 1 position.
 - b. Transfer switch in Source 2 position.
 - c. Source 1 available.

- d. Source 2 available.

J. Data Logging

1. Historical Data recording and storage shall include the following:
 - a. Engine run time.
 - b. Source 1 available time.
 - c. Source 2 available time.
 - d. Source 1 connected time.
 - e. Source 2 connected time.
 - f. Source 1 engine run time.
 - g. Source 2 engine run time.
 - h. Load energized time.
 - i. Number of transfers.
2. Event Summary shall include up to 100 date and time stamped events. All metered values are logged for each event. Event summaries shall include the following:
 - a. Transfer events.
 - b. Alarms.
 - c. Changes to the set points.
 - d. Changes to the time/date.
 - e. Resetting a historical counter.
 - f. Engine run test.
3. Event Details shall include up to 350 date and time stamped events. All metered values are logged for each event. Event details include detailed sequence of operations of a transfer event.
4. Event recording shall capture 4 seconds of metered data, stored every 20 msec for certain events. The data is captured 2 seconds before and 2 seconds after the event. Oscillographic data for 10 events is stored and may be downloaded over USB. Events shall include the following:
 - a. Source unavailability actions that initiate a transfer sequence (undervoltage, overvoltage, etc.)
 - b. Successful transfers (at the point of breaker/contact closure).
 - c. Unsuccessful transfers (at the point of breaker/contact failure to close or open).

K. Integrated Load Metering: The transfer controller shall include integral load metering which shall include the following metered parameters viewable from the controller display and accessible via the controller network communication interface.

1. Source 1 voltages, 3 phase.
2. Source 2 voltages 3 phase.
3. Load voltages, 3 phase.
4. Source 1 frequency.
5. Source 2 frequency.

6. Load currents, 3 phase.
7. Load real, reactive, and apparent power.
8. Load power factor.

2.07 BUS

- A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
- B. A copper ground bus shall be furnished in each section of the assembly.
- C. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with belleville washers.

2.08 WIRING/TERMINATIONS

- A. Control terminal blocks shall conform to NEMA ICS 4.
- B. Terminal facilities shall be arranged for entrance of external conductors from the bottom of the enclosure.
- C. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans and shall be located in the rear cabling compartment of the switch assembly.

2.09 ENCLOSURE

- A. Transfer switch shall be provided in a NEMA 1 freestanding enclosure suitable for use in environments indicated in the Drawings. Transfer switch enclosure system shall have a rear cabling compartment. Minimum assembly depth shall be 48 inches or as recommended by the manufacturer to terminate the size and quantity of feeder conduits indicated on the Drawings; whichever is greater.
- B. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust inhibiting phosphatized coating. Enclosures shall be painted with the manufacturer's standard light gray ANSI 61 paint.

2.10 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for each power switching device. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16 inch high, minimum. Nameplates shall give item designation and circuit number.
- B. Furnish master nameplate giving transfer switch designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.
- C. Control components mounted within the assembly, such as fuse blocks, relays, network hardware, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's drawings.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which automatic transfer switches are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION

- A. Install automatic transfer switches as indicated on the Drawings, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate automatic transfer switch installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- D. Field wiring shall meet the requirements of specification 26 05 19. Cables larger than No. 6 AWG which hang from their vertical connections shall be supported within 2 feet of the connection.

3.03 GROUNDING

- A. General: Provide grounding connections to automatic transfer switches as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.04 FIELD QUALITY CONTROL

- A. General: Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- B. Manufacturer's Certification: A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.
- C. The Contractor shall provide a copy of the manufacturer's representative's certification.

3.05 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms and doors for free mechanical movement and proper alignment.
- B. Touch-up scratched or marred surfaces to match original finish.
- C. Remove all dust, debris and other foreign material from the switch enclosure.

3.06 TESTING

- A. General: Automatic transfer switches shall be field acceptance tested in accordance with Section 26 08 00.
- B. Settings: Provide final adjustment of all time delays and pickup settings as recommended by the transfer switch manufacturer and the final power system studies.

3.07 TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic transfer switches.

END OF SECTION

SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

- 1. Section 26 05 53, Identification for Electrical Systems

1.02 SUMMARY

- A. The work covered under this section of the specifications consists of furnishing labor, materials and services required for design, provision, and installation of a functional and unobtrusive lightning protection system.
- B. Extent, location, and details of lightning protection work are indicated on Drawings.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Shop drawings detailing the layout of the roof system with air terminal connections, interconnecting circuits, down conductor locations, metal equipment to be bonded, and grounding. Installation details shall be provided to specifically address installation requirements for all building mounted system components including air terminals, main and down conductors, conductor terminations at structural steel members, etc.
 - 2. Manufacturer's catalog data for all materials with complete description of material components.
 - 3. Schedule: Lightning protection submittals shall be submitted for review and approval within 120 days of Notice to Proceed.
 - 4. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested

deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Designer/Installer's Qualifications: Firms actively engaged in the design and installation of Certified Lightning Protection Systems and listed with Underwriters' Laboratories, Inc. and the Lightning Protection Institute with at least 10 years of successful installation experience on projects utilizing lightning protection systems similar to those required for this project.
- B. Codes and Standards: Lightning protection systems shall be designed, manufactured, tested and installed in accordance with the latest applicable standards of the following standards writing bodies and testing agencies
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. UL Compliance: Provide products which are listed and labeled by UL under the following standards. UL Master Label shall be furnished as evidence that the installation has met the UL requirements.
 - a. UL Std. 96 Lightning Protection Components
 - b. UL Std. 96A Installation Requirements for Lightning Protection Systems
 - 3. ANSI/NFPA Compliance: Provide components and installation which complies with the following standards:
 - 4. NFPA 780 Standard for the Installation of Lightning Protection Systems
 - 5. Lightning Protection Institute, LPI 175

1.05 DESIGN CRITERIA

- A. General: The lightning protection system shall be designed in accordance with the specified standards and codes and the requirements specified herein. The general intent shall be to provide a functional lightning protection system that is concealed within the building system components to the maximum extent possible. Locations and installation requirements for lightning system components including air terminals and conductors shall be coordinated with the Construction Manager during the submittal process.
- B. Lightning protection system work shall not be exposed with the exception of air terminals and conductor connections to roof mounted HVAC and process equipment and antenna masts.
- C. Main, down, and bonding conductors shall not be exposed on the roof, on the building exterior walls, or within architecturally finished spaces.
- D. The structural steel framework of the building shall be used as the main and down conductors where permitted by the referenced standards and codes.
- E. Air Terminals:
 - 1. Air terminals shall be symmetrically positioned along roof ridgelines and wall lengths.
 - 2. Air terminals required on parapet walls shall be mounted on the inside face of the parapet wall and not on the sheet metal coping.

- F. The lightning protection contractor shall be responsible for coordinating with the single ply membrane and prefinished sheet metal roofing contractor(s) for lightning protection penetrations, attachments, and installation requirements required by the respective roofing system manufacturers.
- G. Specific Metal Roof Application Criteria: Where main and down conductors are required to serve air terminals located on the following metal roof applications, the conductors shall be installed as specified below.
 - 1. TBD
- H. Metallic bodies having a thickness 3/16 inches or greater may serve as strike termination devices without the addition of air terminals. These bodies shall be made a part of the lightning protection system by connection(s) according to the referenced standards and codes using main size conductors and bonding fittings with 3 square inches of surface contact area.
- I. Lightning protection materials shall be coordinated with building construction materials to assure compatibility. Aluminum lightning protection materials shall not be embedded in concrete or masonry, installed on or below copper surfaces, or used for the in-ground system. Copper lightning protection materials shall not be installed on aluminum surfaces. Copper system components within 2 feet of chimney exhausts shall be tin coated to protect against deterioration.
- J. Strike termination devices shall be provided to place the entire structure under a zone of protection as defined by the referenced standards and codes. Air terminals shall be of suitable length to project a minimum of 10 inches above protected areas or objects.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Robbins Lightning, Inc.
 - 2. Thompson Lightning Protection Company

2.02 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. General: All materials shall comply in weight, size, and composition with the requirements of the UL 96 Materials Standards. All equipment shall be UL listed and properly labeled. The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment in accordance with the referenced standards and codes. Equipment shall be the manufacturer's latest approved design of construction to suit the application where it is to be used in accordance with specified industry standards.
- B. Air Terminals: Air terminals shall be 1/2" x 12" solid copper with integral threaded copper adapter.
- C. Air Terminal Base:
 - 1. Ridge Saddle Base: Ridge saddle base shall be copper strap with integral die cast bolt-tension cable clamp and terminal adapter.

- 2. Side Mount Base: Side mount base shall be cast bronze with integral bolt tension cable clamp and terminal adapter suitable for installation on a vertical surface.
- D. Through-Roof Cable Connector: Through-roof cable connector shall be suitable for termination of copper cables and shall provide a watertight seal where down conductors pass through the roof structure.
- E. Conductors: Lightning cables shall be a smooth twist, 28 strand, 14 gauge, ½-inch diameter bare copper conductor. Connectors and splicers shall be of suitable configuration and type for the intended application and of the same material as the conductors or of electrolytically compatible materials.
- F. Bonding Plates: Bonding plates shall be diecast bronze with 8 square inch tinned contact area. Bonding plate shall have integral cable clamp and two holes for attaching the plate to the surface to be protected.
- G. Miscellaneous Hardware: Miscellaneous hardware shall include pipe and cable clamps and cable holders shall be of copper construction, compatible with the specified cable and shall be UL listed for the application.
- H. Ground Rods: Ground rods shall be as specified in specification section 26 05 26, Grounding and Bonding.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which lightning protection systems are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
- B. The Construction Manager shall have final authority on resolving conflicts between proposed locations of lightning protection system components and other construction/equipment and provide recommendations for alternate locations for lightning protection conductors and components.

3.02 INSTALLATION OF LIGHTNING PROTECTION SYSTEMS

- A. Install lightning protection systems as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NFPA, and UL and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Air Terminal Bases:
 - 1. Ridge Saddle Base: Base shall be attached with stainless steel self-tapping screws and sealed watertight in accordance with the roofing manufacturer's instructions.
 - 2. Side Mount Base: Base shall be mounted to the snow retention system bar with stainless steel self-tapping screws.
- C. Roof penetrations required for down conductors or for connections to structural steel framework shall be made using through-roof assemblies with solid bars and appropriate roof flashings. The roofing contractor shall furnish the methods and materials required at roofing penetrations of the lightning protection components and any additional roofing materials or preparations required by

the roofing manufacturer for lightning conductor runs to assure compatibility with the warranty for the roof.

- D. Lightning conductors shall be securely fastened to the building structure at 3 feet (maximum) intervals in such a way as to connect each terminal to the rest.
- E. Cable conductors shall be free of excessive splices and sharp bends. No bend of a conductor shall form a final included angle of less than 90 degrees nor have a radius of bend less than 8 inches.
- F. Conductors shall always maintain a horizontal or downward path and each terminal shall have two paths to ground.
- G. Terminate each down conductor in a properly made ground connection.
- H. No splices shall be made in lightning cable runs. Make connections to branches with pressure type bolted or compression type connectors. Make underground connections with pressure type bolted or exothermic welded connectors.
- I. All fastening hardware shall be stainless steel construction.

3.03 GROUNDING

- A. Provide common grounds between the lightning protection system and electrical systems.
- B. General: Provide grounding connections to transformers as indicated. Transformers shall be grounded as separately derived systems in accordance with the National Electrical Code, NFPA 70. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.04 INSPECTION AND CERTIFICATION

- A. Upon completion of the installation, the Contractor shall furnish the Master Label issued by Underwriters Laboratories, Inc. for this system.

3.05 TESTING

- A. General: Transformers shall be field acceptance tested in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 43 13

SURGE PROTECTION DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies low voltage surge protection devices (SPD) designed for integration and mounting within power distribution equipment for the protection of building electrical and electronic systems from the effects of line and electromagnetic induced transient voltage surges and coupled lightning discharged transients.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Provide verification that the SPD equipment complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In). Verification that the SPD device complies with the required UL 1449 and UL 1283 validation or certification.
 - 2. Manufacturer's catalog data indicating standard and optional features, equipment specifications, and interrupting, withstand, and continuous current ratings of all relevant equipment and components.
 - 3. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: SPD equipment shall be designed, manufactured, and tested in accordance with the latest applicable standards of the following standards writing bodies and testing agencies.
1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 2. UL Compliance: Provide products which are listed and labeled by UL under the following standards:
 - a. UL 1449 - Standard for Surge Protective Devices
 - b. UL 1283 - Standard for Electromagnetic Interference Filters
 3. ANSI/IEEE Compliance: Provide products which comply with the following standards:
 - a. IEEE C62.41 - Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits
 - b. IEEE C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits
 - c. IEEE C62.72 - Guide for the Application of Surge-Protective Devices for Low Voltage (1000V or Less) AC Power Circuits
- B. Warranty: The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local electric code.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
1. Eaton
 2. Advanced Protection Technologies
 - 3.

2.02 ELECTRICAL REQUIREMENTS

- A. Unit Operating Voltage: The operating voltage and unit configuration shall be as shown on the Drawings.
- B. Maximum Continuous Operating Voltage (MCOV): The MCOV shall be greater than 115 percent of the nominal system operating voltage.
- C. Core Suppression Component: The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

- D. Protection Modes: The SPD shall protect all modes of the electrical system being utilized For WYE systems, the SPD equipment shall have the following protection modes: line-line (L-L), line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G).
- E. Nominal Discharge Current (In): Type 1 SPDs shall have a minimum 10kA In rating at all operating voltages. Type 2 SPDs shall have a minimum 10kA In rating at all operating voltages.
- F. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR): The maximum ANIS/UL 1449 3rd Edition VPR for the device must not exceed the following:

<u>Mode</u>	<u>208Y/120</u>	<u>480Y/277</u>
L-N; L-G; N-G	700 V	1200 V
L-L	1200 V	1800 V

2.03 DESIGN REQUIREMENTS

- A. Maintenance: The SPD shall require minimal maintenance through its life, including periodic inspection of diagnostic indicators and period tightening of power connections. Connecting conductors to the SPD shall be as short and straight as possible.
- B. Balanced Suppression Platform: The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
- C. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
- D. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
- E. Monitoring Diagnostics: Each SPD shall provide the following integral monitoring features:
 - 1. Protection Status Indicators: Each unit shall have a green/red solid-state indicator light that reports the status of the protection on each phase.
 - a. The indicator lights shall report the status of all protection elements and circuitry in the L-N and L-G modes and shall also contain an additional green/red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode.
 - b. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes.
 - 2. Remote Status Monitor: The SPD shall include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
 - 3. Audible Alarm and Silence Button: The SPD shall contain an audible alarm that shall activate under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

4. Surge Counter: The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - a. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
- F. Overcurrent Protection: The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
- G. Fully Integrated Component Design: All of the SPD's components and diagnostics shall be contained within one discrete assembly.
- H. Safety Requirements: The SPD shall minimize potential arc flash hazards by containing no user serviceable/replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted.

2.04 SYSTEM APPLICATION

- A. General: The SPD applications covered under this section include distribution and branch panel locations, motor control centers (MCC), switchgear, and switchboard assemblies as indicated on the Drawings. The branch panel located SPD shall be tested and demonstrate they are suitable for ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity: The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Category	Application	Per Phase
C	Service Entrance (Switchgear, Switchboards, Switchgear, Motor Control Centers, Main Entrance)	240 kA
B	Motor Control Centers, Distribution Panelboards	150 kA
A	Branch Locations (Panelboards, MCCs)	100 kA

- C. SPD Type: All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.05 LIGHTING AND DISTRIBUTION PANELBOARD APPLICATIONS

- A. Unless specified otherwise, all panelboards shall be provided with an integrated Type 1 or Type 2 SPD. The SPD units shall be tested to demonstrate suitability for ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 40A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 40A circuit breaker.
5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard. Side mounted SPDs shall not be accepted except where specifically designated on the Drawings.
6. The complete panelboard including the SPD shall be UL67 listed.
7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.06 SWITCHGEAR, SWITCHBOARD, AND MOTOR CONTROL CENTER APPLICATIONS

- A. The SPD application covered under this section is for switchgear, switchboard, and motor control center locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
 1. The SPD shall be of the same manufacturer as the switchgear, switchboard, or motor control center in which it is installed.
 2. The SPD shall be factory installed inside the switchgear, switchboard, or motor control center at the assembly point by the original equipment manufacturer
 3. SPD shall be located on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
 4. The SPD shall be connected through a disconnect (30 ampere circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
 5. The SPD shall be integral to switchgear, switchboard, or motor control center as a factory standardized design.
 6. All monitoring and diagnostic features shall be visible from the front of the equipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install SPD systems as indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Provide properly wired electrical connections for SPD systems within enclosures.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where

manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

3.02 GROUNDING

- A. Provide equipment-grounding connections to SPD as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.03 FIELD QUALITY CONTROL

- A. Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

3.04 TESTING

- A. SPD equipment shall be tested in accordance with specification Section 26 08 00.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies interior and exterior lighting fixtures, controls, and their installation.
- B. Extent, location, and details of interior and exterior lighting fixture work are indicated on Drawings and in schedules.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 26 05 00.
 - 1. Product Data:
 - a. Manufacturer's catalog information describing light fixture construction, materials, ratings and dimensions.
 - b. Catalog data shall include the makeup of the complete model number.
 - c. Catalog information shall be organized by fixture type.
 - d. Manufacturer's catalog information for all lighting control devices and systems.
 - 2. Lighting Control Systems:
 - a. Coverage Plans: Floor plan drawings shall be prepared for all areas in which occupancy sensor type controls are specified. Drawing shall show proposed sensor locations, coverage patterns, mounting heights, and orientation. Proposed sensor placement shall provide PIR coverage that covers the entire space and all entrance points. Sensor locations and quantities required shall be per manufacturer's best practice recommendations.
 - b. Wiring Diagrams: Wiring diagrams shall be prepared for each lighting control system application. Wiring diagrams shall be specific for each space and shall indicate device wire number/color, interconnection requirements, terminal numbers, etc.
 - 3. Light fixture photometric data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.
 - 4. Shop Drawings:
 - a. The light fixture manufacturer shall prepare drawings to detail the specific fixture configuration, construction features, and installation requirements for all fixture types.

5. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
2. IESNA Compliance:
 - a. IESNA LM-80-08, IES Approved Method for Measuring Lumen Maintenance of LED Light Sources
 - b. IESNA TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources
3. NECA Compliance:
 - a. NECA 501, Standard for Installing Exterior Lighting Systems
 - b. NECA 502, Standard for Installing Industrial Lighting Systems
4. ANSI Compliance:
 - a. ANSI C62.41, Guide for Surge Voltages in Low-Voltage AC Power Circuits.
5. UL Compliance:
 - a. UL 844, Standard for Luminaires for Use in Hazardous (Classified) Locations
 - b. UL 924, Emergency Lighting and Power Equipment
 - c. UL 1598, Luminaires

- B. Provide lighting fixtures and components which are UL-listed and labeled.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.
- B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off the ground.
- C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.06 SEQUENCING AND SCHEDULING

- A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of interior lighting fixtures with other work.
- B. Sequence lighting fixture installation with other work to minimize possibility of damage and soiling during remainder of construction.

1.07 SPARE PARTS

- A. None.

PART 2 PRODUCTS

2.01 FIXTURES

- A. Each fixture shall bear the Underwriters Laboratories, Inc. label.
- B. All lighting fixtures shall be furnished complete with lamps of the size and type as indicated on the Drawings and all fittings and hardware necessary for a complete installation.
- C. Lighting fixtures shall have all parts and fittings necessary to completely and properly install the fixtures.
- D. Fixture leads shall be as required by NEC and shall be grounded by the equipment grounding conductor in the conduit.
- E. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.
- F. Emergency fixtures shall be UL 924 listed and have a minimum 90 minutes battery back-up.
- G. Fixtures for use in hazardous locations shall be UL 844 Listed.
- H. Fixtures specified to be damp or wet locations rated shall be UL 1598 listed.
- I. Fixtures shall be as specified in the fixture schedule on the Drawings.

2.02 LED DRIVERS

- A. Drivers shall have a voltage range of 120-277 volts AC \pm 10 percent at a frequency 60Hz.
- B. All drivers shall be designed to a power factor greater than 90 percent with a total harmonic distortion less than 20 percent at full load.
- C. Case temperature shall be rated for -40 degrees C through 80 degrees C.
- D. Drivers shall have overtemperature protection, self-limited short circuit protection and overload protection.
- E. Drivers shall be furnished with a fused primary. Fixtures operating on 208 volts, 240 volts, or 480 volts shall have double-fusing with fuses present on all line connections.

- F. Drivers shall have an output current ripple less than 30 percent
- G. Drivers shall have a five-year (50,000 hour) warranty.
- H. Drivers shall be manufactured by Advance, Universal or equal.
- I. Drivers shall be UL Listed for damp location, UL1012, UL935, ROHS.
- J. Drivers shall meet FCC 47 Sub Part 15.
- K. All drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

2.03 LEDS

- A. Luminaires provided with LED technology shall utilize high brightness LEDs.
- B. Color temperature shall be as specified in fixture schedule.
- C. Junction point shall be designed and manufactured to allow adequate heat dissipation.
- D. LEDs shall be rated for 50,000 hours of life, minimum (based on IESNA L70). The 50,000-hour life guarantee shall be based on in-fixture tests. LED L70 lifetime values that are collected with the LED not installed in the submitted fixture are not acceptable.

2.04 LIGHTING CONTROLS

- A. Ceiling Mount Occupancy Sensor: Ceiling mounted occupancy sensors shall be as manufactured by nLight, Model nCM PDT 10 RJB or approved equivalent.
- B. Power Relay Module: Power relay modules shall be as manufactured by nLight, Model nPP16 D EFP or approved equivalent.
- C. Dimming Control Wall Module: Dimming control wall modules shall be as manufactured by nLight, Model nPODMA 2P DX WH or approved equivalent.
- D. Wall Switch Sensors:
 - 1. Type 1: Type 1 wall switch sensors shall be as manufactured by SensorSwitch, Model WSXA 2P FAN WH or approved equivalent.
 - 2. Type 2: Type 2 wall switch sensors shall be as manufactured by SensorSwitch, Model WSXA D WH or approved equivalent.

2.05 PHOTOELECTRIC CELL UNITS

- A. Fixture Mounted Photoelectric Cell Units: Fixture mounted photoelectric cell units shall be plug-in type suitable for outdoor installation and shall be factory-installed on the light fixture by the fixture manufacturer. Photoelectric cell units shall be rated as required to switch the associated light fixture.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF LIGHTING FIXTURES AND CONTROLS

- A. Install lighting fixtures in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to insure that lighting fixtures fulfill requirements.
- B. Lighting fixtures shall be located symmetrically with building lines as shown on the Drawings. The Contractor shall furnish and install the lighting fixtures to allow "convenient" access for maintenance such as cleaning, relamping, and other activities. The fixtures shall be installed to be accessed by a 12 ft. (max.) ladder. Where fixtures are shown in locations on the Drawings where maintenance would be difficult, the Contractor shall notify the Engineer for direction.
- C. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated on the Drawings or specified herein, for review by Engineer.
- D. Install flush-mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.
- E. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
- F. Fasten fixtures securely to indicated structural supports; and insure that pendant fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum one inch vertical adjustment.
- G. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer.
- H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and the National Electrical Code.
- I. Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. A fixture shall be connected to a junction box using flexible conduit with a temperature rating equal to that of the fixture.
- J. Where recessed fixtures are required, the fixture shall be provided with mounting hardware for the ceiling system specified. Catalog numbers given on the lighting fixture schedule shall not be used for selection of mounting hardware, but only as a reference to the type of fixture required.
- K. Fixtures recessed in concrete shall have protective coating of bituminous paint.
- L. Fixtures shall be aligned and directed to illuminate an area as specified.

- M. Conduit system shall not be used to support fixtures. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.
- N. Underground and outdoor wire splices shall be in accordance with Section 16120.
- O. Photoelectric cells shall be oriented toward the north.

3.03 FIELD QUALITY CONTROL

- A. At Date of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Construction Manager.

3.04 ADJUSTING AND CLEANING

- A. Clean lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.
- B. Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures
- C. Protect installed fixtures from damage during remainder of construction period.

3.05 GROUNDING

- A. Provide equipment grounding connections for lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.06 TESTING

- A. Upon completion of installation of lighting fixtures and associated control systems, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. All control features shall be demonstrated. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 31 05 00

EARTHWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies earthwork required to complete the work of the project as described in the Contract Documents, including, but not be limited to, excavating, removing, loading, transporting, placing, and compacting of all earthen materials and associated work and incidentals. Excavation for structures, pipelines, ponds, and associated facilities.
- B. Backfilling under and around structures, backfilling of trenches and pits, construction of fills, embankments, and pond liners.
- C. Sheeting and bracing, including, but not be limited to, the furnishing, placing, and removing of sheeting and bracing necessary to safely support the sides of all excavations and the supporting of structures above and below the ground during earthwork operations.
- D. Dewatering as necessary to complete the work, including but not limited to, all pumping, ditching, draining, and other required measures for the removal or exclusion of water from excavations.
- E. The disposal of excess excavated materials including handling and disposal of contaminated soils.
- F. Borrow from onsite locations or importation from off-site of suitable materials for various purposes as specified and to make up deficiencies for fills.
- G. Other incidental earthwork, as indicated on the drawings and as required for completion of the project.

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C117 – Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing.
 - 2. ASTM C136 – Standard Method for Sieve Analysis of Fine and Course Aggregates.
 - 3. ASTM D75 – Standard Practice for Sampling Aggregates.
 - 4. ASTM D422 – Test Method for Particle-Size Analysis of Soils.
 - 5. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 6. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 7. ASTM D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 8. ASTM D1633 – Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders.

9. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
10. ASTM D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
11. ASTM D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
12. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
13. ASTM D5084 – Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
14. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth))
15. American Association of State Highway Transportation Officials (AASHTO) T272, Standard Method of Test for Family of Curves-One Point Method, in the Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II, Testing.
16. Colorado Department of Transportation, Standard Specifications for Road and Bridge Construction (CDOT Standard Specifications).

1.03 OSHA STANDARDS

- A. The Contractor's attention is directed to the latest provisions of Section 1926 of the OSHA Safety and Health Standards for Construction.

1.04 SUBMITTALS

- A. All submittals shall be in accordance with Section 01 33 00.
- B. At least 30 days prior to the start of excavation submit an Excavation Plan detailing:
 1. Methods and sequencing of excavations
 2. Numbers, types, and sizes of proposed excavation equipment
 3. Control and removal of groundwater and stormwater from surface and excavations
 4. Proposed locations and configuration of stockpiles for excavated materials
- C. Copy of Colorado Department of Public Health & Environment Water Quality Construction General Permit.
- D. For all imported materials proposed to be used in the work submit:
 1. Certified test results documenting conformance with all specification requirements. Imported fill materials will be tested by Contractor's testing laboratory at the source prior to being transported to the site.
 2. Samples taken at the source. Sample sizes shall be as required by the testing laboratory.
- E. Submit means, methods and material specification for backfilling structures, pipe, and appurtenances to the limits shown on the Drawings. Include information on set time(s) and strength characteristics for controlled strength fill material, placement of bulkheads and methods for verifying fill quantities.

- F. Submit certified design of sloping, bracing, sheeting/shoring and support systems for excavations and trenches in accordance with OSHA requirements and other governing Laws and Regulations and including certification of the qualifications of the engineering design professional responsible for the design.

1.05 QUALITY ASSURANCE

- A. General: All soils testing will be performed by an Engineer and Owner approved testing laboratory of the Contractor's choice at the Contractor's expense. Copies of all test reports shall be sent to the Owner and Engineer at the same time they are sent to the Contractor.
- B. Where soil material is required to be compacted to a percentage of relative compaction, the maximum density at optimum moisture content will be determined in accordance with ASTM D698 or ASTM D1557 as indicated, except as otherwise stated in these Specifications. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D4253 and D4254. Field density in-place tests will be performed in accordance with ASTM D1556, ASTM D6938, or by other means acceptable to the Owner.
- C. When tests of fill or backfill show noncompliance with the required density, gradations, or other physical properties, Contractor shall take whatever actions are necessary and as may be required to remedy any deficiencies and ensure conformance with specifications and requirements. Subsequent testing to show compliance shall be at the Contractor's expense.
- D. Certify that all off-site import materials meet the requirements of this Specification prior to being delivered to the site. Particle size analysis of soils and aggregates shall be determined in accordance with ASTM D422.
- E. Unified Soil Classification System (USCS): References in these Specifications to soil classification types and standards set forth in ASTM D2487 have the meanings and definitions indicated in the 1992 revision.
- F. Provide adequate survey control to avoid unauthorized over-excavation and to provide elevation datum for testing agency.
- G. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until the material has completely thawed.
- H. Material excavated during inclement weather shall not be used as fill or backfill until after the material drains and dries sufficiently for proper compaction.
- I. Notify the Owner and Engineer when any of the following occur:
 - 1. Embankment fill is about to be placed on prepared foundation, or embankment fill operations are about to be resumed after a period of inactivity.
 - 2. Subgrade fill is about to be placed in overexcavated areas or subgrade fill operations are about to be resumed after a period of inactivity.
 - 3. Structures are ready for backfilling or backfill operations are about to be resumed after a period of inactivity.
 - 4. Soft or loose surface is encountered where fill or backfill is to be placed.
 - 5. Materials appear to be deviating from specifications.
 - 6. Initial sampling of imported material is to be conducted or importing of material to the site is about to begin.

- J. Notify and assist testing agency two weeks before backfill operations to obtain samples for Proctor compaction tests.

PART 2 PRODUCTS

2.01 SUITABLE FILL AND BACKFILL MATERIALS

- A. Suitable Materials: Soils not classified as unsuitable as defined in paragraph entitled, "Unsuitable Material" herein, are defined as suitable materials and may be used in fills, for backfilling, and for embankment construction subject to the limitations specified herein.
- B. Suitable materials may be obtained directly from on-site excavations, may be processed on-site materials, or may be imported.

2.02 DRAINROCK

- A. A crushed, angular material meeting the requirements of Colorado Department of Transportation, Class B filter material as follows:

<u>Sieve Size</u>	<u>Percentage Passing</u>
1-1/2-inch	100
No. 4	20 – 60
No. 16	10 – 30
No. 50	0 – 10
No. 200	0 – 3

2.03 RIPRAP

- A. Hard, durable, angular rock free from cracks, overburden, shale, and organic matter.
- B. Broken concrete or asphalt pavement is unacceptable.
- C. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone is unacceptable.
- D. Rock minimum specific gravity shall be 2.5 or greater and determined according to the bulk-saturated, surface-dry basis, AASHTO Test T85.
- E. Rock minimum density shall be 165 pounds per cubic foot.
- F. Rock shall have a percentage loss of not more than 40 percent after 500 revolutions by the Los Angeles abrasion test machine, ASTM C535.
- G. Rock shall have a percentage loss of not more than 10 percent after 12 cycles of freezing and thawing when tested in accordance with AASHTO Test T103, Procedure A, for ledge rock.
- H. Riprap shall meet the following gradation:

<u>Riprap Designation</u>	<u>Percent Smaller than Given Size by Weight</u>	<u>Intermediate Rock Dimensions (inches)</u>	<u>d₅₀ (inches)</u>
	70-100	21	
	50-70	18	
Type M	35-50	12	12"
	2-10	4	

- I. Grouted boulders shall be Classification B18, nominal size 18 inches, size range 17 to 20 inches with a ratio of largest to smallest dimension of individual boulders less than 2.5.
- J. Granular bedding for riprap shall conform to CDOT Section 703 requirements for aggregates and shall have the following gradations:

US Standard <u>Sieve Size</u>	Percent Passing by Weight	
	<u>Type I</u>	<u>Type II</u>
3-in		90-100
1.5 in		
3/4 in		20-90
3/8 in	100	
#4	95-100	0-20
#16	45-80	
#50	10-30	
#100	2-10	
#200	0-2	0-3

2.04 ROCKFILL

- A. A mixture of loose, hard, durable, angular rock free from cracks, overburden, shale, and organic matter meeting the following gradation:

<u>Sieve Size</u>	<u>Percentage Passing</u>
12-inch	70 – 100
9-inch	50 – 100
6-inch	35 – 50
2-inch	2 – 10

2.05 AGGREGATE BASE COURSE

- A. Imported, hard, durable, natural crushed stone or crushed gravel with sand and sufficient finer material for proper compaction, well-graded, and free from deleterious materials.

- B. Gradation as determined in accordance with ASTM C 117 and C 136:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4-inch	100
No. 4	30 – 65
No. 8	25 – 55
No. 200	3 – 12

- C. Liquid Limit not exceeding 30 and Plasticity Index not exceeding 6 as determined in accordance with ASTM D 4318.
- D. Percentage of wear by LA abrasion test less than 50 percent as determined in accordance with ASTM C 131.
- E. Material meeting the requirements of Class 6 Aggregate Base Course Material as specified in CDOT Section 703.03 may meet the requirements specified herein except that crushed slag, crushed reclaimed concrete, and asphalt, will not be allowed.

2.06 BEDDING AND PIPE ZONE MATERIAL

- A. Clean, well-graded, free-draining sand or squeegee sand with no clay fines and meeting the following gradation:

Sand

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/8-inch	100
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	10 – 30
No. 100	2 – 10
No. 200	0 – 5

Squeegee Sand

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/8-inch	100
No. 200	0 – 3

2.07 TRENCH ZONE MATERIAL

- A. Material not otherwise classified as unsuitable.

2.08 STRUCTURAL FILL OR BACKFILL

- A. Well graded crushed rock or natural gravel meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
2-inch	100
No. 4	30 – 100
No. 50	10 – 60
No. 200	5 – 10

2.09 RANDOM FILL

- A. On site fill material that has been previously placed over natural soil layers. Random fill shall not be used as structural fill, backfill, trench zone material or placed under paved surfaces. Random fill may be placed in landscaped areas with the approval of the Geotechnical Engineer.
- B. It is expected that Random Fill material in varied depths will be encountered in all required excavations and shall be removed.

2.10 SOIL FILTER MATERIAL

- A. Soil filter media shall consist of a silt sand soil mixture combined with a mature, moderately fine shredded bark or wood fiber mulch. The resulting mixture shall have 8% to 12% passing the No. 200 sieve and a clay content less than 2%. The soil mixture shall be composed of 50% sand meeting the requirements in the table below, 20% sandy loam meeting the requirements in the table below, and 30% mature composted woody fibers and fine shredded bark.

Sand Requirements	
Sieve #	% Passing by Weight
No. 10	85-100
No. 20	70-100
No. 60	15-40
No. 200	8-15
200 (clay size)	< 2.0

Sandy Loam Requirements	
Sieve #	% Passing by Weight
No. 4	75-95
No. 10	60-90
No. 40	35-85
No. 200	20-70
200 (clay size)	< 2.0

2.11 TOPSOIL

- A. Defined as the top 12± inches of the native soil profile in open or unimproved areas or as determined in the field by the Engineer.

2.12 CONTROLLED STRENGTH MATERIAL

- A. Seven (7)-day Compressive Strength: Not less than 100 psi or not more than 200 psi. Determine in accordance with ASTM D4832.
- B. Soil: Meeting the following requirements when tested in accordance with the designations as shown in the Eighth Edition - Revised Reprint of the Bureau of Reclamation (USBR) Concrete Manual and the Third Edition of the Bureau of Reclamation Earth Manual, Part 2.
- C. Soil producing a color darker than the standard color in the calorimetric test for organic impurities shall be rejected until further tests are performed to determine the nature of the material and its effect on the time of set and strength of cement (designation 14, Concrete Manual).
- D. The amount of soil passing the No. 200 sieve shall not exceed 30 percent, by weight, and the amount of soil passing the No. 100 sieve shall not exceed 50 percent, by weight (USBR 5530, Earth Manual). The soil shall be nonplastic or of low plasticity.
- E. The soil shall be selected or processed so that the gradation of the soil is such that all particles will remain in suspension, or no segregation will occur, when the controlled strength material is placed. The maximum particle size in the soil shall not exceed 1/8 of the open distance between the pipe and the trench wall or 1-1/2 inches, whichever is less.
- F. The maximum size of any clay balls in the soil shall be one-half inch. The maximum percentage of clay balls, by wet weight of the soil, shall not exceed 10 percent.
- G. The Water-Cement Ratio: Not to exceed 3.5:1. The water content shall not exceed that required to provide a mix that will flow and can be pumped.
- H. Batching Equipment: Provide to obtain the proper weights of soil, cement, and water. All measuring devices shall be sensitive to a 2% variation above or below the actual weights required.
- I. Mixers: Operate such that the slurry is discharged uniformly and is consistent throughout each batch.
- J. Consistency: Such that the controlled strength material flows easily into all openings between the pipe and the lower portion of the trench. When trenches are on a steep slope, a stiffer mix may be required. When a stiffer mix is used, vibrate to ensure the controlled strength material completely fills all spaces.

2.13 TRENCH PLUGS

- A. Construct from compacted clay soils with USCS classification of CL or CH and with at least 60 percent fines (passing the No. 200 sieve) and a Plasticity Index of 15 or greater. Alternatively, trench plugs may be constructed with lean concrete, controlled strength material, or on-Site silty sand soils processed with 20 lbs. bentonite clay per cubic yard.

2.14 UNSUITABLE MATERIAL

- A. Except where specifically noted otherwise, the following are unsuitable materials for fill, backfill and embankment materials.
1. Soils which, when classified under ASTM D2487, fall in the classifications of Pt, OH, CH, MH, ML or OL or obvious clayey materials or expansive soils as determined by the Engineer.
 2. Any soil that cannot be compacted sufficiently to achieve the percentage of maximum density specified for the intended use shall be classed as unsuitable material.
 3. Materials that are wet, soft, or frozen.
 4. Materials containing asphalt, concrete chunks, cinders, ashes, refuse, vegetable or organic material, boulders, rocks or other undesirable deleterious material.

2.15 GEOTEXTILES

- A. Woven: Composed of polypropylene yarn interlaced to form planar structure with uniform weave pattern. Inert to biological degradation. Manufacturers: Mirafi 500X or approved equivalent
- B. Nonwoven: Composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Edges finished to prevent outer material from pulling away from geotextile. Manufacturers: Mirafi 140N or approved equivalent.

2.16 GEOMEMBRANE

- A. 30 mil (minimum) PVC liner meeting the following requirements:

Thickness, % Tolerance	+/-5
Tensile Strength, KN/m (lb/in)	12.25 (70)
Modulus at 100% Elongation, KN/m (lb/in)	5.25 (30)
Ultimate Elongation, %	350
Tear Resistance, N (lbs)	38 (8.5)
Low Temperature Impact, deg C (deg F)	-29 (-20)
Volatile loss, % Maximum	0.7
Pinholes, no. per 8 m ² (10 yd ²)	1 (max)
Bonded Seam Strength, % of Tensile	80

2.17 WATER

- A. Water for moisture conditioning shall be free from oil, acids, alkalis, organic materials, hazardous or toxic contaminants, or other contaminants deleterious to proper compaction. Water shall be provided at a source designated by the Owner. Contractor shall be responsible for the transportation of the water from the source to the point of application by methods acceptable to the Engineer.

PART 3 EXECUTION

3.01 EXCAVATION GENERAL

- A. Excavation is unclassified, and includes all materials encountered, regardless of type, condition, nature or extent.
- B. Any over-excavation carried below the grade ordered, specified, or shown, without written authorization from the Engineer shall be backfilled to the required grade with the specified material and compacted and graded as specified at no additional cost to the Owner.
- C. All excavation shall be performed in the dry but may require wetting to prevent dust from leaving the site.
- D. Selectively excavate, segregate, handle, haul, process and stockpile excavated materials as necessary to yield the maximum quantities of suitable materials for use as fill and backfill. Wetting stockpiles may be necessary to prevent blowing dust.
- E. Install and maintain sheeting, shoring, bracing and sloping as necessary to support the sides of excavations to protect against movement that may damage adjacent structures or foundations, damage or delay the work, or endanger life and health. Install and maintain sheeting, shoring, bracing and sloping as required by OSHA and other applicable governmental regulations or agencies.

3.02 STRUCTURE, ROADWAY AND EMBANKMENT EXCAVATION

- A. Excavate to the lines, grades and dimensions indicated and as necessary. Unless otherwise indicated, excavate to within a tolerance of plus or minus 0.1 foot. The bottom of the excavation shall not extend more than 3 inches below the lines and grades shown on the Drawings at any point.
- B. Unless otherwise specified, excavate a sufficient distance from walls and footings to allow access for the performance and inspection of placement and removal of forms, installation of reinforcement, embedments, bulkheads and blockouts, and placement of concrete.
- C. Excavation under roadways and paved areas shall extend to the top of natural soil layers. On site fill material is to be placed to the elevations indicated on the Drawings.

3.03 TRENCH EXCAVATION

- A. Unless otherwise shown or specified, excavate for pipelines and utilities using open-cut trenches.
- B. Trench Width:
 - 1. Within the pipe zone
 - a. Provide a minimum of 12 inches on either side for pipe zone material or controlled strength material.
 - b. For multiple pipes, conduits, cables or duct banks in a single trench, 18 inches greater than the aggregate width of pipes, conduits, cables or duct banks plus space between.
 - c. Pipe of greater strength or superior bedding, when approved by the Engineer in writing, may be used in lieu of maintaining the specified trench widths within the pipe zone.

2. Increase trench widths by thickness of sheeting
 3. Above pipe zone: maximum trench width unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property or completed work.
- C. Trench Bottom: Excavate uniformly to 6 inches below the bottom of the pipe.
- D. Open Trench: The maximum amount permitted in any one location shall be 150 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. All trenches at road intersections shall be fully backfilled at the end of each day, including temporary asphalt surfacing. At the end of the day, the length of trench left open shall not exceed 150 feet. Barricades, fencing, and warning lights meeting OSHA and the Manual on Uniform Traffic Control Devices requirements shall be provided and maintained.
- E. Over-Excavation and Trench Stabilization: When ordered by the Engineer, over-excavate to the depth ordered, cover the excavated surface with woven geotextile fabric such as Mirafi 500X, and backfill with Rockfill or Drainrock to 6 inches below the pipe. Additional payment will be made under the separate unit price bid item only for authorized over-excavation ordered by the Engineer.
- F. Where pipelines are to be installed in embankment or structure fills, construct the fill to a level at least one foot above the top of the pipe before the trench is excavated.
- G. When a movable trench shield is used it shall be moved by lifting free of the trench bottom or backfill then moving horizontally. Do not drag shield along trench in such a way as to cause damage or displacement of trench sidewalls, pipe, pipe bedding, or backfill.

3.04 EXCAVATION IN UNIMPROVED AREAS

- A. In unimproved areas, topsoil shall be stripped from the area of disturbance and stockpiled. Topsoil stockpiles shall be suitably protected from erosion by wind and water and shall be clearly identified.

3.05 PERMANENT EXCAVATION SLOPES

- A. Shape, trim and finish cut slopes to conform with the lines, grades, and cross sections indicated, with proper allowance for topsoil, or slope protection where shown. Slopes are not to exceed 3:1.
- B. Remove stones and rocks that exceed 6-inches in diameter and that are loose and could roll down-slope. Remove exposed roots from cut slopes.

3.06 REUSE OF CLEAN EXCAVATED MATERIAL

- A. Clean excess excavated material and rock that meet the specified requirements may be utilized as fill material.
- B. Contractor shall comply with all applicable federal, state, and county regulations, and town ordinances.
- C. Segregate and stockpile suitable excavated materials until material is needed for fill or backfill.
- D. Locate stockpiles as directed by the Engineer, stabilize slopes and provide erosion protection in accordance with the Grading, Erosion and Sedimentation Control Plan.

- E. Post signs indicating proposed use of stockpiled materials. Post signs that are clearly worded and readable from all directions of approach to each stockpile by equipment operators from their normal seated position.
- F. Do not stockpile excavated materials adjacent to trenches or other excavations unless excavation side slopes and support systems are designed, constructed and maintained for stockpile loads.
- G. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if the weight of stockpiled material could induce settlement or displacement.

3.07 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL

- A. Dispose of excavated materials which are unsuitable or exceed the quantities needed for fill or backfill in locations as directed by the Engineer.
- B. Moisture content alone shall not be an adequate reason for wasting otherwise suitable material. Moisten or dry such excavated materials to the specified moisture range and use for fill or backfill.

3.08 DISPOSAL OF A.C. PAVEMENT MATERIAL

- A. Asphalt pavement material may be disposed of at a certified asphalt recycling center. Pavement material not disposed of at a certified asphalt recycling center shall be disposed of in accordance with all federal, state, county and town ordinances.

3.09 BACKFILL GENERAL

- A. Do not drop directly upon any structure or pipe. Do not place around or upon any concrete structure until the concrete has attained sufficient strength to withstand the loads imposed. Sufficient strength shall mean full design strength unless directed otherwise by the Engineer. Backfill water retaining structures only after hydrostatic testing is complete and with the structure full of water.
- B. Except for Rockfill or Drainrock materials being placed in over-excavated areas in trenches, place backfill only after all water is removed from the excavation and bottom and sidewalls have dried to a moisture content suitable for compaction.
- C. Immediately prior to placing backfill material remove any loose or caving soil from the bottom and sidewalls of the excavation or trench.
- D. Keep placement surfaces free from standing water, debris, and foreign materials during placement and compaction of fill and backfill.
- E. Do not place fill or backfill if material is frozen or if the placement surface is frozen.
- F. Place and spread backfill materials in even layers, mixing as necessary to produce uniformity of moisture and material within the layer. The thickness of each layer shall be thin enough to allow the available equipment to achieve the specified compaction uniformly throughout but shall not exceed 8 inches.
- G. Adjust the moisture content of backfill material by wetting or drying and mixing as necessary until the moisture content is within the specified range.
- H. Compact each lift to the specified density at the specified moisture content prior to placing succeeding lifts.

- I. Slope lifts only as necessary to conform to final grades or to keep surfaces drained of water.
- J. Grade to establish the elevations, slopes and drainage as indicated on the drawings within a tolerance of 0.1 foot.
- K. Correct any settlement areas and repair any subsequent damage to structures, slabs, piping and other facilities caused by settlement of fill or backfill.

3.10 QUALITY CONTROL

- A. Quality control tests will be performed in accordance with Paragraph 1.5 prior to and during fill and backfill placement. Testing frequencies are to be coordinated with the Engineer. Additional testing will be performed whenever the initially established frequencies are unrepresentative due to variability in materials or construction operations, and to retest previously failed areas after corrective actions have been taken. Soil testing results indicated as passing shall be considered to be valid for a period of 72 hours unless soil conditions are believed to have been changed during that time due to a weather event. If work is not in progress after 72 hours or there has been a weather event retesting will be required.
- B. Prior to placement of fill and backfill a minimum of one laboratory compaction density test in accordance with ASTM D698, ASTM D 1557, or ASTM D 4254, as applicable, shall be performed for each different soil and bedrock material used. During fill and backfill placement, additional laboratory compaction tests will be done whenever material variation occurs such that the existing relationships are not representative of the material being placed.
- C. In place density and moisture content testing will be conducted at least once per day for each type of material being placed that day but not less than the following minimum frequencies:
 - 1. Pipe Zone Backfill: Once per 200 lineal feet of trench length at various depths from spring line to 1 foot above the top of pipe.
 - 2. Trench Zone Backfill: One test for each 1 foot of backfill for each 200 lineal feet of trench at various depths from 2 feet above the top of pipe to 1 foot below the ground surface.
 - 3. Random fill: Once per 500 cu yd
 - 4. Subgrade fill/Backfill: Once per 200 cu yd
- D. Verbal pass/fail reports shall be given to the Contractor immediately after completion of each field test, and written copies will be sent to the Engineer, Owner and Contractor and shall be available on-site at all times.

3.11 MOISTURE CONDITIONING AND PROCESSING EQUIPMENT

- A. Provide water trucks and/or tankers and other supplemental equipment necessary to uniformly apply water for moisture conditioning for proper compaction and wetting of completed courses prior to placement of overlying courses. Watering equipment shall have pressurized nozzles or other suitable means to assure uniform application of water at a controlled rate.
- B. Provide blades, discs, rotomill and other supplemental equipment as necessary to process borrow materials and pulverize bedrock into acceptable size particles, to blend fill and backfill materials, blend water with dry material, aerate and dry out wet material and for scarification of completed courses.
- C. Discs shall be of the type, size and power to blend to the full depth of loose lifts and to scarify a completed course to a depth of 2-inches for bonding overlying lifts. Discs shall be adjustable to provide light scarification where needed.

3.12 COMPACTION EQUIPMENT

- A. Provide dedicated compaction equipment of suitable type and size, specifically designed to achieve the requirements of the specifications with the types of soil materials used for the various purposes as specified.
- B. Provide hand-operated equipment in confined areas not accessible to larger equipment or where large equipment could damage structures or piping.

3.13 MOISTURE CONDITIONING AND PROCESSING

- A. Moisture condition and process material prior to and during borrow excavation so that material is within the specified moisture content and particle size limits at the time it is delivered to the fill area.
- B. Provide supplemental sprinkling on the fill to keep material within specified moisture content limits throughout the placement and compaction process, and to preserve moisture in completed courses until placement of overlying courses.
- C. Blend material by discing, blading, or harrowing to maintain uniform moisture content throughout the lift.
- D. Do not attempt to compact material that contains excessive moisture. Material that becomes too wet shall be removed or reworked. Aerate material by blading, discing, harrowing, or other methods to hasten the drying process.
- E. Provide suitable types and numbers of watering and blending equipment to keep pace with fill and backfill placement activities. Provide additional equipment or restrict material placement rates if watering and blending equipment cannot keep pace with fill and backfill placement.
- F. Maintain moisture conditions of the fill surface during nights, weekends, holidays, and other periods of temporary work stoppage.

3.14 COMPACTION

- A. Each layer of material shall be mechanically compacted to the specified percentage of maximum or relative density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content. If tests indicate that the material, moisture content, or compaction are not as specified, or if the compaction equipment being used is not as specified or capable of producing specified results, suspend material placement and take corrective action as necessary.
- B. Operate compaction equipment in strict accordance with manufacturer's instructions and recommendations. Maintain the equipment so that it will deliver the rated compactive effort.
 - 1. Operate tamping foot rollers at a speed less than 5 miles per hour, and vibratory drum rollers at a speed less than 3 miles per hour.
 - 2. Operate sheepsfoot and tamping foot rollers to maintain the spaces between the individual feet clear of adherent materials that impair the effectiveness of the roller.
- C. In cold weather do not place new material on frozen soil and prevent new material from freezing.

3.15 COMPACTION REQUIREMENTS

A. Aggregate Base Course

Compaction:	98% Standard Proctor Compaction (ASTM D698)
Compaction Moisture:	2% below to 2% above optimum
Max. Lift Thickness:	6 inches

B. Pipe Bedding and Pipe Zone

Compaction:	95% Standard Proctor (ASTM D 698)
Compaction Moisture:	N/A
Max. Lift Thickness:	8 inches

C. Trench Zone

Compaction:	Under roads, sidewalks, roadway shoulders and irrigation ditches: 95% Standard Proctor (ASTM D 698) All other areas: 95% Standard Proctor (ASTM D 698)
Compaction Moisture:	2% below to 2% above optimum
Max. Lift Thickness:	8 inches

D. Subgrade Fill/Backfill

Compaction:	95% Standard Proctor (ASTM D 698)
Compaction Moisture:	2% below to 2% above optimum
Max. Lift Thickness:	8 inches

E. Random Fill

Compaction:	92% Standard Proctor (ASTM D698)
Compaction Moisture:	2% below to 2% above optimum
Max. Lift Thickness:	8 inches

F. Topsoil

Compaction:	85% Standard Proctor (ASTM D 698)
Compaction Moisture:	2% below to 2% above optimum

3.16 FOUNDATION PREPARATION

- A. All fill material shall be removed beneath structures and paved areas. Natural soils exposed in the excavation shall be inspected and approved of by the Geotechnical Engineer. Additional material that is required to be placed over the natural soil shall be installed to achieve elevations shown on the Drawings.
- B. Shape the excavation to provide a uniform and regular profile without abrupt changes in slope, sharp projections, overhangs, steps or benches.
- C. Maintain the foundation in the soundest possible condition and free from standing water or deleterious materials.
- D. Do not allow equipment on prepared foundation surface.
- E. Complete construction of structure as soon as practical after foundation preparation is complete.

- F. Repair any damage to foundation from Contractor's operations, weather, or deterioration due to extended exposure before construction.

3.17 STRUCTURE, ROADWAY AND EMBANKMENT FILL AND BACKFILL

- A. Structure excavations shall be filled to final grade with compacted subgrade fill.
- B. Backfill within 5 feet of structures shall be subgrade fill compacted to a minimum of 98 percent Standard Proctor compaction (ASTM D 698) using hand-operated or walk behind compaction equipment.
- C. Backfill more than 5 feet from structures shall be subgrade fill compacted to a minimum of 95 percent Standard Proctor compaction (ASTM D 698) except under roadways and parking areas.
- D. Under paved areas and roads the exposed subgrade surface shall be scarified to a depth of 8 inches, moisture content adjusted to 2 % below to 2% above optimum, and compacted to a minimum of 98 percent of Standard Proctor density (ASTM D 698). Compacted subgrade fill is to be placed on prepared subgrade surface as needed to bring the finish grade up to elevations indicated on the Drawings. The finished subgrade shall have a uniform self-draining surface sloped to match the finished pavement. Regrade as required to eliminate low areas that could accumulate standing water.
- E. Place and compact aggregate base course on nonwoven geotextile fabric installed over prepared subgrade fill for paved areas and roads as soon as practical after subgrade preparation is complete. See Drawings for geotextile fabric requirements.

3.18 RIPRAP

- A. Place riprap at the locations and to the dimensions, depths and grades as indicated on the drawings.
- B. Place riprap on a bed of granular bedding material consisting of 4-in minimum of Type I material overlain by 4-in minimum of Type II material. Alternatively, a single 12-in layer of Type II material may be used except at drop structures where the two layer system shall be used.
- C. Place riprap commencing at the bottom of slopes working up the slopes. Place riprap in a stepped fashion with the bottom of the uphill riprap below the top of the downhill riprap by half of the height of the riprap minimum.
- D. Place riprap to its full course thickness in one operation and avoid displacing the underlying granular bedding material.
- E. Individual riprap rocks shall be carefully set in place using equipment or by hand. Dumping is prohibited.
- F. Place and distribute riprap so that rocks of different sizes are well mixed with no large accumulations of either large or small stones. Stones with dimensions equal to d50 or larger shall be placed at the top surface with faces and shapes matched to minimize voids and form as smooth a surface as practical. Hand placement will be required to achieve proper distribution.

3.19 GROUTED BOULDERS

- A. Place grouted boulders at the locations and to the dimensions, depths and grades as indicated on the drawings.

- B. Grade subbase to the lines and grades as required to produce the finished lines and grades as indicated on the drawings. Compact subbase as needed to provide a smooth uniform surface suitable for placement of grouted boulders. Place grouted boulders directly on prepared subbase without granular bedding.
- C. Place boulders as tightly as possible with required boulder height vertical and voids for grouting minimized.
- D. Prior to grouting, clean dirt and other material from rock that could prevent grout from bonding to rock.
- E. Grout shall fill all voids around the lower 2/3 of boulders. Top 1/3 of boulders shall remain clean and free of grout.
- F. Inject grout using a low-pressure grout pump using a suitably sized nozzle. Build up grout from the bottom of the boulder layer and use a pencil vibrator to ensure full depth penetration of grout and prevent voids.
- G. Immediately after grout placement remove grout spatters from exposed rock by scrubbing with wet brooms and brushes.
- H. Apply curing compound as specified in Section 03 30 00 to exposed grout surfaces.

3.20 PIPE TRENCH BACKFILL

- A. Pipe Bedding: Pipe bedding as shown on the Drawings shall be pipe zone material placed and compacted as specified herein. After placing the bedding, perform a final trim for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for welding shall be made as necessary.
- B. Pipe Zone Backfill
 - 1. Pipe zone backfill, as shown on the Drawings shall be pipe zone material.
 - 2. Where required, install tracer wire and cathodic protection prior to the start of backfill.
 - 3. The pipe zone shall be backfilled and compacted with the specified pipe zone material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, or the pipe itself during the installation and backfill operations.
 - 4. Place and spread evenly in layers. When compaction is achieved using mechanical equipment, do not exceed 8-inches uncompacted thickness.
 - 5. Restrain all pipe as necessary to prevent movement during backfill operations.
 - 6. Place material simultaneously in 8-inch horizontal lifts on both sides of pipe and, if applicable, between pipes installed in the same trench.
 - 7. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.
 - 8. After the full depth of the pipe zone material has been placed, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the pipes and between the sides of the pipe and the trench walls.
 - 9. Do not use power-driven impact compactors to compact pipe zone material.
 - 10. Where the material moisture content is below the optimum moisture content, add water until the proper moisture content is achieved.

11. Where the material moisture content is too high to permit the specified degree of compaction, dry the material until the proper moisture content is achieved.
12. After placement of pipe zone backfill and prior to placement of trench zone backfill, the center of the pipe(s) shall be marked with pipe marking tape.

C. Trench Zone Backfill

1. Trench zone backfill as shown on the Drawings shall be suitable material placed and compacted as specified herein.
2. After the pipe zone backfill has been placed as specified above, and after any excess water has completely drained or been removed from the trench, backfilling of the trench zone may proceed.
3. Trench zone backfill material under roads or paved surfaces shall be structurally placed subgrade fill.

D. Backfill beneath Paved Areas

1. Backfill below paved areas shall be brought up to the bottom of the layer of aggregate base course.
2. All areas to receive pavement or concrete shall be proof-rolled prior to placement of these materials. Proof-rolling shall be conducted on all subgrade, fill or base material. After the material has been compacted, tested and found to meet specifications, the entire area shall be proof-rolled with a heavily loaded vehicle to ensure uniformity of the materials. The vehicle must have a loaded GVW of 50,000 pounds with a loaded single axle weight of at least 18,000 pounds and a tire pressure of 90 psi. Material which is pumping or deforming as identified by the Engineer must be reworked, replaced or otherwise modified to form a smooth, stable, non-yielding base for subsequent paving courses.

E. Topsoil: In unimproved or open areas, topsoil shall be evenly redistributed over all disturbed areas. Care shall be taken to conform to the required final grades.

F. Trench Plugs: Trench plugs shall be placed every 500 feet along the length of the pipe in wet areas, and where shown on the Drawings or as directed by the Engineer. Trench plugs shall be a minimum thickness of 2 feet as measured along the longitudinal pipe axis and replace the pipe zone material.

3.21 CONTROLLED STRENGTH MATERIAL

A. Placement: The pipe shall be laid on sand or earth berms, free from rocks larger than 3 inches and located at pipe quarter points. Controlled strength material shall be placed from one side of the pipe and rodded or vibrated, if necessary, so that it flows under the pipe until it appears on the other side. Controlled strength material shall then be added to both sides of the pipe and rodded or vibrated until it completely fills the space between the pipe and the lower portion of the trench. Where required to prevent uplift, the controlled strength material shall be placed in two stages, allowing sufficient time for the initial set of the first stage before the remainder is placed. Controlled strength material shall be deposited as nearly as practicable in its final position and shall not disturb the pipe trench or cause foreign material to become mixed with the controlled strength material. Controlled strength material shall be brought to 6 inches above the top of the pipe. Backfill shall not be placed until the controlled strength material has reached the initial set. If it is anticipated that backfill will not be placed over the controlled strength material within 8 hours, a 6-inch minimum cover of moist backfill shall be placed over the controlled strength material. The moisture in the 6-inch minimum cover shall be maintained until additional backfill is placed. If the

ambient temperature is 50°F or less, an additional 12-inch minimum cover of loose backfill shall be placed over the 6-inch moist backfill cover prior to the end of the working day.

- B. Controlled strength material shall not be mixed or placed when the air temperature is below 40°F. Provided, that if the temperature is 35°F or above, controlled strength material may be placed if the temperature is rising. Temperature of the controlled strength material shall be 50°F or greater at time of placement. If the Engineer determines that weather conditions are unsuitable, controlled strength material shall not be placed.
- C. No controlled strength material shall be placed in pipe trenches when the trench bottom or walls are frozen or contain frozen materials. Backfill placed as cover over the controlled strength material shall not contain any frozen material.

END OF SECTION

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1. Related Report Documentation
 - a. Geotechnical Engineering Study (if applicable)
 - b. CWA Section 404 Permit Evaluation (if applicable)
 - c. Materials Management Plan (MMP) (if applicable)

1.02 SUMMARY

- A. This Section includes requirements for stripping sod and removing and disposing of vegetation and debris.
- B. Related Sections
1. Division 01 Section "Temporary Facilities".
 2. Division 01 Section "Tree Retention and Protection".
 3. Division 31 Section "Erosion Control".
 4. Division 31 Section "Earthwork".

1.03 DEFINITIONS

- A. Clearing and Grubbing: Refers to removing all surface objects and protruding objects not designated to remain shall be cleared and grubbed. This shall include but is not limited to trees, brush, stumps, logs, grass, weeds, roots, decayed vegetable matter, poles, stubs, rubbish, refuse dumps, sawdust piles, and loose boulders of one cubic yard (1 yd³) or less existing outside of the construction limits, debris resting on or protruding through the ground surface, or appearing on the construction limits before final acceptance of the work. Clearing also includes removing and disposing of obstructions, such as fences, bridges, buildings, and other incidental structures within the construction limits and shown on the Site Demolition Plans.
- B. Sod Stripping: Shall be used when the vegetative material to be removed is mow able and generally less than twelve-inches (12") tall.
- C. Tree Removal: Refers to any individual woody plant with a height greater than overall width.
- D. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- E. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow, and ; reasonably free of subsoil, clay lumps, gravel, and other objects more than two-inches (2") in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

- F. Plant-Protection Area: Area surrounding shrub beds or massings, or other vegetation or sensitive areas to be protected during construction and indicated on Contract Drawings.
- G. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, see Division 01 Section "Tree Retention and Protection".
- H. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.04 SUBMITTALS

- A. Existing Conditions: Documentation of existing conditions, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed digital photographs or videos.
 - 2. Include plans and notations to indicate specific damaged conditions of existing construction, site elements, and landscape.

1.05 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Project Manager.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Project Manager.
- B. Improvements on Adjoining Property: Not allowed without prior approval from Project Manager. Work only within Work Limit Line as defined on drawings.
- C. Salvable Items: Carefully remove items indicated to be salvaged and store on City property where indicated.
- D. Protection and Repair of Underground Lines
 - 1. Existing Public Utilities: The Contractor shall have existing underground utilities located within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. The Contractor is responsible for providing written and graphical documentation from the utility owner. The Contractor shall take whatever precautions are necessary, including potholing, to verify location and depth to protect these underground lines from damage. Should unmarked or incorrectly marked utilities or other piping be encountered during excavation, notify the Project Manager immediately for direction. If damage does occur, all damage shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable, verbal all clears will not be accepted.
 - 2. Existing Private Utilities: The Contractor shall have existing underground utilities located within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. The Contractor is required to contact all private utility companies, to locate all private utilities. The Contractor is responsible for providing written and graphical documentation from the private utility owner. The request for locates shall be a minimum of seventy-two (72) prior to proceeding with any

excavation. If, after such requests, private utilities are encountered and damaged by the Contractor, these utilities shall be repaired at no cost to the City. If the Contractor damages staked or located private utilities, they shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable, verbal all clears will not be accepted.

- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree and or plant protection measures are in place.

1.06 DELIVERY STORAGE AND HANDLING

- A. All materials except for stripped topsoil and materials indicated to remain or to be stockpiled, shall remain the property of the City. All other materials shall be removed at the Contractor's expense.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PROTECTION

- A. The Contractor shall protect existing site conditions from damage during construction.
 - 1. The Contractor shall restore existing or protected conditions damaged by the Contractor during the Work of this Contract to its original condition, as acceptable by the Project Manager.

3.02 CLEARING

- A. Remove brush and vegetation from areas designated to be cleared. As directed by the Project Manager and the Office of the City Forester, trim low hanging, unsound, or unsightly branches on existing trees and shrubs designated to remain. All cuts shall be in accordance with the Office of the City Forester's standards and specifications.

3.03 GRUBBING

- A. Remove all stumps, roots, and debris a minimum of twelve-inches (12") below finish grade in all areas as required. Use hand methods for grubbing inside the tree protection zone of trees to remain. Backfill and compact stump and root holes to a maximum of eighty-five percent (85%) in landscape areas and ninety-five percent (95%) under hardscape or as directed by the Project Manager and the Office of the City Forester.

3.04 TOPSOIL STRIPPING

- A. See Division 31 Section "Earthwork".

3.05 SOD STRIPPING

- A. Strip sod in all areas to be re-graded to a depth of one-inch (1"), so that a relatively clean dirt surface remains.

3.06 TREE REMOVAL

- A. In all proposed landscaped areas, stumps and surface roots shall be ground to a minimum of twelve-inches (12") below finish grade. In proposed hardscape areas, all roots shall be removed entirely.

3.07 DISEASED TREE REMOVAL AND DISPOSAL

- A. The removal of diseased and infested trees includes the requirement of offsite burial of all parts of the trees immediately following removal. This includes logs, stumps, roots, branches and composted and un-composted chips. Under no circumstances should diseased or infected wood be left or taken for firewood, mulch or taken to a wood processing mill.

3.08 DISPOSAL

- A. Haul and dispose of all removed materials, trash, debris and waste materials legally inside and outside of the City's property.

END OF SECTION

SECTION 31 23 19

DEWATERING AND DRAINAGE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Design, furnish, install, operate, monitor, maintain and remove a temporary dewatering system as necessary to lower and control water levels below subgrades of excavations to permit construction in the dry.
- B. Provide, maintain, and remove temporary surface water control measures adequate to drain and remove surface water entering excavations.
- C. Collect and properly dispose of all discharge water from the dewatering and drainage systems in accordance with Project permits and Section 01 41 00.

1.02 RELATED WORK

- A. Environmental protection procedures are included in Section 01 41 00 and Section 01 57 19.
- B. Sedimentation and erosion control in accordance with the Contract Documents, Town of Silt Criteria, and Urban Drainage and Flood Control District Drainage Criteria Manual Vol. 3.
- C. Design and execute methods of controlling surface water and groundwater.
- D. Be solely responsible for damage to properties, buildings or structures, sewers and other utility installations, pavements, and Work that may result from Contractor's dewatering or surface water control operations.
- E. Design review and field monitoring by Owner or Engineer shall not relieve the Contractor of responsibility for the Work.

1.03 SUBMITTALS

- A. In accordance with Section 01 33 00, submit a proposed initial plan for dewatering and coordinate with methods of excavation and excavation support.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Pipe for observations wells, if required, shall consist of minimum 1-inch I.D. Schedule 80 PVC pipe and machine slotted PVC wellpoints, maximum size slot 0.020-inches.

PART 3 EXECUTION

3.01 GENERAL

- A. Control surface water and groundwater such that excavation to final grade is made in-the-dry, the bearing soils are maintained undisturbed, and softening and/or instability or disturbance due to

the presence or seepage of water does not occur. All construction and backfilling shall proceed in the dry and flotation of completed portions of work shall not be permitted.

3.02 SURFACE WATER CONTROL

- A. Construct surface water control measures, including dikes, ditches, sumps, and other methods to prevent, as necessary, flow of surface water into excavations.

3.03 EXCAVATION DEWATERING

- A. Provide and maintain proper equipment and facilities to remove promptly and dispose of properly all water entering excavations. Excavations shall be kept dry, so as to obtain a satisfactory undisturbed subgrade foundation condition until the fill, structure, or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural elevations.
- B. Pipe and concrete shall not be laid in water nor submerged within 24 hours after being placed. Water shall not flow over new concrete within four (4) days after placement.
- C. In no event, shall water rise to cause unbalanced pressure on structures until the concrete or mortar has set at least 24 hours. Prevent flotation of pipe by promptly placing backfill.
- D. Dewatering shall at all times be conducted in such a manner as to preserve the natural undisturbed capacity of subgrade soils to proposed bottom of excavation. If the subgrade of the trench bottom or excavations becomes disturbed due to inadequate drainage, excavate below normal grade as directed by the Engineer and refill with screened gravel as specified in Section 31 05 00 Earthwork at the Contractor's expense.
- E. Evaluate the impact of the anticipated subsurface soil/ water conditions on proposed method of excavation and removal of water.
- F. Where groundwater level is above the proposed bottom of excavation level, it is expected that some type of pumped dewatering system will be required for pre-drainage of soils prior to final excavation and for maintaining the lowered groundwater level until construction has been completed to such an extent that the structure, pipeline, or fill will not be floated or otherwise damaged. It is further expected that the type of system, spacing of dewatering units and other details of the Work will have to be varied depending on soil/water conditions at a particular location and the season in which the work is being performed in.
- G. Dewater and excavate in a manner which does not cause loss of ground or disturbance to the pipe bearing soil or soil which supports overlying or adjacent structures.
- H. If initial dewatering system does not properly dewater the trench or excavation as specified, install groundwater observation wells as directed by the Engineer. Do not place any pipe or structure until the readings obtained from the observation wells indicate that the groundwater has been lowered a minimum of 6 inches below the bottom of the final excavation within the trench limits.
- I. Dewatering units used in the Work shall be surrounded by suitable filter sands and no fines shall be removed by pumping. Pumping from the dewatering systems shall be continuous until pipe or structure is adequately backfilled. Stand-by pumps and stand-by power shall be provided. Full-time monitoring and assignment of a full-time attendant may be required.
- J. Water entering the excavation from precipitation or surface runoff shall be collected in the shallow ditches around the perimeter of the excavation, drained to sump and pumped from the excavation to maintain a bottom free from standing water.

- K. Existing or new sanitary sewers shall not be used to dispose of drainage.

END OF SECTION

SECTION 31 25 00
EROSION CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section covers work necessary for temporary stabilization of soil to prevent erosion during and after construction and land disturbing activities. This work includes furnishing of all labor, materials, tools, and equipment to perform the work and services necessary as herein specified and as indicated on the Drawings. This work includes installation, maintenance, and final removal of all temporary soil erosion and sediment control measures as appropriate.
- B. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. Owner reserves the right to modify the use, location, and quantities of soil erosion and sediment control measures based on activities of Contractor and as Engineer considers to be in the best interest of Owner.
- C. See additional requirements in the Drawings.

1.02 SUBMITTALS

- A. Informational Submittals
 - 1. All permits related to control of erosion and sediment.
 - 2. Manufacturer's certificate of compliance attesting that erosion and sediment control products meet requirements of these Specifications.

1.03 GENERAL

- A. Soil erosion stabilization and sedimentation control consist of the following elements:
 - 1. Maintenance of existing permanent or temporary storm drainage piping and channel systems, as necessary.
 - 2. Construction of new permanent and temporary storm drainage piping and channel systems, as necessary.
 - 3. Construction of temporary erosion control facilities such as silt fences, check dams, etc.
 - 4. Topsoil and Seeding: Placement and maintenance of temporary seeding where indicated on the Drawings and on all areas disturbed by construction outside of the designated Work Limits.
- B. Contractor shall be responsible for phasing Work in areas allocated for his exclusive use during this Project, including all proposed stockpile areas, to restrict sediment transport. This will include installation of all required temporary erosion control devices, ditches, or other facilities.
- C. The areas set aside for Contractor's use during the Project may be temporarily developed to provide satisfactory working, staging, and administrative areas for his exclusive use. Preparation of these areas shall be in accordance with other requirements contained within these Specifications and shall be done in a manner to prevent sediment transport away from the area.

- D. All stockpiles anticipated to be left idle for longer than 14 days are considered permanent stockpiles and shall be stabilized by temporary seeding, covering, or similar measures, and protected by construction of silt fences and 2-foot, minimum depth, ditches, completely surrounding stockpiles and located within 10 feet of the toes of the stockpile slopes.
- E. Sediment transport and erosion from working stockpiles shall be controlled and restricted from moving beyond the immediate stockpile area by construction of temporary toe-of-slope ditches, berms, and silt fences, as necessary. Contractor shall keep these temporary facilities in operational condition by regular cleaning, regrading, and maintenance. Stockpiles remaining in place longer than 14 calendar days shall be considered permanent stockpiles for purposes of erosion and sediment control.
- F. Contractor shall maintain all erosion and sediment control measures in functional conditions for the duration of this Project. Formal inspections by Contractor shall be conducted every 2 weeks and as soon as possible after a stormwater runoff event to evaluate Contractor conformance to the requirements of these Specifications. Contractor shall include results of these required inspections, and a summary of all corrective actions, in Contractor's daily reports. Additional inspections may be conducted by Engineer at the discretion of Engineer.
- G. All silt traps shall be cleaned of collected sediment after every storm or as determined from the biweekly inspections. Cleaning shall be done in a manner that will not direct the sediment into natural or man-made storm drainage systems. Removed sediment shall be taken to an area selected by Engineer where it can be cleaned of sticks and debris, then allowed to dry. Final sediment and debris disposal shall be on-site as designated by Engineer.
- H. Replacement or repair of failed or overloaded silt fences, check dams, or other temporary erosion control devices shall be accomplished by Contractor as needed, but not later than 2 days after receiving written notice from Engineer.
- I. Unpaved earth drainage ditches shall be regraded as needed to maintain original grade and remove sediment buildup. If a ditch becomes difficult to maintain, Contractor shall install additional erosion control devices such as check dams, temporary paving, or silt fences upgradient of the ditch, or as directed by Engineer. Contractor is responsible for obtaining all necessary permits for ditch cleaning.
- J. Seeding of disturbed surfaces shall be completed as soon as practicable after grading is substantially completed in a given area (as defined by Engineer).
- K. Fugitive dust emissions resulting from grading activities and/or wind shall be controlled using the best available control technology, as defined by the Colorado Department of Public Health and Environment, at the time of grading. During grading, applying a combination of water, tackifier and silt fence to break up wind surface velocities may control dust. If wind speeds exceed the ability of BMPs to control fugitive dust, grading activities must cease.
- L. If Contractor has not complied with any of the above maintenance efforts to the satisfaction of Engineer within 2 working days after receiving written notification from Engineer, Owner shall have the prerogative of engaging others to perform any needed maintenance or cleanup, including removal of accumulated sediment at constructed erosion control facilities, and deduct from Contractor's monthly partial payment the costs for such efforts plus a \$500 administration fee.

1.04 DEFINITIONS

- A. Pure Live Seed (PLS): Pure live seed expressed as a percentage. It is the result of a calculation that takes into account the percentage purity of a given seed lot and the percentage viability of the seed in that lot. PLS tests are performed on single species lots.

$$\text{PLS \%} = \% \text{ Purity} \times \% \text{ Live Seed}$$

- B. Purity is the percentage of desirable seed in the lot sample. Any weed seed or chaff in the lot sample reduces the purity percentage. Any seed species other than the target seed species is considered weed seed. All seed mixes shall be totally free of noxious weed seeds.

- C. The live seed percentage combines three separate values:

% germination + % hardness + % dormancy.

Therefore: $\text{PLS \%} = \% \text{ purity} \times (\% \text{ germination} + \% \text{ hardness} + \% \text{ dormancy})$.

PART 2 PRODUCTS

2.01 DELIVERY, STORAGE, AND PROTECTION

A. Seed

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Other Materials

1. Furnish in standard packaging.
2. Keep dry during storage

2.02 TEMPORARY SEED

- A. As specified in the Drawings.

2.03 FERTILIZER

- A. Fertilizer shall be commercial, chemical type, uniform in composition, free-flowing, conforming to state and federal laws, and suitable for application with equipment designed for that purpose.
- B. Fertilizer composition to be pre-determined and agreed upon by Owner and Engineer prior to start of fertilizer application. Do not use fertilizer unless approved by Owner.
- C. Fertilizer shall have a minimum percentage of plant food by weight for the following: Permanent fertilizer mix shall be 10 percent nitrogen, 10 percent phosphoric acid, and 10 percent potash.

2.04 MULCH

- A. Use only 100 percent certified weed free mulch. Use locally or regionally produced mulch when practicable.

2.05 TACKIFIER

- A. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.
 - 1. Capable of hydrating in water, and to readily blend with other slurry materials.
 - 2. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.
 - 3. Manufacturers and Products:
 - a. Rantec; "Super Tack".
 - b. Or approved equivalent

2.06 EROSION CONTROL BLANKET AND LOGS

- A. Material
 - 1. Excelsior or straw; anchorages as recommended by manufacturer. No plastic net will be acceptable.
 - 2. Material shall be photo-degradable so that it will naturally degrade and deteriorate in its entirety in a few years.
 - 3. Pins and Staples: 0.162 inch in diameter minimum wire "U" shaped with legs 8 inches long and 1 inch crown, or wood stakes are to be used. "T" shaped pins are not permitted.
 - 4. Manufacturers and Products:
 - a. American Excelsior Company, AEC Premier Coconut™
 - b. Or approved equivalent
 - c. For areas of concentrated water flow as approved by the Engineer: North American Green C350™ TRM, or approved equivalent

2.07 SILT FENCE

- A. As specified in the Drawings.

2.08 STRAW BALES

- A. Machined baled clean salt hay or straw of wheat or barley, free from seed of noxious weeds.

2.09 CONCRETE WASHOUT STRUCTURE

- A. As specified in the Drawings.

2.10 VEHICLE TRACKING PADS

- A. As specified in the Drawings.
- B. Geotextile: Class A meeting the requirements of Colorado Department of Transportation, Standard Specifications for Road and Bridge Construction, Table 712-2.

2.11 CURB SOCKS

- A. As specified in the Drawings.

2.12 REINFORCED PLASTIC COVERING

- A. Co-extruded, copolymer laminate reinforced with nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.
- B. Black in color and ultraviolet stabilized.
- C. Physical Requirement (Minimum Average Roll Values):
 - 1. Tear Strength: 130 pounds.
 - 2. Elongation: 620 percent.

PART 3 EXECUTION

3.01 GENERAL

- A. Minimize the area of disturbance to defined construction limits and limit the time bare soil is exposed.
- B. Contractor shall install erosion and sediment control measures as shown on the Drawings and additional measures as may be necessary. All erosion and sediment control measures shall be maintained throughout construction.
- C. Contractor shall provide and maintain Temporary Seeding at all times.
- D. In areas where work is complete and no additional construction traffic is expected, Contractor shall provide permanent seeding per the Permanent Seeding Schedule.

3.02 SILT FENCE

- A. Maintain silt fence as specified in the Drawings.

3.03 TEMPORARY SEEDING

- A. General
 - 1. Temporary seeding shall be promptly placed and maintained over all disturbed areas.
 - 2. Contractor shall give at least 3 days notice to Engineer prior to seeding to allow Owner to inspect the prepared areas. Contractor shall rework any areas not approved for seeding to Owner satisfaction.
 - 3. Contractor shall keep Engineer advised of schedule of operations.
 - 4. Seed shall be clean, delivered in original unopened packages and bearing an analysis of the contents, guaranteed 95 percent pure with minimum germination rate of 85 percent.
- B. Seedbed Preparation
 - 1. Scarify disturbed areas that have been subject to vehicular and/or equipment traffic to a minimum depth of 4 inches.
 - 2. If the surfaces of stockpiles are loose and generally uncompacted, they do not need to be scarified.

C. Seeding Schedule

1. Temporary Seeding shall be performed in accordance with the following schedule:
 - a. Temporary seeding may be applied anytime, as long as the soil is not frozen or wet. Erosion blankets or crimped mulch are required for ground stabilization if conditions are unfavorable for temporary seeding.

D. Temporary Seeding

1. Install seeding as specified in the Drawings. Temporary seeding shall be broadcast applied with mulch. Contractor may opt to drill seed in areas where Contractor determines that drill seeding will result in more successful growth of temporary seeding.
2. Mulch shall be crimped into the ground with a disk to protect site. On areas with slopes equal to or steeper than 3H:1V, in windy areas, and in areas with concentrated runoff flows, install and anchor erosion control blankets over the mulch. Select blanket type and installation method according to manufacturer's specifications.
3. Hydroseeding will be permitted as an alternative method of applying seed and associated soil conditioning agents described above. If Contractor prefers to apply temporary seeding by hydroseeding methods, Contractor shall submit an operational plan for approval.
4. Maintain temporary seeding until such time as areas are approved for permanent seeding. As a minimum, maintenance shall include fix-up and reseeded of bare areas or redisturbed areas.

3.04 MULCHING

- A. Application: As specified in the Drawings.

3.05 TACKIFIER

- A. Apply on areas mulched with straw.
- B. Spray on after mulch is in place.
- C. Apply in quantities sufficient to equal retention properties of a CSS-1 asphalt emulsion being applied at rate of 400 gallons per acre.

3.06 STRAW BALES

- A. Install as specified in the Drawings.

3.07 CONCRETE WASHOUT STRUCTURE

- A. Rinse out concrete mixers and hoppers of concrete pumps after delivery into concrete washout structure. Provide potable water for rinsing as necessary.
- B. Construct as indicated in the Drawings. Size to handle solids, wash water, and rainfall to prevent overflow.
- C. Site concrete washout structures at least 500 feet away from any waterway.

- D. Inspect concrete washout structures after use. Maintain and repair as necessary. Prevent runoff of liquids from structure. Clean out and dispose material once the structure is filled to 75 percent capacity to an appropriate disposal facility.

3.08 VEHICLE TRACKING PADS

- A. Install vehicle tracking pads at locations shown in the Drawings. Install and maintain in accordance with the Drawings.

3.09 CURB SOCKS

- A. Install curb socks for storm inlet protection.
- B. Install and maintain curb socks in accordance with the Drawings.

3.10 REINFORCED PLASTIC COVERING

- A. Place on areas where hydroseeding and erosion control blankets have not controlled erosion.
- B. Install in single thickness, strips parallel to direction of drainage.
- C. Maintain tightly in place by using sandbags on ropes with a maximum 10-foot grid spacing in all directions.
- D. Tape or weight down full length, overlap seams at least 12 inches.
- E. Remove at final acceptance unless notified otherwise by Engineer.

END OF SECTION

SECTION 31 32 50

WATERING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes requirements for furnishing, hauling, and applying water required for compaction of embankments, backfills, sub-grade, and for landscaping, dust control, and other construction operations.

- B. Related Sections

- 1. Division 01 Section "Tree Retention and Protection".
 - 2. Division 01 Section "Erosion and Sedimentation Control".
 - 3. Division 31 Section "Earth Moving".
 - 4. Division 31 Section "Excavation and Backfilling of Trenches".
 - 5. Division 32 Section "Aggregate Base Course".
 - 6. Division 32 Section "Turfgrass Seeding".
 - 7. Division 32 Section "Native Seeding".
 - 8. Division 32 Section "Sodding".
 - 9. Division 32 Section "Trees, Plants, and Groundcovers".

PART 2 PRODUCTS

2.01 WATER

- A. Water for the project will be available through existing park or nearby infrastructure.
 - 1. Irrigation System: Existing irrigation is typically available from May 1st to October 1st. When existing irrigation system is not available, either during seasonal shut-downs or Project shut-downs, the Contractor is responsible to bring water to the site.
 - a. If access to the existing irrigation system is needed during seasonal shut-downs and if approved by the Project Manager and Park Operations, the Contractor shall take responsibility for start-up and winterization of the irrigation system to avoid damage to the system. The Contractor shall take the irrigation system on at their own risk and at no additional cost to the Town if damage occurs.
 - 2. Hydrant: If water supply is from a hydrant, the Contractor shall supply an approved and calibrated water meter to measure water usage and be responsible to pay all costs related to water usage.

- B. Water applied for moisture density control, pre-wetting, and as dust palliative shall be free of debris, organic matter, and other objectionable substances.
- C. Water for landscaping shall be free from oils, acids, salts or any substance that may be harmful to plant life. Non-potable water may be accepted on a case-by-case basis as approved by Project Manager.
- D. When the water source proposed for use by the Contractor is not known, the Contractor shall provide an analysis of water samples from an approved testing laboratory. The analysis shall be provided to the Project Manager prior to use.

PART 3 EXECUTION

3.01 EXISTING PARK IRRIGATION

- A. The Contractor shall be responsible to coordinate access and operation of the existing irrigation system with the Project Manager and Park Operations. The Contractor shall provide the Project Manager and Park Operations with the required irrigation schedule and identify the zones that need to be activated or turned off within the Project limits. The Contractor shall be responsible to irrigate per the requirements of the Contract Documents.

3.02 HYDRANT

- A. The Contractor shall be responsible to manage the use of the hydrant per the requirements of the Contract Documents.

3.03 APPLICATION

- A. Pressure type distributors or a pipeline equipped with sprinkler system.
- B. Moisture and Density Control: Ensure a uniform and controlled application of water without ponding or causing erosion for optimum moisture content.
- C. Pre-wetting: Pre-wetting material in excavation areas prior to removal for placement in embankments will be allowed as approved by the Project Manager. Prior to excavation the Contractor shall drill, bore or dig test holes to the full depth of excavation to determine moisture requirements. The contractor will identify and confirm with the Project Manager the areas for pre-wetting, including equipment to be used for the pre-wetting operations.
- D. Landscape Watering: The Contractor shall provide water for seeding, mulching, planting, transplanting, sodding, herbicide treatment, maintenance operations including watering during establishment periods or any other landscape related activities when called out on the Contract Drawings or Specifications.
- E. If overwatering occurs during any of the above operations, de-water at no additional expense to the Town.

END OF SECTION

SECTION 32 80 00

IRRIGATION SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Report Documentation
 - 1. Town and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix).
 - 2. Town and County of Denver – Guidance for Reuse of Soil on Town Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix).

1.02 SUMMARY

- A. This Section includes the requirements for the installation of an underground irrigation system including the following:
 - 1. Trenching, stockpiling excavation materials, refilling and compacting trenches.
 - 2. Complete irrigation system including but not limited to piping, valves, fittings, heads, wiring, sensors, backflow preventer(s), Automatic Irrigation Controller(s) and final adjustments to insure complete coverage.
 - 3. Water connections.
 - 4. Replacement of unsatisfactory materials.
 - 5. Cleanup, inspections, and approval.
 - 6. Testing.
- B. Related Sections
 - 1. Division 01 Section “Contractor Quality Control”.
 - 2. Division 01 Section “Erosion and Sedimentation Control”.
 - 3. Division 01 Section “Operation and Maintenance Data”.
 - 4. Division 01 Section “Contract Record Documents”
 - 5. Division 01 Section “Tree Retention and Protection”.
 - 6. Division 31 Section “Earth Moving”
 - 7. Division 31 Section “Excavation and Backfilling of Trenches”.
 - 8. Division 32 Section “Concrete Walks, Curbs, and Miscellaneous Flatwork”.
 - 9. Division 32 Section “Soil Preparation”.
 - 10. Division 32 Section “Topsoil”.

11. Division 32 Section "Automatic Irrigation Controllers"
12. Division 32 Section "Turfgrass Seeding".
13. Division 32 Section "Native Seeding".
14. Division 32 Section "Sodding".
15. Division 32 Section "Trees, Plants, and Groundcovers".
16. Division 32 Section "Landscape Management and Maintenance."

1.03 REFERENCES

- A. Conform to requirements of reference information listed below except where more stringent requirements are shown or specified in Contract Documents.
1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.
 2. Underwriters Laboratories (UL) - UL Wires and Cables.
 3. National Sanitation Foundation (NSF) – Piping and backflow prevention.
 4. American Water Works Association (AWWA) – Piping and backflow prevention.

1.04 QUALITY CONTROL

A. Special Requirements

1. Tolerances: Specified depths of mains and laterals and pitch of pipes shall be installed per the Contract Drawings and specifications.
2. Compaction: Settlement of trenches is cause for removal of finish grade treatment, refilling, compaction, and repair of finish grade treatment.
3. Coordination with Other Contractors: Protect, maintain, and coordinate work with work under other Sections.
4. Damage to other Improvements: Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, planting and/or new site features done under other Sections during Work associated with installation of irrigation system at no additional cost to the Town.
5. Damage or Disturbance to the Existing Irrigation Components: Damage to existing components as a result of work being performed by the Contractor will require the Contractor to replace the damaged components to the Town's current standards, at no additional cost to the Town.
6. Salvaged Parts: The Contractor is responsible for removal of all existing heads, valves and valve boxes being replaced as part of the Project. Equipment shall be returned to Denver Parks Operations and Maintenance staff.
7. Water Delivery Interruption: When working on an existing irrigation system, the Irrigation Contractor shall contact the Project Manager and inform them, seventy-two (72) hours in advance, of any water interruption that is required. The maximum irrigation system interruption is to be no more than seventy-two (72) hours during the growing season, without prior approval from the Project Manager. The Contractor shall make all necessary provisions including material, equipment, labor, delivery and scheduling as required to complete all points of connection, upgrades, and improvements within seventy-two (72) hours.

8. Watering: The Contractor is responsible for following all Denver Water rules and regulations for sod and seed establishment, available at <http://www.denverwater.org>. The Contractor shall post signs per Denver Water in a visible location(s) on site indicating "IRRIGATION TESTING AND MAINTENANCE IN PROGRESS" when Work (establishment, construction or warranty) requires irrigation system operation between the hours of 10 AM to 6 PM. The signs to be used are included within the Appendix.
9. Permits: Work involving high voltage electrical wiring, grounding and related Work shall be executed by licensed and bonded electrician. Secure a permit at least forty-eight (48) hours prior to start of installation

B. Pre-Construction Conferences and Site Meetings

1. Contractor shall schedule and conduct a pre-construction conference to review in detail quality control and construction requirements for equipment and materials used to perform the Work. Conference shall be scheduled not less than ten (10) days prior to commencement of Work. All parties required to be in attendance shall be notified no later than seven (7) days prior to date of conference. Contractor shall notify qualified representatives of each party concerned with that portion of Work to attend conference, including but not limited to the Project Manager, Denver Parks District Manager, Operations Supervisor, the Contractor's Superintendent, and Installer.
2. Prior to commencement of Work, Contractor shall schedule an on-site conference with Project Manager, Office of the Town Forester and any other parties designated by Project Manager to discuss tree protection requirements, staging locations, traffic control, and equipment access. Provide a minimum of seven (7) days' notice prior to date of conference.
 - a. Identify on Contact Drawings all locations of existing components.
 - b. Verify the operation of each component.
 - c. Provide documentation of existing components and conditions to the Project Manager prior to starting Work.
3. Contractor shall schedule on-site conferences the frequency of which is to be determined by the Project Manager and any other parties designated by the Project Manager to review project progress.
4. Contractor shall record Meeting Minutes of each conference and distribute to all parties in attendance within three (3) days of conference.

1.05 SUBMITTALS

- A. Prepare and make submittals in accordance with conditions of the Contract prior to installation of any irrigation equipment:
- B. Material List: Submit a PDF file of complete list of materials, and cut sheets indicating manufacturer, model number and description of all materials and equipment to be used. Only include specific cut sheets for the products being used as part of the Project. Show appropriate dimensions and adequate detail to accurately portray intent of construction.
- C. Shop Contract Drawings: If applicable, submit shop Contract Drawings for pumps, backflows and assemblies. Include plumbing and foundation/support systems if the installation differs from the manufacturer's recommended installation.

- D. Mock-ups:
1. Valve assembly: Provide a completely built electrical valve assembly. This mock-up, to include electric valve, service tee, lateral valve riser, length as required for mainline depth, and male thread by spigot outlet adapter. The mock-up may be incorporated into the work toward the end of the project.
 2. Swing joints: Provide a swing joint assembly for each detail shown (e.g. - quick coupler, rotors and pop-up spray head) or as directed by the Project Manager
 3. Drain valves: Provide a mock-up including the service tee, required fittings, and drain valve.
 4. Other: Mock-ups that may be requested by the Project Manager.
- E. Operation and Maintenance Manual: Supply Operation and Maintenance information for installed booster pumps and pump stations. See Division 01 Section "Operation and Maintenance Data" for manual requirements.
- F. Warranty: Submit a written Warranty, in accordance with WARRANTY/GUARANTEE section.

1.06 CONTRACT RECORD DRAWINGS

- A. Prior to the installation of the irrigation system, the Contractor will provide on-site copies of the original irrigation design Contract Drawings for "Contract Record Drawings". Contractor to revise Contract Record Drawings in red ink as the Work progresses to show any changes to the plan and include field dimensions. Contract Record Drawings shall be brought up-to-date prior to any Pay Application Submittals that contain irrigation installation. Should the Contractor choose to utilize GPS for the purposes of documenting Work in progress, a hard copy print will need to be provided prior to Pay Application Submittal. A print of Contract Record Drawings shall be available at Project Site for review by the Project Manager at any time during the project.
- B. Contract Record Drawings shall be completed by an Irrigation Consultant or qualified draftsman. Encompass entire Scope of Work including any altered existing equipment and altered zones. Note the Automatic Irrigation Controller zone number, type of irrigation equipment, gallons per minute (GPM) and operating pressure (PSI) for any altered or added zone.
- C. Preparation of Contract Record Drawings: Dimension from two (2) permanent points of reference (building corners, sidewalk corners/intersections, road intersections, permanent structures, light poles, or utility cabinets) the location of the following items:
1. Point of connection
 2. Meters and Vaults
 3. Curb stops
 4. Drain valves
 5. Pumps
 6. Backflows
 7. Bypass lines
 8. Service lines
 9. Routing of irrigation mainline. Provide dimensions for each change of direction and every two hundred linear feet (200 L.F.) maximum along each run
 10. Routing of non-pressure lateral lines, layout and size, if altered from original design

11. Zone control valves
 12. Quick coupling valves
 13. Flow meter
 14. Master valve
 15. Rain sensors/rain gauges/weather stations
 16. Wire splice boxes
 17. Control wire routing, if not with pressure mainline
 18. Gate valves
 19. Air relief valves
 20. Sleeves
 21. Flush valves
 22. Power service drop
 23. Two-wire ground rods and plates
 24. Other related equipment as directed
- D. Make dimensions accurately at the same scale used in the original Contract Drawings, or larger. Notes and dimension lettering must be legible. Dimension lines shall be drawn on the plan(s) neatly along the outside edge and shall be red for clarity. Do not place dimension lines or lettering on top of irrigation lines or heads. Scale shall be included on the drawings. PDF version to be black and white with red lines and text for dimensions.
- E. The irrigation legend and zone call outs must be changed to accurately reflect the irrigation equipment installed, if such equipment is not the same as originally specified on the contract documents. This includes type of head, flow rates, effective spray diameter/radius and operating pressure of all sprinkler heads.
- F. The Project Manager will not certify any pay request submitted by the Contractor if the Contract Record Drawings are not current, and processing of pay request will not occur until Contract Record Drawings are updated.
- G. Prior to the Substantial Completion walk, the Contractor shall provide a digital copy of the irrigation design with record installation information that reflects all changes made over the course of the construction project. Contract Record Drawings shall include details of any revisions as per actual installation. Deliver and submit to the Project Manager for review of the following items:
1. Digital Contract Record Drawings in both PDF and AutoCAD format (include any related X-ref files, plot files and pen settings.) Make any additional changes to the file as directed by the Project Manager prior to final submittal and approval.
- H. Request for Substantial Completion will not be processed until all Contract Record Drawing prints and digital files have been received and approved by the Project Manager.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver all components to job site in original unopened packaging containers prominently displaying manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law. Remove and replace cracked, broken, or

contaminated items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.

B. Handling, Storage and Delivery of PVC Pipe:

1. Exercise care in handling, loading and storage of PVC pipe.
2. All PVC pipe shall be transported in a vehicle which allows length of pipe to lie flat so as not to subject it to undue bending or concentrated external loads. All sections of pipe that have been dented or damaged shall be discarded and shall be replaced with new piping.

C. Storage and Protection: Deliver, unload, store, and handle materials, packaging, and products in dry, weatherproof condition in manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism.

D. Only materials and equipment meeting project specifications and to be used as part of Project shall be stored on site. Project Manager to may verify at any time during construction period.

1.08 JOBSITE CONDITIONS

A. Existing Conditions

1. Soil Conditions: The Contractor is responsible for investigating the type of soil and conditions in which lines are to be installed. No extra payment will be allowed due to difficulty in trenching, unless approved by the Project Manager.
2. Contractor is responsible for understanding the scope of related operations as specified and indicated in the Contract Drawings and Specifications before beginning Work under this Section.
3. Report unsatisfactory conditions in writing to the Project Manager within twenty-four (24) hours of discovery. Commencement of installation means acceptance of existing conditions by the Contractor.

B. Protection of Property

1. Protect buildings, walks, walls, and other property from damage. Erect and maintain barricades, warning signs and lights, and provide guards as necessary or required to protect all persons on the site. Damage caused to asphalt, concrete, monuments, structures or other building material surfaces shall be repaired or replaced at no cost to the Town. Restore all disturbed areas to original condition.
2. The Contractor is responsible for potholing of all existing utilities, irrigation lines or any other underground improvements that may be damaged due to the installation of Irrigation Systems.

C. Protection of Existing Trees

1. Refer to Division 01 Section "Tree Retention and Protection".

D. Protection and Repair of Underground Lines

1. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. Take whatever precautions are necessary, including pot holing to verify location and depth to protect these underground lines from damage. If damage does occur, all damage shall be repaired by the Utility Owner. All costs of such repairs shall be paid by Contractor.

2. The Contractor is required to contact all private utility companies including Denver Town Departments to locate all private utilities. The request for locates shall be a minimum of seventy-two (72) hours prior to proceeding with any excavation. If, after such requests private utilities are encountered and damaged by the Contractor these shall be repaired at no cost to the Town. If the Contractor damages staked or located private utilities, they shall be repaired by the Utility Owner at the Contractor's expense.
- E. Replacement of Paving and Curbs: Any damage due to work that occurs adjacent to or crosses existing roadways, paths, trails, curbing, sidewalks, etc. shall be restored to original condition at the contractors expense, and the satisfaction of the Project Manager.

1.09 WARRANTY/GUARANTEE

- A. Provide a one (1) year written warranty for material and installation from the date of Substantial Completion.
- B. Expenses due to vandalism before Substantial Completion shall be the Contractor's responsibility.
- C. Any settling of backfilled trenches that occurs during warranty period shall be repaired at no expense to the Town, including complete restoration of damaged property.
- D. The Contractor is responsible to monitor and coordinate Automatic Irrigation Controller scheduling and maintenance with the Project Manager for any seeding, sodding, or planting areas under the Contractor's warranty.
- E. Project Manager reserves the right for Parks Operations Staff to make temporary repairs during the warranty period as necessary to keep systems in operating condition without voiding the Contractor's warranty, nor relieving the Contractor of their responsibilities.
- F. The Contractor shall make repairs and replacements within three days of notification. If the Contractor fails to make repairs within three days, the Town will make such repairs at the Contractor's expense.

1.10 TURN OVER ITEMS

- A. Where applicable, furnish the following maintenance items to Town prior to Substantial Completion:
 1. Two (2) sprinkler heads for each size and type specified.
 2. Two (2) nozzles for each type of head and spray pattern.
 3. Two (2) head adjustment tools for each type of head installed.
 4. Two (2) valve keys for operating each type of manual valve. (Manual drain valves, gate valves and angle valves).
 5. Two (2) valve keys and hose swivels for each type of quick coupling valve.

1.11 MAINTENANCE DURING PROJECT CONSTRUCTION

- A. Within Limit of Work: Contractor shall fence, water, and keep weed free any turf, trees and any plantings within the Limit of Work. Contractor is responsible for maintenance which includes picking up trash, weed control and mowing of turf and native areas within the Limit of Work. Contractor is responsible for watering existing landscape within the Limit of Work. Turf and plants affected by mainline work or irrigation water service shutdown during irrigation season shall

receive watering per Parks' schedule, with no interruption of watering greater than seventy-two (72) hours. The Contractor is responsible for maintenance until Final Acceptance is granted.

B. Outside Limit of Work: Coordinate Automatic Irrigation Controller scheduling and maintenance operations with Project Manager for portions of Town property unaffected by Construction.

C. Additional Maintenance During Warranty Period:

1. Make repairs and replacements needed due to defective workmanship and materials.
2. Winterization: Include cost in bid for winterizing complete system at conclusion of irrigation season (during which system received Final Acceptance) within three (3)-days of notification by the Town. System shall be voided of water using compressed air. Coordinate with the Denver Parks Operations Supervisor and the Project Manager to be present during the winterization procedures. The Contractor shall notify all persons that are to be present a minimum of forty eight (48) hours prior to the winterization of the system.
3. Spring Start Up: To take place the following season within three (3) days of notification by the Town. Open, operate, adjust system, and make any necessary repairs. Coordinate with the Denver Parks Operations Supervisor and the Project Manager to be present during the spring start up procedures. The Contractor shall notify all persons that are to be present at the spring start up a minimum of forty-eight (48) hours prior to starting of the system.

PART 2 PRODUCTS

2.01 GENERAL

- A. Equipment must have performance characteristics to operate per the design conditions indicated. If any discrepancy or conflict exists between the quantities of equipment listed in the schedule and quantities shown on the Contract Drawings, the greater quantity shall govern.
- B. All material shall be of the highest grade possible and where applicable, shall be marked accordingly and shall be new.

2.02 PIPE AND PIPE FITTINGS

A. Ductile Iron Pipe

1. Ductile Iron Pipe: Centrifugal cast ductile iron in metal molds for water pipe in accordance with ANSI C151 and AWWA A21.51 with asphaltic exterior coating and interior lining and coating in accordance with ANSI C151 and AWWA A21.51. Rubber-Gasket joints shall conform to ANSI/AWWA C111/A2.11.

B. Ductile Iron Fittings

1. All ductile iron fittings shall be made of class 350 ductile iron and shall have slanted, deep bell, rubber gasket style made in accordance with ASTM A-536, Grade 65-45-12 & AWWA C153. All fittings shall have a minimum of five (5) degree freedom of pipe deflection within the bell end.
2. All ductile iron pipe fittings, joint restraints and mainline isolation gate valves shall carry a minimum 10-Year warranty on any defective replacement products and labor replacement costs. Prior to the installation of pipe fittings, joint restraints and mainline

gate valves, the manufacturer shall provide documentation stating the above warranty information in writing and signed by the Manufactures Representative.

3. All ductile iron fittings and joint restraints shall have a fusion bonded epoxy coating on interior and exterior of the product surface, average of ten to twelve mm (10-12) thickness. Epoxy coating shall conform to the requirements of CSA Z245.20-20 and NSF 61 for water services. Tar/bitumen coating will not be approved.

C. Copper Pipe and Fittings

1. Pipe: Type K, rigid, hard tempered.
2. Fittings - Wrought copper, solder joint type. Joints - Soldered with solder, forty five percent (45%) silver, fifteen percent (15%) copper, sixteen percent (16%) zinc, and twenty four percent (24%) cadmium and solidus at 1125° F and liquids at 1145° F.

D. Main and Lateral Lines

1. Main Lines (pressurized, downstream of backflow prevention units):
 - a. Class 200 PVC BE, size one inch (1") through two inch (2").
 - b. Class 200 PVC RT/Gasketed, size two and one-half inches (2-1/2") and larger.
 - c. Velocities in PVC mainline shall not exceed five feet (5') per second.
 - d. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-2241.
2. High Density Polyethylene (HDPE) pipe
 - a. Pressure rating DR 11 two hundred (200) PSI
 - b. PE4710, ASTM F714.
 - 1) May be used by approval of the Project Manager for portions of irrigation system that require boring such as below trees and paving.
 - c. HDPE to PVC mainline and laterals require either an epoxy coated repair coupler with joint restraints and stainless-steel pipe stiffener or Series 730 Poly-Cam Transition Fitting or approved equal.
3. Polyvinyl Chloride (PVC) Lateral Lines
 - a. Class 200 PVC BE, size one inch (1") to three inch (3").
 - b. Velocities in PVC mainline shall not exceed five feet (5') per second.
 - c. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-2241.
4. Polyethylene Lateral Lines:
 - a. One hundred (100) PSI High Density NSF Polyethylene Piping – one inch (1") minimum diameter.
 - b. VeloTown of water flow in polyethylene pipe shall not exceed seven and one half (7-1/2) feet per second.

E. Sleeving

1. Horizontal sleeves under paved surfaces: Class 200 PVC.
2. Vertical sleeves for access to drains and valves: Class 200 PVC.
3. Horizontal sleeving for boring applications: DR 11 HDPE.

F. Brass Pipe and Fittings

1. Brass Pipe: Eighty-five percent (85%) red brass, ANSI Schedule 40 threaded pipe.
2. Fittings: Medium brass, threaded one hundred twenty-five (125) pound class.

G. Pipe and Fittings

1. Identification Markings: Identify all pipe with following indelible markings:
 - a. Manufacturer's name.
 - b. Nominal pipe size.
 - c. Schedule of class.
 - d. Pressure rating.
 - e. NSF (National Sanitation Foundation) seal of approval.
 - f. Date of extrusion.
2. Class 200 PVC Pipe (pressurized mainline one and one-half inches (1-1/2") and smaller):
 - a. Pipe will be assembled with Schedule 80 PVC fittings and solvent welded using ASTM-F-656 purple primer followed with heavy bodied ASTM-D-2564 cement.
3. Class 200 PVC Pipe (pressurized mainline two inches (2") and larger):
 - a. Manufactured from virgin Polyvinyl Chloride compound in accordance with ASTM D2241 and ASTM D1784; cell classification 1254-B, Type 1, Grade 1.
 - b. All fittings, service tees and pipe restraints shall be epoxy-coated ductile iron fittings.
4. Class 200 PVC Pipe (all lateral lines)
 - a. Pipe will be assembled with Schedule 40 PVC fittings and solvent welded using ASTM-F-656 purple primer followed with heavy bodied ASTM-D-2564 cement.
5. High Density Polyethylene (HDPE)
 - a. Must meet ANSI/AWWA C906, ASTM F714/D3035. Materials used for the manufacture of polyethylene pipe and fittings shall be made from PE 4710 high density polyethylene resin compound meeting cell classification 445574C/E per ASTM D3350. Certification ANSI/NSF 61/14. All fittings shall be installed using butt-fused fittings or thermo-fused fittings/couplings and must be approved by the Project Manager.
6. Polyethylene Lateral lines (non-pressure lateral lines)
 - a. Manufactured from virgin polyethylene in accordance with ASTM D2239, designated as PE 3408. Maximum size two inches (2"); minimum size one inch (1").
 - b. Fittings: Manufactured in accordance with ASTM D2609; PVC Type 1 cell classification 12454-B.
 - c. Clamps: All stainless-steel worm gear screw clamps. Use two (2) clamps per connection on all insert fittings.

2.03 DETECTABLE WARNING TAPE

- A. Refer to Division 31 Section "Excavation and Backfilling of Trenches" for detectable warning tape requirements.

- B. Tape shall be blue with "Caution Irrigation Line Buried Below" or purple with "Caution Recycled/Reclaimed Water Line Buried Below".

2.04 VALVES

A. Gate Valve or Isolation Valve

1. Valve for one and one-half inch (1-1/2") and smaller mainline: Shall be Class 125, 304 Stainless Steel with screw-in bonnet, non-rising stem, left hand opening with a stainless steel cross top handle gate valve with clear waterway equal to full diameter of pipe. Able to withstand continuous working pressure of two hundred (200) PSI. Wheel type handle is unacceptable.
2. Valve for two inch (2") and larger mainline: Shall be epoxy coated interior and exterior ductile iron body which meets ASTM A-536, Grade 65-45-12, push-on, left-hand opening, square nut operated, resilient wedge, mechanical joint AWWA C153 gate valve with clear waterway equal to full diameter of pipe. Able to withstand continuous working pressure of two- hundred fifty (250) PSI. Wheel type handle is unacceptable.

B. Stop and Waste Valve

1. For once inch (1") through two inch (2") mainlines. Must meet ANSI/AWWA C800 standard and certified to NSF 61 and rated for 175 PSIG. One-piece, closed bottom body, with no metal to metal contact between plug and body. Mueller Mark II Oriseal H-10284N or approved equal.

C. Automatic Control Valve

1. Automatic Valve for Potable Water System: Hunter ICV Series Valve having manual flow adjustment and both internal and external manual bleed. Accu Sync shall be used if pressure at the heads is greater than ten pounds over the optimal pressure as stated on the plans or measured in the field.
2. Automatic Valve for Non-Potable Water System: Hunter ICV with Filter Sentry Series. Accu Sync shall be used if pressure at the heads is greater than ten (10) pounds over the optimal pressure as stated per the manufactures catalog, plans, or measured in the field.
3. Valve Riser: Epoxy coated ductile iron riser with integral stainless-steel angle valve or approved equal.
4. Valve ID Tag: Install one flexible marker tag on each valve. Mark each tag with indelible ink indicating zone number. Tags shall be: Potable water systems (yellow), Non-potable systems (purple)

D. Manual Drain Valve

1. Drain Valve: Mueller Oriseal #H-10283N with brass swing joint assembly, or approved equal.

E. Quick Coupling Valves

1. Buckner QB44LRCAR10 brass two-piece body with winged stabilizer, designed for working pressure of one hundred fifty (150) PSI; one inch (1") FIP. Size as shown on drawing.
2. Quick Coupling Valves immediately after the backflow are used for winterization and shall be constructed of all brass swing joint and fittings. All other Quick Coupling Valve swing joints shall be constructed as shown on the details.

F. Master Valve

1. Mainline two and one-half inch (2-1/2") and smaller, Master Valve shall be Superior 3100 normally open valve.
2. Mainline three inch (3"), and larger, Master Valve shall be Bermad 410 normally open valve (Bermad 420 when pressure regulation is required).

G. Flow Meter Assembly

1. Mainline one inch (1") through twelve inch (12"), flow meter shall be FloMec QS-200, sized according to mainline size.

H. Valve Boxes

1. All valve boxes shall have a stainless steel hex bolt locking lid system.
2. Isolation Valves, Quick Coupling Valves, Drain Valves, Wire Splices and Ground Rods: Shall be branded with equipment type as outlined in Part 3 - Execution.
 - a. Rain Bird VB10RNDH, round body.
3. Electric Control Valve Box: Shall be branded with the zone numbers as outlined in Part 3 - Execution.
 - a. Three-quarter inch (3/4") through one inch (1") valves: Rain Bird VBSTDH, standard body.
 - b. One and one-half inch (1-1/2") through two-inch (2") valves: Rain Bird VBJMBH, jumbo body.
 - c. Sub-surface dripline valve assemblies: Rain Bird VBSPRH super jumbo body.
 - d. One inch (1") through two and one-half inch (2-1/2") Master Valves: Rain Bird VBJMBH jumbo body.
 - e. Three-inch (3") through six-inch (6") master valves: Rain Bird VB-MAX
 - f. Flow Meter: VBJMBH maxi jumbo body.
4. Valve box cover color:
 - a. Green for potable systems.
 - b. Purple for non-potable systems.
5. Gravel Leveling Bed and Drainage Sump in Valve Boxes: three quarter inch (3/4") crushed gravel covered in geotextile fabric, as indicated on the Contract Drawings.

I. Backflow Preventer

1. High hazard, reduced pressure type, approved by University of Southern California (USC) or other approved testing laboratory; fully ported, ball-type gate valves on units 2-inch or smaller, as manufactured by Febco Model 825YA or approved equal. Resilient gate valves on units larger than two inch (2"); as manufactured by Febco Model 880V or approved equal.
2. Backflow Preventer Cover: Guardshack enclosure of appropriate size, equipped with Lock Shield Brackets, manufactured by BPD. Color: forest green.
3. Concrete Pad: Comply with Division 32 Section "Concrete Walks, Curbs and Miscellaneous Flatwork".

- J. Air Relief Valve: On mainlines three inches (3") or larger, as per plan: Bermad C31 2-inch combination vacuum/air release valve or approved equal.
- K. Pressure Regulating Valve (where water supply pressures exceed one-hundred (100) PSI):
 - 1. Bermad 420 pressure regulating master valve for three inch (3") and larger mainlines.
 - 2. Zurn 500XL3 pressure regulating valve for three-quarter inch (3/4") thru two and one-half inch (2-1/2") mainlines.

2.05 IRRIGATION HEADS

- A. Heads: Provide swing joints of the type and size as indicated on the Contract Drawings. Heads of a specific type or function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and identification in such a position that they can be identified without being removed from the system.
 - 1. Pop-Up Sprinkler Heads in turf areas: Rain Bird RD-06-S-F series.
 - a. P30 for spray nozzles
 - b. P45 for rotary nozzles
 - 2. Pop-Up Sprinkler Heads in non-turf/native areas and shrub/flower bed areas: Rain Bird RD-12-S-F series.
 - a. P30 for spray nozzles
 - b. P45 for rotary nozzles
 - 3. Pop-Up Sprinkler Heads for trees in native areas; Rain Bird RD-12-P45-S-F series with specified rotary nozzles as indicated on contract drawings.
 - 4. Pop-Up Sprinkler Nozzles shall be Rain Bird MPR Series nozzle. Strip series and HE-VAN nozzles may be used for specific approved applications at the direction of the Project Manager.
 - 5. Gear Driven Heads: Hunter I-20-06, I-20-12, I-25-06, I-40-06 with stainless steel risers, internal check valve, PRS and MPR as specified per Contract Drawings. Plastic risers are permitted on twelve-inch (12") rotor heads used in native areas. Minimum riser height shall be six inches (6") in turf areas.
- B. Connections to Lateral Pipe
 - 1. Pop-up Heads: Shall be one-half inch (1/2") swing pipe, 0.49 inside diameter with an operating pressure of eighty (80) PSI.
 - 2. Gear Driven Heads: Shall be Rain Bird TSJ Series swing joints.

2.06 LOW VOLUME IRRIGATION

- A. Valve: Hunter ICZ Drip Control Zone Kit with stainless steel filter and forty (40) pound pressure regulation, size per Contract Drawings.
 - 1. Valve shall be installed in a valve box as noted in Section "Valve Boxes".
- B. Supply Header: Class 200 PVC. All supply header piping to be installed at a twelve inch (12") depth.

- C. Sub-surface Irrigation: Landscape Dripline, emitter spacing and flow as per Contract Drawings. All sub surface laterals to be buried at a minimum four-inch (4") depth in soil.
 - 1. Flush valve installed in a round valve box as noted in Section "Valve Boxes".
 - 2. Operation Indicator Head - Rain Bird RD12 spray head with closed 6 series (orange) VAN nozzle shall be installed adjacent to flush valve at each end of the zone.
- D. Sub-surface Dripline: Sixteen (16) to seventeen millimeter (17mm) flexible polyethylene tubing. Internal emitters to be pressure compensating and self-flushing to clear debris. Must be designed to prevent root intrusion by incorporating copper oxide into the product. Also must include a check valve and have a sealed outlet when system is not irrigating.

2.07 AUTOMATIC CONTROL SYSTEM

- A. See Division 32 Section "Automatic Irrigation Controllers".
- B. Electrical Control Wiring
 - 1. Two Wire Systems:
 - a. Two-Wire Decoder Cable – Two (2), #12 or #14 AWG UL parallel wires each with single, solid copper conductors with polyethylene insulation. Wires shall be contained within separate polyethylene jacket. Cable shall be Regency Maxi Cable or Paige P7072D with red jacket (NO SUBSTITUTIONS).
 - 1) 14 AWG for up to twenty-five hundred feet (2500').
 - 2) 12 AWG for over twenty-five hundred feet (2500').
 - b. Incoming (controller side) of the two-wire cable shall be identified by placing a black zip-tie tightly on the cable.
 - c. Two-wire single station decoders Toro SB-DAC-1 to be installed in each valve box, one per valve. Decoders shall have a serial number engraved on each decoder for future identification. Decoder to be mounted on the inside wall of the valve box.
 - d. Two-wire decoder cable shall have surge arrestors Toro SB-BLA installed every five hundred (500) ft. along two-wire path or every eight decoders whichever is the shortest distance. Surge arrestors are to be placed in valve box containing automatic control valve or in separate round valve box as noted in Section "Valve Boxes". Surge arrestor grounding shall be installed per manufacturer's recommendations.
 - e. Copper wire shall be six (6) gauge bare solid copper wire connected to the ground rod using a Cadweld GR1161GPLUS "Plus One Shot" welding kit. Wire connection between surge arrestor and copper ground wire to be made using a high strength corrosion-resistant bronze alloy split-bolt.
 - f. Two-Wire Splice Box: To be installed in a round valve box as noted in Section "Valve Boxes".
 - 2. Conventional Wire Systems:
 - a. Electrical Control Wire for 24VAC Solenoid: Golf Course Sprinkler Wire - #12 to #14 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation 0.045-inch thickness.

- b. Electrical Common Wire: Golf Course Sprinkler Wire - #12 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation 0.045-inch thickness.
 - c. Wire Colors: Match existing color system throughout.
- C. Miscellaneous control wiring materials:
 - 1. Materials for both standard and two wire systems.
 - a. Data Wires: Paige 7171D-A direct burial shielded and armored signal cable with polyethylene jacket (NO SUBSTITUTIONS)
 - 1) Data Wire connections and splices shall be made with Ranger Servi-Seal.
 - b. Control Wire and Two-Wire Decoder Cable connections and splices shall be made with 3M DBR/Y-6M direct bury splice, or approved equal, UL listed dry splice methods.
 - c. Spare Wire and wire ends shall be capped with 3M DBR/Y.
 - d. Mainline Tracer Wire: One (1) continuous #10 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation 0.045-inch thickness. tracer wire as detailed above all mainline.
 - e. Splice Box: To be installed in a round valve box as noted in Section "Valve Boxes".

PART 3 EXECUTION

3.01 PREPARATION

- A. Utility Locates: Refer to Division 31 Section "Excavation and Backfilling of Trenches".
- B. Landscape Plan Review and Coordination: Contractor will be held responsible for coordination between landscape and irrigation system installation. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the landscape plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor's expense.
- C. Pressure Verification: Contractor shall field verify the tap size, static pressure and verify gallons per minute flow at the project site, prior to commencing Work or ordering irrigation materials, and submit findings in writing to the Project Manager. If Contractor fails to verify tap size, static water pressure and flow prior to commencing Work or ordering irrigation materials, Contractor shall assume responsibility for all costs required to make system operational and the costs required to replace any damaged landscape material. Damage shall include all required material costs, design costs, labor costs and plant replacement costs.
- D. Inspection: Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.
 - 1. Grading operations, with the exception of finish grading, shall be completed and approved by Project Manager before staking or installation of any irrigation system begins.
- E. Layout: Layout and stake system before beginning installation. Staking shall occur as follows:

1. Mark, with paint, routing of pressure supply line and valve boxes. Flag heads for all new zones. Contact the Project Manager forty-eight (48) hours in advance and request review of layout and staking. The Project Manager will review layout and direct changes if required. Review does not relieve installer from coverage problems due to improper placement of heads after staking.
2. Valve boxes and mainline shall not be located in ball fields, multi-use sport fields, recovery zones, or below playground equipment.
3. If project has significant topography, free form planting beds, or other amenities which could require alteration of irrigation equipment layout as deemed necessary by the Project Manager, do not install irrigation equipment in these areas until the Project Manager has reviewed equipment staking.
4. The Project Manager will request the Office of the Town Forester's approval of proposed trenching prior to start of trenching. The Contractor shall be following Division 01 Section "Tree Retention and Protection".
5. Review backflow prevention device location and operation with the Project Manager prior to mainline installation.

3.02 EXCAVATION AND BACKFILL

A. Refer to Division 31 Section "Excavation and Backfilling of Trenches".

1. Directional Boring:
 - a. Directional boring locations as indicated on the Contract Drawings.
2. Clearances and Depths:
 - a. Main pressure line: Make trenches of enough width to properly assemble and position pipe in trench.
 - b. Clearances:
 - 1) Mainline and Lateral Piping clearance: Minimum clearance shall be two inches (2") horizontally on both sides of the pipe.
 - 2) Line Clearance: Provide minimum six inches (6") of clearance between each line, and minimum twelve inches (12") of clearance between lines of other trades.
 - 3) Installation of multiple runs of piping in one common trench is prohibited.
 - c. Pipe and Wire Depth to finish grade:
 - 1) PVC Pressure Supply Piping: Twenty-six inches (26") to twenty-eight (28") from the top of pipe.
 - 2) HDPE Pressure Supply Piping: Thirty inches (30") to thirty-six inches (36") from the top of pipe.
 - 3) HDPE Lateral Lines: Eighteen inches (18") to twenty-four inches (24") from top of pipe.
 - 4) PVC Sleeving: At specified pipe or wire depth.
 - 5) Non-pressure Piping (gear driven heads): Eighteen inches (18") from top of pipe, maximum variation two inches (2").
 - a) Native seed zones using twelve-inch (12") rotors: Twenty-four inches (24") from top of pipe, maximum variation two inches (2")

- 6) Non-pressure Piping (pop-up heads): Eighteen inches (18") from top of pipe.
 - 7) Control Wiring and Two-Wire Decoder Cable: Side of mainline when installed in the same trench; twenty-four (24") inches deep when installed separately from the mainline trench.
3. Vibratory Plow: Not permitted without written approval from the Project Manager.

3.03 INSTALLATION OF IRRIGATION EQUIPMENT

- A. Locate all equipment as near as possible to locations designated. Deviations shall be reviewed and approved by the Project Manager prior to installation.
- B. Service Line Piping (copper or ductile iron piping from water meter to connection to backflow prevention device) - When pipe installation is not in progress, or at the end of each day, close pipe ends with tight plug or cap.
1. Ductile Iron Pipe – Provide and install full pipe length protective polyethylene factory-formed sleeves around all piping to be buried. Pipe shall be bedded per Denver Water current standards and specifications.
 2. Copper piping – Installation shall match specifications for copper service line as required by Denver Water and in accordance with Town and County of Denver Building Codes.
- C. Sleeving
1. Install sleeving under any hard surface prior to surface being installed to accommodate piping and wiring. If irrigation is not being modified, the Contractor shall work with the Project Manager and Park Operations to identify locations and size for sleeves for future use.
 2. Minimum depth to top of pipe shall be determined by depth of mainline and lateral lines. Sleeving depth shall match pipe and wire depth for all pressure and non-pressure piping installed under all hardscape surfaces, asphaltic concrete, or concrete paving.
 3. Sleeving under existing walks or concrete pavement shall be done by directional boring or hydraulic driving. Where cutting of asphalt and/or concrete is necessary, it shall be done per the Contract Drawings and Details and/or per the Town and County of Denver Right of Way Standards. When cutting concrete, the entire section or "stone" must be removed from joint to joint. The Project Manager shall approve the final locations prior to removal.
 - a. HDPE pipe may be used for sleeving when directional boring takes place under existing hard surfaces, walks, roadways, trees, etc.
 - b. A sleeve is not required if the irrigation line is installed via directional boring with HDPE pipe as indicated by the Contract Documents.
 4. Compact backfill material in three uniform lifts, using mechanical tamping devices under pavement.
 5. Do not allow sleeves to become filled with soil or other undesirable material. Tape ends of sleeves until commencement of pipe installation.
 6. Mark sleeves on hard surfaces with a three inch (3") by three inch (3") "X" as per plans in a manner to ensure easy location in the future.
 7. Sleeve size requirements for wire and pipe, control wire shall be placed in sleeving separate from pipe sleeving:

a.	1" to 1-1/4" Pipe	2" PVC
b.	1-1/2" to 2" Pipe	4" PVC
c.	2-1/2" to 3" Pipe	6" PVC
d.	4" Pipe	8" PVC
e.	6" Pipe	10" PVC
f.	8" Pipe	12" PVC
g.	1 to 25 Control Wires	2" PVC
h.	26 to 50 Control Wires	3" PVC
i.	Two-Wire Decoder Cable	2" PVC

D. Installation of Piping

1. PVC Mainlines:

- a. Ensure that pipe is placed at a consistent depth and on a level base free of rocks and stones. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe laying is not in progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.
- b. Install mainlines a minimum of thirty-six inches (36") off any hard surface and thirty-six inches (36") away from swales.
- c. Solvent Weld PVC Pipe (required on all pipe two inch (2") or smaller and all PVC mainline within sleeves): Lay pipe and make all connections in accordance with manufacturer's recommendations. Do not install pipe when air temperature is below forty degrees (40°) F.
- d. Gasketed End Pipe (required on all pipe two and one-half inches (2-1/2") or larger): Lay pipe and make pipe-to-fitting or pipe-to-pipe joint, following the manufacturer's recommendations. Install joint restraint fittings and pipe restraints on all fittings and adjacent pipe runs per manufacturer's recommendations and per the Contract Drawings.

2. PVC Lateral Lines:

- a. Ensure that pipe is placed at a consistent depth and on a level base free of rocks and stones. When pipe laying is not in progress, or the end of each workday, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.
- b. Install lateral lines a minimum of twelve inches (12") off any hard surface and thirty-six inches (36") away from swales.
- c. Solvent Weld PVC Pipe (required on all lateral lines): Lay pipe and make all connections in accordance with manufacturer's recommendations. Do not install pipe when air temperature is below forty degrees (40°) F.

3. HDPE Lines:

- a. All connections between HDPE pipe sections are to be made with fusion welded fittings per the manufacturer's recommendations.
- b. All connections between HDPE and PVC are to be installed per manufacturer's recommendations.

- c. All connection fittings between HDPE and PVC or any other pipe material being used are to be made a minimum of thirty-six inches (36") away from any hard surface.
- E. Installation of Detectable Warning Tape:
 - 1. Refer to Division 31 Section "Excavation and Backfilling of Trenches" for installation depths.
 - 2. Detectable warning tape shall be installed on all irrigation mainline and lateral lines.
- F. Joint restraints on all gasketed PVC mainline pipe two and one-half inch (2-1/2") and larger: Install joint restraints per the plans and or manufacturer's recommendations.
 - 1. Joint restraints shall be installed as shown on the plans or per the manufacturer's recommendations. Prior to backfilling any joint restraints the Project Manager shall be present to verify that the restraints were installed in the proper locations and that all bolts have been tightened to the manufacturer's recommendations. Any restraints that are buried prior to inspection shall be excavated to allow for review and inspection at no additional cost to the Town.
- G. PVC Pipe Deflection
 - 1. Solvent welded pipe will meet manufacturer's recommendations.
 - 2. Gasketed pipe will not exceed one-inch (1") or two (2) degrees offset per twenty feet (20') in length.
- H. Flexible Plastic (Polyethylene) Pipe: Lay pipe and assemble fittings according to manufacturer's recommendations and per the Contract Drawings and Details.
- I. Control Wiring
 - 1. Two-wire control wiring:
 - a. Bury two-wire decoder cable between Automatic Irrigation Controller and electric valves in pressure supply line trenches, strung as close as possible to mainline with such cable to be consistently located to one side of pipe, or in separate trenches.
 - b. Make wire/cable splices at electric control valve connections as follows:
 - 1) Two-wire cable to two-wire cable - watertight connectors.
 - 2) Two-wire cable to electric valve solenoid wires - watertight connectors.
 - 3) Install all two-wire decoder cable splices not occurring at control valve in a separate round valve box as noted in section "Valve Boxes".
 - 2. Standard Low Voltage Control Wire:
 - a. Install one control wire for each control valve on standard low voltage wire systems.
 - b. On standard low voltage wire systems install a total of five spare fourteen (#14) AWG UFUL control wires and one spare twelve (#12) AWG UFUL common wire from Automatic Irrigation Controller pedestal to the end of each leg of mainline. Label spare wires at Automatic Irrigation Controller and wire splice box.
 - c. Make all splices and electric control valve connections using 3M DBR/Y connectors

3. Bury control wiring between Automatic Irrigation Controller and electric valves in pressure supply line trenches, strung as close as possible to mainlines with such wires to be consistently located to one side of pipe, or in separate trenches.
 - a. For standard low voltage wire systems bundle all twenty-four (24) volt wires at ten-foot (10') intervals.
 4. Provide an expansion loop at every mainline change of direction, every electric control valve location (in valve box), and every five hundred feet (500').
 - a. Form expansion loop in each control valve box by wrapping twenty-four inches (24") of wire around a one-inch (1") pipe and withdrawing pipe.
 - b. Leave seventy-two inches of extra two-wire cable in each valve box.
 5. Install all control wire splices not occurring at the control valve in a separate wire splice round valve box as noted in section "Valve Boxes".
 6. Wire Testing:
 - a. Existing wiring indicated to remain on documents is to be ohm-tested for continuity prior to construction. The Contractor shall produce the report and copy the Project Manager of the results of such testing.
 - b. New wiring: All new wiring to be tested for proper resistance prior to connection to valves and controller(s) for continuity. The Contractor shall produce the report and copy the Project Manager of the results of such testing.
 7. Tracer Wire:
 - a. One (1) continuous #10 AWG UL twenty-four inches (24") looped into each valve box, gate valve and quick coupler, and terminated inside the irrigation controller cabinet. Installed per the Contract Drawings.
 8. Detectable Warning Tape:
 - a. Refer to Division 31 Section "Excavation and Backfilling of Trenches".
- J. Installation of Valves:
1. Electric Control Valves: Install electric control valves as detailed on the Contract Drawings.
 - a. Electric Control Valves for two-wire system: Install electric control valves as detailed on the Drawings. Install one valve decoder module (Toro SB-DAC-1) per valve box.
 2. All low volume irrigation shall be zoned independently from turf, and product applications may not be mixed within zone.
 3. Quick Coupling Valves: Install quick coupling valves as detailed on the Contract Drawings.
 4. Drain Valves: Install manual drain valves at all low points in pressure supply line, whether indicated on the Contract Drawings or necessitated by actual conditions, to ensure proper drainage of the mainline.
 5. Isolation/Gate Valves: Install as detailed in locations shown on the Contract Drawings.
 6. Valve Boxes: Install one valve box for each type of valve as detailed. Install compacted gravel leveling bed after compaction of subgrade and prior to setting of valve box.
 - a. Install geotextile fabric over gravel prior to setting valves boxes. Ensure that geotextile fabric extends a minimum of six inches (6") from the bottom and no

more than six inches (6") from the top of box. Secure the geotextile fabric to the side of box with duct tape.

- b. Install valve boxes flush with finish grade and square to adjacent surface features and one another
- c. When valve boxes are grouped together, allow at least twenty-four inches (24") between valve box sides.
- d. Install valve boxes a minimum of eighteen inches (18") away from any hard surface.
- e. Cutting of valve boxes to give clearance for piping or valves is not permitted, except for the Master Valve and Flow Meter boxes.

K. Valve Box Identification Branding

- 1. Brand Lids as follows in two inch (2") high, minimum letters:
 - a. Isolation/Gate Valve "GV"
 - b. Quick Coupler Valve "QC"
 - c. Manual Drain Valve "DV"
 - d. Air Relief Valve "AR"
 - e. Master Valve "MV"
 - f. Flow Meter "FM"
 - g. Wire Splice Box "WS"
 - h. Grounding Rod "GR"
 - i. Filter "FIL"

3.04 BACKFLOW PREVENTION

A. Backflow Prevention Device: Contractor must meet all applicable laws, rules and codes, including but not limited to Uniform Building codes and applicable amendments Plumbing Codes and State Water Regulations. Assemblies must be installed per the manufacturer's specifications.

- 1. Install in strict accordance with current requirements of Denver Water. Connections to the Denver Water System are to have an approved assembly for the type of protection they provide, either isolation or containment.
- 2. Successful Testing of backflow assembly by a certified Backflow Prevention Assembly Tester is Contractor's responsibility and any cost shall be considered incidental. Test reports shall be forwarded to Denver Water in accordance with the State of Colorado regulations. Copies of the report, the tester's certification and the certification of the testing equipment used are to be forwarded to the Project Manager.
- 3. Request for final payment will not be certified or processed until certification reports have been filed with Denver Water and received by the Project Manager.

3.05 INSTALLATION OF SPRINKLER HEADS

A. Install sprinkler heads where designated after the Project Manager has approved staking. Set to finish grade as detailed.

1. Spacing of heads shall not exceed the maximum indicated on the Contract Drawings unless re-staked or as directed by the Project Manager. In no case shall the spacing exceed maximum recommended by manufacturer, with the exception of native areas as shown in the Contract Documents.
2. Install gear driven heads on swing-joint risers as detailed. Swing joints to non-pressure lines shall be set at no more than forty-five degrees (45°) or less than ten degrees (10°).
3. Install pop-up heads on swing pipe as detailed.
4. Adjust part circle heads for proper coverage. Adjust heads to correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other equipment. The Project Manager may request nozzle changes or adjustments without additional cost to the Town.

3.06 BACKFILLING

A. Refer to Division 31 Section "Excavation and Backfilling of Trenches".

1. Ensure backfill compaction is adequate so that settling does not occur.
2. Repair of turfgrass areas shall be as follows:
 - a. Seed is permitted for irrigation trenches up to twelve inches (12") in width.
 - b. Sod is required for any turf repair wider than twelve inches (12") and shall be installed as full width.

3.07 ADJUSTING

- A. Upon completion of installation, "fine-tune" entire system by regulating valves, adjusting arcs and radius, and setting pressure reducing valves at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible. Heads of same type shall be operating at same pressure within plus or minus ten percent (10%).
- B. If it is determined by the Project Manager or Denver Parks Operations Staff that irrigation adjustments will provide improved coverage and water distribution, the Contractor shall make such adjustments prior to Final Acceptance. Adjustments may include but not limited to changes in nozzle sizes, degrees of arc, and adjusting flow control. Adjustments shall be completed at no additional costs to the Town.
- C. All sprinkler heads shall be set perpendicular to finish grade or within allowable limits shown on Contract Drawings.
- D. Areas that do not conform to designated operation requirements, due to unauthorized changes or poor installation practices, shall be immediately corrected at no additional cost to the Town.

3.08 FIELD QUALITY CONTROL

- A. Flushing: After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, quick coupler assemblies, and hose valves, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for five (5) minutes through furthest valves. Cap risers after flushing.
- B. Testing Pressurized Mainline: Prior to installing any plant materials (sod, seed, trees, shrubs, perennials) arrange and conduct pressure test(s) in the presence of the Project Manager.

Arrange for testing a minimum of forty eight (48) hours in advance. The contractor is responsible to supply the hydrostatic test pump and all other equipment required to complete the test.

1. Set in place, cap and pressure test all piping under paving, in presence of the Project Manager prior to backfilling and paving operations.
2. After installation and backfilling of all control valves, fill pressure supply line with water, and pressurize to forty (40) PSI over the static pressure or to one hundred twenty (120) PSI, whichever is greater, for a test period of two (2) hours. Testing pressure not to exceed one hundred forty-five (145) PSI.
3. All isolation valves, angle valves, ball valves and zone valve flow controls are to remain open during testing.
4. Leakage, Pressure Loss:
 - a. Solvent welded PVC Pipe: Test is acceptable if zero (0) pounds of pressure is evident during the test period.
 - b. Gasketed Pipe: Test is acceptable if two (2) pounds of pressure or less is evident during the test period.
5. Leaks: Detect and repair leaks. Replace defective PVC pipe with new full length pipe section. No pipe splices will be accepted within pipe sleeve. No PVC pressure couplings or slip-fix repair couplings will be allowed.
6. Retest system until test pressure can be maintained for duration of test.

3.09 COMPLETION INSPECTION

- A. Arrange for the Project Manager to be present. Provide a minimum of forty-eight (48) hours of notice in advance of walk-through.
- B. Entire system shall be completely installed and operational and trenches shall be finish graded and sod and/or seed in place prior to scheduling of walk-through.
- C. Electrically operate each zone in its entirety for the Project Manager the time of walk-through.
- D. A project inspection walk through shall include but is not limited to the following:
 1. Contractor shall adjust, straighten and nozzle all heads prior to walk through. Review operation, coverage, head/nozzle adjustment, and system adjustment per specifications.
 2. Contractor shall have all valves boxes unlocked prior to walk through. Open valve boxes to confirm materials, geotextile fabric, gravel bedding, wire splices, compaction, elevation, workspace access within boxes, clearance from lid and bedding, locking mechanisms, and zone branding. Interior of boxes should be free of foreign material, only geotextile fabric shall be visible in the bottom of boxes. All valves must be tagged with zone identification, Christy's valve marker tags or equal and valve box lids must be branded with zone valve identification. Verify connections in all valve and wire splice boxes.
 3. Contractor shall provide documentation that resistance tests for all spare common and hot wires and tracer wire has been performed and the results for ohms reading on each wire tested.
 4. Confirm irrigation heads are at specified elevation and distance(s) from paved surfaces and curbs, plumb and soil compacted.

5. Inspect concrete size and elevation of pads for backflow assembly, booster pump, and controller enclosure pads. Confirm quality of concrete, finishes, access to the Irrigation Controller and spare conduit/sleeving as required for wiring.
6. Review trench and related excavation repair including backfill, compaction, fine grade, seed, and sod installation.
7. Review appropriate use of purple valve covers and other product as required for non-potable water applications.
8. Generate a punch list of items to be corrected, prior to Substantial Completion.
9. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.

3.10 CLEANING

- A. Maintain continuous cleaning operation throughout duration of Work. Dispose of, all trash, waste materials, debris and excess soil generated by installation of irrigation system, off-site, at no additional cost to the Town. Contractor shall clear all debris, including, soil, from all paths, walks, roads, and other hard surface areas.

3.11 PROTECTION

- A. The Contractor shall repair any damage that occurs from construction operations at no additional cost to the Town.
- B. Restrict vehicular and pedestrian traffic from areas where irrigation has been installed. Erect temporary fencing or barricades and install warning signs as required or directed by the Project Manager at no additional cost to the Town.

END OF SECTION

SECTION 32 90 00
GENERAL LANDSCAPE

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish all trees, shrubs, and other plant materials, labor equipment, and non-plant materials required to complete installation of planting indicated on the landscape Drawings and details. Furnish all soil preparation, fertilizer, soil mulching, trees, shrubs, groundcovers, sodding, bed mulching, labor and equipment required to landscape all areas as indicated on the landscape Drawings.
- B. Work in this Section includes, installation of trees, shrubs, perennials, annuals, ornamental grasses, sodding of lawns, installation of mulch materials and mitigation of areas damaged by construction activities performed under this Contract.
- C. Section includes Specifications for the installation of trees, shrubs, ornamental grasses, perennials, annuals, turf, seeding, installation of mulch materials and mitigation of areas damaged by construction activities performed under this Contract.
- D. Owner Furnished Items - None
- E. Permits – Contractor will be responsible for obtaining all necessary permits required for installation of landscape and irrigation. Contractor shall know, understand, and comply with all watering restrictions. Permits may be necessary if restrictions are in effect.

1.02 REFERENCES

- A. Refer to Drawings and general provisions of the Contract, including General and Supplementary Conditions.
- B. Refer to Section on Soil Preparation
- C. Refer to Section on Sodding
- D. Refer to Section on Seeding

1.03 DEFINITIONS

- A. Subgrade: The final elevation of material supporting additional material above it.
- B. Finished Grade: The final elevation of the upper most surface material. (sod shall be top of thatch layer.)

1.04 SUBMITTALS

- A. Submittals and Samples shall be submitted in accordance with Specification Section 01 33 00.
- B. Product Data – Submit product data sheets for each of the following items. Submittals must be made prior to commencing any activities.

- 1. Weed Control Fabric

2. Compost
3. Sod
4. Seed
5. Weed control herbicide (including Material Safety Data Sheet [MSDS])
6. Insecticides and fungicides (including MSDS)

C. Samples

1. Submit physical samples of each of the following materials for approval. All samples shall be submitted in a one quart, clear, plastic bag (Ziploc type) or appropriate container. Submittals must be made prior to commencing any activities. All samples shall be clearly labeled with the following information:
 - a. Project Name Site Improvements
 - b. Material name as shown on Drawings and Specifications
 - c. Supplier or distributor's name
 - d. Supplier or distributor's product name and/or order number
2. Required samples are as follows
 - a. Wood Mulch
 - b. Rock Mulch
 - c. Compost

D. Supplier List – A single list of all material Suppliers for plant material, and all related landscape and irrigation materials to complete the Work in this section and related sections. List must be submitted prior to commencing any activities.

E. Construction Schedule – Prior to beginning installation of the landscape, the Contractor is to submit a Project construction schedule to the Construction Manager for approval in accordance with Specification Section 01 32 00. The schedule should include the areas and types of construction to be undertaken and the sequence which will be used to accomplish the completion of the Project. Schedule must be submitted prior to commencing any activities.

F. Certificates for Inspections of Materials

1. All State, Federal, or other inspection certificates shall be submitted to the Construction Manager prior to acceptance of the plant material along with other information showing the source or origin.
2. Current grower or nursery certifications indicating that all Contractor-supplied plant material is healthy, vigorous, and free from insect pests, plant diseases, and injuries.

G. Contract Closeout Submittals

1. Operation and Maintenance Manual – At the completion of the Work, furnish written maintenance instructions to the Construction Manager for maintenance and care of the landscaping in accordance with Specification Section 01 78 23. Instructions shall include directions for irrigation, weeding, pruning, fertilization, and spraying, as required for continuance of proper maintenance through one full growing seasons and dormant periods.

2. Guarantee and Warranty – At completion of Work, furnish written guarantee and warranty to the Construction Manager based on the requirements of this section.

1.05 QUALITY ASSURANCE

A. Reference Standards

1. U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and equal in quality to standards for Certified Seed.
2. Requirements for measurements, grading, branching, quality, and the balling and burlapping of plants listed in the plant list shall follow the current issue of American Standard for Nursery Stock issued by the American Association of Nurserymen, Inc. (ANSI-Z 60.1-1990)
3. Plants shall equal or exceed the measurements specified in the plant list, which are minimum acceptable sizes. Plants shall be measured before pruning with branches in normal position. Any necessary pruning shall be done at the time of planting.

B. Quality of Materials

1. All materials shall be subject to inspection and approval. The Engineer reserves the right to reject at any time or place, prior to acceptance, the Work and all materials which in the Engineer's opinion fails to meet these Specification requirements.
2. Inspection is primarily for quality; however, other requirements are not waived even though visual inspection results in approval. Materials may be inspected where growing but inspection at the place of growth shall not preclude the right of rejection at the Site. Inspection may be made periodically during installation of materials, at completion, and at the end of guarantee periods by the Engineer. Plants shall have a habit of growth that is normal for the species. They shall be healthy, vigorous, and free from insect pests, plant diseases, and injuries. All plant material shall be inspected stock conforming to all State and Federal Regulations.
3. Plant material shall not exhibit signs of accelerated growth.

- C. Vandalism – The Contractor will not be responsible for malicious destruction of plantings after final acceptance of the Project. Contractor will, however, be responsible for replacement of vandalized materials stored but not yet installed, and vandalized material prior to final acceptance. All cases of vandalism shall be promptly reported to the Construction Manager and Owner. The Contractor shall inform the Construction Manager in writing if additional protection must be installed to protect the landscaping from damage after installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping

1. Deliver fertilizer to Site in original unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance to State law. Notify Construction Manager of delivery schedule in advance so material may be inspected upon arrival at the job Site.
2. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at the Site. Provide copies of delivery receipts for materials to be incorporated into the construction to the Construction Manager as the deliveries are made. Materials to be accounted for include fertilizers, soil amendments, peat moss, manure, grass seed, plant tabs, and mulches.

3. Plants shall be containerized with limbs bound, properly wrapped and prepared for shipping in accordance with recognized standard practice. The root system shall be kept moist and plants shall be protected from adverse conditions due to climate and transportation, between the time they are dug and actual planting.
4. Each plant shall be identified by means of a grower's label affixed to the plant. The grower's label shall give the data necessary to indicate conformance to specifications. Use durable waterproof labels with water resistant ink which will remain legible for at least 60 days. Notify the Construction Manager prior to delivery of plant materials to the Site so that a pre-planting inspection may be made by Engineer or indicate delivery schedule in advance so plant material may be inspected upon arrival at job Site, whichever is more appropriate.
5. Do not drop plants. Do not lift plants by the trunk, stems, or foliage. The ball of the plant shall be natural, and the plant shall be handled by the ball at all times. All plants shall be protected at all times from drying out or other injury. Minor broken and damaged roots shall be pruned before planting.

B. Acceptance at Site

1. Remove unacceptable plant material immediately from job Site.
2. Major damage shall be cause for rejection.
3. No balled or burlapped plant shall be accepted if the ball is broken or the trunk is loose in the ball.

C. Storage and Protection

1. Deliver trees and shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than four (4) hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage, and keep roots moist by setting balled stock on ground and cover ball with soil, peat moss, or other acceptable mulch material.
2. Keep root balls moist at all times. Do not allow root balls to dry out.
3. Protect all existing and newly planted trees, shrubs, and groundcover within the areas of construction and related excavation as herein specified. Provide suitable barricades and/or fences as required.

1.07 PROJECT/SITE CONDITIONS

- A. The Contractor must examine the subgrade upon which Work is to be performed, verify subgrade elevations, observe the conditions under which Work is to be performed, verify suitability of the soil and notify the Construction Manager in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Construction Manager. Commencement of Work shall mean acceptance of the Site conditions.

B. Existing Conditions

1. The Site will be provided to the Contractor within ± 0.2 foot of finish grades.
2. Utilities – Determine location of Underground Facilities and perform Work in a manner which will avoid possible damage. Do not permit heavy equipment such as trucks, rollers, or bulldozers to damage utilities. Hand excavate when called for to minimize the possibility of damage to underground utilities. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned. Any damage to utilities that

may result in spite of protective measures must be completely corrected and repaired by the Contractor at no additional cost to the Owner.

1.08 SEQUENCING & SCHEDULING

A. Planting Schedule

1. Schedule each type of landscape work required during the normal season for such work in the area of the Site. Establish dates for each type of work and establish a completion date. Correlate Work with specified maintenance periods to provide maintenance until accepted by the Owner. Do not depart from the accepted schedule, except with written authorization. Submit request to the Construction Manager for changes in the planting schedule. When delays in the planting schedule are unavoidable, include documentation of the reason for delay.
2. Plant trees and shrubs during normal season for such work in the location of the Project.

B. Coordination with Lawns – Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to the Engineer. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.09 WARRANTY AND GUARANTY

1. Guarantee trees, shrubs, groundcovers and all plant material for a period of one year from the date of final acceptance against defects not resulting from neglect of Owner, or abuse and damage by others.
2. For a period of one year after acceptance of Work, at no additional cost to the Owner, the Contractor is to replace any plants that are dead, or that are in unhealthy or unsightly condition, or have lost their natural shape due to dead branches or excessive pruning. Inadequate maintenance by the Owner shall not be cause for replacement. All replacement planting is to be done no later than the succeeding season.
3. Replacement plants shall be of the same variety and size or larger as originally specified in the plant list. Plants shall be planted as originally specified. All areas damaged by planting or replacement operations shall be fully restored to their original condition as specified. Remove all dead or defective plant material from the Site immediately.
4. A one-year warranty shall also apply to the plants replaced at the first warranty walk-through.

1.10 MAINTENANCE

- A. Begin interim maintenance period immediately after planting of landscape materials, and after planting of lawn areas, and continue interim maintenance until landscape Work is deemed substantially complete and accepted by the Owner.
- B. The maintenance period will commence when all areas have received Substantial Completion. Large or phased projects may require adjustments to this date. This can be negotiated with the Owner and Construction Manager after installation has begun.
- C. Meet with the Owner's Related Entities prior to final acceptance, and prior to the termination of the maintenance period, to go over maintenance requirements of the Project and/or to conduct training in accordance with Specification Sections 01 78 23 and 01 91 13. Note that information conveyed to the Owner shall be consistent with the maintenance instructions provided by the

Contractor in accordance with Specification Section 01 78 23, and as part of the Contract close out submittals in accordance with Specification Section 01 77 00.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Mulches – Refer to Drawings for specified materials.
- B. Edger
 - 1. Refer to Drawings for color, thickness, and height of edging material.
 - 2. Steel edger shall be used to contain all planting beds, except where adjacent to sidewalks, paving, walls, or other solid edges.
 - 3. Edger shall be interlocking.
 - 4. All steel edger placed within ten (10) feet of building or structure (excluding retaining walls) or completely encircling a building's perimeter (regardless of distance) shall be perforated to allow positive drainage away from the building and not allowing water to pond or be dammed along the edger line.
- C. Stakes and Guys
 - 1. Stakes - 6' and 2' long, heavy-duty t-bar steel posts.
 - 2. Guys - 12-gauge galvanized steel wire
 - 3. Nylon straps - 1 1/2", with metal grommets ends.
 - 4. 3/4" white, PVC pipe, 24" lengths.
- D. Tree Wrapping – Clark's Tree Wrap, 4" wide, designed to prevent winter bark injury. Secure with flexible grafting ties.
- E. Weed Control Fabric – Superior 3.5 oz. Spun bonded landscape fabric or approved equal. Submit sample and data sheet containing tear strength, water flow rate, permeability, and puncture strength.
- F. Soil and Soil Amendments
 - 1. Ground Compost (Item #18-126) as supplied by Front Range Materials (303-425-9992), or approved equal. Refer to Section 32 90 10 for expectations of the compost.
 - 2. Fertilizer – Granular, inorganic mixture. Refer to section 32 92 00 for specific types.
- G. Sod – Refer to Drawings for specified turf blend, as supplied by Bittersweet Turf Farms (303-659-5118).
- H. Fertilizer – Refer to individual sections.
- I. Water – Free of substances harmful to plant growth. Be responsible for furnishing water from underground sprinkler system, quick couplers, or other source.
- J. Trees, Shrubs, Ornamental Grasses, and Flowers

1. Provide nursery-grown trees, shrubs, ornamental grasses, and flowers except as otherwise indicated, grown in a recognized nursery in accordance with good horticultural practice, with healthy root systems developed by transplanting or root pruning. Provide only healthy vigorous stock, free of diseases, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions, or disfigurement. Plants grown in Hardiness Zones 2, 3, 4, 5, and 6 only, will be accepted. Hardiness Zones are defined in U.S. Department of Agriculture publications. Grower's certificates may be required when doubt exists as to the origin of the plant material.
2. Provide trees, shrubs, ornamental grasses, and flowers true to name and variety established by the American Joint Committee on Horticultural Nomenclature "Standardized Plant Names", Second Edition, 1942.
3. Provide trees, shrubs, ornamental grasses, and flowers of the size shown or specified in the plant list and in accordance with the dimensional relationship requirements of ANSI Z60.1 for the kind and type of plant material required. Plant material of larger than specified size may be used, in which case the sizes of the root balls will be increased proportionately.
4. Label each tree and shrub with a securely attached waterproof tag bearing legible designation of botanical and common name and size.
5. Where formal arrangements or consecutive order of plants are shown, select stock for uniform height and spread, and label with numbers (if necessary) to assure symmetry in planting.
6. Provide plant material complying with the recommendations and requirements of ANSI Z60.1 "Standard for Nursery Stock" and as further specified.

K. Deciduous Trees

1. Provide trees of the height and caliper listed or shown.
2. Where shade trees are required, provide single stem trees with straight trunk and intact leader, free of branches to a point.
3. Where small trees of upright or spreading type are required, provide trees with single stem, branched or pruned naturally according to species and type, and with the relationship of caliper and branching recommended by ANSI Z60.1, unless otherwise shown.
4. Where shown as "bush form" provide trees with 3 or more main stems starting close to the ground in the manner of a shrub.
5. Where shown as a "clump form" provide trees with 3 or more stem starting from the ground.
6. Provide balled and burlapped deciduous trees unless noted as container plants. Balled and burlapped plants shall be dug with firm, natural balls of earth of the diameter specified or larger, to encompass the fibrous and feeding root system necessary for full recovery of the plant. No balled or burlapped plant shall be accepted if the ball is broken or the trunk is loose in the ball.

L. Deciduous Shrubs and Groundcovers

1. Provide deciduous shrubs with not less than the minimum number of canes required by ANSI Z60.1 for the type and height of shrub specified.
2. Plants furnished in containers shall have been grown in pots, cans, or baskets long enough to have sufficient roots to hold earth together intact after removal from container, without being root bound.

M. Coniferous and Broadleaf Evergreens

1. Provide evergreens of the size shown. Dimension indicates minimum spread for spreading and semi-spreading type evergreens and height for all other types such as globe, dwarf, cone, pyramidal, broad- up-right, and columnar.
2. Provide evergreens with well-balanced form complying with requirements for other size relationships to the primary dimension shown.
3. Trees shall exhibit consistent growth periods and shall not exhibit signs of accelerated growth.
4. Provide balled and burlapped evergreen trees unless otherwise noted as container or collected stock.
5. Foliage shall have a good intense color.
6. Trees shall contain a central dominant leader with evenly spaced branches. Plants containing multiple central leaders will be rejected.

N. Requirements for Balled and Burlapped Stock

1. Where shown or specified to be balled and burlapped, provide trees and shrubs dug with a firm, natural ball of earth in which they were grown.
2. Provide ball size of not less than the diameter and depth recommended by ANSI Z60.1 for the type and size of tree or shrub required. Increase ball size or modify ratio of depth to diameter as required to encompass the fibrous and feeding root system necessary for full recovery of trees or shrubs subject to unusual or atypical conditions of growth, soil conditions, or horticultural practice.
3. Wrap and tie earth ball as recommended by ANSI Z60.1 for the size of balls required. Drum-lace balls with a diameter of thirty inches (30") or greater.

O. Requirements for Container Grown Stock

1. Where specified as acceptable, provide healthy, vigorous well rooted shrubs or ornamental grasses established in the container in which they are sold.
2. No bare rooted or recently containerized stock will be accepted.
3. Established container stock is defined as a tree or shrub transplanted into a container and grown in the container for a length of time sufficient to develop new fibrous roots so that the root mass will retain its shape and hold together when removed from the container.
4. Use rigid container which will hold ball shape and protect root mass during shipment.
5. Provide trees and shrubs established in containers of not less than the minimum sizes recommended by ANSI Z60.1 for the kind, type, and size of trees and shrubs required.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Contractor shall inspect the Site with the Engineer and Construction Manager prior to beginning any activities on Site. The Contractor shall provide a written report of any discrepancies that would interfere with their scope of work or would delay progress on the Project.

3.02 INSTALLATION/APPLICATION/ERECTION

- A. Proceed with and complete the landscape Work as rapidly as portions of the Site become available, working within the seasonal limitations for each kind of landscape work required.
- B. Cooperate with any other contractors and trades which may be working in and adjacent to the landscape work areas.
- C. Fine Grading and Soil Preparation – Refer to section 32 92 00.
- D. Seeding – Refer to section 32 92 00.
- E. Edger
 - 1. Outline edger lines with stakes or paint, for acceptance by Engineer, before installing irrigation.
 - 2. Steel edger shall be in all locations as identified in construction drawings. Minor fine tuning of these lines may be required after the placement of sod.
 - 3. Perforated steel edger shall be installed around buildings to prevent ponding or damming of water.
- F. Final Plant Locations
 - 1. Stake location of individual trees, for approval by Engineer prior to planting or excavating.
 - 2. If a new tree or shrub relocation is necessary due to interference with underground piping or wiring, the Contractor shall notify the Construction Manager and receive approval of a new location from the Engineer.
 - 3. The Engineer must approve the precise location of all plants prior to pit excavation and installation.
 - 4. Make minor adjustments as requested by the Engineer, or as necessary to avoid conflicts with sprinkler line locations.
- G. Excavation for Planting
 - 1. Where rubble fill is encountered, notify Construction Manager and prepare planting pits properly by removal of rubble or other acceptable methods.
 - 2. If rock, underground construction work, or other obstructions are encountered in excavation for planting of trees or shrubs, notify the Construction Manager. If necessary, new locations may be selected by the Engineer.
 - 3. If subsoil conditions indicate the retention of water in planting areas, as shown by seepage or other evidence indication the presence of underground water, notify the Construction Manager before backfilling.
 - 4. Tree pits shall be dug with flat bottoms and vertical sides. Tree pits shall be dug with radius equal the diameter of the root ball. All tree pits shall have a minimum depth to accommodate root ball.
 - 5. At the Engineer's option, tree pits will be filled with water and must drain completely within twenty-four hours to be acceptable. Pits that do not drain shall be provided with twelve-inch (12") diameter X thirty-six inch (36") deep auger holes (one per tree pit) to be

filled with 1 1/2" gravel. A Change Order will be issued if the Engineer determines drain holes shall be installed.

H. Setting and Backfilling

1. Set container-grown stock, excavate as specified for balled and burlapped stock except container width and depth shall govern. Pit shall be at least twice as wide as the container.
2. Set tree ball, plumb and in the center of pit or trench with top of ball 2", minimum, above adjacent landscape grades. Remove burlap from sides and tops of balls, but do not remove from under balls. Remove platforms, if any, before setting. Do not use stock if ball is cracked or broken before or during planting operation. When setting place additional backfill around base and sides of ball and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.
3. No burlap shall be pulled out from under balls.
4. A minimum of three-quarters of the wire basket and surplus nylon or binding shall be completely removed, taking care not to damage the root ball. Any roots which are bruised or broken shall be pruned at the time of planting.
5. After planting, the Contractor shall water each plant regularly until final acceptance.
6. Set container-grown stock as specified for balled and burlapped stock, except cut cans on 2 sides with a metal cutter and remove bottoms of wooden boxes before setting. Carefully remove cans and sides of wooden boxes after partial backfilling so as not to damage root balls.
7. For plantings in non-turf areas, provide berm around the edge of excavations to form shallow saucer to collect water and to hold mulch.

I. Mulching

1. Fine grade all planting beds to be mulched allowing for full depth of specified mulch.
2. Place specified mulch evenly over all areas at depth indicated on Drawings.
3. Rake and feather finish grade of mulch level and 1/2" below adjacent edger surfaces.
4. Make sure mulch is at full depth at adjacent walks and paved surfaces and that mulch doesn't protrude above these surfaces.
5. Mulch a 36" diameter ring around all trees in turf areas with specified depth of wood mulch, after irrigation areas have been watered in.
6. All trees and shrubs in native areas are to have a mulch ring equal to the diameter of the planting pit. Mulch shall be a uniform three inches in depth. Do not remove saucer (or berm) around plants in native areas when mulching.

J. Weed Fabric

1. When required, fabric should be cut around plants and not tucked and folded.
2. In parking lot islands and in high wind areas, the perimeter of all weed fabric shall be secured using sod staples (or equal) evenly spaced at intervals of approximately three feet.
3. Fabric shall be overlapped at seams, approximately twelve inches and stapled along the seam every three feet.

4. Weed fabric should not be used in annual or perennial flower beds.

K. Pruning

1. Prune, thin out, and shape trees and shrubs in accordance with standard horticultural practice. Prune trees to retain required height and spread.
2. Do not cut tree leaders and remove only injured or dead branches from flowering trees, if any.
3. Prune shrubs to retain their natural character and shape, and to accomplish their use in the landscape design.
4. Required shrub sizes are the size after pruning.
5. Remove and replace excessively pruned or deformed stock resulting from improper pruning.

L. Guying and Staking

1. Standard Guying System – Pound stakes into undisturbed soil beyond the planting pit so that stake is secure (2' deep minimum). Secure wire through metal grommets on nylon strap and wrap above first branch or at mid-point of tree. Secure guy wire to stake so that it is taut but allows some movement and so that no sharp projection of wire are extending from post. Adjust tension on wire if needed. Flag guy wire with 3/4" PVC pipe for visibility.
2. Alternate (Conifer) Guying System – Pound stakes into undisturbed soil beyond the planting pit so that stake is secure (2' deep min.), angling away from planting pit and so that top is flush with finish grade. Secure wire through metal grommets on canvas strap and wrap at mid point of tree. Secure guy wire to stake so that it is taut but not overly tight and so that no sharp projections of wire are extending from post. Adjust tension on wire if needed. Flag guy wire with 3/4" PVC for visibility.

3.03 FIELD QUALITY CONTROL

- A. When all the landscape Work is completed, the Construction Manager and Engineer shall upon seven (7) calendar days advance notice, make an inspection of the landscape Work to determine if the Work is complete. The Construction Manager and Engineer shall prepare a punch list of items improperly installed, inadequately sized or otherwise deficient based on the findings of their inspection. The punch list shall be completed not more than seven (7) working days after the field inspection. When the Contractor has remedied all deficiencies and completed all items on the punch list, the Contractor shall request another inspection by the Construction Manager and Engineer to determine whether the deficiencies have been adequately corrected. Once the punch list items have been corrected and re-inspected, the Construction Manager shall issue a written certificate to the Owner who will then respond to the Contractor in writing formally accepting the Work and beginning the warranty and guarantee period.
- B. Additional landscape inspections shall be conducted upon request by the Owner, to determine the condition of the Work at the completion of the warranty period.
- C. The required maintenance instructions shall be forwarded to the Construction Manager prior to the final acceptance to inform the Owner of any maintenance responsibilities that would be required for the Project.

3.04 ADJUSTING AND CLEANING

- A. During landscape work, store materials and equipment where directed.

- B. Keep pavements clean and work areas in an orderly condition.
- C. Protect landscape Work from loss, damage, and deterioration during storage, installation, and maintenance periods.
- D. Protect from unauthorized persons (trespassers), as well as from operations by other contractors and tradesmen and landscape operations.
- E. At the time of the final inspection of the Work and before the issuance of final acceptance, all paved areas shall be thoroughly cleaned by the Contractor by sweeping and washing. All construction equipment and excess materials shall have been removed and any debris or rubbish shall have been removed from the Site.

END OF SECTION

SECTION 32 90 10

REVEGETATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies revegetation requirements including all material, labor, and equipment for reseeding all areas disturbed during construction. Reseed all areas within the construction limits which are unpaved, are not drives or parking areas, are not structures, and are not rock or concrete lined outfall areas. Reseeding shall consist of soil preparation, spreading fertilizer, and reseeding with the seed type specified.

1.02 REFERENCES

- A. CDOT Standard Specifications for Road and Bridge Construction, 1999, with the following revisions:
1. Replace the word "roadway" with the word "construction".
 2. Replace the word "Division" with the word "Owner".
 3. Replace the word "Engineer" with word "Owner".

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 and CDOT Section 212.07:
1. Manufacturer's test reports for purity and germination of seed, dated within six months of seeding.
 2. Name of subcontractor, qualifications, and experience in this type of work.
 3. A revegetation plan describing the type of materials proposed for reseeding, the techniques for reseeding, and a proposed schedule for reseeding in accordance with CDOT Section 212 and Weld County Natural Resources Conservation Service (NRCS).
 4. Supplier and supplier's type designation for all fertilizers and commercial products and manufacturer's certification that fertilizer meets specifications.
 5. Seed bag weight tickets upon delivery of unopened containers or bags. Each bag of seed must have its original seed tag attached at the time of delivery and should remain attached until the seed is used. Test date shown on seed tags must be current. All seed tags shall be saved and provided to the Owner.
 6. Certification that mulch is weed free as designated in CDOT Section 213.

PART 2 PRODUCTS

2.01 SEED MIXTURE

- A. Seed shall meet all the requirements of CDOT Section 212 and Weld County Natural Resource Conservation Service (NRCS). It shall be drilled at the rate of pounds per acre of pure live seed as designated herein. The native upland seed mixture as required by NRCS shall be as follows:

Species	Scientific Name	Rate-PLS lbs/acre	% of Mix
Western Wheatgrass	<i>Agropyron smithii</i> 'Arriba'	8.0	30%
Sideoats Grama	<i>Bouteloua curtipendula</i> 'Vaughn'	4.5	25%
Blue Grama	<i>Bouteloua gracilis</i> 'Hachita'	1.5	20%
Little Bluestem	<i>Panicum virgatum</i> 'Blackwell'	2.5	15%
Little Bluestem	<i>Schizachyrium scoparium</i> 'Pastura'	3.5	10%
Total PLS lbs/Acre		20	100

2.02 SOURCES

A. Native seed sources are:

1. Granite Seed
1697 West 2100 North
Lehi, Utah 84043
(801) 768-4422
2. Western Native Seed
P.O. Box 188
Coaldale, CO 81222
(719) 942-3935

2.03 SEED QUALITY

- A. All seed shall be free from such noxious weed seeds such as Russian or Canadian, thistle, coarse fescue, European bindweed, Johnson grass, Purple Loosestrife, and leafy spurge as well as additional weeds that are to be controlled by Weld County including Musk Thistle, Scotch Thistle, Field Bindweed, Russian Knapweed, Diffuse Knapweed, Spotted Knapweed, and Dalmation Toadflax. Furnish to the Town a signed statement certifying that the seed furnished is from a lot that has been tested by a recognized laboratory. Seed that has become wet, moldy, or otherwise damaged in transit or in storage, will not be acceptable. The tags from the seed mixes must be supplied to the Town.

2.04 SEED PURITY AND GERMINATION

- A. The seed shall have a minimum germination and a minimum purity of 85 percent. If available seed products do not meet the minimum purity and germination percentages specified, furnish sufficient additional seed of lower percentage of purity or germination to equal the specified product. The formula for determining the quality of pure live seed (PLS) shall be:

$$(\text{Pounds of seed}) \times (\text{germination}) \times (\text{purity}) = \text{pounds of pure live seed (PLS)}$$

2.05 MULCH

- A. Mulch shall be the Hay or Straw type, and shall conform to CDOT Section 213.02. Tackifier material shall consist of a free-flowing, noncorrosive powder produced from the natural plat gum of plantago insularis (Desert Indianwheat), applied in a slurry with water and wood fiber. The powder shall possess the following properties:

1. Protein Content: 1.6 +/- 0.2%
2. Ash Content: 2.7 +/- 0.2%

3. Fiber: 4.0 +/- 0.4%
 4. pH 1% Solution: 6.5 – 8.0
- B. The material shall not contain any mineral filler, recycled cellulose fiber, clays, or other substances, which may inhibit germination or growth of plants. The wood fiber and water used shall conform to CDOT 213.02 – par. 2, and 209.02, respectively.

2.06 FERTILIZER

- A. Fertilizer in upland native seeded areas shall be 40# available phosphate per acre. Application shall conform with CDOT Section 212.06, subparagraph (b). Time of application will be as applicable to the kind of fertilizer and type of equipment used.

PART 3 EXECUTION

3.01 GENERAL

- A. All work related to re-seeding of disturbed areas shall comply with Sections 212 and 213 of CDOT, Construction Requirements, except as modified herein.

3.02 SOIL PREPARATION

- A. Topsoil
1. Salvage, place, and key topsoil to the underlying material in accordance with CDOT Section 207. A uniform 6-inch depth of topsoil shall be stripped, stockpiled, and spread uniformly over the disturbed areas to be seeded or planted. The soil shall be free of clods in excess of 2 inches in diameter and brought to the desired line and grade. Till topsoil in accordance with CDOT Section 212.06 subparagraph (a).
- B. Fertilizer
1. Apply fertilizer at the rate of 40 pounds available phosphorus per acre over all disturbed areas. Mix fertilizer into top 2 inches of soil by harrowing or tilling.
- C. Fine Grading
1. Correct irregularities in the ground surface resulting from soil preparation operations and slope upland areas to drain.

3.03 SEEDING

- A. Seeding shall conform to CDOT Section 212.03 – Seeding Seasons and 212.06 – Native Seeding, except as modified herein.
- B. Rework previously prepared areas that have become compacted or damaged by rains or traffic.
- C. Apply by drilling at the rate specified herein. Seed shall be drilled with a drill that is capable of placing the specified seed and the specified rate, at a ¾-inch depth. The drill should have a 7-inch or less drill row spacing and be equipped with packer wheels to firm the soil over the drill row. Dragging chains behind the drill to cover seed is not acceptable.
- D. Broadcast seeding will be allowed only in those areas not accessible to drilling equipment. Broadcast seeding rates will be twice that designated for drilling. Cover broadcast seed to a

depth between ½ and ¾-inch by raking or harrowing. Hydraulic seeding or hydroseeding is not allowed.

- E. Firm seeded areas with roller weighing maximum of 100 lbs per foot of width.

3.04 MULCHING

- A. Mulching shall be accomplished by the crimping method using straw or hay. Mulching shall be applied at the rate of 1 ton per acre in accordance with CDOT Section 213. A tackifier shall be applied to the crimped in mulch as specified. All seeded areas shall be mulched, crimped, and tackified within 24 hours after seeding. Otherwise, areas shall be reseeded, at the Contractor's expense, prior to the mulching, crimping, and tackifying. Tackifier shall be applied with a spray nozzle, dispensing a mist that will uniformly cover the surface.

3.05 MAINTENANCE

- A. All seeded areas shall be kept in a damp condition for at least 14 days after seeding, to aid in germination. It is the Contractor's responsibility to provide an acceptable method to keep the areas damp as required. Direct flows from large hoses which could damage the mulch or cause erosion will not be permitted.

3.06 RESEEDING AND REPAIR

- A. Restore and re-seed eroded areas and areas lacking a satisfactory stand of grasses at the end of 12 months following seeding. A satisfactory stand is defined as a minimal coverage of 6 healthy plants per square foot. Reseeding and repair shall occur during the earliest seeding season.

END OF SECTION

SECTION 32 91 13

SOIL PREPARATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Report Documentation
 - 1. Geotechnical Engineering Study (if applicable)
 - 2. CWA Section 404 Permit Evaluation (if applicable)
 - 3. Materials Management Plan (MMP) (if applicable)

1.02 SUMMARY

- A. This Section includes requirements for the preparation of soil for seeding, sodding, or planting operations. Soil preparation consists of ripping, fertilizing, soil conditioning, and fine grading the topsoil. Soil preparation as specified herein must precede all seeding, sodding, and planting.
- B. Related Sections
 - 1. Division 01 Section "Tree Retention and Protection".
 - 2. Division 01 Section "Erosion and Sedimentation Control".
 - 3. Division 31 Section "Clearing and Grubbing".
 - 4. Division 31 Section "Earth Moving".
 - 5. Division 32 Section "Topsoil".
 - 6. Division 32 Section "Turfgrass Seeding".
 - 7. Division 32 Section "Native Seeding".
 - 8. Division 32 Section "Sodding".
 - 9. Division 32 Section "Trees, Plants, and Groundcovers".

1.03 DEFINITIONS

- A. Fertilizer: A substance that is added to soil to help the growth of plants.
- B. Soil Amendment: Any substance which is intended to improve the physical, chemical, or other characteristics of the soil.
- C. Soil Conditioner: Combination of slow-release fertilizer, humate, and Mycorrhiza.

1.04 SUBMITTALS

- A. See Division 01 Section "Submittals" for submittal requirements.
- B. Testing Agency Qualifications: The Project Manager to approve prior to construction.

- C. Soils Test Data: See Quality Control.
 - 1. Material Test Reports
 - a. Soil analysis for native soils at the project site.
- D. Product Data (for each type of product):
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Material Certificates: For each type of soil conditioner, soil amendment, and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. State, Federal and other inspection certificates shall accompany invoice for materials showing source or origin.
- E. Samples: For each bulk-supplied material, one (1) quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.05 QUALITY CONTROL

- A. Testing Agency: Retain an independent, state-operated, or university operated laboratory experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated and that specializes in the types of tests to be performed.
 - 1. Laboratories: Subject to compliance with requirements, provide testing of materials in the Section by a qualified testing laboratory approved by the Project Manager.
 - 2. Multiple Laboratories: Work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.
- B. Preconstruction Testing
 - 1. Engage the approved testing agency to perform preconstruction soil analyses on existing on-site soil, imported topsoil, and pre-amended imported soil.
 - 2. Notify Project Manager seventy-two (72) hours in advance of the dates and times when laboratory samples will be taken.
- C. Soil Sampling Requirements
 - 1. Sample Collection and Labeling: Have samples taken and labeled by the Contractor in the presence of the Project Manager and under the direction of the testing agency.
 - 2. Number and Location of Samples: Minimum of five (5) samples for projects up to one (1) acre in size and two (2) additional samples for each additional acre of project size. Samples shall be collected randomly throughout the areas that will receive similar soil preparation, including seed/sod, native seeding, planting beds, and gardens. Provide a site plan of the sampling locations to the Project Manager for approval, prior to sampling.
 - 3. Procedures and Depth of Samples: Collect composite samples to a depth of six inches (6") and combine in a clean plastic container.
 - 4. Mixing of Samples: Mix samples together thoroughly, removing plant debris and breaking up clods.

5. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

D. Testing Requirements

1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
2. Fertility Testing: Soil-fertility analysis shall, include the following:
 - a. Percentage of organic matter.
 - b. CEC, calcium percent of CEC, and magnesium percent of CEC.
 - c. Soil reaction (acidity/alkalinity pH value).
 - d. Buffered acidity or alkalinity.
 - e. Lime estimate.
 - f. Soil texture estimate.
 - g. Nitrogen ppm.
 - h. Phosphorous ppm.
 - i. Potassium ppm.
 - j. Manganese ppm.
 - k. Zinc ppm.
 - l. Iron ppm.
 - m. Boron ppm.
 - n. Copper ppm.
 - o. Sodium ppm
 - p. Sodium absorption ratio (SAR).
 - q. Soluble-salts ppm.
 - r. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 - s. Other deleterious materials, including their characteristics and content of each.

- E. Recommendations: Based on the test results, provide recommendations for soil treatments, amendments, and conditioners to be incorporated to produce a soil suitable for healthy viable plant growth for the species indicated in the Contract Documents. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per one thousand (1,000) sq. ft. for six inch (6") depth of soil.

2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per one thousand (1,000) sq. ft. for six inch (6") depth of soil.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with State and Federal laws if applicable.
- B. Bulk Materials
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Do not move or handle materials when they are wet or frozen.
 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. Notify the Project Manager of delivery schedule in advance so material can be inspected upon arrival at the project site. Immediately remove unacceptable material from the project site.

1.07 PROJECT/SITE CONDITIONS

- A. General: Do not perform work when climate and existing site conditions will not provide satisfactory results.
- B. Vehicular site access shall be limited to the area(s) indicated on the Contract Drawings or as defined by the Project Manager.
- C. Damage to turf, natural areas, pavements, irrigation systems, underground utilities, and any other improvements shall be repaired by the Contractor at no additional cost to the Town.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Shall be as specified under Division 32 Section "Topsoil".
- B. Soil Amendments
 1. Class I compost material shall consist of aged organic matter, free of weed or other noxious plant seeds, lumps, stones, or other foreign contaminants harmful to plant life, and having the following characteristics based on a nutrient test performed no longer than 3 months prior to its incorporation into the project:
 - a. Organic matter: twenty-five (25%) percent maximum.
 - b. Salt content: Five (5.0) mmhos/cm maximum.
 - c. pH: 7.5, maximum.
 - d. Carbon to nitrogen ratio shall be less than 20:1.

2. Mountain peat, aspen humus, gypsum and sand will not be accepted.
- C. Soil Conditioners
1. In general, native seed areas shall receive Soil Conditioners unless otherwise noted or specified by the Project Manager. For the purpose of bidding the contractor shall assume the products listed below will be applied at the rate specified by the manufacturer for each planting type identified in the Construction Documents. Once soils tests have been received and a determination is made on the proper amount to be added to the site-specific soils, the rate to be applied may be adjusted per the price based on the Schedule of Values for Soil Conditioner.
 - a. Organic slow release fertilizer (6-1-1), acceptable product: "Biosol" or approved equal.
 - b. Granular Humic Acid soil conditioner, acceptable product: "Menefee Humate Soil Conditioner".
 - c. Mycorrhizal Fungi:
 - 1) Native Seeding: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of endomycorrhiza.
 - 2) Woody Plantings: Dry, granular inoculant containing at least ninety-five (95) million spores per lb (0.45 kg) of ectomycorrhizal fungi, thirty-three percent (33%) hydrogel, and a maximum of five and one-half percent (5.5%) inert material.

PART 3 EXECUTION

3.01 SITE EXAMINATION

- A. Examine the site for compliance with requirements and other conditions affecting performance.
1. General: Verify that existing site conditions are as specified and indicated on the Contract Drawings before beginning work under this Section.
 2. Grades: Inspect to verify rough grading is within +/- one tenth of one foot (0.1') of grades indicated and specified.
 3. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
 4. Unsatisfactory Conditions: The General Contractor shall notify the Project Manager in writing of any known unsatisfactory site conditions. If the soil is found to be unfit to support planting as described above, it is to be removed and replaced with clean soil from a source approved by the Project Manager.
- B. Locate all utilities (sewer, water, irrigation, gas, electric, phone, and other conduits and subsurface equipment) prior to commencing work. The Contractor shall be responsible for the protection of all new and existing infrastructure and repair any damages caused by work under this Section at no additional cost to the Town.
- C. Protect grade stakes set by others until removal is directed by the Project Manager.

3.02 PREPARATION

- A. In general, turf and planting areas shall receive Soil Amendments unless otherwise noted or specified by the Project Manager. For the purpose of bidding, the Contractor shall assume all areas to receive soil amendments will be at four (4) cubic yards per one thousand (1,000) square feet. Once soils tests have been received and determination is made on the proper amount to be added the site-specific soils the rate to be applied may be adjusted per the price based on the Schedule of Values for Soil Amendments.
- B. Weed Seed Eradication: Perform pesticide treatment over the entire area to be planted during the growing season. Allow enough time to successfully complete the entire pesticide treatment process (germinate / terminate) before proceeding with planting.
1. Water surface one half (1/2") inch per week for two (2) weeks prior to application if natural precipitation does not supply this amount to encourage weed seed germination.
 2. Notify Project Manager forty-eight (48) hours in advance of each pesticide treatment.
 3. Apply pesticide in accordance with manufacturer's recommendations.
 4. Two (2) weeks after the first pesticide application, review surface for evidence of plant growth.
 5. If there is no evidence of plant growth, obtain the Project Manager's approval of surface conditions to proceed with Soil Preparation.
 6. If more than 10% of the area to be planted contains new plant growth, the pesticide and watering application shall be repeated until new plant growth is satisfactorily eradicated.
 7. Remove plant debris from treated area.
- C. Areas of Compacted Topsoil: Areas within the work limits, or as defined on the Contract Drawings or by the Project Manager, that have vegetation that is sparse, stunted, anemic, weedy or was used as construction staging, a parking area, and/or subjected to heavy use will require ripping to prepare the soil for planting. Scarify compacted soil to an eight-inch (8") minimum depth to loosen topsoil.
- D. Areas of Disturbance from Additional Construction Activities: Areas that have been disturbed for construction implementation activities shall have the vegetation removed, soil prepared per the specifications, and soil recompacted to meet the compaction requirements for the specified area.
- E. Areas of Disturbed Topsoil: Areas disturbed but not severely compacted, as determined by the Project Manager, shall be deep tine aerated or shattered to prepare the soil for revegetation.
- F. Areas of Undisturbed Natural Topsoil: Undisturbed sites that are or were supporting healthy plant growth need only surface seedbed preparation prior to sowing seed.
- G. Area of Bluegrass Conversion
1. Irrigate existing bluegrass to be replaced to ensure an actively growing stand of grass. Continue irrigation for duration of seedbed preparation.
 2. Spray existing bluegrass to be replaced up to three (3) times with glyphosate per manufacturer's rates and directions. The second (2nd) application to take place one week after the first (1st) application.
 3. Apply herbicide a third (3rd) time if needed. Third (3rd) application to take place two weeks after the second (2nd) application.

4. Remove weeds, debris, and rocks larger than 1" which may hinder seeding or subsequent operations. Dispose of accumulated debris at direction of Project Manager.

3.03 INSTALLATION OF SOIL AND SOIL AMENDMENTS

- A. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.
- B. Beginning of installation means Acceptance of existing conditions by the Contractor.
- C. Install topsoil as required in Division 31 section "Earth Moving" and Division 32 Section "Topsoil".
- D. Timing: Perform soil preparation just prior to planting operations and in accordance with final planting schedule.

1. Coordinate with irrigation system installation to avoid damage.

E. Soil Preparation in Turf Grass and Planting Bed Areas:

1. Apply Soil Amendments at the following rates:
 - a. Soil Amendments: Bid quantity to be four (4) cubic yards per one thousand (1,000) square feet, or per soil test recommendations.
 - b. Fertilizer: Refer to Related Sections. Mycorrhizal inoculants: Apply per manufacturer's instructions and quantities appropriate to the planting type.
2. After applying Soil Amendments, thoroughly till area to depth of six inches (6") minimum by plowing, rototilling, harrowing, or disking until soil is well pulverized and thoroughly mixed. Soil Conditioners and Fertilizer shall be applied topically once final grade has been established and just prior to sodding or seeding.
3. Take soil samples, in similar locations to pre-construction testing, and test amended soil to ensure the final product meets the laboratory recommendations prior to planting.

F. Soil Preparation in Native Grass Areas

1. Apply Soil Amendments/Conditioners per manufacturer's recommendation, at the quantities indicated in soil test results.
2. Deep Core Aeration:
 - a. Use a hollow core tine aerator. Plugs shall be 3" long, minimum.
 - b. Flag all irrigation heads within conversion area prior to aeration and seeding. Alternatively, irrigation heads may be temporarily removed, capped, and replaced.
 - c. Make three passes over all the treated (dead) grass, going in different directions each time, leaving the plugs on the surface.
 - d. Do not aerate within 4' radius of existing trees to avoid injury to surface roots.

G. Fine Grading in all Landscape Areas

1. Complete fine grading for all areas prior to seeding or planting. Allow for natural settlement.
2. For ground surface areas surrounding buildings to be landscaped, maintain required positive drainage away from buildings.

3. Establish finish grades as follows:
 - a. Lawn, Seeded, and Unpaved Areas: Finish areas to within not more than +/- five one-hundredths (.05') of a foot above or below required elevations.
 - b. Athletic Fields: Finish areas to within not more than +/- two one-hundredths (0.02') of a foot from required elevation.
4. Finish grade shall be below edge of pavement prior to sodding, seeding or planting.
 - a. Sodded Areas: Allow one and one-half inches (1-1/2") for sod.
 - b. Seeding Areas: Allow one inch (1") for seed.
 - c. Planting Beds: Allow four inches (4") for mulch.
5. Compaction of Surface Grade Prior to Landscape Installation: Firm, but not hard, eighty five percent (85%) standard Proctor density within two percent (2%) optimum moisture.
6. Turfgrass Lawn Areas: Prior to acceptance of grades, hand rake to smooth, even surface, free of debris, clods, rocks and organic matter greater than one inch (1").
7. Restore planting areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

3.04 INSPECTION

- A. Provide notice to the Project Manager requesting inspection at least seventy-two (72) hours prior to anticipated date of the work.
- B. Deficiencies: The Project Manager will specify deficiencies to the Contractor who shall make satisfactory adjustments and shall again notify the Project Manager for an additional inspection.

3.05 CLEANING

- A. Protect areas adjacent to soil preparation and planting areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove debris and excess materials from site. Clean out drainage inlet structures. Clean all paved and finished surfaces that are soiled as a result of work under this Section.

3.06 PROTECTION AND REPAIR

- A. Provide and install barriers as required and as directed by the Project Manager to protect completed areas against damage from pedestrian and vehicular traffic until Acceptance by the Town.
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Vehicle traffic.
 4. Foot traffic.
 5. Erection of sheds or structures.
 6. Impoundment of water.

- 7. Excavation or other digging unless otherwise indicated.
- C. If prepared soil or subgrade is disturbed or contaminated prior to planting, the Contractor shall restore or replace the planting soil as directed by the Project Manager at no cost to the Town.

END OF SECTION

SECTION 32 91 20

TOPSOIL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Report Documentation
 - 1. Geotechnical Engineering Study (if applicable)
 - 2. CWA Section 404 Permit Evaluation (if applicable)
 - 3. Materials Management Plan (MMP) (if applicable)

1.02 SUMMARY

- A. This Section includes requirements for furnishing, stockpiling, and placing topsoil on a previously prepared subgrade.
- B. Related Sections
 - 1. Division 01 Section "Tree Retention and Protection".
 - 2. Division 01 Section "Erosion and Sedimentation Control".
 - 3. Division 31 Section "Earth Moving"
 - 4. Division 31 Section "Excavating and Backfilling of Trenches".
 - 5. Division 32 Section "Soil Preparation".
 - 6. Division 32 Section "Turfgrass Seeding".
 - 7. Division 32 Section "Native Seeding".
 - 8. Division 32 Section "Sodding".
 - 9. Division 32 Section "Trees, Plants, and Groundcovers".

1.03 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

- E. Planting Area: Areas to be planted.
- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.04 SUBMITTALS

- A. See Division 01 Section "Submittals" for submittal requirements.
- B. Testing Agency Qualifications: The Project Manager to approve prior to construction.
- C. Soil Analysis Report: See Quality Control.
 - 1. Material Test Reports
 - a. Soil analysis for each imported topsoil to be used.
 - b. Soil analysis for each amended planting soil.
 - c. Soil analysis for each manufactured topsoil.
- D. Product Data (for each type of product):
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Material Certificates: For each type of soil conditioner, soil amendment, and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. State, Federal and other inspection certificates shall accompany invoice for materials showing source or origin.
- E. Samples: One (1) quart volume per five hundred (500) cubic yards for each type of soil used. Soil shall be in sealed containers with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished and provide an accurate representation of composition, color, and texture and be accompanied by the results of the analysis.
- F. A source for imported material (imported topsoil, amended planting soil, manufactured topsoil, etc) shall be submitted for approval by the Project Manager.
 - 1. Imported Material from a Quarry: A letter shall be submitted to the Project Manager specifying the type of material.
 - 2. Imported Material from a Source Other than a Quarry: Submit a Phase I Environmental Assessment (ESA) and sampling protocol and/or a Phase II ESA or similar.

1.05 QUALITY CONTROL

A. Existing On-Site Topsoil

1. Sample Collection and Labeling: Samples shall be taken and labeled by the Contractor in the presence of the Project Manager.
2. A map of the site illustrating the locations of each sample is to be submitted to the Project Manager for approval prior to collecting the samples. Samples shall be collected randomly throughout the areas to receive similar topsoil, including seed/sod, native seeding, planting beds, and gardens.
3. Follow instructions from soil testing laboratory when collecting samples.
4. A minimum of five (5) samples for projects up to one (1) acre in size and two (2) additional samples for each additional acre of project size. Individual tests are to be completed for each sample.
5. Submit soil analysis report for stockpiled on-site topsoil from the State University Agricultural Extension Service or other approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH, percentage organic matter, and soluble salts (electric conductivity in milliohms/centimeter) and shall include additive recommendations.
6. Testing will be at the expense of the Contractor.

B. Imported Topsoil

1. Submit source location for topsoil to be imported to site for approval by the Project Manager.
 - a. Any topsoil or fill material to be moved to and placed on Town-owned property must be free of contamination (observed or previously documented) and be acceptable for unrestricted residential use. Imported topsoil or material that contains stains, odors, or debris regardless of analytical results shall not be imported to CCD-owned property.
2. A soil analysis report for topsoil imported to site shall be provided, from the State University Agricultural Extension Service or other approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH, percentage organic matter, and soluble salts (electric conductivity in milliohms/centimeter) and shall include additive recommendations.
 - a. One 1-quart sample per five hundred (500) cubic yards of imported soil is required, with individual tests completed for each sample.
 - b. Follow instructions from soil testing laboratory when collecting samples.
3. Testing will be at the expense of the Contractor.

C. Manufactured Topsoil

1. A soil analysis report for stockpiled on-site topsoil shall be provided from the State University Agricultural Extension Service or other approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH, percentage organic matter, and soluble salts (electric conductivity in milliohms/centimeter)
 - a. Test is to be completed within sixty (60) days preceding delivery to site. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH,

percentage organic matter, and soluble salts (electric conductivity in milliohms/centimeter).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver or place topsoil in a frozen, wet, or muddy condition.
- B. Protect stored and placed topsoil from vehicular traffic, equipment storage, material storage, or from contaminants or pollution sources. Topsoil that is compacted or tainted during construction is to be removed from site and disposed of at a licensed landfill at no additional cost to the Town.

PART 2 PRODUCTS

2.01 ON-SITE TOPSOIL

- A. Topsoil previously stripped and stockpiled prior to earthwork operations. See Division 31 Section "Earth Moving".

2.02 IMPORTED TOPSOIL

- A. All topsoil shall be a loam or sandy loam conforming to ASTM D 5268. At least ten (10) days prior to topsoil delivery, notify the Project Manager of the source(s) from which topsoil is to be furnished. Topsoil shall be furnished by the Contractor and shall be a natural, friable soil representative of productive soils and shall meet the following conditions.
 - 1. It shall be obtained from the top six-inches (6") of well drained areas.
 - 2. Fertile, friable, loamy soil, reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than one-inch (1"), coarse sand, noxious seeds, sticks, brush, litter, and other deleterious substances; suitable for the germination of seeds and the support of vegetative growth.
 - 3. The pH value shall be between 6.5 and 8.5.
 - 4. Soil Texture:
 - a. Sand: thirty percent (30%) – fifty percent (50%)
 - b. Silt: thirty percent (30%) – fifty percent (50%)
 - c. Clay: five percent (5%) – thirty percent (30%)
 - 5. Additives: As determined by soil fertility tests.
 - 6. Percent Organic Content:
 - a. Turf grass shall be three to five percent (3-5%) maximum after amending or conditioning.
 - b. Native grass shall be one to three percent (1-3%) maximum after amending or conditioning.
 - 7. Soluble Salts: Electric conductivity (EC) shall be less than two (2.0) mmhos/cm for turfgrass areas, dryland areas, and planting beds.

2.03 MANUFACTURED TOPSOIL

- A. If applicable, the Consultant shall fill in information on Manufactured Topsoil. "Amended Topsoil" as manufactured by A-1 Organics, or substitution as approved by the Project Manager.

PART 3 EXECUTION

3.01 SITE EXAMINATION

- A. Examine areas where the Work of this Section will be performed for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
 - 2. Verify that final grades are completed in accordance with the Contract Drawings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by Project Manager.

3.02 INSTALLATION OF TOPSOIL

- A. Scarify compacted subgrade to an eight-inch (8") depth to bond topsoil to subsoil. Place topsoil to a minimum depth of six-inches (6") after settlement. Topsoil shall be free from weeds, sod, and material larger than 1-inch (1"), toxic substances, litter or other deleterious material. Spread evenly and grade to elevations and slopes shown on the Contract Drawings. Hand rake inaccessible areas to machine grading.
- B. Utilize salvaged topsoil as the top layer to the extent available. If enough on-site material is not available, the Contractor shall furnish and install imported topsoil in the manner described above. Topsoil shall be mixed thoroughly with the salvaged topsoil prior to placement.

3.03 CLEANING

- A. Keep adjacent paving and other areas free of topsoil. Maintain a clean and orderly work area.
- B. Remove debris and excess materials from site. Clean out drainage inlet structures. Clean all paved and finished surfaces that are soiled as a result of work under this Section.

3.04 PROTECTION AND REPAIR

- A. Provide and install barriers as required and as directed by the Project Manager to protect completed areas against damage from pedestrian and vehicular traffic until Acceptance by the Town.
- B. Protect areas of topsoil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.

- C. If prepared soil or subgrade is disturbed or contaminated prior to planting, the Contractor shall restore or replace the planting soil as directed by the Project Manager at no additional cost to the Town.

END OF SECTION

SECTION 32 92 00

SEEDING

PART 1 GENERAL

1.01 SUMMARY

- A. The Contractor shall supply all material and labor necessary for seeding of irrigated seed mix, dryland grasses, non-irrigated seed mix, and wetland seeding, in areas shown on Drawings.
- B. The Contractor will be expected to produce a lush stand of grasses by the end of the two-year establishment period.

1.02 REFERENCES

- A. Reference Standards: Comply with U.S. Department of Agriculture Rules and Regulations under Federal Seed Act and be equal in quality to standards for Certified Seed.
- B. Refer to General Landscape Section
- C. Refer to Landscape Maintenance Section
- D. Refer to Soil Preparation Section.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements

1. Irrigated Seed Areas – This includes all areas with in the limits of Work that are recently planted and irrigated. Contractor should monitor these areas on a regular basis for the presence of weeds. Areas will require individual attention and separate maintenance schedules; thus, the Contractor is responsible for developing and sustaining a weed-free, lush stand of specified grasses. Chemical, mechanical, or manual methods should be implemented to prevent the spread of weeds. Mowing is the preferred method to help establish newly seeded areas. Contractor will be expected to re-seed or over-seed areas as bare spots develop. Bare spots should not exceed 8 inches square by the end of the first full growing season.
2. Non-irrigated Dryland Seeded Areas – This includes all areas with in the limits of Work that are recently seeded, and do not receive supplemental watering. Contractor should monitor these areas on a regular basis for the presence of weeds. Areas will require individual attention and separate maintenance schedules; thus, the Contractor is responsible for developing and sustaining a weed-free, lush stand of dryland grasses. Chemical, mechanical, or manual methods should be implemented to prevent the spread of weeds. Mowing is the preferred method to help establish newly seeded areas. Contractor will be expected to re-seed or over-seed areas as bare spots develop. Bare spots should not exceed 12 inches square by the end of the first full growing season.

1.04 SUBMITTALS

- A. Refer to submittals in General Landscape Section.

1.05 QUALITY ASSURANCE

- A. Refer to General Landscape Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00.
- B. Deliver seed in sealed standard containers stating correct name and composition on the outside of the container. Seed damaged in transit or storage will not be accepted.

1.07 PROJECT/SITE CONDITIONS

- A. Existing Conditions – Vehicular accessibility on the overall Project site shall be as directed by Construction Manager. Repair damage to prepared ground and surfaces caused by vehicular movement during Work under this section to original condition at no additional cost to Owner.
- B. Environmental Conditions – Do not drill or sow seed during windy weather or when ground is frozen or otherwise un-tillable.

1.08 WARRANTY

- A. At completion of Work, furnish written warranty to Owner based upon requirements as specified.

1.09 MAINTENANCE

- A. The interim maintenance period shall begin immediately after each area is seeded and continue until Substantial Completion of entire Project. Final acceptance of seeded areas will not be given until Engineer is satisfied with germination and a full stand of grass is in a vigorous growing condition, with consistency and completion of coverage. During this time, be responsible for watering, mowing, spraying, weeding fertilizing and all related work as necessary to ensure that seeded areas are in a vigorous growing condition. Provide all supervision, labor, material, and equipment to maintain seeded areas.

PART 2 PRODUCTS

A. MATERIALS

- 1. Seed Mix – Refer to Drawings for seed mixture.
- 2. Seeding Rate – Refer to Drawings for drilled seed, seeding rate.

2.02 SOURCE QUALITY CONTROL

A. Inspection

- 1. Primarily for quality; however, other requirements are not waived even though visual inspection results in acceptance.
- 2. Inspection will be made periodically during seeding and at completion of the Work by Construction Manager and Engineer, and at end of warranty period by Engineer.
- 3. Seed material is subject to inspection and acceptance. Engineer reserves the right to reject at any time or place prior to acceptance, any work and seed which in Engineer's opinion fails to meet specification requirements.

B. Testing Requirements

1. Seed and seed labels shall conform to current State and Federal regulations and be subject to testing provisions of the Association of Official Seed Analysis.
2. The Engineer may require tests of seed verification at the Contractor's expense.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing Site conditions are as specified and indicated before beginning Work under this section.
- B. Layout – Verify layout of seeding areas as indicated prior to starting seeding operations.
- C. Grades – Inspect to verify that rough grading is within 0.2 foot of grades specified and indicated.
- D. Unsatisfactory Conditions – Report in writing to Construction Manager.
- E. Acceptance – Beginning of installation means acceptance of existing conditions by the Contractor.

3.02 PREPARATION

- A. Protection
 1. Be responsible for proper repair to landscape, utilities, fences, pavements, and other site improvements damaged by Contractor's operations under this Section.
 2. Identify prepared seeding areas requiring protection and erect barriers for proper protection and traffic control.
- B. Erosion Control – Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the Site throughout the duration of Work.
- C. Seeding Areas – Remove weeds, debris, and rocks larger than ½" which may hinder seeding or subsequent operations. Dispose of accumulated debris in accordance with the Contract Documents and at the direction of Construction Manager.
- D. Fine Grading – Perform as required to maintain positive drainage, prevent ponding and direct run-off into catch basins, drainage structures, etc. and as required to provide smooth well-contoured surface prior to proceeding. Tolerance: + 0.04 foot.
- E. Soil Preparation
 1. Soil preparation in all native seed areas is critical to the success and establishment of the plant material. Contractor is to ensure that all areas receive proper and adequate soil preparation.
 2. If the area to be developed is infested with noxious or invasive weeds, a chemical application will be required, at a rate recommended on the chemical's product label.

3.03 SEEDING

- A. Drill or plant in manner such that after surface is raked and rolled, seed shall have 1/4" of cover. Accomplish seeding by 'Rangeland' type drills. Any furrows left by drill seeding shall be rolled to a smooth surface. Smaller areas inaccessible with a seed drill can be hand broadcast and the seed can be raked into the surface.
- B. If broadcast seeding is necessary, the seed rate shall be doubled.
- C. If hydroseeding is necessary, the seed rate specified should be multiplied by four.
- D. When using a drill type seeder, the seeder should cover the area twice. The first pass and second pass should be perpendicular to each other. Each pass of the seeder should apply approximately ½ of the required seeding rate.
- E. On sloped or shaped areas, the first pass of the seeder shall attempt to follow the general contour.
- F. All seeding shall occur between September 15th and May 15th, unless otherwise approved by the Engineer.

3.04 RESEEDING

- A. Areas shall be reseeded if they exhibit areas with bare spots greater than the acceptable amounts noted in Part 1 of this section. Reseeding shall occur continually during the establishment period.

3.05 MOWING AND TRIMMING

- A. Irrigated Seed Areas
 - 1. Contractor should set mower deck heights as high as possible, to avoid cutting too much of the new grass. Mowing is intended to cut broad leaf weeds so that sunlight can better reach new grasses. Additionally, it is intended to cut and desiccate the weed's flower buds before they develop and spread seeds.
 - 2. Irrigated grasses should be mowed approximately every three weeks during the growing season (April 1 to October 1). The actual frequency will be related to how fast the grass and weeds are growing. Since this is based on the amount of irrigation received and environmental conditions it is difficult to determine the total number of mowings required. The Contractor should expect to mow a total of eight times during the growing season. Bids shall reflect an allowance for which mowing is billed against.
 - 3. The Contractor shall schedule mowing to occur within one week's time if so, directed by the Engineer or Construction Manager.
 - 4. Mowing of irrigated grasses should begin once weeds reach 8" in height, or prior to flowering (and re-seeding) of weeds. Cut these areas as high as possible, but enough to remove the weed's flowers and a substantial portion of the leaves.
 - 5. Remove clippings from adjacent pavement or irrigated turf areas.
 - 6. Second and subsequent growing seasons, irrigated native areas should be mowed only as required to control weeds. Contractor shall mow grasses twice during these growing seasons. The first mowing shall occur the first week of June. A second mowing shall occur the first week of October. This mowing pattern shall continue until the native grass stand is adequately developed, as determined by the Engineer.

7. At no time should weeds be allowed to flower or reach a height of eight inches.
8. Mowing should be rescheduled if the ground is wet, and the potential exists for causing damage from equipment.

B. Non-Irrigated Seed Areas

1. Contractor should set mower deck heights as high as possible, to avoid cutting too much of the new grass. Mowing is intended to cut broad leaf weeds so that sunlight can better reach new grasses. Additionally, it is intended to cut and desiccate the weed's flower buds before they develop and spread seeds.
2. Mowing of non-irrigated grasses should begin once weeds reach 8" in height, or prior to flowering (and re-seeding) of weeds. Cut these areas as high as possible, but enough to remove the weed's flowers and a substantial portion of the leaves. Remove clippings from adjacent pavement or irrigated turf areas.
3. Generally, the Contractor shall mow grasses twice during the growing seasons. The first mowing shall usually occur the first week of June. A second mowing shall usually occur the first week of October. This mowing pattern shall continue until the native grass stand is adequately developed, as determined by the Engineer. The Contractor should expect to mow a total of two times during the growing season. Bids shall reflect an allowance for which mowing is billed against.
4. At no time should weeds be allowed to flower or reach a height of eight inches.
5. Mowing should be rescheduled if the ground is wet, and the potential exists for causing damage from equipment.

3.06 WEED CONTROL

- A. Mowing is the preferred method of weed control on seeded areas.
- B. Mowing is discouraged for wildflower areas, as a method of weed control.
- C. Manual, mechanical, or chemical methods are acceptable.
- D. Notify Owner and/or Construction Manager at least three days in advance before any chemical application.
- E. As required, using selective herbicides approved by Engineer. Apply according to manufacturer's instructions.
- F. Comprehensive Broadleaf Weed Herbicide program as needed once grasses have reached 8" to 12" height.
- G. Spot weeding with Systemic Herbicide program on bi-weekly basis on entire area to eradicate all broadleaf weeds.
- H. Hand weed areas where weeds are evident and spray application would damage existing grasses.

3.07 INSECT AND DISEASE CONTROL

- A. As required, apply insecticide and fungicide approved by Engineer. Apply according to manufacturer's instructions.

- B. Notify Owner and/or Construction Manager at least three days in advance before any chemical application.

3.08 FERTILIZER

- A. Initial fertilizer application under the Soil Preparation Section.
- B. Fertilizer may be mixed with hydromulch and tackifier, instead of mixing with soil amendments, if pre-approved by Engineer.
- C. Second and subsequent applications of fertilizer are as follows.
 - 1. Application of 20-5-10-1% Fe 25% SCU at the rate of 5 lbs. per 1,000 sq. ft. for 1 lb. Actual Nitrogen per 1,000 sq. ft. Thoroughly sweep curb, gutter, and walks after application of fertilizer and prior to irrigating. Do not apply fertilizer during rainfall or when rainfall is imminent. Protect all concrete from iron spots due to fertilizer.

3.09 MULCH

- A. Utilize hydromulch and tackifier or straw and crimp as directed by Engineer. A combination of these methods may be used.
- B. Utilize hydromulch and tackifier on irrigated seed areas, unless slopes exceed 3:1 (horizontal:vertical)
- C. Utilize straw and crimp for large open spaces where finish grades are not as critical at the time of establishment.
- D. Hydromulch shall be applied at a minimum rate of 2,000 pounds per acre with 3% tackifier.
- E. Straw shall be applied at a minimum rate of 2,000 pounds per acre and with partial embedment into the soil by a crimper or similar implement.
- F. Materials for straw and crimping mulching shall consist of Certified Weed Free field or marsh hay or straw of oats, barley, wheat, rye or triticale certified under the Colorado Department of Agriculture Weed Free Forage Certification Program and inspected as regulated by the Weed Free Forage Act, Title 35, Article 27.5, CRS. Each certified weed free mulch base shall be identified by one of the following:
 - 1. One of the ties binding the bale shall consist of blue and orange twine, or.
 - 2. One of the ties binding the bale shall consist of specially produced galvanized shiny wire, or.
 - 3. The bale shall have a regional Forage Certification Program tag indicating the Regional Forage Certification Program Number.
 - 4. Mulch shall be inspected for and Regionally Certified as weed free based on the Regionally Designated Noxious Weed and Undesirable Plant List for Colorado, Wyoming, Montana, Nebraska, Utah, Idaho, Kansas, and South Dakota.
 - 5. The Contractor shall not unload certified weed free mulch bales or remove their identifying twine, wire, or tags until the Engineer has inspected and approved them.
 - 6. The Contractor shall provide a transit certificate that has been filled out and signed by the grower and by the department of Agriculture inspector.

7. The Contractor may obtain a current list of Colorado Weed Free Forage Crop Producers who have completed certification by contacting the Colorado Department of Agriculture, Division of Plant Industry.
 8. Straw or hay in an advanced stage of decomposition or old, dry straw which breaks in the crimping process will not be accepted.
- G. Timing – Mulch seeded areas immediately after seeding. Areas not mulched within 24 hours after seeding shall be reseeded with the specified seed mix prior to mulching.
- H. Quality Control – Repair and remulch areas improperly mulched or damaged by Contractor's negligence, in specified manner. Mulch removed by circumstances beyond the Contractor's control shall be repaired and remulched as ordered with payment for this corrective work, when ordered, at the Contract prices.
- 3.10 EROSION CONTROL
- A. Contractor shall abide by all Town of Silt requirements for erosion control.
- B. Refer to Section 31 25 00.
- C. Apply erosion control netting to any area which is vulnerable to soil erosion such as swales or steep slopes.(3:1 or steeper slopes)
- D. If Contractor fails to net such areas and soil erosion subsequently occurs, Contractor shall re-establish finish grade, soil preparation, seed bed, and apply jute netting at his own expense.
- E. Erosion Control Netting
1. Roll out in direction of flow after seeding and mulching.
 2. Apply material loosely and smoothly on soil surface without stretching.
 3. Avoid walking directly on seed-bed either before or after jute is applied.
 4. In cases where one roll of netting ends and second roll is needed, overlap up-channel piece over second roll by at least 18". Where two or more widths of netting are applied side by side, make overlap of at least 4".
 5. Outside Edges of Netting – Spread loose topsoil over edges to allow for smooth entry of water.
 6. Stapling – Staple overlaps which run parallel to direction of flow in channel bottoms on 2 foot intervals. Staple outside edges, centers, and overlaps on banks on 2 foot intervals.
 7. Each Width of Cloth – Install row of staples down center as well as along each side.
 8. Staple check slots and junctions of new rolls across channel on 6" intervals.
 9. On soft or sandy soil or in windy areas, apply staples in alternate slanting position and space at 14" to 18".
 10. For extra hard soil or shale areas, use sharp hardened steel 3" fence type staples. Do not use 3" staples on normal turf.

3.11 NOTIFICATION AND INSPECTION

A. Inspection

1. When germination is complete, and plants are visible, the Contractor shall notify the Construction Manager. The inspection will be used to determine if the area is substantially complete (meaning that there is definitive widespread germination of seed that appears will fill in the first year as required) and if the warranty period should commence.
2. All washouts, thin, weak, or dead areas should be repaired prior to the inspection.

- B. Deficiencies – Engineer and/or Construction Manager will specify deficiencies to Contractor who shall make satisfactory adjustments and shall again notify Construction Manager for inspection.

3.12 CLEANING

- A. Remove debris and excess materials from Site. Clean paved and finished areas soiled as a result from Work under this section, in accordance with direction given by Construction Manager. Clean out drainage inlet structures.
- B. Remove mulch, from seeding operations, immediately from trees, shrubs, and sod to prevent damage to same.

3.13 PROTECTION

- A. Provide and install barriers as required and as directed by Construction Manager, or as needed to protect seeded areas from damage from pedestrian and vehicular traffic. Contractor is responsible for malicious destruction of seeding caused by others.

END OF SECTION

SECTION 32 92 20

NATIVE SEEDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Report Documentation
 - 1. Geotechnical Engineering Study (if applicable)
 - 2. CWA Section 404 Permit Evaluation (if applicable)
 - 3. Materials Management Plan (MMP) (if applicable)

1.02 SUMMARY

- A. This Section includes requirements for the installation of native seed, mulch, erosion control material (if applicable), and establishment of the seeded areas, to be achieved as outlined in these Specifications until Final Acceptance.
- B. Related Sections:
 - 1. Division 01 Section "Erosion and Sedimentation Control".
 - 2. Division 01 Section "Tree Retention and Protection".
 - 3. Division 31 Section "Earth Moving".
 - 4. Division 31 Section "Watering".
 - 5. Division 32 Section "Irrigation System".
 - 6. Division 32 Section "Soil Preparation".
 - 7. Division 32 Section "Topsoil".
 - 8. Division 32 Section "Trees, Plants, and Groundcovers".

1.03 REFERENCES

- A. Comply with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and be equal to or better in quality than the standards for Certified Seed.

1.04 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.

- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments, soil conditioners and fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.
- H. Weeds: Including but not limited to Puncturevine, Field Bindweed, Dandelion, Jimsonweed, Diffuse, Spotted and Russian Knapweed, Quackgrass, Horsetail, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canada Thistle, Nutgrass, Blackberry, Tansy Ragwort, Bermuda Grass, Johnsongrass, Poison Ivy, Nut Sedge, Nimble Weed, Bent Grass, Barnyard Grass, Perennial Sorrel, Cheatgrass, Kochia, Prickly Lettuce, Feral Rye, and Brome Grass or any weed listed on Colorado Noxious Weed List and Watch List.

1.05 SUBMITTALS

- A. See Division 01 Section "Submittals" for submittal requirements.
- B. Materials: The Contractor shall submit to the Project Manager for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Project Manager.
 - 1. Certification of Seed: From seed vendor for each seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 2. Native Grass Species (supplied as pure live seed): Submit lab germination test results for all grass species. Submit an affidavit that describes estimated purity for all forb species that are not typically tested.
 - 3. Pesticides: Include product label and manufacturer's application instructions specific to this Project.
 - 4. Soil Conditioners (if applicable): Include product label and manufacturer's application instructions specific to the project.
 - 5. Mulch: Include product label and manufacturer's application instructions specific to the project. The contractor shall provide ship tickets to verify application rates.
 - 6. Tackifier: Include product label and manufacturer's application instructions specific to the project.
 - 7. Product Certificates: For soil amendments, soil conditioners and fertilizers, from the manufacturer.

- C. Qualification Data: For qualified landscape Installer.
- D. Pesticide application records, per State requirements.
- E. Material Test Reports
 - 1. Soil analysis for native soils at the project site: See Division 32 Section "Soil Preparation"
 - 2. Analysis for each soil amendment.
 - 3. Analysis for each soil conditioner.
- F. Analysis and standards: Wherever applicable, for non-packaged materials, provide the analysis by a recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.
- G. Seeding schedule: Submit the proposed seeding schedule, indicating dates for site preparation, seeding, mulching, erosion control, and coordination with plant procurement, planting soil preparation, plant delivery and planting. Schedule all work during specified planting seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.
- H. Maintenance Instructions: Maintenance is per Division 32 Section "Landscape Maintenance" if a maintenance contract exists, or per the establishment subsection. Include recommended procedures for maintenance of irrigated and non-irrigated (if applicable) native seed areas during a calendar year. Submit before expiration of required initial maintenance or establishment periods.
- I. Contract Closeout Submittals
 - 1. Operating and Maintenance Data: At completion of work, submit one (1) digital copy to the Project Manager in accordance with Division 01 Section "Contract Closeout". Include directions for irrigation, aeration, mowing, fertilizing, and spraying as required for continued and proper maintenance through full growing season and dormant period.
 - 2. Warranty for Native Seed Areas: At Substantial Completion submit a written warranty to the Project Manager based upon specified requirements.

1.06 QUALITY CONTROL

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful native grass establishment.
 - 1. Experience: Five (5) years' experience in native seed installation in addition to requirements in Division 01 Section "Quality Control".
 - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 3. Personnel Certifications: Installers shall have certification the following categories from the NALP:
 - a. Landscape Industry Certified Technician - Exterior, with installation maintenance irrigation specialty area(s).
 - 4. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

- 5. Pesticide Applicator: Applicators shall be a Colorado State licensed, Commercial Applicator.
- B. Soil Analysis: See Division 32 Section "Soil Preparation" and Division 32 Section "Topsoil".
- C. Pre-installation Conference: Conduct conference at the Project site to coordinate the seeding process with the Project Manager and other trades. This meeting shall include coordination of equipment movement within planting areas to avoid soil compaction, an overview of proposed methods of installation, review of the performance criteria and maintenance procedures, and an overview of underground utility location maps and plans. This meeting shall be coordinated by the Contractor and comply with requirements in Division 01.
- D. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All seed shall be free from insects and disease. Species shall be true to their scientific name as specified.
- E. Any native seed species substitutions shall be submitted to and approved by the Project Manager prior to installation.
- F. All species shall be supplied as pure, live seed.
- G. Equipment: The Contractor shall furnish all equipment free of noxious weeds, weed seed, plant material, and contaminated soil.
- H. The Project Manager reserves the right to reject the seed at any time prior to Acceptance and that fails to meet specification requirements. Promptly remove rejected seed from site.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Bulk Materials
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- B. Seed and Other Packaged Materials: Shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, the lot number, net weight, origin, the percent of weed seed content, the guaranteed percentage of purity and germination, pounds of pure live seed (PLS) of each seed species, and the total pounds of PLS in the container. Seed that has become wet, moldy or damaged in transit or in storage will not be acceptable.
- C. Soil Conditioner and Fertilizer: Deliver products to the site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.
- D. Material will be inspected upon arrival at project site. Project Manager will reject any opened or unacceptable materials as described above. Store all materials in a manner to prevent wetting and deterioration.
- E. Immediately remove unacceptable material from job site.

1.08 PROJECT/SITE CONDITIONS

- A. Work scheduling: Proceed with and complete landscape work rapidly, as portions of the site become available, working within the specified planting season and approved schedule.
- B. Vehicular accessibility on site shall be approved by the Project Manager
- C. Seeding Season: Seeding shall generally occur during the specified windows below. Seeding dates may be modified when temperature and moisture conditions are favorable.

<u>Seed Type</u>	<u>Irrigated Areas Only</u>	<u>Non-Irrigated Areas</u>
Native Grasses	April 15-Sept.1	Nov. 15-April 15

- 1. Dormant Seeding: Upon approval of the Project Manager, dormant seeding for Irrigated and Non-irrigated areas may be accomplished between November 15 and April 15. No seeding shall be done when the ground is frozen, muddy, covered with snow, or otherwise in a condition unsuitable for seeding. Dormant seeding will not relieve the Contractor from the Warranty or the Acceptance requirements specified elsewhere in this specification.
- D. Coordination
 - 1. Coordinate with construction of utilities on site. Do not begin placing native seed until underground work is completed in the area.
 - 2. Coordinate seeding with approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than three (3) days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty-four (24) hours after fine grading.
 - 3. No vehicular or equipment access shall be allowed within areas that have been seeded.
 - 4. Coordinate with installation of underground irrigation system.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Soil Preparation: See Division 32 Section "Soil Preparation".
- B. Topsoil: See Division 32 Section "Topsoil".
- C. General
 - 1. The selected seed mix must be approved by the Project Manager prior to its incorporation into the project.
 - 2. All seed brands shall be free from Colorado prohibited noxious weed seeds, including but not limited to Canada Thistle, Field Bindweed, Johnsongrass, and Leafy Spurge. The Contractor shall furnish to the Project Manager a signed statement certifying that the seed is from a lot that has been tested by a recognized laboratory for seed testing within six months prior to the date of delivery.
 - 3. Computation for quantity of seed required on the project is based on Pure Live Seed (PLS).

4. The formula used for determining the quantity of PLS shall be:

$$\text{Pounds of Seed} \times (\text{Purity} \times \text{Germination}) = \text{Pounds of PLS.}$$

5. If seed available on the market does not meet the minimum purity and germination specified, the Contractor must compensate for a lesser percentage of purity or germination by furnishing sufficient additional seed to equal the specified product. Product comparison shall be made on the basis of PLS in pounds, stated on each seed bag.

D. Seed Mixes

1. Short Grass Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
<i>Bouteloua dactyloides</i>	Buffalograss	10.0	11	7
<i>Bouteloua curtipendula</i>	Sideoats grama	4.5	20	13
<i>Bouteloua gracilis</i>	Blue grama	1.5	27	17
<i>Elymus elymoides</i>	Bottlebrush squirreltail	2.0	9	6
<i>Koeleria macrantha</i>	Prairie junegrass	0.5	21	13
<i>Nassella viridula</i>	Green needlegrass	1.2	5	3
<i>Pascopyrum smithii</i>	Western wheatgrass	4.2	13	8
<i>Sporobolus cryptandrus</i>	Sand dropseed	0.1	6	4
	Graminoid Totals	24.0	111	72
Forbs				
<i>Artemesia frigida</i>	Prairie sagewort	0.1	10	7
<i>Machaeranthera tanacetifolia</i>	Tanseyleaf tansyaster	1.0	9	6
<i>Ratibida columnifera</i>	Upright prairie coneflower	0.6	10	7
<i>Sphaeralcea coccinea</i>	Scarlet globemallow	0.9	10	7
<i>Vicia americana</i>	American vetch	5.0	4	3
	Forb Totals	7.6	44	28
	Total	31.6	155	100

Drill Seeded Rate: 31.6 PLS#/Acre

Mechanical Broadcast Rate: 31.6 PLS#/Acre

Hand Broadcast Areas Rate: 63.2 PLS#/Acre

2. Short Grass Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
<i>Bouteloua curtipendula</i>	Sideoats Grama	4.9	21	16.45
<i>Bouteloua gracilis</i>	Blue Grama	2.0	36	28.00
<i>Buchloe dactyloides</i>	Buffalograss	10.8	12	9.18
<i>Elymus elymoides</i>	Bottlebrush Squirreltail	2.0	9	6.82
<i>Koeleria cristata</i>	Prairie Junegrass	0.5	22	17.22
<i>Nassella viridula</i>	Green Needlegrass	1.4	6	4.33
<i>Sporobolus cryptandrus</i>	Sand Dropseed	0.1	10	7.82
	Total	26.1	130	100

Drill Seeded Rate: 26.1 PLS#/Acre

Mechanical Broadcast Rate: 26.1 PLS#/Acre
Hand Broadcast Areas Rate: 63.2 PLS#/Acre

E. Mulch

1. Straw: Shall be certified weed free. Straw in a stage of decomposition will not be accepted.
2. Hydromulch: Shall consist of virgin wood fibers manufactured from clean, whole wood chips. Fiber shall not be produced from sawdust, paper, cardboard, or residue from paper pulp. The fiber mulch shall be dyed green and shall be biodegradable and not inhibit plant growth. The wood cellulose fiber shall consist of the following properties.
 - a. Percent Moisture Content: 10.0% +/- 3.0%.
 - b. Percent Organic Matter: 99.3% +/- 0.2%.
 - c. Percent Ash Content: 0.7% +/- 0.2%.
 - d. pH: 4.9 +/- 0.5.
 - e. Water Holding Capacity: 1200-1600 grams.
 - f. Hydromulch is only acceptable for irrigated applications

F. Tackifier: Tackifier shall consist of free flowing, non-corrosive powder produced from the natural plant gum of *Plantago insularis* (desert Indianwheat). The powder shall consist of the following properties:

1. Protein Content: 1.6 +/- 0.2%
2. Ash Content: 2.7 +/- 0.2%.
3. Fiber: 4.0 +/- 0.2%.
4. pH 1% Solution: 6.5-8.0.

G. Fertilizer and Soil Conditioner: None required unless otherwise specified by soils test.

H. Water: Contractor to utilize the existing irrigation system and or quick coupler(s) when available. If irrigation or quick coupler(s) are not available, then the contractor is responsible for watering. Water shall be free of substances that may be harmful to seed growth. Hoses and other watering equipment necessary to water the seed to be furnished by Contractor.

2.02 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use 'Restricted Use' pesticides unless authorized in writing by Project Manager and authorities having jurisdiction.

B. Ensure that applications adhere to the product label for restrictions and landscape sites.

C. Selective for either of the following types:

1. Broadleaf:
 - a. 2,4-D Amine,
 - b. Clopyralid,
 - c. Aminopyralid,

- d. Triclopyr,
 - e. Or approved equal.
 - 2. Grasses:
 - a. Imazapic,
 - b. Indaziflam,
 - c. Or approved equal.
 - D. Non-Selective: Broadleaf or Grasses
 - 1. Glyphosate,
 - 2. Or approved equal.
- 2.03 EROSION CONTROL MATERIALS
- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (6") long.
 - B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with fifty (50%) to sixty-five (65%) percent open area. Include manufacturer's recommended steel wire staples, 6 inches (6") long.
 - C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3 inch (3") nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Invisible Structures, Inc.; Slopetame 2.
 - b. Presto Products Company, a business of Alcoa; Geoweb.
 - c. Tenax Corporation - USA; Tenweb.
- 2.04 SUBSTITUTIONS
- A. All substitutions shall be submitted to and approved by the Project Manager prior to installation.

PART 3 EXECUTION

3.01 SITE EXAMINATION

- A. Examine areas to be seeded for compliance with requirements and other conditions affecting performance.
 - 1. Grades shall be in conformance with Division 31 Section "Earth Moving". Finish grades shall have consistent slopes as indicated on the Contract Drawings.
 - 2. Soil preparation of seeded areas shall be in conformance with Division 32 Section "Soil Preparation".
 - 3. Verify that no foreign or deleterious material or liquid such as but not limited to, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in

soil within a seeding area. If contamination is present in soil, remove the soil and contamination as directed by the Project Manager and replace with new soil.

- B. Locate, protect, and maintain the irrigation system during seeding operations. Verify that the irrigation system is operable and a coverage test has been completed and approved prior to seeding by the Project Manager. Irrigation system components damaged during seeding operations shall be replaced or repaired to current irrigation standards at the Contractor's expense.
- C. Locate and protect existing underground utilities. Perform work in a manner to avoid damage. Hand excavate as required.
- D. Protect grade stakes set by others until removal is directed by the Project Manager.
- E. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Project Manager before planting.

3.02 PREPARATION

- A. Notify the Project Manager at least seven (7) working days prior to start of seeding operations.
- B. Utilize equipment having low unit pressure ground contact within seeding areas.
- C. Limit subgrade preparation to areas that can be seeded within twenty-four (24) hours. Seeding beyond twenty-four (24) hours of preparation shall only be done with the approval of the Project Manager.
- D. Uniformly moisten excessively dry soil that is not workable.
- E. The Contractor shall prepare the soil of all areas to be seeded in accordance with the requirements of Division 32 Section "Soil Preparation".
 - 1. Do not mix or place soils and soil amendments in frozen, dry, or excessively wet conditions.
 - 2. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
- F. Weed Control: See Division 32 Section "Soil Preparation" for required weed control procedures. If weeds are present on-site, treat with pesticide prior to preparing soil for installing seed. Do not proceed with planting until the Project Manager have approved the specified and completed weed control measures.
- G. Fine Grading: See Division 32 Section "Soil Preparation".
 - 1. Verify all areas are graded to drain at a minimum of two percent (2%) or as indicated on the Contract Drawings. Maintain positive drainage, prevent ponding, and direct runoff into catch basins, drainage structures, etc., and provide a well -contoured surface prior to proceeding.
 - 2. Verify that the subsurface drainage system and drain inlets, if present, are operative.
 - 3. A firm weed-free seed bed is required. The seed bed shall be totally free from rock or clay clods or any other materials over one inch (1") in diameter. Remove sticks, roots, rubbish, and other extraneous matter and legally dispose of the off-site.

- 4. Obtain the Project Manager's approval of finished grade prior to proceeding with seeding operations.
- H. Transition Grading: When areas of new seed abut existing areas, grade shall transition to prevent any abrupt grade breaks.
- I. When grading is completed, the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper seeded surface.

3.03 INSTALLATION OF NATIVE SEED

- A. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.
- B. Beginning of installation means acceptance of existing conditions by the Contractor.
- C. Install native seed only after all other landscape and irrigation items have been installed and accepted by the Project Manager.
- D. Seed shall be uniformly applied at the specified rate, (half in one direction and the other half perpendicular to the first application). The direction of the final application shall always be perpendicular to the slope or running in the direction of the contour. Seed shall be installed at a depth between one-quarter inch (1/4") and one-half inch (1/2").
- E. Areas that are too small or steep for mechanical seeding may be hand seeded. Seed shall be uniformly applied at the specified rate utilizing a broadcast spreader and then hand raked in to a depth of no more than one-half inch (1/2"), then roll seed bed to ensure proper contact to the soil.
- F. Do not drill or sow seed during windy, rainy weather or when ground is frozen or otherwise unable to be tilled.
- G. Watering: Refer to Division 31 Section "Watering".
- H. Review seasonal restrictions prior to seeding.

3.04 PREPARATION FOR EROSION CONTROL MATERIALS

- A. Review erosion control measures with the Project Manager prior to installation. The Contractor shall take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.
- B. For erosion control mats, install planting soil in two (2) lifts, with second lift equal to thickness of erosion control mats. Install erosion control mat per manufacturer's recommendations.
- C. Fill cells of erosion control mat with planting soil and compact before planting.
- D. Install erosion control blanket on slopes exceeding 4:1, and in swales or other areas of concentrated runoff. As shown on the Contract Drawings or as directed by the Project Manager. Install in accordance with manufacturer's recommendations.
- E. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by the manufacturer. Fasten the blanket per manufacturer's recommendations.

3.05 MULCHING

- A. Straw Mulch Application: Straw shall be applied uniformly with no bare soil showing. It shall be crimped in with a crimper or other approved equipment. The seeded area shall be mulched within four (4) hours of seeding. Immediately apply tackifier evenly across the surface of straw mulch applications per the manufacturer's recommendations. Straw mulch may be used for irrigated or non-irrigated landscapes.
- B. Hydromulch Application: Utilize an approved hydromulcher to apply cellulose fiber at a rate of two-thousand (2,000) pounds per acre. The Contractor shall provide verification of application rates in the form of ship tickets. Hydromulch shall only be used for irrigated landscapes.
- C. Mulching shall not be installed when surface water is present resulting from rain, melting snow, irrigation, or other causes.
- D. Areas not properly mulched, or any damage that may occur during construction is the responsibility of the Contractor and shall be repaired and re-mulched in an acceptable manner at the Contractor's expense. Mulching removed by wind, rain, or other causes prior to acceptance shall be re-established by the Contractor at their own expense.
- E. The seeded area shall be mulched within four (4) hours of seeding. Areas not mulched within twenty-four (24) hours after seeding must be re-prepped and re-seeded with the specified seed mix at the Contractor's expense.

3.06 CLEANING

- A. Perform cleaning during installation of the work and upon completion of the work. Remove all excess materials, debris and equipment from site.
- B. Remove non-degradable erosion-control measures after the establishment period or at the direction of the Project Manager..
- C. Protect adjacent and adjoining areas from hydromulching overspray. The Contractor shall remove all hydromulch from surface areas not specified for seeding, including but not limited to plant materials, fences, paved areas, signs, mulch beds, irrigation components and all other objects as directed by the Project Manager.

3.07 PROTECTION AND REPAIR

- A. The Contractor shall protect existing utilities, irrigation, paving, and other facilities from damage caused by seeding operations. The Contractor shall repair any damage at their expense. Any areas outside the Contract Limits that are disturbed as a result of construction operations shall be restored to Parks standards at no additional cost to the Town.
- B. The Contractor shall repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the Town.
- C. The Contractor shall protect and restrict access from seeded areas until the areas are established and Accepted. Temporary fencing, barricades, and warning signs shall be installed as required, or by direction of the Project Manager at no additional cost to the Town. Maintain fencing and barricades throughout the site until the Project Manager approves removal.

3.08 ESTABLISHMENT

- A. If maintenance is required per the Contract, refer to Division 32 Section "Landscape Management and Maintenance".
- B. If maintenance is not required per the Contract, then the native seed establishment is per the Acceptance sub-section.
- C. Maintenance of the native seed areas are the responsibility of the Contractor until Final Acceptance.

3.09 ACCEPTANCE

- A. Substantial Completion shall be granted when seed has been applied and stabilized or per the discretion of the Project Manager.
- B. Final Acceptance will be granted when native seed areas are in a healthy, vigorous growing condition, and meet the listed Native Seed Establishment Criteria, until the establishment criteria has been met.
- C. Native Seed Establishment Criteria.
 - 1. Irrigated native seed areas shall be established when the following criteria are met:
 - a. After seeding, by the end of the first full growing season, total vegetation cover shall exceed ninety percent (90%) by aerial cover, with eighty percent (80%) of species present being native, and no more than ten percent (10%) being weed species.
 - b. By the end of the first full growing season, seedlings from twenty percent (20%) of planted forb species shall be present, only if forbs are specified in the contract.
 - c. At any time during the Contract period no more than ten percent (10%) by aerial cover of the seeded area shall be dominated by aggressive exotic species (weeds) such as, but not limited to, red clover (*Trifolium* spp.), white or yellow sweet clover (*Melilotus* spp.), Canada thistle (*Cirsium arvense*), tall fescue (*Festuca elatior*), field bindweed (*Convolvulus arvensis*), cheatgrass (*Bromus tectorum*), kochia (*Bassia scoparia*), etc.
 - d. Until Final Acceptance, seeded areas that fail shall be replaced until they meet establishment criteria as required. Replacement materials shall be identical to those originally specified.
 - e. Remedial Action: If seeded areas greater than ten (10) square feet fail to meet the terms of the guarantee shown above, the Contractor will develop and submit to the Project Manager a remedial action plan that takes into consideration the site goals and specific deficiencies causing the remedial action. The Contractor will implement the remedial action plan and submit a report that describes the remedial action taken. If remedial seeding or planting is required, Contractor will not be required to perform additional remedial seeding or planting in the same area for a minimum of two (2) growing seasons. After two (2) growing seasons following the remedial planting, the performance criteria must be met for the second growing season or additional remedial action must be taken. This guarantee remains in effect until all zones meet the third growing season criteria.
 - f. Seeded areas will not be accepted in parts. Each time any portion or section of the entire seeded area requires replacement or remedial action, the

establishment period shall extend until all seeded areas meet the minimum establishment requirements stated above.

- g. All expense incurred including repairs from vandalism for the replacement and or establishment of the seeded areas are the responsibility of the Contractor.
- h. If seeded in the fall, review for establishment shall be no later than June 15 of the following year.
- i. All Native Seeded areas shall be reviewed for a minimum period of one (1) year from the date of Substantial Completion to meet the Establishment Criteria. Any areas not meeting the criteria per the Project Manager will need to be remined prior to acceptance.

END OF SECTION

SECTION 32 93 00

TREES, PLANTS, AND GROWDCOVERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Report Documentation
 - 1. Geotechnical Engineering Study (if applicable)
 - 2. CWA Section 404 Permit Evaluation (if applicable)
 - 3. Materials Management Plan (MMP) (if applicable)

1.02 SUMMARY

- A. This Section includes requirements for furnishing, installing, and maintaining live woody plant material.
- B. Related Sections
 - 1. Division 01 Section "Tree Retention and Protection".
 - 2. Division 31 Section "Clearing and Grubbing".
 - 3. Division 31 Section "Earth Moving"
 - 4. Division 32 Section "Watering".
 - 5. Division 32 Section "Irrigation System".
 - 6. Division 32 Section "Automatic Irrigation Controllers"
 - 7. Division 32 Section "Soil Preparation".
 - 8. Division 32 Section "Topsoil".
 - 9. Division 32 Section "Landscape Management and Maintenance".

1.03 DEFINITIONS

- A. ANSI: American National Standards Institute. Z60.1 is the national standard for nursery stock.
- B. Backfill: The soil used from original excavation site or the act of placing soil in an excavation.
- C. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

- E. Caliper: Caliper of a trunk as measured by a diameter tape at a height six-inches (6") above the root flare for trees up to, and including, four-inch (4") size at this height; and as measured at a height of twelve-inches (12") above the root flare for trees larger than four-inch (4") size.
- F. Cane: A cane shall be considered a primary stem which starts from the ground or at a point close to the ground at a point not higher than one-fourth (1/4) the height of the plant, and which reaches the minimum height stated in the plant size specification.
- G. Central leader: Also referred to as leader or the dominant leader. A continuation of the main trunk located in the center of the crown, beginning at the lowest main scaffold branch and extending to the top of the tree. Central leaders should be straight without defects.
- H. Circling root(s): One or more roots whose diameter is greater than ten percent (10%) of the trunk caliper circling more than one-third of the trunk. Circling roots are unacceptable.
- I. Clear Trunk: The portion of the trunk below the main crown which may include shortened temporary branches.
- J. Co-dominant: Two or more vigorous, upright branches or stems of relatively equal diameter that originate from a common point, usually where the leader was lost or removed. Co-dominant stems are unacceptable.
- K. Container-Grown: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- L. Crown: The portion of a tree beginning at the lowest main scaffold branch extending to the top of the tree. On younger trees, the crown may be comprised of temporary branches.
- M. Cultivar: A named plant selection from which identical or nearly identical plant characteristics can be produced, usually by vegetative propagation or cloning.
- N. Diameter Breast Height (DBH): Diameter of a trunk as measured by a diameter tape at a height 54-inches (54") above the ground line for trees with caliper of six-inches (6") or greater as measured at a height of twelve-inches (12") above the root flare. Per ANSI Z60 American Standard for Nursery Stock.
- O. Drip Zone: The outermost edge of the tree's canopy or branch spread. The area within a tree's drip line is all the ground under the total branch spread.
- P. Finish Grade: Elevation of finished surface of planting soil.
- Q. Genus: Biological classification name for a group of related plants that share similar characteristics or features.
- R. Included Bark: Bark embedded in the union between a branch and the trunk or between two or more stems that prevents the formation of a normal branch bark ridge. Included bark is unacceptable.
- S. Kinked Root: A main root that is sharply bent. Kinked roots are unacceptable.
- T. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and

molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

- U. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- V. Root Ball: Root mass of a tree or shrub after digging or removal of the container. Depth is measured from the base of the root flare to the bottom of the root ball. Width is measured horizontally across the root ball with an approximately circular form or the least dimension for non-round root balls, centered around the trunk within a 10% Root tolerance according to ANSI Z60.1
- W. Root Collar: Also referred to as the root flare. The transition zone where the trunk and root zone meet.
- X. Root Flare: Also called "trunk flare". The area at the base of the tree's stem or trunk where the stem or trunk broadens to form first order roots; the area of transition between the root system and the stem or trunk.
- Y. Scaffold Branches: Large main branches originating from the trunk that form the main structure of the crown.
- Z. Species: Biological classification name for a subgroup of plants within a genus.
- AA. Stem-girdling Root: A circling, bent, or straight root that touches or rests on the trunk or root flare that can become a permanent root. Stem-girdling roots are unacceptable.
- BB. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- CC. Temporary Branch: A small branch that is temporarily retained along the lower trunk of young trees to promote general health and trunk taper.
- DD. Tree Protection Zone: The zone equal to eighteen inches (18") radially from the tree for every one-inch (1") of trunk diameter at breast height.
- EE. Trunk: The main stem of a tree, beginning at the root collar and ending at the lowest main scaffold branch.
- FF. Taper: The thickening of a trunk to the root flare or branch toward its parent base.
- GG. Variety: A naturally occurring named plant selection subtype of a species.

1.04 SUBMITTALS

- A. See Division 01 Section "Submittals" for submittal requirements.
- B. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- C. Product Samples: At a minimum provide the following samples for approval by the Project Manager, additional product samples may be required at the direction of the Project Manager.

1. Mulch: one (1) gallon bag minimum of each type of mulch.
 2. Tree Stakes: one (1) of each type.
 3. Tree Straps: one (1) each.
 4. Guy Material: one (1) linear foot.
 5. Guy Signal: one (1) linear foot.
 6. Tree Wrap: one (1) linear foot.
- D. Pesticides: Product label, Safety Data Sheet (SDS) labels and manufacturer's application instructions specific to Project.
- E. Proper Identification: All plants shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by species and cultivar (as appropriate).
- F. Contractor shall provide a complete list of all plant material for approval by the Project Manager a minimum of ten (10) days prior to delivery. Any substitutions of plant material, including but not limited to size, type, species and variety shall be listed and submitted to the Project Manager for approval.
- G. Contractor shall provide the following certificates:
1. State Inspection Certificate from the origin nursery.
 2. Certificate from origin state.
 3. Quarantine Certificate from origin state.
 4. Any Certificates required by the USDA Animal and Plant Health Inspection Service (APHIS) and ANSI-Z-60 and accompanying Rules and Regulations.
- H. Analysis of existing soil shall be per Division 32 Sections "Topsoil" and "Soil Preparation".
- I. Contract Close Out Submittals
1. Warranty for Trees, Plants, and Groundcovers: At completion of work, furnish written warranty to the Project Manager based upon specified requirements.

1.05 QUALITY CONTROL

- A. All plant material shall comply with federal and state laws and regulations requiring inspection for plant diseases, pests, and weeds. Inspection certificates required by law shall accompany each shipment of plants. Clearance from the local county agricultural commissioner, if required, shall be obtained before planting trees originating outside the county in which they are to be planted. Even though trees may conform to county, state, and federal laws, the Town may impose additional requirements that pertain to local issues.
- B. The Contractor shall arrange for the inspection of plant material upon delivery to the site for compliance with the Specifications and Contract Drawings. The Town Forester and the Project Manager have the right to reject plant material that does not meet Specifications until Final Acceptance. Inspection of materials is primarily for quality, size, form, variety, damage, and proper rooting but other requirements are not waived even though initial visual inspection results in approval. Rejected material shall be removed from the site within twenty-four (24) hours.
- C. The Project Manager and the Town Forester have the right to cull a pre-determined quantity of plant material representative of the genus to invasively inspect for root defects. Upon discovery

of defects that will impact future health and growth, other plant material may be inspected as well to determine quality of overall plant material and possible rejection.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Materials: Deliver materials in original containers with tags showing genus, species and size. Protect materials from damage during delivery and while stored at site. The Project Manager reserves the right to inspect containers before or after installation to verify compliance with Specifications.
- B. Bulk Materials
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants or in tree protection zones.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Trees: Nursery stock shall be harvested and planted during the same growing season. Do not prune, except as approved by the Town Forester and the Project Manager. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and transportation damage. Do not bend, tie, or deliver trees in such a manner as to destroy natural shape. Root balls should be moist and provide protective covering during delivery. Plant materials delivered without protective covering may be rejected. Protect root balls from damage during digging, transferring, loading, unloading and planting. All trees shall be labeled with a securely attached waterproof tag bearing a legible plant name. Remove all tags and flagging as directed by the Project Manager.
- D. Deliver bare-root stock plants within twenty-four (24) hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- E. Store bulbs, corms, and tubers in a dry place at sixty degrees to sixty-five degrees (60° to 65°) F until planting.
- F. Handle planting stock by the root ball only, providing support to top.
- G. Deliver trees after preparations for planting have been completed and install immediately. If planting is delayed more than six (6) hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist.
 - 1. Set balled stock on ground and cover ball with wood chips, or other acceptable material.
 - 2. Do not remove container-grown stock from containers before planting.
 - 3. Water root systems of trees stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.
 - 4. Root balls should be stored in shade and be covered with moist mulch if stored on site for longer than twelve (12) hours.

1.07 PROJECT/SITE CONDITIONS

- A. Vehicular accessibility on site shall be as directed as shown on approved plans or by the Project Manager. Repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the Town.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.08 COORDINATION AND SCHEDULING

- A. Coordinate installation of planting materials during normal planting seasons for each type of plant material required, avoiding temperature extremes. Planting materials should be generally planted between April 15 and October 1, or at the direction of the Town Forester or Project Manager. If irrigation is not available at the time of planting then the Contractor is responsible for watering of all plant material at no additional cost to the Town, refer to Division 31 Section "Watering".
- B. Plant trees after final grades have been accepted and prior to seeding or sodding, unless otherwise authorized by the Project Manager.

1.09 WARRANTY

- A. Warranty: The warranty specified in this Article shall not deprive the Town of other rights the Town may have under other provisions of the Contract Documents and shall be in addition to, and run concurrently with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Trees, Plants, and Groundcovers shall be warranted for a period of one (1) year after date of Substantial Completion, against defects including death, structural failures, dieback as determined by the Town Forester and the Project Manager. Warranty shall not cover defects resulting from lack of adequate maintenance, neglect or abuse by Town staff, hail, or incidents that are beyond Contractor's control.
- C. The Warranty shall not be enforced should any plant die due to vandalism after Substantial Completion.
- D. Remedial Actions
 - 1. Replace any plant materials that have been excessively pruned, more than twenty percent (20%) percent die back in the central leader, or in an unhealthy or declining condition immediately upon notice from the Project Manager during warranty period.
 - 2. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
- E. All plants shall be true to name and meet all conditions of these specifications. Any plant that is not true to name as indicated by form, leaf, flower, or fruiting characteristics shall be replaced at the Contractor's expense.
- F. All tree stabilization materials shall be removed by the end of the Warranty period, if not done prior, unless otherwise directed by the Town Forester and the Project Manager.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

- A. General: Furnish and install nursery-grown trees and shrubs conforming to the requirements of ANSI-Z-60 and ANSI A300, Part 6, with healthy root systems developed by transplanting or root pruning. Provide well shaped, symmetrical, fully branched, healthy, and vigorous stock free of disease, insects, eggs, larvae, girdling, and defects such as sun scald, injuries, abrasions, and disfigurement.
- B. Label all plants of each size, caliper genus, species cultivar or variety with a securely attached waterproof tag bearing legible designation of botanical and common name.
- C. All plants shall be the genus, species, variety or cultivar designated on the Contract Drawings. No substitutions will be accepted without the prior written approval of the Town Forester and the Project Manager. Contractor must provide proof of non-availability.

2.02 TREES

- A. These specifications shall apply to deciduous, broadleaf evergreen and coniferous species. Note that leaf characteristics will not be evident on deciduous trees during the dormant season.
- B. Crown: The form and density of the crown shall be typical for a young specimen of the species/cultivar. Changes in form caused by wind, pruning practices, pests, or other factors shall not substantially alter the form for the species/cultivar. These crown specifications do not apply to plants that have been specifically trained in the nursery to be: topiary, espalier, multi-stem, or clump; or unique selections such as contorted or weeping cultivars.
 - 1. Trees shall have a single, relatively straight trunk, and central leader, unless noted on plans to be "Multi-trunk" or "Clump". They shall be free of co-dominant stems and vigorous, upright branches that compete with the central leader. If the original leader has been headed, a new leader at least one-half of the diameter of the original leader shall be present.
 - 2. Main branches shall be evenly distributed along the central leader, not clustered together. They shall form a balanced crown appropriate for the age of the species/cultivar.
 - 3. Branch diameter shall be no larger than one-half the diameter of the central leader measured one-inch (1") above where the branch is attached.
 - 4. The attachment of the largest scaffold branches shall be free of included bark.
 - 5. Temporary branches, unless otherwise specified, should be present along the lower trunk below the lowest scaffold branch. These branches should be no greater than three-eighths-inch (3/8") diameter. Clear trunk shall be no more than thirty percent (30%) of the total height of the tree, unless otherwise noted.
- C. Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds, except properly made pruning cuts, which shall be closed over or less than three-quarters-inch (3/4") diameter open, sunburned areas, conks (fungal fruiting bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers, stem-girdling ties, or lesions (mechanical injury).
 - 1. Trunk caliper and taper shall be sufficient so that the tree will remain vertical without a stake. Trunk caliper at six-inches (6") above the soil media (substrate) surface shall be a minimum of two inches (2") and a maximum of three inches (3"). Any caliper sizes outside of that range will only be allowed with approval from the Town Forester and the Project Manager.

2. The cut made when re-growing the top should be just above the major structural roots. The “shank” that results from this procedure should be at a consistent height above the structural roots and no longer than five-inches (5”), to ensure that the trees are consistently planted at the correct depth. The base of the trunk should not have a large pruning cut from re-growing the top.
- D. Roots: The root system shall be substantially free of injury from biotic (e. g., insects and pathogens) and abiotic (e. g., pesticide toxicity and salt injury) agents.
1. The uppermost roots or root collar shall be within the upper two-inches (2”) of the soil media (substrate). Depth of the root-ball shall be measured from the top of the ball, which in all cases shall begin at the root flare. Soil above the root flare shall not be included in the root-ball depth measurement, and shall be removed.
 2. The tree shall be well rooted in the soil media (substrate). Root distribution shall be uniform throughout the soil or media and radial from the trunk. Structure and growth shall be appropriate for the genus, species and cultivar or variety. When the burlap or container is removed, the root-ball shall remain intact. Trees should have several lateral roots or many fibrous roots spaced evenly around the trunk to provide support so the trees are stable when planted. Trees should have as many small roots as possible. Fibrous roots can be achieved by root-pruning, using air-pruning containers, or undercutting or root pruning and transplanting at any stage of production.
 3. The root collar and the inside portion of the root-ball shall be free of defects, including circling, kinked, and stem-girdling roots. Soil removal or root washing near the root collar may be necessary to inspect for the aforementioned root defects.
 4. Roots on the periphery and bottom of the root-ball shall be less than one-eighth-inch (1/8”) diameter.
 5. As a general rule for young nursery-grown trees, there should be two or more structural roots within one- to three-inches (1” – 3”) of the soil surface. “First order lateral roots” is another term that has been used for these roots. If the roots are deeper than three-inches (3”), the stock shall be rejected.
 6. Root-balls that are undersized as specified in current edition of ANSI Z60.1. shall be rejected. Field grown trees for balled and burlap delivery shall have the roots pruned at least six-inches (6”) inside the final root-ball size performed within adequate time for the tree to develop fibrous roots at the outer edge of the root-ball prior to harvest and delivery.
 7. Ball and burlap trees are acceptable per the specifications. If ball and burlap trees are not able to be procured, container trees may be substituted with the approval from the Town Forester and the Project Manager.
- E. Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged stress or extended drought as indicated by under or oversized leaves, wilted, shriveled or dead leaves.
- F. Branches: Shoot growth (length and diameter) throughout the crown shall be appropriate for the age and size of the species/cultivar. Trees shall not have dead, diseased, broken, crossing, distorted, or otherwise injured branches.
- G. All deciduous trees of one species used in formal rows or groupings shall exhibit cultural uniformity, i.e. “matched” in height, crown width and shape, height to first branch, and trunk taper. For this reason, it is desired that these trees be produced by a single grower.

- H. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated, and only if approved by the Town Forester and the Project Manager.

2.03 SHRUBS

- A. Container Grown Shrubs: All specifications for container grown plants shall include both plant size and container size. Plant size intervals and reference to height or spread shall be in accordance with the guidelines for the appropriate plant type set forth in ANSI Z60.1; Section 2.2 - Types of Deciduous Shrubs.
- B. Container size shall be by container classification (i.e., not by container volume) as set forth in the ANSI Z60.1 Container Class Table.
- C. In all cases, container grown nursery stock shall meet the following general requirement:
1. All container grown nursery stock shall be healthy, vigorous, well rooted, and established in the container in which it is growing. Container grown nursery stock shall have a well-established root system reaching the sides of the container to maintain a firm ball when the container is removed, but shall not have girdled or kinked roots and/or root growth encircling the inside of the container.
- D. The container shall be sufficiently rigid to hold the ball shape and to protect the root mass during shipping.
- E. Minimum shrub sizes shall conform to the following standards:

1. Tender shrubs (Type 0) that do not produce top growth that is winter hardy:

Height or Spread	Minimum number of canes	Minimum spread of roots
Fifteen-inches (15")	Three (3) canes	Nine-inches (9")

2. Small shrubs (Type 1) that grow to a mature height of not more than three feet (3'):

Height or Spread	Minimum number of canes	Minimum spread of roots
Fifteen-inches (15")	Four (4) canes	Nine-inches (9")

3. Intermediate shrubs (Type 2) that grow to a mature height between three feet (3') and seven feet (7'):

Height or Spread	Minimum number of canes	Minimum spread of roots
Two feet (2')	Four (4) canes	Twelve-inches (12")

4. Large shrubs (Type 3) that grow to a mature height exceeding seven feet (7'):

Height or Spread	Minimum number of canes	Minimum spread of roots
Four feet (4')	Six canes (6)	Twenty-inches (20")

2.04 PERENNIALS, GRASSES, GROUNDCOVERS, AND VINES

- A. All container grown plants shall be healthy, vigorous, well rooted, and established in the container in which they are growing and be in conformance with ANSI Z60.1. A container grown plant shall have a well-established root system reaching the sides of the container to maintain a firm ball when the container is removed but shall not have girdled or kinked roots and/or root growth

encircling the inside of the container. Top growth is to be in conformance with established nursery standards.

2.05 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials

1. Deciduous and Evergreen Tree Stakes: Rough-sawn, sound, new softwood with specified wood preservative treatment by pressure process, free of knots, holes, cross grain, and other defects, two-inch (2") diameter by six feet (6'), pointed at one end.
2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, #14 galvanized-steel wire, two-strand, twisted. Guying must be approved by the Town Forester.
3. Tree-Tie Webbing: UV-resistant nylon webbing with brass grommets, size as indicated.
4. Safety Signals for Guy and Staking Wire: One-half inch (1/2") diameter PVC pipe, length as indicated.

B. Tree-Wrap

1. Two layers of crinkled paper cemented together with bituminous material, four-inches (4") wide minimum, with stretch factor of thirty-three percent (33%).
2. Tree wrap tape: Tape as approved by the Town Forester and the Project Manager.

2.06 PLANTING BACKFILL MATERIAL

A. Unless otherwise directed by the Project Manager, the plant pit backfill material shall consist of the following, thoroughly mixed:

1. Soil originally excavated from the pit: two thirds (2/3) proportion of total mix.
2. Soil Amendment as specified in Division 32 Section "Soil Preparation"; one-third (1/3) proportion of total mix.

B. If imported topsoil is required, it shall meet the requirements specified in Division 32 Section "Topsoil", Article 2.2.

2.07 MULCH

A. Organic Mulch: Organic mulch, free from weeds, chemicals, and/or deleterious materials and suitable as a top dressing of trees and shrubs, consisting of chipped wood material not larger than four-inches (4") in length.

2.08 MISCELLANEOUS MATERIALS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees, as approved by the Town Forester and the Project Manager. Deliver in original, sealed, and fully labeled containers. Mix and apply according to manufacturer's instructions.

B. Pre-Emergent Pesticide: As approved by the Town Forester and the Project Manager.

C. Pesticides: EPA registered and approved, and as approved by the Town Forester and the Project Manager.

D. Subdrainage: See Division 33 Section "Subdrainage Systems".

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify actual grade elevations and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.
 - 1. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, obstructions, or utilities, notify the Project Manager before planting.
 - 2. Verify that adequate overhead clearance exists to planting locations.
 - 3. Suspend planting operations during periods of excessive heat, cold, and/or moisture until acceptable planting conditions exist. The contractor shall obtain approval from the Town Forester and the Project Manager when planting in temperatures above ninety degrees (90°) Fahrenheit.
 - 4. Uniformly moisten excessively dry soil that is not workable.
- C. Verify that no foreign or deleterious material or liquid such as, but not limited to, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area. If contamination is present in the soil within a planting area, notify the Project Manager immediately.
 - 1. If contamination is discovered during Construction the Project Manager will determine the best course of action to remediate the contamination, which may include requesting the Contractor perform the removal of contamination and replacement of clean material.
 - 2. If contamination is determined to be the result of construction operations, Contractor is to remove contaminated material and replace with clean material at the direction of the Project Manager.
- D. Verify final grades are completed in accordance with the drawings. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.
- E. Cooperate with any other contractors and trades, who may be working in and adjacent to the landscape work areas. Examine the Contract Drawings which show the development of the entire site and become familiar with the scope of all work required.

3.02 FINISH GRADING

- A. See Division 31, Sections "Earth Moving and 32 Sections "Soil Preparation" and "Topsoil".

3.03 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, turf areas and existing plants from damage caused by planting operations. Repair damage to surrounding areas and site elements noted above resulting from planting operations at no additional cost to the Town.
- B. Utilities: Contractor shall be responsible locating utilities and, repair of utilities damaged during the Work. Determine location of overhead and underground utilities and perform work in a

manner that will avoid damage. Hand excavate, as required. Maintain markings until their removal is mutually agreed upon by the Contractor and the Project Manager.

- C. Layout, stake and label all individual tree locations for approval by the Project Manager prior to installing trees.
- D. Outline planting beds and mark plant locations within the bed(s) for approval by the Project Manager prior to installing any plant material or mow bands. Make adjustments as directed by the Project Manager at no additional cost to the Town.
 - 1. If formal arrangements or consecutive order of plants is indicated on the Contract Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- E. Prepare planting area for soil placement and mix planting soil according to Division 32 Section "Soil Preparation".

3.04 FIELD QUALITY CONTROL

- A. Provide quantity, size, genus, species, and variety of trees indicated, complying with current applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock", and all applicable state and local rules and regulations.
- B. Inspection: The Contractor shall arrange for the inspection of plant material upon delivery to the site for compliance with the Specifications and Contract Drawings. The Town Forester and Project Manager have the right to reject plant material that does not meet Specifications until Final Acceptance.
- C. Measurements: Measure trees according to the requirements of the ANSI Z-160, with branches and trunks in their normal position. Do not prune to obtain required sizes. Measure main body of tree for height and spread; do not measure branches or roots tip-to-tip.

3.05 WEED CONTROL

- A. Do not proceed with landscape work until weed growth has been controlled and eliminated, per Division 32 Section "Soil Preparation".
- B. See Division 32 Section "Soil Preparation" for detailed weed control measures.
- C. Use pesticides only with the written approval of the Project Manager, and in strict accordance with manufacturer's recommendations.

3.06 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Areas: Excavate by hand, auger or with a mini excavator. Scarify or roughen sides of tree pit by hand to eliminate any glazing. Tree spades may not be used to dig tree pits.
 - 1. Balled and Burlapped Trees:
 - a. Open top of root ball burlap and carefully remove soil to expose trunk flare to first order roots. Set hole depth based on bottom of root ball and base of root flare. The base of the root collar shall be one to two inches (1" - 2") higher than finished grade.

- b. Do not excavate deeper than depth of the root ball. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly compact the soil directly under the root ball to prevent settling.
 - c. Excavate a minimum two times (2X) as wide as ball diameter at base of pit. Excavate a minimum of three to four times (3X – 4X) as wide as ball diameter at top of pit. Slope sides of the pit as shown on the detail.
 - 2. Container-Grown Trees and Shrubs:
 - a. Gently remove excess soil from top of root ball to expose root flare or top of first order root. Set plumb and in center of pit with base of root flare one to two-inches (1" - 2") above adjacent finish grades as indicated.
 - b. Excavate approximately two times (2X) times as wide as container diameter at base of pit. Excavate a minimum of three to four times (3X – 4X) as wide as container diameter at top of pit.
- B. Obstructions
 - 1. Utilities: Notify the Project Manager immediately of utilities that conflict or may potentially conflict with proposed plant locations. In such cases, alternative plant locations will be determined by the Project Manager.
 - 2. Notify the Project Manager prior to planting if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavation.
- C. Drainage: Notify the Project Manager if subsoil conditions show evidence of water seepage or retention in tree or shrub pits.

3.07 PLANTING TREES AND SHRUBS

- A. Balled and Burlapped Stock
 - 1. Prior to hole depth determination, open top of root ball burlap. Gently remove excess soil from top of root ball to expose root flare or top of first order root.
 - 2. Set balled and burlapped stock plumb and in center of pit with base of root flare one to two-inches (1" to 2") above adjacent finish grades as indicated.
 - 3. Gently remove, without damaging the root ball, all of the wire basket and twine. Cut away burlap from minimum top two-thirds (2/3) of the root ball, but do not remove from under ball. Remove pallets, if any, before setting. Do not use planting stock if ball is cracked, loose, or broken before or during planting operation.
 - 4. Place backfill around ball in layers. When pit is approximately one-half backfilled, water thoroughly and allow to absorb into soil to eliminate voids and air pockets prior to placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.
- B. Container Grown Stock
 - 1. Carefully remove containers so as not to damage root balls.
 - 2. Shave exterior 1" of soil and roots from root ball or until all circling roots have been removed and to promote radial fibrous roots. Use sharp spade or handsaw designed specifically for tree work to make clean, non-tearing cuts on roots.
 - 3. Prior to hole depth determination, gently remove excess soil from top of root ball to expose root flare or top of first order root.

4. Set plants plumb and in center of pit with base of root flare and/or first order lateral root one to two inches (1" to 2") above adjacent finish grades as indicated.
 5. Place backfill around ball in layers. When pit is approximately one-half backfilled, water thoroughly and allow to absorb into soil to eliminate voids and air pockets prior to placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.
- C. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare two-inches (2") above adjacent finished grade.
1. Backfill: As specified in Part 2 - Products.
 2. Remove girdled or kinked roots and/or root growth that is encircling without tangling or turning toward surface, spread roots laterally. Plumb before backfilling and maintain plumb while working.
 3. Carefully work backfill in layers around roots by hand eliminating air pockets. Bring roots into close contact with the soil.
 4. When planting pit is approximately one-half filled, water thoroughly and allow to absorb into soil before placing remainder of backfill. Repeat watering until no more water is absorbed.
 5. Continue backfilling process. Water again after placing final layer of soil.
- D. Shrubs and perennials shall be planted outside of the root ball of trees.

3.08 TREE WRAP

- A. Inspect tree trunks for injury, improper pruning, and insect infestation and take corrective measures required before wrapping. Inform the Town Forester of conditions prior to wrapping. Wrap trees starting at the base of the trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Use black electrical tape to secure. Do not use staples.
1. All smooth barked trees shall be wrapped with the exception of any Populus species by November 1st and removed by May 15 or per the direction of the Town Forester and the Project Manager.
 2. Contractor shall be responsible for wrapping, re-wrapping if needed, and unwrapping trees during the warranty period.

3.09 PRUNING OF PLANTS

- A. Prune only damaged or dead branches as directed by the Town Forester and the Project Manager.

3.10 TREE STABILIZATION

- A. Install site-fabricated trunk stabilization as follows, unless otherwise indicated on Contract Drawings.
1. Drive wood stakes into undisturbed grade within the mulched area. Avoid penetrating root balls or root masses.
 2. Align tree stakes with the prevailing wind or parallel to hard surfaces.
 3. Securely attach specified wire to stakes.

4. Support trees with specified wire and tree tie webbing from the tree trunk to each stake. Allow one to two inches (1" to 2") of slack to avoid rigid restraint of the tree.
5. For staked trees: Attach twenty-four inch (24") long by one-half inch (1/2") diameter PVC pipe flagging to each wire.
6. For guyed trees: Must have prior approval from the Town Forester.

3.11 MULCHING

- A. Trees: Create a forty-eight-inch (48") radius from the outside of the trunk, by three inch (3") high formed soil berm around tree and fill with three-inch (3") deep specified wood mulch. Mulch shall be kept four to six-inches (4"-6") away from tree trunk.
- B. Shrubs:
 1. Mulch backfilled surfaces of pits, planting beds areas, and other areas indicated or as directed by the Project Manager.
 2. Mulch in shrub bed areas: Apply three-inch (3") thick layer of mulch and finish level with adjacent finish grades. Do not place mulch against stems of plants.

3.12 ANTIDESICCANT

- A. Apply antidesiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage. Apply only when directed and approved by the Town Forester.
- B. When deciduous plants are moved in full leaf, the Town Forester and the Project Manager may direct the use of an antidesiccant at nursery before moving and again two (2) weeks after planting. Antidesiccant to be supplied and applied by Contractor at no additional cost to the Town.

3.13 CLEANING

- A. Perform cleaning during installation of the work and upon completion of the Work, to the satisfaction of the Project Manager. Remove all excess materials, debris, and equipment from site. Repair any damage resulting from planting operations.
- B. Remove surplus soil, excess subsoil, unsuitable soil, and waste material including trash and debris generated during installation at no additional cost to the Town.

3.14 PROTECTION

- A. Protect existing utilities, paving and other facilities from damage caused by planting operations. The Contractor shall repair any damage at no additional cost to the Town.
- B. Restrict vehicular and pedestrian traffic from planted areas. Erect temporary protection zones with signs and/or barriers as required or directed by the Project Manager at no additional cost to the Town.
- C. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

3.15 MAINTENANCE

- A. The Contractor shall be responsible for maintaining all trees, shrubs, and groundcover until Substantial Completion is issued.

- B. Maintain trees by pruning as directed by the Town Forester or the Project Manager, cultivating, season appropriate watering, mulching, weeding, wrapping, unwrapping, restoring planting saucers, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Monitor and control as required to keep trees free of insects and disease. Restore or replace damaged tree wrappings, stakes, guying.
- C. During the irrigation season (generally May through September), water may be available from on-site quick couplers. When the system is not charged, it shall be the Contractor's responsibility to supply adequate amounts of water from a water truck or other approved source. Hoses and other watering equipment shall be supplied by Contractor.
 - 1. Watering Amount:
 - a. Minimum watering requirements shall be twenty-five (25) gallons of water per caliper inch of every tree when temperatures are at or above forty degrees (40°) F.
 - b. Watering frequency shall be based on the average soil moisture level throughout the planting area.
 - 1) An average of six (6) "Average" on a soil moisture meter shall be maintained during establishment.
 - 2) Readings shall be taken every two (2) weeks at a minimum during the Construction period and at a minimum of four (4) locations throughout the planting area.
 - 2. Readings shall be taken at a depth of eight inches (8"). At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.
- D. If Landscape Maintenance is included in the contract then the Contractor shall continue maintenance of all trees, shrubs, and groundcovers after Substantial Completion as specified in Division 32 Section "Landscape Maintenance".

END OF SECTION

SECTION 32 97 00

LANDSCAPE MANAGEMENT AND MAINTENANCE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. The Landscape Management and Maintenance Scope of Work will be awarded to a single Contractor through the Denver Parks and Recreation Construction On-Call Contract as a component of the Rosamond Park Playground & Basketball Court Renovations but will be contracted and managed through a separate Contract.
- B. This Section includes requirements for furnishing of all supervision, labor, materials, equipment, and transportation required to maintain the landscape areas called for under this contract for the time-period specified. The work includes but is not limited to; weed control, re-seeding, re-sodding, mowing, watering of plant material and pruning, irrigation system repair and maintenance, fence installation and maintenance, maintenance of erosion control measures (BMPs) including storm water features, and coordination with Town staff.
- C. Related Sections
 - 1. Division 01 Section "Tree Retention and Protection".
 - 2. Division 01 Section "Erosion and Sedimentation Control".
 - 3. Division 03 Section "Cast-in-Place Concrete".
 - 4. Division 31 Section "Earth Moving".
 - 5. Division 31 Section "Excavating and Backfilling of Trenches".
 - 6. Division 31 Section "Watering".
 - 7. Division 32 Section "Asphalt Pavement".
 - 8. Division 32 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
 - 9. Division 32 Section "Crushed Stone Paving".
 - 10. Division 32 Section "Pavement Markings".
 - 11. Division 32 Section "Playground Protective Surfacing".
 - 12. Division 32 Section "Site Furnishings".
 - 13. Division 32 Section "Irrigation Systems".
 - 14. Division 32 Section "Automatic Irrigation Controllers".
 - 15. Division 32 Section "Soil Preparation".
 - 16. Division 32 Section "Topsoil".
 - 17. Division 32 Section "Turfgrass Seeding".
 - 18. Division 32 Section "Native Seeding".

19. Division 32 Section "Sodding".
20. Division 32 Section "Trees, Plants, and Groundcovers".
21. Division 33 Section "Subdrainage Systems".

1.03 SUBMITTALS

- A. See Division 01 Section "Submittals" for submittal requirements.
- B. Management and Maintenance Plan: Submit a detailed management and maintenance plan for review and approval prior to the start of the Management and Maintenance Period by the Project Manager, Parks Operations, and the Office of the Town Forester.
- C. Maintenance Reports: Submit detailed maintenance quarterly reports and schedules, and watering logs for the Management and Maintenance Period for review and approval by the Project Manager, Parks Operations, and the Office of the Town Forester.
- D. Final Report: Submit a final detailed report that outlines final site conditions as outlined in Section "Scheduling/Progress Reports".
- E. Material List: Submit a detailed list of materials to be used for seeding, fertilization, pesticide, plant health, and mulching.
- F. Equipment List: Submit a detailed list of equipment and chemical controls to be used for all landscape management and maintenance purposes.
- G. Work Examples: Submit list of three (3) projects completed in the last two (2) years of similar complexity to this project. Include the name and location of the project, the Project Manager's name, email address, and telephone number, and the name of the project landscape architect, email address, and telephone number. Include certifications held by contractor and subcontractor employees who will oversee the work during the Management and Maintenance Period.

1.04 CONTRACTUAL REQUIREMENTS

- A. Preferred Management and Maintenance Contractor: Management and maintenance to gain establishment of the landscape to be performed by a Preferred Maintenance Contractor.
 1. Denver Parks and Recreation to provide a list of Prequalified Contractors from the Restoration, Ecological, and Technical Services On-Call list.
 2. Self-Performed Work/Alternate Contractors: Contractors proposing to self-perform or request an alternate Contractor to fulfill the requirements of the Landscape Management and Maintenance Scope of Work will be required to provide the following information:
 - a. Self-Performed: Description of the company's capability to successfully self-perform the management and maintenance to establish the site and provide three (3) examples of similar projects within the last five (5) years highlighting the company's experience with site establishment; OR
 - b. Alternate Contractor: A list of alternate Sub-Contractor(s) to perform the Work with the company's capability to successfully perform the management and maintenance to establish the site and provide three (3) examples of similar projects within the last five (5) years highlighting the company's experience with site establishment.
- B. Management and Maintenance Period for Separate Contract: The Management and Maintenance Period shall commence from the date of Substantial Completion on an existing Contract, or a

start date established by a separate Management and Maintenance contract in accordance with these Specifications. The Management and Maintenance Period shall continue for the contract duration, up to two (2) years.

- C. Limits of Work Area: All improvements and maintenance within the project work area are included unless otherwise indicated on the Contract Drawings or directed by the Project Manager. Areas outside defined areas, as illustrated on the Contract Drawings, will be maintained by the Town.
- D. Performance of Work: The Contractor's equipment shall be accepted by the Project Manager prior to the commencement of the Management and Maintenance Period. If the Project Manager finds any items unacceptable, the Contractor shall make the revisions noted by the Project Manager at no cost to the Town.
- E. Scheduling / Progress Reports
 - 1. Scheduling: Prior to the beginning of the Management and Maintenance Period, the Contractor shall submit for approval by the Project Manager a detailed schedule identifying all activities which are to be performed. Examples of such commitments include the regular intervals for weed control, fertilization, pesticide applications and mowing and other operations and the month and week which are scheduled for other major activities such as reseeding and mulching. It is not the Project Manager's intent to require the Contractor to meet each deadline on a specific day, but merely to identify the general time periods for such activities. The Contractor may modify the schedule due to weather conditions, providing that the Project Manager is notified in advance of any changes.
 - 2. Notification: The Contractor shall be required to notify the Project Manager a minimum forty-eight (48) hours in advance of all major work so the Project Manager has the option of being present at the time of the work. Examples of such work are clean cultivation, mowing, spraying, seeding, mulching or other activities relating to the repair of landscape items. If proper notification is not given by the Contractor, the Project Manager shall have the right to require the Contractor to reschedule any such work until such time that the Project Manager is available. The above provision applies only to work which could be perceived as normal or regularly scheduled maintenance; emergency repairs do not apply.
 - 3. Progress Reports: The Contractor shall submit quarterly progress reports. The written progress reports shall be sent to the Project Manager, prior to quarterly on-site meetings, outlining the work completed, damage incurred, percent of cover, desirable and undesirable species, and problems encountered. Progress reports shall contain digital photo documentation of work.
 - 4. Site Meetings: The Contractor shall meet, on site, with the Project Manager and Town staff on a quarterly basis to review the project status.
 - 5. After Hours Contact: The Contractor shall provide one (1) after hours contact, and telephone number.
 - 6. Final Report: Prior to Acceptance of this Specification, provide a final report that outlines the major actions on the site, pre-emergent applications, recent reseeding applications, any concerns about the site moving forward, and any expectations for certain areas on the site (ie: type of weed growth in particular areas of the site, etc.).
- F. Management and Maintenance Coordination: The Contractor shall coordinate maintenance operations and activities with the Project Manager.

- G. Failure to Perform: In the event that, in the Project Manager's opinion, action has not been taken on the part of the Contractor to properly maintain the project, the Project Manager may take whatever action deemed necessary to affect such repairs and any costs incurred will be deducted from the Contract amount.
- H. Licenses, Taxes, and Insurance
 - 1. Licenses: The Contractor agrees to obtain and pay for all licenses required by the Town, State, and Federal governments that are necessary for legally conducting business. The Contractor shall maintain all licenses and permits required for maintenance activities (e.g. pesticide application).
 - 2. Taxes: The Contractor shall pay all applicable taxes, including sales taxes on materials supplied.
 - 3. Insurance: The Contractor shall maintain all insurance policies in accordance with the General Contract Conditions of the contract through the entire term of the Management and Maintenance Period.
- I. Payment Schedule: Payments shall be made as indicated in Measurement and Payment section.

PART 2 PRODUCTS

2.01 REFER TO PART 1 – GENERAL: RELATED SECTIONS.

PART 3 EXECUTION

3.01 IRRIGATED TURF CARE (BLUEGRASS SOD AND SEED)

- A. Refer to Division 32 Section "Turfgrass Seeding" and Division 32 Section "Sodding" for satisfactory establishment criteria.
- B. The Management and Maintenance Period shall begin at Substantial Completion and continue for the period specified until Acceptance occurs. Acceptance of turf areas will not be given until the Management and Maintenance Period has ended and the Project Manager is satisfied with the germination and the growing condition of the turf with consistent and complete coverage in accordance with the Specifications. During this time, the Contractor shall be responsible for watering, mowing, spraying, weeding, fertilizing and all related work as necessary to ensure that turf areas are in a vigorous growing condition. The Contractor shall provide all supervision, labor, material, and equipment to develop and maintain the areas.
- C. The Contractor shall protect the site during the Management and Maintenance Period. All damage that occurs to the turf areas during the Management and Maintenance Period, including vandalism, shall be repaired by the Contractor with approved materials at no additional cost to the Town.
- D. Watering: All watering shall be done in such a way as to encourage establishment, deep root growth and drought tolerance.
- E. Soils Testing: The Contractor shall provide soils testing prior to Substantial Completion or at the start of the Landscape Management and Maintenance Period and include recommendations for turf fertilization. Testing shall also be completed at approximately one (1) year after the turf has been installed to determine if the required fertilizer formula is to be adjusted.

- F. Fertilization: Turf areas shall be fertilized with material approved by the Project Manager. Typical fertilization material and application shall be (20-5-10) two (2) times per growing season at a rate of one pound (1 lb) of nitrogen per one-thousand square feet (1,000 sf), once between April 15 and June 1 and once again between August 1st and September 15th. For verification of fertilization and quantities, the Contractor shall provide the chemical nutrient analysis from the fertilizer bags prior to fertilization and show that the nitrogen source of the fertilizer is at least fifty percent (50%) slow released. The Project Manager may approve a substitution for fertilization based on site conditions.
- G. IPM (Integrated Pest Management): Apply approved pesticides as needed to control establishment and growth of annual and perennial weeds. Spot applications shall be required in areas of excessive growth. The Contractor is responsible for ensuring turf establishment and that turf is not adversely affected by pesticide applications. No pesticides will be allowed until seedlings are at least three (3) months old. After establishment, pesticide applications shall be done as required and directed by the Project Manager during the Management and Maintenance Period.
- H. Insect and Disease Control: Insects and disease treatment shall be by an application approved and at the direction of the Project Manager and Parks Operations as conditions require.
- I. Topdressing
1. Soil used as topdressing material is to be consistent with existing soil texture where it is to be applied. Organic materials used are to meet Denver Park's organic material specifications.
 2. Topdressing is to be used in non-athletic fields when soil tests or leveling needs determine the application.
 3. Filling Low Spots: Fill low spots with matching existing soil when filling noticeable depressions or holes. Compact per Division 31 Section "Earth Moving".
- J. Repair all bare areas or dead areas of grass greater than 1 square foot (1 sq. ft.). Repairs shall occur within five (5) calendar days of notice to repair the condition. Upon the Project Manager's written approval, the Contractor may repair turf later.
1. Seeding: If the original installation was by seed, repairs to such areas are to be reseeded. Replacement products and installation shall comply with specifications for original seeding.
 2. Sodding: If the original installation was sodded, repairs to such areas are to be re-sodded. Replacement products and installation shall comply with specifications for original sodding.
- K. Mowing, Trimming and Edging
1. The Contractor shall be responsible for mowing of all areas defined by the contract and Contract Drawings until acceptance.
 2. When turfgrasses reach three and one-half-inch (3-1/2") height, begin weekly mowing and trimming program to maintain turf at a 2- and one-half inch (2 1/2") to a maximum of 3-inch (3") height. Do not remove more than thirty-three percent (33%) of grass leaf in single mowing. Do not mow when soil is wet. Remove clippings from adjacent paved areas. Mower blades are to be sharp to avoid tearing grass blades.
 3. Areas not accessible to riding mowers shall be string line trimmed at each mowing, if necessary, to match the mowing height. Limit string line trimming around trees and objects (i.e., posts, utility boxes), by applying pesticide for at least six inches (6") around

the object. The base of shrubs and trees require a forty-eight inch (48") minimum radius clear of turf (bare soil or mulch per plan).

4. Turf along concrete edges will be removed in cool season turf areas to the edge of the concrete curb or walkway using the appropriate edging equipment. The edge of the concrete surface should be visible after edging.

3.02 NATIVE SEEDING AREAS

- A. Refer to Division 32 Section "Native Seeding" for satisfactory establishment criteria.
- B. The Management and Maintenance Period shall begin at Substantial Completion and continue for the period specified until Acceptance of native seed areas. Acceptance of native seed areas will not be given until the Management and Maintenance Period has ended and the Project Manager is satisfied with the germination, coverage, and the vegetation is in a healthy and vigorous growing condition in accordance with the Specifications. During this time, the Contractor shall be responsible for watering, mowing, spraying, weeding, fertilizing and all related work as necessary to ensure that seeded areas are in a vigorous growing condition. The Contractor shall provide all supervision, labor, material, and equipment to develop, manage, and maintain seeded areas.
- C. The Contractor shall protect the site during the Management and Maintenance Period. All damage that occurs to the seeded areas during the Management and Maintenance period, including vandalism, shall be repaired by the Contractor with approved materials at no additional cost to the Town.
- D. Maintain and establish native seed areas by weeding, mowing, trimming, replanting, watering, and performing other operations as required to establish healthy, viable vegetation. Roll, regrade, and replant bare or eroded areas and re-mulch to produce healthy vegetation. Provide materials and installation the same as those used in the original installation.
 1. Fill in as necessary soil subsidence that may occur because of settling, damage, or other processes.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep seeded areas free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticide and reduce hazards.
- E. Watering: All watering shall be done in such a way as to encourage establishment, deep root growth and drought tolerance.
 1. Watering: Utilize irrigation system to water native seeded areas to obtain establishment of an acceptable grass stand, and to supplement natural moisture levels during dry periods.
 - a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas. Obtain approval of Project Manager of irrigation system and schedule proposed for use.
 - b. Water native grasses with fine spray at a minimum rate of one-half inch (1/2") per week for six (6) weeks after planting unless rainfall precipitation is adequate, or water rates approved by the Project Manager and Denver Parks Water Conservation.

- c. Do not over-water in a manner which kills drought-tolerant components of the seed mix.

F. Mowing

1. Year One: Mowing of native grasses in the first year after seeding shall be avoided unless approved by the Project Manager. If mowing in the first year is allowed, then mow only in the late in the fall to allow grass seeds to drop. Mowing shall be at a height of six inches (6") to eight inches (8").
2. Year Two: Control undesirable plant species as necessary by mowing, hand-pulling, selective pesticide application, and/or prescribed burning. If required, mow native grasses in the late fall to allow desirable grass seeds to drop. Mowing shall be at a height of six inches (6") to eight inches (8").

G. Weed Control

1. Weed control shall be done for the duration of the Management and Maintenance Period and until Final Acceptance per the Establishment section in Division 32 Section "Native Seeding". Weed control shall be completed by one (1) or more of the following methods approved by the Project Manager:
 - a. Mowing: Mowing of undesirable species shall only be done per the approval the Project Manager as a weed control method. Undesirable species shall not be allowed to seed on the site. Avoid distribution of weed seeds by catching all clippings, bagging clippings, and removing them from the site. Existing grass stands to remain shall not be mowed until late fall to encourage seed drop.
 - b. Hand Removal: Hand-removal shall include the removal of all above-ground and below-ground stems, roots, and flower masses prior to the development of seed.
 - c. Chemical Control: If necessary, apply to perennial and annual weeds by a licensed applicator trained in plant identification at no additional cost to the Town. Obtain the Project Manager's approval prior to applying pesticide. Apply per manufacturer's recommendations. Contractor is responsible for ensuring seed establishment and that seed is not adversely affected by pesticide applications. The Contractor shall use pesticide for specific species as recommended by CSU Agricultural Extension Service.
 - d. Spot Application Chemical Control: Apply pesticide by hand applicator directly to invasive annual and perennial weeds. Allow a minimum two (2) weeks between application and any seeding activities or per label specifications on the product used.

H. Reseeding

1. Evaluate native grass areas quarterly during the Management and Maintenance Period to review the germination and coverage. Use the following criteria:
 - a. Reseed all areas that meet the following conditions:
 - 1) Areas of bare or dead grass greater than twenty-four inches (24") by twenty-four inches (24") square.
 - 2) Areas of weed density are per the Acceptance section in Division 32 Section Native Seeding".
2. Reseed unacceptable areas as defined above. Reseeding, soil preparation and mulching shall comply with Division 32 Sections "Native Seeding" and "Soil Preparation". If approved, seed mixes may be revised (% of species) to better suit site conditions. If

requested by the Project Manager, the mix shall be revised at no additional cost to the Town. Where drill seeding is not feasible, hand broadcast seed and rake into the soil to achieve 1/4- to 1/2-inch coverage of soil. The seed application rate shall be doubled in all areas where it is mechanically broadcast and quadrupled in areas requiring hand broad casting. Hydroseeding is not allowed.

3. Timing of reseeding shall be as specified herein. With written approval of the Project Manager, the Contractor may reseed later.

3.03 TREE, SHRUB, AND PLANT CARE

- A. Pruning: Refer to Division 32 Section "Trees, Plants, and Groundcovers" for maintenance requirements.
- B. All plants are the responsibility of the Contractor during the Management and Maintenance Period. Which includes, but not limited to, mulching tree rings annually. All tree stabilization materials shall be removed per the direction of the Project Manager and the Office of the Town Forester prior to Final Acceptance.
- C. Insect and Disease Control: Insect and disease treatment shall be by an application approved and at the direction of the Project Manager, Parks Operations, and the Office of the Town Forester as conditions require.
- D. Replacement of Plants: Remove and replace dead, diseased, dying, or damaged plants (including material damaged by vehicles or vandalism) within fourteen (14) calendar days of notification by the Project Manager or the Office of the Town Forester. Upon the Project Manager's written approval, the Contractor may replace rejected plants later, provided that the Contractor removes all rejected plants within fourteen (14) calendar days of the notice to replace such plants. If temperature or weather conditions are not conducive to planting, obtain approval from the Project Manager and the Office of the Town Forester prior to planting. If the rejected plants are not removed within fourteen (14) calendar days, the Town may remove and replace these plants and any costs associated with the removal and replacement shall be deducted from the Contract price. All areas damaged by replacement operations are to be fully restored to their original condition as specified. Plant material damaged by vehicles or vandalism shall be replaced by the Contractor at no cost to the Town. Guarantee all plantings to be true to name and to meet all conditions of these specifications. Any plant which is not true to name as indicated by leaf, flower form or fruiting characteristics revealed within Management and Maintenance Period shall be replaced by the Contractor at the Contractor's expense.
- E. Transplanted Material: Refer to Division 32 Section "Tree Transplanting".
- F. Non-Irrigated Plant Material: All plant material that is not served by an automatic underground irrigation system shall be watered by the Contractor for the duration of the Management and Maintenance Period. Water all plant material at a rate of twenty-five (25) gallons per inch of tree caliper to maintain optimum growth. Watering frequency shall be adjusted based on rainfall, season, and plant performance. Maintain a large enough water basin around plants so that enough water can be applied to establish moisture through the major root zone.
- G. Winter Watering: Winter watering is the responsibility of the Contractor throughout the Management and Maintenance Period as required to maintain plant health. Trees shall be deep root watered at a minimum interval of one (1) time every two (2) weeks when temperatures are at or above forty degrees Fahrenheit (40°F). Refer to section above for rate. Watering may be done by water truck but must not promote or cause erosion or displacement of mulch or erosion control items.

3.04 IRRIGATION SYSTEM AND WATER MANAGEMENT

- A. Contractor shall check all irrigation systems for proper operation after each mowing, and any deficiencies or adjustments shall be repaired prior to the next watering cycle. Any damage to system caused by Contractor's operations shall be repaired without charge to Town.
- B. Contractor is responsible for following all Denver Water restrictions and establishment rules for new landscapes per Denver Water, rules and regulations at: <http://www.denverwater.org>.
- C. Contractor shall be responsible for providing an Establishment Watering Schedule, Transition Watering Schedule and a Maintenance Watering Schedule to the Project Manager, the Operation Supervisor, and the Toro Field Representative (when applicable).
 - 1. All irrigation schedules and zone controller charts shall ensure that there will be no ponding or runoff of water during any of the scheduled times.
 - 2. Prior to any plant material being installed all schedules shall be provided to the Project Manager and the Operations Supervisor.
 - 3. The water schedule templates are available from Denver Parks Water Conservation and the Project Manager. See Appendix
 - 4. Contractor shall make any modifications to the programming as requested by the Project Manager.
 - 5. Initial Irrigation (Days 1-21):
 - a. Plants shall be adequately watered for the first twenty-one (21) days after installation or until seeds have germinated and emerged or sod has become firmly rooted.
 - b. Exact timing of irrigation cycles will depend on weather conditions, soil conditions, and speed of emergence of grass seed.
 - c. Short, frequent irrigation cycles shall be used.
 - d. Split cycles or the 'cycle and soak' feature must be employed to reduce erosion or run off in seeded areas.
 - e. Do not exceed three inches (3") of total water per week.
 - f. Coordinate the irrigation system schedule and programming with the Project Manager, and Town staff. Project Manager may choose to involve other parties from the Town or irrigation equipment manufacturer.
 - g. Do not over-water native seeded areas in a manner which adversely impacts germination and growth of any components of the seed mix.
 - h. Contractor shall submit a meter reading before and after establishment to verify water use.
 - 6. Transition Irrigation (Days 21-60):
 - a. Less frequent, but longer watering cycles will provide moisture at depths that will encourage seedlings to continue to develop and sod to develop deeper roots.
 - b. Allow the surface soils to dry slightly between watering to encourage deeper rooting.
 - c. Watering shall be done utilizing historic evapotranspiration rates for the current watering month(s).
 - d. Do not over-water native seeded areas in a manner which adversely impacts germination and growth of any components of the seed mix.

7. Maintenance Irrigation (Days 61 – End of Management and Maintenance Period):
 - a. Irrigate as needed to maintain an optimum stand of turf while minimizing water use.
 - b. Irrigation frequency shall be adjusted monthly, at a minimum, based on historical evapotranspiration rates and plant (turf and tree) water requirements.
 - c. It is the responsibility of the Contractor to coordinate with Project Manager, Operations Staff, and local Toro Field Representative the programming of irrigation controllers, to properly irrigate plant materials and turfgrass.
 - d. Do not over-water native seeded areas in a manner which adversely impacts germination and growth of any components of the seed mix.
8. Once sod has been installed, begin watering to build up the sub-soil moisture. This will be the most critical time to apply water.
 - a. Water up to one and one-half inches (1-1/2") of water per day for the first two (2)-to three (3)-days.
 - b. Probe the soil to determine if the moisture has penetrated down to a minimum of four inches (4").
 - c. During the next three (3) weeks the amount of water needed will be like that of the historical evapotranspiration rates for the season per day.
 - d. Each day may require more than one application depending on wind and temperature to keep the root zone and blades moist.
- D. Time of Irrigation: Watering shall occur during the approved Town and Denver Water-allowed water window. Coordinate times with the Project Manager.
- E. Winterization of Irrigation System: Under the Management and Maintenance Period, the Contractor shall be responsible for winterizing the irrigation system and pumps, if applicable, for the full Management and Maintenance Period.
 1. Remove water from system by use of compressed air.
 2. Remove water from drip lines by opening flushing plugs.
 3. Submit a meter reading after winterization of the system has occurred to Parks Water Conservation.
 4. Winterization shall occur no later than October 15th unless a variance has been granted from the Project Manager.
- F. Spring Start-Up: The Contractor shall be responsible for starting up the irrigation system in the spring (April 15).
 1. Fully activate the system including controller start-up, to demonstrate that it is in full working order.
 - a. Any repairs that are needed because of improper winterization shall be corrected by the Contractor at no additional cost to the Town.
 2. Correct all deficiencies and make any adjustments to ensure proper system function.
 3. Submit a meter reading prior to spring start-up to the Project Manager.
- G. It shall be the responsibility of the Contractor to ensure the satisfactory operation of the entire irrigation system and workmanship within the project area. The entire system, including materials, shall be maintained to be complete and remain operable in every detail by the

Contractor throughout the Management and Maintenance Period, and the Contractor agrees to make any adjustments or repair any defects occurring within the Management and Maintenance Period within 7 calendar days of notification by the Project Manager.

1. The Contractor shall replace any materials with manufacturer's defects at no additional cost to Town.
 2. Replacement of any equipment shall match that installed and designed on the irrigation plans unless a variance is approved in writing from the Project Manager.
 3. Problems resulting in leakage or water waste shall be repaired within 12 hours of notification.
 4. If an emergency repair is necessary, the Contractor is responsible for shutting down valves on the mainline.
 - a. If the Contractor neglects to perform these duties within the specified time, the Town may make such repairs at the Contractor's expense.
 - b. In the case of an emergency, where in the judgment of the Town, delay would cause serious loss or damage, repairs or replacement may be made by verbal communication and without notice being sent to the Contractor, and the Contractor shall pay the cost thereof.
 - c. Any disruption to the irrigation system for a period of five (5) days or longer, the Contractor shall hand water the site plantings.
- H. Any settling of irrigation trenches/backfill material during the Management and Maintenance Period shall be repaired by the Contractor's at no additional cost to the Town.
- I. Contract documents shall govern irrigation replacement during Management and Maintenance Period the same as new work.
- J. Replacements are to be made at no additional cost to the Town.
- K. All damage to irrigation system during the Management and Maintenance Period, including vandalism, shall be repaired and/or replaced by the Contractor with approved materials at no additional cost to the Town.

3.05 INSPECTION AND ACCEPTANCE

- A. Formal Inspections: The project will be inspected during the Management and Maintenance Period at the following points:
1. Quarterly Inspections
 2. Contract Completion Inspection
- B. Quarterly Inspections: Shall occur quarterly from the date of Substantial Completion. The review will consist of a review of all maintenance contract responsibilities. The Contractor shall keep a quarterly report to be turned in at inspections to review work done to date, including any subcontracting, frequency of schedule, notifications made, materials list, equipment list etc.
- C. Contract Completion Inspection and Acceptance: The Contractor must give seven (7) days of notice to the Project Manager requesting a Contract Completion Inspection. During the inspection, the Contractor shall prepare a punch list of any defects discovered during the inspection and submit the punch list to the Project Manager. When all work has been completed per the Contract Documents, the Contractor may request in writing from the Project Manager Final Acceptance.

END OF SECTION

SECTION 33 31 30.90

ABANDONMENT OF EXISTING FACILITIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to abandon and/or remove the existing pipelines and structures to the limits shown on the Drawings.
- B. Blasting and the use of explosives will not be permitted for any abandonment work.

1.02 SUBMITTALS

- A. Submit to the Owner for approval, the proposed methods and operations of abandoning the pipeline and appurtenances in accordance with Section 01 33 00 prior to the start of work. Provide a detailed sequence of abandonment work, including:
 - 1. Sequence, length, and volume of reaches to be abandoned.
 - 2. Sequence, structure dimensions, and volume of structures to be abandoned.
 - 3. Methods and materials to isolate reaches and structures to be abandoned.
 - 4. Means and method to demonstrate abandoned reaches of pipe are completely filled with abandonment grout material.
 - 5. Specification and data sheet, including set time(s) and strength characteristics for abandonment grout material.

PART 2 PRODUCTS

2.01 ABANDONMENT GROUT

- A. Abandonment grout shall be a material that has flowing characteristics such that it will completely fill (with no space at the crown) the pipe to be abandoned, will set within a reasonable time (initial set time of less than 24 hours), will have an ultimate compressive strength of 100 psi minimum, will exhibit shrinkage not exceeding 1 percent of the abandoned pipe diameter, and will cause no damage to surroundings while filling pipe, while setting, or after setting.
- B. Grout may be a cement and sand type mixture with good flowing characteristics, a low-density cellular concrete such as Mearlcrete, or a fly ash-based mixture.
- C. Abandonment grout may be replaced with sand for the abandonment of precast manhole structures only.

PART 3 EXECUTION

3.01 ABANDONMENT OF EXISTING PIPELINES AND FACILITIES

- A. Complete all new work, including installation, testing, and tie-in connections before commencing abandonment work.

- B. The new WTP shall be commissioned and operating prior to abandonment of facilities that affect operation of the existing WTP.
- C. Actual abandonment shall not begin until authorized in writing by the Owner.
- D. Access to pipe to be abandoned may be through existing manholes or through excavated access pits.
- E. Isolate reaches to be abandoned by installation of bulkheads to control and monitor amount of abandonment grout/ material installed.
- F. Plug ends of abandoned pipe with concrete plugs as shown on the drawings.
- G. Remove existing manhole ring and covers and top barrel or cone section from pre-cast manholes to a minimum of 24-inches below finished grade prior to filling with abandonment material.
- H. If sand is used to abandon pre-cast manhole structures, place sand and compact as required.

3.02 SITE SAFETY

- A. Execute the abandonment with means that will prevent damage and injury to adjacent structures, and so as to not interfere with the use of, and safe and free passage to and from adjacent areas or structures.
- B. Closing or obstructing of roadways, railways, sidewalks, or passageways adjacent to the Work by abandonment activities will not be permitted, without written permission of Town. Erect and maintain barriers, and lights around work area, as required. Provide alternate routes around closed or obstructed traffic ways.

3.03 QUALITY ASSURANCE

- A. Provide test cylinders and testing to demonstrate strength and set time for abandonment grout material.
- B. Additional testing may be provided by the Town.

3.04 REPAIRS TO DAMAGE

- A. Promptly repair damage caused to adjacent facilities by abandonment operation, as directed by the Project Manager and at no cost to the Owner.

3.05 SURFACE RESTORATION AND CLEAN-UP

- A. Remove from the site all debris resulting from the abandonment operations. Upon completion of the Work, all materials, equipment, waste, and debris of every sort shall be removed, and the site shall be left clean and orderly.
- B. Restore surface area to a condition compatible with surrounding area and as specified in 32 90 10.

END OF SECTION

SECTION 33 13 00

DISINFECTION OF WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, and equipment required to perform the cleaning and disinfection of potable water pipelines. Pipeline chlorination disinfection shall be in accordance with this Specification and the requirements of the Colorado Department of Health.
- B. Disinfection shall be accomplished by the Chlorine Concentration Test followed by the Bacteria Test, as hereafter specified, and as specified in the Town of Silt Standards.
- C. All chlorine and bacteria testing shall be conducted by and at the expense of the Contractor.

1.02 SUBMITTALS

A. General

- 1. Submit shop drawings in accordance with Section 01 33 00, Submittal Procedures.

B. Action Submittals

- 1. The Contractor shall submit a written plan for the disinfection of the pipelines for this project prior to beginning the disinfection process for the Owner's review and acceptance.

1.03 REFERENCE STANDARDS

A. American Water Works Association (AWWA)

- | | | |
|----|------------|---|
| 1. | C651 | AWWA Standard for Disinfecting Water Mains |
| 2. | B 300 | AWWA Standard for Hypochlorites |
| 3. | Manual M3 | Safety Practice for Utilities |
| 4. | Manual M20 | Water Chlorination Principles and Practices |

PART 2 PRODUCTS

2.01 SODIUM HYPOCHLORITE

- A. Sodium hypochlorite shall conform to ANSI/AWWA B300. Sodium hypochlorite shall contain 5 percent to 15 percent available chlorine, and the storage conditions and time must be controlled to minimize its deterioration. (Available chlorine is expressed as a percent of weight when the concentration is 5 percent or less, and usually as a percent of volume for higher concentrations. Percent x 10 = grams of available chlorine per liter of hypochlorite.)

2.02 CALCIUM HYPOCHLORITE (GRANULES OR TABLETS)

- A. Calcium hypochlorite conforming to ANSI/AWWA B300 is available in granular form or in 5-g tablets and must contain approximately 65 percent available chlorine by weight. The material should be stored in a cool, dry, dark environment to minimize its deterioration.
 - 1. Tablets dissolve in approximately 7 hours and must be given adequate contact time. Do not use calcium hypochlorite intended for swimming pool disinfection, as this material has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time has been achieved.

2.03 PERMATEx NO. 1

- A. A product of the Permatex Company, Brooklyn, New York and Kansas City, Kansas.

PART 3 EXECUTION

3.01 GENERAL

- A. All new main line construction shall be chlorinated in accordance with this Specification, AWWA 651, and the local health authority having jurisdiction. The chlorinating agent and method of application shall be approved by the Owner. Pipeline chlorination shall be performed subsequently to the hydrostatic testing.

3.02 METHODS OF CHLORINATION DISINFECTION

- 1. Before filling the pipe with water, the pipe shall be clean and free of debris to the satisfaction of the Owner. The chlorination shall be applied in amounts sufficient to produce a dosage of 100 mg/liter and shall be performed in accordance with AWWA C651.
- 2. The chlorinating material shall be either calcium hypochlorite (70% available chlorine by weight) or sodium hypochlorite (in 5 ¼% - 15% available chlorine). The Contractor shall chlorinate the pipeline by either of the following methods:
 - B. Slug Method
 - 1. The slug method shall be used for large mains when continuous feed or tablet methods are not practical.
 - 2. Before filling the pipe with water, the pipe shall be clean and free of debris to the satisfaction of the Owner. The pipeline shall be completely filled with water to remove air pockets and flushed to remove any remaining debris particles. Contractor shall provide a temporary water supply connection (backflow protected as required) which will allow for water to be fed into the pipeline at a constant, measured rate. Contractor shall submit the chlorination plan and calculations for approval prior to beginning pipeline disinfection.
 - 3. At a location not more than 10 feet downstream from the beginning of the pipeline, water entering the pipeline shall receive a dose of chlorine fed at a constant rate such that all interior surfaces will be exposed to a concentration of at least 300 milligrams per liter of chlorine for at least 3 hours.
 - 4. The free chlorine residual shall be measured in the slug as it moves through the pipeline. Test locations and the number of samples shall be as directed by the Owner. If at any time it drops below 50 mg/L, the flow shall be stopped; chlorination equipment shall be

relocated at the head of the slug; and, as flow resumes, chlorine shall be applied to restore the free chlorine in the slug to not less than 300 mg/L.

5. As the chlorinated water flows past fittings and valves, related valves and hydrants shall be operated so as to disinfect appurtenances and pipe branches, unless they are being left closed in order to assure that the highly chlorinated water does not enter the existing distribution system.
6. The Contractor shall be fully responsible for not allowing any highly chlorinated water to enter the existing distribution system

C. Chlorine Concentration Test

1. The chlorine concentration shall be tested at accessible locations and as required by the Engineer. This shall include, but not be limited to, fire hydrants, blow-offs, and stub lines. Chlorine shall be tested by either Amperometric Titration or the DPD Test. Orthotolidine colorimetric testing shall not be an acceptable means of testing the chlorine concentration.

D. Tablet Method: The tablet method consists of placing calcium hypochlorite granules or tablets in the water main as it is being installed and then filling the main with potable water when installation is completed. This method may be used only if the pipes and appurtenances are kept clean and dry during construction. The tablet method is not permissible when the temperature is below 5 degrees centigrade.

1. During construction, 5-g calcium hypochlorite tablets shall be placed at the top of the waterline in each section of pipe and also in pipe appurtenances.
 - a. Under normal conditions, the following table should produce the required concentrations using $3\frac{3}{4}$ grams available chlorine per gram tablet.

Diameter of Pipe (inches)	Number of Tablets				
	6	8	10	12	16
Length of Pipe Section (Feet)	Number of Tablets				
Less than 18	2	2	3	5	9
18	2	3	5	6	12
20	3	4	5	7	14
30	3	5	7	10	20
40	4	6	9	14	25

2. The tablets shall be secured to the pipe wall by use of Permatex No. 1 or other adhesive which has been approved by the Engineer. There shall be adhesive only on the broadside of the tablet attached to the surface of the pipe. Attach tablets inside and at the top of the waterline, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on the section to indicate that the pipe has been installed with the tablets at the top.
3. When installation has been completed, the main shall be filled with potable water at a rate to ensure that the water within the main will flow at a velocity no greater than 1 ft/sec. The Inspector must be notified 24 hours in advance of filling the line. Precautions shall be taken to ensure that air pockets are eliminated. After the water line has been filled, the concentration of chlorine shall be at least 50 milligrams per liter at all test locations. The chlorinated water shall remain in the pipeline for a minimum time period of 24 hours in

accordance with AWWA C651. If the water temperature is less than 41 degrees F, the chlorinated water shall remain in the pipeline for a minimum time period of 48 hours. When the line is full, all valves shall be operated to insure total chlorination. At the end of the appropriate time period, the chlorine residual in the water in the pipeline shall be tested by the Inspector. The residual chlorine content shall not be less than 25 milligrams per liter. If residual chlorine is less than the required amount, the line shall be re-chlorinated, allowed to stand for another time period as specified, and re-tested. It is the Contractor's responsibility to coordinate residual testing.

4. All valves in lines being disinfected shall be opened and closed several times during the contact period unless they are being left closed in order to assure that the highly chlorinated water does not enter the existing distribution system. The Contractor shall be fully responsible for not allowing any highly chlorinated water to enter the existing distribution system.

E. Continuous Feed Method

1. This method shall be used if it is necessary to flush the water line prior to chlorination or for rechlorination if the tablet method fails.
2. Water from the existing distribution system shall be made to flow at a constant rate through the line to be disinfected. The Inspector must be notified 24 hours in advance of filling the line. Chlorine is then pumped into the line at the source of fresh water at a rate which will result in a chlorine concentration of at least 50 milligrams per liter measured at all accessible locations and as required by the Engineer.
3. All valves shall then be operated to ensure total chlorination. After setting in the line for 24 hours, the chlorine residual shall be not less than 25 milligrams per liter measured at all accessible locations and as required by the Engineer. The following table should meet these requirements under normal conditions.

Chlorine required to produce 50 mg/L chlorine concentration per 100 feet of pipe		
Pipe Size (inches)	100% Chlorine (lb.)	1 percent Chlorine Solution (gal.)
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
14	0.333	3.98
16	0.435	5.20

F. Special Conditions

1. When water mains are cut into or repaired, precautions shall be taken to avoid contamination. When it is possible to isolate the section of line, the continuous feed or slug methods of chlorination shall be used, followed, and preceded by thorough flushing. The absolute minimum amount of disinfection shall be swabbing all couplings, tapping sleeves and any other materials to be used with a 5 percent Sodium Hypochlorite solution or a 350 mg/L available Chlorine solution made from Calcium Hypochlorite* just prior to being installed.
2. *One 5g table of Calcium Hypochlorite (70% available Chlorine) per 10 liter of water is equal to 150 mg/L of available Chlorine.

3.03 FLUSHING

- A. Once the residual chlorine content has met the specified amount and has been accepted by the Owner, the pipeline shall be thoroughly flushed with clean water to remove the heavily chlorinated water. The Inspector must be notified 24 hours in advance of any flushing. The entire line, including appurtenance leads, branch lines, and dead end mains shall be flushed. Flushing shall be continued until the residual chlorine content is not greater than 1.0 part per million.
 - 1. Flushing shall be performed with a flushing velocity of at least 2 ½ feet per second. The Contractor shall provide all fittings required to flush the line. Care shall be taken in flushing the pipeline to prevent property damage and danger to the public. The discharge of flushed water shall be accomplished in such a manner that no erosion will occur and with no damage to streets, fish, animals, plants, or other property. The method of disposal of the chlorinated water must be approved by the Owner prior to the flushing of the line, and de-chlorination will be required. Any damage caused by flushing shall be repaired by the Contractor to the original condition.

3.04 CLEAR WATER TEST

- A. Twenty-four (24) hours after the chlorination disinfection, flushing and hydrostatic testing of the pipeline have been successfully completed, the Contractor shall sample for bacterial contamination. The number and frequency of samples shall conform to the requirements of the Public Health Authority having jurisdiction. However, a minimum of two (2) locations (4 samples) shall be analyzed on distribution mains. Test locations shall be at the Owner's discretion. All samples shall be collected in duplicate, that is, two samples from each location tested. If the samples show no bacteriological growth and prove to be comparable in quality to the water served the public from the existing water supply system, the Owner shall release the main for service and the Contractor shall initiate the required forms. If the pipeline fails the bacteriological testing, the line shall be re-chlorinated as directed by the Engineer. The pipeline shall not be placed into service until all testing has been successfully completed.

3.05 DRAINING AND DISPOSAL OF TESTING WATER

- A. At the successful completion of all hydrostatic testing, chlorination, and bacteriological testing, the Contractor shall be responsible for draining all water from the newly constructed pipeline and appurtenances, and properly disposing of the drained water in accordance with all applicable County and State regulations.

END OF SECTION

SECTION 33 14 13

PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies plant piping systems, fittings, pipe support systems, pressure and leak testing, installation requirements, and piping schedules.
- B. All piping and ancillary materials that comes into contact with raw or treated water or substances that will be combined with raw or treated water shall be NSF 61 certified.

1.02 REFERENCES

- A. This section contains references to the following industry and trade group standards. They are a part of this section as specified and modified. The latest version of the standard references shall apply. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
AASHTO HS20	Loading, Tractor Truck with Semi Trailer
AASHTO HB-17	Standard Specifications for Highway Bridges
AASHTO T99-01	Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305-mm (12-in) Drop
ASME B16.25-1999	Butt-Welding Ends
ASTM A674-00	Standard Specification for Polyethylene Encasement for Ductile Iron Pipe for Water and Other Liquids
ASTM A153/A153M-03	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASME B31.1-2001	Power Piping - ASME Code for Pressure Piping
ASME B31.3-2002	Process Piping
ASME B31.9-1996	Building Services Piping - ASME Code for Pressure Piping
ASME BPVC-2013	Boiler and Pressure Vessel Code
AWWA C111/ANSI A21.11-00	Standard for Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings
AWWA C104/ANSI A21.4-03	Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water
AWWA C105/ANSI A21.5-99	Polyethylene Encasement for Ductile Iron Pipe Systems
AWS QC1	Certification of Welding Inspections
MSS SP-58-2009	Pipe Hangers and Supports – Material, Design, and Manufacturer
MSS SP-69-2002	Pipe Hangers and Supports - Selection and Application

NFPA 24	Standard for Installation of Private Fire Service Mains and Their Appurtenances
SSPC SP1	Surface Preparation Specification No. 1 - Solvent Cleaning
SSPC SP2	Surface Preparation Specification No. 2. - Hand Tool Cleaning

1.03 DEFINITIONS

A. Wetted and Submerged

1. For the purposes of defining piping installations and the required materials, joints and corrosion protection, these terms are defined as any location at an elevation below the elevation of the following, as applicable:
 - a. Inside hydraulic structures and channels.
 - b. The top face of hydraulic structure and channel walls and cover slabs.
 - c. Walkways over hydraulic structures and channels.

B. Pressure Terms

1. Maximum operating: The greatest continuous pressure at which the system operates.
2. Test: The pressure used to determine system acceptance.

1.04 SUBMITTALS

A. Provide following submittals consistent with Section 01 33 00.

B. Metal Framing Pipe Support Systems

1. Detailed installation drawings, catalog information, and complete component specifications.

C. Ductile Iron Wall Pipe

1. Manufacturer's data, including thrust collar type and the test report substantiating the pressure rating and safety factor for fabricated thrust collars.

D. Expansion Joints and Expansion Compensators

1. Manufacturer's data on materials, construction, and ratings.

E. Flexible Metal Hose

1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths.

F. Couplings

1. Manufacturer's data on materials, construction and ratings for middle rings, followers, gaskets, nuts, and bolts.

G. Fittings

1. Manufacturer's data on materials, construction, and ratings for fittings.
- H. Support System
1. Drawings of piping, locating supports, hangers, guides, and anchors. Identify support, hanger, guide, and anchor type by catalog number and shop drawing detail number.
- I. Shop Fabricated Piping Systems or Assemblies
1. Submit layout drawings that detail each pipe and fitting. Also include numbering or other labeling system that shall be used in the field to assemble prefabricated components.
- J. Pipe Wall Thickness
1. Identify wall thickness and standard applied for each size of each different service including exposed, submerged, buried, and concrete-encased installations.
- K. Hydraulic Thrust Restraint
1. Details including materials, sizes, and assembly ratings, and pipe attachment methods for each pipe material.
- L. Dissimilar Pipes
1. Provide joint types and drawings for dissimilar pipes.
- M. Welding
1. Inspection and Testing Laboratory Qualifications: Submit background information including experience, years in business, and three references for proposed independent testing laboratory.
 2. Performance Qualifications: Prior to start of work, submit list of welders and welding operators, and types of welding for which each has been qualified, for both shop and field welding.
- N. Ductile Iron Wall Pipe
1. Manufacturer's certified test report substantiating pressure rating and safety factor specified.
- O. Pipe Base and Pipe Zone Materials
1. Identify material type, gradation, and source.
- P. Steel Pipe and Fittings Certification
1. Steel pipe and fittings on this project shall be manufactured and fabricated in a plant certified under the Steel Plate Fabricators' Association Quality Assurance Program.
- Q. Manufacturer's Certification of Compliance
1. For manufactured items and materials to certify compliance with the Specifications.
- R. Certificates of Inspection and Testing

1. For Specified inspection and testing, include test logs and reports.

S. Hydrostatic Testing

1. Detailed plan for filling and testing pipeline sections; submit at least 14 days in advance of testing.
2. Testing procedures to be used, locations for necessary equipment and materials, and date and duration of tests.
3. Results of all pipe testing.

T. Contract Closeout

1. Maintenance and operation information on piping support systems, corrosion protection, and insulation, as applicable.
2. List of manufacturer's recommended spare parts inventory for specified item.
3. Accessories and components having a shorter service life than their respective piping.

1.05 QUALITY ASSURANCE

A. Welder And Welding Operator Performance

1. Qualify welders and welding operators by approved testing laboratory before performing any welding under this section.
2. Perform welder qualification tests in accordance with AWS D1.1.
3. Qualification tests may be waived if the Engineer deems evidence of prior qualification suitable.
4. Qualify welders and operators in the performance of making welds in each different pipe material, including carbon steel pipe for each welding process to be used.
5. Qualify welders and welding operators for stainless steel as stated herein on the type of stainless steel being welded with the welding process used.
6. Retest any welders at any time when Engineer considers quality of the welder's work substandard. Labor costs for retest will be borne by the Owner if welder successfully passes test. If welder fails test, all costs shall be borne by the Contractor.

B. Welder Inspection and Testing Laboratory Qualifications

1. Owner may retain approved independent testing laboratory that will provide the services of an AWS certified welding inspector qualified in accordance with AWS QC1 with prior inspection experience of the welds specified herein.

1.06 DELIVERY, STORAGE AND HANDLING

A. Pipe

1. Protect, support, and handle in a manner to prevent damage to the products, especially linings and coatings.
2. When necessary, provide shelter to store pipe and apply water to prevent excessive drying.
3. During cold weather, store pipe on supports to prevent coating from freezing to the ground.

4. Do not store pipe on rock or other hard surface.
5. Use implements, tools, facilities, and equipment suitable for proper and safe protection and handling of piping; do not drop or dump pipe into trenches.
6. Use heavy canvas or nylon slings, not chains or cables, to lift pipe and fittings.
7. Cement-Mortar Lined Steel Pipe: Tightly close ends with polyethylene plastic wrap to protect cement-mortar lining during shipment; leave plastic wrap on pipe until installation.
8. Remove pipe that, in the opinion of the Engineer, is damaged beyond repair.

B. Gaskets

1. Store in a cool, well-ventilated area.
2. Do not expose to the direct rays of the sun.
3. Do not allow contact with oils, fuels, or petroleum solvents.

1.07 SYSTEM DESIGN REQUIREMENTS

A. General

1. The Specifications and Drawings are not all inclusive of explicit piping details; provide piping in accordance with laws and regulations and intended use, including:
 - a. Power Piping: ANSI/ASME B31.1-2002 Code.
 - b. Building Service Piping: ANSI/ASME B31.9-1996 Code, as applicable.
 - c. Uniform Plumbing Code.
2. Pressure Ratings and Materials Specified: Represent minimum acceptable standards for piping systems.
3. Piping Systems: Suitable for the services specified and intended.

B. Buried Piping

1. Provide to be suitable for design conditions as follows: HS20 traffic loads (AASHTO Standard Specifications for Highway Bridges) with 1.5 impact factor. Designed for piping with and without internal pressure.

C. Support Systems

1. Design, size, and space supporting devices adequate to maintain the pipelines, appurtenances and equipment in proper position and alignment under all operating and testing conditions with allowances for expansion and contraction.
2. Design all supporting devices to minimize interference with access and movement. Eliminate potential injuries due to protruding support devices.
3. Select and design within the specified spans and component requirements.
4. The absence of pipe supports and details on the Drawings shall not relieve Contractor of responsibility for sizing and providing supports throughout plant.
5. Meet requirements of ANSI/MSS SP-58-2009, "Pipe Hangers and Supports-Materials, Design, and Manufacture."
6. Criteria for Structural Design and Selection of Pipe Support System Components:

- a. Dead loads imposed by the weight of the pipes filled with water, except air and gas pipes within specified spans and component requirements, plus any insulation.
 - b. Safety Factor: Minimum of 5.
 - 7. Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor the support, to withstand the shear and pullout loads imposed by loading and spacing on each particular support.
 - a. Piping smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
 - 8. Framing Support Systems
 - a. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
 - b. Column Members: Size in accordance with the manufacturer's recommended method.
 - c. Support Loads: Calculated for pipes filled with water.
 - d. Electrical Conduit Support: Include in design of framing support system.
 - 9. Support Spacing for Piping: Design actual support spacing and rod size based on pipe strength, anticipated loads, configuration, and other considerations. Acceptable limits are shown on the drawings.
- D. Thrust Restraint
- 1. Ties: Generally not shown on Drawings of the individual pipelines; their absence shall not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended.
 - 2. Buried thrust blocks shall not be used.

PART 2 PRODUCTS

2.01 GENERAL

A. Pipe Materials

- 1. General materials to be used for the piping systems are listed by service in the Piping Schedule at the end of this section.
- 2. Specific material requirements are specified in the Piping Specifications.
- 3. Like Items of Materials: End products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
- 4. Furnish grooved-end pipe fittings and couplings from the same manufacturer.

B. Components

- 1. Furnish new products of equal material and rating as connecting pipe.

C. Galvanizing

- 1. Hot-dip applied, meeting requirements of ASTM A153/A153M-03 except with an extra heavy coating thickness equal to minimum coating thickness Grade 85.

2. Hardware: Hot-dip galvanize process in accordance with ASTM A153/A153M-03.
 - a. Bolts, nuts and washers may be mechanically galvanized in accordance with ASTM B695.
 - b. Galvanize all components in connection utilizing the same galvanizing process.
 - c. Oversize threaded components in accordance with the respective ASTM specifications for the galvanizing process and material fabrication.
 - d. Lubricate nuts with a clean, non-oily and dry to touch lubricant. Provide lubricant with visible dye.
3. Electroplated zinc or cadmium plating is unacceptable.
4. Stainless steel components may be substituted where galvanizing is specified.
5. Repair methods should be in accordance with ASTM A780.

D. Shop Fabricated Piping

1. Furnish in accordance with approved layout drawings
2. Fabricate outlets and bends in appropriate lengths so that when installed they will be located as shown on layout drawings.
3. Mark each pipe and fitting on the outside to include:
 - a. Size or diameter and class of pipe
 - b. Manufacturer's identification and pipe serial number
 - c. Location number on layout drawing
 - d. Date of manufacture.
4. Where galvanizing is specified, hot-dip after fabrication in accordance with ASTM A123 and piping specifications.

E. Fittings

1. Manufacture fittings to standard dimensions and suitable for pressure specified. Provide fittings of the same or heavier wall thickness as the pipe of which they are a part.
2. Provide screwed and welded fittings meeting the requirements specified in the Piping specifications at the end of this section.
3. Provide fabricated steel fittings with plain end or welded flanges.
4. Where galvanized is specified, hot-dip galvanize after fabrication in accordance with ASTM A123 and piping Specifications.

F. Glass Lining

1. Glass lining shall be hard, smooth, continuous vitreous material formulated to resist the adherence of crystalline metal salt deposits in sludge and centrate lines.
2. The glass portion of the lining shall have a density of 2.5 to 3.0 grams per cubic centimeter when measured per ASTM D792.
3. The finished lining shall have the following characteristics:
 - a. Minimum dry film thickness of 10 mils when measured per ASTM D7901.
 - b. The lining shall withstand a strain of 0.001 inch/inch of the base metal without damaging the glass.

- c. Minimum hardness of 5 on Mohs hardness scale.
- 4. Installation shall be completed in a twostep firing process including a ground coat and cover coat application.
- 5. Quality Assurance: Inspect each pipe/fitting prior to shipment, including:
 - a. Minimum lining thickness test to verify 10 mil thickness.
 - b. Holiday test using low voltage wet sponge testing apparatus per ASTM D5162. Allowable holiday indications are given below.

Fittings	Max # of Holidays	Pipe	Max # of Holidays*
		3" diameter (maximum length 10')	6
4" through 8" diameter	5	4" through 8" diameter	12
10" through 18" diameter	8	10" through 18" diameter	20

*Except where noted, values are for 20' pipe lengths. For shorter lengths maximum holidays is proportional.

- c. Finished glass lined pipe straightness shall be 3/8" in 20 feet for flanged and grooved end pipe and 5/8" in 20 feet for bell and spigot pipe.
- d. Applicator shall have a minimum of five years of experience in the application of high temperature coatings for the wastewater industry.
- 6. Welding and tapping of glass-lined pipe shall be completed prior to glass lining.

2.02 JOINT FOR EXPOSED PIPING

A. General

- 1. Furnish joints of the type specified in the Piping Specifications at the end of this Section.

B. Grooved-End Joints

- 1. Provide for exposed piping as specified in the applicable Piping Specification.
- 2. Type: Rigid, except where joints are used to correct misalignment, to provide flexibility, and where shown otherwise, in which case provide flexible type.

C. Flanged Joints

Use for pipe joints only as follows:

- 1. Grooved-end joints are not specified in the Piping Specification.
- 2. Grooved-end joints are not available, as on certain pipe sized and fittings.
- 3. Grooved joints are not permitted because of service.
- 4. Grooved-end Flange Adapter Manufacturer: Victaulic flange adapter.
- 5. Verify compatibility of pressure class, flange drilling, and mating flange to adapter flange gasket prior to selecting grooved end adapter flanging.
- 6. Provide all flanges for steel pipe of the slip-on welding type with hubs meeting the requirements specified in the Piping Specifications at the end of this section.
- 7. Provide for exposed steel pipe where specifically shown on the Drawings:

- a. Provide flanged joints with bolts or bolt studs with a nut on each end.
 - b. Provide bolts, stud bolts and nuts meeting the requirements specified in Piping Schedule.
 - c. Provide bolts that have a ¼-inch projection beyond the nut when joint with gasket is assembled.
- 8. Provide gaskets for flanged joints meeting the requirements specified in the Piping Specifications.
- 9. Dielectric Insulation: Provide dielectric insulating-flanged joints as required. Provide flange insulation kits to include flange insulating gasket, flange bolt insulating sleeves and flange bolt insulating washers.
- D. Grooved-End Piping Compatibility
 - 1. Provide fittings and couplings from same manufacturer to assure uniformity and compatibility of grooved-end piping components.
- E. Dismantling Joint
 - 1. All dismantling joints shall be designed, manufactured, and tested in accordance with the requirements AWWA C219 for bolted couplings.
 - 2. The dismantling joint shall be a self-contained flanged restrained joint fitting, including both flanged components and sufficient harness bars to withstand the imposed thrust. The dismantling joint shall allow for up to 2-inches of longitudinal adjustment. The dismantling joint shall be rated at a pressure of 250 psi and flanges shall be in accordance with AWWA C207 Table D. The dismantling joint shall be furnished as a complete assembly consisting of spigot piece, flange adapter, tie bars and gasket. The dismantling joint shall be designed so that no part of the restraint system extends outside the flange diameter. The internal bore shall match that of the pipe system.
 - 3. The spigot piece shall be made of steel to ASTM A283 Grade C. The flange adapter for pipe up to 12-inches in diameter shall be either steel to ASTM A283 Grade C or ductile iron to ASTM A536 Grade 65-45-12. The flange adapter for pipe greater than 12-inches in diameter shall be steel to ASTM A283 Grade C. Tie bars shall be ASTM A193 Grade B7 threaded rod with rolled threads. Gasket shall be EPDM Grade E in accordance with ASTM D2000. The dismantling joint shall be supplied with an in-house applied fusion bonded Epoxy or Rilsan Nylon coating applied by fluidized bed method. The coating shall comply with the requirements of AWWA C550 as applicable. Tie bars, nuts, and washers shall be zinc coated.
 - 4. The dismantling joint shall comply with AWWA C219 where applicable. The manufacturer must have manufactured the dismantling joint for a minimum of 5 years. The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system. Tie rod diameter shall be compatible with the corresponding bolt diameter of the mating flange. The tie rod restraint system shall be capable of withstanding full pressure thrust that the pipe system can develop at no more than 50% of the yield strength of the tie rod material.
 - 5. The dismantling joint shall be as manufactured by Smith-Blair, Inc., Romac, or engineer approved equal.

2.03 JOINTS FOR BURIED PIPING

A. Ductile Iron Pipe

1. Pressure Services:
 - a. Provide joint thrust restraint designed for test pressures shown in Piping Schedule.
 2. Connection to Existing Piping System:
 - a. Use mechanical joint anchor gland follower where thrust ties.
 - b. Anchor type, wedge action, ductile iron with break-off tightening bolts.
 - c. Manufacturer: EBAA Iron, Inc., Megalug.
- B. Steel Pipe
1. Gravity and Non-pressure Services: Provide flexible couplings or bell-and-spigot joints with constrained gaskets, as specified.
 2. Pressurized Services: Provide joint similar to gravity and non-pressure services with thrust restraint.
 - a. Thrust Protection: Sustain force developed by 1-1/2 times operating pressure specified
- 2.04 EXPANSION JOINTS
- A. Metal Expansion Joints
1. Stainless Steel Pipe Expansion Compensator where indicated on Drawings: Type 304 stainless steel single-ply unlaminated bellows with type 304 stainless steel flanges. Minimum working pressure 8.5-psig. Hyspan models 2505-067-3.0, 2505-080-3.0, 2505-084-3.0 or Engineer-approved equal bellows.
 2. Carbon Steel Pipe Expansion Compensator where indicated on Drawings: Type 304 stainless steel single-ply unlaminated bellows with A-36 carbon steel plate flanges. Minimum working pressure 8.5-psig. Hyspan model 2505-080-3.0 or Engineer-approved equal bellows.
- B. Rubber Expansion Joints
1. Elastomer bellows, reinforced, rubber spool type of a single, open wide-arch design.
 2. End Connections: rubber flanged, 125-pound ANSI with split, galvanized steel retaining rings.
 3. Washers: Over the retaining rings to help provide a leak-proof joint under test pressure.
 4. Thrust Protection: Provide control rods to protect the bellows from over extension. The number and size of the control rods shall be sufficient for the maximum system test pressure.
 5. Materials of Construction: Chlorobutyl, fiberglass, and Kevlar with EPDM lining and cover.
 6. Bellows Arch Lining: Viton or EPDM. Arch lining shall be chemically compatible with fluid. See Elastomer materials listed in Valve Schedule (Specification 33 14 19) for acceptable materials for specific chemical service; coordinate with Engineer.
 7. Rated Temperature: 300 F for Viton and 250 F for EPDM.
 8. Rated Deflection and Pressure: Lateral Deflection 3/4-inch minimum. Burst Pressure four times the working pressure.

9. Compression deflection and minimum working pressure as follows:

Size (inch)	Deflection (inch)	Pressure (psig)
2.5 to 12	1.06	7.5
14	1.65	7.5

10. Manufacturers and Styles: General Rubber Corp., Style 1015 Single Arch; Garlock, Style 204 Single Arch; Flexicraft Industries, Ultraspool, or Engineer-approved equal.

2.05 JOINT LUBRICANT

- A. Furnished with pipe.
- B. Amount and Type: As recommended by pipe manufacturer.
- C. Composition: Water soluble, nontoxic, vegetable soap compound conforming to United States Pharmacopoeia No. P39, suitable for use in potable waterlines.

2.06 PIPE GUIDES

A. Intermediate Guides

1. Piping 6 Inches and Smaller: Pipe clamp with oversize pipe sleeve to provide minimum 1/8-inch clearance as manufactured by Kin-Line, Inc., Figure 417 or Grinnell Power Strut, Figure P5932.
2. Piping 8 Inches and Larger: Specially formed U-bolts with double nuts to provide 1/4-inch minimum clearance around pipe. U-Bolt Stock Size shall be as follows:
 - a. 8-Inch Pipe: 5/8-inch U-bolt.
 - b. 10-Inch Pipe: 3/4-inch U-bolt.
 - c. 12 through 16-Inch Pipe: 7/8-inch U-bolt.
 - d. 18 through 30-Inch Pipe: 1-inch U-bolt.

B. Alignment Guides

1. Piping 8 Inches and Smaller: Galvanized steel spider or sleeve type.
2. Piping 10 Inches and Larger: Galvanized roller type guides as manufactured by Flexonics, or Kin-Line.

2.07 PIPE ANCHORS

- A. Galvanized steel anchor chair with U-bolt strap.
- B. Manufacturers and Models: Grinnell, Figure 198 or B-Line, Figure B3147A or B.

2.08 COUPLINGS FOR METALLIC PIPING

A. General

1. Thrust Ties: Provide where shown and where required to restrain the force developed by 1-1/2 times the test pressures specified.

- a. Steel Pipe: Attach with fabricated lugs per AWWA Manual 11.
 - b. Flanged Coupling Adapters: Employ manufacturer's anchor studs through the coupling sleeve for exposed installations.
 - 2. Exposed Installations: Zinc-plated nuts and bolts; however, high-strength, low-alloy steel, in accordance with AWWA C111, may be substituted for use on cast iron and ductile iron couplings.
 - 3. Buried and Submerged Installations: Provide Type 304 stainless steel bolts and nuts.
- B. Steel Sleeve Type Couplings
- 1. General
 - a. Pressure Rating: Provide couplings with a minimum pressure rating equal to test pressure of the pipeline.
 - b. Middle Rings and Followers: Provide middle rings without pipe stop and at least 3/8 inch thick and 7 inches wide for 10 inch through 30-inch pipe and 1/2 inch thick and 10 inches thick for 36 inch and larger pipe. Provide middle rings manufactured of steel meeting requirements of ASTM A513.
 - c. Followers: provide followers manufactured of rolled AISI C1012 or C101B steel and of proper thickness.
 - d. Gasket Material: Use rubber compound gaskets that are not affected by the fluid service of the pipeline.
 - e. Bolting Hardware: Exposed Installations: Provide steel bolts and nuts meeting requirements of AWWA C111 or ANSI A21.11.
 - f. Coatings: Line and coat steel sleeve type couplings in accordance with Section 09 90 00. Coat all bolts, nuts and coupling after the joint has been made.
 - 2. Flexible Couplings:
 - a. Manufacturers for Steel Pipe: Dresser, Style 38; Smith Blair, Style 411.
 - b. Manufacturers for Ductile Iron Pipe: Dresser, Style 53 or 153; Smith Blair, Style 431.
 - 3. Transition Couplings: Connect similar pipe with small difference in outside diameter. Manufacturers: Dresser, Style 162; Rockwell, Style 413.
 - 4. Flanged Coupling Adapters:
 - a. Manufacturers for Steel Pipe: Smith Blair, Series 913; Dresser Industries, Inc., Style 128.
 - b. Manufacturers and Models for Ductile Iron Pipe: Smith Blair, Series 912; Dresser Industries, Inc., Style 127.
 - c. Where restrained flanged coupling adapters are indicated on drawings, flanged coupling adapters shall be provided with factory installed anchor studs.

2.09 SERVICE SADDLES

A. Ferrous Metal Piping (Except Stainless Steel)

- 1. Double-strap design capable of withstanding 150 psi internal pressure without leakage or overstressing.

2. Run diameter compatible with the outside diameter of the pipe on which the saddle is installed.
 3. Taps with iron pipe threads.
 4. Malleable or ductile iron bodies and galvanized steel straps, steel hex nuts with washers, and neoprene seals.
 5. Manufacturers: Dresser, Style 91, Smith Blair, Style 317.
- B. Stainless Steel Pipe Service Branches
1. Provide as specified in the applicable Piping Specification.
- C. Plastic Piping
1. Nylon-coated iron bodies with Buna-N seals and stainless steel clamps with stainless steel clamps and nuts. Manufacturer to be Smith Blair Model 315 or 317, or approved equal.
 2. In the chemical area of the Blower Building, clamp on style pipe saddle constructed with PVC or CPVC body with stainless steel bolts as manufactured by Spears or engineered approved equal. PVC shall be cell class 12454 and CPVC shall be cell class 23447. O ring material shall be elastomer listed in valve schedule in Specification 33 14 19.
- 2.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS
- A. Ductile Iron Wall Pipe
1. For penetrations through concrete walls, floors, slabs, or roofs that are to be watertight.
 2. Diameter and Ends: Same as connecting ductile iron pipe.
 3. Thickness: Equal to or greater than remainder of pipe in line.
 4. Fittings: In accordance with the applicable Detail Piping Specification.
 5. Provide taps for stud bolts in flanges set flush with wall face.
 6. Seep Rings: Material and construction ductile iron or cast iron, cast integral with wall pipe wherever possible. Fabricated by welded attachment of ductile iron thrust collar to pipe where casting impossible. Perform in pipe manufacturer's shop by qualified welders as specified herein with electric arc welds of ductile iron with NI-55 or FC-55, nickel-iron-carbon weld rod. Continuously weld on each side all around.
 7. Manufacturer: American Cast Iron Pipe Co. or approved equal
- B. Steel Or Stainless Steel Wall Pipe
1. Fabricate of same material and thickness as connecting pipe; however, minimum thickness of 1/4 inch is required.
 2. Lining: Same as connecting pipe.
 3. Seep Rings shall have outside diameter 3 inches greater than outside diameter of wall pipe and be continuously fillet welded on each side all around.
- C. Pipe Sleeves
1. Fabricate of 3/16-inch minimum thickness steel pipe.
 2. Above grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.

3. Below grade or in Submerged or Damp Environments: Lined and coated after fabrication as specified in Section 09 90 00.
4. Seep Ring: Provide 3/16-inch minimum thickness center flange for water stoppage on sleeves in exterior or water-bearing walls. Outside Diameter: 3 inches greater than wall pipe outside diameter. Continuously fillet weld on each side all around.
5. Existing Walls: Holes drilled with a rotary drill may be provided in lieu of sleeves.

D. Modular Mechanical Seal

1. Provide for existing wall penetrations by pipe sleeve as shown on the Drawings.
2. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
3. Assemble interconnected rubber links with Type 316 stainless steel bolts, nuts, and pressure plates.
4. Size modular mechanical seals according to manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a minimum hydrostatic head of 40 feet of water.

2.11 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. General

1. Materials and Rating: In accordance with the applicable Piping Specification.

B. Dielectric Flange And Union

1. Dielectric flange and union manufacturers to be Epco Sales, Inc.; Capitol Insulation Unions.

C. Insulating Coupling

1. Insulating coupling manufacturers to be Dresser, STAB-39; R. H. Baker, Series 216.

2.12 PIPING SUPPORT SYSTEMS

A. General

1. Provide Contractor-designed system as specified herein.
2. Fabricate pipe supports of the correct material to general configuration indicated by catalogs when specified items are not available in specified material.
3. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports and hangers to be provided.
4. Special support and hanger details are shown to cover typical locations where standard catalog supports are inapplicable.
5. Concrete Anchors and Anchor Bolts: Type 316 SS.
6. Hanger and Support Materials, Type 304 or 316 stainless steel for following locations: Submerged or less than 1 foot above the liquid surface. Below tops of channel walls. Under covers or slabs of channels and tanks. In other damp locations.
7. Galvanized and painted pipe hanger and support materials, as specified in Section 09 90 00, at all other locations.

8. Submerged Metal Piping: Electrically isolate from supports with a wrap of 1/4-inch by 3-inch neoprene rubber between the pipe and oversize clamps.

B. Saddle Support

1. Pedestal Type: Schedule 40 steel pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable saddle, MSS SP-69-2002, Type 37 with U-bolt: Grinnell, Figure 259; B-Line, Figure B3093.
3. Adjustable saddle, MSS SP-69-2002, Type 38 without clamp: Grinnell, Figure 264; B-Line, Figure B3092.
4. Neoprene Waffle Isolation Pad: Mason Industries, Type W; Korfund, Korpapad 40.

C. Hangers

1. Hanger, MSS SP-69-2002, Type 1 and Type 6: Grinnell, Figure 104 or 260; B-Line, Figure B3198H or B3100.
2. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP-69-2002.
3. Attachments to Steel Beams: Concentric loading I-beam clamp, MSS SP-69-2002, Type 21, 28, 29, or 30 which engage both sides of the flange.
4. Concrete Attachment: Concrete inserts, MSS SP-69-2002, Type 18, continuous channel insert or clip angles with anchor bolts.
5. Welding Insulation Saddles: MSS SP-69-2002, Type 39 for insulated steel piping: Grinnell, Series 160; B-Line, Series B3160.
6. Insulation Shields: Galvanized steel and stainless steel, MSS SP-69-2002, Type 40: Grinnell, Figure 167; B-Line, Figure B3151.

D. Wall Brackets

1. One-hole clamp type: Grinnell, Figure 126.
2. Welded steel, MSS SP-69-2002, Type 33 (heavy-duty): Grinnell, Figure 199; B-Line, Figure B3607.
3. Channel Type: Unistrut; Kin-Line.

E. Pipe Clamps

1. Riser clamps, MSS SP-69-2002, Type 8: Grinnell, Figure 261; B-Line, Figure B3373.

F. Channel Type Support Systems

1. 12-gauge, 1-5/8-inch wide series, pre-galvanized in accordance with ASTM A525, Class G90, or hot-dip galvanized after fabrication or, when required by location, Type 304 stainless steel.
2. Members and Connections: Design for all loads with a safety factor of 5.
3. Manufacturers: Kin-Line, Series CI3812; Unistrut, Series P3200.

2.13 INSULATION

A. In accordance with Section 22 07 00

2.14 CONCRETE

- A. Provide concrete encasement in accordance with Section 03 30 00.

2.15 TRENCH EXCAVATION AND BACKFILL

- A. As specified in Section 31 05 00.

2.16 HEAT TRACING SYSTEM

- A. See Section 22 07 00, if applicable.

2.17 TAPE WRAP

- A. Provide 15-mil butyl rubber adhesive, polyethylene-backed tape wrap system including appropriate primer, weld strip tape, filler tape, and tape layering in accordance with ANSI/AWWA C 209, C 214.
- B. Manufacturers: Tek-Rap, Inc.; Polyken Division of the Kendall Co.; Royston

2.18 PIPE MARKERS

- A. Markers shall be installed for all NEW utilities including but not limited to, pipelines, electrical feeds and major ductbanks.
- B. Markers shall be provided and installed by the Contractor at all test station, bend, air release, valve, and blow-off locations, where none of these conditions exist the markers shall be placed at 250-foot intervals.
- C. Markers shall be Carsonite Utility Markers, red for electrical utilities.
- D. Each BLUE (water-pipeline) marker shall have an adhesive decal as supplied by the Marker post manufacturer with the following lettering:

"CAUTION – WATER PIPELINE; BEFORE DIGGING CALL (970) 876-2353; TOWN OF SILT"
- E. Each RED (electrical) marker shall have an adhesive decal as supplied by the marker post Manufacturer with the following lettering:

"CAUTION – ELECTRICAL CONDUIT; BEFORE DIGGING CALL (970) 876-2353; TOWN OF SILT"
- F. Contractor shall submit the proposed marker post complete with adhesive decal to the Owner for review prior to installation.

2.19 PIPE TRACER WIRE

- A. Attach 12 gauge single strand copper tracer wire to pipe with 2-inch wide PVC tape. PVC tape shall be 10 mil and a minimum of 200% elongation and 25 psi tensile strength. Splicing of tracer wire shall be per manufacturer's recommendation. The tracer wire shall run to a test station or valve box. All piping shall be within 500 feet of a test station. Location of test stations shall be coordinated with the Engineer.

2.20 PAINT STENCILS:

1. Of size and color per ANSI/ASME A13.1 using clean cut letters and oil base semigloss enamel paint.
2. Paint material shall be in accordance with Section 09 90 00.
3. Size of Legend and Letters for Stencils:

<u>Insulation or Pipe Diameter</u>	<u>Length of Color Field</u>	<u>Size of Letters</u>
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
6" to 10"	24"	2-1/2"
>10"	32"	3-1/2"

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Existing Pipe and Penetrations:

1. Prior to ordering materials, expose all existing pipes that are to be connected to new pipelines.
2. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes.
3. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings before installing connecting pipes.

3.02 PREPARATION

A. New Pipe And Fittings

1. Inspect before exposed pipe or fitting is installed or buried pipe or fitting is lowered into the trench.
2. Clean ends of pipe thoroughly, remove foreign matter and dirt from inside of pipe, and keep clean during and after laying.

B. Field Fabrication

1. Notify Engineer at least 2 weeks prior to fabrication of pipe or fittings and at least 3 days prior to start of any surface preparation or coating application work.

3.03 FIELD WELDING

A. General

1. In accordance with ANSI/AWWA C206.
 - a. All Piping: AWWA C206.
 - b. Heating and Cooling Water Services: ANSI B31.1.
 - c. Flammable Gas, LP Gas, Ammonia, Chlorine Liquid and Vapor, Engine Exhaust, and Compressed Air Services: ANSI B31.3-2001.

2. See the Piping Specifications for additional requirements.
 3. Field welding permitted only on pipes in which linings will not be damaged by welding or in which linings are designed for field repair and inspection.
- B. Identification Of Welds
1. Mark each weld with a symbol that identifies the person who made the weld.
- C. Surfaces
1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
- D. Alignment And Spacing
1. Align ends to be joined within existing commercial tolerances on diameters, wall thickness, and out-of-roundness. Root Opening of Joint: As stated in paragraph Procedure, below.
- E. Procedure
1. Shielded Metal-Arc Process: Use for all field welding, unless otherwise approved or specified herein or in the Detail Piping Specifications.
 2. Welding on Stainless Steel: Use direct current, reverse polarity, shielded metal-arc or gas metal-arc process; or, use direct current, straight polarity, gas tungsten-arc or gas metal-arc process, unless otherwise approved.
 3. Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 degrees F.
 4. Tack Welds: Remove completely prior to proceeding with welding if all following requirements are not met:
 - a. Tack welds performed by qualified welder using the same procedure as for the completed weld.
 - b. Tack welds made with an electrode similar or equivalent to electrode to be used for first weld pass.
 - c. Not cracked or otherwise inconsistent.
 5. Thoroughly clean each layer of deposited weld metal, including the final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
 6. Surface Defects: Chip or grind out those that will affect the soundness of weld.
 7. Welds: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of the limits prescribed in Chapter V of the specified ANSI Codes.
 8. Branch Connections: Fit and groove weld in accordance with the details described and shown in Chapter V of the specified ANSI Codes.

3.04 PIPING INSTALLATION

A. General

1. Install in conformance with reviewed shop drawings.

B. Piping Expansion Provisions

1. Piping: Install to allow for thermal expansion due to differences between installation and operating temperatures.
 2. Anchors and Anchor Walls: Install as shown to withstand expansion thrust loads and to direct and control thermal expansion.
 3. Pipe Guides: Install an intermediate pipe guide for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, install pipe alignment guides adjacent to the expansion device and within four pipe diameters as shown.
 4. Expansion Devices: Install devices as specified and at locations shown.
- C. Piping Flexibility Provisions
1. Install thrust protection as specified.
 2. Install flexible couplings and expansion joints for piping systems and at connections to equipment where shown.
 3. Install additional pipe anchors and flexible couplings to facilitate piping installation, in accordance with reviewed shop drawings.
- D. Pipe Fittings And Appurtenances
1. In accordance with the manufacturer's instructions and these Specifications.
- 3.05 FLEXIBLE COUPLINGS, FLANGED COUPLING ADAPTERS, GROOVED JOINT COUPLINGS, AND SERVICE SADDLES
- A. Thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket.
 - B. Wipe gaskets clean prior to installations.
 - C. Lubricate flexible couplings and flanged coupling adapter gaskets with soapy water or manufacturer's standard lubricant before installation on the pipe ends.
 - D. Install couplings, service saddles, and anchor studs in accordance with manufacturer's instruction.
 - E. Tighten bolts progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness.
 - F. Use only torque-limiting wrenches to tighten bolts. Torque setting shall be in accordance with manufacturer's written recommendations or applicable standards, whichever is more stringent.
- 3.06 INSULATING FLANGES, COUPLINGS, AND UNIONS
- A. General
- Install at following locations:
1. Copper and ferrous metal piping connections.
 2. Cathodically protected piping penetration to buildings, and watertight structures.
 3. Submerged metallic piping and unsubmerged piping connections.
 4. Stainless and carbon steel connections
 5. Where shown on the Drawings.

B. Flange Drillings For Installation Of Insulating Kits

1. Drill oversize to accommodate insulating sleeves through the drilling using standard bolt sizes.

C. Insulated Joints

1. Insulating joints connecting immersed piping to non-immersed piping shall be installed above maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete basins shall be isolated from the concrete reinforcement

3.07 PIPING SUPPORT SYSTEMS

A. General

1. Install Contractor-designed and selected support system, as approved, in accordance with Manufacturers Standardization Society of the Valve and Fitting Industry, Inc. (MSS) SP-69-2002, "Pipe Hangers and Supports-Selection and Application" and as specified herein.
2. Support piping connections to equipment by pipe support and not by the equipment.
3. Support large or heavy valves, fittings, and/or appurtenances independently of connected piping.
4. Support no pipe from the pipe above it.
5. Provide supports at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown.
6. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
7. Vibration Isolation Pad: Provide for pedestal type pipe supports under base flange adjacent to equipment and where required to isolate vibration.
8. Insulation Piping: Install oversized supports to fit the closed-cell rigid insulation inserts. Install supports with galvanized or stainless steel protection shields and oversized rollers.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
10. Dielectric Barrier: Provide between supports and copper or stainless steel pipe. Provide between stainless steel supports and non-stainless steel ferrous piping.
11. At each channel type support, provide every pipe with intermediate pipe guide, except where pipe anchors and alignment guides are required.
12. Channel Type Support Framing System Spacing: Install on 10-foot maximum centers, unless otherwise shown. Generally satisfactory for steel and ductile iron pipe 3 inches and larger. Other pipelines and special situations will require supplementary hangers and supports.

B. Support Methods

1. Horizontal Suspended Pipes:
 - a. Single Pipes: Adjustable swivel-ring, split-ring, or clevis hangers.
 - b. Multiple Pipes: Trapeze hangers with channel type supports.

2. Horizontal Pedestal Mounted: Saddle type supports.
3. Horizontal Wall Mounted: Wall brackets.
4. Vertical Pipes: Wall brackets, base elbows, or riser clamps on floor penetrations.

3.08 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Ductile Iron, Steel, And Stainless Steel Wall Pipes

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

B. Steel Pipe Sleeves

1. Above grade in Non-submerged Areas: Hot-dipped galvanized after fabrication.
2. Below grade or in Submerged or Damp Environments: Lined and coated as specified in Section 09 90 00.
3. Support non-insulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.

C. New Penetrations Of Existing Slabs, Floors, Walls And Roofs

1. Except as otherwise noted, core drill openings of diameter required to accommodate pipe penetration system.
 - a. When Drawings indicate existing reinforcement to remain, locate reinforcement with pachometer prior to coring. Adjust core location as required to avoid damage to reinforcement.
 - b. Clean opening surfaces of coring residue.
 - c. When penetration is below tank liquid level, patch voids or discontinuities in the opening that would prevent obtaining watertight seal of the mechanical seal.
2. Install type of seal system between pipe and opening indicated on the Drawings.
3. Modular mechanical expanding rubber seal:
 - a. Install as per manufacturer's recommendations.
4. Grouted penetration:
 - a. Fill and pack annular space between pipe and opening with non-shrink grout. Finish grout flush with face of opening when backer rod and sealant are not required.
 - b. Install backer rod and sealant at face of opening when indicated.

3.09 TRENCH EXCAVATION AND BACKFILL

- #### A. In accordance with Section 31 05 00.

3.10 BURIED PIPE PLACEMENT

- #### A. General

1. Lay pipe and fittings in conformance with reviewed laying drawing, manufacturer's instructions and alignment and elevations shown.
2. Provide special tools and devices, such as special jacks, chokers, and similar items required for proper installation.
3. Use pipe joint lubricant as specified; no substitutions will be permitted.
4. Do not lay pipe in water or when, in the opinion of the Engineer, trench conditions are unsuitable.
5. Prevent uplift and floating of pipe prior to backfilling.
6. Minimum Pipe Cover: 5 feet unless otherwise shown.
7. Do not deviate more than 1 inch from line or 1/4 inch from grade for gravity piping.
8. Measure for grade at the pipe invert, not at the top of the pipe.
9. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found.
10. Dig bell holes at joint locations of ample dimensions in the bottom and sides of the trench where necessary to permit visual inspection and testing of the entire joint.
11. Prevent foreign material from entering pipe at all times during placement.
 - a. If pipe cannot be placed without foreign material entering pipe, place a tightly woven canvas bag snugly over each end before lowering pipe.
 - b. Leave bags in-place until connection is made to adjacent pipe.
12. Lay pipe upgrade with bell ends pointing in direction of laying.
13. After a section of pipe has been lowered into the prepared trench, clean the end of the pipe to be joined, the inside of the joint, and the rubber ring immediately before joining the pipe.
14. Check gasket position with feeler gauge furnished by the pipe manufacturer to assure proper seating. Feeler Gauge shall be of proper size, type, and shape for use during installation for each type of pipe furnished.
15. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
16. After the joint has been made as specified under Section 2.3 and Section 3.10, subsections 3.10B and 3.10C, check pipe for alignment and grade. Maximum Deviation: 2 inches from line, and 1/2 inch from grade.
17. Joint Deflection:
 - a. Deflect pipe at joints for pipelines laid on a curve, using unsymmetrical closure of spigot into bell.
 - b. Maximum Deflection: 75 percent of maximum deflection recommended by pipe manufacturer.
 - c. Use one of the following methods if joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment: Shorter pipe lengths, special mitered joints, or standard or special fabricated bends.
 - d. Install thrust restraint if special mitered joints or bends are used.
18. Do not vary actual horizontal position of pipe centerline on alignment around curves by more than 1.5 feet from position shown.

19. Apply sufficient pressure in making the joint to assure that the joint is "home," as defined in the standard installation instructions provided by the pipe manufacturer.
20. Place sufficient pipe zone material to secure the pipe from movement before the next joint is installed.
21. Keep trench dry until the pipe laying and jointing are completed.
22. Close and block the open end of the last laid section of pipe-to prevent entry of foreign material or creep of the gasketed joints at all times when laying operations are not in progress, at the close of the day's work, or when the workers are absent from the job.

B. Bell-And-Spigot With Rubber Gasket Joints (Push-On Joints)

1. Assemble in accordance with manufacturer's instructions, and the following:
 - a. As next section of pipe is being readied for laying, clean bell of previously laid pipe of foreign material and apply thin film of specified lubricant to entire surface of bell ring.
 - b. At same time, lubricate gasket and install in spigot groove.
 - c. Ensure gasket tension is uniform around groove before placing pipe in trench.
 - d. Lower pipe section into trench until approximately in line with previously laid pipe section and spigot is centered in bell.
 - e. Force pipe "home" as defined in manufacturer's installation instructions and secure to proper alignment and grade with specified pipe zone material.
 - f. Check gasket position with feeler gauge, furnished by pipe manufacturer, to assure proper seating.
2. Flexible Couplings:
 - a. Before coupling, clean pipe holdback area of oil and dirt.
 - b. Remove pipe coating only if necessary to present smooth surface.
 - c. Preferably, do not remove pipe coating; repair if damaged before joint is made.
 - d. Install couplings in accordance with manufacturer's instructions.
 - e. Clean gaskets before installation and, if necessary, lubricate with gasket lubricant for installation on pipe ends.
 - f. Tighten coupling bolts progressively, drawing up bolts on opposite sides a little at a time until all bolts have uniform tightness. Tighten bolts with torque-limiting wrenches; do not overstress bolts to compensate for poor alignment of flanges.
3. Connections to Concrete Structures:
 - a. Make as shown.
 - b. If connection is not shown, locate standard pipe joint no more than 24 inches from structure.

C. Concrete, Ductile Iron, And Polyvinyl Chloride (Gravity) Pipe

1. Join pipe in accordance with manufacturer's instructions.
2. Joint Gaps for Concrete Pipe and Mortar Lined Ferrous pipe: Maximum of 3/8-inch wide inside piping 21 inches in diameter and smaller.

3. For pipe Concrete and Mortar Lined Ferrous pipe of 24 inches nominal diameter and larger, fill and seal with premixed mortar and trowel smooth on the inside surface.
- 3.11 CONNECTING DISSIMILAR PIPE
 - A. Flexible Transition Couplings: Install in accordance with pipe manufacturer's instructions.
 - 3.12 BURIED PIPE IN CONCRETE ENCASEMENTS OR CONCRETE BEDDING
 - A. Pipe Coatings: Continuous through concrete encasements, anchors, collars, etc., unless otherwise shown.
 - 3.13 FLEXIBLE JOINTS AT CONCRETE BACKFILL OR ENCASEMENT
 - A. Install flexible pipe joint within 18 inches or 1/2 the pipe diameter, whichever is less, from the terminations of any concrete backfill or concrete encasement, except for welded pipe joints.
 - 3.14 FLEXIBLE JOINTS AT CONCRETE STRUCTURES
 - A. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded pipe joints are not.
 - B. Provide flexible joints at the face of all structures, whether or not shown.
 - C. Joint may be flush with face or may be up to one pipe diameter away from face, but not further than 18 inches away from face.
 - D. Install a second flexible joint for:
 1. Pipelines Smaller than 18 Inches in Diameter: Within 18 inches of the first joint.
 2. Pipelines Larger than 18 Inches in Diameter: Within one pipe diameter of the first joint.
 - 3.15 CLOSURES
 - A. Closure Pieces
 1. Install as necessary to complete closure assembly where pipes meet other pipes or structures.
 2. Elastomer sleeves bonded to pipe ends are not acceptable.
 - B. Pressure Pipeline Closures
 1. Plain end pieces with double flexible couplings, unless otherwise shown or approved
 - C. Restrained Joint Pipe Closures
 1. Install with thrust tie-rod assemblies in accordance with NFPA No. 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
 - D. Gravity Pipe Closures
 1. As specified for pressure pipelines. Concrete closures may be used only when approved by the Engineer.

E. Concrete Closures

1. Provide with smooth interior surfaces conforming to pipe surface and construct using forms. Forms must be removed.
2. Locate away from structures so that there are at least two flexible joints between the closure and pipe entering the structure.

3.16 THRUST RESTRAINT

A. Location

1. At pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist. Ties shall be installed where required, whether or not shown.

B. Mechanical Joint Valves In Proprietary Restrained Joint Pipe And Fitting

1. Restrain mechanical joints with the proprietary restrained joint manufacturer's adapter gland follower and pipe end retainer or provide thrust tie-rods and socket clamps. Multiplied by the chord length for the curve along the centerline of the fitting.

3.17 INSULATION

A. In accordance with Section 22 07 00.

3.18 TAPE WRAP FOR BURIED STEEL AND COPPER PIPE

- A. Field Applied: In accordance with manufacturer's instructions and as specified herein
- B. Fully meet the requirements of ANSI/AWWA C 209, C 214.

3.19 MARKING TAPES WIRE

- A. In accordance with manufacturer's recommendation. Coordinate test point locations with Engineer and Owner.

3.20 EXPOSED PIPING INSTALLATION

A. General

1. Install parallel to building lines, unless shown otherwise.
2. Align hangers supporting adjacent piping with equal support spans where possible.
3. Install piping without springing or forcing of the pipe which would create stresses in the pipe, valves, or connected equipment.
4. Use torque-limiting wrenches to tighten bolts.
5. Straight runs of piping upstream and downstream of flow measuring devices shall be smooth.

B. Pipe Flanges

1. Set level, plumb, and aligned.
2. Install flanged fittings true and perpendicular to the axis of the pipe.

3. Bolt holes shall straddle vertical centerline of pipes.
 4. Plastic Flanges: Bolt up, using a filler gasket, at any joint with a raised face. The filler gasket shall bear the bolt load uniformly and remove the flange moment from that part of the flange protruding beyond the outer edge of the raised face.
- C. Unions
1. Install where required for piping or equipment installation.
- D. Valve Orientation
1. As shown where valve handwheels are shown.
 2. Where valve handwheels are not shown, orient to permit easy access to the valve operator, and to avoid interference.
- E. Pipe Tap Connections
1. Taps to the pipe barrel are unacceptable.
 2. To Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
 3. To Steel Piping: Connect only with a welded threadolet connection.
- 3.21 VENTS AND DRAINS
- A. Vent the high points and drain the low points of pipelines as shown.
- 3.22 PIPE IDENTIFICATION, PAINTING, AND COLOR CODING
- A. As specified in Section 09 90 00.
- B. Apply painting and color coding to the exterior covering of insulated piping.
- 3.23 CORROSION PROTECTION
- A. General
1. Protect all pipe and piping accessories from corrosion and adverse environmental conditions.
 2. Additional requirements for protection to those specified below are included in the Detail Piping Specifications and in Section 09 90 00.
 3. Galvanize in accordance with Division 5.
- B. Buried Or Encased Carbon Steel Or Copper Piping
1. Tape coated. Steel pipe shall be prepared and coated in accordance with ANSI/AWWA C 209, C 214 and manufacturer's recommendations, and these specifications. Copper piping shall be coated in accordance with manufacturer's recommendations and these specifications.
 2. Solvent clean, SSPC-SP 1, pipe surface and wire brush, SSPC-SP 3, to remove dirt, loose rust, and mill scale.

3. Immediately prime with tape manufacturer's recommended primer in accordance with manufacturer's instructions.
 4. Spirally apply tape to pipe, with minimum 50 percent overlap, after primer has thoroughly dried.
 5. Joints: Tape wrap or heat shrink wrap. Complete joints above grade or excavate a sufficient size hole beneath couplings to permit joint wrapping without contamination of joint and wrap.
- C. Buried Or Encased Ductile Iron And Cast Iron Soil Pipe
1. Wrap buried ductile iron and cast-iron soil piping with specified polyethylene encasement.
 2. Install encasement in accordance with AWWA C105/ANSI A21.5 and manufacturer's instructions.
 3. Do not provide polyethylene encasement for concrete encased pipe.
- D. Buried Piping Accessories
1. Provide corrosion protection for ferrous metal piping appurtenances.
 2. Tie-Rods and Similar Items: Coat with mastic coal tar epoxy.
 3. Flange Bolts, Nuts, and Similar Items: Coat with mastic coal tar epoxy.
 4. Flexible Couplings, Grooved Couplings, and Similar Items: Coat with mastic coal tar epoxy.
 5. Buried Valves and Similar Elements on Wrapped Pipelines Coat with mastic coal tar epoxy.
 6. Ductile Iron or Nonmetallic Pipelines: Exposed Nuts and Bolts Coat with mastic coal tar epoxy. Valves, wrap entire valve in 8-mil polyethylene as specified for ductile iron pipe.
- E. Atmospheric Exposed Pipe
1. Copper Pipe: Paint as specified in Section 09 90 00. Apply paint prior to insulating.
 2. Ductile Iron Pipe: As specified in Section 09 90 00.
 3. Piping Accessories: Paint atmospheric exposed surfaces of black and hot-dip galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, as applicable to the base metal material. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
- F. Submerged Pipe
1. Carbon Steel Piping: Clean and repair abraded areas of coatings on carbon steel pipe to be submerged or embedded, to provide a protective covering equal to original. Coat exterior of submerged or embedded carbon steel as specified in Section 09 90 00.
 2. Ductile Iron and Cast-Iron Soil Pipe: Coat as specified in Section 09 90 00. Clean and repair all abraded areas of coal-tar epoxy coatings on ductile iron or cast-iron soil pipe to be submerged or embedded, to provide a protective covering equal to the original and acceptable to the Engineer.

3.24 PIPE TESTING

A. General

1. Conduct pressure and leakage tests on newly installed pipelines and appurtenances, in accordance with the Town of Silt Standards, these specifications, and the reviewed testing plan.
2. Furnish necessary equipment and material and make taps in piping, as necessary for testing and as specified.
3. Engineer or Owner will observe the tests.
4. Provide 14 days advance written notice of start of testing to Engineer and Owner.
5. Test Pressures and Type of Test: As specified in the Piping Schedule.
6. Separately test pressure pipe sections that can be isolated by valves.

B. Test Records

1. Make records of each piping system during the test to document the following:
2. Date of test.
3. Description and identification of piping tested.
4. Test fluid.
5. Test pressure.
6. Remarks, including: Leaks (type, location), repairs made on leaks, certification by Contractor and signed acknowledgment by Engineer or Owner that tests have been satisfactorily completed.

C. Testing New Pipe Connected To Existing Pipe

1. Isolate new pipe with grooved-end pipe caps or blind flanges.
2. Test joint between new piping and existing piping by methods, approved by the Engineer, that do not place the entire existing system under test load.

D. Buried Pressure Piping

1. Initial Service Leak Test: Conduct with partially backfilled trench and joints left open for inspection, as field conditions permit and as approved by Engineer.
2. Final Hydrostatic Acceptance Test: Conduct after trench has been completely backfilled.
3. Expose all joints on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.

E. Exposed Pressure Piping

1. Conduct tests after piping has been completely installed and inspected for proper installation - including all supports, hangers, and anchors - prior to installation of insulation.

3.25 HYDROSTATIC LEAK TESTING

A. Procedure

1. Use water as the hydrostatic test fluid.
2. Provide clean, potable test water of quality necessary to prevent corrosion of the materials in the piping system.
3. Open vents at all high points of the piping system to purge air pockets while the piping system is filling.
4. Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
5. Test all parts of the piping system at the test pressure specified.
6. Maintain hydrostatic test pressure continuously for 120 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
7. Examine all joints and connections for leakage.
8. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking.
9. Correct visible leakage and retest.

B. Buried Pressure Piping

1. Per AWWA M11.
2. Cement-Mortar Lined Piping: Slowly fill test section with water and allow to stand for 24 hours under low pressure to allow cement-mortar lining to absorb water.
3. Expel all air from piping system prior to testing.
4. Apply and maintain specified test pressure with hydraulic force pump.
5. Valve off the piping system when test pressure is reached.
6. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.

3.26 PNEUMATIC LEAK TESTING

A. Limitations

1. Do not pneumatically test the following piping:
 - a. PVC or CPVC.
 - b. Piping larger than 2 inches, except as provided in paragraph 3.28 TESTING GRAVITY SEWERS.

B. Procedure

1. Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.
2. Perform tests only on exposed piping.
3. Test all parts of the piping system at the test pressures specified.
4. Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.
5. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.
6. Apply soap bubbles to joints and connections for examining leakage.

7. Apply maximum 25 psig preliminary pneumatic test to piping system prior to final leak testing, to locate visible leaks.
8. Correct visible leaks and repeat the preliminary test until all visible leaks are corrected.
9. Gradually increase pressure in the system to not more than 1/2 of specified test pressure.
10. Thereafter increase pressure in steps of approximately 1/10 of specified test pressure, until required test pressure is reached.
11. Maintain pneumatic test pressure continuously for minimum 10 minutes and for such additional time as necessary to conduct a soap bubble examination for leakage.
12. Correct visible leakage and retest.
13. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
14. Following pneumatic testing and final cleaning, thoroughly purge lines which are to carry flammable gases with nitrogen to assure no explosive mixtures will be present in the system during the filling process.

3.27 TESTING GRAVITY SEWERS

A. General

1. Gravity sewers, including those designed to operate under surcharged conditions, shall be air tested as specified hereafter and visually examined for leaks.
2. Plug all wyes, tees, stubs, and lateral connections with gasketed caps or plugs securely fastened or tied to withstand the internal test pressure.
3. Such plugs or caps shall be removable, and their removal shall provide a bell suitable for making a flexible jointed lateral connection or extension.
4. Furnish all necessary testing equipment and perform the tests in a manner satisfactory to the Engineer.
5. Arrange testing equipment to provide observable and accurate measurements of leakage under the specified conditions.
6. Do not test sections of constructed sanitary sewer for acceptance until all connections, manholes, and backfilling are completed between the stations to be tested.

B. Procedure - Air Testing

1. After all plugs are in-place and securely blocked, introduce air slowly into the pipe section to be tested until the internal air pressure reaches 4 pounds per square inch greater than the average back pressure of any groundwater that may submerge the pipe.
2. Allow a minimum of 2 minutes for the air temperature to stabilize.
3. Determine the height of the groundwater table at the time of the test.
4. Pipe and joints being air tested shall be considered satisfactory when tested at an average pressure of 3 pounds per square inch greater than the average back pressure of any groundwater that may submerge the pipe, and when: Total rate of air loss from the section being tested does not exceed 2 cubic feet per minute, and the section of line does not lose air at a rate greater than 0.0030 cubic feet per minute per square foot of internal pipe surface.
5. Upon completion of an air test, open a bleeder valve to allow air to escape; do not remove plug until all air has been released.

6. Do not allow any persons to enter trench or structure containing piping that is pressurized during an air test.

3.28 FINAL CLEANING

A. Interim Cleaning

1. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication.
2. Examine piping to assure removal of these and other foreign objects prior to assembly and installation.

B. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water to remove accumulated construction debris and other foreign matter.

1. Plant process air, natural gas, chemical, and instrument air-lines shall be blown clean of loose debris with compressed air at 4,000 feet per minute. Do not flush these piping systems with water.
2. Immediately after cleaning pipes, dry this piping with compressed air.

C. Flush until all foreign matter is removed from the pipeline.

D. Provide hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties.

E. Minimum Flushing Velocity: 2.5 fps

F. For large diameter pipe where it is impractical to flush the pipe at 2.5 fps velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flush the line at a lower velocity.

G. Insert cone strainers in the flushing connections to attached equipment and leave in-place until cleaning has been accomplished.

H. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.29 DISINFECTION

A. Disinfect the following Piping Services before placing in service in accordance with AWWA C653:

1. Filtered Water (FW)
2. Potable Water (PW)
3. Sample Water (SP), off FW and PW systems only

3.30 PIPING SCHEDULE AND SPECIFICATIONS

A. Following are a Piping Schedule and Piping Specifications that detail the piping systems used in this contract.

Piping Schedule

Service Legend	Service	Size Range, inches	Piping Specification	Test Pressure, psig	Test Type	Installation	Location	Notes
A	Air	6	CS1	25	PN	Exposed	Inside	
A	Air	≤ 1	COP1	25	PN	Exposed	Inside	Drain lines on air piping
ACH	Aluminum Chlorohydrate	½-6	PVC2	50	HS	Exposed	Inside	Includes drains and vents
BWS	Backwash Supply	8-12	CS1, DI1	50	HS	Exposed, submerged	Inside	Filter backwash
BWS	Backwash Supply	1	COP1	150	HS	Exposed	Inside	Strainer backwash
BWW	Backwash Waste	2	GAL2	25	HS	Exposed	Inside	Strainer waste line
BWW	Backwash Waste	16	CS1, DI1	25	HS	Exposed	Inside	
BWW	Backwash Waste	16	CS1	25	HS	Encased	Under Building	
BWW	Backwash Waste	16	PVC4	25	HS	Buried	Outside	
CLO	Chlorine Dioxide	≤ 2	CPVC	50	HS	Exposed	Inside	Includes drains and vents
D	Drain	1 - 2	COP1	50	HS	Exposed	Inside	
D	Drain	3-6	PVC DWV	----	HS	Exposed, Encased	Inside and within 5 feet of buildings	Test per plumbing code.
D	Drain	6	PVC DWV, CISP	----	HS	Buried	Outside, beyond 5 feet of buildings	Test per plumbing code.
FM	Force Main	2.5	PVC2	50	HS	Exposed, Buried	Inside, Outside	
FTW	Filter to Waste	12	CS1, DI1	25	HS	Exposed	Inside	
FTW	Filter to Waste	12	CS1	25	HS	Encased	Under Building	
FW	Filtered Water	8-16	CS1, DI1	50	HS	Exposed	Inside	

Piping Schedule

Service Legend	Service	Size Range, inches	Piping Specification	Test Pressure, psig	Test Type	Installation	Location	Notes
FW	Filtered Water	12-16	CS1	50	HS	Encased	Under Building	
FW	Filtered Water	16	PVC4	50	HS	Buried	Outside	DR 18
NPW	Non-potable Water	≤ 2	COP1, PVC2	225	HS	Exposed	Inside	Upstream of PRV
NPW	Non-potable Water	≤ 2	COP1, PVC2	150	HS	Exposed	Inside	Downstream of PRV
OF	Overflow	4	PVC2	25	HS	Buried	Under Building, Outside	
OF	Overflow	4	DI1	25	HS	Exposed	Inside	
PA	Pressurized Air	≤ 1	COP1	150	PN	Exposed	Inside	
PA	Pressurized Air	≤ 1	COP2	150	PN	Buried	Outside	
PD	Pumped Drain	1 ½	PVC2	75	HS	Exposed, Buried, Encased	Inside, Outside	SRW pump drains
								DR 18
POL	Polymer	½-2	PVC2	50	HS	Exposed	Inside	Includes drains and vents
PW	Potable Water	6-12	PVC4	225	HS	Buried	Outside	DR 14
PW	Potable Water	6	PVC4	225	HS	Buried	Outside	DR 14
PW	Potable Water	≤ 6	COP1, PVC2	225	HS	Exposed	Inside	Upstream of PRV
RW	Raw Water	16	PVC4	75	HS	Buried	Outside	DR 18
RW	Raw Water	10-16	DI1, CS1	75	HS	Exposed	Inside	
RW	Raw Water	12-16	CS1	75	HS	Encased	Under building	
SC	Sodium Chlorite	½-2	PVC2	50	HS	Exposed	Inside	
SH	Sodium Hydroxide	½-6	PVC2	125	HS	Exposed	Inside	Includes drains and vents

Piping Schedule

Service Legend	Service	Size Range, inches	Piping Specification	Test Pressure, psig	Test Type	Installation	Location	Notes
SH	Sodium Hydroxide	1	PE	125	HS	Exposed, Buried, Encased	Inside, Outside, Under Building	Where encased or buried install in 3" Sch40 PVC casing pipe
SHC	Sodium Hypochlorite	½-2	CPVC	125	HS	Exposed	Inside	Includes drains and vents
SHC	Sodium Hypochlorite	1	PE	125	HS	Exposed, Buried, Encased	Inside, Outside, Under Building	Where encased or buried install in 3" Sch40 PVC casing pipe
SRW	Solids Residual Waste	≤ 3	PVC2	75	HS	Exposed	Inside	
SRW	Solids Residual Waste	3	PVC DWV	25	HS	Buried	Outside	
STW	Settled Water	12-16	CS1, DI1	50	HS	Exposed	Inside	
TD	Tank Drain	2-4	PVC2	25	HS	Exposed	Inside	
TD	Tank Drain	4-6	PVC DWV, CISP	See Note	HS	Encase	Under Building	Test per plumbing code
TD	Tank Drain	6	PVC DWV, CISP	See Note	HS	Buried	Outside	Test per plumbing code
V	Vent	≤ 6	CISP unless noted	---	---			Test in accordance with the Uniform Plumbing Code
V	Vent	1-2	PVC2	NA	HS	Exposed	Inside	

HS = Hydrostatic

PN = Pneumatic

PIPING SPECIFICATION CISP CAST IRON SOIL PIPE		
PIPE \geq 2"	SERVICE WEIGHT, CAST IRON	CISPI 301 ASTM A888, ASTM A 74
FITTINGS \geq 2"	ABOVE SLAB—HUBLESS;	CISPI 301 ASTM A74
	BURIED-- HUB AND SPIGOT	ASTM C564
JOINING \geq 2"	ABOVE SLAB—HUBLESS;	CISPI 310 ASTM A 1277
	BURIED: HUB AND SPIGOT	ASTM C 1540
GASKETS	NEOPRENE SEALING SLEEVE, AISI SERIES 300 SHIELD AND CLAMP NEOPRENE GASKET COMPRESSION JOINT	ASTM C564 ASTM C 1563
QUALITY ASSURANCE	ALL PIPE AND FITTINGS SHALL BEAR THE COLLECTIVE TRADEMARK OF THE CAST IRON SOIL PIPE INSTITUTE OR HAVE PRIOR APPROVAL OF ENGINEER.	
LINING	NONE	
COATINGS: EXPOSED	PER SECTION 09 90 00	
BURIED OR ENCASED	BITUMINOUS	

PIPING SPECIFICATION COP1 COPPER TUBING		
TUBING ≤ 3"	TYPE "L," COPPER HARD DRAWN ABOVE GROUND	ASTM B88
FITTINGS ≤ 3"	WROUGHT COPPER, SOLDER ENDS	ASTM B75 ANSI B16.22
UNIONS ≤ 3"	150# CAST BRONZE, SOLDER ENDS	ASTM B62
GASKETS	1/8" THICK EPDM, FULL FACE	50-60 DUROMETER
BOLTING	GALVANIZED OR CAD PLATED	ASTM A307 GR A
LINING	NONE	
COATING, EXPOSED	PER SECTION 09 90 00	
Notes: 1. Use lead free solder; ASTM B32 2. Use threaded adaptors for valves >1/2" use brass compression type fittings		

PIPING SPECIFICATION COP2 COPPER TUBING		
TUBING ≤ 3"	TYPE "K," COPPER HARD DRAWN BELOW GROUND	ASTM B88
FITTINGS ≤ 3"	WROUGHT COPPER, SOLDER ENDS	ASTM B75 ANSI B16.22
LINING	NONE	
COATING, BURIED OR ENCASED	Tape wrap buried piping	
1. Note: Use lead free solder; ASTM B32		

PIPING SPECIFICATION CS1 CARBON STEEL - EXPOSED		
PIPE < 10"	SCH 40 CARBON, GRADE B, ERW OR SEAMLESS	ASTM A53 or ASTM A106
PIPE ≥ 10"	1/4" MIN. THICKNESS OR 3/8" MIN. THICKNESS	AWWA C200 OR ASTM A53, GRADE B
FITTINGS ≤ 2"	2,000# FORGED CARBON STEEL, SOCKET WELD OR TAPER THREADED	ASTM A105 ANSI B16.1 ANSI B.1.20.1
FITTINGS > 2"	BUTT WELDED, GROOVED END OR FLANGED	ASTM A234 GRADE WPB ANSI B16.9 AWWA C208
FLANGES > 2"	STEEL, SLIP ON, RING OR HUB TYPE. FLANGE CLASS D, TEST PRESSURE RATING SHALL MEET OR EXCEED HYDROSTATIC TEST PRESSURE SHOWN IN PIPE SCHEDULE.	AWWA C207
COUPLINGS	SLEEVE TYPE	
GASKETS	1/8" THICK, EPDM, FULL FACE	50-60 DUROMETER
BOLTING	GALVANIZED OR CAD-PLATED	ASTM A307 GR B
UNIONS ≤ 2"	3,000# FORGED CARBON STEEL, SOCKET WELD, STEEL SEATS	ASTM A105
BRANCH CONNECTIONS ≤ 2"	2,000# WOG, FORGED CARBON STEEL, WELDED, SOCKET WELDED OUTLET	ASTM A105 GRADE II
BRANCH CONNECTIONS > 2"	STD. WEIGHT, FORGED STEEL, WELDING BRANCH FITTINGS	ASTM A105 GRADE II or AWWA C208
LINING > 3" Except Piping Service BWS & BWW	CEMENT MORTAR	AWWA C205
LINING ≤ 3" AND ALL SIZES OF BWS & BWW SERVICES	MODIFIED POLYAMINE EPOXY - SUITABLE FOR POTABLE WATER SERVICE and PIPES SMALLER THAN 4" (TNEMEC SERIES 22 or FC22) TOTAL DFT ≥40 MILS (See Section 09 90 00)	AWWA C210 NSF certified per ANSI/NSF Std 61
COATING	PER SECTION 09 90 00	
Notes: 1. Gaskets on all blower discharge piping shall be Victaulic Type L (Silicone, Temperature Range - 30°F to 350°F) 2. No lining for air or gas service 3. Provide dielectric insulating flanges between dissimilar metals		

PIPING SPECIFICATION CS2 CARBON STEEL – BURIED		
PIPE < 10"	SCH 40 CARBON, GRADE B, ERW OR SEAMLESS	ASTM A53 or ASTM A106
PIPE ≥ 10"	1/4" MIN. THICKNESS OR 3/8" MIN. THICKNESS	ASTM A139 GRADE C OR ASTM A53, GRADE B
FITTINGS	BUTT WELDED	AWWA C208
COUPLINGS	SLEEVE TYPE; FOR AIR DISCHARGE PIPE: VICTAULIC (SEE NOTE)	
GASKETS	1/8" THICK, EPDM, FULL FACE	50-60 DUROMETER
BOLTING	GALVANIZED OR CAD-PLATED	ASTM A307 GR B
JOINTS	BUTT-WELDED OR DOUBLE LAP-WELDED	AWWA C200 AWWA C206
LINING > 3"	CEMENT MORTAR	AWWA C205
LINING ≤ 3" and	MODIFIED POLYAMINE EPOXY – SUITABLE FOR POTABLE SERVICE TOTAL DFT 20 MILS (TNEMEC SERIES FC22)	AWWA C210 NSF Std. 61
AND ALL SIZES OF BWS & BWW SERVICES	MODIFIED POLYAMINE EPOXY - SUITABLE FOR POTABLE SERVICE TOTAL DFT >20 MILS (TNEMEC SERIES 22 or FC22)	AWWA C210 NSF Std. 61
COATING, BURIED OR ENCASED	POLYURETHANE PER SECTION 09 91 00	AWWA C222
Notes: 1. No lining for air or gas service 2. Gaskets on all blower discharge piping shall be Victaulic Type L (Silicone, Temperature Range - 30°F to 350°F) 3. See test pressure in piping schedule for pressure requirements. 4. Provide dielectric insulating flanges between dissimilar metals		

PIPING SPECIFICATION CS3 CARBON STEEL (DRAIN SERVICE)		
PIPE ≤ 3"	SCH 40 CARBON, GRADE B, ERW OR SEAMLESS	ASTM A53 or ASTM A106
FITTINGS ≤ 3"	CAST IRON, THREADED DRAINAGE FITTINGS, GALVINIZED	ASTM A126 ANSI B16.12
LINING	NONE	
COATINGS: EXPOSED BURIED OR ENCASED	PER SECTION 09 90 00 TAPE WRAP 80 MILS	AWWA C214

PIPING SPECIFICATION D11 DUCTILE IRON-ABOVE GROUND		
PIPE	CENTRIFUGALLY CAST CLASS 250 DUCTILE IRON	AWWA C151 or ANSI 21.51
FITTINGS	GRAY OR DUCTILE IRON 150 PSI MIN. EXCEPT PW AND NPW 250 PSI MIN.	AWWA C110, C153 ANSI B16.1
	GROOVED ENDS-RIGID	AWWA C606
	FLANGED 250 PSI WORKING PRESSURE-ANSI CLASS 125	AWWA C110
FLANGES	DUCTILE IRON-250 PSI WORKING PRESSURE, 125 POUND ANSI GROOVED END PIPE ADAPTER-MALLEABLE OR DUCTILE IRON	ANSI A21.15 AWWA C115 ASTM A47 ASTM A536
COUPLINGS	GROOVED ENDS PIPE COUPLINGS-RIGID	VICTAULIC STYLE 31 OR GUSTIN-BACON
BOLTING	GALV. OR CAD PLATED CARBON STEEL	ASTM A307 GR B
GASKETS	GROOVED END-FLUSH SEAL TYPE FLANGE GASKETS 1/8" THICK FULL FACE, 50-60 DUROMETER EPDM	AWWA C606 ASTM D1330 ASTM D2000
LINING	CEMENT-MORTAR LINING	AWWA C104
COATINGS: ENCASED EXPOSED	1 MIL ASPHALTIC COATING PER SECTION 09 90 00	AWWA C151
Notes: 1. Use care not to damage cement lining 2. Provide dielectric insulating flanges between dissimilar metals		

PIPING SPECIFICATION DI2 DUCTILE IRON--BELOW GROUND		
PIPE	CENTRIFUGALLY CAST DUCTILE IRON 250 PSI MIN WORKING PRESSURE	AWWA C151
JOINTS	PUSH-ON, BELL AND SPIGOT, RESTRAINED - PROPRIETARY RESTRAINED; CLOW, SUPER- LOCK; AMERICAN CAST IRON PIPE; FLEX-RING OR LOK-RING; US PIPE TR FLEX, OR EQUAL OR EBAA IRON, INC. SERIES 1700, UNI-FLANGE SERIES 1450, OR EQUAL	AWWA C151, C111
FITTINGS	DUCTILE IRON 250 PSI MIN. MECHANICAL JOINTS, RESTRAINED EBAA IRON, INC. MEGALUG SERIES 1100 OR EQUAL OR PROPRIETARY RESTRAINED; CLOW, SUPER- LOCK; AMERICAN CAST IRON PIPE; FLEX-RING OR LOK-RING; US PIPE TR FLEX, OR EQUAL	AWWA C110, C111 and C153
COUPLINGS	SLEEVE TYPE	
BOLTING	GALV. OR CAD PLATED COR-BLUE COATED OR 316 SS	ASTM A307 GR B AWWA C111 ASTM A193 B8M CLASS 2
GASKETS	EPDM 50-60 DUROMETER	AWWA C111 ASTM D2000
LINING	CEMENT-MORTAR LINING	AWWA C104
COATING	1 MIL ASPHALTIC COATING ENCASE BURIED PIPE AND FITTINGS WITH POLYETHYLENE FILM	AWWA C151
Notes: 1. Use care to not damage cement lining. 2. See test pressure in piping schedule for pressure requirements. 3. Provide dielectric insulating flanges between dissimilar metals		

PIPING SPECIFICATION GAL2 GALVANIZED STEEL		
PIPING < 2"	SCH. 40 CARBON STEEL, GALVANIZED	ASTM A53 TYPE E or S, GRADE A or B
FITTINGS < 2" AND BRANCH CONNECTIONS	CLASS 300 MALLEABLE IRON, GALVANIZED, SCREWED	ASTM A197
FLANGES	CLASS 300 FORGED STEEL, GALVANIZED FLAT FACE, SCREWED	ASTM A105
UNIONS < 2"	CLASS 300 MALLEABLE IRON, GALVANIZED, SCREWED, BRASS SEATS	ASTM A197
NIPPLES < 2"	SCH. 80 CARBON STEEL, GALVANIZED, THREADED ENDS	ASTM A106 GR B
PLUGS < 2"	CLASS 300 MALLEABLE IRON, GALVANIZED, SCREWED, SQ. HD.	ASTM A197
GASKETS	FULL FACE, EPDM, 1/8" THICK	50-60 DUROMETER
BOLTING	GALVANIZED OR CAD-PLATED	ASTM A307 GR B
LINING	NONE	
COATING, EXPOSED	PER SECTION 09 90 00	
Notes: 1. Contractor shall have a licensed plumber confirm the piping system pressure capacity indicated in the Piping Schedule. 2. Contractor shall insulate per Section 22 07 00 3. Screwed connections: made by wrapping male thread with Teflon tape.		

PIPING SPECIFICATION PE1 POLYETHYLENE PLASTIC PIPE AND TUBING FOR NATURAL GAS		
PIPE AND TUBING <2"	POLYETHYLENE 250 PSI PRESSURE RATING CELL CLASS 445574	AWWA C901 ASTM D3035 ASTM D3350
FITTINGS	SOCKET TYPE BUTT FUSION ELECTROFUSION	ASTM D2683 ASTM D3261 ASTM F1055
Note: 1. Connections to metallic pipe meeting ASTM D 2513, ASTM F 1973, or ASTM F 2509.		

PIPING SPECIFICATION PVC1 POLYVINYL CHLORIDE		
PIPE \leq 12"	SCH. 40 PVC	ASTM D1784
FITTINGS \leq 12"	SCH. 40 PVC, SOLVENT WELD	ASTM D2466
GASKETS	PW AND NPW FULL FACE EPDM 50-60 DUROMETER CHEMICAL PTFE	ASTM D2466
FLANGES \leq 12'	150# PVC SOCKET TYPE SCH 40	ASTM D2466
UNIONS $\frac{1}{2}$ " – $1\frac{1}{2}$ "	SCH. 40 PVC, SOCKET TYPE	ASTM D2466
NIPPLES $\frac{1}{2}$ " – $1\frac{1}{2}$ "	SCH. 40 PVC, MOLDED, THREADED ENDS	ASTM D2464
PLUGS $\frac{1}{2}$ " - $1\frac{1}{2}$ "	SCH. 40 PVC, SCREWED	ASTM D2464
BOLTING	GALVANIZED OR CAD-PLATED CARBON STEEL	ASTM A307 GR B
LINING	NONE	
COATINGS: EXPOSED BURIED OR ENCASED	PER SECTION 09 90 00 NONE	
Notes: 1. Socket type connections: made using solvent welding cement ASTM D2564. 2. Piping, fittings, etc. Schedule 40 unless noted otherwise on the Drawings		

PIPING SPECIFICATION PVC2 POLYVINYL CHLORIDE		
PIPE $\leq 12"$	SCH. 80 PVC	ASTM D1785
FITTINGS $\leq 12"$	SCH. 80 PVC, SOLVENT WELD	ASTM D2467
GASKETS	PW AND NPW FULL FACE EPDM 50-60 DUROMETER CHEMICAL PTFE	ASTM D1330
FLANGES $\leq 12'$	150# PVC Socket Type SCH 80	ASTM D2467
UNIONS $\frac{1}{2}" - 1\frac{1}{2}"$	SCH. 80 PVC, SOCKET TYPE	ASTM D2467
NIPPLES $\frac{1}{2}" - 1\frac{1}{2}"$	SCH. 80 PVC, MOLDED, THREADED ENDS	ASTM D2467
PLUGS $\frac{1}{2}" - 1\frac{1}{2}"$	SCH. 80 PVC, SCREWED	ASTM D2464
BOLTING	GALVANIZED OR CAD-PLATED CARBON STEEL	ASTM A307, GR B
LINING	NONE	
COATINGS: EXPOSED BURIED OR ENCASED	PER SECTION 09 90 00 NONE	
Notes: 1. Socket type connections: made using solvent welding cement ASTM D2564. 2. Piping, fittings, etc. Schedule 80 unless noted otherwise on the Drawings		

PIPING SPECIFICATION PVC3 POLYVINYL CHLORIDE		
PIPE 4"-12"	PVC SDR 35	ASTM D3034
JOINING: 4"-12"	PUSH-ON WITH NITRILE GASKET	ASTM F477 ASTM D3212
FITTINGS: 4"-12"	PVC, ENDS TO MATCH PIPE	ASTM D3034
LINING	NONE	
COATINGS	NONE	

PIPING SPECIFICATION PVC4 POLYVINYL CHLORIDE PRESSURE PIPE		
PIPE	PVC PRESSURE PIPE DR 14 OR DR 18 (SEE PIPE SCHEDULE)	AWWA C900
FITTINGS	GRAY OR DUCTILE IRON 150 PSI MIN. EXCEPT PW AND NPW 250 PSI MIN. MECHANICAL JOINTS, RESTRAINED EBAA IRON, INC. MEGALUG SERIES 2000PV OR EQUAL.	AWWA C110, C153 AWWA C110, C111 AND C153
JOINTS	PUSH-ON, BELL AND SPIGOT – UNRESTRAINED PUSH-ON, BELL AND SPIGOT – RESTRAINED – EBAA IRON, INC. SERIES 1500, UNI-FLANGE SERIES 1390-C, OR APPROVED EQUAL	AWWA C900
BOLTING	GALV. OR CAD PLATED COR BLUE COATED OR 316 SS	ASTM A307 GR B AWWA C111 ASTM A193 B8M CLASS 2
GASKETS	EPMD 50-60 DUROMETER	AWWA C111 ASTM D2000
LINING	NONE	
COATING	ENCASE BURIED FITTINGS WITH POLYETHYLENE FILM	AWWA C151

PIPING SPECIFICATION PVC5 POLYVINYL CHLORIDE DWV		
PIPE \leq 18"	SCH. 40 PVC	ASTM D1784
FITTINGS \leq 18"	PVC DWV, THREADED OR SOLVENT WELD	ASTM D2665, D3311
UNIONS $\frac{1}{2}$ " - $1\frac{1}{2}$ "	PVC DWV, THREADED OR SOLVENT WELD	ASTM D2665, D3311
NIPPLES $\frac{1}{2}$ " - $1\frac{1}{2}$ "	PVC DWV, THREADED OR SOLVENT WELD	ASTM 2665, D3311
PLUGS $\frac{1}{2}$ " - $1\frac{1}{2}$ "	PVC DWV, THREADED OR SOLVENT WELD	ASTM 2665, D3311
GASKETS	NONE	
BOLTING	NONE	
LINING	NONE	
COATING, EXPOSED	NONE	
COATING, BURIED OR ENCASED	NONE	
Notes: 1. Screwed connections: made by wrapping male thread with Teflon tape. 2. Socket type connections: made using solvent welding cement ASTM D2564. 3. Piping, fittings, etc. PVC DWV unless noted otherwise on the Drawings.		

PIPING SPECIFICATION CPVC CHLORINATED POLYVINYL CHLORIDE		
PIPE ≤ 12"	SCH. 80 CPVC	ASTM F441 ASTM D1784
FITTINGS ≤ 12"	SCH. 80 CPVC, SOCKET TYPE	ASTM F439
FLANGES ≤ 12"	150# CPVC, SOCKET TYPE SCH. 80	ASTM F437
UNIONS ½" - 1½"	SCH. 80 CPVC, SOCKET TYPE	ASTM F439
NIPPLES ½" - 1½"	SCH. 80 CPVC, MOLDED, THREADED ENDS	ASTM F439
PLUGS ½" - 1½"	SCH. 80 CPVC, SCREWED	ASTM F439
GASKETS	PTFE	ASTM C111
BOLTING	GALVANIZED OR CAD-PLATED CARBON STEEL	ASTM A307 GR B
Notes: 1. Screwed connections: made by wrapping male thread with Teflon tape. 2. Socket type connections: made using solvent welding cement ASTM D2564. 3. Piping, fittings, etc. shall be Schedule 40 unless noted otherwise on the Drawings.		

PIPING SPECIFICATION SS1 STAINLESS STEEL GENERAL SERVICE		
PIPE \geq 3"	SCHEDULE 10S, WELDED	ASTM A240 TYPE 304L ASTM A778 OR ASTM A409 HT-0 ANSI B36.19, TABLE 2
FITTINGS	BUTT WELD, THICKNESS TO MATCH PIPE	ASTM A774 TYPE 304L
FLANGES	STAINLESS STEEL BACKING FLANGE; REFER TO ASME / ANSI B16.5 – 1996- PIPE FLANGES AND FLANGED FITTINGS FOR FLANGE THICKNESSES	TYPE 304L
COUPLINGS	SLEEVE TYPE; FOR AIR DISCHARGE PIPE: VICTAULIC (SEE NOTE)	
FACE RINGS	BUTT WELD OR SLIP ON	ASTM A240 TYPE 304L
GASKETS	1/8" THICK FULL FACE EPDM	50-60 DUROMETER
BOLTING	STAINLESS STEEL	ASTM A193 AND ASTM A194
Notes: 1. Gaskets on blower discharge piping shall be Victaulic Type L (Silicone, Temperature Range -30°F to 350°F). 2. The angle face ring thickness shall be equal or greater than the wall of the pipe or fitting to which it is welded, and it shall be continuously welded on both sides to the pipe or fitting. 3. Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276, shop welded to the pipe at the locations specified. 4. After all shop operations have been completed, pipe and fittings shall be pickled and passivated in the manufacturer's plant, and scrubbed and washed until discoloration and possible iron picked up from the manufacturing process are removed. 5. Provide dielectric insulating flanges between dissimilar metals. 6. A submittal for the prefabricated square to round eccentric intake transition piece and blower header piping as shown on Drawings M-3500 and M-3501 must be provided, and include information from approved blower and louver submittals to provide a fully functioning system. 7. Gaskets on digester gas service (DG) shall be Nitrile/Buna-N.		

PIPING SPECIFICATION SS2 ≤ 2" STAINLESS STEEL GENERAL SERVICE		
PIPE ≤ 2"	SCH. 40S STAINLESS STEEL, WELDED	ASTM A312 TP 304L
FITTINGS ≤ 2"	SCH. 40S STAINLESS STEEL, SOCKET WELD	ASTM A182 F 304L
FLANGES ≤ 2"	SOCKET WELD	ASTM A182 F 304L
COUPLINGS	SLEEVE TYPE; FOR AIR DISCHARGE PIPE: VICTAULIC (SEE NOTE)	
NIPPLES ½" - 1½"	SCH. 40S STAINLESS STEEL, SEAMLESS	ASTM A312 TP 304L
WELDOLET ≤ 2"	STANDARD WEIGHT STAINLESS STEEL	ASTM A182 F 304L
GASKETS	1/8" THICK, EPDM	50-60 DUROMETER
BOLTING	GALVANIZED OR CADMIUM-PLATED	ASTM A307 GR B
Notes: 1. Gaskets on blower discharge piping shall be Victaulic Type L (Silicone, Temperature Range -30°F to 350°F) 2. Screwed connections: made by wrapping male thread with Teflon tape. 3. Screwed valves: used for drains, vents, and instrumentation connections only. 4. Gaskets on digester gas service (DG) shall be Nitrile/Buna-N.		

PIPING SPECIFICATION SS3 STAINLESS STEEL GENERAL SERVICE		
PIPE	DOUBLE WALL STAINLESS STEEL CHIMNEY SYSTEM, INNER WALL 20 GAUGE 304SS, OUTER WALL 24 GAUGE 304SS	UI-103 Section 22A
JOINTING	MADE USING ASSEMBLY BAND, FINISHING BAND, AND SEALING MATERIAL SUPPLIED BY MANUFACTURER.	
INSULATION	HIGH TEMPERATURE INSULATION RATED TO 1000 °F	
Notes: 1. UL listed as a Building Heating Appliance (B.H.A) chimney for continuous operation up to 1000 °F 2. Install per manufacturer's recommendations.		

END OF SECTION

SECTION 33 14 14

PIPING APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies level gauges, pressure devices, strainers, thermometers, and injection quills.
- B. Exclusions: Temperature, pressure, level, and flow measuring devices used for instrumentation are specified in Division 40.

PART 2 PRODUCTS

2.01 LEVEL GAUGES

- A. General: For level measuring devices that interface with process control systems, refer to Division 40. Unless otherwise specified, level gauges shall be float type with external level indicating board. Float and cable fastener shall be fiber reinforced vinyl ester with PTFE float and guide cable. Sheave elbows shall be cast iron or 316 SS. Level indicating board shall be in English units and accurate within one (1) inch of internal liquid level in tank. Level gauges shall be Varec or Engineer-approved equal. Contractor to confirm chemical compatibility of all components with manufacturer and Engineer prior to ordering.

B. ROTAMETERS

1. Low Capacity. Unless otherwise specified, rotameters for purges and other low capacity services (max scale less than 60 gallons per hour) shall be Brooks model 1355 Sho-Rate "50", Wallace & Tiernan 3-inch purge meter, or Engineer-approved equal, with integral needle valve and flow controller. Meter tubes shall be glass with glass floats, Teflon tube packing, Viton o-rings, and aluminum or stainless steel cases, unless other material requirements are necessary for flow range or fluid compatibility. Rotameter scale shall indicate the units of flow. Unless otherwise specified, meter size shall be selected so that the flow rate recommended by the manufacturer of the purged equipment falls within the middle third of the meter scale. Units shall have a 3-inch minimum scale.
2. High Capacity. Unless otherwise specified, rotameters for high capacity service (max scale equal to or more than 60 gallons per hour) shall be King Series 7530, Brooks, Wallace & Tiernan, or Engineer-approved equal, with integral needle valve. Meter tubes shall be acrylic with a 4-inch minimum scale, with 316L stainless steel fittings and valve, and elastomers compatible with the fluid. Rotameter scale shall indicate the units of flow. Unless otherwise specified, meter size shall be selected so that the flow rate recommended by the manufacturer of the purged equipment falls within the middle third of the meter scale.

2.02 PRESSURE DEVICES

- A. General: For pressure measuring devices that interface with process control systems, refer to Division 40.
- B. Gauge Cocks: Unless otherwise specified, gauge cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gauge cock shall be protected by a brass plug.

C. Pressure Gauges

1. Unless otherwise specified, pressure gauge scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale, shall be 4 ½-inch, 270-degree movement, ½-percent accuracy full-scale, and suitable for bottom stem mounting. Gauges shall have a type 316 stainless steel bourdon tube and socket. All gauges shall have a 300 series stainless steel case, shatterproof glass, and a ½-inch NPT bottom connection.
2. Pressure gauges for air, gas, and low-pressure services (0 to 10 feet) shall be premium grade, heavy-duty bourdon-tube units (bellow type for vacuum) with Delrin bushings and pinion, and stainless steel sector.
3. Pressure gauges for liquid service shall be as noted above, except they shall be provided with an internal pulsation damping system consisting of either a glycerin fill or a silicon fluid fill. Snubbers or orifices shall not be utilized. Gauges shall be Ashcroft Duragauge type 1279, Ametek model 1981, or Engineer-approved equal.

D. Diaphragm Seals: Unless otherwise specified, seals shall be diaphragm type with ¼-inch flushing connection, Type 316 stainless steel body and Type 316L diaphragm. Fill fluid shall be Silicone DC200 unless otherwise specified.

E. Compressed Air Regulator and Air Dryer: Main line compressed air regulators shall be installed into the primary air supply line after the air compressors. Compressed air regulators control the pressure in the air supply that is delivered by the air compressor. The air inlet size shall be 1/2-inch, contractor to confirm the air flow direction, the maximum flow rate is 15 cfm, the thread type is NPT, maximum operating pressure is 125 psi, and the maximum operating temperature is 120° F. The desiccant material shall be silica gel and shall be designed to be refillable with fresh desiccant and reused. Manufacturer shall be SPEEDAIRE Desiccant Air Dryer: 4-Stage, 1/2-inch NPT, 15 cfm, 125 psi or engineer approved equivalent.

2.03 STRAINERS

A. Chemical Strainers: Unless otherwise specified, chemical strainers shall be a basket type, 2inch flanged CPVC or PVDF body, bonnet, plugs, and pressure relief valve, with Viton O-rings, and 3/32" perforated CPVC baskets. Chemical strainers shall have a minimum 6:1 open area ratio through the strainer basket to the corresponding piping system. Chemical strainers shall be rated to 100 psi at 75 degrees Fahrenheit, with phenolic molded hand knobs with brass threaded inserts. Chemical strainers shall be Spears Manufacturing Company, Plast-O-Matic Valves, Inc, Micromold Products, or Engineer-approved equal. Contractor to confirm chemical compatibility of all components with manufacturer and Engineer prior to ordering.

B. Y-Strainers: Strainers shall be Y-type, true union, constructed from clear PVC Type I, ASTM D1784- Cell Classification 12454. All O-Rings shall be EPDM. All Y-Strainers shall have replaceable PVC Screen and O-Ring sealed drain plugs. Screens shall be 20 mesh and be serviceable without removing the strainer from the pipeline. All 1/2" Through 2" Y-Strainers shall be pressure rated to 150 psi for water at 73°F. Strainers shall be manufactured by Spears Manufacturing Company, Asahi/America, Hayward, or engineer approved equal.

2.04 INJECTION QUILLS

A. Injection quills for chemical injection points are located and detailed on the Drawings. Acceptable injection quill is Saf-T-Flo EB retractable series or Engineer-approved equal. Confirm injection quill material chemical compatibility and installation suitability with the manufacturer and Engineer.

2.05 PNEUMATIC QUICK CONNECT COUPLERS

- A. Pneumatic one-way shutoff push-to-connect, female coupler suitable to mate with industrial interchange nipples manufactured to A-A-59439 (MIL-C-4109F, ISO 6150-B) standards. Brass body, stainless steel springs & locking balls, nitrile seal material. NPT pipe connection shall be sized to match connecting pipe and isolation valves indicated on drawings.

2.06 CAM-LOCK COUPLERS

- A. Cam-lock or cam action couplings shall comply with both US Military Specification, MIL-C-27487 and US Federal Standard A-A-59326. Couplings shall be pressure tested to three times the recommended working pressure. Stainless steel body and handles with EPDM gaskets. Where cam-lock coupling is indicated on the drawings, provide complete assembly including 'Part D' female cam-lock x pipe connection (typically female NPT thread coupling), 'Part DP' male cam-lock dust plug, and retaining chain. Pipe connection shall be sized to match connecting pipe and isolation valves indicated on drawings.

2.07 PULSATION DAMPENER

- A. Pulsation dampeners shall have a maximum operating pressure rating of 275 psi and a capacity of 2310 cubic inches. Pulsation dampeners shall have carbon steel wetted and non-wetted housing, EPDM bladder, and stainless steel gauges, valves, and assembly bolts. The inlet shall have 4" Class 150 flanged connection. Pulsation dampeners shall be chargeable.
- B. Pulsation dampeners shall be Blacoh model CT5440ND or Engineer-approved equal.

2.08 EDUCTORS

- A. A cast iron 1-1/2" Jerguson/Jacoby-Tarbox HL, Penberthy, or Engineer-approved equal, eductor will be provided to move sodium hypochlorite and sodium hydroxide solutions. The unit will require less than the maximum feed system service water supply flow and pressure specified for motive water to move the dosed chemicals the injection point.

PART 3 EXECUTION

3.01 GAUGE TAPS

- A. Gauge taps shall be provided on the suction and discharge of pumps, fans, compressors, vacuum pumps, and blowers. Gauge taps shall consist of a 1/2-inch gauge cock attached by a threaded nipple to the pipeline, duct, or equipment.

3.02 VENTS AND DRAINS

- A. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted 4 feet above the floor. Vents in piping systems for fluids containing solids shall be 1-inch nonlubricated eccentric plug valves fitted with quick couplers.
- B. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted 4 feet above the floor or immediately below the drain pipe invert, whichever is lower. Drain valve shall be threaded end plug valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access as approved by the Engineer prior to installation.

END OF SECTION

SECTION 33 14 19
VALVES AND OPERATORS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This specification covers manual and automatic valves with accessories.

1.02 REFERENCES

A. American National Standards Institute (ANSI)

1. B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
2. C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. A21.11 Rubber Gasket Joints for Ductile - Iron and Grey Iron.
4. B1.20.1 Valve and Connections (Threaded).
5. B16.18 Valve and Connections (Soldered).
6. B16.11 Forged Steel Fittings, Socket-Welding and Threaded.
7. B16.18 Cast Copper Alloy Solder Joint Pressure Fittings.
8. B16.24 Bronze Pipe Flanges and Flanged Fittings, Class 150 and 300.
9. B16.25 Butt-Welding Ends.
10. B16.5 Pipe Flanges and Flanged Fittings.
11. A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

B. American Society of Sanitary Engineers (ASSE)

1. 1011 Performance Requirements for Hose Connections Vacuum Breakers.

C. American Society of Mechanical Engineers (ASME)

1. B31.1 Power Piping - ASME Code for Pressure Piping.
2. B31.9 Building Services Piping - ASME Code for Pressure Piping.

D. American Society for Testing and Materials (ASTM)

1. A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
2. A351 Standard Specification for Castings, Austenitic, Austenitic-Ferric (Duplex), for Pressure-Containing Parts.
3. B61 Standard Specification for Steam or Valve Bronze Castings.
4. B62 Standard Specification for Composition Bronze or Ounce Metal Castings.
5. B98 Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

6. A126 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 7. B127 Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
 8. B139 Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
 9. B164 Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
 10. B194 Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
 11. B584 Standard Specification for Copper Alloy Sand Castings for General Applications.
 12. D429 Test Methods for Rubber Property—Adhesion to Rigid Substrates.
 13. D1784 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- E. American Water Works Association (AWWA)
1. C500 Gate Valves for Water and Sewerage Systems.
 2. C504 Standard for Rubber-Seated Butterfly Valves.
 3. C508 Standard for Swing-Check Valves for Waterworks Service, 2 in. Through 24 in. NPS.
 4. C509 Resilient-Seated Gate Valves for Water and Sewerage Systems.
 5. C510 Double Check Valve, Backflow-Preventer Assembly.
 6. C511 Required Pressure Backflow-Prevention Assembly.
 7. C540 Power-Actuating Devices for Valves and Sluice Gates.
 8. C550 Protective Epoxy Interior Coatings for Valves and Hydrants.
 9. C606 Grooved and Shouldered Joints.
 10. C800 Underground Service Line Valves and Fittings.
- F. Manufacturer's Standardization Society (MSS)
1. SP-6 Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings.
 2. SP-25 Standard Marking System for Valves, Fittings, Flanges and Unions.
 3. SP-42 Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends.
 4. SP-45 By-pass and Drain Connection Standard.
 5. SP-53 Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Magnetic Particle Examination Method.
 6. SP-54 Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components-Radiographic Examination Method.
 7. SP-55 Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components-Visual Methods.
 8. SP-61 Pressure Testing of Steel Valves.

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| 9. | SP-67 | Butterfly Valves. |
| 10. | SP-70 | Cast-iron Gate Valves, Flanged and Threaded Ends. |
| 11. | SP-71 | Cast-iron Swing Check Valves, Flanged and Threaded Ends. |
| 12. | SP-72 | Ball Valves with Flanged or Butt-Welding Ends for General Service. |
| 13. | SP-78 | Cast-iron Plug Valves, Flanged and Threaded Ends. |
| 14. | SP-80 | Bronze Gate, Globe, Angle and Check Valves. |
| 15. | SP-81 | Stainless Steel, Bonnetless, Flanged Knife Gate Valves. |
| 16. | SP-84 | Steel Valves - Socket Welding and Threaded Ends. |
| 17. | SP-85 | Cast-iron Globe & Angle Valves, Flanged and Threaded Ends. |
| 18. | SP-86 | Guidelines for Metric Data in Standards for Valves, Flanges and Fittings. |
| 19. | SP-88 | Diaphragm Type Valves. |
| 20. | SP-91 | Guidelines for Manual Operation of Valves. |
| 21. | SP-92 | MSS Valve User Guide. |
| 22. | SP-93 | Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components-Liquid Penetrant Examination Method. |
| 23. | SP-94 | Quality Standard for Ferritic and Martensitic Castings for Valves, Flanges, and Fittings and Other Piping Components-Ultrasonic Examination Method. |

1.03 SUBMITTALS

A. Provide following submittals consistent with Section 01 33 00:

1. Product data sheets for make and model, complete catalog information, descriptive literature, specifications, and identification of materials of construction.
2. Complete dimensioned drawings showing the installation of the valves, piping connections, operators, floor stands, and supports as required.
3. When indicated for the valve type, provide a valve coefficient (CV) curve versus percent stroke. Use the equation:

$$CV = Q/(\Delta P)^{0.5},$$
 Where: Q = Valve discharge in gallons per minute and
 ΔP = The pressure loss in the valve in pounds per square inch
4. Provide the maximum valve thrust requirement for operation and the thrust provided by the operator.
5. Valve pressure and temperature rating.

B. Quality Control:

1. Certificate of Compliance for:
 - a. Butterfly valves; full compliance with AWWA C504 as required.
2. Tests and inspection data.

- 3. Manufacturer's Certificate of Proper Installation and that factory coatings have been applied and tested in the manufacturing plant prior to shipment in accordance with contract documents.
- C. Provide Operations and Maintenance Manual(s) in accordance with Section 01 78 23.
- D. As-built drawings including actual layout drawings for valves, operators, floor stands, and supports if any deviations from proposed layout drawings. Include all dimensions.

1.04 WARRANTY

- A. As specified in Section 11 00 00.

PART 2 PRODUCTS

2.01 GENERAL

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired. Acceptable manufacturers include those explicitly listed or Engineer-approved equal, modified to meet the requirements of this specification
- B. Valve to be new and of current manufacturer and to include operator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.
- C. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- D. Valve same size as adjoining pipe unless otherwise noted.
- E. Valve ends to suit adjacent piping.
- F. Size operator to operate valve for the full range of pressures and velocities.
- G. Valve to open by turning counterclockwise.
- H. Factory-mount operator and accessories.

2.02 SCHEDULE

- A. Requirements relative to this section are shown on Valve Schedule located at the end of this section.

2.03 MATERIALS

- A. Brass and bronze valve components and accessories that have surfaces in contact with water, to be alloys containing less than 16 percent zinc and 2 percent aluminum.
- B. Approved alloys are of the following ASTM designations:
 - 1. B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.

2. Stainless steel Alloy 18-8 may be substituted for bronze.

2.04 FACTORY FINISHING

- A. Epoxy line and coat cast iron body valves, where specified in accordance with Section 09 90 00 and AWWA C550.

2.05 AIR RELEASE VALVE

- A. Type ARV1 – Valves shall have an ASTM A126 Class B cast iron body and cover with threaded inlet and outlet connections. Valve float shall be stainless steel and have a replaceable seat for drip tight shutoff. Internal linkage mechanism shall be stainless steel. Valves shall be rated for a working pressure of 150 psi minimum with the ability to accommodate 10 scfm of air. Operating pressures will be less than 1 psi. Coordinate valve size and orifice size with manufacturer so that the above stated requirements are met.

1. Manufacturer

- a. DeZurik/APCO
- b. Cla-val
- c. Valmatic

2.06 COMBINATION AIR VALVE

- A. Type CAV1 Combination Air/Vacuum Valve 4 inches and smaller shall allow large volumes of air into and out of the pipe through a large orifice during filling and draining and small amounts to escape through a small orifice during normal operation. Combination air release and vacuum valve manufactured in accordance with AWWA C512. The combination air release and vacuum break valve shall be of the compact single chamber design with an ASTM A126 Class B or ASTM A48 Class 35 cast iron, or ASTM A536 Grade 65-45-12 ductile iron body. Internal valve components shall be of stainless-steel construction. Valve shall be epoxy powder coated. Inlet shall have tapered iron pipe thread conforming to AWWA C800 for valve inlets 3-inches or less. Flanged inlets shall be provided for valves 4 inches and larger to conform to ANSI B16.1 Class 125. Valve float and linkage shall be 316 stainless steel per ASTM A240 and have a Buna-N or EPDM seat.

1. Manufacturer

- a. DeZurik/APCO
- b. Cla-val
- c. Valmatic

2.07 VACUUM BREAKER VALVE

- A. Type VAC1 Vacuum Breaker Valve 4 inches and smaller. Vacuum breaker valve in accordance with AWWA C512. Ductile iron globe style body with integrally cast Class 150 flanged ends, stainless steel internal parts, and Buna-N seats. The valve shall have a cross-sectional inflow area 10% greater than the equivalent pipe size. The plug shall have guides at both ends and be normally closed by means of a stainless steel spring. Valves shall be NSF 61 certified.

1. Manufacturer

- a. DeZurik/APCO
- b. Cla-val

- c. Valmatic

2.08 BACK FLOW PREVENTER

- A. Type BP1 Reduced Pressure Principle Back Flow Preventers. Assemblies shall include ball valves on the upstream and downstream sides of the valve for isolation. Main valve body shall be lead free cast copper silicon alloy with stainless steel springs and silicone elastomer discs. Back flow preventer shall have a minimum pressure rating working pressure of 175 psi. Valve shall meet NSF 61 requirements and conform to AWWA C511. Isolation valves shall have non-rising stems. Valve shall be FM approved and UL classified.

- 1. Manufacturer

- a. Febco; Model LF860.
 - b. Engineer approved equal.

- B. Type BP2 Double Check Back Flow Preventers. Assemblies shall include NRS gate valves on the upstream and downstream sides of the check valve assembly for isolation. Main valve body and internal parts shall be 300 series stainless steel. The check valves shall be of thermoplastic construction. The check valves shall seal to the valve body by using nitrile rubber O-rings. Back flow preventer shall have a minimum pressure rating working pressure of 175 psi. Valve shall be lead free, meet NSF 61 requirements and conform to AWWA C510. Valve shall be FM approved and UL classified.

- 1. Manufacturer

- a. Watts Series 774.
 - b. Engineer approved equal.

2.09 BALL VALVES

- A. Type VB1 Ball Valve 3 Inches and Smaller for General Water and Air Service: All-bronze, two-piece, full port, end entry type, PTFE seats, stainless trim, hand lever operator, rated 150 pound SWP, 600 pound WOG, NSF 61 certified on all potable (1W, 2W) water service. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation.

- 1. Manufacturers:

- a. Milwaukee: BA100, threaded end
 - b. Nibco; T-585-70, threaded end
 - c. Milwaukee; BA150, soldered ends
 - d. Nibco; S-858-70, soldered ends
 - e. Apollo
 - f. Jamesbury
 - g. Ford

- B. Type VB2 Ball Valve 3 Inches and smaller: Carbon steel, two-piece, full port, end entry type, PTFE seats, stainless steel ball and trim, hand lever operator, class 150 flanged end connections, rated 285 psi CWP, Conforms to ANSM/ANSI B16.34. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation.

- 1. Manufacturers:

- a. Nibco; T-515-CS-F-66-FS
 - b. Milwaukee; F20 Series
 - c. Engineer Approved Equal
- C. Type VB3 PVC Ball Valve 3 Inches and Smaller: Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation.
 - 1. Manufacturers:
 - a. Spears Manufacturing True Union Ball Valve
 - b. Nibco Chemtrol True Union, True-Bloc U45TB
 - c. ASAHI-America
 - d. Spears Manufacturing
- D. Type VB4 Ball Valve 6 Inches: Carbon steel, split-body, full port, end entry type, PTFE seats, stainless steel ball and trim, blowout-proof stem, hand lever operator, class 150 flanged end connections, vented ball, rated 285 psi CWP, Conforms to ANSM/ANSI B16.34. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation.
 - 1. Manufacturers:
 - a. Nibco: F-515-CS-F-66-FS
 - b. Engineer approved equal.
- E. Type VB5 Ball Valve smaller than 3 Inches: Carbon steel, three-piece, full port, end entry type, PTFE seats, stainless steel ball and trim, hand lever operator, threaded end connections, rated 1000 psi CWP, Conforms to MSS SP-110. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation.
 - 1. Manufacturers:
 - a. Nibco; T-595-CS-R-66-LL
 - b. Milwaukee
 - c. Engineer Approved Equal
- F. Type VB6 CPVC Ball Valve 3 Inches and Smaller: Vented ball valve. Rated 150 psi at 73 degrees F, with ASTM D1784 CPVC, ball, and stem, end entry, double union design, solvent-weld socket ends. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation.
 - 1. Manufacturers:
 - a. Spears Manufacturing True Union Ball Valve
 - b. Nibco Chemtrol True Union, True-Bloc U45TB
 - c. ASAHI-America Type 21
 - d. Plast-O-Matic True Blue Ball Valve

2.10 BUTTERFLY VALVES

- A. General: All butterfly valves are required to meet the following requirements:

1. Suitable for throttling operations and infrequent operations after periods of inactivity.
2. If elastomer seats are bonded or vulcanized to body, they shall have adhesive integrity of bond between seat and body assured by testing with minimum 75-pound pull in accordance with ASTM D429, Method B.
3. Bubble-tight with rated pressure applied from either side.
 - a. No travel stops for the disc on interior of the body.
 - b. Self-adjusting V-type or O-ring shaft seals.
 - c. Isolate metal-to-metal thrust bearing surfaces from flowstream.
4. Epoxy lined.
5. Tested to 110% of full differential pressure rating.

B. Type VF1 Butterfly Valve 16 Inches and Smaller

1. Lug Body type for air or water service
2. Cast iron body with all exposed surfaces to be epoxy coated.
3. NSF 61 Certification required on all non-potable (NPW, 3W) and potable water (1W) service as indicated on the Valve Schedule.
4. Coatings per Spec 09 90 00.
5. 316 SS Stem and Disc except as noted on Valve Schedule
6. Seal elastomer material shall be as shown in Valve Schedule at the end of this specification.
7. Minimum rated working pressure of 150 psi. Bi-directional dead-end service rating of 150 psi sandwiched between two flanges. With no downstream flange, dead-end service rating of 75 psi (2-12") or 50 psi (14-18").
8. Manufacturers:
 - a. Keystone
 - b. Pratt
 - c. Clow
 - d. Dezurik

C. Type VF3 Flanged Butterfly Valve 4 inches and larger

1. Flanged ends, short body.
2. Meets or exceeds AWWA C504, Class 150B including shaft diameters and body shell thicknesses.
3. NSF 61 Certification required on all non-potable (NPW, 3W) and potable water (1W) service as indicated on the Valve Schedule.
4. Suitable for throttling operations, and infrequent use after extended periods of inactivity,
5. Double flanged body with flange drilling in accordance with ANSI B16.1
6. Cast or ductile iron body, stainless steel stem and cast iron or stainless steel disc, seals self-adjusting V-type or O-rings, bronze bearings, Buna N packing.
7. Manufacturers:
 - a. Keystone

- b. Dezurik
- c. Clow
- d. Pratt

D. Pneumatic actuators for Butterfly Valves

1. Each butterfly has a pneumatic actuator that shall be compatible with specifications according to the table, below. Pneumatic actuators shall actuate on open and close and be installed with a parallel orientation to the associated piping. The air requirement for the pneumatic actuators is 80 psi. The maximum differential pressure for the pneumatic actuators is 50 psi.

Valve Label	Service	Pipe Size	Modulating	Failure State
CV 1101	RW	12"	No	Closed
CV 1201	RW	12"	No	Closed
CV 3110	STW	12"	No	Open
CV 3120	BWS	12"	No	Closed
CV 3130	A	6"	No	Closed
CV 3150	FW	12"	Yes	Closed
CV 3160	FTW	12"	No	Closed
CV 3210	STW	12"	No	Open
CV 3220	BWS	12"	No	Closed
CV 3230	A	6"	No	Closed
CV 3250	FW	12"	Yes	Closed
CV 3260	FTW	12"	No	Closed

2.11 CHECK VALVES

- A. Type VC1 Lever and Weight Swing Check Valve 2 Inches through 12 Inches: Flanged end, cast iron body, metal to metal seating, bronze mounted swing type, solid bronze hinges, stainless steel hinge shaft (keyed to disc and lever), adjustable outside lever and weight, rated 125-pound SWP, 200-pound WOG. NSF 61 certified for drinking water on all non-potable (NPW, 3W) water service as indicated on the Valve Schedule.

1. Manufacturers:
 - a. Golden Anderson,
 - b. APCO,
 - c. Or Engineer approved equivalent

- B. Type VC2 Silent Check Valve 2 inches: Flanged end with Class 150 flange drilling, globe style, cast or ductile iron body, resilient seated nitrile rubber, stainless steel internal parts. Valves shall be rated to 150 psi. NSF 61 certified for drinking water on all potable, non-potable, and raw water lines water service as indicated on the Valve Schedule.

1. Manufacturers:
 - a. Valmatic,
 - b. APCO,

- c. Or Engineer approved equivalent
- C. Type VC3 Ball Check Valve: Valve body shall be PVC per ASTM 1784 or CPVC per ASTM F1970 to match the piping service it is on with dimensions that conform to either ASTM D 2467 or F 439 for Schedule 80 pressure fittings for socket or threaded end connections. Valve shall have True Union fittings. Valve shall come clearly marked with flow direction, material designation, and NSF-61 certification on all non-potable (NPW, 3W) water service as indicated on the Valve Schedule. Valve shall be rated for a minimum of 150 psi at 73 degrees F. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation
 - 1. Manufacturers:
 - a. Nibco Chemtrol Ball Check Valve
 - b. Engineer approved equal.
- D. Type VC4 Inline, elastomer check valves. 3 inches. Cast iron ASTM A126 body, fabric reinforced replaceable EPDM check sleeve, clean out, flushing connection, valve body to fit ANSI B16.1 flanges. Valve shall be suitable for a maximum pressure of 50 psig and a maximum backpressure of 50 psig. Valve shall be capable of passing the 150% of the flow the design flow of the pump upstream at a maximum headloss of 5 psi. Valve shall open with an upstream pressure no greater than 2 inches more than the downstream pressure. Elastomer material is shown in Valve Schedule.
 - 1. Manufacturers:
 - a. Tideflex Technologies, Series 39/33,
 - b. Proco Series 750,
 - c. Or Engineer approved equivalent
- E. Type VC5 Double disc check, lug style, valve for air or water service. Rated at 250-deg F for air service. Valve to be 150-pound class, ductile body, aluminum-bronze or ductile iron doors, resilient seats, 316 stainless steel hinge pin, stop pin spring.
 - 1. Manufacturers:
 - a. APCO, Series 9000L
 - b. Or Engineer approved equivalent.
- F. Type VC6 Flanged "duckbill" check valves. Elastomer duckbill check valve with integrally cast elastomer flange. Backing support flange shall be 316 stainless steel. Valve shall be suitable for a maximum pressure of 50 psig and a maximum backpressure of 15 psig. Valve shall be capable of passing the 150% of the flow the design flow of the pump upstream at a maximum headloss of 5 psi.
 - 1. Manufacturers:
 - a. Tideflex Technologies, Series 35
 - b. Or Engineer approved equivalent.
- G. Type VC7 Flanged, eccentric "duckbill" check valves. Eccentric, elastomer duckbill check valve with integrally cast elastomer flange. Backing support flange shall be 316 stainless steel. Valve shall be suitable for a maximum pressure of 50 psig and a maximum backpressure of 15 psig. Valve shall be capable of passing the 150% of the flow the design flow of the pump upstream at a maximum headloss of 5 psi.

1. Manufacturers:
 - a. Tideflex Technologies, Series 39
 - b. Or Engineer approved equivalent.
 - H. Type VC8 Ball Check Valve 2 inches and larger: Valve body shall be cast iron per ASTM A126 Class B with flanged ANSI 125 connections. Valve shall come clearly marked with flow direction. Valve shall be rated for a minimum of 150 psi at 180 degrees F. Provide manufacturer's recommendation for seal material if different from that specified. Seal materials shall be in accordance with the Valve Schedule and manufacturer's recommendation.
 1. Manufacturers:
 - a. Flomatic Valves
 - b. Engineer approved equal.
- 2.12 GATE VALVES
- A. Type GV1 Gate Valve 2 Inches and Larger: Iron body, bronze mounted, flanged ends, solid wedge gate, non-rising bronze stem, rated 125-pound SWP, 200-pound WOG.
 1. Manufacturers:
 - a. Stockham; Figure G612
 - b. Nibco F619
 - B. Type GV2R Gate Valve 3 Inches and Smaller: All-bronze, screwed bonnet and ends, single solid wedge gate, rising stem, rated 150-pound SWP, 300-pound WOG. MSS-SP-80. Valve shall be NSF 61 certified.
 1. Manufacturers:
 - a. NIBCO T-113-LF
 - b. Or Engineer approved equivalent.
 - C. Type GV5HB Gate Valve 3 Inches and Larger for Buried High Pressure Water Service: Iron body, bronze mounted, mechanical joint ends, double disc gate, non-rising bronze stem, O-ring sealed stuffing box, 2-inch square wrench nut conforming to AWWA C500-02, rated 250 psi non-shock cold water.
 1. Manufacturers:
 - a. M&H; Style 871
 - D. Type KGV1 Knife Gate Valve 2 to 24 inches: Stainless steel body and gate, resilient seat gate with non-rising stainless steel stem, cast iron handwheel, flanged ends, rated for 150 psi normal working pressure. Provide operating nut, stainless steel stem extensions and handwheel floor stand with gate position indicator, handwheel and fittings on 18" knife gate valves.
 1. Manufacturers:
 - a. DeZurik KGC ES
 - b. Or Engineer approved equivalent

2.13 PLUG VALVES

- A. Type VP1 Eccentric Valve: Non-lubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body, flanged ends, cast iron plug with round or rectangular port, coated with Buna-N or Hycar, seat Type 316 stainless steel or nickel, stem bearing self-lubricating stainless steel or reinforced Teflon, stem seal multiple V-rings, U-cups, or O-rings of nitrile rubber.
1. Manufacturers:
 - a. Henry Pratt; Ballcentric
 - b. DeZurik; Eccentric Valve

2.14 FLOW CONTROL VALVES

- A. Type FCV1 Flow Control Valve: Hydraulically operated, pilot controlled, diaphragm globe valve controlled by the differential pressure across an orifice plate. A solenoid valve allows the main valve to be closed. Valve body shall be ductile iron with bronze trim and stainless steel stem, nut, and spring. End connections shall be ANSI B 16.42 Class 150 flanges. Disc and diaphragm shall be Buna-N. Provide valve with closing and opening speed control and valve position indicator and orifice plate.
1. Manufacturers
 - a. Cla-Val Model 43-01
 - b. Engineer approved equivalent.

2.15 PRESSURE RELIEF/REDUCING VALVES

- A. Type PRV1 Air Pressure Relief Valve
1. Direct-operated, spring controlled, bronze body. Valve housing shall be heavy duty casting. Dual Control rings for precise flow off control. Valve shall be rated for 300 psi. Valve shall have NSF 61 certification for use in a water treatment facility.
 2. Manufacturer:
 - a. Kunkle Model 6182
 - b. Engineer approved equivalent.
- B. Type PRV2 Pressure Reducing Valve
1. Direct diaphragm, spring controlled, steel body, spring case, see schedule for seat and diaphragm material, stainless steel valve stem. Valve shall be capable of reducing pressures to between 5-150 psi, have a pressure rating of 300 psi, and have an NSF 61 certification.
 2. Manufacturer:
 - a. Fisher 95 Series
 - b. Flowmatic, model C150E
 - c. Engineer approved equivalent.
- C. Type PRV3 Pressure Reducing Valve:

1. Direct diaphragm, spring controlled, anti-cavitation, ductile iron body, spring case, disc and diaphragm as listed in Valve Schedule at end of this section, stainless steel valve stem, nut, and spring. Valve shall be capable of reducing pressures between 30-300 psi and have NSF 61 certification.
2. Manufacturer
 - a. Cla-Val Model 90-01KO
 - b. Engineer approved equivalent.

D. Type PRV4 Backpressure Relief Valve

1. Direct-operated, spring controlled, PVC or CPVC body to match pipe material for each service, zinc plated spring, PTFE wetted diaphragm, stainless steel lock nut and screw, and a non-wetted u-cup TKM seal that isolates the spring. Valve shall have a maximum inlet capacity of 150 psi and a relief setting between 5 and 100 psi. Valve shall come with a fail-dry safety vent that indicates a failure of the valve seal. Valve shall have NSF 61 certification for use in a water treatment facility.
2. Manufacturer:
 - a. Plast-o-matic Series RVDT
 - b. Engineer approved equivalent

2.16 MISCELLANEOUS VALVES

- A. Type TV1 – Telescopic Valve 6 inches and smaller. Manually operated with 16-inch aluminum handwheel and 1 1/8-inch stainless steel threaded rod for slip tube movement. A brass lifting nut and polymer bearing pads are contained in a cast aluminum housing. The unit shall have a floor stand of 4 inch square stainless steel tube with 1/8 inch wall and mounted to a 1/2 inch thick stainless steel base plate mounted to manhole. The slip tube shall be stainless steel. The minimum straight pipe length shall be travel plus 9 inches. End connections shall be ANSI B 16.42 Class 150 flanges. Wipe gasket shall be 1/4-inch thick neoprene.

1. Manufacturers
 - a. Halliday Series V4A Model 501
 - b. Engineer approved equivalent.

- B. Type SV1 - Solenoid Valve 2 inches and smaller: See Section 40 05 82 Solenoid Valves.

2.17 MANUAL OPERATORS

A. General

1. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway. Provide gear reduction operator when force exceeds 40 pounds.
2. Operator self-locking type or equipped with self-locking device.
3. Position indicator on quarter-turn valves.
4. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rods with internally threaded bronze or ductile iron nut. Operators shall be provided with external open and close stop adjustment.

B. Exposed Operator

1. Galvanized and painted handwheels.
2. Lever operators allowed on quarter-turn valves 8 inches and smaller when operator force does not exceed 40 pounds.
3. Cranks on gear type operators.
4. Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.
5. Valve handles to take a padlock and wheels a chain and padlock.

C. Buried Operator

1. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
2. Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.
3. Buried valves shall have extension stems, bonnets, and valve boxes.

2.18 ACCESSORIES

- A. Tagging: 1-1/2-inch diameter heavy brass or stainless-steel tag for each valve operator, bearing the valve tag number .

B. T-Handled Operating Wrench

1. One each galvanized operating wrenches, 4 feet long.
2. Manufacturers:
 - a. Mueller; No. A-24610.
 - b. Clow No.; F-2520.
3. One each galvanized operating keys for cross handled valves.

- C. Extension Bonnet for Valve Operator: Complete with stem and accessories for valve and operator.

1. Manufacturers:
 - a. Pratt.
 - b. Allis-Chalmers.

D. Floor Stand and Extension Stem

1. Nonrising, indicating type.
2. Complete with stem, coupling, hand-wheel, stem guide brackets, and yoke attachment.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 SST.
5. Manufacturers:
 - a. Clow; Figure F-5515.

b. Mueller, Figure A-26426.

E. Floor Box and Stem

1. Plain type, for support of nonrising type stem.
2. Complete with stem, operating nut, and stem guide brackets.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 SST.
5. Manufacturers:
 - a. Tyler/Union, 6855 Series.

F. Chain Wheel and Guide

1. Handwheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.
4. Manufacturers:
 - a. Clow Corp.; Figure F-5680.
 - b. Walworth Co.; Figure 804.
 - c. DeZurik Corp.; Series GS Series Worm Gear or L&M Series Traveling Nut Actuator.

G. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 6-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum depth 3 inches, marked WATER.
3. Extensions: Cast iron.

H. Concrete Valve Box: Designed for traffic loads, sliding type, with minimum of 8-inch ID shaft.

1. Box: Concrete, minimum depth 12 inches, cast iron ring seat.
2. Lid: Cast iron, minimum depth 3 inches, marked WATER.
3. Extensions: cast iron pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. General

1. Install all valves, gates, operating units, stem extensions, valve boxes, floor stands, and accessories in accordance with manufacturer's written instructions and as shown and specified. Any proposed deviations thereof must have the written consent of the Engineer.
2. Support all valves to avoid undue stresses on the adjoining pipe.

3. Install all valves, appurtenances and accessories to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators with other systems, equipment, handrails, structural components, and any other items.
 4. Install access doors in finished walls and plaster ceilings for valve access.
- B. Flange Ends
1. Flanged valve bolt-holes shall straddle vertical centerline of pipe.
 2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
- C. Screwed Ends
1. Clean threads by wire brushing and swabbing.
 2. Apply Teflon tape.
- D. Valve Orientation
1. Except for plug valves as modified by (3) below;
 - a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
 - b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above finish floor, unless otherwise shown.
 2. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.
 3. If no plug valve seat position is shown, locate as follows:
 - a. Horizontal Flow: The flow shall produce an “unseating” pressure, and the plug shall open into the top half of valve (stem horizontal).
 - b. Vertical Flow: Install seat in the highest portion of the valve.
- E. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.
- F. Install safety isolation valves on compressed air and fuel oil.
- G. Extension Stem for Operator: Where the depth of the valve is such that its centerline is more than 3 feet below grade, furnish an operating extension stem with 2-inch operating nut to bring the operating nut to a point 6 inches below the surface of the ground and/or box cover.
- H. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.
- I. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.
- J. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finished floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors.

3.02 COATINGS AND LININGS

- A. In accordance with Section 09 90 00.
- B. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels: Safety Yellow.

3.03 TESTS AND INSPECTION

- A. Factory test all valves prior to shipment at a minimum of 1.5 times the rated working pressure.
- B. Field test all valves to the method and test pressure of adjoining pipe either while testing pipelines or as a separate step.
 - 1. Test and demonstrate that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
 - 2. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- C. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.
- D. Set, verify, and record set pressures for all relief and regulating valves.
- E. Test automatic valves in conjunction with control system testing. Test manual override provisions as applicable.
- F. Installation, start-up and testing shall be conducted in accordance with Section 01 91 13 and Section 11 00 00.

3.04 TRAINING

- A. Training shall be conducted in accordance with Section 01 79 00 and Section 11 00 00 for all sleeve valves, pressure reducing valves, air release valves, and combination air/vacuum valves. Training shall consist of a minimum of two 1-hour sessions per valve type addressing the theory of operation, testing, troubleshooting, and maintenance of the equipment.

3.05 FIELD SERVICE

- A. Provide the service of a qualified representative for one (1) trip and one (1) day to inspect the equipment installation, assist in startup, and instruct plant personnel in the operation and maintenance of all sleeve valves, pressure reducing valves, air release valves, and combination air/vacuum valves.

Service Legend	Service	Size Range, inches	Valve Type, No.	Valve Type	Operator Type	Elastomer Material	Notes
A	Air	6	VF1, VF3,	Butterfly, Ball	Manual	EPDM	Vendor Supplied
A	Air	6	VC5, VAC1	Check Valve	Hydraulic	EPDM	
A	Air	6	VF1, VF3	Butterfly Valve	Pneumatic	EPDM	Vendor Supplied

Service Legend	Service	Size Range, inches	Valve Type, No.	Valve Type	Operator Type	Elastomer Material	Notes
A	Air	≤ 6	VF1, VF3	Butterfly Valve	Manual	EPDM	
ACH	Aluminum Chlorohydrate	≤ 3	VC3, VB3, PRV4	Check Valve, Ball Valve, PRV	Manual, Hydraulic	PTFE	
BWS	Backwash Supply	8	VF1, VF3, VC2	Butterfly Valve & Check Valve	Manual	EPDM	
BWS	Backwash Supply	12	VF1, VF3	Butterfly Valve	Pneumatic	EPDM	Vendor Supplied
BWS	Backwash Supply	4	FCV1	Flow Control Valve	Hydraulic	EPDM	
BWS	Backwash Supply	2	CAV1	Combination Air Valve	Hydraulic	Buna-N	
CLO	Chlorine Dioxide	½	VB6, VC3, PRV4	Ball Valve	Manual, Hydraulic	PTFE	
D	Drain	2	VB1	Ball Valve	Manual	--	Vendor Supplied
FTW	Filter to Waste	12	BP2	Double Check Backflow Preventer	Hydraulic	EPDM	
FW	Filtered Water	12, 16	VF1, VF3	Butterfly Valve	Manual	EPDM	
FW	Filtered Water	≤ 2	VB1	Ball Valve	Manual	Teflon	
FW	Filtered Water	12	VF1, VF3	Butterfly Valve	Pneumatic	EPDM	Vendor Supplied
FW	Filtered Water	≤ 2	CAV1		Hydraulic	Buna-N	
NPW	Non-Potable Water	½, 1	VB1	Ball Valve	Manual	PTFE	
PA	Pressurized Air	1	VB1	Ball Valve	Manual	PTFE	
PD	Pumped Drain	1½	VB2	Ball Valve	Manual	PTFE	
POL	Polymer	≤ 2	PRV4		Hydraulic	Buna-N	
POL	Polymer	≤ 2	VB3	Ball Valve	Manual	EPDM	
POL	Polymer	≤ 2	VC3		Hydraulic	PTFE	
PW	Potable Water	≤ 2	VB1	Ball Valve	Manual	Teflon	
PW	Potable Water	≤ 6	BP1	Backflow preventer	Hydraulic	Buna-N	
PW	Potable Water	≤ 2	PRV2		Hydraulic	Buna-N	

Service Legend	Service	Size Range, inches	Valve Type, No.	Valve Type	Operator Type	Elastomer Material	Notes
PW	Potable Water	> 2	PRV3		Hydraulic	Buna-N	
PW	Potable Water	4, 6	VF1, VF3	Butterfly Valve	Manual	Buna-N	
RW	Raw Water	12	VF1, VF3	Butterfly Valve	Manual	Buna-N	
RW	Raw Water	12	VF1, VF3	Butterfly Valve	Pneumatic	Buna-N	Vendor Supplied
SC	Sodium Chlorite	2	VB3	Ball Valve	Manual	PTFE	
SH	Sodium Hydroxide	≤ 3	VB3	Ball Valve	Manual	PTFE	
SH	Sodium Hydroxide	≤ 3	PRV4, VC3		Manual, Hydraulic	PTFE	
SHC	Sodium Hypochlorite	½	PRV4, VC3		Manual, Hydraulic	PTFE	
SHC	Sodium Hypochlorite	≤ 2	VB6	Ball Valve	Manual	PTFE	
SRW	Solids Residual Waste	1 ½	VB2	Ball Valve	Manual	PTFE	Vendor Supplied
STW	Settled Water	12, 16	VF1, VF3	Butterfly Valve	Manual	Buna-N	
STW	Settled Water	12	VF1, VF3	Butterfly Valve	Pneumatic	Buna-N	Vendor Supplied
TD	Tank Drain	2	VB2	Ball Valve	Manual	PTFE	
TD	Tank Drain	4	VF1, VF3	Butterfly Valve	Manual	Buna-N	

END OF SECTION

SECTION 40 05 82

SOLENOID VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. This section specifies 2- way and 3-way solenoid valves, direct or pilot operated type, for control of process fluids.

B. Type

1. Valves with piping connections less than 1 ½ inches in diameter shall be direct-acting type.
2. Valves with piping connection 1 ½ inches in diameter and greater shall be pilot operated globe body type.

C. Design Requirements

1. Unless otherwise specified, solenoid valves shall be designed to seal the pressurized (supply) port upon deenergization.
2. Valves shall be listed by Underwriters Laboratories Inc. in accordance with UL 429, 508, and UL 1002 and shall comply with ICS-6 ANSI/NEMA. Solenoid valves for gas service shall be approved by Factory Mutual Engineering Corporation.

1.02 REFERENCES

This paragraph contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM A48M-03	Standard Specification for Gray Iron Castings
UL 429-82	Electrically Operated Valves
UL 429-82	Controls Standards
UL 1002-88	Electrically Operated Valves for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G.
ASTM F594	Standard Specification for Stainless Steel Nuts
AWWA C561	Fabricated Stainless Steel Slide Gates

1.03 SOLENOID VALVE SCHEDULE

Service	Solenoid Valve (SV) Number	Valve to Equip Description	Solenoid Type	Line Size ^(b) inches	Operating pressure, min/max, psig	Unpowered Position ^(a)
NPW	SV 3170	Control Valve	2-way, Direct, NEMA 4X	1	0/110	N.C.
A	SV 3171	Control Valve	2-way, Direct, NEMA 4X	1/4	0/110	N.C.
NPW	SV 3270	Control Valve	2-way, Direct, NEMA 4X	1	0/110	N.C.
A	SV 3271	Control Valve	2-way, Direct, NEMA 4X	1/4	0/110	N.C.
A	SV 3811	Control Valve	2-way, Direct, NEMA 4X	1/4	0/110	N.C.
A	SV 3821	Control Valve	2-way, Direct, NEMA 4X	1/4	0/110	N.C.

(a) N.O.: Normally Open, N.C.: Normally Closed

(b) Line size is also valve size in inches.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Direct Acting Type

1. Valves shall be ASCO or Engineer approved equal, modified to provide the specified features.

2.02 MATERIALS

A. Direct Acting Type

1. Materials of construction shall be as follows:

<u>Component</u>	<u>Material</u>
Body	Stainless steel, Type 304
Seal	Teflon
Disc	Teflon

2.03 MANUFACTURER

A. General

1. Solenoid valves shall be rated for continuous duty at 120 volts AC. Valves shall be threaded for sizes 3 inch and smaller.

B. Direct Acting Type

1. Unless otherwise specified, valves shall have NEMA 4X solenoid coil enclosures and molded Class F coils. Valve assembly shall include an integral NEMA 4X junction box with screw terminals, ½-inch conduit hub, and grounding provisions.
2. Unless otherwise specified, valves shall have NEMA 7 solenoid coil enclosures and molded Class F coils. Valve assembly shall include an integral NEMA 7 junction box with screw terminals, ½-inch conduit hub, and grounding provisions.

2.04 PRODUCT DATA

- A. Manufacturer's product data shall be provided in accordance with specification Section 01 33 00.

PART 3 EXECUTION

- A. Solenoid valves shall be installed in accordance with the manufacturer's recommendations. Testing shall be as specified in Section 40 61 21.

END OF SECTION

SECTION 40 61 00

PROCESS CONTROL SYSTEMS GENERAL PROVISIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. General: This section specifies general requirements that are applicable to all process instrumentation and control systems.
 - B. Scope:
 - 1. The process instrumentation and control system shall include field-mounted process variable transmitters and primary elements, control devices, programmable logic controllers, control panel assemblies, local control panels, signal conditioning equipment, and utility and support systems.
 - 2. The process instrumentation and control system shall be configured as specified herein and as indicated on the Drawings.
 - 3. Work of this Specification shall include engineering, furnishing, installing, start-up, calibrating, and testing of all instrumentation and control systems required for the construction, integration and commissioning of a complete process instrumentation and control system. Total integration of field-mounted instrumentation, control devices, and process equipment furnished and installed as work of this Specification, and of similar equipment furnished and installed as work of other sections shall be the responsibility of this section of the Specifications.
 - C. Drawings: Examine all drawings relating to the project. Include all work, materials, and equipment mentioned or shown as being provided under this division. Refer to all Drawings and details in coordinating and completing the work. Study all Drawings to determine any conflicts with ordinances and statutes. Report any discrepancies, conflicts, or omissions; accomplish work required for conformance and/or completion.
 - D. Specifications: Examine all specification divisions relating to the Project. Include all work, materials, and equipment mentioned as being provided under this division. Study all specifications to determine any conflicts with ordinances and statutes. Report any discrepancies, conflicts, or omissions; accomplish work as required for conformance and/or completion.
 - E. Training and Documentation: Comprehensive training and system documentation shall be provided for all systems furnished as work of this section of the Specifications.
- ##### 1.03 COORDINATION WITH PROCESS INSTRUMENTATION AND CONTROL SYSTEM WORK
- A. General: Refer to the Division 01 sections for general coordination requirements applicable to the entire Work. It is recognized that the Drawings are diagrammatic in showing certain physical

relationships that must be established within the process instrumentation and control system work, and in its interface with other work including electrical, process, and mechanical work, and that such establishment is the exclusive responsibility of the Contractor.

1. Locate operating and control equipment properly to provide easy access and arrange instruments, control devices, and related equipment with adequate access for operation and maintenance.
2. Advise other trades of the following:
 - a. Requirements for process instrument interfaces with mechanical and process systems.
 - b. Requirements for access to process instruments and control panels for operating and maintenance activities.
 - c. Installation, mounting height, and orientation requirements for instruments, panels, and other process control devices that may be installed by other trades.
 - d. Precautions necessary to protect stored or installed process instrumentation and control system equipment.
3. Installation details are included in the Drawings to describe the specific installation practices to be followed as work of this Contract. Although the details may not be specifically referenced from the Drawings, the installation practices described by each detail shall be applied as generally described by the title of the detail.
4. The Contractor shall examine the mechanical and process drawings and specifications to determine actual locations, sizes, materials, and ratings of process connections.

1.04 QUALITY ASSURANCE, STANDARDS, DEFINITIONS, AND SYMBOLS

- A. General: Refer to Division 01 for general administrative/procedural requirements related to compliance with codes and standards. At a minimum, materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards, and utility company regulations. In the event of conflict between codes, state laws, local ordinances, industry standards, utility company regulations, and the contract documents, the most stringent of these shall govern the requirements to be satisfied.
- B. Basis of Design: The process control system design is based on the integration of products of a single manufacturer to provide a unified architecture upon which the major components of the process control system can efficiently communicate and operate in concert with each other. The intent of this design and the solution described by these documents is to provide a networked automation system that leverages the resources in the intelligent field device and communication infrastructure to support a level of data integration between all system components that streamlines development and deployment, improves plant management and control, and enhances operation and maintenance.
 1. The Allen-Bradley family of products for programmable logic controller systems, motor control centers, variable frequency drives, operator interface terminals, and network switches serve as the basis for this design. Products of other manufacturers may be considered at the Contractor's discretion but it shall be the Contractor's responsibility to demonstrate that any alternative solution will provide the depth of integration inherent in the control system as designed. Criteria upon which alternate solutions shall be evaluated include the following:
 - a. The automation network utilizes a single communication protocol to integrate all the system components listed in the paragraph above.

- b. All the tools necessary to configure, program, and maintain the various system components are incorporated into a single development environment.
 - c. Field device profiles are used in the automation controller system to facilitate field device configuration, automatically create field device-related data references and tags, and provide for automatic reconfiguration of replacement devices.
 - d. A similar breadth of operational, fault, and diagnostic data is available from all system components as is available in the system as designed.
 - e. The integration extends to all mechanical process equipment packages that include PLC-based controls as specified in Division 46 of these specifications.
 - f. No redesign effort is required to implement the alternative solution. Should any redesign be required, the Contractor shall bear all costs.
2. As a condition of acceptance, an alternate process control system solution shall include the additional work described as follows:
- a. The existing PLC9100 system located in local control panel LCP9100 shall be replaced with a comparable PLC system from the product family proposed in the alternate process control system solution. The new PLC system shall be programmed to replicate the control logic defined in the existing PLC system.
 - b. The existing HMI/SCADA process visualization system (GE Digital iFix) shall be modified as necessary to communicate with the new PLC system replacing the LCP9100 PLC system. Database tags shall be developed to link to all dynamic graphic objects on the associated operator interface displays to the new PLC system.
 - c. Full featured PLC programming software for the PLC hardware proposed to be used in the alternate process control system solution shall be provided and licensed in the Owner's name. License term shall be two (2) years.
 - d. An I/O driver compatible with the existing HMI/SCADA process visualization system shall be provided to support communications between the HMI/SCADA server and the new PLC systems.
- C. Standards: This division contains references to the following standards issuing organizations. Where a specific standard is referenced in these specifications, the standard shall be considered part of this division as specified and modified. Unless otherwise specified, references to standards shall mean the standard in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced standards have been discontinued by the issuing organization, references to those standards shall mean the replacement standards issued or otherwise identified by that organization or, if there are no replacement standards, the last version of the standard before it was discontinued. Where standards dates are referenced, references to those standards shall mean the specific standard version associated with that date, whether or not the standard has been superseded by a version with a later date, discontinued or replaced.

<u>Reference</u>	<u>Standards Organization</u>
ANSI Standards	American National Standards Institute
ASTM Standards	American Society of Testing Materials
IEEE Standards	Institute of Electrical and Electronic Engineers
ICEA Standards	Insulated Cable Engineers Association
ISA Standards	International Society of Automation
NEMA Standards	National Electrical Manufacturers Association
NFPA Standards	National Fire Protection Association
NFPA 70	National Electrical Code (NEC)
OSHA Standards	Occupational Safety and Health Act

D. Definitions

1. General: The definitions of terminology used in these Specifications shall be defined in ISA Standard S51.1 unless otherwise specified.
2. Two-Wire Transmitter: A transducer which derives operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. As used in this Specification, two-wire transmitter refers to a transmitter which produces a 4 to 20 milliampere current regulated signal in a series circuit with a 24 volt direct current driving potential and a maximum circuit resistance of 600 ohms.
3. Four-Wire Transmitter: A transducer which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120 volt alternating current or 24 volt direct current input power supply.
4. Galvanic Isolation: Pertaining to an electrical node having no direct current path to another electrical node. As used in this Specification, galvanic isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.
5. Panel: An instrument support system which may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Panels may provide mechanical protection, electrical isolation, and protection from dust, dirt, and chemical contaminants which may be present in the atmosphere. Panel shall include consoles, cabinets and racks.
6. Data Sheets: Data sheets as used in this Specification shall refer to ISA S20.
7. Signal Types: The following types of signals are used in systems specified in this specification.
8. Signal Types: The following types of signals are used in systems specified in this division.
 - a. Low Level Analog: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.
 - b. Digital Code: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized and not those cases where the signal is modulated.
 - c. Pulse Frequency: Counting pulses such as those emitted from speed transmitters.
 - d. High Level Analog: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.
 - e. Discrete Events: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.
 - f. Low Voltage Control: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

- E. Identification of Listed Products: Process instrumentation and control system components shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.
1. When a product is not available with a testing laboratory listing for the purpose for which it is to serve the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.
- F. Symbols: Except as otherwise indicated, refer to the symbol legend on the Drawings for definitions of symbols used on the Drawings to show process instrumentation and control work.
- G. Drawings: The Drawings included in this project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. The Contractor, as part of his work, shall prepare detailed construction drawings as specified below.
1. General:
 - a. Drawings shall be prepared on 11-inch by 17-inch drafting media.
 - b. Drawings shall have borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing.
 - c. Each revision of a drawing shall carry a date and brief description of the revisions.
 - d. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers.
 2. Elementary and Loop Diagrams:
 - a. The Contractor shall provide elementary diagrams for all each control loop.
 - b. Loop diagrams shall be prepared in compliance with ISA S5.4 and shall be provided for all analog loops.
 - c. Elementary diagrams and loop diagrams shall show circuits and devices of a system. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system.
 - d. Elementary and loop diagrams shall also show wire numbers, wire color codes, signal polarities, and terminal block numbers.
 - e. Elementary and loop diagrams shall be completely and accurately documented and cross-referenced to similar drawings for other related systems such as motor control centers, equipment control panels, local control panels, field-mounted instruments, etc. All interfaces to remote systems shall include panel and /or equipment designations, wire numbers, and terminal designations.
 3. Connection Diagrams:
 - a. Connection diagrams for panels shall be provided by the Contractor.
 - b. Connection diagrams shall show components of a control panel in an arrangement similar to the actual layout of the panel.
 - c. Internal wiring between devices within the panel shall be shown on these diagrams.

- d. Connection diagrams shall show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such.
 - e. Connection diagrams shall indicate conductor insulation color code, signal polarities, and shall show wire numbers and terminal block numbers.
- 4. Interconnection Diagrams:
 - a. Interconnection diagrams shall be provided by the Contractor for field wiring.
 - b. Interconnection diagrams shall show each panel and all field devices.
 - c. Wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers shall be shown.
- 5. Panel Layout and Assembly Drawings:
 - a. Panel layout and assembly drawings shall provide dimensioned front and back panel equipment layouts and sections showing clearances between face and rear mounted equipment.
 - b. Drawings shall include a separate bill of materials for all panel components in each individual panel.
 - c. Drawings shall include PLC layout and configuration details, individual PLC module configuration switch settings, jumper positions, and final addressing of all communication network nodes.
 - d. Equipment shall be identified on all drawings and diagrams by a functional description and a cross reference to the bill of materials.
 - e. Drawings shall include a nameplate engraving schedule showing engraving by line, character size and font, and nameplate size.

1.05 SUBMITTALS

- A. General: Compliance submittals shall be prepared and submitted in accordance with the Conditions of Contract, Division 01 Specification Sections, and this specification section. The types of submittals required for electrical work are defined herein. Refer to each Division 40 specification section for detailed requirements for submittal content. Administrative submittals are specified elsewhere in the Contract Documents.
- B. Electronic Submittals: Each submittal shall be prepared as an electronic file and shall be prepared in accordance with the following requirements.
 - 1. Each submittal shall be an electronic file in the Portable Document Format (PDF). The latest version of Adobe Acrobat or Bluebeam available at the time of execution of the Agreement shall be used in preparation of the submittals.
 - 2. PDF files shall be created from the native digital form of the document. Scanned images are not acceptable.
 - a. Materials not available in original digital format shall be scanned into digital format and cleaned to remove smudges, fingerprints, artifacts, and other extraneous marks. All scanned documents shall be processed by an optical character recognition (OCR) application to make the document searchable. The original scanned image shall be retained with the file.
 - b. Text shall be searchable and shall appear and paginated as it would in hardcopy.
 - 3. Submittals shall be organized with internal bookmarking using the bookmarking utility. Bookmarking within the document shall be organized as follows:

- a. Each section and individual documents within each section shall be bookmarked.
 - b. Each manufacturer's manual, catalog, or other published document shall be bookmarked using the title of the document.
 - c. Contractor-prepared forms such as transmittal forms, motor data forms, and the like shall be bookmarked.
 - d. Bookmarks shall be organized in a hierarchical structure as required to represent the purpose of the individual documents and their association to each other.
 - e. Documents representing specific pieces of equipment such as performance curves and analyses, motor characteristics, dimension, and assembly drawings, etc., shall be organized and bookmarked for each piece of equipment.
 - f. Bookmarks shall be collapsed to the top level bookmarks and be visible when the file is opened.
 - g. Bookmarks zoom level shall be set to "Fit Page".
 - 4. PDF files shall be set to open with the following Initial View settings:
 - a. Navigation Tab: Bookmarks Panel and Page.
 - b. Page Layout: Single Page.
 - c. Magnification: Fit Page.
 - 5. General information shall be added to each PDF file including title, subject, author, and keywords.
 - 6. PDF files submitted for review may be secured; however, the following actions within Adobe Acrobat shall be permitted by the reviewer.
 - a. Printing.
 - b. Content copying or extraction.
 - c. Content copying for accessibility.
 - d. Commenting.
 - 7. PDF files submitted as final documents shall be unsecured, unencrypted, and not password protected.
 - 8. PDF files shall be configured to print legibly at either 8-1/2 inch x 11-inch or 11-inch by 17-inch paper sizes. No other paper sizes shall be permitted.
 - 9. New electronic files shall be prepared for each resubmittal.
 - 10. Each electronic submittal shall also include a copy of the Contractor's transmittal form.
 - 11. Contractor authorizes the Engineer to reproduce and/or redistribute each file as many times as necessary for the project.
- C. Content: Compliance submittals shall include the following information.
- 1. Elementary and loop diagrams.
 - 2. Connection and interconnection diagrams.
 - 3. Panel layout and assembly drawings.
 - 4. Instrument data sheets each process instrument in accordance with ISA S20.
 - 5. Manufacturer's product data for all specified equipment.

- a. Product data shall include catalog cuts, technical specifications, and application information.
 - b. Product data shall be edited to indicate on those items, model, or series of equipment which are being proposed. All extraneous materials shall be crossed out or otherwise obliterated.
 - c. Product data shall include information to interpret the complete model number of the equipment or system represented by the submittal
 - 6. Sizing calculations or power budgets for all power supply and conditioning equipment. Calculations shall address both watt and volt-ampere components of the demand load. All assumptions made regarding load size or demand factor shall be clearly stated.
 - 7. Sizing calculations for enclosure heating and ventilation systems.
 - 8. Test procedure documentation.
 - 9. Specification Conformance: Each electrical submittal shall include a copy of the applicable specification section, inclusive of all addendum updates, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
- D. Partial, incomplete or illegible submittals or submittals not formatted in accordance with the specification requirements will be returned to the Contractor without review for re-submittal.
- E. Re-Submittals: Each resubmittal shall include the Contractor's written response to the previous submittal review comments. Contractor's written response shall include the original review comment directly followed by the Contractor's response to that comment. The Contractor's response shall describe how the issue pertaining to the review comment has been addressed in the re-submittal.

1.06 INSTRUCTION MANUALS

- A. General: Submittals shall be in accordance with Conditions of Contract and Division 01 Specification Sections and the requirements of this specification section. Instruction manuals shall be submitted complete prior to commencing any training; partial or incomplete data shall not be accepted.
- B. Electronic Submittals: In addition to the requirements of the Conditions of Contract and Division 01 Specification Sections, an electronic version of each instruction manual shall be prepared and submitted as work of the Contract. Electronic submittals shall be prepared in accordance with specification 40 61 00-1.05 B.
- C. Content: Instruction manuals shall include the following information.

1. Contact Information: Instruction Manuals shall include the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts.
2. Manufacturer's Product Warranties: Manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits.
3. User Manuals: The written instructions by the manufacturer, fabricator, or installer of equipment or systems, detailing the procedures to be followed by the Owner in configuration, operation, control, and shutdown of each operating item of the equipment or system.
4. Maintenance Manuals: The compiled information provided for the Owner's maintenance and troubleshooting of each system of operating equipment, including lubrication, emergency control, parts replacement, spare parts inventory recommendation, listing of tools and accessories needed for maintenance, and similar instructions.
5. Guarantees: The Contractor's specific signed commitment (including countersignature by others as required) to the Owner that acts of restitution will be performed when and if electrical work fails within certain operational conditions and time limits.
6. Certifications: Written statements, either standard printed forms or specifically prepared text, executed specifically for the project application by an authorized officer of the contracting firm, manufacturer, or other firm as designated, certifying the equipment installation, configuration, and startup is in compliance with the manufacturer's recommendations and the project requirements.
7. Test Reports: The results of all specified factory and field tests shall be included with the instruction manuals.
8. Startup Reports: Equipment manufacturer's field startup reports shall be included with the instruction manuals.
9. Configuration Data: A written record documenting the setup and configuration of each system that is software, hardware, or firmware configurable in the field shall be included in the instruction manual. All configuration parameters including those left in the factory default state, jumpers, switch settings, etc., shall be recorded.
10. As-Built Control Wiring Diagrams and Assembly Drawings: As-built control diagrams and assembly drawings shall be provided in appropriately sized slant D-ring binders. Drawings shall not be folded or otherwise reduced in size for assembly in the instruction manual binder. As-built drawings shall be organized by facility or location in separate binders or with section dividers in a single binder.

1.07 PROJECT/SITE CONDITIONS

- A. Environmental Conditions: Refer to Section 01 81 16 for information regarding environmental conditions for the project.

1.08 STORAGE, DELIVERY, AND HANDLING OF MATERIALS AND EQUIPMENT

- A. Delivery: Deliver electrical materials and equipment properly packaged. Utilize factory fabricated containers or wrappings for materials and equipment which protect materials and equipment from damage. Inspect materials and equipment to ensure that no damage has occurred during shipment.

- B. Storage: Store electrical materials and equipment indoors in original packaging in areas specifically designated for equipment storage. Protect equipment and materials from construction traffic and debris.
- C. Handling: Handle electrical materials and equipment carefully to prevent physical damage to materials and equipment. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which could damage the materials and equipment contained therein. Do not install damaged materials or equipment; remove from site and replace damaged materials and equipment with new.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions in which equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and equipment properly packaged. Utilize factory fabricated containers or wrappings for materials and equipment which protect materials and equipment from damage. All process control and instrumentation systems and equipment shall be stored in a clean, dry, temperature-controlled location. Inspect materials and equipment to ensure that no damage has occurred during shipment.
- B. Store materials and equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
- C. Handle materials and equipment carefully to prevent physical damage to materials and equipment. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which could damage the materials and equipment contained therein. Do not install damaged materials or equipment; remove from site and replace damaged materials and equipment with new.

3.03 INSTALLATION

- A. General: Equipment shall be located so that it is readily accessible for operation and maintenance. Where installation procedures are not specified herein, applicable ISA standards shall be used as a guide.
- B. Sensitive electronic equipment shall not be installed until all construction activities that result in the production of any air borne matter such as dust, dirt, paint, etc., are completed. Such

equipment includes, but not by way of limitation, programmable logic controllers, DC power supplies, uninterruptible power supplies, and network hardware.

C. Field Equipment:

1. Equipment shall be provided as specified on the Drawings such that ports and adjustments are accessible for in-place testing and calibration equipment.
2. Where possible, equipment shall be located between 48 inches and 60 inches above the floor or a permanent work platform.
3. Instrumentation equipment shall be mounted for unobstructed access, but mounting shall not obstruct walkways.
4. Equipment shall not be mounted where shock or vibration will impair its operation.
5. Support systems shall not be attached to handrails, process piping or mechanical equipment except for measuring elements and valve positioners.
6. Cabinets and enclosures supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between enclosure and wall.

D. Support Systems: Support systems shall be constructed of materials complying with specification 26 05 29. Support systems, including panels, shall be designed in accordance with Uniform Building Code for the applicable seismic zone and to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

E. Electrical Connections:

1. General: Electric power wiring and equipment shall be in compliance with Division 26.
2. Signal Connections: Electric signal connections to equipment shall be made on terminal blocks or by locking plug and receptacle assemblies.

F. Signal Transmission:

1. Analog Signals: Signal transmission between electric or electronic instruments shall be 4 to 20 milliamperes and shall operate at 24 volts DC unless otherwise specified.
 - a. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.
 - b. Measurement loops shall be grounded at external terminals by bonding to the instrument panel signal ground bus.
 - c. The Contractor shall provide isolating amplifiers for field equipment possessing a grounded input or output.
2. Discrete Signals: Relay or switch contact configurations shall be as follows:
 - a. Alarms: Contact outputs used for alarm initiation shall be normally closed and shall open to initiate the alarm.
 - b. Control: Contact outputs used to control equipment shall be normally open and shall close to initiate equipment operation.
 - c. Status: Contact outputs used to indicate equipment operating status shall be normally open and shall close to indicate the active (run, ready, etc.) status.

3.04 HOUSEKEEPING

- A. General: Process instrumentation and control equipment shall be protected from dust, water, and damage during the construction period.
- B. Remove all construction debris, packing materials, shipping labels, etc., from the interior and exterior of the equipment.
- C. Clean exterior surfaces of equipment of all construction debris and markings and leave the equipment in an unblemished condition.
- D. Touch-up scratched or marred surfaces to match original finish.
- E. Clean or replace all equipment filters in accordance with the manufacturer's instructions.

3.05 ADJUSTING

- A. Adjust operating mechanisms, enclosure doors, etc., for free mechanical movement.

END OF SECTION

SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies the acceptance testing of the process control and instrumentation systems including the graphical operator interface, programmable logic controllers, process instrumentation and ancillary support equipment and systems. Contractor shall provide all labor, tools, material, power and other services necessary to provide the specified tests.
- B. Requirements for testing in accordance with this section are specified in this and other sections of Division 40. Where testing in accordance with this section is required, the required tests, including correction of defects where found, and subsequent retesting, shall be completed prior to commissioning any equipment or systems.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 40 61 00.
 - 1. Test procedure documentation report.
 - 2. Examples of test report forms for all specified tests.
 - 3. Sample inspection deficiency report.
 - 4. Listing of instruments to be factory calibrated.
 - 5. Final test report.
 - 6. Instrument technician certification.
 - 7. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT AND MATERIALS

- A. General: Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

PART 3 EXECUTION

3.01 GENERAL

- A. All process instrumentation and control system testing shall be conducted by the installing contractor and shall be performed in strict conformance with the process instrumentation and control systems test procedures. The process instrumentation and control test procedures shall be developed by the installing contractor in accordance with the requirements of this specification and approved by the Construction Manager. The types of equipment and/or systems to be inspected and tested shall be as specified herein
- B. Materials, equipment, and systems included as work of the Division 40 specifications shall be inspected and tested by the Contractor as specified herein.
- C. Observation: The Construction Manager reserves the right to observe all testing activities. The Contractor shall notify the Construction Manager five (5) days prior to commencing any testing activities.

3.02 TECHNICIAN QUALIFICATIONS

- A. Contractor-Commissioned Instruments: Contractor-commissioned instruments shall be configured, calibrated, and tested on site by an instrument technician who, by virtue of attendance at an acceptable control systems technician certification or training program is qualified to commission that instrument. Acceptable training shall include successful completion of the instrument manufacturer's training course, certification through The Instrumentation, Systems, and Automation Society Certified Control Systems Technician program, or evidence of 10 or more years of relevant experience. Evidence of certification shall be submitted as specified in paragraph 40 61 21-1.3.
- B. Manufacturer-Commissioned Instruments: Manufacturer-commissioned instruments shall be configured, calibrated, and tested by the instrument manufacturer or its authorized representative.

3.03 DOCUMENTATION

- A. Test Procedures
 - 1. Test procedures shall be fully developed by the Contractor and submitted to the Construction Manager for approval no later than 180 days from the date of Notice to Proceed. A written report shall be prepared which details the test procedures for each analog and discrete loop in the process control system. The test procedure documentation report shall be organized and assembled in separate volumes for each process area or facility.
 - 2. Test procedure documentation shall include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for point(s) of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions. Test report forms for each loop, including forms

for wiring, piping, and individual component tests, shall be included with the test procedure documentation. The actual test results shall be recorded on these forms and a final test report assembled as specified in paragraph 40 61 21-3.10.

- B. Test Report Forms: Test report forms which appropriately and completely address field test procedures shall include, but not by way of limitation, the following information. Test report forms shall be preprinted and completed to the extent possible prior to commencing testing.

1. Project name.
2. Process area or facility associated with the equipment under test.
3. Instrument/loop description.
4. Instrument/loop identification number.
5. Instrument nameplate data.
6. Instrument setup and configuration parameters.
7. Time and date of test.
8. Inspection checklist and results.
9. Reference to applicable test procedure.
10. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
11. Test equipment used.
12. Space for remarks regarding test procedure or results, unusual or noteworthy observations, etc.
13. Name and signature of testing personnel.
14. Name and signature of test witness.

3.04 PERFORMANCE DEVIATION TOLERANCES

- A. Tolerances shall be determined from applicable contract requirements. Where tolerances are not specified, they shall be determined from manufacturer's published performance specifications. Overall accuracy requirements for loops consisting of two or more components shall be the root-summation-square (RSS) of the individual component accuracy specifications. Tolerances for each required calibration point shall be calculated and recorded on the associated test report form.

3.05 FACTORY-CERTIFIED TEST REPORTS

- A. Where field calibration is not feasible, certified instrumentation calibration reports may be submitted for field calibration reports subject to the prior written approval of the Construction Manager. A request to submit certified calibration reports in lieu of field calibration reports shall include the name and address of the laboratory selected to conduct the calibration testing and a detailed description of the field test and inspection activities which will be performed to supplement off-site calibration activities in order to insure proper installation and freedom from damage subsequent to the off-site calibration. Field test and inspection activities shall include verification of instrument parameter setup, verification of instrument zero, and verification of operation at three operating points within the instrument range.

- B. Certified test reports may be submitted for the following instrument types in lieu of field calibration:

<u>Instrument Type</u>	<u>Description</u>
FM (Section 40 71 00)	Magnetic flow metering system

- C. No further range adjustments (zero and span) or parameter adjustment shall be permitted on instruments accepted as off-site calibrated. Any instrument which fails to demonstrate proper performance or is adjusted in the field shall be returned for re-calibration.

3.06 TEST EQUIPMENT AND MATERIALS

A. General

1. Contractor shall provide all test equipment required to conduct the specified tests.
2. Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test.
3. Each test instrument shall have a current calibration sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Certified calibration reports traceable to the National Institute of Standards and Technology shall be included with the final test report.

- B. Buffer/Reference Solutions: The Contractor shall provide buffer solutions and reference fluids required for all tests of analytical equipment.

3.07 FIELD TESTS AND INSPECTION PROCEDURES

- A. Inspection and Test Sequence: Inspection and test procedures shall be conducted in the following sequence. Successful completion of each activity shall be required prior to proceeding to the subsequent activity. Each instrument loop shall be tested in the following sequence:

1. Wiring and piping tests
2. Inspection
3. Individual component test
4. Loop test
5. Functional checkout

- B. Piping Testing: Pneumatic and instrument piping systems shall be tested for leaks in compliance with ISA RP7.1, except that the test shall be performed at ten times the normal system operating pressure.

- C. Wiring Testing: Wiring tests shall be conducted in accordance with specification 26 08 00. Wiring tests shall not be conducted until cables have been properly terminated, tagged and inspected.

- D. Inspection: Each component of the process control and instrumentation system shall be inspected for conformance with this specification and applicable industry standards. All instruments and system components shall be inspected including instruments approved for off-site calibration. Inspection activities shall include the following:

1. Compare and validate instrument type and nameplate data with the drawings, specifications, and data sheet.
2. Validate instrument identification tag.

3. Confirm instrument installation conforms to the drawings and specifications and manufacturer's instructions.
4. Verify proper conductor termination and tagging.
5. Visually inspect for signs of physical damage, dirt accumulation and corrosion.
6. Verify that all applicable ancillary devices including isolation amplifiers, surge protection, and safety barriers have been provided and properly installed.
7. All deficiencies identified as a result of the inspection procedures shall be recorded on the inspection deficiency form and reported to the Construction Manager within 24 hours of discovery. No instrument or system component shall be tested until all deficiencies are addressed.

E. Individual Component Calibration and Test

1. Each receiving and transmitting instrument including programmable logic controller input/output and fieldbus subsystems and final elements shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test form. Alarm trips, control trips, and switches shall be set to initial values specified in the Instrument Schedules.
2. The calibration of each process instrument shall be tested at 0, 10, 50, 90, and 100 percent of its specified full scale range. Each signal sensing trip and process sensing switch shall be adjusted to the required setting. All test data shall be recorded on test forms in compliance with this specification.
 - a. Pressure instrument calibration shall be tested shall be tested by applying a calibrated pressure source.
 - b. Level instrument calibration shall be tested by physically simulating the process media level.
 - c. Magnetic flow metering system operation shall be tested utilizing the flow meters output signal simulation feature.
3. Final element alignment shall be tested and adjusted to verify that each final element operates smoothly over its range in response to the specified process control signals.
4. The output configuration of process switches and similar digital signal devices shall be verified to comply with the requirements of specification 40 61 00.
5. Any component which fails to meet the specified tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.
6. A calibration sticker shall be placed on each instrument following successful calibration. The calibration sticker shall indicate the date of calibration and the name of the testing company and personnel who calibrated the instrument.

F. Loop Test

1. Each instrument and control loop shall be tested as an integrated system. This test shall check operation from the field device or signal source to all receiving components or final elements within the loop and verification of the data handling functions through the process control system programmable logic controllers. Signals shall be injected at the signal connection to primary measuring elements or signal source.
2. Testing of loops which include an interface to a programmable logic controller shall include verification of the programmable logic controller input/output assignment and

verification of operation of the input/output system and processor. The appropriate data table or register in the programmable logic controller memory shall be inspected and manipulated (in the case of output functions) to verify proper operation of these systems. The Contractor shall be responsible for any programmable logic controller programming and/or configuration required to support the loop testing activities.

3. The normal operating state of all programmable logic controller digital input circuits shall be verified to comply with the configuration requirements specified.
 4. If any output device fails to indicate properly, corrections to the loop circuitry shall be made as necessary and the test repeated until all instruments operate properly
- G. Functional Checkout: Functional testing shall be conducted to verify the operation of the process control system including hardwire interlocks and control circuits. Checkout shall consist of exercising all operator interface functions including the field control stations and energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs.

3.08 POWER CONDITIONING EQUIPMENT TESTS

- A. General: Power conditioning systems shall be tested in accordance with the manufacturer's instructions to demonstrate proper operation. In addition, power conditioning system tests shall include a functional checkout of the equipment to verify the operational integrity of all system controls, indicators, and input/output signals. The input and output voltages shall be measured both unloaded and under system load.
- B. Uninterruptible Power Supply (UPS) Systems: UPS systems shall be tested in both the line and battery mode. UPS system output voltage and current shall be recorded in the battery mode of operation at 10-minute intervals for the duration that the UPS system supports the connected load or one hour (maximum). All test results shall comply with manufacturer's specifications.
- C. Test Results: The test results shall be recorded and submitted with the final test report.

3.09 EQUIPMENT TESTING

- A. General: The inspection and test procedures described herein shall establish the minimum requirements for process instrumentation and control system equipment and component inspection and testing. Additional testing required by the equipment manufacturer for proper installation and commissioning of the process control and instrumentation system shall be conducted by the Contractor at no additional cost to the Owner.
- B. Equipment/Instrument Commissioning and Testing
1. Contractor-Commissioned Equipment and Instruments: The following types of equipment and/or systems shall be commissioned and tested by the Contractor:
 - a. Process variable transmitters.
 - b. Process switches.
 - c. Signal conditioning modules.
 - d. Power conditioning equipment.
 - e. Programmable automation controllers including all input/output subsystems and communications modules.

2. Manufacturer-Commissioned Equipment and Instruments: The following types of equipment and/or systems shall be commissioned and tested by the equipment/instrument manufacturer.
 - a. Water quality analyzers.

3.10 FINAL TEST REPORT

- A. General: The final test report(s) shall be submitted to the Construction Manager in accordance with paragraph 40 61 21-1.03 A. Final test report(s) shall be assembled in a 3-ring binder and submitted at the completion of the inspection and testing activities for a process area or facility. Binder cover and spine shall be labeled to identify the project name and process area or facility. Test report shall include all applicable test procedures for the process area, the completed inspection and test report forms associated with the equipment and systems of that area, and the final instrument setup and configuration parameter listing. Test results shall be organized by equipment item or system with individual, labeled tab dividers to identify each. All system deficiencies and non-compliant test results identified in the final test report shall be acknowledged by the responsible testing entity as corrected. All electronic calibration files shall be submitted with the final test report.

END OF SECTION

SECTION 40 63 43

PROGRAMMABLE LOGIC CONTROLLERS (PLC)

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. Supplement A, PLC System Configuration Summaries, appended to the end of this Section.

1.02 SUMMARY

- A. General: This section specifies general requirements for Programmable Logic Controllers (PLC). The Contractor shall furnish and install the PLC equipment, and accessories as indicated on the Drawings and as specified herein.
- B. Supplement A, PLC System Configuration Summaries: General requirements for PLC systems shall be as specified by the PLC System Configuration Summaries, Supplement A.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Section 40 70 00.
- B. List of system components by location.
- C. Product data for the PLC and any component equipment, including the following:
 - 1. PAC information
 - a. Memory
 - b. Input/Output (I/O) capacity
 - c. Nonvolatile program and data retention
 - 2. I/O Modules information
 - a. Type and rating
 - b. Standard wiring diagrams
- D. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with

justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Quality assurance requirements as specified in Section 40 70 00.
- B. Codes and Standards
 - 1. UL Compliance: All components of the PLC system shall be UL listed and approved.
 - 2. ODVA Conformance: PLC shall be conformance tested to EtherNet/IP specifications.
- C. Single Manufacturer: PLC system components shall be from a single manufacturer.
 - 1. Only communication modules for communication or network media functions that are not provided by the PLC manufacturer may be produced by third-party sources.
 - 2. Only PLC manufacturer-approved hardware, including cables, mounting hardware, connectors, enclosures, racks, communication cables, splitters, terminators, taps, and removable media, may be used.
- D. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of PLCs with other components of the facility process control system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. PLC components shall be delivered in packaging designed to prevent damage from static electricity and physical damage.
- B. PLC components shall be stored in accordance with PLC manufacturer requirements and in a clean and dry space at an ambient temperature range of 32°C to 40°C.
- C. PLC components shall be protected from exposure to dirt, water, fumes, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. PLC systems shall be from the Allen-Bradley CompactLogix 5380 family of programmable automation controllers or approved equivalent.

2.02 GENERAL

- A. Each PLC system shall be configured as indicated on the Drawings and as specified herein.
 - 1. PLC systems shall include all system components required for a complete, fully functional PLC system including processors, I/O systems, power supplies, racks, communication interfaces, and all power and communication interface cabling.
 - 2. The PLC shall be of a slot-mount design permitting application versatility, flexibility, and expandability through the use of modular hardware components.
 - 3. Future expansion of the control application shall be easily accommodated by the PLC through the addition of I/O modules, memory, and user programming modifications.

4. All PLC component modules shall be interchangeable with modules of like function.
- B. System Configuration: The configuration of each PLC system shall be as described by the respective PLC configuration summary.

2.03 SPARE PARTS

- A. General: Provide the following PLC components as spare parts.
 - 1.
- B. Delivery: Spare parts shall be delivered to the Construction Manager in the manufacturer's sealed packaging within ninety (90) days of acceptance of applicable submittal data.

PART 3 EXECUTION

3.01 INSTALLATION

- A. PLC systems shall be installed in control panels in accordance with specification 40 67 00.
- B. PLC installation shall conform to all manufacturer's recommended installation practices including cooling clearances, wiring, and grounding.

3.02 PLC PROGRAMMING AND CONFIGURATION STANDARDS

A. Standard Practices and Criteria

1. General
 - a. PLCs shall be used to provide automatic control, alarm detection, and continuous loop control.
 - b. All data scaling, control routines, algorithms, and alarm generation shall be implemented in the PLC system, i.e., not in the HMI.
2. PAC Name
 - a. PLCs shall be named in accordance with the process area served and shall identify the type of controller.
3. Programming Language: Ladder diagram only.
4. Firmware Version: The PLC firmware version used for each project shall be the most recent release unless otherwise directed by the Owner.

B. Tag Organization and Naming

1. Organization
 - a. User-defined data types (UDT) shall be utilized to the extent practicable to organize the tags related by equipment type, process, function, utility, etc. into a single tag structure.
2. Tag Naming Guidelines
 - a. Tag names shall consist of application specific terms that readily associate the tag with the process data represented by the tag.
 - b. Terms used in tag names shall be consistently applied throughout the project.

- c. Tag names shall include the associated equipment tag number where applicable.
 - d. Separate the equipment tag number from the tag description with an underscore.
 - e. Use all capital letters in equipment tag number prefixes.
 - f. Use upper case in the first letter of each word that makes up the tag name description (UpperCamelCase).
 - g. Abbreviations shall be permitted to comply with the tag name character limit; abbreviations shall be documented and consistently applied.
3. User Defined Tags (UDT)
- a. Members of a UDT shall be arranged to promote efficient use of controller resources and communication bandwidth, i.e., group Boolean data types together whenever possible.

C. Program Code Organization and Structure

- 1. General
 - a. Task, Program and Routine Naming Conventions: The names of tasks, programs, and routines shall describe the primary purpose or function in appropriate terms.
- 2. Tasks
 - a. Configuration:
 - 1) All tasks should be configured as periodic type.
 - 2) The default continuous task should be deleted to improve system performance and predictability of CPU resources for system communications.
 - 3) The number of tasks should be kept to a minimum. Tasks that are not required by the application shall be deleted.
- 3. Routines
 - a. Routines shall be grouped within programs by associated process or function.
 - b. Use routines to organize the program code into logical, manageable sections.
 - c. Routine names should clearly describe the process or function associated with the routine.
 - d. Each program shall have a designated main routine named "MainRoutine" and shall be used primarily for program control.
 - e. Use a name prefix such as "_sub" to identify routines that may be called multiple times from multiple locations versus those routines that are only called from the main routine.
- 4. Logical Organizer
 - a. The Logical Organizer shall be utilized to arrange the controller programs into a structure that resembles the logical flow of the process as well as into units of code that are associated by function.
- 5. Ladder Programming Guidelines
 - a. Limit the number of instructions and branches in a rung to make inspection of the rung manageable in both the ladder editor and in printed form.
 - b. Divide large complex rungs into multiple smaller rungs.

D. Code Commenting and Annotation

1. General

- a. Descriptions and comments shall utilize nomenclature and terminology that is consistent with the water and wastewater industry as well as any associated construction documents.
- b. Abbreviations shall not be used without prior approval with the exception of engineering unit abbreviations which may be used.

2. Tasks, Programs, and Routines, Description Property

- a. Provide a brief functional description on the Properties dialog for each task, program, and routine.

3. Routines

- a. General: Complete grammatically-correct sentences shall be utilized in the development of routine and rung comments.
- b. Routine Comment: Provide a NOP (No Operation) instruction as the first rung of each routine. This rung shall include a comment that describes the intention and function of the routine. The routine comment shall include the following:
 - 1) Routine name or title.
 - 2) Detailed description of the function of the routine.
 - 3) If the routine application is process control, the comment shall include a description of the process and its intended operation.
 - 4) Where multiple control modes are provided each shall be described in the comment.
 - 5) Description of each input parameter, if any.
- c. Section Marker: Section markers shall be used to identify the beginning of a block of rungs that are all related to a common function, e.g., pump staging, pump 1 control, etc. Section markers shall be highlighted with a continuous top and bottom border consisting of "equal sign" characters.
- d. Rung Comment: Each rung shall be provided with a comment that describes the function of the rung. Additional information shall be provided if the rung includes any of the following:
 - 1) Equations: Where a rung includes a CPT (compute) or similar instruction where multiple variables and/or constants are used, the rung shall include a representation of the equation using standard math operators and a description of each variable and constant and the associated engineering units of each.

4. Tags

- a. General:
 - 1) A description shall be provided for all tags.
- b. Analog
 - 1) Provide a description of the analog variable represented by the tag.
 - 2) If the variable represents the value of different states, each state value shall be defined in the description, e.g., HOA switch function (0-Off, 1-Hand, 2-Auto).

- c. Discrete (Boolean)
 - 1) Provide a description of the condition represented by the tag.
 - 2) The on and off state labels and the associated tag value shall be included in the description. See the following example.

Sodium Hypochlorite
 Chemical Feed System
 - Potable Water
 Disinfection Pump
 Ready
 (0-Not Ready,
 1-Ready)
 SodiumHypochlorite_PotableWater.MP8319.Ready

5. Add-On Instructions
 - a. Documentation within an add-on instruction logic shall be the same as that defined for Routines.
 - b. Add-on instructions shall be provided with a full description in the Extended Description Text field of the instruction Help definition. The Extended Description Text shall include a functional description of the instruction and each parameter. If Prescan or Postscan routines are required for the add-on instruction, a functional description of each shall also be included in the Help definition.
 - c. Provide meaningful descriptions for each Parameter of the add-on instruction.

E. Common PLC Functions

1. General: The following identifies common PLC logic functions that are required to be present in every PLC system. Routines or add-on instructions shall be developed to implement these functions. The following list identifies each function and the associated features.
 - a. PLC Health
 - 1) Purpose: Monitor the PLC system and component health for reporting to the HMI.
 - 2) Application: All PLC systems.
 - 3) Features:
 - a) Detection and reporting of the following conditions:
 - (1) Processor status conditions including run, fault, and program modes.
 - b) Processor fault conditions including minor and major faults.
 - c) Processor key switch position.
 - d) Processor energy storage module status.
 - e) Processor LED status.
 - b. Fault Handler
 - 1) Purpose: Detect and clear PLC major faults as appropriate for the application.

- 2) Features:
- 3) Log fault type and time stamp.
- 4) Log the number of times a fault occurs and is automatically handled.
- c. PLC Processor Clock Management
 - 1) Purpose: Synchronize the processor clock with the system's designated master clock.
 - 2) Application: All PLC systems.
 - 3) Features:
 - a) Automatic synchronization of the processor clock.
 - b) Conversion of the process clock data to a controller-scoped tag for reporting to the HMI.
- d. Analog Data Processing
 - 1) Purpose: Manage process data derived from process instruments.
 - 2) Application: Analog data derived from analog and fieldbus process variable transmitters shall be processed as described.
 - 3) Features:
 - a) Enable/disable channel.
 - b) Scaling raw data to engineering units.
 - c) Alarm detection and management:
 - (1) Adjustable thresholds for high-high, high, low, and low-low conditions and adjustable validation time delays for each condition.
 - (2) Adjustable alarm threshold validity limits with limit violation detection and annunciation.
 - (3) Range limit violation detection.
 - (4) Fail value override to force the current value of the process variable to an adjustable value to mitigate process disturbances upon detection of a module fault condition.
 - (5) Forced return-to-zero with adjustable threshold.
 - (6) Calibration hold with excessive hold time alarm.
 - (7) Input channel data including PLC name, rack, slot, and channel assignment for reporting to the HMI.
- e. Equipment Runtime
 - 1) Purpose: Generate runtime data for any equipment for which run status is monitored.
 - 2) Application: Runtime data shall be generated for all rotating equipment for which its run status is monitored by the control system.
 - 3) Features:
 - a) Runtime accumulators.

- (1) Daily: Runtime accumulated during a 24 hour period from midnight to midnight with a precision of 0.1 hours. Maintain daily runtime accumulators for current day and previous day.
 - (2) Maintenance: Manually resettable runtime accumulator with a precision of 1 hour to facilitate scheduling maintenance activities.
 - (3) Non-Resettable: Runtime accumulated since the equipment was put into service. Resettable through the PAC programming software only. Provide a precision of 1 hour.
- f. Fail to Operate
- 1) Purpose: Detect and annunciate equipment fail to run and fail to stop alarm conditions.
 - 2) Application: Automatically-controlled equipment shall be monitored for these alarm conditions.
 - 3) Features:
 - a) Adjustable fail detection time setting.
 - b) Detect both fail to run and fail to stop conditions.
- g. Fail to Position
- 1) Purpose: Detect and annunciate a valve failure to reach its commanded position.
 - 2) Application: All automatically-controlled valve actuators shall be monitored for these alarm conditions.
 - 3) Features:
 - a) Adjustable position target deadband.
 - b) Fail detection time based on valve travel time.
- h. Flow Totalization
- 1) Purpose: Manage flow total data generated by each flow transmitter.
 - 2) Application: Control and manage the flow totalizer functions provided by the fieldbus flow transmitter.
 - a) Features:
 - (1) Selectable totalizer units.
 - (2) Totalizer reset with the following functions:
 - (a) Selectable reset interval – hourly, daily, weekly, monthly, yearly.
 - (b) Selectable reset hour.
 - (c) Selectable reset day.
 - (3) Totalizer hold.
 - (4) Record totalizer previous period value.

F. Add-On Instructions

1. General: Add-on instructions shall be used where appropriate to standardize the logic, interface, and documentation for commonly-used functions.

G. Peer-to-Peer PLC Communications

1. Produced and consumed tags shall be used for peer-to-peer PLC communications. Produced and consumed tag arrays shall be developed for this purpose.
 - a. Produced Tag Arrays: Data intended to be communicated to other PLC systems shall be moved to the appropriate produced tag array so it is available to any PLC that subscribes to that produced tag array.
 - 1) Produced tag arrays shall be created for both real and integer data.
 - 2) Produced Integer Tag Properties:
 - a) Name: ProducedInteger
 - b) Description: Produced Integer Tag Array
 - c) Connection: 5 Max Consumers
 - d) Data Type (UDT): ProdCon_Integer
 - (1) Connection Status Tag
 - (2) Double integer array (50 elements minimum)
 - e) External Access: Read/Write
 - 3) Produced Real Tag Properties:
 - a) Name: ProducedReal
 - b) Description: Produced Real Tag Array
 - c) Connection: 5 Max Consumers
 - d) Data Type (UDT): ProdCon_Real
 - (1) Connection Status Tag
 - (2) Real array (50 elements minimum)
 - e) External Access: Read/Write
 - b. Consumed Tag Arrays: When a PLC requires data from another PLC for use in a related process control function, a consumed tag shall be created. The consumed tag shall subscribe to the produced tag that contains the required data.
 - 1) Consumed tag arrays shall be created as necessary for both real and integer data.
 - 2) Consumed Integer Tag Properties:
 - a) Name: ConsumedInteger_*HostPLCName*
 - b) Description: Consumed Integer Tag Array – *HostPLCName*
 - c) Connection, RPI: 100 ms
 - d) Data Type (UDT): ProdCon_Integer
 - (1) Connection Status Tag
 - (2) Double integer array (50 elements minimum)
 - e) External Access: Read/Write

- 3) Consumed Real Tag Properties:
 - a) Name: ConsumedReal_*HostPLCName*
 - b) Description: Consumed Real Tag Array - *HostPLCName*
 - c) Connection, RPI: 100 ms
 - d) Data Type (UDT): ProdCon_Real
 - (1) Connection Status Tag
 - (2) Real array (50 elements minimum)
- 4) External Access: Read/Write

3.03 SUPPLEMENTS

- A. Supplement A, PLC Configuration Summaries: The following PLC configuration summaries are included in Supplement A.
 - 1. Table 40 63 43 A.1, PLC9000 PLC System Configuration Summary.
- B. PLC Configuration Summaries: The PLC Configuration Summaries, appended to the end of this specification section, provide a listing of the required PLC system components and assigned input/output points for the specified PLC system.
 - 1. Hardware Configuration Table Entries: The entries in the Hardware Configuration Table identify the major system components required for each PLC system as well as other information pertinent to the configuration of each PLC system.
 - 2. Input/Output Summary Table Entries: The entries in the PLC Input/Output Summary tables are defined as follows.
 - a. Signal: Tag number for the input/output signal.
 - b. Description: Description of the input/output signal.
 - c. Circuit Termination/Device: Identifies the device to which the associated signal circuit is terminated.
 - d. Circuit Termination/Location: Identifies the location of the device to which the associated signal circuit is terminated.
 - e. Signal Type: Identifies the type of signal.
 - f. Notes: Provides additional reference information as necessary.

END OF SECTION

Table 40 63 43-A.1
CPLX9000 PLC System Configuration Summary

Hardware Configuration				
General		Manufacturer	Model No.	Notes
Designation:	CPLX9000			
Location:	LCP 9000			
PLC Type (RE: Specification 40 63 43):	1	Rockwell Automation	5069-L320ER	CompactLogix 5380 Controller
Chassis Size:	NA	Rockwell Automation	NA	
Power Supply:	24 Volt DC	Rockwell Automation		
Slot Number	Module Description	Manufacturer	Model No.	Notes
1	Analog Input Module, 8 Channel	Rockwell Automation	5069-IF8	
2	Digital AC Input Module, 16 Point	Rockwell Automation	5069-IA16	
3	Digital AC Input Module, 16 Point	Rockwell Automation	5069-IA16	
4	Digital DC Input Module, 16 Point	Rockwell Automation	5069-IB16	
5	Digital DC Output Module, 8 Point	Rockwell Automation	5069-OB8	

Table 40 63 43-A.1
CPLX9000 PLC System Configuration Summary

Input/Output Summary					
Signal	Description	Circuit Termination		Signal Type	Notes
		Device	Location		
FY-3430	Backwash Supply Flow	FIT 3430	Backwash Supply Pump Station	Analog Input	
FY-4270	Plant Water Flow	FIT 4270	Pretreatment Area	Analog Input	
LY-3440	Backwash Supply Tank Level	LIT 3440	Backwash Supply Pump Station	Analog Input	
LY-8401	NaOH Storage Tank 1 Level	LIT 8401	Chemical Room	Analog Input	
LY-8501	ACH Storage Tank 1 Level	LIT 8501	Chemical Room	Analog Input	
PY-3750	Plant Air System Pressure	PIT 3750	Filter Area	Analog Input	
TY-8401	NaOH Storage Tank 1 Temperature	TT 8401	Chemical Room	Analog Input	
FYH-9331	Emergency Eyewash/Shower Flow	FSH 9331	Chemical Room	Digital Input - AC	
LLA-9200a	Standby Generator Fuel Level Low	GEN 9200	Yard	Digital Input - AC	
LLA-9200b	Standby Generator Fuel Level Critically Low	GEN 9200	Yard	Digital Input - AC	
TLA-1101	Chemical Room Makeup Air Unit Supply Air Temperature	MAU 1101	Roof	Digital Input - AC	
TLA-1110	Electrical Room Rooftop Unit Supply Air Temperature	RTU 1110	Roof	Digital Input - AC	
TLA-1121	Filter Area Rooftop Unit Supply Air Temperature	RTU 1121	Roof	Digital Input - AC	
TLA-1122	Pretreatment Area Rooftop Unit Supply Air Temperature	RTU 1122	Roof	Digital Input - AC	
YA-1101a	Chemical Room Makeup Air Unit General Alarm	MAU 1101	Roof	Digital Input - AC	
YA-1110	Electrical Room Rooftop Unit General Alarm	RTU 1110	Roof	Digital Input - AC	
YA-1121	Filter Area Rooftop Unit General Alarm	RTU 1121	Roof	Digital Input - AC	

Table 40 63 43-A.1
CPLX9000 PLC System Configuration Summary

Input/Output Summary					
Signal	Description	Circuit Termination		Signal Type	Notes
		Device	Location		
YA-1122	Pretreatment Area Rooftop Unit General Alarm	RTU 1122	Roof	Digital Input - AC	
YA-9000r	Motor Control Center Surge Protective Device Fault	SPD 9000	MCC9000	Digital Input - AC	
YA-9000s	Transfer Switch General Fault	ATS 9000	Electrical Room	Digital Input - AC	
YA-9200a	Standby Generator General Fault	GEN 9200	Yard	Digital Input - AC	
YA-9200b	Standby Generator Fuel Leak Detection	GEN 9200	Yard	Digital Input - AC	
YA-9200c	Standby Generator Battery Charger Trouble	GEN 9200	Yard	Digital Input - AC	
YY-1101	Chemical Room Makeup Air Unit Air Flow Status	MAU 1101	Roof	Digital Input - AC	
YY-1110	Electrical Rooftop Unit Air Flow Status	RTU 1110	Roof	Digital Input - AC	
YY-1121	Filter Area Rooftop Unit Air Flow Status	RTU 1121	Roof	Digital Input - AC	
YY-1122	Pretreatment Area Rooftop Unit Air Flow Status	RTU 1122	Roof	Digital Input - AC	
YY-9000a	Transfer Switch - Utility Power Status	ATS 9000	Electrical Room	Digital Input - AC	
YY-9000b	Transfer Switch - Emergency Power Status	ATS 9000	Electrical Room	Digital Input - AC	
YY-9000c	Transfer Switch - Standby Generator Engine Cooldown	ATS 9000	Electrical Room	Digital Input - AC	
YY-9000e	Transfer Switch Utility Circuit Breaker ARM Status	ATS 9000	Electrical Room	Digital Input - AC	
YY-9200a	Standby Generator Run Status	GEN 9200	Yard	Digital Input - AC	
YY-9200b	Standby Generator Automatic Control Mode Status	GEN 9200	Yard	Digital Input - AC	
YY-9330	Eyewash/Shower Tempered Water Heater Priority Control	WH 9330	Chemical Room	Digital Input - AC	

Table 40 63 43-A.1
CPLX9000 PLC System Configuration Summary

Input/Output Summary					
Signal	Description	Circuit Termination		Signal Type	Notes
		Device	Location		
ZY-9000a	Transfer Switch Position - Utility	ATS 9000	Electrical Room	Digital Input - AC	
ZY-9000b	Transfer Switch Position - Emergency	ATS 9000	Electrical Room	Digital Input - AC	
ZY-9000c	Transfer Switch Automatic Control Mode Status	ATS 9000	Electrical Room	Digital Input - AC	
ZYL-3401	Backwash Water Supply Tank Fill Control Valve Position	CV 3401	Pretreatment Area	Digital Input - AC	
YA-9000a	Bulk DC Power Supply A Fault	DCPS-9000-BULK-A	LCP 9000	Digital Input - DC	
YA-9000b	Bulk DC Power Supply B Fault	DCPS-9000-BULK-A	LCP 9000	Digital Input - DC	
YA-9000c	Bulk DC Power Redundancy Module Operating Status	DCRM-9000-BULK	LCP 9000	Digital Input - DC	
YA-9000d	Bulk DC Power Redundancy Module Current Balance	DCRM-9000-BULK	LCP 9000	Digital Input - DC	
YA-9000e	PLC Mod DC Power Supply A Fault	DCPS-9000-MOD-A	LCP 9000	Digital Input - DC	
YA-9000f	PLC Mod DC Power Supply B Fault	DCPS-9000-MOD-B	LCP 9000	Digital Input - DC	
YA-9000g	PLC Mod DC Power Redundancy Module Operating Status	DCRM-9000-MOD	LCP 9000	Digital Input - DC	
YA-9000h	PLC Mod DC Power Redundancy Module Current Balance	DCRM-9000-MOD	LCP 9000	Digital Input - DC	
YA-9000i	PLC SA DC Power Supply A Fault	DCPS-9000-SA-A	LCP 9000	Digital Input - DC	
YA-9000j	PLC SA DC Power Supply B Fault	DCPS-9000-SA-B	LCP 9000	Digital Input - DC	
YA-9000k	PLC SA DC Power Redundancy Module Operating Status	DCRM-9000-SA	LCP 9000	Digital Input - DC	
YA-9000l	PLC SA DC Power Redundancy Module Current Balance	DCRM-9000-SA	LCP 9000	Digital Input - DC	
YA-9000m	LCP9000 UPS System Operating Status	UPS-9000	LCP 9000	Digital Input - DC	

Table 40 63 43-A.1
CPLX9000 PLC System Configuration Summary

Input/Output Summary					
Signal	Description	Circuit Termination		Signal Type	Notes
		Device	Location		
YA-9000n	LCP9000 UPS System Fault	UPS-9000	LCP 9000	Digital Input - DC	
YA-9000p	LCP9000 UPS System Battery Voltage Low	UPS-9000	LCP 9000	Digital Input - DC	
YA-9000q	LCP9000 Surge Filter Fault	SF-9000	LCP 9000	Digital Input - DC	
ZC-3401	Backwash Water Supply Tank Fill Control Valve	CV 3401	Pretreatment Area	Digital Output	

SECTION 40 66 13

NETWORK AND COMMUNICATION EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. Supplement A, Network Switch Summary, appended to the end of this Section.

1.02 SUMMARY

- A. General: This section specifies general requirements for network hardware including active components such as ethernet switches and passive components such as cable management systems, data outlets, etc. The Contractor shall furnish and install the network and communication equipment, and accessories as indicated on the Drawings and as specified herein.
- B. Supplement A, Network Switch Summary: General requirements for network switches shall be as specified by the Network Switch Summary, Supplement A.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Section 40 70 00.
- B. List of system components by location.
- C. Product data for all specified equipment.
- D. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Quality assurance requirements as specified in Section 40 70 00.
- B. Codes and Standards

1. UL Compliance: All network and communication equipment shall be UL listed and approved.
 2. ODVA Conformance: Provide EtherNet/IP network system components that have been conformance tested in accordance with ODVA requirements and manufactured by companies that have been authorized to use ODVA technology and are compliant with the applicable ODVA Terms of Usage Agreement(s).
- C. Single Manufacturer: Network switches shall be from a single manufacturer.
- D. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of network switches with other components of the facility process control system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Network and communication equipment shall be delivered in packaging designed to prevent damage from static electricity and physical damage.
- B. Network and communication equipment shall be stored in accordance with the manufacturer's requirements and in a clean and dry space at an ambient temperature range of 32°C to 40°C.
- C. Network and communication equipment shall be protected from exposure to dirt, water, fumes, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Network switches shall be from the Allen-Bradley Stratix family of ethernet network switches or approved equivalent.

2.02 ETHERNET NETWORK SWITCHES

- A. Type 1, Managed Industrial Network Switch: Industrial network switch shall be IEEE 802.3 compliant managed switch and shall fully support EtherNet/IP protocols. Switches shall be designed for DIN rail mounting and housed in an industrial enclosure. Switch shall have the following features:
1. Ethernet Data Rate: 10/100 Mbps.
 2. Power Supply: 12 to 48 volt DC.
 3. Diagnostic indicators for port status (link status and data rate) and switch status (power, switch status, and fiber optic uplink status).
 4. Removable Secure Digital memory card to facilitate device replacement.
 5. Switch shall be supported by an Add-on Profile to integrate the switch into the process control system PLC programming environment.
 6. Port type and count shall be as specified below:
 - a. Type 1: Switch shall have full-featured Layer 2 firmware. Switch port configuration shall include eighteen (18) 10/100/1000BASE-TX full/half duplex RJ45 copper ports and two (2) gigabit ethernet combination ports (user selectable RJ45 or SFP media types). Switch shall be equipped with a 1000 Base-SX multimode transceiver module where scheduled in Table 40 66 13-A.

Switch shall be as manufactured by Rockwell Automation, Stratix 5200, Catalog Number 1783-CMS20DP or approved equivalent.

- b. Type 2: Switch shall have Layer 2 firmware. Switch port configuration shall include eighteen (18) 10/100BASE-TX full/half duplex RJ45 copper ports and two (2) gigabit ethernet combination ports (user selectable RJ45 or SFP media types). Switch shall be as manufactured by Rockwell Automation, Stratix 5200, Catalog Number 1783-CMS20DB or approved equivalent.
- c. Type 3: Switch shall have Layer 2 firmware. Switch port configuration shall include eight (8) 10/100BASE-TX full/half duplex RJ45 copper ports and two (2) gigabit ethernet combination ports (user selectable RJ45 or SFP media types). Switch shall be as manufactured by Rockwell Automation, Stratix 5200, Catalog Number 1783-CMS10B or approved equivalent.

2.03 ETHERNET PATCH PANELS:

- A. Modular DIN-Rail Mounted Patch Panels: Patch panels shall be modular network media termination panels consisting of an aluminum chassis suitable for mounting on a 35-mm DIN rail and a mix of media termination modules to accommodate both fiber optic and copper cables. Patch panel chassis shall accommodate a maximum of six (6) single-width modules, three (3) double-width modules, or an equivalent combination of the two. Patch panel shall be as manufactured by Belden, Model MIPP or approved equivalent.
 - 1. Fiber Optic Cable Modules: Fiber optic cable termination modules shall have single mode, LC type duplex adapters. Termination modules shall accommodate twelve (12) fiber connections in a single width module. Fiber optic termination modules shall include a splice tray and management fingers and have top and bottom cable entry points with integral cable gland strain relief.
 - 2. Copper Cable Modules: Copper cable termination modules shall have four (4) Category 6 RJ-45 keystone jacks in a single width module. Jacks shall be shielded or unshielded as required to accommodate the cable type served by the jack.
 - 3. Configuration: Patch panels shall be fitted with the number and type of termination modules required for each application described on the Drawings. Each patch panel chassis shall be assembled with one (1) spare module mounting slot fitted with a blind module.

2.04 SPARE PARTS

- A. General: Provide the following network communication components as spare parts.
 - 1. One (1) Type 1 Ethernet network switch.
 - 2. One (1) of each type SFP module used on the project.
- B. Delivery: Spare parts shall be delivered to the Construction Manager in the manufacturer's sealed packaging prior to plant commissioning and startup.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Network switches shall be installed in control panels in accordance with specification 40 67 00.

- B. Network switch installation shall conform to all manufacturer's recommended installation practices including cooling clearances, wiring, and grounding.

3.02 SUPPLEMENTS

- A. Supplement A, Ethernet Network Switch Summaries: The following switch configuration summaries are included in Supplement A.
 - 1. Table 40 66 13 A.1, Ethernet Network Switch Summary.
- B. Ethernet Network Switch Summaries: The network switch summaries, appended to the end of this specification section, provide a listing of the required network switches.
 - 1. Hardware Configuration Table Entries: The entries in the Hardware Configuration Table identify the major system components required for each PLC system as well as other information pertinent to the configuration of each PLC system.
 - 2. Input/Output Summary Table Entries: The entries in the PLC Input/Output Summary tables are defined as follows.
 - a. Switch Number: Unique equipment tag number assigned to the switch.
 - b. Description: General description of the switch.
 - c. Type: Switch type referenced to this specification.
 - d. Number of Ports:
 - 1) Copper: Number of RJ45 copper ports.
 - 2) Combo: Number of combination type ports.
 - e. Fiber Optic SFP Modules: Quantity and type of SFP modules to be furnished with the switch.
 - 1) FEMM: 100 Mbps, multimode fiber.
 - f. Location: Designation of the panel in which the switch is to be installed.

END OF SECTION

**Table 40 66 13-A.1
Ethernet Network Switch Summary**

Switch Number	Description	Type	Number of Ports		Fiber Optic SFP Modules (Qty/Type)	Location
			Copper	Combo		
SW-SCN9000	Managed Switch	1	18	2	1/FEMM	LCP 9000
SW-ION9000	Managed Switch	2	18	2		LCP 9000
SW-ION9100	Managed Switch	3	8	2		LCP 9100

SECTION 40 67 00

PANELS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 40 62 63, Operator Interface Terminals.
 - 2. Section 40 63 43, Programmable Logic Controllers.
 - 3. Section 40 66 36, Process Instrumentation Networks.
 - 4. Section 40 67 63, Power Supply and Conditioning Equipment.
- C. Panel Data Sheets appended to the end of this Specification.

1.02 SUMMARY

- A. This section specifies requirements for panels, cabinets, consoles, instrument backboards, and racks for instrumentation and communication equipment.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 40 61 00.
 - 1. Drawings in accordance with specification Section 40 61 00.
 - a. Panel layout and assembly drawings.
 - b. Interconnection and connection wiring diagrams.
 - 2. Nameplate engraving schedule showing engraving by line, character size, and nameplate size.
 - 3. Manufacturer's product data for all enclosure systems edited to indicate only those items, model or series of equipment that are being provided.
 - 4. Space heater sizing calculations.
 - 5. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the

identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of panels, enclosure, and console systems of types, sizes, and ratings required, whose products have in satisfactory use in similar service for not less than 10 years.
- B. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. TIA/EIA Compliance: Provide components that comply with the following TIA/EIA standards:
 - a. TIA/EIA RS-310-C - Racks, Panels, and Associated Equipment
 - 3. ISA Compliance: Provide components that comply with the following standards:
 - a. ISA RP60.11 - Guide to the Available Methods for Control Center Crating, Shipping and Handling
 - 4. NEMA Compliance: Provide components that comply with the following standards:
 - a. NEMA 250 - Enclosures for Electrical Equipment
 - 5. UL Compliance: Comply with requirements of UL and UL standards pertaining to control panels and consoles. Provide products that have been UL listed and labeled.
 - a. Control panels shall bear a UL 508 label.
 - 6. NFPA Compliance: Control panel construction shall be in full compliance with the requirements of NFPA 70, Article 409.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Panels shall be shipped, protected, and stored in accordance with the requirements of this specification and the applicable requirements of ISA RP60.11.
- B. Shipping: Panels shall be shipped in Type 2S general purpose, humidity protected crates as defined by ISA RP60.11. Panels shall be prepared for shipment in accordance with ISA RP60.11, paragraphs 5.2 and 5.3. All sensitive electronic components, including programmable logic controller components, with the exception of input/output chassis, shall be removed from panels and shipped separately in accordance with manufacturer's instructions.
- C. Storage: Store panels in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
- D. Handling: Handle equipment carefully to prevent damage, breaking, and scoring of finishes. Do not install damage units or components; replace with new.

PART 2 PRODUCTS

2.01 GENERAL

A. Types: The following types of panels are specified:

Type	Fabrication
Open	Open panel with instruments, interconnections, and accessories surface mounted.
1	Fully enclosed, wall mounted enclosure with lift off screw cover. NEMA 1 sealing rating.
2	Panel with face mounted instruments flush or semi-flush mounted. Panel rear is not enclosed.
3	Fully enclosed unit with face-mounted instruments flush or semi-flush mounted on the front surface. Free-standing panel configuration may include rear access door(s) for interior mounted instruments and equipment.
4	Fully enclosed unit with front access only and face mounted instruments, door mounted or as required, mounted on an interior hinged subpanel. NEMA 4 sealing rating.
4X	Same as Type 4 except provided with corrosion resistant and water tight construction. 316 Stainless Steel construction for damp/wet locations. NEMA 4X sealing rating.
5	Fully enclosed, freestanding unit with front access only with interior mounted equipment and instruments.
6	Fully enclosed, freestanding unit with front access only and integrated electronic-type equipment rack.
12	Fully enclosed unit with front access only and face mounted instruments, door mounted or as required, mounted on an interior hinged subpanel. NEMA 12 sealing rating.

B. Panel Design: Instrumentation and control panels shall be complete pre-wired integrated instrument and control stations with the required operator interface functions as detailed on the Drawings and ancillary equipment as specified herein. Panel size and equipment layout requirements shall be as specified herein and as indicated on the Drawings.

C. Power Distribution

1. Each process control cabinet and console shall be provided with DIN rail mounted circuit breakers on each incoming branch circuit serving the cabinet. DIN rail mounted circuit breakers shall also be provided for each 120-volt AC power branch circuit derived from the cabinet power distribution system and serving equipment either within the cabinet or external to the cabinet. Circuit breakers shall be sized in accordance with the National Electrical Code and shall be 3 ampere minimum for instrument loads and 15 ampere minimum for receptacle, ventilation, and lighting loads. Individual branch breakers shall be provided for the following types of equipment:
 - a. Programmable logic controller systems. Provide an individual circuit breaker for each programmable logic controller system power supply.
 - b. Bulk DC power supplies
 - c. Communication hardware
 - d. Operator interface stations
 - e. Internal or external computer hardware

- f. External control panels or stations, power metering systems, or other process control system related equipment served by the process control cabinet power distribution system.
 - g. Internal and external receptacle or plug strip circuits.
 - h. 120 volts AC field instruments (individual circuit breaker for each instrument unless indicated otherwise)
 - i. Cabinet lighting and ventilation systems
 - 2. Each cabinet shall be provided with the following spare circuit breakers:
 - a. One spare 15 ampere, single pole breaker and one spare 3 ampere, single pole breaker both connected to the uninterruptible power supply (UPS) power distribution bus.
 - b. One spare 15 ampere, single pole breaker connected to the utility power distribution bus.
 - 3. 120-volt AC duplex receptacles for installation in control panels shall be suitable for DIN rail mounting with an integral terminal strip.
 - a. Receptacles installed on utility circuits shall have integral surge protection.
 - b. Receptacles installed on uninterruptible power supply system circuits shall have an isolated ground and be of orange color.
 - c. Receptacles shall be Phoenix Contact, EM-DUO or approved equivalent.
 - 4. Type 6 electronic equipment cabinets shall be provided with receptacles for distribution of 120-volt AC power to all plug and cord connected equipment located within the cabinet. Provide one spare unused duplex receptacle connected to the UPS power distribution system and one spare unused duplex receptacle connected to the utility power distribution within each cabinet.
- D. Power Supplies: Each panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified in Section 40 67 63.

2.02 FABRICATION

A. General

- 1. Panel work shall be designed for the seismic requirements as defined by the International Building Code. Structures and equipment shall be braced to prevent damage from specified forces. Equipment shall not be required to function properly during periods of seismic disturbance but shall be capable of manual restart following a disturbance.
- 2. Cutouts for future equipment shall be blanked off with suitable covers. Instruments shall be mounted in a manner that allows ease of access to components and ease of removal.
- 3. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4-ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
- 4. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons.
- 5. Cabinets less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform or, if panel weighs less than 100 pounds and wall space is available, wall mounting may be used in lieu of a floor stand.

6. All equipment mounted within or on panels shall be identified by function and loop number where applicable. Identification labels shall be installed on the panel interior adjacent to the equipment and an identical label installed on the equipment itself. Nameplates shall be provided for all face-mounted instruments. Instruments shall be mounted in a manner that allows complete access to all components for inspection, calibration, troubleshooting, and removal.
 7. Anodized aluminum blanking panels with natural finish shall be provided to close all unused space on 19-inch rack mounting systems. All rack-mounted equipment shall be provided with telescoping slide rails to facilitate access to rear of equipment.
- B. Open Type Fabrication
1. Aluminum: Panels shall be aluminum plate, ASTM B209 6063 alloy, 3/8-inch thickness. Plates over 2 feet in any dimension shall be braced with 1-1/2-inch aluminum angles for rigidity.
 2. Non-Metallic: Non-metallic panels shall be of fiberglass reinforced plastic (FRP) or high-density polyethylene (HDPE) structural sheet stock. Color shall be gray. Front panel edge shall be chamfered.
 3. Equipment shall be surface mounted on the panel's front face. All equipment, piping, tubing, and appurtenances shall be secured to the panel in a manner which permits removal and replacement without disturbing the support systems or requiring access to the rear of the panel.
 4. Mounting hardware shall be type 316 stainless steel.
 5. U-channel mounting systems shall be FRP construction.
 6. Wiring shall be carried in rigid metal conduit with cast fittings.
- C. Type 1 Fabrication: Panel shall be NEMA 250, Type 1 painted sheet steel enclosure with lift-off screw cover. Panel shall have mounting holes in the back of the enclosure and provisions for grounding. Perforated back panels shall be provided for equipment mounting.
- D. Type 2 Fabrication: Panels shall be fabricated from 3/16-inch minimum thickness stretcher leveled sheet steel. Leading and adjoining edges shall be constructed with 2-inch turnbacks with formed radii not less than twice the material thickness. Panels shall be provided with structural steel frame to provide a rigid structure.
- E. Type 3 Fabrication: Cabinet shall be a NEMA 250, Type 1 enclosure. Cabinet shall be fabricated from stretcher leveled sheet steel. Sheet steel for cabinet doors and body shall be 16 gauge minimum for cabinets with no dimension greater than or equal to 20 inches and 14 gauge for cabinets with any dimension greater than 20 inches. Cabinet shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Cabinets shall be provided with equipment mounting back panels and a 12-inch by 12-inch by 1-inch data pocket. Door(s) shall be hung on removable pin hinges and equipped with vault-type latch capable of accepting a 3/8-inch-shackle padlock. Three-point latch hardware shall be provided for doors exceeding 30 inches height. Where cabinet width exceeds 36 inches, multiple doors no wider than 24 inches shall be provided.
- F. Type 4 Fabrication: Cabinet shall be a NEMA 250, Type 4 enclosure fabricated from stretcher leveled sheet steel. Sheet steel for cabinet doors and body shall be 16 gauge minimum for cabinets with no dimension greater than or equal to 20 inches and 14 gauge for cabinets with any dimension greater than 20 inches. Cabinets shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Face-mounted instruments shall be mounted in the door. Arrangement of face-mounted instruments shall be as detailed on the Drawings. Cabinet

shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Cabinets shall be provided with equipment mounting back panels and a 12-inch by 12-inch by 1-inch data pocket. Doors shall be hung on full-length piano-type hinges and equipped with vault-type latch capable of accepting a 3/8-inch-shackle padlock. Three-point latch hardware shall be provided for doors exceeding 30 inches height. Door width shall not exceed 30 inches.

G. Type 4X Fabrication

1. Stainless Steel: Type 4X cabinet shall comply with NEMA 250, Type 4X enclosure fabricated from type 316 or 304 stainless steel. Cabinet doors and body shall be 16 gauge minimum for cabinets with no dimension greater than or equal to 20 inches and shall be 14 gauge for cabinets with any dimension greater than 20 inches. Cabinets shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Where face-mounted instruments are specified, they shall be mounted in the door or on an interior hinged subpanel arranged to swing completely out of the enclosure. Arrangement of face-mounted instruments shall be as detailed on the Drawings. Cabinets shall be provided with equipment mounting back panels and a 12-inch by 12-inch by 1-inch data pocket. Hinges shall be full-length piano-type. Subpanel, when specified, shall be provided with quarter-turn screw type latches. Cabinet door shall be provided with stainless steel door clamps with quick-release mechanisms and a key-locking vault type latch. Door width shall not exceed 36 inches, unless otherwise noted.
2. Polycarbonate: Type 4X cabinet shall comply with NEMA 250, Type 4X enclosure, fabricated from high impact, UV resistant polycarbonate. Enclosure body shall have molded internal pads for mounting panels and other components. Enclosure shall have a hinged clear polycarbonate cover with seamless gasket and quick release polycarbonate latches. Enclosure shall be equipped with an unpainted equipment mounting back panel. Enclosure color shall be light gray with a smooth gloss finish.

H. Type 5 Fabrication

1. Type 5 cabinet shall comply with NEMA 250, Type 12 requirements. Cabinet shall be totally enclosed with front door(s), removable side panels, and equipment mounting panels as indicated on the Drawings. Cabinets shall be of formed and welded construction utilizing a pre-punched, roll-formed or multi-fold frame profile system to form a rigid assembly. Cabinet enclosure shall be of sheet steel construction. Rear wall and top shall be of 14-gauge construction. Side walls shall be removable and shall be of 16-gauge construction. Front door(s) shall be of 14-gauge construction and shall be provided with reversible, concealed 140 degree pinned hinges and lever-type handle and key-locking insert. Doors shall have a foamed-in perimeter gasket to form the NEMA 12 sealing rating. Rear equipment mounting panel shall be of 12-gauge construction. Mounting panels shall be set forward from the rear of the panel and provided with panel joining pieces to provide a continuous equipment mounting panel between adjacent cabinet sections. Each cabinet shall be provided with 3-part bottom panels with gasketed cable entry system and a 4-inch high plinth with removable front and side panels. Cabinets shall be provided with a 12-inch by 12-inch by 1-inch data pocket.
2. Type 5 cabinets shall be provided with the following accessories and support systems:
 - a. Interior enclosure light fixture with door-activated switch in each cabinet section.
 - b. Forced air ventilation system consisting of pagoda-type 120 volts AC fan, replaceable filters, and thermostat.
 - c. Power distribution system as specified in paragraph 40 67 00-2.01 C.
3. Dimensions:
 - a. Height: 2200 mm

- b. Depth: 800 mm
- c. Width: As indicated on the associated Panel Data Sheet.
- 4. Type 5 cabinets shall be provided with side cable entry cabinets where specified. Side cable entry cabinets shall be the full height and depth of the enclosure system and shall extend the width of the enclosure system by 10 inches. The side cable entry system shall mechanically attach to the enclosure system and maintain the NEMA sealing rating of the enclosure system. Solid top and bottom closure plates shall be provided to facilitate conduit terminations in the top of the cable entry cabinet.
- 5. Type 5 cabinet finish shall be dip-bath primed and powder coated. Finish color shall be manufacturer's standard.
- 6. Type 5 cabinets shall be assembled as indicated on the Drawings from the Hoffman Proline System, Rittal PS 4000 System or approved equivalent.

I. Type 6 Fabrication

- 1. Cabinet shall be totally enclosed with front door, removable side panels, aluminum 19-inch angles and rear equipment mounting panels as required to accommodate the rack-mounted and panel-mounted equipment indicated on the Drawings. Cabinet shall be include a 19-inch electronic-type rack in compliance with EIA RS-310C and shall be NEMA 250, Type 12. Cabinets shall be of formed and welded construction utilizing a pre-punched, roll-formed or multi-fold frame profile system to form a rigid assembly. Cabinet enclosure shall be of sheet steel construction. Rear wall and top shall be of 14-gauge construction. Side walls shall be removable and shall be of 14-gauge construction. Hinged side doors with lever-type handle and key-locking insert shall be provided where specified. Front door shall have an anodized, extruded aluminum frame and transparent acrylic glass viewing panel and shall be provided with reversible, concealed 140 degree pinned hinges and lever-type handle and key-locking insert. Doors shall have an integral glued seal to ensure the NEMA 12 sealing rating. Rear equipment mounting panel shall be of 12-gauge construction. Mounting panels shall be set forward from the rear of the panel and provided with panel joining pieces to provide a continuous equipment mounting panel between adjacent cabinet sections. Each cabinet shall be provided with 3-part bottom panels with gasketed cable entry system and a 4-inch high plinth with removable front and side panels unless otherwise noted. Cabinets shall be provided with a 12-inch by 12-inch by 1-inch data pocket.
- 2. Electronic equipment mounting racks shall be provided with telescoping slide rails for equipment installation and blanking panels and trim to cover unused mounting space.
- 3. Type 6 cabinets shall be provided with the following accessories and support systems:
 - a. Interior enclosure light fixture with door-activated switch in each cabinet section.
 - b. Forced air ventilation system consisting of fan top with 120 volts AC fans, replaceable filters, and thermostat.
 - c. Power distribution system as specified in paragraph 40 67 00-2.01 D.
 - d. Fixed shelves as required for mounting of desktop type equipment.
 - e. 18-inch-deep, fully extendable, telescoping solid shelf to provide support for portable diagnostic and programming equipment. Shelf shall be located 30 to 42 inches above finished floor. Blanking trim shall be provided above and below the shelf.
- 4. Dimensions:
 - a. Height: 2200 mm

- b. Depth: 800 mm
 - c. Width: As indicated on the associated Panel Data Sheet.
- 5. Type 5 cabinets shall be provided with side cable entry cabinets where specified. Side cable entry cabinets shall be the full height and depth of the enclosure system and shall extend the width of the enclosure system by 10 inches. The side cable entry system shall mechanically attach to the enclosure system and maintain the NEMA sealing rating of the enclosure system. Solid top and bottom closure plates shall be provided to facilitate conduit terminations in the top of the cable entry cabinet.
- 6. Type 6 cabinet finish shall be dip-bath primed and powder coated. Finish color shall be manufacturer's standard.
- 7. Type 6 cabinets shall be assembled as indicated on the Drawings from the Hoffman Proline System, Rittal PS 4000 System or approved equivalent.
- J. Type 12 Fabrication: Cabinet shall be a NEMA 250, Type 12 enclosure fabricated from stretcher leveled sheet steel. Sheet steel for cabinet doors and body shall be 16 gauge minimum for cabinets with no dimension greater than or equal to 20 inches and 14 gauge for cabinets with any dimension greater than 20 inches. Cabinets shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Face-mounted instruments shall be mounted in the door. Cabinets shall be provided with equipment mounting back and side panels as required and a 12-inch by 12-inch by 1-inch data pocket. Doors shall be hung on full-length piano-type hinges and equipped with vault-type latch capable of accepting a 3/8-inch-shackle padlock. Three-point latch hardware shall be provided for doors exceeding 30 inches height. Door width shall not exceed 30 inches.

2.03 HEATING AND VENTILATING

- A. Forced air ventilation shall be provided for cabinets types 5 and 6 as specified. All ventilation systems shall be provided with filtered intake grilles.
- B. Ventilation systems shall be provided with washable filters and provide at least 240 cfm. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units. Fans shall be suitable for operation at 120 volts AC. All ventilation systems shall be thermostatically controlled.
- C. Outdoor cabinets shall be provided with thermostatically controlled forced-air electric space heaters. Heaters shall be provided with integral thermostat. Space heaters shall be Hoffman, DAH Series or approved equivalent.

2.04 NAMEPLATES

- A. Panel Exterior: Machine engraved laminated white phenolic nameplates with black lettering shall be provided for all equipment panels. The nominal size of the nameplates shall be 3/4 inch high by 2 inches long. Nameplate engraving shall include the associated equipment description without abbreviation and the equipment tag number, if applicable, in 3/16-inch minimum size lettering. Nameplates shall be attached to the panel with epoxy based adhesive. The Contractor shall verify all nameplate wording prior to commencement of engraving or shall provide replacement labels at no cost to the Owner in the event that nameplate descriptions change.
- B. Panel Interior: Machine engraved laminated white phenolic nameplates with black lettering shall be applied on the interior of panels to identify tag number of instruments and equipment mounted inside panels and face-mounted in panel doors. Label engraving shall match the designations provided on the panel documentation. Nameplates shall be attached to panel surfaces, not to equipment or wire management systems without approval of the Construction Manager.

2.05 CONTROL RELAYS

- A. Load Switching Control Relays: Control relays used for switching loads (solenoids, actuators, contactors, motor starter coils, etc.) shall be general purpose, plug-in blade base type with a matching DIN-rail relay socket. Contacts shall, as a minimum, be 2-pole, double throw rated 10 amperes, 250-volt AC. Relays shall have LED indicator wired in parallel with coil to indicate relay status and a manual test button with fixed engagement. Relay coil voltage shall be as indicated on the Drawings. Relay socket shall have coil and contact connections on opposite sides of the base with a relay retaining bracket and labeling area. Relays shall be Phoenix Contact, PR2 Series, or approved equivalent.

2.06 INTERCONNECTION WIRING AND ELECTRICAL DEVICES

A. Interconnection Wiring

1. Power and control wiring shall be single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum.
2. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels. Wiring channels shall comply with UL 94, Type V and shall be 4" deep (minimum). Wiring channel fill shall not exceed 40 percent.
3. Wiring shall be tagged at terminations. Wire identification system shall be as specified in Section 26 05 53. Wire numbers shall consist of three parts. The prefix of the wire number shall be the instrument loop number. If an instrument loop number is not available, the lowest mechanical equipment number of all final drives in the circuit shall be used. Following the prefix shall be a code letter. The third part of the wire number shall be a number that identifies wires in a circuit that are electrically identical. Code letters and wire colors are given in the following tables:

120 Volt AC Wire Color Codes

<u>Code</u>	<u>Description</u>	<u>Color</u>
L	Power	Black
LU	Power (UPS)	Black w/red tracer
C	Control	Red
N	Neutral	White
PG	Ground	Green

24 Volt DC Wire Color Codes

<u>Code</u>	<u>Description</u>	<u>Color</u>
P+	Power Supply – Positive	Blue
P-	Power Supply – Common	White/Blue
PU+	UPS Power Supply – Positive	Orange
PU-	UPS Power Supply – Common	White/Orange
C	Control	Violet
S	Signal (positive)	Black
SG	Signal ground	White
PG	Equipment ground	Green

4. All conductors carrying a foreign voltage within a cabinet shall be yellow for AC circuits and yellow with blue tracer for DC circuits.

5. Wiring shall comply with the requirements of NFPA No. 70 as a minimum. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.
 6. All field wiring terminating within a panel shall be terminated on terminal blocks. Conductor termination preparation shall be as required to interface with the specified terminal block. Conductors terminating on compression-type terminals shall have the insulation removed to the wire strip length recommended by the terminal block manufacturer. Conductors terminating on strap/screw type terminal blocks shall be terminated with locking spade-type insulated, crimp-on lugs.
 7. Field connections shall be to separate, designated terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel.
 8. Circuits shall be fused. Fuses on 120-volt AC circuits shall be tube type with 25,000 amperes interrupting capacity at 125 volts and neon blown fuse indicator lamps. Fuses for 24-volt DC circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops. Fuse holders for 120-volt AC shall be draw out type and molded from melamine plastic.
- B. Programmable Logic Controller (PLC) Input/Output (I/O) Signal Circuits: Wiring between PLC I/O module wiring arms and the associated field terminal blocks shall be stranded copper 20 AWG minimum multiconductor cable assemblies. Each multiconductor cable shall have the number of conductors required to implement the wiring configuration indicated on the Drawings. A conductor count in excess of that required to implement the specified wiring configuration shall not be permitted. Cable assemblies for analog signal circuits shall have individually shielded and twisted triads for each input/output channel. There shall be one cable assembly to serve each PLC I/O module.
1. Analog I/O Signal Circuits: Analog I/O signal circuits shall be configured as specified in the PLC Configuration Summary tables appended to the end of Section 40 63 43. Analog input signal circuits shall be connected as either 2-wire (associated instrument power sourced from the signal circuit) or 4-wire (associated instrument power sourced from an external source).
 2. Digital I/O Signal Circuits: Digital I/O signal circuits shall be configured as specified in the PLC Configuration Summary tables appended to Section 40 63 43.

2.07 TERMINAL BLOCKS

- A. General: Unless otherwise shown or specified, terminal blocks shall be captive screw with pressure plate type rated 600 volts AC with dual center bridge shafts and shall be suitable for DIN rail mounting. Terminal blocks shall be feed-through type with three wiring compartments on each block. Terminal block type and application shall be as specified in the following table. Terminal blocks shall be Phoenix Contact, UT4 Twin or equivalent. Terminal block assemblies shall be complete including end caps, markers, insertion bridges, mounting hardware, etc. Terminal block marking shall be machine printed.

<u>Description</u>	<u>Type</u>	<u>Application</u>
Fused terminal block w/blown fuse LED indicator	UT4-HESILED24	Control power supply
Grounding terminal block	UT4-PE	Equipment ground conductor
Terminal block	UT4 TWIN	Control signal
Disconnect terminal block	UT4-MT	Analog signal circuits

- B. Assembly: Terminal block assembly shall be in accordance with the following:
1. Mounting Rail: Terminal blocks shall be assembled on aluminum "high rise" mounting rail. Terminal blocks shall be organized by function and provided with group markers to identify function or input/output module reference.
 2. Marking: Each terminal block and logical/functional groups of terminal blocks shall be provided with machine printed labels.
 3. Bridging: Insulated insertion bridges shall be utilized where indicated on the Drawings and to bridge common terminal blocks together without the use of jumper wiring. Insertion bridges shall be manufactured by the manufacturer of the terminal block. Insertion bridges shall be provided in continuous lengths up to fifty (50) position. Splicing shorter bridge lengths is not acceptable. Bridges shall be color coded to indicate function.

2.08 SURGE PROTECTION

- A. General: Surge protectors for panel applications shall be as specified in Section 40 67 63.
- B. Power Distribution: AC power filters shall be provided in each panel housing electronic equipment such as PLC systems, network and computer hardware, etc. AC power filters shall be provided on the branch circuit serving the equipment. Panel AC power distribution systems serving utility systems such as ventilation, lighting, and receptacles shall not require AC power filters.

2.09 PANEL LIGHT FIXTURES

- A. General: Panel light fixtures shall be LED, 120-volt AC fixtures designed for control panel applications. Light fixture shall magnetically attach to a flat steel surface. Each light fixture shall be furnished with an 80-inch power cable assembly including a mating connector on one end and a conductor pig tail on the other. Light fixtures shall be Hoffman, Model LEDA1M35 or approved equivalent.
1. Door Switch: Light fixtures shall be controlled by a door-activated switch. Switch shall be designed for mounting on the enclosure frame remote from the associated light fixture.

2.10 MOUNTING RAIL

- A. Standard: 35mm x 7.5mm symmetrical mounting rail of zinc-plated steel construction.
- B. High Rise Mounting Rail: 35mm x 7.5mm, 2.26 inches high mounting rail of copper-free aluminum construction.
- C. Mounting rail shall be provided in the lengths required for each application.

2.11 PANEL GROUNDING

- A. General: Each panel shall be provided with two copper ground bars. One bar shall be bonded to the panel frame or sheet metal and to the station ground system. The second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the frame ground bar at one point only. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar. In panel line-ups exceeding 30-inches width, ground bars shall be 1/4 by 1-inch copper bars extending the entire length of the panel.

- B. Cable Shield Ground Bar Assembly: Cable shield ground bar assembly shall consist of the following components as manufactured by Phoenix Contact or approved equivalent.
1. Tin-plated copper conductor bar.
 2. Conductor bar mounting brackets with integral retaining screw and conductive metal inlay for non-isolated installation on associated mounting surface.
 3. Shield clamps appropriately sized for each cable application.

2.12 ACCESSORIES

- A. Folding Shelf: Folding shelf shall be an 18" x 18" hinged steel horizontal work surface designed to be folded down when not in use. Shelf shall lock in the horizontal position. Shelf shall include a vertical component for mounting to a vertical surface. Folding shelf shall be as manufactured by Hoffman, Catalog Number ACSHELF18 or approved equivalent.
- B. Thru-Panel Ethernet Receptacle: Two-position receptacle assembly shall be industrial grade, Category 5e with an IP20 light duty sealing rating. Receptacle shall be equipped with two RJ45 socket-to-socket female inserts and an appropriate mounting frame for thru-panel mounting in the panel of an industrial enclosure. Connector shall be Phoenix Contact, PLUSCON VS-08 Series or approved equivalent.
- C. Utility Box: Plastic utility box with slide out drawer to store spare fuses within a control panel. Utility box shall mount on a 35 mm DIN rail and shall be as manufactured by Weidmuller, Part Number 7914760001, or approved equivalent.

PART 3 EXECUTION

3.01 GENERAL

- A. Examine areas and conditions under which panels, enclosures, and consoles are to be installed. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
- B. Coordinate console and enclosure installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- D. Install consoles and enclosures at the locations indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

3.02 INSTALLATION OF PANELS

- A. Control room cabinets shall be mounted on channel iron sills as specified. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in control rooms or electrical equipment rooms.

- B. Conduits shall be terminated on the sides and bottom of enclosures. Conduits shall not be installed in the top of the enclosure without approval of the Engineer.
- C. Conduits may be installed in the top of cable entry cabinets where provided for Type 5 and 6 modular enclosure systems.
- D. Free-standing panels in areas of new construction shall have all conduits terminated within the confines of the plinth base. All conductors shall be routed from the conduit system to the panel interior through the cable entry system in the panel bottom plate.
- E. Free-standing panels in areas of existing construction where bottom access is not readily available shall have all conduits terminate in the side panel of the enclosure. Conductors shall be routed from the conduit system to the field terminal block in plastic wiring channels.
- F. Floor-mounted cabinets except in control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases where indicated on the Drawings.
- G. Each panel shall have its record connection and interconnection diagrams provided in clear plastic envelope in the panel print pocket.
- H. All spare or otherwise unused programmable automation controller input/output channels shall be provided with interconnecting cabling to field terminal blocks.
- I. Type 6 panels and all associated equipment shall not be installed until all debris and dust producing construction activities are completed in the vicinity of the panel.
- J. Wall-Mounted Enclosures:
 - 1. Enclosure mounting height shall be 72 inches above finished floor to top of enclosure unless otherwise noted.
 - 2. Enclosure shall be mounted on u-channel supports or approved mounting brackets anchored to associated wall.

3.03 GROUNDING

- A. General: Provide equipment grounding connections to panels, enclosures, and consoles as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.04 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms and doors for free mechanical movement.
- B. Remove all construction markings and touch-up scratched or marred surfaces to match original finish.

3.05 PANEL ASSEMBLY AND CONFIGURATION

- A. General: Panel assemblies, including area control center cabinets, local control panels, and consoles shall be configured as specified below and as indicated on the Drawings. Specific configuration features, which may not be detailed on the Drawings, are identified below. In addition to the configuration requirements below, all ancillary equipment and utility systems shall be provided as specified for each type of assembly.

- B. Equipment Layout: Equipment layout within control panels shall be in accordance with the following:
1. Equipment of similar function shall be grouped together in common areas of the back panel. Equipment arrangement shall permit ready access to terminals, ports, adjustments, indicators, and nameplates to facilitate programming, setup, troubleshooting, and operation of the equipment without disassembly.
 2. Programmable automation controllers shall be located with spare mounting space to the right of the controller for future addition of input/output modules. Spare mounting space shall be the equivalent of 150 percent of the width of the controller.
 3. Equipment with integral batteries shall be located near the bottom of the control panel.
 4. Control panel interior layout shall include areas designated for conduit entry. Conduit entry locations shall be in the bottom panel or lower side panel of the enclosure near the field terminals. No conduit entry shall be permitted in the top panel of the enclosure.
 5. Field terminals shall be arranged in an area of the control panel separate from the fixed equipment. Provide 25 percent spare DIN rail mounting space for future input/output field terminal blocks.
 6. Door-mounted equipment shall be logically arranged by function. Each door mounted equipment item shall have a nameplate located above the equipment to identify the equipment.
 7. Folding shelves shall be mounted to provide a work surface height of 36 to 42 inches above finished floor. Shelves shall either be mounted to the enclosure door unless otherwise indicated.
 8. All terminal blocks shall be mounted on high rise DIN rail. All equipment with conductor terminals that would be less than 3 inches from the enclosure back mounting panel when mounted directly to the back panel, shall be mounted high rise DIN rail.
 9. Patch panels shall be provided to facilitate termination of all Ethernet horizontal station cables in control panels.

3.06 PANEL DATA SHEETS

- A. Panel data sheets are appended to the end of this section of the Specifications. Panel data sheets provide configuration and installation data and requirements pertinent to each panel.
- B. Panel data sheets are not provided for control stations.

END OF SECTION

PANEL DATA SHEET

PROJECT	Silt Water Treatment Plant	LOCATION	Electrical Room
OWNER	Town of Silt		
PANEL TYPE	Local Control Panel		
PANEL TAG NOS.	LCP9000		
DESCRIPTION	Local control panel serving the water treatment processes and supporting utilities.		

DOCUMENT REFERENCES			
PLAN DRAWING(S)	E-1105	WIRING DIAGRAM(S)	I-11, I-12
ONE-LINE DIAGRAM(S)	E-250	DETAIL(S)	I-10
		EQUIP SCHEDULE	I-10

PANEL/ENCLOSURE	
TYPE	Type 12
MOUNTING	Freestanding
DOORS	Double
DIMENSIONS	84"H x 78"W x 18"D
BACK PANEL	Conductive
	FOLDING SHELF <input checked="" type="checkbox"/>

POWER CONDITIONING	ENVIRONMENTAL CONTROLS
SURGE FILTER <input checked="" type="checkbox"/> 24 VDC POWER SUPPLY <input checked="" type="checkbox"/> TYPE Spec 40 67 63-2.02 A REDUNDANCY MODULE <input checked="" type="checkbox"/> UPS SYSTEM <input checked="" type="checkbox"/> TYPE Spec 40 67 63-2.03 A	LIGHTING <input checked="" type="checkbox"/> VENTILATION <input checked="" type="checkbox"/> HEAT <input type="checkbox"/>

PAC/PLC SYSTEM	
DESIGNATION CPLX9000 CONFIGURATION Table 40 63 43-A.1 <hr/> DESIGNATION CONFIGURATION	

SPECIAL FEATURES AND EQUIPMENT
<ol style="list-style-type: none"> 1. Folding shelf shall be mounted on the inside of the enclosure door at a height that positions the shelf 40 inches AFF when in the extended position. 2. Three individual redundant power supply systems are required. Refer to the referenced wiring diagrams. 3. Top entry conduits shall only be permitted in the top right panel of the enclosure. The shop drawings for this panel shall designate this location for top entry conduits. Conduit entries shall not be permitted in the top left panel over the electronic equipment.

PANEL DATA SHEET

PROJECT	Silt Water Treatment Plant	LOCATION	Process Area
OWNER	Town of Silt		
PANEL TYPE	Terminal Box		
PANEL TAG NOS.	TB3410, TB3420		
DESCRIPTION	Intermediate termination point for backwash supply pump motor moisture/temperature sensor cables.		

DOCUMENT REFERENCES			
PLAN DRAWING(S)	E-1102	WIRING DIAGRAM(S)	E-300A
ONE-LINE DIAGRAM(S)	E-201	DETAIL(S)	

PANEL/ENCLOSURE	
TYPE	Type 4, Painted Steel
MOUNTING	Surface, Wall
DOORS	Single
DIMENSIONS	10" x 10" x 6"
BACKPANEL	Conductive
FOLDING SHELF	<input type="checkbox"/>

POWER CONDITIONING	ENVIRONMENTAL CONTROLS
SURGE FILTER <input type="checkbox"/> 24 VDC POWER SUPPLY <input type="checkbox"/> TYPE <input style="width: 100%;" type="text"/> REDUNDANCY MODULE <input type="checkbox"/> UPS SYSTEM <input type="checkbox"/> TYPE <input style="width: 100%;" type="text"/>	LIGHTING <input type="checkbox"/> VENTILATION <input type="checkbox"/> HEAT <input type="checkbox"/>

PAC/PLC SYSTEM	PROFIBUS NETWORK HARDWARE
DESIGNATION <input style="width: 100%;" type="text"/> CONFIGURATION <input style="width: 100%;" type="text"/> OPERATOR INTERFACE <input style="width: 100%;" type="text"/>	SINGLE CHANNEL REPEATER <input type="checkbox"/> <input style="width: 100%;" type="text"/> MULTI-CHANNEL REPEATER <input type="checkbox"/> <input style="width: 100%;" type="text"/> COUPLER <input type="checkbox"/> <input style="width: 100%;" type="text"/> COUPLER DIAGNOSTIC MODULE <input type="checkbox"/> <input style="width: 100%;" type="text"/> COUPLER DIAGNOSTIC GATEWAY <input type="checkbox"/> <input style="width: 100%;" type="text"/> SEGMENT PROTECTOR <input type="checkbox"/> <input style="width: 100%;" type="text"/> ACTIVE TERMINATOR <input type="checkbox"/> <input style="width: 100%;" type="text"/> DRAWING REFERENCES: <input style="width: 100%;" type="text"/>

ETHERNET NETWORK HARDWARE
TYPE 1 SWITCH (SPEC 17150-2.2 A) <input style="width: 100%;" type="text"/> TYPE 2 SWITCH (SPEC 17150-2.2 B) <input style="width: 100%;" type="text"/>

SPECIAL FEATURES AND EQUIPMENT
<ol style="list-style-type: none"> 1. Provide terminal blocks to transition from pump motor moisture/temperature sensor cable to twisted shielded pair cable from the associated pump VFD. 2. Mount the terminal blocks on the righthand side of the backpanel to provide pass through space for the power feeder conductors.

PANEL DATA SHEET

PROJECT	Silt Water Treatment Plant	LOCATION	Exterior
OWNER	Town of Silt		
PANEL TYPE	Terminal Box		
PANEL TAG NOS.	NA		
DESCRIPTION	Power distribution terminal box serving the roof walkway heated mats and controller.		

DOCUMENT REFERENCES			
PLAN DRAWING(S)	E-1105	WIRING DIAGRAM(S)	E-303
ONE-LINE DIAGRAM(S)	NA	DETAIL(S)	

PANEL/ENCLOSURE	
TYPE	Type 4X, Stainless Steel
MOUNTING	Surface, Wall
DOORS	Single
DIMENSIONS	10" x 10" x 6"
BACKPANEL	Conductive
FOLDING SHELF	<input type="checkbox"/>

POWER CONDITIONING	ENVIRONMENTAL CONTROLS
SURGE FILTER <input type="checkbox"/> 24 VDC POWER SUPPLY <input type="checkbox"/> TYPE <input style="width: 150px;" type="text"/> REDUNDANCY MODULE <input type="checkbox"/> UPS SYSTEM <input type="checkbox"/> TYPE <input style="width: 150px;" type="text"/>	LIGHTING <input type="checkbox"/> VENTILATION <input type="checkbox"/> HEAT <input type="checkbox"/>

PAC/PLC SYSTEM	PROFIBUS NETWORK HARDWARE
DESIGNATION <input style="width: 150px;" type="text"/> CONFIGURATION <input style="width: 150px;" type="text"/> OPERATOR INTERFACE <input style="width: 150px;" type="text"/>	SINGLE CHANNEL REPEATER <input type="checkbox"/> <input style="width: 100px;" type="text"/> MULTI-CHANNEL REPEATER <input type="checkbox"/> <input style="width: 100px;" type="text"/> COUPLER <input type="checkbox"/> <input style="width: 100px;" type="text"/> COUPLER DIAGNOSTIC MODULE <input type="checkbox"/> <input style="width: 100px;" type="text"/> COUPLER DIAGNOSTIC GATEWAY <input type="checkbox"/> <input style="width: 100px;" type="text"/> SEGMENT PROTECTOR <input type="checkbox"/> <input style="width: 100px;" type="text"/> ACTIVE TERMINATOR <input type="checkbox"/> <input style="width: 100px;" type="text"/> DRAWING REFERENCES: <input style="width: 150px;" type="text"/>

ETHERNET NETWORK HARDWARE
TYPE 1 SWITCH (SPEC 17150-2.2 A) <input style="width: 200px;" type="text"/> TYPE 2 SWITCH (SPEC 17150-2.2 B) <input style="width: 200px;" type="text"/>

SPECIAL FEATURES AND EQUIPMENT
1. Provide terminal blocks as indicated by the wiring diagram. Terminal blocks shall be rated 20 ampere, minimum.

PANEL DATA SHEET

PROJECT	Silt Water Treatment Plant	LOCATION	Exterior, Roof
OWNER	Town of Silt		
PANEL TYPE	Terminal Box		
PANEL TAG NOS.	NA		
DESCRIPTION	Power distribution terminal box serving the roof walkway heated mats.		

DOCUMENT REFERENCES			
PLAN DRAWING(S)	E-1105	WIRING DIAGRAM(S)	E-303
ONE-LINE DIAGRAM(S)	NA	DETAIL(S)	

PANEL/ENCLOSURE	
TYPE	Type 4X, Stainless Steel
MOUNTING	Surface, Wall
DOORS	Single
DIMENSIONS	8" x 8" x 6"
BACKPANEL	Conductive
FOLDING SHELF	<input type="checkbox"/>

POWER CONDITIONING	ENVIRONMENTAL CONTROLS
SURGE FILTER <input type="checkbox"/> 24 VDC POWER SUPPLY <input type="checkbox"/> TYPE <input style="width: 100%;" type="text"/> REDUNDANCY MODULE <input type="checkbox"/> UPS SYSTEM <input type="checkbox"/> TYPE <input style="width: 100%;" type="text"/>	LIGHTING <input type="checkbox"/> VENTILATION <input type="checkbox"/> HEAT <input type="checkbox"/>

PAC/PLC SYSTEM	PROFIBUS NETWORK HARDWARE
DESIGNATION <input style="width: 100%;" type="text"/> CONFIGURATION <input style="width: 100%;" type="text"/> OPERATOR INTERFACE <input style="width: 100%;" type="text"/>	SINGLE CHANNEL REPEATER <input type="checkbox"/> <input style="width: 100%;" type="text"/> MULTI-CHANNEL REPEATER <input type="checkbox"/> <input style="width: 100%;" type="text"/> COUPLER <input type="checkbox"/> <input style="width: 100%;" type="text"/> COUPLER DIAGNOSTIC MODULE <input type="checkbox"/> <input style="width: 100%;" type="text"/> COUPLER DIAGNOSTIC GATEWAY <input type="checkbox"/> <input style="width: 100%;" type="text"/> SEGMENT PROTECTOR <input type="checkbox"/> <input style="width: 100%;" type="text"/> ACTIVE TERMINATOR <input type="checkbox"/> <input style="width: 100%;" type="text"/> DRAWING REFERENCES: <input style="width: 100%;" type="text"/>

ETHERNET NETWORK HARDWARE
TYPE 1 SWITCH (SPEC 17150-2.2 A) <input style="width: 100%;" type="text"/> TYPE 2 SWITCH (SPEC 17150-2.2 B) <input style="width: 100%;" type="text"/>

SPECIAL FEATURES AND EQUIPMENT
<ol style="list-style-type: none"> 1. This panel data sheet applies to three terminal boxes as indicated on the referenced wiring diagram. 2. Provide terminal blocks as indicated by the wiring diagram. Terminal blocks shall be rated 20 ampere, minimum. 3. Provide a stainless cable gland fitting of the appropriate size in the bottom panel of the box to accept the power cord from the associated walkway mat.

SECTION 40 67 61

OPERATOR CONTROL DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

- 1. Section 26 05 53, Identification for Electrical Systems

1.02 SUMMARY

- A. This section specifies operator control devices including selector switches, push buttons, pilot lights and related accessories.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Specification 40 61 00.

1.04 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. UL Compliance:
 - a. UL 508A, Standard for Industrial Control Panels
- B. Provide components that are listed and labeled by UL.

PART 2 PRODUCTS

2.01 CONTROL DEVICES

- A. General
 - 1. Control devices shall be 30 mm, heavy-duty, corrosion-resistant with NEMA 4/4X/12 sealing rating.
 - 2. Device escutcheon legend shall be as specified on the Drawings.
 - 3. Operator control devices shall be Allen-Bradley Bulletin 800H or approved equivalent.

B. Pushbuttons

1. Pushbutton operators shall be flush head type; red for stop functions and black for all other functions.
2. Unless otherwise specified, pushbuttons shall be momentary contact type.

C. Selector Switches

1. Selector switches shall be provided with black standard knob operators unless otherwise specified.
2. Selector switches shall be maintained position unless otherwise specified as spring return.
3. Selector switches shall have the number of operating positions as required to perform the specified operations.

D. Indicating Lights: Indicating lights shall be 120-volt AC, LED, push-to-test type. LED lamps shall be high intensity, transformer type.

1. Colors: Indicating light lens and LED colors shall be as scheduled below:

Color	Function	Example
Green	Run, open valve	Equipment operating, motor running
Red	Stopped, closed valve	Equipment "OFF" and in ready condition
Amber	Failure	Abnormal condition
White	Normal condition	Equipment power or control power "ON"

E. Contact Blocks: Each operator control device operator shall be fitted with the type and quantity of contacts blocks required for each application.

1. Load Switching, 120 Volt AC Circuits, Non-Corrosive Area Applications
 - a. NEMA ICS-2 designation A600
2. Load Switching, 120 Volt AC Circuits, Corrosive (NEMA 4X) Area Applications
 - a. NEMA ICS-2 designation C300/Q150
 - b. Hermetically sealed construction
 - c. Stainless steel terminal clamps
3. PLC Input Circuits, 24-volt DC/120 volt AC
 - a. NEMA ICS-2 designation C300/R150
 - b. Pentafurcated spanner of inert precious metal alloy construction
 - c. Rounded, gold-plated stationary contact
 - d. Stainless steel terminal clamps

2.02 CONTROL STATION ENCLOSURES

- A. General: Control station enclosures shall be surface mount, screw cover boxes with the quantity of operator device openings as required for each application.
- B. Enclosures: Unless otherwise noted, control station enclosure sealing rating and materials of construction shall be in accordance with paragraph 26 05 00-1.08.

- C. Grounding: Control station enclosures shall have an integral ground terminal.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which operator control devices are to be installed. Notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION

- A. Control Stations

1. Shall be mounted 48 inches above the floor to centerline.
2. Shall be mounted on control station mounting stands as detailed on the Drawings unless the control station can be wall-mounted in the immediate vicinity of the location indicated on the Drawings. Final location and mounting shall be approved by the Engineer.
3. Shall not be mounted on handrails unless otherwise detailed on the Drawings.

3.03 GROUNDING

- A. General: All fieldbus network components shall be grounded in accordance with manufacturers recommendations.

END OF SECTION

SECTION 40 67 63

POWER SUPPLY AND CONDITIONING EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies requirements for power supply and conditioning equipment required to support process control instrumentation and communication systems.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with the requirements of Specification 40 61 00.
 - 1. Manufacturer's product data for all power supply and conditioning equipment edited to indicate only those items, model or series of equipment that are being proposed.
 - 2. Equipment connection diagrams.
 - 3. Equipment sizing calculations or power budgets for all power supply and conditioning equipment.
 - 4. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (in the margin adjacent to the beginning of the paragraph) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and the National Electrical Code, NFPA 70.
 - 2. UL Compliance: Provide components that are listed and labeled by UL under the following standards:
 - a. UL 1012, Power Supplies

- b. UL 508A, Standard for Industrial Control Panels

PART 2 PRODUCTS

2.01 ALTERNATING CURRENT POWER FILTERS

- A. General: Power filters shall provide transient voltage surge suppression and noise attenuation and shall be designed for protection of microprocessor-based industrial control equipment and shall be in compliance with ANSI/IEEE C62.41-1991. Power filters shall be suitable for operation on a 3 wire, grounded system.
- B. Performance: Power filters shall meet or exceed the following specifications.
 - 1. Input Voltage 120 volts AC, single phase
 - 2. Load Capacity 20 amperes
 - 3. Frequency 60 Hz
 - 4. Protection Modes L-N, L-G, N-G
 - 5. Maximum Continuous Operating Voltage 150 volts
 - 6. Noise Attenuation
 - a. Normal Mode -50 dB @ 100 kHz
 - b. Common Mode -30 dB @ 1 kHz
 - 7. Filter Bandwidth 10 kHz to 50 mHz
 - 8. Total Peak Surge Current (8/20) 10/30 kA
 - a. Per Mode 10,000 amperes
 - b. Total 30,000 amperes
 - 9. Operating Temperature -40 to +85 degrees C
 - 10. Response Time Less than 1 nanosecond
- C. Features: Power filters shall be provided with the following features:
 - 1. DIN rail or back panel mountable.
 - 2. Diagnostic LEDs on the face of the unit.
 - 3. Form "C" output contact for remote indication of system status.
- D. Manufacturer: Power filter shall be as manufactured by Phoenix Contact, Trabtech Surge Filter or approved equivalent.

2.02 DIRECT-CURRENT POWER SUPPLIES

- A. DIN Rail Mounted Bulk Power Supply
 - 1. General: Direct-current DIN-rail mounting power supplies for bulk 24-volt nominal instrumentation power shall be convection-cooled switched output type. Power supplies shall be UL recognized.
 - 2. Performance: The DC power supply system shall meet or exceed the following specifications.

- a. Input Voltage: 85-264 volts AC, 60 Hz., nominal.
 - b. Output Voltage: 24 volts DC, adjustable 22.5 to 28.5 volts DC.
 - c. Output Rating: Power supply shall be sized to accommodate the initial load served plus 50 percent spare capacity. Minimum power supply output rating shall be 5 amperes at 24 volts DC and 40 degrees C.
 - d. Efficiency: 88 percent, typical.
 - e. Voltage Regulation: Output residual ripple less than 100 mV peak-to-peak.
 - f. Operating Ambient Temperature: Power supply shall be rated for continuous duty from 0 to 60 degrees Centigrade.
3. Features: Each power supply shall be provided with the following features:
 - a. Integral LED status indicator.
 - b. Field configurable for parallel operation.
 - c. Relay contact output indicating power supply operating status, rated 30 volt AC/DC, 1 ampere.
 4. Manufacturer: Power supplies shall be Phoenix Contact, Quint Series, Sola SDN, or approved equivalent.

B. DIN Rail Mounted, Compact

1. General: Direct-current DIN-rail mounting power supplies for bulk 24-volt nominal instrumentation power shall be convection-cooled switched output type. Power supplies shall be UL recognized.
2. Performance: The DC power supply system shall meet or exceed the following specifications.
 - a. Input Voltage: 85-264 volts AC, 60 Hz., nominal.
 - b. Output Voltage: 24 volts DC
 - c. Output Rating: 30 watts
 - d. Efficiency: 87 percent (120 volt AC), typical.
 - e. Voltage Regulation: < 60 mV peak-to-peak.
 - f. Operating Ambient Temperature: Power supply shall be rated for continuous duty from -25 to 70 degrees Centigrade.
3. Features: Each power supply shall be provided with the following features:
 - a. Integral LED status indicator.
4. Manufacturer: Power supplies shall be Phoenix Contact, Uno Series or approved equivalent.

C. Redundancy Module

1. General: Direct-current DIN-rail mounting redundancy module for 24-volt nominal instrumentation power shall be active current balancing (ACB) style and monitoring. Modules shall be UL recognized. Modules shall decouple the outputs from each power supply to prevent one power supply overloading the other.
2. Performance: The redundancy module shall meet or exceed the following specifications.
 - a. Input Voltage: 24VDC, nominal. Voltage range between 18VDC and 28 VDC.

- b. Input Amperage: 20A combined, nominal. 30A combined, maximum.
 - c. Output Voltage: 24 volts DC, adjustable 22.5 to 28.5 volts DC.
 - d. Output Rating: Modules shall be sized to accommodate the total nameplate rating of the power supplies being paralleled.
 - e. Voltage Drop: 0.6V or less.
 - f. Efficiency: 97 percent or greater, typical.
 - g. Operating Ambient Temperature: Power supply shall be rated for continuous duty from -25 to 70 degrees Centigrade.
 - h. Altitude: If module is installed at greater than 2000m (6500 ft), module shall be derated for installation elevation. Derating shall be as per manufacturer's recommendation.
- 3. Features: Each power supply shall be provided with the following features:
 - a. Integral LED status indicator.
 - b. Relay contact output indicating module operating status, rated 30 volt AC/DC, 2 ampere.
 - 4. Manufacturer: Redundancy modules shall be Phoenix Contact, Quint ORING Series, or approved equivalent.

2.03 ALTERNATING-CURRENT UNINTERRUPTIBLE POWER SUPPLY SYSTEMS (UPS)

A. Panel-Mount UPS System: Panel-mount UPS systems shall be industrial grade suitable for DIN-rail and back panel mounting. UPS system shall meet or exceed the following specifications and shall be as manufactured by Rockwell Automation, Bulletin 1609D or approved equivalent.

- 1. Input:
 - a. Voltage, nominal: 120-volt AC
 - b. Voltage Range, default: 81 to 143 volts AC
 - c. Voltage Range, widest, on line: 75- to 153-volt AC
 - d. Frequency: 47 to 63 Hz, auto-adjusting
- 2. Output:
 - a. Voltage, nominal: 120-volt AC
 - b. Rating: UPS system shall be sized to accommodate the initial load served plus 50 percent spare capacity. Minimum output rating shall be 600 VA.
- 3. On-Line:
 - a. Output Voltage Range, default: 96- to 138-volt AC
- 4. On Battery:
 - a. Voltage: 120-volt AC, nominal
 - b. Frequency: 60 \pm 0.5 Hz.
 - c. Total Harmonic Distortion: <10 percent at full (linear) load
- 5. Short Circuit Protection:
 - a. Crest Factor: 2.2:1

6. Efficiency:
 - a. On Battery: 75 percent
 - b. On Line: 86 percent
7. Battery Pack:
 - a. Run Time: Greater than 5 minutes at full load
 - b. Type: Sealed lead acid, valve regulated, hot swappable, user replaceable
 - c. Recharge Time: Less than 8 hours to 90 percent capacity
 - d. Lifetime: 2 to 3 years @ 25 °C ambient
8. Environment:
 - a. Operating Temperature: 0 to 40 °C
 - b. Altitude: 6600 feet operating without derating
 - c. Humidity: 0-95 percent non-condensing (operating)
9. Communication:
 - a. Individual Form C dry contact closures representing the following conditions.
 - 1) Battery voltage low
 - 2) On battery
 - b. EtherNet/IP communication interface.

2.04 SURGE PROTECTIVE DEVICE

- A. General: Surge protective devices shall be provided for power supply and signal circuits serving process instruments as scheduled in the process instrument schedules appended to each process instrument specification.
- B. Four-Wire Transmitter Power Supply (at panel field terminals): Surge protective device shall be provided on the power supply serving four-wire instruments and shall be DIN rail mounted in the control panel from which the power supply circuit originates.
 1. Surge protective device shall be as manufactured by Phoenix Contact, PLUGTRAB PT or approved equivalent.
- C. Transmitter Signal Circuits (at panel field terminals): Analog and fieldbus signal circuits shall be provided with a DIN rail mounted surge protective device where the signal circuit enters the control panel or cabinet.
 1. Surge protective device shall be Phoenix Contact, PLUGTRAB PT or approved equivalent.
- D. Two-Wire Transmitter Signal Circuits (at field device): Surge protective device shall be installed at the field device.
 1. Surge arresters shall be Phoenix Contact, PIPETRAB or approved equivalent.
- E. Four-Wire Transmitters (at field device): Surge protective device shall provide protection for both the AC/DC power supply circuit and the analog or fieldbus signal circuit and shall be installed at the field device. Surge protection system shall consist of one signal circuit surge protective

device and one power circuit surge protective device DIN rail mounted in a NEMA 4X polycarbonate enclosure with clear hinged cover.

1. Surge protective devices shall be Citel, CAD Series or approved equivalent.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which power supply and conditioning equipment are to be installed. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 PROTECTION

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.03 INSTALLATION OF POWER SUPPLY AND CONDITIONING EQUIPMENT

- A. Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions unless otherwise specified. Line side disconnect switches or circuit breakers shall be provided for power supply and conditioning equipment. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70.

3.04 TRAINING

- A. The Contractor shall provide the services of a factory-trained instructor for the purpose of training the Owner's personnel in the proper operation and maintenance of the UPS systems. A 2-hour (minimum) training session shall be conducted in accordance with specification 40 61 00 for each type of UPS system.

3.05 TESTING

- A. Testing requirements shall be as specified in Section 40 61 21.

END OF SECTION

SECTION 40 70 00

COMMON WORK RESULTS FOR PROCESS INSTRUMENTATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including Procurement and Contracting Requirements and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. General: This section specifies several categories of provisions for process instrumentation work including the following:
 - 1. Certain adaptive expansions of requirements specified in each process instrument specification.
 - 2. General performance requirements for process instruments as a whole.
 - 3. Ancillary equipment for process instrument applications.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Section 01 33 00 and the following:
 - 1. Instrument Installation Review and Certification: The instrument supplier shall review each of the instrument installation details provided on the Drawings and acknowledge in writing that the installation conditions described by the detail conform to all applicable installation requirements for the particular instrument.

1.04 QUALITY ASSURANCE

- A. Quality assurance requirements as specified in Section 01 45 16.
- B. Examine the Contract Documents and verify the instruments are fully compliant with the specified application and installation conditions including the following:
 - 1. All process conditions including the chemical and fluid characteristics of the measured medium, flow range, operating pressure and temperature ranges, etc.
 - 2. Mechanical process compatibility including connection type, piping configuration, materials of construction, etc.
 - 3. Environmental compatibility including hazardous classification, corrosion susceptibility, vibration, temperature, ultraviolet exposure, EMI/RFI influence, etc.
 - 4. Electrical compatibility including power source, output signal characteristics, power/signal conduit and conductor interface, grounding, surge protection, sensor/transmitter interconnection, etc.

- C. Notify the Engineer of any process, mechanical, environmental or electrical conditions that conflict with or do not fully comply with the instrument manufacturer's recommendations, practices, or specifications.

PART 2 PRODUCTS

2.01 SURGE PROTECTION

- A. General: Surge protective devices shall be provided for power supply and signal circuits serving process instruments as scheduled in the process instrument schedules appended to each process instrument specification.
- B. Four-Wire Transmitter Power Supply (at panel field terminals): Surge protective device shall be provided on the power supply serving four-wire instruments and shall be DIN rail mounted in the control panel from which the power supply circuit originates.
 - 1. Surge protective device shall be as manufactured by Phoenix Contact, PLUGTRAB PT or approved equivalent.
- C. Transmitter Signal Circuits (at panel field terminals): Analog and fieldbus signal circuits shall be provided with a DIN rail mounted surge protective device where the signal circuit enters the control panel or cabinet.
 - 1. Surge protective device shall be Phoenix Contact, PLUGTRAB PT or approved equivalent.
- D. Two-Wire Transmitter Signal Circuits (at field device): Surge protective device shall be installed at the field device.
 - 1. Surge arresters shall be Phoenix Contact, PIPETRAB or approved equivalent.
- E. Four-Wire Transmitters (at field device): Surge protective device shall provide protection for both the AC/DC power supply circuit and the analog or fieldbus signal circuit and shall be installed at the field device. Surge protection system shall consist of one signal circuit surge protective device and one power circuit surge protective device DIN rail mounted in a NEMA 4X polycarbonate enclosure with clear hinged cover.
 - 1. Surge protective devices shall be Citel, CAD Series or approved equivalent.

2.02 INSTRUMENT STANDS

- A. Floor Stand: Floor stand shall be vertical mount, 2-inch diameter, 52-inch high, Schedule 40, steel pipe with 1/4-inch x 10-inch x 10-inch carbon steel baseplate. Instrument stand shall be full-perimeter welded at baseplate and shall have two 1/4-inch gussets welded 90 degrees apart. Baseplate shall have 1.5 inch by 0.62 inch slotted openings in each corner to accommodate mounting hardware. Instrument stand shall be metallized with pure zinc. Instrument stand shall be as manufactured by O'Brien Corporation Saddlepak System, Model FP52 or equivalent.
- B. Wall Stand: Wall stand shall be vertical mount, 2-inch diameter, 16-inch high, Schedule 40, steel pipe with 1/4-inch x 6.5-inch x 6.5-inch carbon steel baseplate. Instrument stand shall be full-perimeter welded at baseplate. Baseplate shall have 0.88 inch by 0.44-inch slotted openings in each corner to accommodate mounting hardware. Instrument stand shall be metallized with pure zinc. Instrument stand shall be as manufactured by O'Brien Corporation Saddlepak System, Model WE16M or equivalent.

2.03 INSTRUMENT IDENTIFICATION

- A. Identification Tags: All instruments, including process variable transmitters, analyzers, and switches, shall be provided with a 316 stainless steel identification tag attached to the instrument with 316 stainless steel wire. The instrument tag number shall be stamped in the identification tag in 1/8-inch minimum height characters.
- B. Instrument Labeling: Where space is provided on the instrument faceplate for user labeling, an adhesive, machine-printed label with black lettering on white background shall be provided. The label shall identify the instrument tag number, description, and operating range with engineering units.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which process instruments are to be installed, and process connections to which instruments are to be interfaced. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 PROTECTION

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.03 INSTALLATION OF PROCESS INSTRUMENTS

- A. Instruments shall be installed in accordance with manufacturer's instructions, and the specified functional requirements.
- B. Instruments shall be positioned in accordance with the following requirements:
 - 1. Instrument operator interface and indicators are visible from the process floor, walkway or platform at which the instrument is located.
 - 2. All ports are accessible for connection of in-place calibration and testing equipment.
 - 3. Instrument wiring terminal compartment and operator interface covers and doors are oriented to permit access with the standard tools required for removal and to permit doors to swing freely to their most open unobstructed position.
 - 4. Instrument wiring terminal compartments and operator interface compartments shall have adequate unobstructed access to permit the use of standard tools and diagnostic equipment.
- C. Raceway Connections
 - 1. Liquidtight flexible conduit shall be used between equipment and rigid raceway systems except that flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use.
 - 2. Flexible cable, receptacle and plug assemblies shall be used only where specified.
 - 3. The length of flexible conduit or cord assemblies shall not exceed 2 feet.

- D. Where possible, the equipment shall be located between 48 inches and 66 inches above the floor or a permanent work platform.
- E. Instruments shall not be mounted where shock or vibration will impair its operation.
- F. Instrument stands shall be provided for supporting instruments as detailed on the Drawings.
- G. Instruments supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall.
- H. Flange bolts shall be tightened to instrument manufacturer's specified torque.

3.04 FIELD ADJUSTMENTS AND TESTING

- A. Calibration and Testing: Process instruments shall be calibrated and tested in accordance with the manufacturer's instructions and Specification Section 40 61 21.

3.05 HOUSEKEEPING

- A. Process instruments shall be protected from dust, water and damage during the construction period.
- B. Cleaning
 - 1. Touch-up scratched or marred enclosure surfaces to match original finishes. Remove all dust, debris, paint, and other foreign material from the instrument enclosure and associated stands, manifolds, tubing, etc.
 - 2. Thoroughly clean and remove all residue and construction debris from interior surfaces.
 - 3. Instruments shall be left in an unblemished condition.

3.06 TRAINING

- A. The Contractor shall provide the services of a factory-trained instructor for the purpose of training the Owner's personnel in the proper configuration, operation and maintenance of process instruments where specified in each process instrument specification sections. Training shall address instrument theory of operation, application guidelines, configuration, installation, and maintenance. Instruments shall be provided for hands-on demonstration and exercises.

END OF SECTION

SECTION 40 71 00
FLOW MEASUREMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including Procurement and Contracting Requirements and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 40 70 00, Common Work Results for Process Instrumentation.
 - 2. Section 40 67 63, Power Supply and Conditioning Equipment.
 - 3. Section 40 79 00 Instrument Valves, Tubing, Fittings, and Supports.
- C. Flow Measurement Instrument Specification Sheets, Supplement A, appended to the end of this Section.
- D. Flow Meter Instrument Schedules, Supplement B, appended to the end of this Section.

1.02 SUMMARY

- A. This section specifies requirements for flow measurement process instruments.
- B. Supplement A, Flow Measurement Instrument Specification Sheets: General requirements for flow measurement instruments and ancillary equipment shall be as specified by the Flow Measurement Instrument Specification Sheets, Supplement A.
- C. Supplement B, Magnetic Flow Meter Instrument Schedules: Application requirements for flow metering systems are specified in the respective Instrument Schedules, Supplement B, appended to the end of this Section.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Section 40 70 00.

1.04 QUALITY ASSURANCE

- A. Quality assurance requirements as specified in Section 40 70 00.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to Supplements A and B appended to this Section.

PART 3 EXECUTION

3.01 GENERAL

- A. Refer to Section 40 70 00.

3.02 SUPPLEMENTS

- A. Supplement A, Flow Measurement Instrument Specification Sheets: The following Flow Measurement Instrument Specification Sheets are included in Supplement A.

<u>Instrument Designation</u>	<u>Instrument Description</u>	<u>Instrument Function</u>
FM	Magnetic Flow Metering System	Liquid Flow Measurement

- B. Supplement B, Flow Measurement Instrument Schedules: The following instrument schedules are included in Supplement B.

1. Table 40 71 00 B.1, Magnetic Flow Meter Instrument Schedule.

END OF SECTION

FUNCTION	Liquid flow measurement
DESCRIPTION	Magnetic flow metering system

PRODUCT DESCRIPTION

General:

1. Magnetic flow metering systems shall consist of a flow sensor and transmitter. The flow metering system shall utilize Faraday's Law of Electromagnetic induction to produce an induced voltage that is proportional to the velocity of the liquid flow through the sensor.

Flow Sensor:

1. Magnetic flow metering systems shall consist of a flow sensor and transmitter. The flow metering system shall utilize Faraday's Law of Electromagnetic induction to produce an induced voltage that is proportional to the velocity of the liquid flow through the sensor. The instrument shall require no inlet or outlet runs.
2. Electrodes: Flow sensor shall be provided with integral sensing electrodes for fluid velocity measurement, grounding, and empty pipe detection.
3. Ground Rings: Flow tubes shall be provided with 0.125-inch thick grounding rings. Grounding rings shall be fabricated from ASTM A312, Type 316 stainless steel. Grounding ring inside diameter shall be 1/16 inch smaller than flow tube inside diameter. Flow tube flanges shall be drilled and tapped for termination of ground conductors.
4. Submersible Service: Where the sensor Housing Rating is designated as "NEMA 6P" in the Instrument Schedule, the flow metering system shall be suitable for submersible applications (permanent immersion in water to a depth of 3 meters) and include the following features:
 - a. Remote-mounted transmitter.
 - b. Factory-installed potted cable furnished with the flow tube. Cable length shall be as required to be installed in the specified raceway system from the sensor housing to the transmitter location.

Transmitter:

1. The transmitter shall contain all electronics associated with the magnetic flow metering system. Enclosure shall be coated aluminum with a dedicated compartments for power, field connections and calibration adjustments separate from digital circuitry.
2. Transmitter shall be provided with optical keys to permit non-intrusive setup and calibration. The transmitter shall contain self-diagnostic capabilities and shall be interchangeable with other units of the same type without special re-calibration. Transmitter shall include an integral 4 line, 16-digit illuminated LCD display behind a glass window. Display shall have white background lighting during typical operation with red backlighting to indicate a device error. Features shall include signal output simulation, empty pipe detection, and galvanically isolated active/passive pulse outputs.
3. Transmitter output(s) shall be as scheduled.
4. Remote mounted transmitter housing shall be designed for wall or pipe mounting.
5. Transmitter housing electrical connections shall consist of 3 (minimum) ½ inch NPT conduit hubs.

Sensor Cable:

1. Where Transmitter Enclosure Mounting is scheduled in the Instrument Schedule as "Remote", the transmitter housing shall be provided with interconnecting coil and signal cables. Cable length shall be as required to be installed in the specified raceway system from the sensor housing to the transmitter location.

PERFORMANCE

- | | |
|-------------------------------|---|
| 1. Error: | 0.2% of reading \pm 0.08 inches/second. |
| 2. System Repeatability: | \pm 0.1% of reading \pm 0.02 inches/second. |
| 3. Ambient Temperature Range: | -20 to +60 degrees C. |
-

SOFTWARE

1. When Ethernet/IP digital communication interface is the scheduled output protocol the instrument manufacturer shall provide the following software.
 - a. Electronic Data Sheet (EDS): The EDS shall define the instrument input/output requirements within the PLC programming environment and provide the PLC cyclic access to the following data from the instrument. In addition the EDS definition shall include a connection fault status tag to allow real time monitoring of the health of the communication connection between the PLC and the instrument.
 1. Instrument Diagnostics
 2. Volume Flow
 3. Totalizer 1
 4. Totalizer 2
 5. Totalizer 3
 - b. Add-on Profile (AOP): The AOP shall provide graphical user interface within the specified PLC programming environment to permit online configuration of key instrument parameters.
-

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Weather/UV ProtectionWeather Protection: Weather protection cover shall be provided to shield the instrument from direct sunlight. Cover shall be of stainless-steel construction and shall be designed to accommodate the mounting method specified for the associated instrument. Weather protection cover shall be furnished by the instrument manufacturer.
 2. Surge Protection: Surge protection in accordance with Section 40 67 63.
-

ACCEPTABLE MANUFACTURERS

Endress+Hauser Promag W 400

Substitutions Permitted

Yes

TRAINING

2 Hours

Table 40 71 00 B.1
Magnetic Flow Meter Instrument Schedule

Instrument Description		Process Conditions				Transmitter				
Tag Number	Service	Fluid	Pressure	Nominal Flow Range	Max Flow Range	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting
FE/FIT 1080	Raw Water Flow	Raw Water	75 psig	0 to 2100 gpm	155 to 5700 gpm	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Integral
	Sensor				Accessories			Document Reference		Notes
	Tube Diameter	Flanges	Tube Material	Liner Material	Electrode Material	Housing Rating	Surge Protection	Weather Protection	Drawings	Details
	12 inches	ASME B16.5 Carbon Steel	Stainless Steel	Polyurethane	316L Stainless Steel	NEMA 4X			P-1000 E-1000	1/I-2
Instrument Description		Process Conditions				Transmitter				
Tag Number	Service	Fluid	Pressure	Nominal Flow Range	Max Flow Range	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting
FE/FIT 1101	Actiflo Train A Influent Flow	Raw Water	75 psig	0 to 700 gpm	155 to 5700 gpm	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Integral
	Sensor				Accessories			Document Reference		Notes
	Tube Diameter	Flanges	Tube Material	Liner Material	Electrode Material	Housing Rating	Surge Protection	Weather Protection	Drawings	Details
	12 inches	ASME B16.5 Carbon Steel	Stainless Steel	Polyurethane	316L Stainless Steel	NEMA 4X			P-1100 E-1101	1/I-2
Instrument Description		Process Conditions				Transmitter				
Tag Number	Service	Fluid	Pressure	Nominal Flow Range	Max Flow Range	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting
FE/FIT 1201	Actiflo Train B Influent Flow	Raw Water	75 psig	0 to 700 gpm	155 to 5700 gpm	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Integral
	Sensor				Accessories			Document Reference		Notes
	Tube Diameter	Flanges	Tube Material	Liner Material	Electrode Material	Housing Rating	Surge Protection	Weather Protection	Drawings	Details
	12 inches	ASME B16.5 Carbon Steel	Stainless Steel	Polyurethane	316L Stainless Steel	NEMA 4X			P-1200 E-1101	1/I-2

Table 40 71 00 B.1
Magnetic Flow Meter Instrument Schedule

Instrument Description		Process Conditions				Transmitter				
Tag Number	Service	Fluid	Pressure	Nominal Flow Range	Max Flow Range	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting
FE/FIT 3184	Fiter 1 Filtered Water Flow	Filtered Water	50 psig	0 to 700 gpm	155 to 5700 gpm	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Integral
	Sensor				Accessories			Document Reference		Notes
	Tube Diameter	Flanges	Tube Material	Liner Material	Electrode Material	Housing Rating	Surge Protection	Weather Protection	Drawings	Details
	12 inches	ASME B16.5 Carbon Steel	Stainless Steel	Polyurethane	316L Stainless Steel	NEMA 4X			P-3100 E-1102	1/I-2
Instrument Description		Process Conditions				Transmitter				
Tag Number	Service	Fluid	Pressure	Nominal Flow Range	Max Flow Range	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting
FE/FIT 3284	Fiter 2 Filtered Water Flow	Filtered Water	50 psig	0 to 700 gpm	155 to 5700 gpm	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Integral
	Sensor				Accessories			Document Reference		Notes
	Tube Diameter	Flanges	Tube Material	Liner Material	Electrode Material	Housing Rating	Surge Protection	Weather Protection	Drawings	Details
	12 inches	ASME B16.5 Carbon Steel	Stainless Steel	Polyurethane	316L Stainless Steel	NEMA 4X			P-3200 E-1102	1/I-2
Instrument Description		Process Conditions				Transmitter				
Tag Number	Service	Fluid	Pressure	Nominal Flow Range	Max Flow Range	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting
FE/FIT 3430	Backwash Water Supply Flow	Potable Water	150 psig	0 to 2900 gpm	155 to 5700 gpm	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Remote
	Sensor				Accessories			Document Reference		Notes
	Tube Diameter	Flanges	Tube Material	Liner Material	Electrode Material	Housing Rating	Surge Protection	Weather Protection	Drawings	Details
	12 inches	ASME B16.5 Carbon Steel	Stainless Steel	Polyurethane	316L Stainless Steel	NEMA 4X			P-3400 E-1102	1/I-2

Table 40 71 00 B.1
Magnetic Flow Meter Instrument Schedule

Instrument Description		Process Conditions				Transmitter				
Tag Number	Service	Fluid	Pressure	Nominal Flow Range	Max Flow Range	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting
FE/FIT 4270	House Water System Flow	Potable Water	150 psig	0 to 350 gpm	16 to 650 gpm	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Integral
	Sensor					Accessories		Document Reference		Notes
	Tube Diameter	Flanges	Tube Material	Liner Material	Electrode Material	Housing Rating	Surge Protection	Weather Protection	Drawings	Details
	4 inches	ASME B16.5 Carbon Steel	Stainless Steel	Polyurethane	316L Stainless Steel	NEMA 4X			P-4100 E-1101	1/I-2

SECTION 40 72 00
LEVEL MEASUREMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including Procurement and Contracting Requirements and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 40 70 00, Common Work Results for Process Instrumentation.
 - 2. Section 40 67 63, Power Supply and Conditioning Equipment.
 - 3. Section 40 79 00 Instrument Valves, Tubing, Fittings, and Supports.
- C. Level Measurement Instrument Specification Sheets, Supplement A, appended to the end of this Section.
- D. Level Measurement Instrument Schedules. Supplement B, appended to the end of this Section.

1.02 SUMMARY

- A. This section specifies requirements for level measurement process instruments.
- B. Supplement A, Level Measurement Instrument Specification Sheets: General requirements for level measurement instruments and ancillary equipment shall be as specified by the Level Measurement Instrument Specification Sheets, Supplement A.
- C. Supplement B, Level Measurement Instrument Schedules: Application requirements for level measurement instruments are specified in the respective Instrument Schedules, Supplement B.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Section 40 70 00.

1.04 QUALITY ASSURANCE

- A. Quality assurance requirements as specified in Section 40 70 00.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to Supplements A and B appended to this Section.

PART 3 EXECUTION

3.01 GENERAL

- A. Refer to Section 40 70 00.

3.02 SUPPLEMENTS

- A. Supplement A, Level Measurement Instrument Specification Sheets: The following Level Measurement Instrument Specification Sheets are included in Supplement A.

<u>Instrument Designation</u>	<u>Instrument Description</u>	<u>Instrument Function</u>
LHS	Hydrostatic Level Transmitter	Level Measurement
LRT	Radar Level Transmitter	Level Measurement

- B. Supplement B, Level Measurement Instrument Schedules: The following instrument schedules are included in Supplement B.

1. Table 40 72 00 B.1, Hydrostatic Level Transmitter Instrument Schedule
2. Table 40 72 00 B.2, Radar Level Transmitter Instrument Schedule

END OF SECTION

TYPE DESIGNATION - LHT

SHEET 1 OF 1

FUNCTION	Liquid level measurement
DESCRIPTION	Hydrostatic level transmitter

PRODUCT DESCRIPTION

General:

1. Level measurement system shall consist of a submerged hydrostatic pressure sensor, integral transmitter, and interconnecting extension cable suitable for use in a water/wastewater environment. Transmitter electronics housing, extension cable, and sensor shall be factory assembled as a unit.

Transmitter:

1. Housing: Housing sealing rating and materials of construction shall be as indicated in the Instrument Schedule.
2. Operator Interface: Transmitter shall have an integral 3-button membrane keypad and 4-line alphanumeric LCD display and bar graph for display of the measured variable in engineering units and the annunciation of diagnostic messages.
3. Electrical Connection: Conduit, threaded, ½ inch NPT.
4. Power Supply: Derived from the output signal circuit.

Process Connection:

1. The transmitter process connection shall be one of the following as scheduled in the Instrument Schedule.
 1. Type 1, Flange: Class 150, ANSI B16.5 flange, 316 stainless steel, size as scheduled.

PERFORMANCE

1. Error:	±0.2% of measurement
2. Ambient Temperature Limits:	
a. Transmitter electronics and sensor:	-40 to 185 degrees Fahrenheit
b. Display:	-4 to 185 degrees Fahrenheit

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Weather/UV ProtectionWeather Protection: Weather protection cover shall be provided to shield the instrument from direct sunlight. Cover shall be of stainless-steel construction and shall be designed to accommodate the mounting method specified for the associated instrument. Weather protection cover shall be furnished by the instrument manufacturer.
2. Surge Protection: Surge protection in accordance with Section 40 67 63.

ACCEPTABLE MANUFACTURERS	Endress+Hauser Deltapilot M FMB52
Substitutions Permitted	Yes

TRAINING	2 Hours
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TYPE DESIGNATION - LRT

SHEET 1 OF 2

FUNCTION	Liquid level measurement
DESCRIPTION	Radar level transmitter

PRODUCT DESCRIPTION

General:

1. Radar level transmitter shall be a non-contact, radar time-of-flight level measuring device. It shall consist of a radar frequency emitter and integrally-mounted transmitter electronics unit.

Transmitter:

1. Housing: Housing shall be configured with a separate, dedicated cable termination compartment. Housing sealing rating and materials of construction shall be as indicated in the Instrument Schedule.
2. Operator Interface: Transmitter shall have an integral 3-button membrane keypad and 4-line alphanumeric LCD display and bar graph for display of the measured variable in engineering units and the annunciation of diagnostic messages.
3. Antenna: Flush mounted, completely filled PTFE horn antenna; K-band operating frequency (~26 GHz).
4. Electrical Connection: Conduit, threaded, ½ inch NPT.
5. Power Supply: Derived from the output signal circuit.

Process Connection:

1. The transmitter process connection shall be one of the following as scheduled in the Instrument Schedule.
 1. Type 1, Flange: Class 150, ANSI B16.5 flange, 316 stainless steel, size as scheduled.
 2. Type 2, Flange: Schedule 80 PVC flange, size as scheduled.

PERFORMANCE

- | | |
|--|--|
| 1. Error: | ±0.08 inches plus 0.02% of measurement |
| 2. Ambient Temperature Limits: | |
| a. Transmitter electronics and sensor: | -40 to 176 degrees Fahrenheit |
| b. Display: | -4 to 158 degrees Fahrenheit |

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Weather/UV ProtectionWeather Protection: Weather protection cover shall be provided to shield the instrument from direct sunlight. Cover shall be of stainless-steel construction and shall be designed to accommodate the mounting method specified for the associated instrument. Weather protection cover shall be furnished by the instrument manufacturer.
2. Surge Protection: Surge protection in accordance with Section 40 67 63.

ACCEPTABLE MANUFACTURERS

Endress+Hauser Micropilot FMR52

Substitutions Permitted

Yes

Supplement A
Level Measurement Instrument Specification Sheets

TYPE DESIGNATION - LRT

SHEET 2 OF 2

TRAINING

2 Hours

Table 40 72 00 B.1
Radar Level Transmitter Instrument Schedule

Instrument Description			Process Conditions			Transmitter				
Tag Number	Service	Media	Measurement Range	Mounting Height	Output	Antenna Size	Process Connection	Enclosure Rating	Enclosure Material	Flange Size
LE/LIT 3430	Backwash Water Supply Tank Level	Potable Water	0 - 9 feet	11.17 feet	4-20 mA DC	3 inch	Type 2	NEMA 4X	Coated Aluminum	6 inch
	Accessories			Document Reference			Notes			
	Surge Protection	Weather Protection		Drawings	Details					
						P-4000 E-1102	3/I-2			

Instrument Description			Process Conditions			Transmitter				
Tag Number	Service	Media	Measurement Range	Mounting Height	Output	Antenna Size	Process Connection	Enclosure Rating	Enclosure Material	Flange Size
LE/LIT 8401	Sodium Hydroxide Storage Tank 1 Chemical Level	Sodium Hydroxide	0 -14 feet	15 feet	4-20 mA DC	3 inch	Type 2	NEMA 4X	Coated Aluminum	3 inch
	Accessories			Document Reference			Notes			
	Surge Protection	Weather Protection	Remote Indicator	Drawings	Details					
			✓			P-8400 E-1103				

Instrument Description			Process Conditions			Transmitter				
Tag Number	Service	Media	Measurement Range	Mounting Height	Output	Antenna Size	Process Connection	Enclosure Rating	Enclosure Material	Flange Size
LE/LIT 8501	Aluminum Chlorohydrate Storage Tank 1 Chemical Level	Sodium Hydroxide	0 - 8 feet	9 feet	4-20 mA DC	3 inch	Type 2	NEMA 4X	Coated Aluminum	3 inch
	Accessories			Document Reference			Notes			
	Surge Protection	Weather Protection	Remote Indicator	Drawings	Details					
			✓			P-8500 E-1103				

Table 40 72 00 B.2
Float Level Switch Instrument Schedule

Instrument Description		Process Conditions		Switch Output		Document Reference		Notes
Tag Number	Service	Media	Mounting Height	Rating	Contact Form	Drawings	Details	
LSH 9110	Sanitary Lift Station	Municipal Wastewater	See Notes	120 volt AC .16 mA - 1 A	SPDT	E-1103		Cable length shall be as required for each application.

SECTION 40 73 00

PRESSURE MEASUREMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including Procurement and Contracting Requirements and Division 1 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 40 70 00, Common Work Results for Process Instrumentation.
 - 2. Section 40 67 63, Power Supply and Conditioning Equipment.
 - 3. Section 40 79 00, Instrument Valves, Tubing, Fittings, and Supports.
- C. Pressure Measurement Instrument Specification Sheets, Supplement A, appended to the end of this Section.
- D. Pressure Instrument Schedules, Supplement B, appended to the end of this Section.

1.02 SUMMARY

- A. This section specifies requirements for pressure measurement process instruments.
- B. Supplement A, Pressure Measurement Instrument Specification Sheets: General requirements for pressure measurement instruments and ancillary equipment shall be as specified by the Pressure Measurement Instrument Specification Sheets, Supplement A.
- C. Supplement B, Pressure Measurement Instrument Schedule: Application requirements for pressure measurement instruments are specified in the respective Instrument Schedules, Supplement B.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Section 40 70 00.

1.04 QUALITY ASSURANCE

- A. Quality assurance requirements as specified in Section 40 70 00.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to Supplements A and B appended to this Section.

PART 3 EXECUTION

3.01 GENERAL

- A. Refer to Section 40 70 00.

3.02 SUPPLEMENTS

- A. Supplement A, Pressure Measurement Instrument Specification Sheets: The following Pressure Measurement Instrument Specification Sheets are included in Supplement A.

<u>Instrument Designation</u>	<u>Instrument Description</u>	<u>Instrument Function</u>
PGT	Gauge Pressure Transmitter	Gauge Pressure Measurement

- B. Supplement B, Pressure Measurement Instrument Schedules: The following instrument schedules are included in Supplement B.

1. Table 40 73 00 B.1, Gauge Pressure Transmitter Instrument Schedule.

END OF SECTION

TYPE DESIGNATION - PGT

SHEET 1 OF 3

FUNCTION	Pressure Measurement
DESCRIPTION	Gauge Pressure Transmitter

PRODUCT DESCRIPTION

General:

1. Gauge pressure transmitter shall be capacitance type with a ceramic, oil-free pressure sensing diaphragm. Pressure transmitter electronics and sensor shall form a single mechanical unit.

Sensor:

1. Sensor shall have a ceramic process isolating diaphragm. Ceramic shall be 99.9 percent pure aluminum oxide to ensure broad chemical compatibility and durability.
2. Sensor shall not utilize any fill fluid.

Transmitter:

1. Housing:
 - a. The transmitter shall have separate compartments for field wiring termination and operator interface with threaded covers over each compartment.
 - b. The display orientation shall be field adjustable in 90 degree steps within the housing. The orientation of the transmitter housing relative to the sensor shall be field adjustable permitting a full 360 degree rotation of the transmitter housing separate from the sensor to facilitate proper alignment of the unit.
 - c. The transmitter housing shall have a glass viewing window in the operator interface compartment cover.
2. Operator Interface:
 - a. The transmitter operator interface shall include an 8-digit measured value display indicating polarity, decimal point, and engineering units in addition to a bar graph representation of the measured value.
 - b. The operator interface shall include a membrane keypad to facilitate configuration and operation of the transmitter.
3. Electrical Connection: Conduit, threaded, ½ inch NPT

Process Connection:

1. The transmitter process connection shall be one of the following as scheduled in the Instrument Schedule.
 - a. Type 1, Pressure Tap: 1/2-inch diameter male NPT, 316Ti stainless steel
 - b. Type 2, Pressure Tap, Non-Metal: 1/2-inch diameter male NPT, PVDF
 - c. Type 3, Flange: Class 150, ANSI B16.5 flange, 316 stainless steel, size as scheduled
 - d. Type 4, Flush Mount: 316 stainless steel weld spud fitting with Teflon seal and Viton O-ring seals unless otherwise indicated in the Instrument Schedule.
 - e. Type 5, Flush Mount: 1-1/2 inch diameter male NPT threaded connection
-

Supplement A
Pressure Measurement Instrument Specification Sheets

TYPE DESIGNATION - PGT

SHEET 2 OF 3

PERFORMANCE

- | | | |
|----|---|--------------------------|
| 1. | Span Adjustment: | |
| | a. Sensor Upper Range Limit \leq 6 psig: | 80:1 |
| | b. Sensor Upper Range Limit \geq 15 psig: | 100:1 |
| 2. | System Error: | $\pm 0.05\%$ of set span |
| 3. | Overpressure Limit: | |
| | a. Sensor Upper Range Limit, 6 psig: | 120 psi |
| | b. Sensor Upper Range Limit, 15 psig: | 150 psi |
| | c. Sensor Upper Range Limit, 30 psig: | 270 psi |
| | d. Sensor Upper Range Limit, 60 psig: | 375 psi |
| | e. Sensor Upper Range Limit, 150 psig: | 600 psi |
| | f. Sensor Upper Range Limit, 600 psig: | 900 psi |
| 4. | Process Temperature Range: | -25 to 125 degrees C |
| 5. | Ambient Temperature Range: | -20 to +70 degrees C |

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Weather Protection: Weather protection cover shall be provided to shield the instrument from direct sunlight. Cover shall be of stainless-steel construction and shall be designed to accommodate the mounting method specified for the associated instrument. Weather protection cover shall be furnished by the instrument manufacturer.
2. Weld Spud: 1-1/2" diameter 316L stainless steel weld spud fitting. Endress+Hauser part number 52024469 or approved equivalent. Provide for each Type 2 Flush Mount process connection specified.
3. Heat Sink: Provide one (1) heat sink plug designed to prevent distortion of the weld spud during installation. Endress+Hauser part number 52024471 or approved equivalent. Provide one (1) when Type 2 Flush Mount process connection is specified.
4. Mounting Bracket: Provide stainless steel bracket designed to support the transmitter from a vertical mounting surface.
5. Surge Protection: Surge protection in accordance with Section 40 67 63.

ACCEPTABLE MANUFACTURERS

Endress+Hauser Cerabar S PMC 71

Substitutions Permitted

Yes

TRAINING

2 Hours

TYPE DESIGNATION - PGT

SHEET 3 OF 3

EXECUTION

Process Connections:

1. Type 1, Pressure Tap:
 - a. A root valve shall be provided at the process pressure tap on the associated process piping. All unused openings on the root valve shall be provided with plugs of the same material as the root valve. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording.
 - b. Where the pressure instrument is mounted remote from the pressure tap on the process pipe stainless steel instrument tubing shall be provided from the process pressure tap to the pressure instrument. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance from the process floor.
 1. Liquid Applications: The instrument tubing shall slope down from the process tap to the pressure transmitter and the pressure tap shall be made in the side of the process pipe.
 2. Gas Applications: The instrument tubing shall slope up from the process tap to the pressure transmitter and the pressure tap shall be made in the top of the process pipe.
 2. Type 2, Pressure Tap: Pressure transmitter shall be mounted directly to the designated process pressure tap.
 3. Type 3, Flanged: Pressure transmitter shall be mounted to the flanged process opening where indicated on the Drawings.
 4. Type 4, Flush Mount: Weld spud shall be welded to the specified surface in accordance with manufacturer's instructions.
 5. Type 5, Flush Mount: Pressure transmitter shall be mounted directly to a threaded connection on the process pipe.
-

Table 40 73 00 B.1
Pressure Transmitter Instrument Schedule

Instrument Description				Process Conditions				Transmitter					
Tag Number		Service		Media	Pressure Range		Output	Enclosure Rating	Enclosure Material	Upper Range Limit	Notes		
PIT	1054	Raw Water Strainer Discharge Pressure		Liquid	0 to 5		4-20 mA DC	NEMA 4X	Coated Aluminum	15			
				Raw Water	psig					psig			
		Sensor				Accessories				Document Reference			
		Wetted Materials	Process Connection	Seal Material	Flange Size	Valve/ Manifold	Mounting Stand	Mounting Bracket	Weld Spud	Surge Protection	Weather Protection	Drawings	Details
		316 Stainless Steel	Type 1	EDPM		Root Valve						P-1000 E-1000	2/I-2

Instrument Description				Process Conditions				Transmitter					
Tag Number		Service		Media	Pressure Range		Output	Enclosure Rating	Enclosure Material	Upper Range Limit	Notes		
PIT	3182	Filter 1 Filtered Water Discharge Pressure		Liquid	0 to126		4-20 mA DC	NEMA 4X	Coated Aluminum	166			
				Filtered Water	Inches H2O					Inches H2O			
		Sensor				Accessories				Document Reference			
		Wetted Materials	Process Connection	Seal Material	Flange Size	Valve/ Manifold	Mounting Stand	Mounting Bracket	Weld Spud	Surge Protection	Weather Protection	Drawings	Details
		316 Stainless Steel	Type 1	EDPM		Root Valve						P-3100 E-1102	2/I-2

Instrument Description				Process Conditions				Transmitter					
Tag Number		Service		Media	Pressure Range		Output	Enclosure Rating	Enclosure Material	Upper Range Limit	Notes		
PIT	3282	Filter 2 Filtered Water Discharge Pressure		Liquid	0 to 126		4-20 mA DC	NEMA 4X	Coated Aluminum	166			
				Filtered Water	Inches H2O					Inches H2O			
		Sensor				Accessories				Document Reference			
		Wetted Materials	Process Connection	Seal Material	Flange Size	Valve/ Manifold	Mounting Stand	Mounting Bracket	Weld Spud	Surge Protection	Weather Protection	Drawings	Details
		316 Stainless Steel	Type 1	EDPM		Root Valve						P-3200 E-1102	2/I-2

Table 40 73 00 B.1
Pressure Transmitter Instrument Schedule

Instrument Description				Process Conditions			Transmitter					
Tag Number		Service		Media	Pressure Range		Output	Enclosure Rating	Enclosure Material	Upper Range Limit	Notes	
PIT 3750	Plant Air System Pressure			Gas	0 - 120		4-20 mA DC	NEMA 4X	Coated Aluminum	150		
				Air	psig					psig		
	Sensor					Accessories				Document Reference		
	Wetted Materials	Process Connection	Seal Material	Flange Size	Valve/ Manifold	Mounting Stand	Mounting Bracket	Weld Spud	Surge Protection	Weather Protection	Drawings	Details
		316 Stainless Steel	Type 1	EDPM		2-Valve	Wall				P-3700 E-1102	4/I-2

SECTION 40 75 00

ANALYTICAL MEASUREMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. The following Specifications are related to Work described in this Specification section. This list of related specifications is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - 1. Section 40 70 00, Common Work Results for Process Instrumentation.
 - 2. Section 40 67 63, Power Supply and Conditioning Equipment.
- C. Analyzer Instrument Specification Sheets, Supplement A, appended to the end of this Section.
- D. Analytical Measurement Instrument Schedules, appended to the end of this Section.

1.02 SUMMARY

- A. This section specifies requirements for analytical measurement instruments including process analyzer controllers, sensors, and related support systems.
- B. Supplement A, Analyzer Instrument Specification Sheets: General requirements for process analyzers and ancillary equipment shall be as specified by the Analyzer Instrument Specification Sheets, Supplement A.
- C. Supplement B, Analytical Measurement Instrument Schedule: Application requirements for process analyzers are specified in the respective Instrument Schedules, Supplement B.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with the requirements of Specification 40 70 00.

1.04 QUALITY ASSURANCE

- A. Quality assurance requirements as specified in Section 40 70 00.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to Supplements A and B appended to this Section.

PART 3 EXECUTION

3.01 GENERAL

- A. Refer to Section 40 70 00.

3.02 FIELD ADJUSTMENTS AND TESTING

- A. Commissioning: Analyzers shall be configured, calibrated, and tested by a field engineer in the direct employment of the analyzer manufacturer.

3.03 SUPPLEMENTS

- A. Supplement A, Analyzer Instrument Specification Sheets: The following Analyzer Instrument Specification Sheets are included in Supplement A:

<u>Instrument Designation</u>	<u>Instrument Description</u>	<u>Instrument Function</u>
AC1	Analyzer Controller	Controller
ACL	Chlorine Sensor	Chlorine Residual Measurement
APH	pH Sensor	pH Measurement
ATH	Turbidity Sensor, High Range	Turbidity Measurement
ATL	Turbidity Sensor, Low Range	Turbidity Measurement
AZT	Zeta Potential Analyzer	Zeta Potential Measurement

- B. Supplement B, Analytical Measurement Instrument Schedule: The following instrument schedules are included in Supplement B.

1. Table 40 75 00 B.1, Analytical Measurement Instrument Schedule.

END OF SECTION

TYPE DESIGNATION - AC1

SHEET 1 OF 1

FUNCTION	Water Quality Analyzer Controller
DESCRIPTION	Controller
POWER SUPPLY	As Scheduled
SIGNAL INPUT	Scheduled Sensors
SIGNAL OUTPUT	As Scheduled

PRODUCT DESCRIPTION

Microprocessor-based water quality sensor controller designed to interface with the specified water quality sensors. Controllers shall be capable of accepting both analog and digital sensors as well as 4-20 mA DC signals from third party instruments.

Controller shall have the following features:

- a. Menu driven operating system with two access security levels
- b. Integral graphic dot-matrix LCD display with LED backlighting
- c. Internal real-time clock
- d. Internal data logger
- e. Integral SD card reader

The controller housing shall have a NEMA 4X sealing rating. Controller shall be furnished with mounting hardware to facilitate wall, pipe, and panel mounting.

SOFTWARE

1. When Ethernet/IP digital communication interface is the scheduled output protocol the instrument manufacturer shall provide the following software.
 - a. Electronic Data Sheet (EDS): The EDS shall define the instrument input/output requirements within the PLC programming environment and provide the PLC cyclic access to the following data from the instrument. In addition the EDS definition shall include a connection fault status tag to allow real time monitoring of the health of the communication connection between the PLC and the instrument.
 1. Sensor value
 2. Sensor Errors
 3. Sensor Status

ACCESSORIES

1. Weather and sunshield Hach Product Number 9220600

ACCEPTABLE MANUFACTURERS	Hach sc4500 Digital Controller
Substitutions Permitted	No

TRAINING	2 Hours
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Supplement A
Analyzer Instrument Specification Sheets

TYPE DESIGNATION - ACL

SHEET 1 OF 1

FUNCTION	Water Quality Sensor
DESCRIPTION	Free Chlorine Residual Measurement
POWER SUPPLY	Derived from associated controller
SIGNAL INPUT	Process
SIGNAL OUTPUT	Digital interface with specified controller
PROCESS CONNECTION	Tubing connections for sample inlet, sample drain, and instrument drain

PRODUCT DESCRIPTION

General:

Chlorine residual analyzer shall continuously analyze a water sample and produce an output signal linearly proportional to free chlorine residual in the sample. The analyzer shall be microprocessor based and shall utilize colorimetric chemistry as the base method for measuring free chlorine residual. The analyzer system shall consist of a sample valve, flow cell, and buffer and indicator solutions housed in a NEMA 12 enclosure with the gasketed door. Analyzer shall have an integral liquid crystal display and membrane keypad. The enclosure shall have two clear polycarbonate windows for viewing the LCD display and reagent levels.

PERFORMANCE

Range	0.035 to 5 mg/l
Resolution	0.01 mg/l
Repeatability	0.05 mg/l
Accuracy:	±5 percent of reading

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Sample Conditioning Kit: Manufacturer's standard including pressure regulator, strainer, and shut-off valve.
2. Reagents: One (1) year supply of indicator and buffer reagents.
3. Maintenance Kit: One (1) year supply of pre-assembled tubing, caps, funnel, and fittings.
4. Calibration Kit: One (1) complete kit.

ACCEPTABLE MANUFACTURERS

Hach CL17sc

Substitutions Permitted

No

TRAINING

2 Hours

TYPE DESIGNATION – APH

SHEET 1 OF 2

FUNCTION	Water Quality Sensor
DESCRIPTION	pH Measurement
POWER SUPPLY	Derived from associated controller
SIGNAL INPUT	Process
SIGNAL OUTPUT	Digital interface with specified controller

PRODUCT DESCRIPTION

General:

pH sensor shall be an encapsulated sensor consisting of digital signal processor, pre-amplifier, reference electrode, measuring electrode, ground electrode, and replaceable salt bridge. The pH sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling-resistant characteristics. Sensor shall be designed for operation with the water quality analyzer controller specified herein.

The sensor shall have a hex-shaped body to facilitate mounting and shall be constructed of PEEK® material. This material shall enable the sensor to be installed in metal fittings without leakage usually caused by heating and cooling cycles when dissimilar materials are threaded together. The sensor shall have a convertible body style featuring threaded connections on both ends to facilitate mounting alternatives.

The sensor shall be equipped with an integral Pt 1000 RTD temperature compensator and 10-meter cable and plug for interfacing with the associated controller.

Process Connection:

1. The transmitter process connection shall be one of the following as scheduled in the Instrument Schedule.
 - a. Type 1, Flow Cell: Flow cell for remote sampling.
 - b. Type 2, Insertion: Insertion through a tank or pipe wall for direct contact with the process media. mounting hardware for through tank wall or pipe applications.
 - c. Type 3, Immersion: Immersion in an open basin, tank, or channel.

PERFORMANCE

Range	-2.0 to 14 pH
Repeatability	±0.05 pH
Sensitivity:	±0.01 pH

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Flow Cell: Flow cell for mounting the sensor with threaded sample inlet, outlet, and drain connections.

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Analyzer Instrument Specification Sheets

TYPE DESIGNATION – APH

SHEET 2 OF 2

2. Insertion Mounting Hardware: Insertion mounting kit for inline and highline insertion sensors, including ball valve, safety armature and extraction system.
3. Immersion Handrail Mounting Hardware: Handrail mounting kit with sensor adapter.

ACCEPTABLE MANUFACTURERS

Hach pHD sc DPD1P1

Substitutions Permitted

No

TRAINING

2 Hours

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Analyzer Instrument Specification Sheets

TYPE DESIGNATION – ATH

SHEET 1 OF 1

FUNCTION	Water Quality Sensor
DESCRIPTION	Turbidity Measurement, High Range
POWER SUPPLY	Derived from associated controller
SIGNAL INPUT	Process
SIGNAL OUTPUT	Digital interface with specified controller

PRODUCT DESCRIPTION

General:

Turbidity sensor shall utilize the nephelometric method of measurement and shall continuously measure turbidity in a water sample by detection of 90-degree scattered light from particles in the sample. The light shall be directed to the water surface, a glass window or flow cell shall not be used. The sensor shall utilize a single silicon photodiode to detect 90-degree scattered light. The optics of the turbidimeter shall not touch the sample at any time. The sensor assembly optical and hydraulic components shall be housed in a NEMA-12 industrial plastic enclosure. Hydraulic connections to the sample unit are at the bottom of the enclosure. An air purge fitting, to control internal condensation, is installed in the enclosure bottom.

PERFORMANCE

Range	0.1 to 9999 NTU
Repeatability	1.0%
Resolution:	Below 1000 NTU: 0.01 NTU Between 1000 - 9999.9 NTU: 0.1 NTU
Accuracy:	From 0 to 2000 NTU: the greater of $\pm 5\%$ of reading or 0.1 NTU From 2000 to 9999 NTU: $\pm 10\%$ of reading
Response Time:	Initial response in 45 seconds

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Bubble Trap Head Regulator	Hach Product Number 466800
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ACCEPTABLE MANUFACTURERS

Hach Surface Scatter 7 sc

Substitutions Permitted

No

TRAINING

2 Hours

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Analyzer Instrument Specification Sheets

TYPE DESIGNATION – ATL

SHEET 1 OF 1

FUNCTION	Water Quality Sensor
DESCRIPTION	Turbidity Measurement, Low Range
POWER SUPPLY	Derived from associated controller
SIGNAL INPUT	Process
SIGNAL OUTPUT	Digital interface with specified controller
PROCESS CONNECTION	Tubing connections for sample inlet, sample drain, and instrument drain

PRODUCT DESCRIPTION

Turbidity sensor shall utilize the nephelometric method of measurement and shall continuously measure turbidity in a water sample by detection of 90-degree scattered light from particles in the sample in a 360 degree radius around the incident light beam. The incident light source shall be sufficient to meet performance criteria for the measuring limit and sensitivity/resolution data designated below. The instrument shall have active predictive diagnostic capabilities that monitor and indicate overall health of the turbidimeter and time to next required maintenance. The electronic compartment shall be in an IP55 enclosure, the other functional units shall be in an IP65 enclosure with process head attached.

Sensor performance in conjunction with the specified controller shall meet or exceed the following specifications:

PERFORMANCE

Range	0 to 700 NTU
Repeatability	Better than 1% of reading or ± 0.002 NTU, whichever is greater
Resolution:	0.0001 NTU
Accuracy:	$\pm 2\%$ or 0.01 NTU from 0 to 40 NTU $\pm 10\%$ of reading from 40-100 NTU
Response Time:	<45 seconds at 100 mL/min

ACCESSORIES

The following accessories shall be provided for each instrument where a check mark (✓) appears in the associated accessory field of the Instrument Schedule.

1. Automatic Cleaning Module	Hach Product Number LQV159.97
2. Service Bracket	Hach Product Number LZY873
3. Flow Sensor	Hach Product Number LQV160.99
4. Bubble Trap	Hach Product Number LZY828.99
5. Calibration Lid	Hach Product Number LZY 904.97

ACCEPTABLE MANUFACTURERS

Hach TU5300sc

Substitutions Permitted

Yes

TRAINING

2 Hours

TYPE DESIGNATION – AZT

SHEET 1 OF 2

FUNCTION	Water Quality Sensor
DESCRIPTION	Zeta Potential Measurement and Coagulant Dose Control
POWER SUPPLY	Derived from associated controller
SIGNAL INPUT	Process
SIGNAL OUTPUT	Digital interface with specified controller
PROCESS CONNECTION	Tubing connections for sample inlet, sample drain, and instrument drain

PRODUCT DESCRIPTION

The zeta potential analyzer and controls shall provide fully automated coagulant dosing for turbidity control incorporating two components: a dosing control panel and an on-line zeta potential analyzer. The system shall also come with the software and programming to operate the zeta potential analyzer and control the coagulant dose.

The online zeta potential analyzer shall be a light-scattering instrument for characterizing particles in liquid dispersions. It shall measure particle size, zeta potential, electrophoretic mobility, molecular mass and transmittance. It shall offer forward, side or back-scattering measuring angles and continuously measure transmittance allowing for automatic adjustment of measuring parameters. The zeta potential analyzer shall be supplied with a flow module that is separate and removable and facilitates the use of a dosing system. The dosing system shall consist of a peristaltic pump and shall provide automatic dosing of the water sample and simultaneous measurement. The zeta potential analyzer and associated equipment shall be housed in a NEMA 12 enclosure. Operating software shall be supplied with the analyzer and report input parameters, measurements, results, final calculated values and dosing recommendations.

The dosing control panel and operating software shall include a programmable logic controller to control coagulant dose, a human machine interface mounted on the control cabinet, a network switch to allow for remote programming and monitoring via cell modem interface, and an industrial PC for the zeta potential analyzer operating software. The controller shall have operator adjustable alarm, analyzer reporting, and chemical dose set points or ranges. The controller shall communicate with the plant wide SCADA system via Ethernet/IP.

PERFORMANCE

Zeta Potential Analyzer

Particle Size Specifications

Range: 0.3 nm to 10 μ m

Repeatability: Better than 2.0% on NIST traceable standards

Accuracy: Better than 2.0% on NIST traceable standards

Zeta Potential Specifications

Measuring Range: $> \pm 1,000$ mV

Size Range: 3.8 nm to 100 μ m

Sensitivity: 0.1 mg/mL

Repeatability: $\pm 3\%$

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Analyzer Instrument Specification Sheets

TYPE DESIGNATION – AZT

SHEET 2 OF 2

Molecular Mass Specifications

Measuring Range: 980 Da to 20 MDa

Sensitivity: 0.1 mg/mL

Repeatability: $\pm 5\%$

Transmittance Specifications

Measuring Time: 10 seconds

ACCEPTABLE MANUFACTURERS

Zeta Potential Analyzer: Anton Paar Litesizer 500

Controller and Software: Marmac Water LowDose

Substitutions Permitted

No

TRAINING

4 Hours

Table 40 75 00 B.1
Water Quality Analyzer Instrument Schedule

Instrument Description					Process Conditions			Document Reference			
Tag Number	Service		Spec Designation		Media	Media Containment		Drawings	Details		
AIT 1060	Raw Water pH/Turbidity		AC1		Raw Water	Sample Line		P-1000 E-1000	2/I-2		
	Controller										
	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting	Sensor Quantity	Accessories			Notes	
							Surge Protection	UV Protect Screen	Sunroof Visor		
	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Wall	2					
AE 1060	Sensor 1										
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Accessories						
					Extension Cable	Flow Thru Mount	Insertion Mount	Immersion Mount	Handrail Hardware	Ball Float Hardware	Sample Flow Sensor
	pH	2 to 14 pH	Sample Tap	APH	✓		✓				
AE 1090	Sensor 2										
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Accessories						
					Extension Cable	Bubble Trap	Sample Flow Sensor				
	Turbidity	0 to 5000 ntu	Sample Tap	ATH	✓		✓				

Table 40 75 00 B.1
Water Quality Analyzer Instrument Schedule

Instrument Description					Process Conditions			Document Reference		
Tag Number	Service		Spec Designation		Media	Media Containment		Drawings	Details	
AIT 1070	Raw Water Zeta Potential		AZT		Raw Water	Sample Line		P-1000 E-1000		
	Controller									
	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting	Sensor Quantity	Accessories			Notes
							Surge Protection	UV Protect Screen	Sunroof Visor	
	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Wall	1				
AE 1070	Sensor 1									
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Accessories					
					Extension Cable					
	Zeta Potential	>± 1000 mV	Sample Tap	AZT						
Not Required	Sensor 2									
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Accessories					
					Extension Cable	Flow Thru Mount	Insertion Mount	Immersion Mount	Handrail Hardware	Ball Float Hardware

Table 40 75 00 B.1
Water Quality Analyzer Instrument Schedule

Instrument Description			Process Conditions			Document Reference	
Tag Number	Service	Spec Designation	Media	Media Containment		Drawings	Details
	Filter 1 Filtered Water Turbidity	AC1	Filtered Water	Sample Line		P-3100 E-1102	4/I-1
AIT 3183	Controller						
	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting	Sensor Quantity	Accessories
							Surge Protection UV Protect Screen Sunroof Visor
	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Wall	1	
AE 3183	Sensor 1						
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Cleaning Module	Service Bracket	Bubble Trap
							Calibration Lid Sample Flow Sensor
	Turbidity	0 to 10 ntu	Sample Tap	ATL	✓	✓	✓
Not Required	Sensor 2						
	Measurement Parameter	Measurement Range	Process Connection		Extension Cable	Flow Thru Mount	Insertion Mount
							Immersion Mount Handrail Hardware Ball Float Hardware Sample Flow Sensor

Table 40 75 00 B.1
Water Quality Analyzer Instrument Schedule

Instrument Description			Process Conditions			Document Reference	
Tag Number	Service	Spec Designation	Media	Media Containment		Drawings	Details
	Filter 2 Filtered Water Turbidity	AC1	Filtered Water	Sample Line		P-3200 E-1102	4/I-1
AIT 3283	Controller						
	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting	Sensor Quantity	Accessories
							Surge Protection UV Protect Screen Sunroof Visor
	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Wall	1	
AE 3283	Sensor 1						
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Cleaning Module	Service Bracket	Bubble Trap
							Calibration Lid Sample Flow Sensor
	Turbidity	0 to 10 ntu	Sample Tap	ATL	✓	✓	✓
Not Required	Sensor 2						
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Extension Cable	Flow Thru Mount	Insertion Mount
							Immersion Mount Handrail Hardware Ball Float Hardware Sample Flow Sensor
	ATH						

Table 40 75 00 B.1
Water Quality Analyzer Instrument Schedule

Instrument Description			Process Conditions			Document Reference	
Tag Number	Service	Spec Designation	Media	Media Containment		Drawings	Details
	Combined Filtered Water Turbidity	AC1	Filtered Water	Sample Line		P-3200 E-1000	4/I-1
AIT 4001	Controller						
	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting	Sensor Quantity	Accessories
							Surge Protection UV Protect Screen Sunroof Visor
	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Wall	1	
AE 4001	Sensor 1						
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Cleaning Module	Service Bracket	Bubble Trap
							Calibration Lid Sample Flow Sensor
	Turbidity	0 to 10 ntu	Sample Tap	ATL	✓	✓	✓
Not Required	Sensor 2						
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Extension Cable	Flow Thru Mount	Insertion Mount
							Immersion Mount Handrail Hardware Ball Float Hardware Sample Flow Sensor

Table 40 75 00 B.1
Water Quality Analyzer Instrument Schedule

Instrument Description					Process Conditions			Document Reference			
Tag Number	Service		Spec Designation		Media	Media Containment		Drawings	Details		
AIT 4266	Finished Water pH		AC1		Potable Water	Sample Line		P-4100 E-1000	5/I-1		
	Controller										
	Output	Power Supply	Enclosure Rating	Enclosure Material	Enclosure Mounting	Sensor Quantity	Accessories			Notes	
							Surge Protection	UV Protect Screen	Sunroof Visor		
	Ethernet/IP	120 volt AC	NEMA 4X	Coated Aluminum	Wall	2	Sensor 1, AE 4266, is an existing Hach CL17 sc.				
AE 4266	Sensor 1										
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Condition Kit	Reagents	Maint Kit	Accessories			
								Calibration Kit	Sample Flow Sensor		
	Chlorine Free Residual										
AE 4267	Sensor 2										
	Measurement Parameter	Measurement Range	Process Connection	Spec Designation	Extension Cable	Flow Thru Mount	Insertion Mount	Accessories			
								Immersion Mount	Handrail Hardware	Ball Float Hardware	Sample Flow Sensor
	pH	2 to 14 pH	Sample Tap	APH	✓				✓		

SECTION 40 79 00

INSTRUMENT VALVES, TUBING, FITTINGS AND SUPPORTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. This section specifies requirements for valves, manifolds, tubing, fittings and supports used in process instrumentation applications.

1.03 SUBMITTALS

- A. General: Submittals shall be provided in accordance with Specification 40 61 00.

1.04 QUALITY ASSURANCE

- A. Codes and Standards

- 1. ANSI Compliance: Provide products which comply with applicable ANSI standards including the following:
 - a. MSS SP-99, Instrument Valves

PART 2 PRODUCTS

2.01 VALVES

- A. Isolation Valves: Valves shall be full port ball valves with ASTM A276, 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Anderson Greenwood, Parker CPI, Whitey, Hoke, or approved equivalent.
- B. Gauge Valves: Gauge valves shall be block and bleed style, machined from type 316 stainless steel bar stock with Teflon packing, and shall be provided with an integral metal seat, 1/2-inch NPT male process connection, 1/2-inch NPT female instrument connection, and a A276-316 stainless steel bleed plug. Valves shall be Anderson Greenwood Instrumentation Products Model M9 or approved equivalent.
- C. Root Valves: Root valves shall be ASTM A276, type 316 straight grade stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, type 316 stainless steel bleed valve. ASTM276, type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson Greenwood Instrumentation Products Model M5(L) or approved equivalent.

- D. Manifolds: Manifolds shall be multi-valve bar-stock type. Manifold body shall be machined from ASTM, type 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Manifolds shall be designed for mounting on an instrument pipe stand. Associated pressure instrumentation shall be directly mounted to and supported from the valve manifold.
1. Three Valve Manifolds: Manifolds shall be designed for direct mounting to differential pressure transmitters and provided with flanged process connections. Manifold shall be provided with an integral test port. Manifolds shall be Anderson Greenwood Instrumentation Products M4 or approved equivalent.
 2. Two-Valve Manifolds: Manifolds shall be designed for block and bleed, test and calibration, and zeroing of gauge pressure instruments. Two ½ inch FNPT union connectors shall be provided on top of the manifold for instrument connections. One ½ inch NPT threaded port for process connection shall be provided. Vent/calibration ports shall be 1/4 inch NPT threaded connection and fitted with a type 316 stainless steel bleed valve. Unused process connection for single instrument installation shall be provided with a type 316 stainless steel plug. Manifolds shall be Anderson Greenwood Instrumentation Products Model MP2 or approved equivalent.

2.02 TUBING AND TUBING FITTINGS

- A. Tubing: Instrument tubing shall be ASTM A-269 type 316 seamless stainless steel. Tubing shall be 1/2-inch outside diameter by 0.035-inch wall thickness.
- B. Fittings: Tubing fittings shall be type 316 stainless steel. Fittings shall be of the swage ferrule design and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or approved equivalent.
- C. Flexible Coupling: Flexible coupling shall be 1/2-inch type 316 stainless steel braided hose with integral tube end adapters. Minimum coupling length shall be 12 inches.
- D. Tubing Support Systems: Tubing support system shall consist of a two-piece support body, cover plate with hex head bolts, rail nuts, and mounting rail. Cover plate, hex head bolts, rail nuts and mounting rail shall be of stainless-steel construction. Support body shall be of polypropylene construction. Support body size shall be selected to match the outside diameter of the tubing for each application. Tubing support system shall be as manufactured by Swagelok or approved equivalent.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which instrument valves, tubing, fittings and supports are to be installed. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 PROTECTION

- A. General: Protect installed components from damage. Replace damaged items prior to final acceptance.

3.03 INSTALLATION

A. Process Taps

1. Root valves shall be provided at all pressure taps.
2. Process connections shall be arranged, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels.
3. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
4. Where process taps are not readily accessible from instrument locations an isolation valve shall be provided at the instrument. Isolation valves shall also be provided for each instrument where multiple instruments are connected to one pressure tap.

B. Orientation: Valves and manifolds shall be provided as specified on the Drawings such that valve operating handles and ports are accessible for in-place testing and calibration.

C. Tubing supports shall be provided at 3-foot intervals for 1/4-inch tubing and 4-foot intervals for 1/2-inch tubing. Mounting rail length shall be 6 inches, minimum.

D. Cleaning and Fitting

1. Threaded connections shall be inspected on both the valve/manifold and the mating component for thread form and cleanliness.
2. Instrument tubing and valves shall be thoroughly flushed clean prior to operating any valves.

3.04 FIELD ADJUSTMENTS

A. Adjust all valves and manifolds to ensure valve elements operate freely across the full travel range of the valve.

3.05 TESTING

A. Instrument tubing and associated valving shall be pressure tested in accordance with Section 40 61 21.

END OF SECTION

SECTION 43 21 39

SUBMERSIBLE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish, install, start-up and test submersible non-clog pumps including all ancillary items and equipment as shown in the Drawings and as specified herein to provide a fully functioning pumping system.

1.02 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 and Section 11 00 00. The following additional submittals shall be provided in accordance with Section 01 33 00:
1. In addition to the requirements of Section 11 00 00, submit results of pump and motor tests as specified herein.
 2. Pump hoist drawings.
 3. Factory pump test curves as specified in Specification 11 00 00.

1.03 REFERENCES

- A. Industry standard references including but not limited to those listed shall be noted, as applicable, in this specification and shall be considered a part of this specification. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM A48/A48M-03	Standard Specification for Gray Iron Castings
ASTM A276-04	Standard Specification for Stainless Steel Bars and Shapes

1.04 QUALITY ASSURANCE

- A. Manufacturer's Experience. Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The equipment and all ancillary components shall be designed, supplied and warranted as a unit item by a single manufacturer or vendor.
- B. Warranty. As specified in Section 11 00 00.

1.05 EQUIPMENT SCHEDULE

Location	Type	Equipment No.
Backwash Tank Wet Well	Submersible, rail-mounted, non-clogging	P 3410
Backwash Tank Wet Well	Submersible, rail-mounted, non-clogging	P 3420

1.06 SERVICE CONDITIONS

- A. Fluid temperature is expected to range from 0 to 100 degrees Fahrenheit.
- B. The equipment will be installed under the slab of the process building at a water treatment plant located in Silt, Colorado. Approximate elevation at the site is 5,456 feet above mean sea level. All equipment furnished under this Section shall be suitable for the specified installation location, and shall be suitable for continuous daily (24-hours per day) service.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired. Acceptable manufacturers include Flygt or Engineer-approved equal, modified to meet the requirements of this specification. All pumps shall be the same manufacturer.

2.02 GENERAL

- A. This Section specifies a NSF61 certified submersible pump complete with electric motor and all specified appurtenances. Pumps shall be of the submersible, centrifugal non-clog type for use in pumping treated water. The pump and motors shall be suitable for the service specified. Pumps and motors will be submerged for extended periods of time.

2.03 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Performance Requirements

Criteria	Value
Equipment Number	P-3410 & P-3420
Description	Backwash Water Pumps
Discharge pipe size, inches	8" flanged
MAXIMUM SPEED OPERATION	
Condition A- Low Head	
Capacity, gpm	2880
Total Head, feet	55
NPSHA, feet	27
Minimum Efficiency, %	70
Condition B- High Head	
Capacity, gpm	2880
Total Head, feet	48
Efficiency, %	N/A
MINIMUM SPEED OPERATION	
Condition C- Low Head	
Capacity, gpm	1440
Total Head, feet	27
Efficiency, %	N/A

Criteria	Value
Condition D- High Head	
Capacity, gpm	1440
Total Head, feet	34
Efficiency, %	N/A
Motor	
Motor Output Rating, HP (maximum)	60
Motor Speed, rpm (maximum)	1170
Motor Voltage and Phase	460/3
Motor Inverter Duty Rated	Yes

B. Notes

- Condition A shall be taken as the rated, continuous-duty operating condition for the high flow portion of the backwash sequence. Performance at the rated condition shall be guaranteed in accordance with tolerances set forth in the Test Standards of the Hydraulic Institute, except that any increase in head or capacity or both which results in a power requirement greater than the pump motor's nameplate rating will be cause for rejection.
- Condition B is presented to indicate operating conditions when the pump is operating against minimum anticipated system head at maximum speed. This could occur if the water level in the tank is low but the high flow rate is still needed for backwashing. Pumps with steeper head-capacity curves will produce less flow at this head. The reverse will occur with pumps having a shallower head-capacity curve.
- Condition C is the anticipated continuous-duty minimum speed condition for the low flow rate portion of the backwash sequence. Pumps furnished under this specification shall be capable of sustaining operation with no damage to bearings, shafts, shaft sleeves or stationary rotating parts. Pumps with head-capacity curves steeper than that assumed will produce slightly less flow at this head. The reverse will occur with pumps having a shallower head-capacity curve.
- Condition D represents the operating conditions when the pump is operating at the low flow backwash rate with a low water level in the backwash tank.
- Note. Total head in the above tabulation is the algebraic difference between the suction head and the discharge head including 7 psi required at the backwash connection to the tank and as defined in the standards of the Hydraulic Institute. Net positive suction head available (NPSHA) in the above tabulation is referred to project's elevation and is calculated in accordance with Hydraulic Institute standards for the worst combination of fluid temperature and barometric pressure.
- The pump shall be designed to operate without cavitation and the motor and pump combination shall operate without vibration over the specified range of conditions. The pump head capacity curve shall slope in one continuous curve with no point of reverse slope inflection.
- The motor shall be non-overloading at all points on the pump head/capacity curve. Pump selections which do not conform to this requirement without requiring a motor with a nameplate rating greater than that listed are not acceptable

2.04 MATERIALS OF CONSTRUCTION

Component	Material
Pump and motor	Cast iron, A48

Component	Material
Casing discharge	Cast iron, A48
Impeller	Hard-iron, A48
Nuts and bolts	Stainless Steel, ASTM A276 Type 304
Shaft	Stainless Steel, ASTM 276 Type 300

2.05 EQUIPMENT FEATURES

- A. Pump Design. The pump shall be capable of pumping treated water. The discharge elbow shall be permanently installed with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the pump well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a metal watertight contact. Sealing of the discharge interface by means of a diaphragm, O-ring or other device will not be acceptable. No portion of the pump shall bear directly on the floor of the sump, and there shall be no more than one 90-degree bend allowed between the volute discharge flange and sump piping. Guide bars, which shall steer the pump into proper contact with the discharge elbow, shall be non-adjustable and shall not bear the weight of the pump.
- B. Pump Construction
1. Major pump components outside of the impeller shall be a gray cast iron, ASTM A-48 class 30, with smooth surfaces void of blow holes and other irregularities. Where watertight sealing required, O-rings made of nitrile rubber shall be used. All exposed nuts and bolts shall be made of 304 stainless steel. The interior shall be sprayed with a PVC epoxy primer and the exterior sprayed with an epoxy primer and chloric rubber paint finish.
 2. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Fittings shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of nitrile rubber O-rings without the requirement of a specific torque limit. No secondary compounds, gaskets, elliptical O-rings, grease or other devices shall be used.
- C. Cable Seal. The cable entry water seal design shall preclude specific torque requirements to insure water tight and submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder. The cable stator lead sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top. The cable entry must be field serviceable therefore, epoxies, silicones, or other secondary sealing systems shall not be considered acceptable to the compression grommet with strain relief cable entry system specified above.
- D. Wear Rings. A wear ring system shall be installed to provide efficient sealing between the volute and impeller. The ring shall consist of a stationary ring made of nitrile rubber molded with a steel ring insert drive-fitted to the volute inlet. An impeller wear ring of 329 stainless steel shall be shrink-fitted to the impeller hub.
- E. Mechanical Seal. Pumps shall be provided with mechanical seals meeting the requirements of Section 11 00 00.

- F. Impeller. The impeller shall be hard-iron ASTM A-48 class 30, dynamically and hydraulically balanced single suction, one piece, enclosed non-clogging type. The impeller shall be locked to the impeller shaft and shall isolate the shaft from the pumped fluid.
- G. Bearings. Motor bearings shall be designed such that the computed ABMA B-10 life rating is not less than 40,000 hours. Bearings shall be permanently lubricated. The pump shaft shall rotate on two permanently lubricated bearings. The upper bearing shall be a single row deep groove ball bearing and the lower bearings shall be double row angular contact ball bearings.
- H. Motor
1. Motor shall be a NEMA type B squirrel-cage induction shell type design housed in an air filled watertight chamber. Motors shall be specifically designed for inverter service for the speed range and load torque characteristic required by the associated driven equipment. Motors shall be designed to operate over the speed or frequency range specified. Motor insulation shall be Class H trickle impregnated designed to meet NEMA MG 1, Part 31 (1600 volt peak at a minimum of 0.1 microsecond rise time). The motor shall be designed for continuous duty, capable of sustaining a minimum of 15 starts per hour. The temperature rise of the motor shall not be in excess of that specified in NEMA Standard MG-1 for Class B insulating materials when operating continuously under load. The junction chamber, containing the terminal board, shall be hermetically sealed from the motor by an elastomer compression O-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board. The motor stator shall be shrink fitted into the motor housing and shall not require bolts to hold it in place against axial and radial movement.
 2. The combined service factor (combined effect of voltage, frequency, specific gravity, etc.) shall be 1.15. The motor shall have a voltage tolerance of plus or minus 10% and a frequency tolerance of plus 5%. The motor shall be rated for operation in a 40 degree C ambient temperature.
 3. The submersible electrical cable shall be type SPC and be of sufficient length to reach the termination point indicated on the Drawings plus five feet. The cable shall have shielded power conductors suitable for use with pulse-width-modulated VFD controllers and two control conductors for interfacing to the motor overtemperature and moisture sensors. The material shall be hypalon jacketed, rated for 90 degrees C and the insulation shall be nardel. Wicking fillers shall not be accepted. The motor and cable shall have watertight integrity to a depth of 65 feet.
 4. The maximum motor horsepower shall be as specified in paragraph 43 21 39-2.03. The actual horsepower shall be adequate throughout the range of the published curve without overloading.
 5. The motor shall be provided with a overtemperature and moisture protection system consisting of stator overtemperature and seal leakage sensors in the motor housing and a remote mounted supervisory relay. The overtemperature and moisture protection system shall measure current through the sensors using a protected noise-filtered electronic circuit. Motor sensor shall be connected to the remote supervisory relay via a two-wire circuit. The supervisory relay shall have two Form C contacts for independent indication of overtemperature and leakage. Contacts shall be NEMA B300 pilot duty rated 3 amperes, 240 volt AC. The supervisory relay shall have a Manual/Auto reset selector switch and in the manual reset mode shall be reset via a push button on the face of the relay. Supervisory relay shall operate at 120 volts AC and shall be suitable for semi-flush through-door mounting in the door of the motor control center unit serving the pump. Supervisory relay shall be shipped loose for installation as shown on the Drawings.

- I. Explosion Proof Service. The pump system and appurtenances, including the pump, motor and wiring, shall be approved by a nationally approved testing agency for explosion proof service. The system shall be created for Class 1, Division 1 group C and D service as determined by the National Electrical Code and approved by a nationally recognized testing agency (U.L. or F.M.) at the time of bidding of this project.
- J. Upper Guide Bar Bracket. Furnish and install an upper guide bar bracket for each pump with integral hook to hold the hoisting cable. The materials of construction shall be 316 stainless steel. The guide rail pipes shall be furnished in the same material as the upper guide bar bracket. Two pipes are required per pump to act as guide rails. One-guide rail pipe systems are not acceptable.
- K. Mounting Assembly
 - 1. A mounting assembly shall support each pump during operation and guide the unit during installation or removal. Each assembly shall consist of guide brackets, a guiding mast, and a suitable length of support cable. A minimum of three (3) guide brackets shall be provided. Each system shall be constructed as a safe-slide system, providing an overall system height as indicated on the Drawings.
 - 2. One (1) manual hoist shall be furnished to assist in installation, removal, or adjustment of any of the pumps. Each hoist shall be of carbon steel construction and shall include a winch. One (1) lifting cable shall be attached to each pump, which will be threaded onto the winch spool when the pump requires lifting. Each cable's length shall be at least 1.25 times the overall system height. Each assembly shall be capable of lifting the heaviest pump provided in this section.
 - 3. Four (4) platform or wall socket assemblies shall be provided, one for each pump. The Contractor shall coordinate with the Engineer, pump manufacturer, hoist supplier, and any adjacent hand railing, grating, or checker plate installation to ensure the socket is located correctly. The socket shall be located so as to allow for easy hoist removal around the hand railing. The socket shall be located the same distance from each pump so the hoist can be used interchangeably at each pump without setting adjustment.

2.06 SPARE PARTS

- A. The following spare parts shall be furnished for each part type and size specified in this Section. Spare parts shall be tagged and stored as specified in Section 11 00 00.

- 1 – set of all O-rings
- 1 – set of bearings
- 1 – set of wear rings
- 1 – set of mechanical seals

PART 3 EXECUTION

3.01 GENERAL

- A. Installation, start-up and testing shall be conducted in accordance with Section 01 91 13 and Section 11 00 00.

3.02 TESTING

- A. After completion of the installation and manufacturer's certification, equipment shall be field tested to demonstrate compliance with the requirements specified. Testing of equipment shall be conducted in accordance with the requirements of Sections 01 91 13 and 11 00 00.

3.03 FIELD SERVICE

- A. Provide the service of a qualified representative for one (1) trip and one (1) day to inspect the mechanism installation, assist in start-up, and instruct plant personnel in the operation and maintenance of the mechanism.

3.04 TRAINING

- A. Training shall be conducted in accordance with Section 01 79 00 and Section 11 00 00. Training shall consist of a minimum of one 2-hour session addressing the theory of operation, testing, troubleshooting, and maintenance of the system.

END OF SECTION

SECTION 43 41 45

FIBERGLASS REINFORCED POLYESTER STORAGE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section covers the design, fabrication, and testing of fiberglass reinforced polyester (FRP) storage tanks for storage of solutions noted under Section 43 41 45-1.06. The FRP tank equipment shall include bulk storage tanks, flange connections, blind flanges, vent connections, fasteners, couplings, hold down lugs, anchor bolts, and other accessories specified herein.

1.02 SUBMITTALS

- A. Submit shop drawings, product data, materials of construction, and details of installation in accordance with Section 01 33 00. All submitted information must include a certification that the submittal describes exactly the equipment to be provided and substitutions subsequent to submittal approval shall not be tolerated. Submittal data shall include:
1. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Include complete resin system information.
 2. Tank data indicating equipment number, pressure rating, diameter, straight shell length, overall length, wall thickness, corrosion barrier thickness, and details of nozzle designs.
 3. Fabricator's detailed requirements for tank foundations and anchors including any foundation pad block-out requirements.
 4. Recommended bolt torques for all bolted FRP connections.
 5. Fabricator's Certificate of Compliance with fabrication requirements.
 6. Resin manufacturer's written statement that the recommended resin is suitable for specified service.
 7. Resin manufacturer's descriptive literature for recommended resin including chemical resistance tables.
 8. Recommended gasket material.
 9. Special shipping, storage and protection, and handling instructions.
 10. Fabricator's written/printed installation and tank support instructions.
- B. See Chemical Storage Tank Appurtenance Schedule and Chemical Tank Standard Drawing following this Section.

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. ASTM D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
 2. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
 3. ASTM D3299 - Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

- B. American National Standards Institute (ANSI)
 - 1. ANSI B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24
- C. International Building Code (IBC)
 - 1. IBC 2012 Edition
- D. Occupational Safety and Health Administration (OSHA)
 - 1. OSHA 2206; 1910.27 - General Industry Safety and Health Standards; Fixed Ladders

1.04 QUALITY ASSURANCE

- A. All materials shall be new and of the best quality of their respective kinds.
- B. Warranty: The storage tanks specified herein shall be warranted against defects in materials and workmanship for a period beginning at the time of purchase and in effect for (5) full years from the date of start-up. During the warranty period, the tanks will be repaired or replaced at no cost to the Owner.
- C. Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The system shall be designed, supplied and warranted as a unit system by a single manufacturer or vendor.
- D. Hardness Test: Measure Barcol hardness according to ASTM D2583. Barcol hardness must be a minimum of 90% of manufacturer's recommendation. This requirement applies to both interior and exterior surfaces.
- E. Acetone Sensitivity Test: An acetone sensitivity test shall be performed by rubbing a small amount of acetone on a laminate surface until the acetone evaporates. If the surface becomes softened or tacky, the surface shall be considered insufficiently cured.
- F. Visual Inspection: The visual inspection shall be made of all surfaces for laminate defects according to ASTM D2563.
- G. Shop Leak Test: Hydrostatic leak test with the tank full of clean water to overflow level. Allow water to stand for 24 hours to verify no leakage before shipping tank. Provide written report to Engineer within 7 days.
- H. Field Leak Test: Hydrostatic leak test with the tank full of clean water to overflow level. Allow water to stand for 24 hours to verify no leakage before shipping tank. Provide written report to Engineer within 7 days.
- I. Other Tests: Fabricator shall maintain records of tensile and flexural strength tests and glass content tests by an independent laboratory on sample specimens for purchaser's review.

1.05 EQUIPMENT SCHEDULE

Item	Equipment Number	Inside Diameter (ft.)	Top of Sidewall Height (in.)	Top of Tank Height (in.)	Overflow Height (in.) ¹	Nominal Capacity (gallons)	Cover Type
ACH Tank	T 8501	8	101	109	90	2,000	Conical

¹ Overflow height is to center line of overflow pipe.

1.06 SERVICE CONDITIONS

- A. Tanks shall be installed indoors at a water treatment plant in Silt, CO.
- B. Tanks shall be used to store chemicals as listed below:

Liquid	pH	Specific Gravity	Temperature Degrees F	Gasket Material	Special Notes
ACH 50%	3.5	1.33-1.35	40-100	EPDM	

- C. Operating pressure: atmospheric.

PART 2 PRODUCTS

2.01 GENERAL

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
 - 1. Acceptable tank manufacturers include Design Tanks Inc., Sioux Falls, SD; Palmer Tanks, Garden City, KS; Ershigs, Bellingham, WA; or Engineer-approved equal.
 - 2. Acceptable resin manufacturers include Ashland, Reichold, Interplastic, or Engineer-approved equal.
- B. Tanks shall be fabricated by the chop/hoop filament wound process and shall be free of pits, foreign inclusions, dry spots, air bubbles, pinholes, pimples and delaminations.
- C. All materials shall be new and of the best quality of their respective kind.
- D. Tanks shall be fabricated in accordance with ASTM D3299 for filament-wound tanks.
- E. Seismic loading shall be per the IBC 2012 Seismic Design Category C with the tank full.
- F. Shell thickness design shall be determined based on a full tank of liquid of specific gravity listed under the heading Service Conditions specified herein.
- G. In no case shall the minimum total wall thickness be less than ¼ inch.
- H. Tanks shall be of flat bottomed construction and continuously supported.
- I. Tank tops shall be designed for a live load of not less than 250 lb. in a 4" x 4" area and shall be provided with stiffener ribs, thickening of heads, or other means to provide structural rigidity as necessary. Any steel shall be protected from the chemical stored.
- J. The exterior surface shall be relatively smooth with no exposed fibers, sharp projections, air bubble dry spots, pinholes, pimples, or delamination.
- K. Each tank top shall have grit incorporated into the final exterior resin layer to provide a non-slip surface.
- L. Tolerances on tank diameter and height shall be in accordance with ASTM D-3299.

2.02 RESIN

- A. The resin shall be selected by the manufacturer and will be specified in the resin supplier's corrosion guide for the service provided.
- B. The resins to be used are to be commercially available vinylester and are not to contain pigments or fillers unless otherwise specified. Only original manufactured top-grade resins shall be acceptable; no reconstituted or remanufactured resins shall be acceptable.
- C. The resins and curing techniques to be used are the responsibility of the tank supplier. The supplier is responsible for verifying the adequacy of these resins from published test results and technical publications for the specified service.
- D. The resins to be used shall be suitable for the intended service.
- E. 0.25 percent by weight ultraviolet light absorber is to be added to all tanks.
- F. Wax must be added to the final resin layer to prevent air inhibition.
- G. Tanks shall be designed and constructed for continuous, 24 hour per day service.

2.03 LAMINATE

- A. Chop/hoop filament wound tanks shall have a minimum of the following physical properties:

Property	Minimum Value
Tensile strength, axial direction (psi)	13,500
Flexural strength, axial direction (psi)	33,600

- B. The laminate shall consist of an inner surface, an interior layer, and an exterior layer or structural laminate.
- C. The inner surface shall be free of cracks and crazing, with a smooth finish. Between 7 and 20 mils of reinforced resin rich surface shall be provided. This surface is reinforced with glass surfacing veil or a synthetic fiber veil.
- D. All cut edges shall be coated with resin so that no glass fibers are exposed and all voids are filled. The resin used shall be that designated in the tank design materials and must contain paraffin to assure adequate surface cure.
- E. A minimum of 90 mil of laminate is required in the corrosion barrier.
- F. The overall glass content of hand laminated construction shall be between 27 and 33 percent by weight of noncontiguous glass strands having fiber lengths from 0.5 to 2.0 inches. No glass fibers shall be exposed at any surface.
- G. The structural wall glass content of filament wound laminate construction shall be about 50 percent by weight.
- H. The laminate shall be allowed to cure to a tackfree condition at ambient temperature prior to any post cure.

2.04 REINFORCEMENT

- A. Interior Barrier: Resin-rich interior surface of nominal 90 to 100 mils using chopped type E glass. Glass to resin ratio shall be 30/70. Use no additive in the interior barrier.
- B. Chopped strand mat shall be Type E (electrical borosilicate) glass, minimum 1-1/2 oz./sq. ft., with silane finish and a styrene soluble reactive binder.
- C. Chopped roving will be a Type E glass with a silane type finish.
- D. Woven Roving: Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.
- E. Continuous roving used for filament winding: Type E glass with saline type finish, with a nominal yield of at least 110 strand yards per pound. Glass to resin ratio for the structural wall shall be 50/50.
- F. Exterior Corrosion Barrier: When required by the manufacturer for a given chemical service, an exterior corrosion barrier is to be added to the tank wall. Chopped Type E glass is to be used with resin for a thickness of 45 mils, and the glass to resin ratio shall be 70/30.

2.05 TANK CONNECTIONS AND APPURTENANCES

- A. Nozzles shall be of hand-lay-up construction with the flange and size neck molded as one integral unit.
- B. All flanged nozzles shall be ANSI B-16.5 150 lb, rated at 150 psi with dimensions appropriate for pressure rating. All connections are single flange connections with the flange on the outside of the tank.
- C. Bolt holes in flanges are to straddle the vertical centerline.
- D. Nozzles shall be gusseted with conical type gussets, with the exception of the manway.
- E. Two gaskets for each nozzle. Gaskets shall be 1/8-inch thick full-face elastomeric material having a hardness of Shore A60 plus or minus 5. Gasket material shall be suitable as recommended by the tank manufacturer for the intended service as specified herein.
- F. The back face of all flanges shall be spot-faced, flat and parallel to the flange face of sufficient diameter to accept an SAE metal washer under the bolt head or nut.
- G. All connections on equipment and tanks will be FRP flanged unless otherwise specified.
- H. All covered tanks shall be fitted with integral FRP "Unistrut" or equivalent conduit brackets, 3 inches in length, capable of accepting standard conduit/pipe fastening hardware. Conduit brackets shall be installed on 48-inch intervals across the top of the tank from within 12 inches of the level transmitter nozzle to within 12 inches of the tank wall adjacent to the building structure. Refer to Chemical Tank Standard Drawing following this Section.
- I. All cured resin surfaces where parts are to be joined shall first be roughened by sanding or grinding. The roughened area shall extend beyond the work area so that no lay-up is made in a mold surface. Surfaces shall be clean and dry before lay-up. The entire roughened area must be resin coated when the joint is made.

- J. All cut edges exposed to the chemical environment shall have a chemical resistant liner consisting of two mats and a veil. No cloth or woven roving shall be used for this purpose.
- K. Install all appurtenances as indicated on the Chemical Storage Tank Appurtenance Schedule and Standard Drawing following this section.
- L. Provide access ladders designed to meet OSHA standards (OSHA 2206; 1910.27) for fixed ladders. Support ladders on the tank, allowing for tank expansion and contraction due to temperature and loading changes. Ladders shall be removable.
- M. Provide 1-inch diameter blind flanged taps for sight glass connection; do not provide a sight glass.
- N. Hold down lugs shall be provided and shall be capable of allowing for tank expansion and contraction due to temperature and loading changes. Anchor bolt diameter shall be in accordance with manufacturer's written recommendations. Anchor bolts and plates shall be in accordance with Section 05 50 10. Materials and/or coatings to be chemically compatible with the Service Conditions specified herein. See Section 09 90 00 for coating schedule.
- O. Type 316 stainless steel lifting lugs shall be supplied by manufacturer.
- P. Manways: Provide 24-inch diameter manways with full-face gasket of material compatible with intended service.
- Q. Provide gallonage tape with 500-gallon increments for local tank level indication.

PART 3 EXECUTION

3.01 GENERAL

- A. The manufacturer shall assume responsibility for packaging to prevent transit and handling damage, including preventing cracking or spidering of any tank surface.
- B. Store tanks in accordance with the manufacturer's written instructions. Store tanks on surfaces completely free of debris to prevent damage to any tank surface. If stored outside, tanks shall be protected from direct sunlight and freezing. Tanks shall be sufficiently anchored to prevent damage by wind.
- C. All bottom tank ports and drains shall be specially protected against damage during shipping and storage.
- D. The Contractor shall install the complete chemical storage and mixing tank systems where shown on the Drawings and as specified. The Contractor shall install each system component in strict conformance with the manufacturer's written recommendations. Any discrepancies shall be immediately brought to the Engineer's attention.
- E. Damaged or defective areas which are otherwise acceptable to the Engineer shall be repaired in a manner satisfactory to the Engineer.

3.02 INSTALLATION

- A. Install in accordance with the manufacturer's written instructions.

- B. The tank pad shall be smooth and level to within 1/8" over a 10-foot span, or as recommended by the tank manufacturer.
- C. The Contractor shall coordinate foundation pad block outs with the tank manufacturer.
- D. Ensure that the installation surface is completely free from any debris including sand, gravel, rocks, or any construction related material. If required by the manufacturer, provide any additional materials required for proper installation of the tank.
- E. Accurately place anchor bolts after tanks are set in place.

3.03 SCHEDULING

- A. All certification of factory tests and materials shall be submitted and approved by the Engineer before shipping any equipment.

END OF SECTION

SECTION 43 41 48

CROSSLINKED POLYETHYLENE STORAGE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section covers the design, fabrication, and testing of high density crosslinked polyethylene (XLPE) storage tanks for storage of solutions noted under Section 43 41 48-1.06. The XLPE tank equipment shall include bulk storage tanks, flange connections, blind flanges, vent connections, fasteners, couplings, hold down lugs, anchor bolts, and other accessories specified herein.

1.02 SUBMITTALS

- A. Submit shop drawings, product data, materials of construction, and details of installation in accordance with Section 01 33 00. All submitted information must include a certification that the submittal describes exactly the equipment to be provided and substitutions subsequent to submittal approval shall not be tolerated. Submittal data shall include:
1. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Include complete resin system information.
 2. Tank data indicating equipment number, pressure rating, diameter, straight shell length, overall length, wall thickness, corrosion barrier thickness, weight, and details of nozzle designs.
 3. Wall thickness calculations made per ASTM D1998-99 using 600 psi design hoop stress at 100 degrees Fahrenheit.
 4. Fabricator's detailed requirements for tank foundations and anchors including any foundation pad block-out requirements.
 5. Recommended bolt torques for all bolted XLPE connections.
 6. Fabricator's Certificate of Compliance with fabrication requirements including water test results.
 7. Resin used and manufacturer's written statement that the recommended resin is suitable for specified service.
 8. Resin manufacturer's descriptive literature for recommended resin including chemical resistance tables.
 9. Recommended bolt and gasket materials.
 10. Corrosion data for all materials in contact with the media.
 11. Special shipping, storage and protection, and handling instructions.
 12. Fabricator's written/printed installation and tank support instructions.
- B. See Chemical Storage Tank Appurtenance Schedule and Chemical Tank Standard Drawing following this Section.

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. D648 Heat deflection temperature

2. D638 Tensile properties
 3. D790 Flexural properties of plastic
 4. D883 Definitions of terms relating to plastics
 5. D1505 Density by density gradient technique
 6. D1693 Environmental stress crack resistance
 7. D1921 Particle size (sieve analysis) of plastic
 8. D2765 Degree of cross-linking ethylene plastics as determined by solvent extraction
 9. D2837 Standard method for obtaining hydrostatic design basis for thermoplastic pipe materials
 10. D3892 Practice for packaging/packing of plastics
 11. F412 Definitions of terms relating to plastic piping
 12. ARM Std. Low temperature impact resistance (Falling dart test)
- B. American National Standards Institute (ANSI)
1. ANSI B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24
- C. International Building Code (IBC)
1. IBC 2015 Edition
- D. Occupational Safety and Health Administration (OSHA)
1. OSHA 2206; 1910.27 - General Industry Safety and Health Standards; Fixed Ladders
- 1.04 QUALITY ASSURANCE
- A. All materials shall be new and of the best quality of their respective kinds.
- B. Warranty: The storage tanks specified herein shall be warranted against defects in materials and workmanship for a period beginning at the time of purchase and in effect for (5) full years from the date of start-up. During the warranty period, the tanks will be repaired or replaced at no cost to the Owner.
- C. Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The system shall be designed, supplied and warranted as a unit system by a single manufacturer or vendor.
- D. Impact test, falling dart test, gel test, visual inspection, and water tests performed per ASTM D1998, this specification, and other applicable ASTM standards.
- E. Shop Leak Test: Hydrostatic leak test with the tank full of clean water to overflow level. Allow water to stand for 24 hours to verify no leakage before shipping tank. Provide written report to Engineer within 7 days.
- F. Field Leak Test: Hydrostatic leak test with the tank full of clean water to overflow level. Allow water to stand for 24 hours to verify no leakage before shipping tank. Provide written report to Engineer within 7 days.

- G. Other Tests: Fabricator shall maintain records of tensile and flexural strength tests by an independent laboratory on sample specimens for purchaser's review.

1.05 EQUIPMENT SCHEDULE

Item	Equipment Number	Inside Diameter (ft.)	Top of Sidewall Height (in.)	Top of Tank Height (in.)	Overflow Height (in.) ¹	Nominal Capacity (gallons)	Cover Type
Sodium Hydroxide Tank	T 8401	10	172	184	162	7,500	Conical

¹ Overflow height is to center line of overflow pipe.

1.06 SERVICE CONDITIONS

- A. Tanks shall be installed indoors at a water treatment plant in Silt, CO.
- B. Tanks shall be used to store chemicals as listed below:

Liquid	pH	Specific Gravity	Temperature Degrees F	Special Notes
Sodium Hydroxide 25-52%	14	1.5	60-100	Tank insulation and heating system

- C. Operating pressure: atmospheric.

PART 2 PRODUCTS

2.01 GENERAL

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- Acceptable tank manufacturers include Poly Processing Company, Monroe, LA; Assman Corporation of America, Garrett, Indiana; or Engineer approved equal.
 - Acceptable resins shall be Marlex supplied by Phillips 66 or Engineer-approved equal.
- B. XLPE tanks shall be vertical, cylindrical, flat bottom, and dome top.
- C. The resin used shall be virgin crosslinked polyethylene that is FDA conforming.
- D. No fillers shall be added to the resin.
- E. Resins shall not be exposed to temperatures higher than the manufacturers recommended maximum.
- F. All tanks shall contain a suitable ultraviolet stabilizer. The stabilizer shall be compounded into the polyethylene.
- G. All materials shall be new and of the best quality of their respective kind.

- H. Tanks shall be fabricated in accordance with ASTM D1998 Type I. The tanks shall be manufactured by the rotational molding process.
- I. Nominal values for properties of crosslinked plastic material shall be as follows;

Test Procedure	Unite	Value
Tensile Strength at Yield ASTM D-638	psi	3,000
Elongation at Break (%) ASTM D-638	%	>300
Tensile Modulus of Elasticity ASTM D-638	psi	115,000
Flexural Modulus ASTM D790	psi	100,000
Impact Brittleness Temperature ASTM D746	°F	<-180
Heat Deflection Temperature ASTM D648	°F	@66 psi - 150
Vicat Softening Temperature ASTM D1525	°F	250
Environmental Stress Crack Resistance ASTM D1693	Hours	>1,000
Notched Izod ASTM D256	ft-lb/in	17
Notched Izod (-40 °C) ASTM D256	ft-lb/in	4.5
Bulk Density	lbs/ft	23

- J. Seismic loading shall be per the IBC 2015 Seismic Design Category C with the tank full.
- K. Shell thickness design shall be determined based on a full tank of liquid of specific gravity listed under the heading Service Conditions specified herein using the Barlow Formula and a minimum factor of safety shall be 2.
- L. In no case shall the minimum total wall thickness be less than ¼ inch.
- M. Tanks shall be of flat bottomed construction and continuously supported.
- N. Tank tops shall be designed for a live load of not less than 250 lb. in a 4" x 4" area and shall be provided with stiffener ribs, thickening of heads, or other means to provide structural rigidity as necessary. Any steel shall be protected from the chemical stored.
- O. The exterior surface shall be relatively smooth with no visual defects such as foreign inclusions, air bubbles, pin holes, and crater.
- P. Tank top shall have grit incorporated into the final layer to provide a non-slip surface.
- Q. Tolerances on tank diameter and height shall be in accordance with ASTM D-3299.

2.02 RESIN

- A. The resin shall be selected by the manufacturer and will be specified in the resin supplier's corrosion guide for the service provided.
- B. The resins to be used are to be commercially available polyethylene and are not to contain pigments or fillers unless otherwise specified. Only original manufactured top-grade resins shall be acceptable; no reconstituted or remanufactured resins shall be acceptable.
- C. The resins and curing techniques to be used are the responsibility of the tank supplier. The supplier is responsible for verifying the adequacy of these resins from published test results and technical publications for the specified service.
- D. The resins to be used shall be suitable for the intended service.
- E. Minimum 0.25 percent by weight ultraviolet light absorber is to be added to all tanks.

F. Tanks shall be designed and constructed for continuous, 24 hour per day service.

2.03 TANK CONNECTIONS AND APPURTENANCES

A. MANWAY COVERS

1. The manway openings for tanks 2000 gallons and over shall be a minimum of 24" and have a combination type fume tight manway cover. Covers shall be 16-bolt and have a 10" coarse threaded cover with a push plate and XLPE gasket. The 24" cover shall have (2) XLPE foam gaskets, and the bolts shall be polyethylene.

B. INTEGRALLY MOLDED FLANGED OUTLETS (IMFO's)

1. The IMFO shall be located at the bottom of the sidewall and allow the tank to be fully drained. The IMFO shall be integrally molded into the tank during the molding process. The IMFO shall be seamless, flanged, and manufactured from the same material as the tank. Inserts are not acceptable. A PVC companion flange assembly with a split back-up ring, SS bolts, and EPDM gasket shall be provided.

C. SIDE WALL FITTINGS

1. All fittings which are below the liquid level shall be flange bolted bulkhead style. There shall be a single 150 Lb. ANSI PVC flange and a 1/4" EPDM gasket attached to the inside tank wall and a compression ring on the outside. The flange shall be bolted to the tank from the inside with a minimum of four (4) 1/2" diameter 316 S.S. all thread bolts with bolt heads encapsulated in green polyethylene. The encapsulation shall be a minimum 2" in diameter x .75" thick and fully cover the bolt head and a minimum of 1/4" of the threads closest to the bolt head. Each bolt shall have a 1/4" EPDM gasket which is on the inside of the tank. All side wall fittings shall have PVC flanged adapter and be 150 Lb. ANSI.

D. DOME FITTINGS

1. All dome fittings shall be two-flanged Universal Ball Dome style. There shall be a single 150 Lb. ANSI PVC flange a 1/4" EPDM gasket attached to the outside tank wall. The flange shall be bolted to the tank from the inside with a minimum of four (4) 1/2" diameter 316 S.S. all thread bolts with bolt heads encapsulated in green polyethylene. The encapsulation shall be a minimum 2" in diameter x .75" thick and fully cover the bolt head and a minimum of 1/4" of the threads closest to the bolt head. Each bolt shall have a 1/4" EPDM gasket which is on the inside of the tank. Flanges on the inside of the tank are not acceptable. All dome fittings shall be fume tight. All dome fittings shall have PVC flange adapters and be 150 Lb. ANSI.

E. VENT FITTINGS

1. The vent shall be a PVC bulkhead fitting which shall be located center line dome, where the dome is flat. The vent fitting shall be fume tight. The gasket material shall be EPDM of 1/4". Supply a 150 LB. ANSI Flange Adapter with the vent fitting.

F. TIE DOWN SYSTEMS

1. Tie down systems shall be 316 S.S. and be provided by the tank manufacturer. There shall be no protrusions through the wall. Anchor system shall be capable of allowing for tank expansion and contraction due to temperature and loading changes. Anchor bolt diameter shall be in accordance with manufacturer's written recommendations. Anchor bolts shall be supplied by the general contractor.

G. FLEXIBLE JOINT

1. All lower sidewall connections shall have flexible connections. An EPDM Flange x Flange "Flexi-Joint" shall be supplied. Flexi-Joint to be installed after the tank shut-off valve by the CONTRACTOR. Fabricated nozzles, gaskets, and other fittings and accessories shall be chemically compatible with the stored media.
- H. Bolt holes in flanges are to straddle the vertical centerline.
- I. Install all appurtenances as indicated on the Chemical Storage Tank Appurtenance Schedule and Standard Drawing following this section.
- J. Provide access ladders designed to meet OSHA standards (OSHA 2206; 1910.27) for fixed ladders. Support ladders on the tank, allowing for tank expansion and contraction due to temperature and loading changes. Ladders shall be removable.
- K. Provide 1-inch diameter blind flanged taps for sight glass connection; do not provide a sight glass.
- L. Type 316 stainless steel lifting lugs shall be supplied by manufacturer.
- M. Provide gallonage tape with 500-gallon increments for local tank level indication.

PART 3 EXECUTION

3.01 GENERAL

- A. The manufacturer shall assume responsibility for packaging to prevent transit and handling damage, including preventing cracking or spidering of any tank surface.
- B. Store tanks in accordance with the manufacturer's written instructions. Store tanks on surfaces completely free of debris to prevent damage to any tank surface. If stored outside, tanks shall be protected from direct sunlight and freezing. Tanks shall be sufficiently anchored to prevent damage by wind.
- C. All bottom tank ports and drains shall be specially protected against damage during shipping and storage.
- D. The Contractor shall install the complete chemical storage and mixing tank systems where shown on the Drawings and as specified. The Contractor shall install each system component in strict conformance with the manufacturer's written recommendations. Any discrepancies shall be immediately brought to the Engineer's attention.
- E. Damaged or defective areas which are otherwise acceptable to the Engineer shall be repaired in a manner satisfactory to the Engineer.

3.02 INSTALLATION

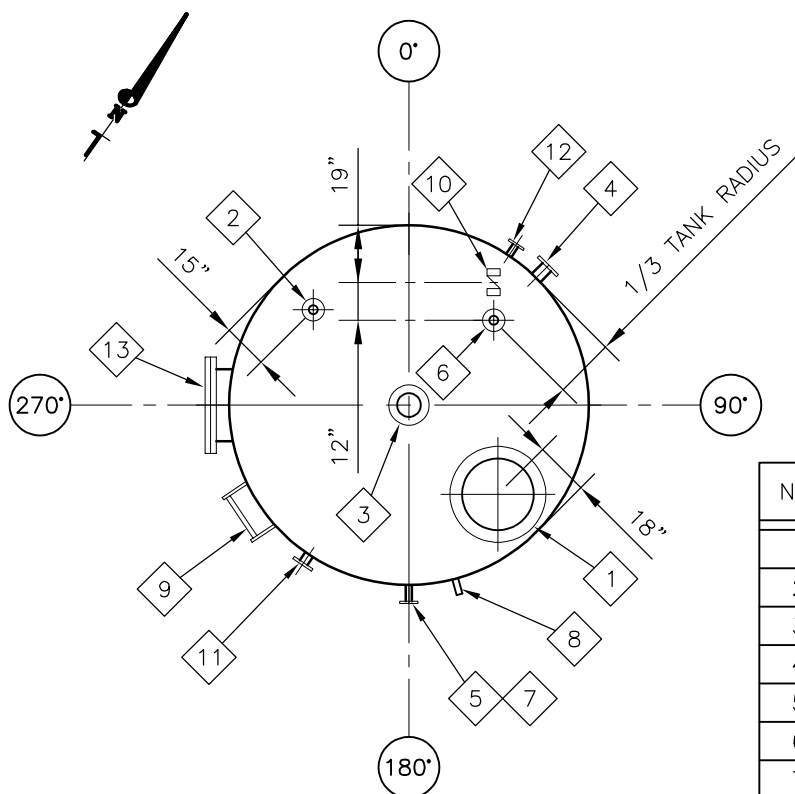
- A. Install in accordance with the manufacturer's written instructions.
- B. The tank pad shall be smooth and level to within 1/8" over a 10-foot span, or as recommended by the tank manufacturer.

- C. Provide 1" Owens Corning 1" Formular 150 or Engineer approved equal between the tank and the pad.
- D. The Contractor shall coordinate foundation pad block outs with the tank manufacturer.
- E. Ensure that the installation surface is completely free from any debris including sand, gravel, rocks, or any construction related material. If required by the manufacturer, provide any additional materials required for proper installation of the tank.
- F. Accurately place anchor bolts after tanks are set in place.

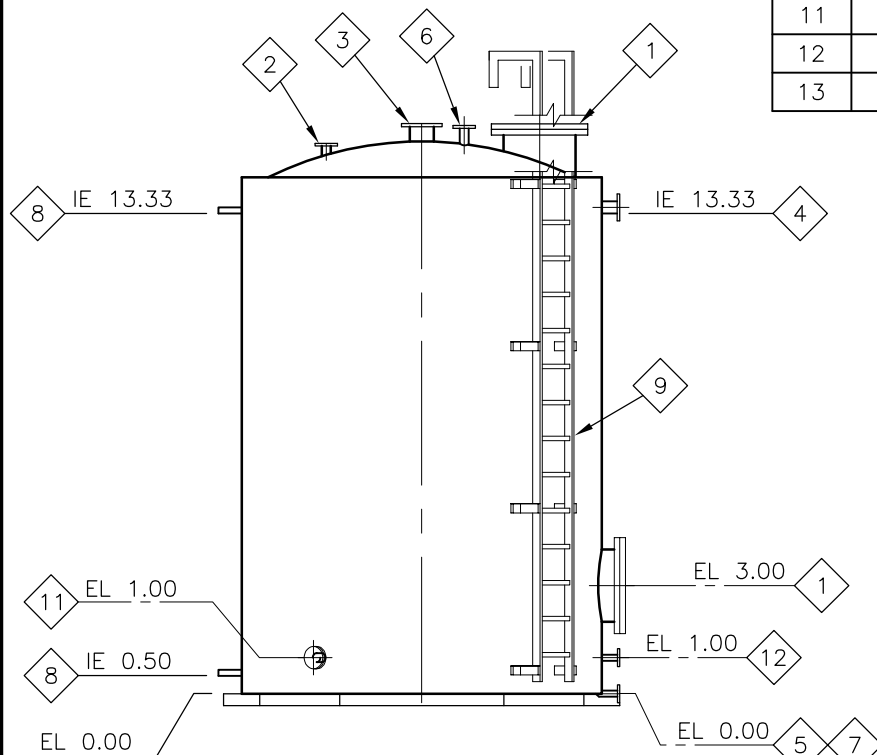
3.03 SCHEDULING

- A. All certification of factory tests and materials shall be submitted and approved by the Engineer before shipping any equipment.

END OF SECTION



PLAN
NO SCALE



ELEVATION
NO SCALE

NO.	DESCRIPTION	SIZE	TYPE	ANGLE
1	TOP MANWAY	24"	FLG	135°
2	FILL LINE	3"	FLG	315°
3	VENT	8"	FLG	N/A
4	OVERFLOW	4"	FLG	45°
5	DRAIN	2"	FLG	180°
6	LEVEL ELEMENT	3"	FLG	45°
7	OUTLET	2"	FLG	180°
8	SIGHT GLASS TAPS	1"	NPT	165°
9	LADDER	18"		236.25°
10	CONDUIT BRACKETS	3"	U-SHAPED	N/A
11	TANK HEATER	3"	FLG	213.75°
12	TEMP SENSOR	2"	FLG	33.75°
13	SIDE MANWAY	24"	FLG	270°

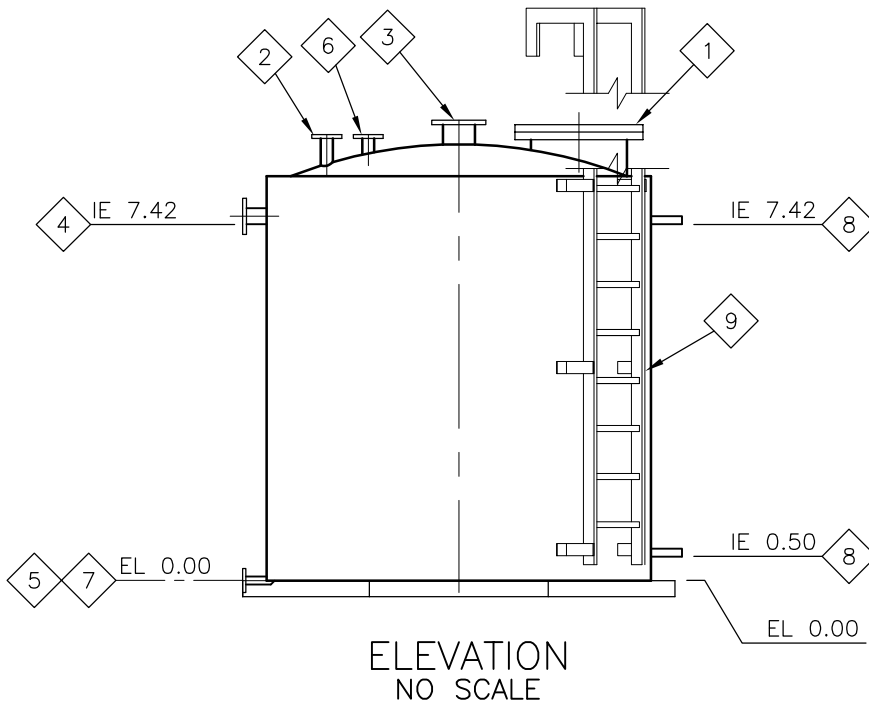
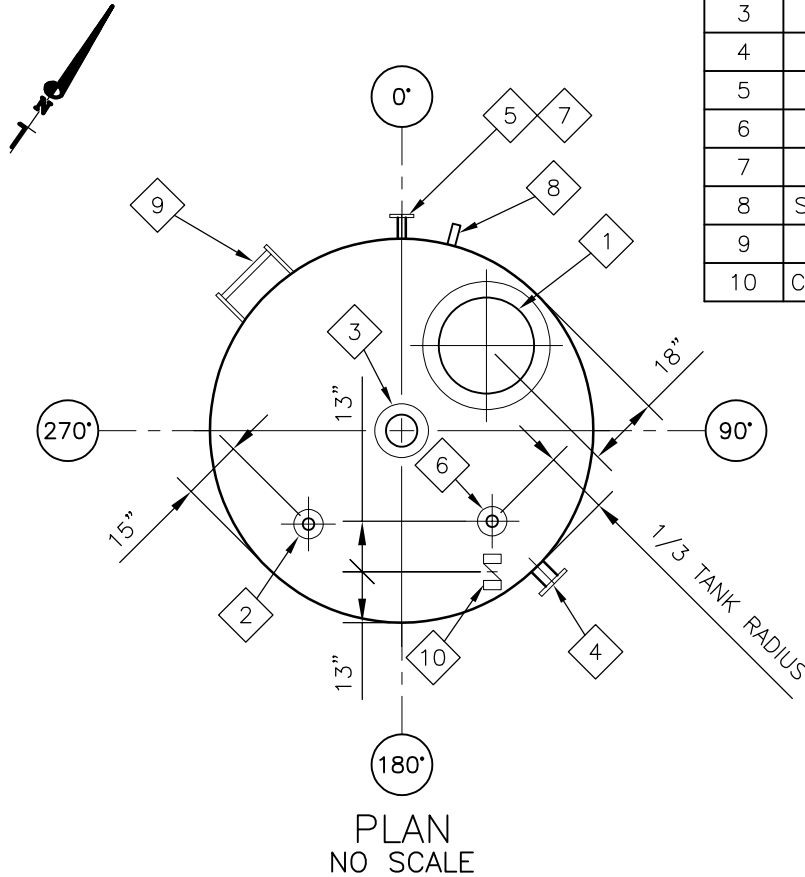
NOTE:

1. CONNECTION FOR TANK DRAIN (5) AND TANK OUTLET (7) IS A SINGLE TANK CONNECTION.
2. LIFTING AND ANCHOR LUGS AS REQUIRED ARE NOT SHOWN. LOCATION AND NUMBER SHALL BE DETERMINED BY TANK MANUFACTURER.
3. NOT ALL TANK APPURTENANCES ARE SHOWN. REFER TO SPECIFICATION SECTION 13215 AND THE DRAWINGS.
4. TANK HEATER CONNECTION #11 AND TEMP SENSOR CONNECTION #12 ARE REQUIRED ONLY ON SODIUM HYDROXIDE TANKS.
5. TANK MAY BE PAD MOUNTED OR SET DIRECTLY ON CONC. SLAB, REFER TO MECH DWGS FOR MOUNTING CONIDITIONS.
6. ANGLES GIVEN IN TABLE ARE MEASURED CLOCKWISE FROM 0°.

NO.	DESCRIPTION	SIZE	TYPE	ANGLE
1	MANWAY	24"	FLG	45°
2	FILL LINE	3"	FLG	225°
3	VENT	8"	FLG	N/A
4	OVERFLOW	4"	FLG	135°
5	DRAIN	2"	FLG	0°
6	LEVEL ELEMENT	3"	FLG	135°
7	OUTLET	2"	FLG	0°
8	SIGHT GLASS TAPS	1"	NPT	15°
9	LADDER	18"		315°
10	CONDUIT BRACKETS	3"	U-SHAPED	N/A

NOTE:

1. CONNECTION FOR TANK DRAIN (5) AND TANK OUTLET (7) IS A SINGLE TANK CONNECTION.
2. LIFTING AND ANCHOR LUGS AS REQUIRED ARE NOT SHOWN. LOCATION AND NUMBER SHALL BE DETERMINED BY TANK MANUFACTURER.
3. NOT ALL TANK APPURTENANCES ARE SHOWN. REFER TO SPECIFICATION SECTION 13215 AND THE DRAWINGS.
4. TANK HEATER CONNECTION #11 AND TEMP SENSOR CONNECTION #12 ARE REQUIRED ONLY ON SODIUM HYDROXIDE TANKS.
5. ANGLES GIVEN IN TABLE ARE MEASURED CLOCKWISE FROM 0°.



SECTION 46 05 10

ELECTRICAL EQUIPMENT AND CONTROL SYSTEMS FOR WATER AND WASTEWATER EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.

1.02 SUMMARY

- A. General: This section specifies several categories of provisions for electrical and control systems work furnished with packaged water and wastewater treatment process systems work.
- B. Drawings: Examine all drawings relating to the project. Include all work, materials, and equipment mentioned or shown as being provided under this division. Refer to all Drawings and details in coordinating and completing the work. Study all Drawings to determine any conflicts with ordinances and statutes. Report any discrepancies, conflicts, or omissions; accomplish work required for conformance and/or completion.
- C. Specifications: Examine all specification divisions relating to the project. Include all work, materials, and equipment mentioned as being provided under this division. Study all specifications to determine any conflicts with ordinances and statutes. Report any discrepancies, conflicts, or omissions; accomplish work as required for conformance and/or completion.

1.03 QUALITY ASSURANCE, STANDARDS, DEFINITIONS, AND SYMBOLS

- A. General: Refer to Division 1 for general administrative/procedural requirements related to compliance with codes and standards. At a minimum, materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards, and utility company regulations. In the event of conflict between codes, state laws, local ordinances, industry standards, utility company regulations, and the contract documents, the most stringent of these shall govern the requirements to be satisfied.
- B. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of instrument and control systems with other components of the facility process control system.
- C. Codes and Standards: Automatic transfer switches shall be designed, manufactured and tested in accordance with the latest applicable edition of the following standards.
 - 1. NEMA Compliance:
 - a. NEMA ICS 2: Industrial Control Devices, Controllers, and Assemblies.
 - 2. NFPA Compliance:
 - a. NFPA 70, National Electrical Code.

- b. NFPA 79, Electrical Standard for Industrial Machinery.
 - 3. UL Compliance:
 - a. UL 508, Standard for Safety Industrial Equipment.
 - 4. ODVA Conformance: Provide EtherNet/IP network system components that have been conformance tested in accordance with ODVA requirements and manufactured by companies that have been authorized to use ODVA technology and are compliant with the applicable ODVA Terms of Usage Agreement(s).
- D. Identification of Listed Products: Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.
- 1. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

PART 2 PRODUCTS

2.01 ALARM AND MALFUNCTION DETECTION

- A. Devices that are used to signal alarm or malfunction shall have a minimum of one contact which shall open on malfunction or alarm condition. Other output relays and devices shall have a minimum of one normally open and one normally closed contact which may be a NEMA Form C contact. If the contact of the device is required for internal equipment control as well as to signal alarm or malfunction conditions, then the manufacturer may make the reset function a part of his equipment's master shutdown system. However, each source of shutdown shall be shown by local trouble lights or flags which are manually reset at the equipment control panel. Trouble and alarm output contacts shall open and remain open until manually reset when equipment is shut down due to a malfunction. Trouble and alarm contacts shall not indicate abnormal conditions when the equipment has been manually shut down.

2.02 RACEWAY, FITTINGS, AND SUPPORTS

- A. General: Conduit shall be provided for all power, control, instrumentation, grounding, and signaling systems.
- B. Raceway Systems: Conduit systems including boxes, fittings, and supports shall be as specified in Section 26 05 33. Conduit system type shall be selected for each application in accordance with the classification of the area in which the equipment is to be installed and the requirements of paragraph 26 05 00 – 1.08.

2.03 CONDUCTORS, WIRE, AND CABLE

- A. General: Conductors, wires, and cable shall be provided for power, control, instrumentation, grounding, and signal circuits.
- B. Power, Control, and Communication Conductors and Cables: Power, control and communication conductors and cables shall be in compliance with all applicable requirements of Specification 26 05 19 and the following:

1. 480 volt AC, Constant Speed Motor Feeders: Conductor type XHHW-2.
 2. 480 volt AC, Variable Speed Motor Feeders: Conductor type VFD.
 3. 120 volt AC/DC and Less Power and Control Circuits: Conductor type THWN.
 4. Data Communications: Cable type UTP.
- C. Splicing and Terminating Methods and Materials: All conductor splicing and terminating methods and materials shall comply with all applicable requirements of Specification 26 05 83.
- D. Wire and Cable Identification: Wire and cable identification shall be in accordance with Specification 26 05 53.

2.04 CONTROL DEVICES

- A. General: Control devices shall be 30.5 mm, heavy-duty, corrosion-resistant with NEMA sealing rating to match enclosure rating. Control devices shall be Allen-Bradley Bulletin 800H or approved equivalent.
- B. Pushbuttons: Pushbutton operators shall be flush head type; red for stop functions and black for all other functions. Unless otherwise specified, pushbuttons shall be momentary contact type.
- C. Emergency/Shutdown Pushbuttons: Pushbuttons designated for emergency operation or shutdown of equipment shall be maintained contact pushbuttons with red mushroom head operators.
- D. Selector Switches: Selector switches shall be provided with standard knob operators and unless otherwise specified, selector switches shall be maintained position. Switches shall be provided with contact blocks and number of positions as required to perform the specified operations.
- E. Indicating Lights: Indicating lights shall be 120 volt AC, high intensity, LED, push-to-test type.
1. Colors: Indicating light LED colors shall be as scheduled in the following table.

<u>Color</u>	<u>Function</u>	<u>Example</u>
Green	Equipment running or open	Equipment operating, motor running
Red	Equipment stopped or closed	Equipment OFF and in ready condition
Amber/Yellow	Failure condition	Abnormal operating condition, equipment fault
White	Normal condition	Equipment power or control power ON

- F. Contact Blocks: Contact blocks shall be NEMA ICS-2 designation A600 except when switching circuits monitored by programmable controllers or other solid state circuits, contact blocks shall be hermetically sealed, logic-reed type as manufactured by Allen-Bradley or approved equivalent.
- G. Process Switches: Contact blocks for process switches including level, pressure, and temperature switches shall be rated NEMA B600 (5 amps continuous at 600 volts AC). Operating ranges shall be as recommended by the mechanical equipment manufacturer.

2.05 GROUNDING

- A. A separate ground conductor shall be run in each conduit with the exception of those housing cables with integral ground conductors. The conductor shall be sized in accordance with NEC Table 250-95. The conductor shall be bonded to the inside of the associated terminal or junction box. Shield drain cables in signal cables shall not be considered a ground conductor.

2.06 MOTOR CONTROLLERS

A. Motor Starters:

1. Motor starters shall be NEMA rated combination type with contactor, motor circuit protector and electronic overload relay sized as required to serve the associated motor load.
2. Control and monitoring of motor starters shall be fully implemented via the Ethernet/IP communication interface provided on the associated overload relay.
3. Motor starters shall comply with the requirements of Specification 26 24 19.

B. Variable Frequency Drives:

1. Variable frequency drives shall be sized as required to serve the associated motor load.
2. Control and monitoring of variable frequency drives shall be fully implemented via the Ethernet/IP interface integral to the variable frequency drive.
3. Variable frequency drives shall comply with the requirements of Specification 26 29 23.

2.07 EQUIPMENT CONTROL PANELS

- A. General: Equipment control panels shall house the power distribution, instrumentation and control devices required to support the specified process equipment as described in the individual equipment specifications. Where specified, equipment control panels shall serve as a point of operator interface for the associated process equipment and shall include panel-mounted operator control devices to provide the specified system control, monitoring and alarm annunciation functions.

- B. Quality Assurance: Equipment control panels shall be designed and constructed in accordance with the requirements of Article 409 of NFPA 70 and UL 508. Each equipment control panel shall bear a UL 508 label as well markings with the information required by Article 409.110 of NFPA 70.

C. Construction:

1. Equipment control panels shall either be free-standing or wall-mount construction as specified.
2. Control panel enclosure sealing rating shall be as specified in the individual process equipment specification.
3. Control panels shall be provided with full height, front-opening, hinged doors and interior fixed back mounting panels. Back mounting panels shall be unpainted conductive type. Panels shall be constructed of 1/8 inch minimum thickness sheet steel and shall be provided with an interior formed steel frame to provide a rigid structure. Hinges shall be of the full-length piano-type. Doors shall be provided with key-locking handle and three-

point latching mechanism. Panel finish shall be enamel over a rust-resistant primer unless otherwise noted. Panel finish color shall be manufacturer's standard.

4. Each control panel door shall be furnished with a 12 inch by 12 inch by 1 inch data pocket.
5. Equipment control panel enclosures specified as NEMA type 4X shall be constructed of stainless steel and shall have an unpainted, smooth, brushed finish.

D. Power Distribution:

1. Main Disconnect: Equipment control panels housing 480 volt AC power distribution or motor control equipment shall be provided with integral short circuit and overcurrent protection and an external operating mechanism which shall function to disconnect power to the equipment control panel.
 - a. The operating mechanism shall be mechanically interlocked with the enclosure door to prevent opening the door when the disconnect switch mechanism is in the ON position and shall have an auxiliary contact which shall open when the mechanism is opened and shall function to disconnect all foreign control voltage sources. The interlock shall be defeatable with a screwdriver.
2. Foreign Voltage Disconnect: All external sources of 120 volt AC power within equipment control panels shall be provided with disconnect-type terminal blocks or circuit breaker to serve as disconnecting means.
3. Distribution Terminal Blocks: Power distribution terminal blocks shall be provided to distribute power to multiple loads and facilitate termination of power distribution wiring within the control panel.
 - a. Power distribution terminal blocks shall be rated as required for each application with the appropriate size and quantity of line and load side termination openings.
 - b. Power distribution terminal blocks shall be provided with protective covers to prevent inadvertent contact with the conducting surfaces of the terminal block.

E. Wiring:

1. Power and Control Wiring:
 - a. Power and control wiring shall be single conductor stranded copper NFPA No. 70 MTW. Minimum wire size shall be No. 16 AWG minimum for control and instrumentation circuits and No. 12 AWG minimum for 480 volt AC and 120 volt AC power circuits.
 - b. Power conductors shall be sized in accordance with the National Electrical Code for the load served.
 - c. Power conductor color coding for 480 volt AC circuits:
 - 1) Phase A – Brown
 - 2) Phase B – Orange
 - 3) Phase C - Yellow.
 - d. Control conductor color coding shall be manufacturer's standard with the exception that all status and alarm signal circuits that will be interfaced with the external process control system shall be yellow to indicate the presence of a foreign control voltage.

2. Analog Signal Wiring: Analog signal wiring shall be Type TSP/TST in accordance with Specification 26 05 19.
 3. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.
 4. Nylon cable ties shall be used for securing all conductors and cables routed outside of wiring channels.
 5. Velcro cable ties shall be used for securing all data communication cables.
 6. Wiring channel fill shall not exceed 40 percent.
 7. Wiring shall be tagged at terminations with machine printed plastic wire markers. Wire numbers shall include terminal number.
 8. All field connections shall be made to separate terminal blocks. Field terminal blocks shall be located adjacent to where the field cables enter the panel.
 9. Wire and terminal numbers shall directly correspond to the final as-constructed wiring diagrams.
 10. Control circuits shall be fused.
 - a. 120 volt AC control fuses shall be 1/4 x 1-1/4 inch ceramic tube type rated for the load served with 25,000 ampere interrupting capacity at 125 volts.
 - b. Fuses for 24 volt DC control circuits shall be fast-acting glass tube type rated for the load served. Fuse holders shall be drawout type and molded from melamine plastic.
 11. Discrete Signals: Relay or switch contact configurations shall be as follows.
 - a. Alarms: Contact outputs used for alarm initiation shall be normally closed and shall open to initiate the alarm.
 - b. Control: Contact outputs used to control equipment shall be normally open and shall close to initiate equipment operation.
 - c. Status: Contact outputs used to indicate equipment operating status shall be normally open and shall close to indicate the active (run, ready, etc.) status.
- F. Terminal Blocks: Terminal blocks shall be provided in accordance with Specification 40 67 00.
- G. Power Conditioning: Equipment control panels shall be provided with power supply and conditioning equipment to support the instrumentation and control systems specified. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA or FM for the applications.
1. Each equipment control panel shall be provided with the following power supply and conditioning equipment in accordance with Specification 40 67 63.
 - a. AC surge filter.
 - b. Redundant DC power supply system.
 - c. Uninterruptible power supply system.
 2. The diagnostic relay outputs provided integral to power conditioning equipment shall be interfaced with and monitored by the PLC system to annunciate abnormal operating conditions.

- H. Ethernet Network Termination: Unless otherwise specified, where equipment control panels are served by Ethernet networks and/or houses Ethernet active hardware, the control panel shall be configured as described herein to accommodate the Ethernet network cabling and termination systems:
1. Modular DIN-rail mounted patch panels shall be provided to terminate each cable that extends beyond the equipment control panel. A dedicated patch panel shall be provided with each network type within the control panel. Patch panels shall have a minimum of two unused ports.
 2. Panel wire duct shall be arranged to provide cable access to the patch panel location.
 3. Wire duct providing the cable access to the patch panel location shall be free of any conductors carrying voltages greater than 120 volts AC.
 4. Patch Cords: Patch cords shall be provided in accordance with the following specifications and shall be color required for each application in accordance with the Owner's standards.
 - a. Patch cable length shall be selected for each application without unnecessary excess.
 - b. UL Listed 1863
 - c. TIA-568-C.2 components of the same category as the horizontal cable application served.
 - d. 100 percent factory fabricated and performance tested.
 - e. Gold-plated (50 micro-inch) contacts.
 - f. Overmolded boot and strain relief.
 - g. Tangle-free latch.
 - h. Shielded construction for all shielded horizontal cable applications.
 - i. Flame-retardant PVC jacket.
- I. Control Relays: Control relays shall be provided in accordance with Specification 40 67 00.
- J. Grounding: Equipment control panels shall be equipped with a copper ground bus running the length of the panel, with the steel structure connected to the bus so as to effectively ground the entire structure. A compression fitting shall be provided at each end of the ground bus for accepting plant ground connections.
- K. Miscellaneous:
1. Lighting: Equipment control panels shall be equipped with LED, 120 volt AC light fixtures designed for control panel applications. Light fixtures shall be controlled by a door-activated switch. A light fixture shall be mounted to the enclosure frame behind each door opening. Switch shall be designed for mounting on the enclosure frame remote from the associated light fixture.
 2. Convenience Receptacle: Equipment control panels shall be provided with one 120 volt AC, 15 ampere, DIN-rail mounted duplex receptacle. Receptacle branch circuit shall be derived from the utility power circuit serving the control panel or in the case of panels served by 480 volt power circuits, derived from the control power transformer.
 3. Folding Shelf: Freestanding equipment control panels shall be provided with folding shelf mounted on the interior of the enclosure door. Folding shelf shall be an 18" x 18" hinged

steel horizontal work surface designed to be folded down when not in use. Shelf shall lock in the horizontal position. Folding shelf shall be as manufactured by Hoffman, Catalog Number ACSHELF18 or approved equivalent.

4. Utility Box: Equipment control panels shall be provided with a plastic utility box with slide out drawer to store spare fuses within a control panel. Utility box shall mount on a 35 mm DIN rail and shall be as manufactured by Weidmuller, Part Number 7914760001, or approved equivalent.

2.08 ETHERNET NETWORK SWITCHES

- A. Ethernet network switch shall be an industrial IEEE 802.3 compliant unmanaged switch and shall fully support EtherNet/IP protocols.
- B. Switch shall have the following features:
 1. Designed for DIN rail mounting and housed in an industrial enclosure.
 2. Designed for operation on 24 volt DC power supply.
 3. Number and type of ports required for each application plus three (2) unused 10/100 Base-TX RJ-45 copper ports.
- C. Dedicated network switches shall be provided for each of the following networks:
 1. Supervisory Control Network: Provide a switch to interface the equipment control system to the plant supervisory control network.
 2. I/O Network: Provide a switch to interface field instruments, motor controllers, and operator interface terminals to the equipment control system programmable logic controller.
- D. Network switches shall be Rockwell Automation Stratix 2000 or approved equivalent.

2.09 PROGRAMMABLE LOGIC CONTROLLERS

- A. PLC systems shall be from the Allen-Bradley CompactLogix 5380 family of programmable automation controllers or approved equivalent.
- B. Input/output modules shall be provided in the quantities required for each application.
- C. Network Communications:
 1. PLC systems shall have EtherNet/IP network communications capabilities and fully support the Common Industrial Protocol (CIP) and the producer-consumer communication model.
 2. PLC controller shall have two embedded 100 Mbps EtherNet/IP communications network ports.
 3. PLC controller EtherNet/IP functionality shall include support for operation of the network ports in the Dual-IP mode.

2.10 GRAPHICAL OPERATOR INTERFACE TERMINALS

- A. Unless otherwise specified, graphical operator interface terminals shall be Allen-Bradley PanelView Plus 7 or approved equivalent. Operator interface terminals shall be rated for 120 volt AC operation.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions in which equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 GENERAL

- A. Coordinate equipment installation work with electrical raceway and wire/cable work, as necessary for proper interface. Should there be any conflict between provisions or requirements elsewhere indicated and the provisions of this division, request written clarification by addendum prior to submission of bid or abide by the interpretation of the Engineer.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

3.03 PROGRAMMABLE LOGIC CONTROLLER (PLC) PROGRAMMING

- A. General: PLC programming shall be logically organized, fully annotated and have all applicable features in accordance with the requirements of Specification 40 63 43.

3.04 ETHERNET NETWORKS

- A. General: The mechanical process equipment control system shall utilize ethernet networks to establish communication with all controllers, instrumentation, and operator interface terminals for the purpose of process control and monitoring. Data traffic shall be segregated on two separate networks as described below.
 - 1. Supervisory Control Network: The supervisory control network shall support communications between the plant HMI system and the various PLC systems deployed in the plant process control system. The supervisory network shall be extended to all mechanical process equipment control systems that employ PLC based controls. The supervisory control network shall facilitate peer-to-peer communications between PLC systems throughout the plant process control system as well as permitting read/write data exchange with the plant HMI. The PLC controller shall be connected to the supervisory control network through a network switch mounted in the equipment control panel.
 - 2. Input/Output (I/O) Network: The I/O network shall support communications between the mechanical process system PLC controller and all devices specified to have ethernet communication capabilities. All devices shall be connected in a star network configuration through a switch mounted in the equipment control panel. The following device types shall be connected to the I/O network.

- a. Variable frequency drives
 - b. Motor starter overload relays
 - c. Instrumentation such as flow meters and analyzers
 - d. Operator interface terminals
- B. Programmable Controller Ethernet Communication Interface: The two ethernet ports embedded in the PLC controller shall be configured for Dual-IP mode with each port assigned a unique address in a separate network collision domain. PLC controller port 1 shall be assigned an address that permits communication on the plant supervisory control network. PLC controller port 2 shall be assigned an address that supports communication between the PLC controller and all instruments and motor controller hardware associated with the mechanical process control system.
 - 1. IP addresses shall be as assigned by the Engineer.

3.05 FIELD QUALITY CONTROL

- A. Field inspection and testing of equipment control panels and associated hardware and devices shall be completed prior to energizing the equipment.
- B. Testing of all mechanical process equipment control systems shall be conducted in accordance with Specification 40 61 21.
- C. Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

3.06 HOUSEKEEPING

- A. General: Equipment control panels shall be protected from dust, water, and damage during the construction period. All equipment shall be wiped free of dust and dirt on the outside and kept dry.
- B. Remove all construction debris, packing materials, shipping labels, construction markings, etc., from the interior and exterior of the equipment control panels.
- C. Clean exterior surfaces of equipment control panels and leave in an unblemished condition. Touch-up scratched or marred surfaces to match original finish.
- D. Clean all equipment filters in accordance with the manufacturer's instructions.

3.07 ADJUSTING

- A. Adjust operating mechanisms, enclosure doors, device cover plates, etc., for free mechanical movement.

END OF SECTION

SECTION 46 31 33

CHLORINE DIOXIDE GENERATOR

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish, install, start-up and test one chlorine dioxide generator including all ancillary items and equipment as shown in the Drawings and as specified herein to provide a fully functioning system.

1.02 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 and Section 11 00 00.

1.03 REFERENCES

- A. Industry standard references including but not limited to those listed shall be noted, as applicable, in this specification and shall be considered a part of this specification. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Experience: Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The equipment and all ancillary components shall be designed, supplied and warranted as a unit item by a single manufacturer or vendor.
- B. Unit Responsibility: As specified in Section 11 00 00.
- C. Warranty: As specified in Section 11 00 00.

1.05 EQUIPMENT SCHEDULE

Item	Location	Type	Equipment Number
Chlorine Dioxide Generator	Chemical Room	Single Precursor	MME 8601

1.06 SERVICE CONDITIONS

- A. The equipment will be installed in a water treatment facility located in Silt, Colorado in Garfield County. Approximate elevation at the site is 5,420 feet above mean sea level. All equipment furnished under this Section shall be suitable for the specified installation location and shall be suitable for continuous (24 hours per day) service.
- B. The system will meet the following:

Item	Value
Water treatment plant flow capacity, mgd	0.3 to 3
Generator source chemicals	Min 31% sodium chlorite
Source chemical use	6 lbs to 1 lb ClO ₂
Chemical generated	Chlorine dioxide

Item	Value
Chemical generation rate range, pounds per hour	< 1 to 20 lb/day 99% pure ClO ₂
Inlet water flow rate, gpm	0.5 to 3
Inlet water pressure, psi	50
Chemical injection piping backpressure at feed system, psi	15
Generator power demand	Three phase 208/230-volt 20A circuit, 5-amp max power draw

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired. Acceptable manufacturer includes PureLine HP-20 or Engineer-approved equal.
- B. Furnish and install any special valves or fittings required to accommodate the system as approved by the Engineer.

2.02 FEATURES

- A. The unit shall be capable of continuous 24 hour per day, 7 day per week operation. The unit will be used in the treatment of raw water from the Colorado River. The chlorine dioxide generated will be used to oxidize metals.
- B. The system shall generally operate as follows.
 1. Chlorine dioxide will be generated on site by the unit using sodium chlorite solution containing a minimum of 31% sodium chlorite, water, and electricity. A chemical feed pump in the unit transfers sodium chlorite to the unit's stripper column where the anolyte, produced using water and electrolytic cell(s), interact with the sodium chlorite to produce chlorine dioxide. An eductor draws the chlorine dioxide from the stripper column and discharges it to the absorber column where it is diluted. The chlorine dioxide solution exits the absorber column and is pumped to the injection locations.
 2. An R.O. system in the unit provides water to the electrolytic cells. A hydrogen disengager removes hydrogen from the spent anolyte. Flow meters in the system monitor the anolyte, gas, and dilution water flow. A solenoid valve and rotameter control the dilution water flow.
 3. Waste streams include maximums of 0.1 gpm sodium hydroxide, 0.1 gpm spent chemical, 0.5% volume of hydrogen gas, and 1.0 gpm of R.O. waste.
 4. The system shall have three peristaltic distribution pumps with separate discharges.
- C. All equipment shall be provided with a cabinet that completely encloses the equipment to protect personnel from accidental exposure to chemicals. The enclosure shall be provided with front access doors having clear panels for viewing the generator equipment. The enclosure shall be made of corrosion resistant materials. The enclosure shall have a NEMA 12 rating.
- D. All piping of motive water, chlorine dioxide solution, vents, drains, etc. shall be constructed of SCH80 CPVC material. Flanged connections shall be used where possible. Threaded pipe connections are to be avoided for wetted connections. Chemical feed tubing and fittings shall be

PVDF and rated for 150 psig. Tubing fittings shall be PVDF and incorporate mechanical tubing grippers for secure connections.

2.03 CONTROLS

- A. The unit operation shall be controlled and monitored by a dedicated Programmable Logic Controller (PLC) contained in the NEMA 12 enclosure. The unit shall be provided with anolyte, gas, and dilution water flow meters and a chlorine dioxide sensor. Safety interlocks shall shutdown the generator if safety levels are exceeded.
- B. The equipment control panel shall be furnished with the following operator control devices mounted in the panel door:
 - 1. Power on indicating light.
 - 2. Alarm indicating light.
 - 3. Emergency stop button.
- C. A local touch-screen operator interface terminal (OIT) shall display process data and provide for local control of the unit. The OIT shall be available in English and metric units. The OIT shall be covered with a NEMA 4 cover to retain enclosure rating. The text shall be displayed in the local language.
- D. Locally, the OIT shall be used to START/STOP the unit, view process data, input set points, and view recent alarms. It shall also be used to set up alarm parameters and operating limits, perform pump calibrations, configure optional features, and perform other set up functions. The unit shall be provided with a local MANUAL STOP that will override local or remote control and prevent unit operation. The unit shall also be fitted with the capability to receive a user configurable discrete RUN PERMISSIVE signal similar in function to the MANUAL STOP.
- E. The unit shall be provided with discrete remote ON/OFF control capability. The PLC shall provide the ability to interface a water booster pump start/stop with the generator start/stop logic using appropriate time delays between pump starting/stopping and generator operation. The generator shall be capable of receiving signals over EtherNet/IP that will automatically adjust the operating rate of the unit linearly with signal.
- F. The unit shall be able to automatically adjust the chlorine dioxide production rate (flow pacing) in response to a dosage input value and a remote analog instrument input (typically a user water flow meter).
- G. The unit shall be fitted with the capability to provide EtherNet/IP feedback of the generator status (on/off & no alarm present/alarm present) and selectable process values (reactor pressure, set rate, or calculated rate by analyzer).
- H. The generator shall have, at a minimum, the following EtherNet/IP signals for remote control and monitoring:
 - 1. Generator Feed Rate Control
 - 2. Generator Summary Alarm
 - 3. Generator Run Status
 - 4. Generator Run Permissive
 - 5. Generator Start/Stop Control

2.04 FACTORY COATINGS

- A. Factory coatings shall comply with Section 09 90 00.

2.05 ANCHORING

- A. Provide type 316 stainless steel nuts, bolts, supports, and tie-down lugs for the equipment and ancillary components.

2.06 SPARE PARTS

- A. The following spare parts shall be furnished for each part type and size specified in this Section. Spare parts shall be tagged and stored as specified in Section 11 00 00.

PART 3 EXECUTION

3.1 GENERAL

- A. Accurately place anchor bolts using templates furnished by the manufacturer.
- B. The Drawings indicate the approximate routing of the piping, valves and fittings. The final routing shall be determined in the field by the Contractor prior to installation and after approval by the Engineer. This work shall be performed at no additional cost to the Owner.
- C. Equipment pipe connection sizes may vary per the equipment furnished. Contractor shall furnish and install all pipe fittings necessary to match the indicated pipe size and as required for a complete installation at no additional cost to the Owner.

3.02 INSTALLATION AND TESTING

- A. After completion of the installation and manufacturer's certification, the equipment shall be field tested to demonstrate compliance with the requirements specified. Installation, start-up and testing shall be conducted in accordance with Section 01 91 13 and Section 11 00 00.
- B. Factory Testing
 - 1. The chemical metering equipment shall be factory assembled and tested. Tests shall include the following as a minimum.
 - a. Piping and valve hydrostatic test at 100 psi for 15 minutes.
 - b. Eductor test at rated flow and pressure.
 - c. Miscellaneous valve functional test for solenoid valves.
 - d. Instrument test for pressure gauges, pressure switches, flow meters, etc. as required.

3.03 TRAINING

- A. Training shall be conducted in accordance with Section 01 79 00 and Section 11 00 00. Training shall consist of a minimum of two 3-hour sessions addressing the theory of operation, testing, troubleshooting, and maintenance of the equipment.

3.04 FIELD SERVICE

- A. Provide the service of a qualified representative for one (1) trip and one (1) day to inspect the equipment installation, assist in startup, and instruct plant personnel in the operation and maintenance of the equipment.

END OF SECTION

SECTION 46 33 33

POLYMER BLENDING AND FEED EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish polymer blending unit(s) (PBU) with progressive cavity pump, motors, and controls, including all integral piping, valves, fitting, pipe supports, special equipment and appurtenances in accordance with these specifications, including all incidental work necessary to make it complete, satisfactory, and ready for operation.
- B. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution ranging from 0.1% to 1% concentration of emulsion polymers with active contents up to 75%.

1.02 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 and Section 11 00 00.
- B. Product Data: Submit data completely describing product, including detailed scope of supply, detailed bill of materials and annotated specification sheets of all components.
- C. Shop Drawings
 - 1. Submit detailed specifications and shop drawings with both shaded isometric and orthogonal views of the proposed system, including dimensions and weights.
 - 2. Submit wiring, control schematics, and control logic diagrams for all electrical and control components furnished.
- D. Operation and Maintenance Manuals: Provide detailed Operations and Maintenance Manuals including storage, installation start-up and operating instructions. Provide safety precautions and warnings of all hazards operating equipment.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Experience
 - 1. Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The equipment and all ancillary items shall be designed, supplied, and warranted as a unit item by a single manufacturer or vendor.
- B. Warranty
 - 1. The complete system shall be covered by a warranty as specified in Section 11 00 00.
 - 2. The mixing chamber shall be warranted for the life of the system against failure for plugging for any reason.
- C. Inspection
 - 1. Prior to shipment the system shall be inspected for quality of construction verifying all fasteners and fittings are tight, all wires are secure and connections whisker-free.

D. Factory Testing

1. The complete system shall be fully factory tested prior to shipment. Testing shall include: setting and verification of all instrumentation and sensors per the design requirements of the application; pressure testing all plumbing systems for a minimum of one hour at 100 psi. If leaks are found they shall be fixed and a new test shall be conducted for one hour at 100 psi until the plumbing system is verified to be leak free; verification of system design flow rates, and; complete functional simulation of operation.

- E. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of mechanical process equipment control systems with other components of the facility process control systems.

1.04 DELIVERY & STORAGE

- A. The equipment will be shipped in a new weatherproof wooden crate. The crate shall include a shock sensor to warn of equipment mishandling during shipment.

1.05 EQUIPMENT SCHEDULE

<u>Item</u>	<u>Location</u>	<u>Equipment number</u>
Polymer Conditioning Units	WTP Process Room	MME 8210, MME 8220, MME 8230

1.06 SERVICE CONDITIONS

- A. Fluid temperature is expected to range from 35 to 100 degrees Fahrenheit.
- B. The equipment will be installed indoors in a water treatment plant in Silt, CO. Approximate elevation at the site is 5,460 feet above mean sea level.
- C. All equipment furnished under this Section shall be suitable for the specified installation location and shall be suitable for continuous (24-hours per day) service.

D. Design Criteria

1. Polymer Type: Emulsion
2. Polymer Activity (percent active): 30 to 75
3. Solution Concentration Range: 0.1% to 2% based on neat polymer
4. Solution Concentration Design Point: 0.5% based on neat polymer

<u>Neat Polymer Flow Range (GPH)</u>	<u>Dilution Water Range (GPH)</u>
0.5 – 10	180 – 1,800

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. VeloDyne - Velocity Dynamics Louisville, CO
- B. Engineer approved equal.

- C. The proposed system, whether named or not, shall be modified as necessary to meet these specifications in full.

2.02 IDENTIFICATION

- A. Provide a name plate securely affixed to the unit providing Manufacturer with phone number, model number, and serial number.

2.03 MATERIALS OF CONSTRUCTION

<u>Component</u>	<u>Material</u>
Skid	304 stainless steel
Hardware	Type 18-8 stainless steel
Inlet and Outlet Fittings	304 stainless steel
Pipe & pipe fittings	Schedule 80 PVC
Tubing and tube fittings	Polyethylene, polypropylene, stainless steel, and Viton
Water solenoid valve	Brass
Pressure Gauges	Stainless Steel, liquid filled
Pressure switches	NEMA 4 brass connection
Flow Meter	Acrylic, stainless steel, PVC, and/or polypropylene
Water Control Valve	Stainless steel with stainless steel seat

<u>Component</u>	<u>Material</u>
Mixing chamber body/flanges	Stainless steel
Mixing chamber cover/chamber	Clear polycarbonate
Mixing chamber discharge	Stainless steel
Impeller	304 stainless steel
Impeller shaft seal	Viton, stainless steel, ceramic, carbon
Mixing chamber pressure relief valve	Brass, stainless steel, or PVC
Metering pump wetted parts	Stainless steel & Viton
Metering pump shaft seals	Viton, stainless steel ceramic, carbon
Control enclosure	FRP

2.04 EQUIPMENT FEATURES

A. Polymer Activation & Blending Chamber

1. These specifications are based on a multi-stage, multi-zone, hydro-mechanical polymer activation & blending technology. Alternate technologies will only be considered if proven to provide an equal level of performance, versatility, reliability, and quality.
2. To provide control and versatility to optimize the performance of the wide range of polymers available and to optimize system reliability, a multi-stage hydro-mechanical polymer blending technology shall be provided with both a non-mechanical and mechanical mixing stage:
 - a. Non-Mechanical Stage: To optimize reliability, the device shall be capable of activating and blending polymer based on plant water pressure alone at 30 psi or greater. Polymer shall be injected directly into a water jet by means of an injection quill positioned such that the non-mechanical mixing energy is no way diminished prior to polymer and water contact. The non-mechanical zone shall be designed such that the velocity of the mixing energy-producing water jet is maintained or increases as flow decreases.
 - b. Hydro-Mechanical mixing Stage: In order to provide optimal polymer performance under all operating conditions and to provide total control over mixing energy, in addition to the non-mechanical mixing stage the device shall be

capable of producing its mixing energy independent of plant water pressure through a variable intensity, controllable stainless steel hydro-mechanical mixer. The mixing impeller shall be fully controllable and capable of inducing ultra high, non-damaging mixing energy at all flow rates. This shall be accomplished by controlling mixing intensity and preventing over exposure to, or damaging recirculation through the impeller. The polymer mixing impeller shall be designed to produce both axial and radial flow to optimize mixing effectiveness and to effectively inducing high, non-damaging mixing energy over the systems full flow range.

- c. Mixers that rely solely on plant water pressure and or flow for mixing energy will not be acceptable. Mixers where performance is affected by flow rate and therefore retention time resulting in under or over exposure to mixing energy, or which rely on constant speed impellers or that rely on close tolerances for blending shall not be acceptable.
3. To prevent polymer build-up, the mixing chamber shall maintain high velocity in the entire chamber.
4. The mixing impeller shall be controlled by an SCR motor controller and driven by a wash-down duty motor. Motors shall not be mounted under the mixing chamber where seal failure or leaks can damage the motor shall not be acceptable.
5. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flush. A drain port behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. All bearings shall be external from the mixing chamber.
6. Both mechanical and non-mechanical mixing zones shall be clear polycarbonate to view the mixing action and blending effectiveness. Acrylic chambers prone to becoming brittle over time and cracking, or opaque pipe are not acceptable. The clear cover shall have a stainless steel reinforced gusseted flange with a stainless-steel discharge connection in order to handle maximum operating pressures.
7. The mixing chamber shall have a maximum rated pressure of 100 psi. Provide a pressure relief on the mixing chamber factory set at 75 psi.
8. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. To minimize check valve plugging due to normally occurring polymer agglomerations, the minimum open area up to and including the valve seat shall be 3/16" without exception. The valve body shall be constructed of Teflon with Viton seals. The valve poppet and spring shall be stainless steel. The spring shall be outside of the polymer flow path to prevent build-up and plugging. The valve shall be readily accessible for cleaning and shall not require tools for removal, cleaning, or replacement. Conventional check valves, valves that rely on ball seals, and or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.

B. Dilution Water Assembly

1. The dilution water flow rate shall be monitored by a paddle type flow meter having the range as specified under paragraph 1.02 above. Unions or flanges shall be provided on the flow meter to allow easy removal for cleaning.
2. The unit shall have an electric solenoid valve for on/off control of total dilution water flow.

3. The unit shall have a linear actuated variable rate control valve to automatically proportion water flow to polymer flow for polymer / water ratio control. Valves that diminish mixing energy in the non-mechanical stage shall not be used.
4. A differential pressure type low water differential pressure alarm shall be provided. The switch shall be adjustable between 9 and 60 psid. Static working pressure, 500 psi. The pressure switch shall be as manufactured by Ashcroft.
5. Provide a 2-1/2" stainless steel liquid filled pressure gauge to monitor dilution water inlet pressure.

C. Progressive Cavity Neat Polymer Mixing Pump

1. Each unit shall have one (1) neat polymer metering pump(s) integrally mounted on the systems skid. The metering pump(s) shall have a range as specified under paragraph 1.6 D. The pump shall be a positive displacement, progressive cavity type constructed of stainless steel and Viton. The shaft seal shall be a lip seal type riding on a ceramic sleeve. Mechanical seals shall not be used. A gear reducer shall be provided to produce a maximum pump shaft speed of not more than 545 RPM. The motor shall be controlled by an SCR motor controller located in the system control panel.
2. Provide a calibration column with two full port PVC ball valves having Viton o- rings. The column shall be calibrated for a one-minute draw-down at maximum pump rate and read in GPH and milliliters. The calibration column shall be rigidly mounted to the systems frame with a minimum of two heavy duty brackets. Mounting the calibration to the neat polymer inlet piping shall not be acceptable. Provide a breather plug in the top of the calibration column designed to allow adequate displacement of air during calibration while preventing water or other foreign material from entering the calibration column.
3. Provide a pressure relief on the discharge of the metering pump, adjustable between 25 and 100 psi. The valve shall be factory plumbed to the suction of the pump. The valve shall have a stainless steel or PVC body with stainless steel, Viton and Teflon internals. Brass pressure relief valves shall not be acceptable.
4. Provide a non-intrusive type loss of polymer flow sensor. Flow sensors that restrict flow or rely on an insertion type sensing probe, such as thermal flow sensors, and therefore are prone to polymer build-up and failure shall not be used.

D. Solution Discharge Assembly

1. Provide a 2-1/2" stainless steel liquid filled pressure gauge to monitor system discharge pressure.
2. Provide a swing type check valve to prevent back flow. The check valve shall be sized for the total solution flow of the system, constructed of PVC and Viton.

E. Controls

1. General: Polymer blending and feed system controls shall be rated for operation from 480 volt AC, 3 phase, 60 Hz power. Each polymer system shall be provided with an integral equipment control panel configured for a single point of power delivery and provide for automatic control of the polymer system. The control system shall include a DC motor controllers, a programmable logic controller (PLC) based control system, a local graphical operator interface terminal, and all ancillary instrumentation and control system components required for a complete, functioning system. Power and control circuits for all polymer system process equipment, controls, and instrumentation shall originate at the equipment control panel.

2. Equipment Control Panel: Each polymer blending and feed system shall be provided with an equipment control panel factory mounted and wired on the polymer system equipment skid. The equipment control panel and associated control system components shall comply with the requirements of Specification 46 05 10 and as specified herein. The equipment control panel shall house the DC motor controllers, PLC system, operator interface system, and all required power distribution and conditioning equipment and control system components. Equipment control panel short circuit current rating shall be 5,000 amperes minimum. Equipment control panel shall include the following features.
 - a. NEMA Type 4X stainless steel enclosure. All specified operator control devices shall be mounted on the door of the enclosure.
 - b. Power distribution system including the following:
 - 1) Main circuit breaker.
 - 2) Individual overcurrent protection for each power circuit.
 - 3) Surge protection device on the incoming line.
 - 4) DC SCR variable speed motor controllers for the polymer pump and mechanical mixer.
 - 5) 120-volt AC hardwire power connection.
 - c. Power Conditioning: The following power conditioning equipment shall be provided.
 - 1) Redundant 24-volt DC power supply system.
 - 2) 120-volt AC surge power filter.
 - 3) Uninterruptible power supply to serve the control system only.
 - d. PLC system configured and programmed as required to implement the polymer system control sequence specified.
 - e. Graphical operator interface terminal (OIT).
 - f. Ethernet network hardware.
 - g. Main Power ON /OFF switch.
 - h. Main Power ON pilot light indicator.
3. Control Sequence: Polymer blending and feed system shall be configured to operate as follows:
 - a. Local/Remote start/stop mode select:
 - 1) Local Start/Stop Mode: System shall start and stop based on operator input from OIT start/stop push-button.
 - 2) Remote Start/Stop Mode: System shall start and stop in response to commands received from the plant process control system.
 - b. Manual/Water Master/Paced Poly Ratio Operational Mode Select:
 - 1) Manual Mode: The desired water flow and polymer flow rates are set manually via the OIT. Solution concentration shall be defined by water and polymer settings.
 - 2) Water Master Mode: Desired water flow rate and solution concentration are set manually via the OIT. Polymer flow rate shall adjust automatically to maintain operator desired solution concentration.

- 3) Paced Polymer Ratio Mode: Water flow adjusts automatically to maintain operator desired solution concentration. Polymer flow paced in proportion to a flow rate pacing signal received from the plant process control system. The desired solution concentration shall be adjusted manually via the OIT.
4. Graphical Operator Interface (OIT) Configuration: The OIT shall be configured to provide the following operator interface.
- a. Manual mode operator interface shall include the following features:
 - 1) Water flow rate control increase/decrease push buttons.
 - 2) Water flow rate (gph) indication.
 - 3) Polymer flow rate control increase/decrease push-buttons.
 - 4) Polymer flow rate (gph) indication.
 - 5) Solution concentration (% polymer) indication.
 - 6) Total solution flow rate (gph) indication.
 - b. Water Master mode operator interface shall include the following features:
 - 1) Water flow rate control increase/decrease push buttons.
 - 2) Water flow rate (gph) indication.
 - 3) Polymer flow rate (gph) indication.
 - 4) Solution concentration control increase/decrease push-buttons.
 - 5) Solution concentration (% polymer) indication.
 - c. Paced Polymer Ratio mode operator interface shall include the following features:
 - 1) Water flow rate (gph) indication.
 - 2) Remote pacing signal value
 - 3) Polymer flow rate (gph) indication.
 - 4) Solution concentration increase/decrease push buttons.
 - 5) Desired solution concentration (% polymer) indication.
 - 6) Solution concentration (% polymer) indication.
 - d. Help Displays: Provide help displays for each mode of operation.
 - e. Alarm Management Display: Provide a system alarm management interface with the following features.
 - 1) Indication of alarm condition.
 - 2) Description of recommended corrective action.
 - 3) Reset.
 - 4) Alarm history.
 - f. System Set-up and Configuration Display: A graphical interface shall be provided to facilitate the following functions.
 - 1) Semi-auto pump calibration.
 - 2) Adjustment of system flush settings.
 - 3) Auxiliary alarm user programming mode.

5. PLC System Programming: PLC system shall be programmed to provide full control and monitoring of the polymer blending and feed system as specified herein. PLC programming shall be in accordance with the requirements of Specification 46 05 10.
6. Network Configuration: Ethernet networks shall be configured in accordance with the requirements of Specification 46 05 10 and consist of two segregated networks as described below.
 - a. Supervisory Control Network: A network switch shall be provided to interface the PLC system with the plant supervisory control network. No devices in this control panel other than the PLC shall be connected to this network.
 - b. Input/Output Network: The control panel OIT shall be connected to the input/output network.

F. System Skid

1. The system's frame shall be of rugged 304 stainless steel construction. All piping shall be rigidly supported.
2. Under no circumstance shall the pump suction exceed 5" from the bottom of the skid for progressive cavity pumps.
3. The skid shall have an integral stainless-steel drip pan located under the neat polymer metering pump. Provide one dozen absorbent pads designed for oil and sized to fit within the drip pan.
4. The overall system dimensions shall not exceed 36"W x 30"D X 72"H.

G. Tote Accessories

1. Provide a polymer tote pump suction assembly. The assembly shall include quick disconnect cam-lock fittings, a 1" full port ball valve, and 15 feet of 1" braided PVC hose.

2.05 SPARE PARTS

- A. The following spare parts shall be furnished for each pump unit specified in this Section. Spare parts shall be tagged and stored as specified in Section 11 00 00.
1. Two (2) progressive cavity pump stators
 2. Two (2) progressive cavity pump lip seals
 3. One (1) banding clamp tool for replacement of the progressive cavity metering pump pin joint banding clamps.
 4. Provide two (2) neat polymer check valves, complete

PART 3 EXECUTION

3.01 GENERAL

- A. Installation, start-up, and testing shall be conducted in accordance with Section 01 91 13 and Section 11 00 00.

3.02 TESTING

- A. After completion of the installation and manufacturer's certification, equipment shall be field tested to demonstrate compliance with the requirements specified. Testing of equipment shall be conducted in accordance with the requirements of Sections 01 91 13 and 11 00 00.

3.03 FIELD SERVICE

- A. Provide the service of a qualified field service technician for one (1) trip consisting of two (2) eight (8) hour days to inspect and certify the equipment installation, assist in start-up, and instruct plant personnel in the operation and maintenance of the equipment and controls.

3.04 TRAINING

- A. Training shall be conducted in accordance with Section 01 79 00 and Section 11 00 00. Training shall consist of a minimum of one 2-hour session addressing the theory of operation, testing, troubleshooting, and maintenance of the system.

END OF SECTION

SECTION 46 33 44

PERISTALTIC CHEMICAL FEED PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish, install, start-up and test peristaltic chemical metering pumps including all chemically compatible ancillary items and equipment as shown in the Drawings and as specified herein to provide a fully functioning system.

1.02 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 and Section 11 00 00.

1.03 REFERENCES

- A. Industry standard references including but not limited to those listed shall be noted, as applicable, in this specification and shall be considered a part of this specification. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Experience: Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The equipment and all ancillary shall be designed, supplied and warranted as a unit item by a single manufacturer or vendor.
- B. Unit Responsibility: As specified in Section 11 00 00. The Contractor shall assign to a single manufacturer full responsibility for furnishing and functional operation of the complete pump system including the pumps, drives, motors, and accessories specified in this Section. The designated single manufacturer shall coordinate the design, assembly, and testing of the units specified herein and in accordance with Section 11 00 00.
- C. Warranty: As specified in Section 11 00 00.
- D. All materials shall be new and of the best quality of their respective kind. All products shall be suitable for the intended use, and shall be provided by reputable manufacturers specializing in the manufacture of the products specified herein.

1.05 EQUIPMENT SCHEDULE

Chemical	Location	Equipment Number
12.5% Sodium Hypochlorite	Chemical Building	P 8310 P 8320 P 8330 P 8340 P 8350
50% Sodium Hydroxide	Chemical Building	P 8410 P 8420
50% Aluminum Chlorohydrate	Chemical Building	P 8510 P 8520

1.06 SERVICE CONDITIONS

- A. Fluid temperature is expected to range from 40 to 100 degrees Fahrenheit.
- B. All equipment furnished under this Section shall be suitable for the specified installation location and shall be suitable for continuous (24-hours per day) service.
- C. The equipment will be installed indoors in a water treatment plant in Silt, Colorado at an elevation of approximately 5,415 feet above mean sea level.
- D. Fluids to be handled shall be as follows:

Equipment Number	Liquid	pH	Specific Gravity
P 8310 P 8320 P 8330 P 8340 P 8350	12.5% Sodium Hypochlorite	12	1.15
P 8410 P 8420	50% Sodium Hydroxide	14	1.53
P 8510 P 8520	50% Aluminum Chlorohydrate	3.5	1.34

- E. Provide the pumps with the following:

Equipment Number	Chemical	Tubing ID (inches), material
P 8310 P 8320 P 8330 P 8340 P 8350	12.5% Sodium Hypochlorite	0.093, norprene
P 8410 P 8420	50% Sodium Hydroxide	0.25, norprene
P 8510 P 8520	50% Aluminum Chlorohydrate	0.187, norprene

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired. The peristaltic pumps shall be Blue-White Industries ProSeries-M Flex-Pro Series, Watson-Marlow 500 Series or Engineer-approved equal modified to meet requirements of this specification.
- B. All wetted components shall meet NSF 61 requirements.

2.02 DESIGN AND PERFORMANCE REQUIREMENTS

Equipment Number	Chemical	Pumping Capacity, gph	Max. Backpressure, psig	Motor hp
P 8310 P 8320 P 8330 P 8340 P 8350	12.5% Sodium Hypochlorite	0.1 – 3.5	15	1/8
P 8410 P 8420	50% Sodium Hydroxide	0.4 – 36	15	1/4
P 8510 P 8520	50% Aluminum Chlorohydrate	0.5 – 9.3	15	1/8

2.03 EQUIPMENT FEATURES

- A. Metering pump shall be a positive displacement, peristaltic type tubing pump with a brushless variable speed motor, non-spring loaded roller assembly located in the pump head, integral tube failure detection system, and flexible tubing with attached connection fittings.
1. There shall be no valves, diaphragms, springs, or dynamic seals in the fluid path. Process fluid shall contact the pump tubing assembly and connection fittings only.
 2. Pump shall be capable of 24-hour continuous duty, self-priming and operating in either direction of flow at the rated maximum pressure specified in the Design and Performance Requirements section of this specification.
 3. Pump shall be capable of running dry without damage.
 4. Pump shall be capable of operating in either direction without output variation.
 5. Suction lift shall be 30 feet of water.
 6. Accuracy: +/- 0.5 percent of full scale. Repeatability: +/- 0.5 percent.
- B. Pump Head
1. The pump head shall be a single, unbroken track with a clear removable cover.
 2. Tube failure detection sensors shall be wholly located in the pump head. Tube failure detection system shall not trigger with water contact.
 3. Squeeze rollers with encapsulated ball bearings shall be directly coupled to a one-piece thermoplastic rotor. Four polymeric rollers shall be provided; two squeeze rollers for tubing compression shall be located 180 degrees apart and two guide rollers that do not compress the tubing shall be located 180 degrees apart. The roller diameters and occlusion gap shall be factory set to provide the optimum tubing compression; field adjustment shall not be required. Spring loaded or hinged rollers shall not be used.
 4. Rotor assembly shall be installed on a D-shaped, chrome plated motor shaft and removable without tools.
 5. For tubing installation and removal, rotor assembly shall be rotated by the motor drive at 6 RPM maximum when the pump head cover is removed. Hand cranking of the rotor assembly shall not be required.
 6. Pump head and tubing compression surface shall be corrosion resistant Valox thermoplastic.
 7. The pump head cover shall be clear, annealed acrylic thermoplastic with an integral ball bearing fitted to support the overhung load on the motor shaft. Cover shall include an

imbedded magnetic safety interlock which will limit the motor rotation speed to 6 RPM when removed.

8. Cover shall be positively secured to the pump head using a minimum of four thumb screws. Tools shall not be required to remove the pump head cover.

C. Pump Tube Assembly

1. To ensure pump performance and accuracy, only tubing provided by the manufacturer is acceptable.
2. Pump tube shall be assembled to connection fittings of PVDF material.
3. Connection fittings shall be permanently clamped to the tubing with stainless steel clamps. To prevent tubing misalignment and ensure accuracy, fittings shall insert into keyed slots located in the pump head and secured in place by the pump head cover.
4. Connection fittings shall be M/NPT.
5. Tube sizes and connections shall be measured in inches.

D. Drive System shall be factory install and totally enclosed in a NEMA 4X, (IP66) wash-down enclosure

1. Motor
 - a. Reversible, brushless DC gear motor rated for continuous duty.
 - b. Motor shall include overload protection.
 - c. The maximum gear motor RPM shall be 125 RPM.
2. Enclosure
 - a. Pressure cast aluminum with exterior grade corrosion resistant polyester polyurethane powder coat bottom housing and thermoplastic upper housing.
 - b. Rated NEMA 4X (IP66).
 - c. Provided with 316SS floor/shelf level mounting brackets and hardware.
 - d. A wiring compartment on the rear of the pump shall be provided for connection of control and network cables. The terminal board shall not be disturbed by the removal of the wiring compartment cover.
 - e. RJ45 receptacle shall be located at the rear of the pump for use with EtherNet/IP network communications.
3. Controls
 - a. An integral EtherNet/IP fieldbus network communication interface shall provide for all pump control and monitoring. The EtherNet/IP interface shall provide the following control and monitoring functions:
 - 1) Control
 - a) Pump speed
 - b) Pump direction
 - c) Start/stop control
 - d) Alarm reset
 - e) Tube revolutions counter reset
 - 2) Monitoring

- a) Pump operating status
 - b) Cover status
 - c) Pump operating direction
 - d) Tube failure alarm
 - e) Pump speed
 - f) Tube revolutions
 - g) Tube hours
- b. All control circuitries shall be integral to the pump and capable of adjusting the pump motor speed from 0.01% to 100.0% in 0.01% increments less than 10% motor speed, in 0.01% and in 0.1% increments greater than 10% motor speed (10,000:1 turndown ratio).
- c. The pump output shall be capable of being manually controlled via front panel touchscreen. The pump motor speed shall be adjustable from 0.01% to 100.0% in 0.01% increments less than 10% motor speed and in 0.1% increments greater than 10% motor speed.
- d.
- e. The pump shall be capable of dispensing upon demand across its full range of flows. The pump motor speed during the dispensing cycle shall be adjustable from 0% to 100.0% motor speed in 0.1% increments. Additionally, the pump shall be capable of stopping upon command either through the front panel stop button or by sending a remote stop command.
- f. Provide front panel user touchpad control for stop/start, configuration menu access and navigation, operating mode selection, auto priming, display options selection, tube life data, and reverse direction.
- g. Provide a multi-color VGA graphic LCD display for menu driven configuration settings, pump output value, service alerts, tube failure detection (TFD) system alarm status, remote input signal values, tubing life timer value. Display color shall be green when indicating normal operation, blue when in stand-by, and red to indicate an alarm condition exists.
- h. Provide a power interruption pump restart option which is user programmable to either automatically restart or require a user re-start if AC mains power is interrupted.
- 4. Power: Pump operating voltage shall be 120 volt AC, single phase and shall be fitted with a grounded NEMA 5/15 power cord (6' length minimum) and plug.

2.04

2.05 SAFETY

- A. The pump shall be NSF 61 certified.
- B. The pump shall be certified to UL standard 778 motor operated pump and CSA standard C22.2 process control equipment.
- C. Tube Failure Detection (TFD) system sensors shall be wholly located in the pump head. TFD system shall stop the pump within three seconds of leak detection. Process fluid waste ports or leak drains shall not be provided as the sole means of protection.

- D. Pump head cover shall include an imbedded magnetic safety interlock which will stop the pump when removed. Pump rotor speed shall be limited to 6 RPM when cover is removed.
- E. Secondary user confirmation input required for motor reversal, tube life revolution count reset, and factory default configuration reset

2.06 SPARE PARTS

- A. The following spare parts shall be furnished for each part type and size specified in this Section. Spare parts shall be tagged and stored as specified in Section 11 00 00.
 - 1. 1 – Spare tubing assembly for each pump model, tubing size, and tubing material variation

PART 3 EXECUTION

3.01 GENERAL

- A. Accurately place anchor bolts using templates furnished by the manufacturer.
- B. Lubricate before operating as per manufacturer's recommendations.

3.02 INSTALLATION AND FIELD TESTING

- A. After completion of the installation and manufacturer's certification, the equipment shall be field tested to demonstrate compliance with the requirements specified. Installation, start-up and testing shall be conducted in accordance with Section 01 91 13 and Section 11 00 00.

3.03 TRAINING

- A. Training shall be conducted in accordance with Section 01 79 00 and Section 11 00 00. Training shall consist of a minimum of two 2-hour sessions addressing the theory of operation, testing, troubleshooting, and maintenance of the equipment.

3.04 FIELD SERVICE

- A. Provide the service of a qualified representative for one (1) trip and one (1) day to inspect the equipment installation, assist in startup, and instruct plant personnel in the operation and maintenance of the equipment.

END OF SECTION

SECTION 46 33 83

LIQUID CHEMICAL FEED ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish, install, start-up and test chemical feed skids for the treatment plant including all ancillary items and equipment as shown in the Drawings and as specified herein to provide a fully functioning system. This work includes the fabrication, delivery, installation, and placement into successful operation of the specified chemical feed skids. The systems shall include, but is not limited to, the following:
1. Mounting panel with pump shelf and all necessary structural supports.
 2. Pipe and fittings.
 3. Valves.
 4. Calibration column.
 5. Pressure indicating transmitter (furnished as work of Division 40)
 6. Pulsation dampener if specified.
- B. Refer to the Drawings for Process and Instrumentation Diagrams showing skid pipe sizing for each pump, and for a detail in the Mechanical Drawings of the chemical feed skid configuration.
- C. Refer to the Section indicated in the Equipment Schedule for the chemical metering pump type to be installed on each chemical feed skid.

1.02 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 and Section 11 00 00.

1.03 REFERENCES

- A. Industry standard references including but not limited to those listed shall be noted, as applicable, in this specification and shall be considered a part of this specification. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
NSF 61	Drinking Water System Components – Health Effects

1.04 QUALITY ASSURANCE

- A. Manufacturer's Experience: Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The equipment and all ancillary components shall be designed, supplied and warranted as a unit item by a single manufacturer or vendor.
- B. Warranty: As specified in Section 11 00 00.

1.05 EQUIPMENT SCHEDULE

Feed Skid for Chemical	Location	Chemical Feed Pump		Panel Material
		Equipment Number	Specification Section	
12% Sodium Hypochlorite	Chemical Room	P 8310	46 33 44	POLYESTER
12% Sodium Hypochlorite	Chemical Room	P 8320	46 33 44	POLYESTER
12% Sodium Hypochlorite	Chemical Room	P 8330	46 33 44	POLYESTER
12% Sodium Hypochlorite	Chemical Room	P 8340	46 33 44	POLYESTER
12% Sodium Hypochlorite	Chemical Room	P 8350	46 33 44	POLYESTER
50% Sodium Hydroxide	Chemical Room	P 8410	46 33 44	VINYL ESTER
50% Sodium Hydroxide	Chemical Room	P 8420	46 33 44	VINYL ESTER
50% Aluminum Chlorohydrate	Chemical Room	P 8510	46 33 44	POLYESTER
50% Aluminum Chlorohydrate	Chemical Room	P 8520	46 33 44	POLYESTER

1.06 SERVICE CONDITIONS

- A. The equipment will be installed in a water treatment facility located in Silt, Colorado. Approximate elevation at the site is 5,420 feet above mean sea level. All equipment furnished under this Section shall be suitable for the specified installation location and shall be suitable for continuous (24 hours per day) service.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All wetted components shall meet NSF 61 requirements.

2.02 FEATURES

- A. Mounting panel and pump shelf
1. Fabricate the mounting panel and pump shelf from fiberglass reinforced polyester (FRP) or vinyl ester a minimum of 3/4-inch thick as required in the table above. Structural supports, bracing, and strut shall be fiberglass. Pieces that are not available as fiberglass shall be carbon steel hot dip galvanized after fabrication. Assemble components using stainless steel nuts and bolts unless chemical compatibility is an issue.
 2. Mount pipe, fittings, valves, and chemical feed skid components to the mounting panel and pump shelf using threaded bolt holes with plastic pipe clamps at minimum 1-foot intervals. Plastic pipe clamps shall be CLIC or Engineer-approved equal. Provide adequate spacers to prevent all components from touching the panel directly.

- B. Pipe and Fittings
 - 1. Refer to Section 33 14 13.
 - 2. Unions shall be threaded, true union type.
- C. Valves
 - 1. Refer to Section 33 14 19.
 - 2. Valve fittings shall be threaded, true-union type.
- D. Calibration Column
 - 1. Calibration column shall be with a sealed cap, installed per manufacturer's recommendations.
 - 2. Calibration column material shall be pVC with end caps matching the pipe material specified in 33 14 13.
 - 3. Coordinate calibration column size with the chemical metering pump's maximum capacity. The calibration column shall be able to hold a volume of fluid equal to 30 seconds of the chemical feed pump running at its maximum speed but shall be no larger than necessary.
 - 4. Calibration column: Griffco PVC or Engineer approved equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Accurately place anchor bolts using templates furnished by the manufacturer.
- B. The Drawings indicate the approximate configuration of the piping, valves and fittings. The final routing shall be determined in the field by the Contractor prior to installation and after approval by the Engineer. This work shall be performed at no additional cost to the Owner.
- C. Equipment pipe connection sizes may vary per the equipment furnished. Contractor shall furnish and install all pipe fittings necessary to match the indicated pipe size and as required for a complete installation at no additional cost to the Owner.

END OF SECTION

SECTION 46 43 66

BALLASTED HIGH RATE CLARIFIER UNIT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall furnish and install two (2) ballasted high rate clarifier units for a water treatment plant similar and equal to ACTIFLO TURBO manufactured by VEOLIA and RAPISAND BALLASTED FLOCCULATION SYSTEM manufactured by WESTECH.
- B. Clarifier units shall include a coagulation tank, flocculation tank, and settling/clarification tank. All major equipment and materials shall be furnished by a single supplier whose experience includes design, fabrication, and operation of water plants of a size and complexity similar to that specified herein.

1.02 SUBMITTALS

- A. Submit shop drawings for product data, materials of construction, power and control wiring diagrams, including terminals and numbers and complete motor nameplate data, and details of installation in accordance with Section 01 33 00. Layout and interconnections of all components must be approved by the Engineer. Final as-built documentation shall also be submitted in accordance with Section 01 33 00.
- B. Submit information on materials of construction, details on electrical and control equipment and detailed information on all ancillary equipment.
- C. Submit detailed narratives of proposed clarifier operations and required control. These narratives will be used for clarifier control programming performed under the work specified in Division 40. The narratives shall include detailed step-by-step explanation of how the system will operate from start-up to shut down, including coagulation, ballasted flocculation, and clarification/settling. The narratives shall also include valve operation, anticipated timing for the various operational modes, and anticipated set points for control instrumentation. The narratives shall be sufficiently detailed so that there is no question as to how the system operates.
- D. Submit testing and start-up schedules to Engineer and Owner at least 10 days prior to testing and start-up. Submit test reports.
- E. Submit manufacturer's installation instructions with details installation drawings.
- F. Submit operation and maintenance manuals in accordance with Section 01 78 23.

1.03 QUALITY ASSURANCE

- A. All materials shall be new and of the best quality of their respective kind.
- B. Excepting interconnecting piping, wiring, and other incidental materials, all equipment and accessories specified herein shall be supplied by the manufacturer and the units shall be warranted as one complete system.
- C. Contractor is responsible for coordinating with the manufacturer and completing the entire installation such that the system performs as specified and so that the system and component warranty is not compromised in any way.

- D. Basis of Design: Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of mechanical process equipment control systems with other components of the facility process control systems.

1.04 DESIGN CRITERIA

A. Influent conditions

Total flow- system	2 MGD
Total flow per unit	1 MGD
Peak Turbidity	1400 NTU
Average Turbidity	100 NTU

B. Design Parameters

Coagulation Tank HRT	1.6-2.3 minutes
Flocculation Basin HRT	2.3-6.9
Hydraulic Loading Rate	12-16 gpm/ft ²
Effluent Turbidity	<2 NTU

- C. The selected process shall be capable of thorough coagulant mixing, microsand and polymer injection and mixing, floc flocculation, settling, and removal.
- D. The flocculation tank must include a mix draft tube to minimize hydraulic retention time and to increase mixing efficiency.
- E. The system shall be capable of beginning operation and reaching 65% of the specified performance within 1 to 2 hydraulic retention times (HRTs) when operated at design flow rate.
- F. Treatment system head loss should be less than 2 feet.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. The high rate clarifier units shall be manufactured by Veolia Water Technologies or WesTech Engineering LLC, modified as necessary to satisfy the requirements of this specification, or an engineer approved equivalent.
- B. Any other manufacturers outside of the two listed above desiring to bid on the project shall be required to pre-qualify their proposed system to the Engineer before being allowed to participate in the bidding process as a deductive alternate. The Pre-bid submittals shall be made to the engineer no less than ten days prior to the bid opening date.
- C. Manufacturer shall supply proof of a minimum of 30 installations of package treatment systems for water systems in 10 years.
- D. Manufacturer shall supply proof of treating high turbid waters, over 1,400 NTU for sustained periods of time and the system must be able to operate between 30 percent and 100 percent of the standard design flow.
- E. Equipment control panels shall be provided by the manufacturer. Provide a separate control panel including PLC-based controls, operator interface terminal, motor controllers and associated ancillary equipment for each clarifier unit.

- F. Contractor shall coordinate all activities related to the installation of the ballasted high rate clarifier system with the manufacturer.

2.02 PRODUCT HANDLING

- A. The manufacturer is responsible for properly protecting all equipment surfaces to prevent rust, corrosion, and damage.
- B. If the treatment system is not installed upon receipt, the contractor shall contact the manufacturer for long-term storage procedures, if applicable.

2.03 CONSTRUCTION

- A. The clarification units shall be contained in a single, rectangular painted carbon steel tank. Major components shall be of the size and shape as shown in the plans and meeting the specified design criteria.
- B. All exterior connections to the unit shall be provided with flanged connections except the sludge recirculation and drainage connections which shall be threaded.
- C. All steel plates shall conform to the requirements of ASTM.
- D. All nuts/bolts/washers for use under water shall be aluminum or stainless steel.
- E. The coagulation tanks shall include a flanged bottom drain with a plug valve.
- F. Access shall be provided in the form of a caged ladder and safety gate to access to the deck of the clarifier unit. The ladder must meet or exceed OSHA and ANSI standards and shall include the required hardware.

2.04 PAINTING

- A. All carbon steel shall be painted except any parts defined as Hot Dip Galvanized. The painting shall be in accordance with the following:
 - 1. Internal
 - a. Surface preparation: SSPC-SP-10
 - b. Coating:
 - 1) Shall be ultra-high solids, edge retentive epoxy that can be applied using normal or plural airless spray
 - 2) Shall be certified in accordance with NSF/ANSI Std. 61 and meet or exceed the requirements of AWWA C210-15
 - 3) 20-28 dry mils per coat
 - 4) White color with gloss finish
 - 5) Volume solids: 98% ± 2%
 - 6) Meets MIL-PRF-23236, Type VII, Class 5, 7, 9, and 11 Grade C
 - 7) Coating shall be Dura-Plate USH from Sherwin-Williams or engineer approved equal.
 - 2. External
 - a. Surface preparation: SSPC-CP-6

- b. Coating:
 - 1) Shall be a high build, direct-to-metal polyaspartic coating that can be applied in a single coat
 - 2) Volume solids: 71% ± 2%
 - 3) Color grey with semi-gloss finish
 - 4) Typical thickness shall be 7-9 mils per coat
 - 5) Coating shall be Envirolastic 940 LV from Sherwin-Williams or engineer approved equal.

2.05 GRATING AND HANDRAILS

- A. Grating shall be provided by the manufacturer and shall be manufactured with non-slip surface.
- B. All grating shall be grey or supplier approved substitute.
- C. Grating shall be FRP molded grating or aluminum.
- D. Handrails shall be provided along the perimeter of the ballasted flocculation unit.
- E. Handrails shall be designed per the drawings and specifications and for a concentrated load of 200 lbs applied in any direction at any point as well as a linear load of 50 lb/ft.

2.06 DRIVE PLATFORMS

- A. Mounting platforms shall attach to the tank walls and shall be used to support the mixers and the scraper/rake drives.
- B. Platform deflection shall not exceed 1/360 of the span apply all dead loads and a live load of 50 lbs/sf.

2.07 INLINE MECHANICAL MIXER

- A. An inline mixer shall be supplied prior to the flow entering the ballasted flocculation tank(s) to aid in coagulation dispersion. Design shall be for long, continuous, and uninterrupted service.
- B. Mixer Body
 - 1. Shall be supplied as a pipe section with both ends flanged. Gaskets shall be supplied for all bolted flanged connections.
 - 2. It shall have an integral mounting flange for connection to the mixer drive.
 - 3. All flanges shall be fabricated per standards for ANSI 150#.
 - 4. The mixer shall be supplied with a drain port directly under the mixer.
- C. Mixer drive shall be designed with a shaft and bearing system suitable for the loadings imposed by the application. All drive bearing shall be of the antifriction type. All bearings shall have minimum L-10 lives of 100,000 hours when operating at full motor horsepower at design speed.
- D. Impellers
 - 1. Shall be high efficiency, axial or radial flow hydrofoil type/pitched bladed impeller designed to achieve vigorous mixing.

2. The impeller unit, including the shaft and impeller, shall be made out of 316 SS.
3. Impellers shall be removable and attach to the impeller shaft by means of a dual set of screws or welding.

E. Motors

1. Motors shall be standard NEMA C-Face, Type 2, inverter duty in accordance with the requirements of Specification 11 05 13.
2. The motor shall be fitted with a shaft grounding unit.
3. Maximum speed of 1800 rpm.

2.08 MIXERS

- A. Mixer assemblies shall consist of an impeller, shaft, coupling, mounting base, and motor as detailed below.

B. Impellers

1. Shall be high efficiency, axial or radial flow hydrofoil type/pitched bladed impeller designed to achieve vigorous mixing.
2. The impeller unit, including the shaft and impeller, shall be made out of 316 SS or 304 SS.
3. Impellers shall be removable and attach to the impeller shaft by means of a dual set of screws or welding.

C. Gear Reducers

1. Speed reducer shall be specifically designed for mixing duty and shall be suitable for continuous operation.
2. All gearing shall be helical AGMA 11, minimum. Gears shall be completely immersed in lubricant. Worm gears are not acceptable.

D. Motors

1. Variable Speed Mixers: Motors shall be standard NEMA C-Face, Type 2, inverter duty in accordance with the requirements of Specification 11 05 13.
 - a. The motor shall be fitted with a shaft grounding unit.
2. Constant Speed Mixers: Motors shall be standard NEMA C-Face Type 2 in accordance with the requirements of Specification 11 05 13.

2.09 VALVES

A. Butterfly Valve

1. Butterfly valves, including automated valves, shall meet the requirements included in specification section 33 14 19- Valves and Operators.

B. Plug Valve

1. All plug valves shall meet the requirements included in specification section 33 14 19- Valves and Operators.

2.10 SCRAPER/RAKE UNITS

- A. Sludge scraper/rake mechanisms shall be suitable for installation within the settling tank. Each scrape shall comprise a complete assembly including center drive assembly, rake arms, and necessary support.
- B. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L-10 life of 50 years or 450,000 hours.
- C. Motors shall be Type 2 in accordance with the requirements of Specification 11 05 13.
- D. The drive shall include a torque overload protection mechanism that shall consist of an AR-coupling, proximity sensor and remote monitoring switch to protect the scraper system from damage.
- E. The scraper/rake mechanism shall be either 304 SS or painted carbon steel. This includes the drive shaft, rake arms, and blades. Adjustable stainless steel squeegees shall be fastened to the blades. Ensure the blades are properly sized to complete scraping/raking of the bottom of the tank twice per revolution.

2.11 TUBE SETTLERS

- A. Tubes shall be either polystyrene or PVC and shall be provided with 304 SS or painted carbon steel supports. Tube settlers shall be designed to promote an even flow distribution. Modules shall be field installed by the contractor with appurtenances including wire rope and clips.

2.12 COLLECTION TROUGHS/LAUNDERS

- A. Collection troughs/launders shall be 304 stainless steel. Troughs and supports shall be provided for the collection of clarified water from the tube settlers.

2.13 SAND RECIRCULATION

- A. Pumps shall be designed to operate at maximum possible efficiency throughout the duty range. Pumps shall be capable of continuous operation.
 - 1. Recirculation pumps shall be cast iron, split case, centrifugal, rubber-lined volute, and impeller.
 - 2. Motors shall be Type 2, inverter duty in accordance with the requirements of Specification 11 05 13.
 - a. The motor shall be fitted with a shaft grounding unit.
- B. Isolation valves shall be ductile iron with ANSI flange connections.
- C. Flush connection valve shall be ball type 304 SS.
- D. Pump pressure transmitter isolation valves shall be ball type 304 SS.
- E. Recirculation system piping shall be provided by the equipment supplier as shown on the project drawings.

2.14 HYDROCYCLONES

- A. Hydrocyclones shall be made of a urethane body. Support stands shall be either painted carbon steel or 304 SS.
- B. Hydrocyclones shall be sized according to the pump nominal recirculation flow and in accordance with the drawings.

2.15 MICROSAND

- A. Effective sand size between 80 and 160 um and a uniformity coefficient <1.7 shall be provided by the equipment supplier for the initial start-up. The microsand shall contain 95% to 99% pure silica sand.

2.16 PROCESS INSTRUMENTATION

A. Turbidity Monitoring

- 1. Turbidity sensor shall be Type ATH in accordance with specification 40 75 00.
- 2. Turbidity sensor shall be installed on the clarifier system settling tank.
- 3. The turbidity sensor shall be designed for immersion mounting and provided with all mounting hardware required for the application.

B. pH Monitoring

- 1. pH sensors shall be Type APH in accordance with specification 40 75 00.
- 2. pH sensors shall be installed on the settling tank.
- 3. pH sensor shall be designed for immersion mounting and provided with all mounting hardware required for the application.

C. Analyzer Controller: Analyzer controller shall be Type AC1 in accordance with specification 40 75 00.

- 1. Analyzer controller shall be provided with an EtherNet/IP communication interface.
- 2. Both the turbidity and pH sensors shall be interfaced to a single analyzer controller.

D. Pressure Transmitter

- 1. Pressure transmitter shall be Type PGT with a Type 1 process connection in accordance with specification 40 73 00. Each pressure transmitter tap shall be fitted with an isolation valve and isolation diaphragm.
- 2. A pressure transmitter shall be used to measure the discharge pressure of the microsand recirculation pump. One pressure transmitter will be supplied per microsand recirculation line.

E. Level Transmitter

- 1. Level transmitter shall be Type PGT with a Type 3 three-inch flanged process connection in accordance with specification 40 72 00.

F. Level Switch

1. A float type level switch shall be provided on the settling tank to detect and annunciate a water level high condition.

2.17 ELECTRICAL AND CONTROLS

- A. General: Each clarifier unit shall be provided with an equipment control panel and instrumentation to control and monitor the filter unit. Control panel shall be shipped loose for installation at the location indicated on the Drawings.
- B. Power Requirements:
 1. Clarifier unit equipment control panels shall be rated for operation from 480 volt AC, 3 phase, 60 Hz power. The clarifier unit equipment control panel shall be configured for a single point of power delivery and provides for control of the clarifier unit. The control system shall include variable frequency drive (VFD) and full voltage non-reversing (FVNR) motor controllers as required to serve associated motor driven equipment.
 - a. VFD controllers shall be provided and mounted in the equipment control panel to serve the following motor driven equipment.
 - 1) Maturation mixer
 - 2) Sand recirculation pumps
 - b. FVNR motor controllers shall be provided and mounted in the equipment control panel to serve the following motor driven equipment.
 - 1) Pre-coagulation tank mixer
 - 2) Coagulation tank mixer
 - 3) Sludge scraper/rake
 2. Equipment control panel shall be provided with a 480/120 volt AC control power transformer to serve the control system components.
 3. Power and control circuits for the clarifier unit process equipment, controls, and instrumentation shall originate at the equipment control panel.
- C. Equipment Control Panel:
 1. The equipment control panel and associated control system components shall comply with the requirements of Specification 46 05 10 and as specified herein.
 2. The equipment control panel shall house the VFD and FVNR motor controllers, PLC system, local operator interface terminal, and all required power distribution and conditioning equipment and control system components.
 3. Equipment control panel short circuit current rating shall be 35,000 amperes minimum.
 4. Equipment control panel shall include all of the features specified in Section 46 05 10 including the following:
 - a. NEMA Type 4 freestanding painted steel enclosure.
 - b. Power distribution system including the following:
 - 1) Main overcurrent protective device.
 - 2) Individual overcurrent protection for each power circuit.
 - 3) Surge protection device on the incoming line.

- 4) VFD and FVNR motor controllers to serve the motor driven equipment furnished with the clarifier unit.
- 5) 480/120 volt AC control power transformer.
- c. Power Conditioning: The following power conditioning equipment shall be provided.
 - 1) Redundant 24-volt DC power supply system.
 - 2) 120-volt AC surge power filter.
 - 3) Uninterruptible power supply system to serve the control system and all associated instrumentation.
 - a) Power for field-mounted instrumentation shall be derived from the equipment control panel's uninterruptible power supply system.
- d. PLC system configured and programmed to operate and monitor the clarifier unit as required to comply with these specifications and to implement the system manufacturer's operating and performance criteria.
 - 1) The following instrumentation furnished as work of Division 40 shall be interfaced with the clarifier unit PLC system via the EtherNet/IP I/O network interface.
 - a) Influent raw water flow meter.
- e. Graphical operator interface terminal mounted on the control panel enclosure door.
- f. Operator control devices for all motor driven equipment mounted on the clarifier unit. Operator control devices shall be hardwired to the associated motor controller to provide manual control and monitoring of the motor controller independent of the PLC-based control system. Operator control devices shall include the following:
 - 1) Hand-Off-Auto maintained position selector switch.
 - 2) Run status indicating light.
 - 3) Motor controller fault indicating light.
 - 4) Overload relay reset push button (FVNR controller applications only).
 - 5) VFD human interface module (VFD applications only).
- g. Main power ON indicating light.
- h. Ethernet network hardware.
5. Each clarifier unit shall be provided with a dedicated equipment control panel shipped loose for installation at the location indicated on the Drawings.
- D. The clarifier unit shall be supplied with a NEMA 4X stainless steel terminal box(s) factory mounted on the clarifier tank.
 1. All equipment and instrumentation mounted on the clarifier unit shall be factory-wired to the terminal box with the exception of data communication network cabling which shall be field installed.
 2. All terminal boxes shall have grounding provisions for the cable types terminated in the box.
 3. Separate terminal boxes shall be provided for following voltage classes:

- a. 480 volt AC power circuits
 - b. 120 volt AC power circuits
 - c. Signal and DC power and control circuits
- 4. All wiring and terminal blocks shall be labeled in accordance with Specification 46 05 10
- E. PLC System Programming: PLC system shall be programmed to provide full control and monitoring of the clarifier unit. PLC programming shall be in accordance with the requirements of Specification 46 05 10.
- F. Operator Interface Terminal Programming: The graphical operator interface terminal shall be programmed to provide the following features.
 - 1. Adjustment of all system operating parameters.
 - 2. Monitoring of all system operating conditions.
 - 3. Trend displays as required to monitor and troubleshoot system performance.
 - 4. Alarm annunciation and management.
 - 5. Time synchronization with the PLC system.
- G. Network Configuration: Ethernet networks shall be configured in accordance with the requirements of Specification 46 05 10 and consist of two segregated networks as described below.
 - 1. Supervisory Control Network: A network switch shall be provided to interface the PLC system with the plant supervisory control network. No devices in this control panel other than the PLC shall be connected to this network.
 - 2. Input/Output Network: The following devices shall be connected to the input/output network.
 - a. Operator interface terminal
 - b. VFDs
 - c. FVNR motor controller overload relays
 - d. pH and turbidity analyzers
 - e. Unit influent raw water flow meter (flow meter furnished as work of Specification 40 71 00)

PART 3 EXECUTION

3.01 INSTALLATION

- A. The ballasted high rate clarifier modular system shall be installed as shown in the contract drawings and as specified in the specifications and in accordance with the manufacturer's instructions.
- B. A manufacturer representative shall be present during installation.

3.02 PLANT STARTUP AND OPERATOR TRAINING

- A. The manufacturer shall supply one electronic copy of each O&M manual for the system. The manuals shall be prepared specifically for this installation and shall include equipment lists,

drawings, descriptions and all other information that is required to instruct personnel on the operation and maintenance of the system.

- B. The manufacturer shall inspect the installation of all equipment prior to start up to verify all equipment has been properly installed and operates as specified.
- C. The manufacturer shall calibrate the equipment alongside the Owner's operator(s).
- D. During start-up the system's performance shall be evaluated for a period of 2 eight hour days. If any part of the system does not meet satisfactory process performance requirement at this time the 2-day test period shall be repeated on those portions that are non-compliant.
- E. After start-up, the manufacturer shall furnish the service of a competent technical service representative one month after Contractor's start-up to instruct the Owner's personnel in the operation and maintenance of the equipment for a three day period during one trip.

3.03 WARRANTY

- A. Warranty shall also be as specified in Section 11 00 00.

END OF SECTION

SECTION 46 61 13

FILTER MEDIA

PART 1 GENERAL

1.01 WORK OF THIS SECTION

- A. The work of this section consists of the furnishing and installation of new granular filter media and greensand in two gravity water treatment filters. New media shall be as specified herein and as indicated on the drawings.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA) B100-16 Standard for Granular Filter Material.
 2. American Water Works Association (AWWA) B102-15 Standard for Manganese Greensand for Filters.
 3. American Water Works Association (AWWA) C653-20 Standard for Disinfection of Water Treatment Plants.
 4. NSF International Standard NSF 61 - Drinking Water System Components – Health Effects.
 5. ASTM C33 Specification for Concrete Aggregates
 6. ASTM C123 Test Method for Lightweight Particles in Aggregate
 7. ASTM C128 Test Method for Specific Gravity and Absorption of Fine Aggregate
 8. ASTM D409 Test Method for Grindability of Coal by the Hargrove Machine Method
 9. ASTM D3174 Test Method for Ash in the Analysis Sample of Coal and Coke from Coal
 10. ASTM D3175 Test Method for Volatile Matter in the Analysis Sample of Coal and Coke
 11. ASTM D4371 Methods for Determining the Washability Characteristics of Coal
 12. ASTM E11 Specification for Wire Cloth and Sieves for Testing Purposes

1.03 SUBMITTALS

- A. Submit the following information for each type and size of material specified:
1. Sand, Greensand, and Gravel:
 - a. Sieve analysis giving particle size distribution, effective size and uniformity coefficient.
 - b. Acid solubility
 - c. Specific gravity
 - d. Mohs scale hardness
 2. Anthracite:
 - a. Sieve analysis giving particle size distribution, effective size and uniformity coefficient

- b. Acid solubility
- c. Specific gravity
- d. Mohs scale hardness
- e. Ash Content in accordance with ASTM D3174
- f. Volatile Content in accordance with ASTM D3175
- g. Hardgroves Grindability Index in accordance with ASTM D409
- h. Percent of material with specific gravity less than 1.4 and greater than 1.95
- i. Carbon Content
- 3. Proof of independent laboratory certification of submitted information
- 4. Documentation verifying NSF 61 certification
- 5. Media installation instructions from the media supplier including recommended procedures for washing and skimming

1.04 QUALITY ASSURANCE

- A. All filter media materials shall meet specifications prior to shipment. The media supplier shall perform verification testing of all specified criteria for all materials prior to shipment.
 - 1. The pre-shipment media testing shall be performed by an independent test laboratory retained by the filter media supplier.
 - 2. Sampling, including sample sizes and number of samples shall be in accordance with AWWA B100-16.
 - 3. Sieve analyses shall be performed in accordance with AWWA B100-16. Test reports shall include raw data, graphical results, computation of effective size, and uniformity coefficient.
 - 4. The specific gravity shall be determined for each sample. Testing shall be in accordance with AWWA B100-16 and ASTM C128.
 - 5. Other test results shall be performed and results reported in accordance with the applicable test standard.
- B. For each type and size of media submit prior to shipment from the point of manufacture:
 - 1. Certified test results from an independent laboratory for approval.
 - 2. Representative sample of approximately 1/2 cubic foot for each size and type of support gravel and sand and 10 pounds for anthracite.
 - 3. Samples shall be shipped in well-sealed properly labeled containers.
 - 4. Note the date of bagging and lot or stockpile number for each sample and test result.
- C. After arrival at the job site and prior to installation, filter media materials shall be tested for compliance with all specified requirements.
 - 1. Sampling and testing shall be done in accordance with AWWA B100-16.
 - 2. Sampling and testing shall be performed by a qualified independent testing laboratory retained by the Contractor and acceptable to the Owner.
 - 3. Certified test results shall be submitted to the Owner for approval prior to the start of installation of the media.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Package filter media in ultra-violet resistant new and unused heavy-duty cloth, paper, woven polypropylene, or polyethylene bags which contain no more than 1 ft³ (0.03 m³) of material. Clearly mark each bag with the material, source, effective size, uniformity coefficient, date of bagging and lot or stockpile number.
- B. When required in the purchase documents, shipment shall be made in suitable new and unused heavy-duty woven polypropylene semi-bulk containers, treated with UV light inhibitors and having a safety factor of at least five. Each container shall hold 1 or more tons of material. To aid in handling, semi-bulk containers should have attached straps or sleeves strong enough to support their entire weight when full. Clearly mark each bag with the material, source, effective size, uniformity coefficient, date of bagging and lot or stockpile number.
- C. Storage space at the job site is limited. Arrange deliveries so that only those materials required for the filters currently having media installed or replaced is on site. Coordinate on-site storage locations and deliveries with the Water Treatment Plant staff in advance.
- D. If indoor storage space is not available on-site. Store material off the ground and keep covered with an ultra-violet resistant tarp to prevent contamination by windblown debris and dirt.

PART 2 PRODUCTS

2.01 GENERAL

- A. Filter Media shall meet all requirements of AWWA B100-16.
- B. Filter Media shall be NSF 61 certified.
- C. Filter media shall be the end product of one responsible manufacturer or responsible supplier expressly qualified to produce and supply granular filter media materials for water treatment filter applications and actively engaged in supplying these materials for at least the past 10 years. The manufacturer or supplier shall furnish and/or coordinate all materials, components and accessories as necessary to provide granular filter media in full conformance with the specified performance, features, and functions indicated. This requirement does not alter or modify the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the materials as specified herein.
- D. Acceptable Suppliers
 - 1. Filter Tech Systems, Grand Junction, CO
 - 2. Leopold a Xylem Brand, Zelienople, PA
 - 3. WesTech Engineering, Inc., Ames, IA
 - 4. Or engineer approved equal
- E. Filter Media shall have a maximum headloss of 10 inches through a clean filter bed and a maximum of 45 inches headloss before backwashing.

2.02 SUPPORT GRAVEL

- A. Support gravel shall consist of coarse silica aggregate comprised of clean, hard, durable, rounded particles, with less than 25 percent (dry weight) of particles having more than one fractured face, meeting the following requirements:

1. Minimum Specific Gravity – 2.5
 2. Acid Solubility – less than 5 percent
 3. Mohs Scale Hardness – 7 minimum
- B. Support gravel shall be visibly free of clay, shale, organic impurities, or other deleterious material.
- C. Not more than 2 percent by weight of particles shall be flat or elongated to the extent that the longest dimension is more than 5 times the smallest dimension.
- D. Support gravel shall meet the following gradations:

Filters FLT 3100 and FLT 3200			
Layer Above Filter Bottom	Depth of Layer ¹ , in	Size	Designation
1	4	1 ½" x ¾"	MS-1 Silica Gravel
2	5	¾" x ⅜"	MS-1 Silica Gravel
3	3	⅜" – 3/16"	MS-1 Silica Gravel
4	3	3/16" – 3/32"	MS-1 Silica Gravel
5	4	1.4 – 1.7 mm	MS-22 High Density Gravel

¹If manufacturer's proposed underdrain allows for less support gravel, that is acceptable

- E. Gravel shall be installed in uniform layers of the indicated thickness. The gravel within each layer shall be uniformly graded and screened so that for each size range a minimum of 92 percent (dry weight) shall be finer than the largest designated size and not more than 8 percent (dry weight) shall be finer than the smallest designated size.

2.03 FILTER SAND

- A. Filter sand shall consist of clean, hard, durable, dense silica sand meeting the following requirements:
1. Average Specific Gravity – less than 2.5
 2. Acid Solubility – less than 5 percent
 3. A uniformity coefficient less than 1.5
 4. Mohs Scale Hardness – 7 minimum
 5. Silicon dioxide content – 85% minimum
- B. Filter sand shall be visibly free of clay, shale, organic impurities, or other deleterious material.
- C. Not more than 1 percent by weight of particles shall be flat or elongated to the extent that the longest dimension is more than 5 times the smallest dimension.
- D. Coarse sand shall be uniformly graded within the following limits based on ASTM E11 square holed sieves:

Sieve Size	Percent Passing
No. 8 (2.38 mm)	90 - 100
No. 12 (1.68 mm)	30 - 60
No. 16 (1.19 mm)	0 - 10

- E. Fine sand shall meet the following requirements:
 - 1. Minimum 98 percent passing No. 16 (1.19 mm) sieve and maximum 2 percent passing No. 50 (0.3 mm) sieve.
 - 2. Effective Size – 0.35 to 0.55 mm
 - 3. Uniformity Coefficient – 1.40 to 1.60
- F. Effective size and uniformity coefficient shall be as defined in AWWA B100-16.
- G. Depth of sand (MS-18 Silica Sand) shall be a minimum of 8 inches layered above MS-22 Silica Sand Garnet.

2.04 GREENSAND

- A. Greensand shall act as a catalyst used in the removal of iron and manganese by oxidation and will be included as a media layer in the mixed media filter.
- B. Greensand shall consist of clean, hard, durable, angular, dense grains of glauconitic sand that will resist degradation during shipping, handling, and usage and will be capable of maintaining a manganese oxide coating. The sand shall meet the following requirements according to AWWA B102-15:
 - 1. Dry Specific Gravity – approximately 2.4
 - 2. Effective size between 0.30 and 0.35 mm
 - 3. A uniformity coefficient less than 1.6
 - 4. Mohs Scale Hardness – 2 minimum
- C. Greensand shall be visibly free of clay, dust, organic impurities, or other deleterious material.
- D. Effective size and uniformity coefficient should be determined after scraping.
- E. Depth of greensand shall be 12 inches layered above silica sand.

2.05 ANTHRACITE

- A. Filter anthracite shall consist of hard, durable anthracite coal particles free of detrimental contaminants meeting the following requirements:
 - 1. Effective Size – 1.0 to 1.1 mm
 - 2. Uniformity Coefficient – less than 1.40 before and after skimming
 - 3. Minimum 98 percent passing No. 8 (2.38 mm) sieve and maximum 2 percent passing No. 25 (0.71 mm) sieve
 - 4. Average Specific Gravity – greater than 1.4
 - 5. Acid solubility less than 5 percent
 - 6. A Mohs scale of hardness greater than 2.7
 - 7. Fraction with Specific Gravity less than 1.4 – 3 percent maximum (dry weight)
 - 8. Fraction with Specific Gravity greater than 1.95 – 3 percent maximum (dry weight)
 - 9. Solubility in 40% Hydrochloric Acid – less than 2.5 percent by weight

10. Solubility in 1% Sodium Hydroxide at 190°F – less than 5 percent by weight
 11. Mohs Scale Hardness – 3.0 minimum
 12. Volatile Matter – 7 percent maximum (dry weight)
 13. Carbon Content – 80 percent minimum (dry weight)
 14. Ash Content – 15 percent maximum (dry weight)
 15. Hardgroves Grindability Index – less than or equal to 38
- B. Effective size and uniformity coefficient shall be as defined in AWWA B100-16.
- C. Anthracite shall be free of iron sulfides, clay, shale, organic impurities, or other deleterious material.
- D. Not more than 1 percent by weight of particles shall be flat or elongated to the extent that the longest dimension is more than 5 times the smallest dimension.
- E. Depth of anthracite (MS-4 Anthracite) shall be at least 18 inches layered above greensand.

PART 3 EXECUTION

3.01 FILTER MEDIA INSTALLATION

- A. General
1. Prior to the placement of any media, the underdrain system shall have had all repairs and specified tests completed and accepted by the Engineer.
 2. Remove any debris and sweep, vacuum and wash down with clear water the entire interior of the filter.
 3. Make a final inspection of the filter interior for damage that may have occurred following completion of the underdrain repairs and correct any deficiencies noted prior to starting installation of media.
 4. Do not permit workers to walk or stand directly on any filter media materials including underdrain gravel. Use boards of sufficient size (minimum 2' x 2' x 1/2") to sustain workers' weight without displacing media.
 5. Contractor shall be responsible for worker's safety and follow all local, State, and Federal guidelines pertaining to confined space entry procedures. Obtain necessary permits for work in confined areas.
 6. Plant staff shall operate filter backwash controls when washing the new filter media after installation. Contractor is responsible for coordinating filter media washing with plant staff to accommodate plant operating requirements.
- B. Filter Media
1. Place filter media material in accordance with AWWA B100-16 and AWWA B102-15.
 2. Transport and place filter media carefully to prevent contamination.
 3. Any filter media which becomes contaminated or dirty (i.e., contains more than 0.5 percent of foreign material by weight) either before or after it has been placed in the filters, shall be removed and replaced with clean media.

4. Each layer shall be completed, including backwashing and all testing, prior to starting the layer above it.
5. Placement of the Silica Garnet MS-22 and the Silica Sand MS-18 shall be completed in reverse; i.e. install MS-18 on bottom and MS-21 on top. Following placement of both layers, execute a backwash to re-stratify.
6. Mark top of each layer on the filter wall for reference when placing media.
7. Place each layer evenly throughout the filter, level by hand to within plus or minus 6 inches of the appropriate mark and screed level prior to backwashing. Exercise care in placing material to avoid disturbing the layer beneath.
8. Place sand and anthracite to an initial depth sufficient to provide for removal of material by scraping.
9. Washing and scraping shall be done in accordance with AWWA B100-16 and AWWA B102-15.
 - a. Wash each layer of support gravel after placement for a minimum of 5 minutes at the maximum available backwash rate but not exceeding 25 gpm/ft². After washing verify that no disruption of the gravel has occurred.
 - b. Wash and scrape each sand, greensand, and anthracite layer in accordance with AWWA B100-16 and AWWA B102-15. The backwash rate shall be as recommended by the media supplier or in accordance with AWWA B100-16 and AWWA B102-15.
 - c. After scraping each layer add sand or anthracite as necessary to bring the top surface to the finished elevation.
10. For each layer, after washing and scraping and prior to placement of the next layer, verify the media depth and surface uniformity of the layer using approved survey equipment.
11. After each media layer has been placed, washed and skimmed and prior to the placement of the next layer the following hydraulic test shall be performed to verify the integrity of the underdrain system and uniformity of backwash water distribution.
 - a. Flood the filter cell with clean water to 6 inches above the top of the media layer.
 - b. Backwash for 4 minutes at a rate of 20 gpm/ft².
 - c. Drain down to the initial level and repeat backwash.
 - d. After 5 backwash cycles, inspect the surface of the media layer. Deviations of more than 1/2" from a level plane indicate uneven distribution of backwash water due to plugged underdrain orifices or grout failure requiring correction prior to continuing with the media installation.
12. After each sand and anthracite layer has been placed, washed scraped and hydraulically tested 3 samples shall be taken at random locations selected by the Engineer and sieve analyzed for compliance with specified effective size, grain size distribution and fraction of flat or elongated particles. Sieve analysis shall be performed by an approved independent testing laboratory retained by the Contractor.

3.02 DISINFECTION

- A. Each filter shall be disinfected by chlorination in accordance with AWWA C653 and Specification 46 61 23.
- B. Disinfection will be performed by the Contractor.

END OF SECTION

SECTION 46 61 23

FILTER UNITS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall furnish and install two (2) rectangular gravity filters for a water treatment plant each having a maximum total filter area of 145 square feet. The capacity of each filter shall be 700 gpm when filtering at a maximum rate of 5 gpm per square foot. Filter systems shall include all ancillary items and equipment as shown in the Drawings and as specified herein to provide a fully functioning system.
- B. Filter units specified under this section have the following identification numbers:
 - 1. FLT 3100
 - 2. FLT 3200
- C. Any wetted equipment must be NSF 61 certified.
- D. Each tank shall have a max height of 11 ft and constructed of 1/4" aluminum plate properly reinforced to withstand the hydrostatic forces encountered during normal operation and any forces encountered during shipping and installing the units.
- E. The filter units supplied shall include gravity filtration compartments, filter media – as specified in Specification 46 61 13, underdrain, filter to waste capabilities, air scour equipment and blowers including air piping and valves, and specified control components and valves and related interconnections. All major equipment and materials shall be furnished by a single supplier whose experience includes design, fabrication, and operation of filter units of a size and complexity similar to that specified herein.
- F. Filter backwash water, filter effluent, filter influent, air scour valves, surface wash valves, and filter to waste valves are provided by the filter manufacturer. Valves and actuators shall be in accordance with Specification 33 14 19.
- G. Each filter unit shall be provided with a dedicated equipment control panel.
- H. Contractor shall coordinate all activities related to the installation of the filter system with the filter manufacturer.

1.02 SUBMITTALS

- A. Submit shop drawings for product data, materials of construction, power and control wiring diagrams, including terminals and numbers and complete motor nameplate data, and details of installation in accordance with Section 01 33 00. Layout and interconnections of all components must be approved by the Engineer. Final as-built documentation shall also be submitted in accordance with Section 01 78 39.
- B. Submit dimensional information, information on materials of construction, details on electrical and control equipment and detailed information on all ancillary equipment.
- C. Submit detailed narratives of proposed filter operations and required control.

- D. Submit testing and start-up schedules to Engineer and Owner at least 10 days prior to testing and start-up.
- E. Submit installation and test reports to the Engineer and Owner.
- F. Submit a list of installations of similar type and size.
- G. Submit operation and maintenance manuals in accordance with Section 01 78 23.

1.03 QUALITY ASSURANCE

- A. **MANUFACTURER'S EXPERIENCE.** Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The equipment and all ancillary components shall be designed, supplied, and warranted as a unit item by a single manufacturer or vendor.
- B. All materials shall be new and of the best quality of their respective kind.
- C. Excepting interconnecting piping, wiring, and other incidental materials, all equipment and accessories specified herein shall be supplied by the filter manufacturer and the filter unit systems shall be warranted as one complete system.
- D. Contractor is responsible for coordinating with the filter manufacturer and completing the entire installation such that the system performs as specified and so that the filter system and component warranty is not compromised in any way.
- E. **Basis of Design:** Refer to Specification 40 61 00 – 1.04 B for requirements pertaining to the integration of mechanical process equipment control systems with other components of the facility process control systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. The filter units shall be manufactured by Filter Tech Systems, Grand Junction, Colorado, Leopold a Xylem Brand, Zelienople, PA, WesTech Engineering, Inc. Ames, IA, or engineer approved equal and modified as necessary to satisfy the requirements of this specification.

2.02 CONSTRUCTION

- A. The filter units shall be of the size and shape as shown in the plans and meeting the specified design criteria. The shell shall be fabricated of a minimum nominal 1/4-inch-thick aluminum plate using marine grade aluminum alloy 5086 H16 or 5086 H32 and shall be suitably braced. Structural members shall be aluminum alloy 6061 T6.
- B. The filter compartment shall have a minimum 2-inch NPT drain located at the lowest possible point to enable the filter to be drained completely. The drain opening shall be designed so media is not lost during filter draining.
- C. All nuts/bolts/washers for use under water shall be aluminum or stainless steel.
- D. Each unit will be provided with the following standard 125# flanged connections:
 - 1. Influent - 12"
 - 2. Effluent/backwash supply - 12"

3. Backwash waste - 16"
 4. Filter drain - 2"
 5. Air scour – 3"
- E. The filter manufacturer shall furnish all dielectric insulators required to attach external piping to the aluminum units.
- F. Prior to shipping filters, the filter manufacturer shall provide a 4" x 4" sample of the finished aluminum tank material for the Engineer's and Owner's approval.
- G. All exterior vertical welds and welds along the top perimeter of the module shall be ground smooth prior to any treatment to present a well finished appearance. This grinding shall be considered by the welders as the tanks are being fabricated to ensure that an adequate amount of weldment remains after grinding.

2.03 FILTER COMPARTMENT

- A. Filter underdrain system of either the header/lateral type or chamber design shall be provided. The system shall be designed and have orifices sized properly to evenly distribute backwash water and collect filtered water while preventing channeling in the filter media. The underdrain materials shall be stainless steel, HDPE, PVC, or another corrosion resistant material designed to adequately support the filter media and perform as specified above.
- B. Water shall enter the filter unit through an influent box constructed of the same material as the filter tank. Configuration of the influent box, including influent and backwash wastewater piping shall be as shown on the Drawings.
- C. Backwash wastewater collection troughs shall be provided by the filter unit manufacturer and shall be designed to carry away the filter backwash wastewater without flooding the troughs. The backwash rate must be a minimum of 15 gpm/ft² and must provide a rate of 20 gpm/ft² or a rate necessary to provide for a minimum of 20 percent expansion of the filter bed. The troughs shall be designed such that no particle shall travel more than 3 feet horizontally to exit over weirs. Troughs shall be constructed of reinforced aluminum plate. Trough weirs shall be the adjustable straight edge type constructed of aluminum plate and secured by aluminum or stainless-steel nuts/bolts/washers.

2.04 FILTER MEDIA

- A. The filter media shall be in accordance with specification 46 61 13.

2.05 AIR SCOUR SYSTEM

- A. An air scour system shall be provided by the filter manufacturer to facilitate complete cleaning of the media. The system shall be header lateral type and placed at the gravel/sand interface or below the gravel layer based on manufacturer's recommendations. The system shall be designed and have orifices sized properly to evenly distribute air and effectively clean the media. The filter manufacturer shall provide all piping valves and valve operators required to ensure a fully operable air scour system.
- B. Two blowers shall be provided by the filter manufacturer. Each blower shall be designed to deliver a minimum of 290 scfm and a maximum of 580 scfm at no less than 6 psig. Each blower shall include an inlet-air filter and silencer, discharge silencer, weighted relief valve, manual shut off-valve, and solenoid operated leg drain all mounted on a steel frame in a sound proof enclosure. The blower shall be shipped to the jobsite as a fully assembled unit.

- C. Blower motor shall be Type 1 in accordance with Specification 11 05 13.
 - 1. Maximum Horsepower: 75 horsepower
 - 2. Maximum RPM: 1800 rpm
- D. Energy dissipaters shall be provided in the filters to avoid any excess loss of media.

2.06 SURFACE WASH

- A. A surface wash shall be provided by the filter manufacturer to facilitate cleaning of the surface of the filter. The surface wash shall consist of a system of fixed nozzles or a revolving-type system. All systems must be designed with:
 - 1. Provisions for water pressures of a minimum 50 psi and a maximum of 90 psi for fixed nozzle systems and revolving-type systems.
 - 2. A properly installed reduced pressure zone backflow preventer to prevent back siphonage if connected to the filtered or finished water system.
 - 3. Minimum rate of flow of 2.0 gpm/ft² of filter area with fixed nozzles or 0.5 gpm/ft² with revolving arms.
 - 4. Surface wash control solenoid valve in accordance with Specification 40 05 82.

2.07 FILTER CONTROL SYSTEMS

- A. General: Each filter unit shall be provided with an equipment control panel and instrumentation to control and monitor the filter unit. Control panel shall be shipped loose for installation at the location indicated on the Drawings.
- B. Power Requirements: Each equipment control panel shall be served by two 120 volt AC, single phase circuits. Each branch circuit shall be terminated on a circuit breaker in the control panel.
 - 1. UPS Branch Circuit: The UPS branch circuit shall serve the panel uninterruptible power supply system.
 - 2. Utility Branch Circuit: The utility branch circuit shall serve the control panel lighting and receptacle circuits.
- C. Equipment Control Panel:
 - 1. The equipment control panel and associated control system components shall comply with the requirements of Specification 46 05 10 and as specified herein.
 - 2. Equipment control panel shall include all of the features specified in Section 46 05 10 including the following:
 - a. NEMA Type 4 freestanding painted steel enclosure.
 - b. Power distribution system including the following:
 - 1) Main overcurrent protective device.
 - 2) Individual overcurrent protection for each power circuit.
 - 3) Surge protection device on the incoming line.
 - 3. Power Conditioning: The following power conditioning equipment shall be provided.
 - a. Redundant 24-volt DC power supply system.

- b. 120-volt AC surge power filter.
 - c. Uninterruptible power supply system to serve the control system and all associated instrumentation.
 - 1) Power for field-mounted instrumentation shall be derived from the equipment control panel's uninterruptible power supply system.
 - 4. PLC system configured and programmed to operate and monitor the filter unit as required to comply with these specifications and to implement the system manufacturer's operating and performance criteria.
 - a. The following instrumentation furnished as work of Division 40 shall be interfaced with the filter unit PLC system either directly via an analog input channel or the EtherNet/IP I/O network interface.
 - 1) Filtered water pressure transmitter.
 - 2) Filtered water turbidimeter.
 - 3) Filtered water flow meter.
 - 5. Graphical operator interface terminal mounted on the control panel enclosure door.
 - 6. Main power ON indicating light.
 - 7. Ethernet network hardware.
- D. The filter unit shall be supplied with a NEMA 4X stainless steel terminal box factory mounted on the filter tank. All instrumentation mounted on the filter unit shall be factory-wired to the terminal box. All wiring and terminal blocks shall be labeled in accordance with Specification 46 05 10.
- E. PLC System Programming: PLC system shall be programmed to provide full control and monitoring of the filter unit. PLC programming shall be in accordance with the requirements of Specification 46 05 10.
- F. Operator Interface Terminal Programming: The graphical operator interface terminal shall be programmed to provide the following features.
- 1. Adjustment of all system operating parameters.
 - 2. Monitoring of all system operating conditions.
 - 3. Trend displays as required to monitor and troubleshoot system performance.
 - 4. Alarm annunciation and management.
 - 5. Time synchronization with the PLC system.
- G. Network Configuration: Ethernet networks shall be configured in accordance with the requirements of Specification 46 05 10 and consist of two segregated networks as described below.
- 1. Supervisory Control Network: A network switch shall be provided to interface the PLC system with the plant supervisory control network. No devices in this control panel other than the PLC shall be connected to this network.
 - 2. Input/Output Network: The following devices shall be connected to the input/output network.
 - a. Operator interface terminal
 - b. Filtered water turbidimeter (furnished as work of Specification 40 75 00)

- c. Filtered water flow meter (furnished as work of Specification 40 71 00)

2.08 GAUGES

- A. The filter manufacturer shall furnish pressure gauges for the backwash supply lines. They shall be a minimum of 3.5 inches diameter, liquid filled, bronze movement and element material, and have recalibration capabilities. Gauges shall be equipped with snubbers and attached to gage cocks or 1/4-inch ball valves for isolation service. Gauge cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gauge cock shall be protected by a brass plug. Gauges shall have a range from 0 to 50 psi. Gauges shall be Ashcroft Duragauge type 1279, Ametek model 1981, or Engineer-approved equal.

2.09 FILTER INSTRUMENTATION

- A. Level Transmitter: Level transmitter shall be Type LRT in accordance with specification 40 72 00.
- B. Level Switch: A float type level switch shall be provided to detect and annunciate a water level high condition.

2.10 OBSERVATION PLATFORM STAIRWAY

- A. An observation platform and stairway built to conform to the dimensions and details shown on the Drawings shall be included as a part of each filter unit. The platform and stairways shall be furnished by the Contractor and shall be compatible with the filter modules.

PART 3 EXECUTION

3.01 FILTER INSTALLATION

- A. Filters shall be installed according to manufacturer's instruction and the contract documents.

3.02 MEDIA INSTALLATION

- A. Refer to Specification 46 61 13 for details on filter media installation.

3.03 DISINFECTION PROCEDURE

- A. Disinfection shall be performed by the Contractor.
- B. After media has been installed in a filter and all backwashing and skimming operations are complete for that filter the media bed is ready for disinfection.
- C. Drain all water from the filter. Sufficient chlorine shall be injected into the backwash water to produce a free chlorine residual of at least 25 mg/L throughout the filter per AWWA Standard C653-20.
- D. With drain valve closed: SLOWLY add water through the backwash system. Continue adding water until the water level is just over the top of the anthracite.
- E. Allow the media bed to soak in the chlorine solution for at least 12 hours. The chlorinated water shall be tested to determine the amount of free chlorine residual. If the free residual is less than 15 mg/L, the chlorination process shall be repeated. After soaking, the filter may be backwashed filtered to waste until free of chlorine.

3.04 PLANT STARTUP AND OPERATOR TRAINING

- A. The Contractor shall provide for a manufacturer's technical representative for two (2) days of filter startup assistance and operator training. Training shall be provided in accordance with Section 01 79 00. The startup assistance and training shall take place during two trips. The trips will include placement directions of the filter media and air scour system, plant equipment and control checkout, and operator instruction. The manufacturer's technical representative shall have had experience in training operators at least five plants of the size and complexity similar to this project.

3.05 PERFORMANCE TESTING

- A. The Contractor will perform a 3-week performance test on each completed filter. Performance testing will include:
1. Unit filter run volume
 2. Filtered water turbidity
 3. Filtered water particle counts
 4. Unfiltered and filtered water Microscopic Particle Analysis
- B. Acceptance of the results of these tests by the Owner and Engineer shall constitute demonstration of satisfactory performance.

END OF SECTION

SECTION 46 61 73

AUTOMATIC STRAINING EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish, install, start-up and test one automatic self-cleaning strainer including all ancillary items and equipment as shown in the Drawings and as specified herein to provide a fully functioning system.

1.02 REFERENCES

- A. Industry standard references including but not limited to those listed shall be noted, as applicable, in this specification and shall be considered a part of this specification. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard
ASME Section VIII Division 1	Boiler and Pressure Vessel Code, Rules for Construction of Pressure Vessels

1.03 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 and Section 11 00 00. The following additional submittals shall be provided in accordance with Section 01 33 00:

1. Headloss curve across the strainer's flow range capacity.

1.04 QUALITY ASSURANCE

- A. **MANUFACTURER'S EXPERIENCE.** Manufacturer shall be one who has been regularly engaged in the business specified herein for at least 5 years. The equipment and all ancillary components shall be designed, supplied, and warranted as a unit item by a single manufacturer or vendor.
- B. **UNIT RESPONSIBILITY.** As specified in Section 11 00 00.
- C. **WARRANTY.** As specified in Section 11 00 00.
- D. The strainer shall be factory tested for performance and hydrostatic and working pressure as specified in the Hydraulic Institute Test Code. Test results shall be signed and certified by an officer of the manufacturing corporation.

1.05 EQUIPMENT SCHEDULE

<u>Item</u>	<u>Location</u>	<u>Type</u>	<u>Equipment number</u>
Raw Water Strainer	Raw Water Gallery	Self-cleaning	STR 1055

1.06 SERVICE CONDITIONS

- A. Fluid temperature is expected to range from 35 to 75 degrees Fahrenheit.
- B. The equipment will be installed at a water treatment plant located in Silt, Colorado. Approximate elevation at the site is 5,415 feet above mean sea level. All equipment furnished under this Section shall be suitable for the specified installation location and shall be suitable for continuous (24-hours per day) service.
- C. The raw water strainer will process a raw water supply from the Colorado River and alluvial wells.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Reference to a manufacturer's name and model number or catalog number is for the purpose of establishing the standard of quality and general configuration desired. Acceptable manufacturer includes Fluid Engineering model 721 Hyper-Jet or engineer-approved equal.
- B. The automatic self-cleaning strainer system shall be designed for continuous removal of suspended particles from the raw water supply to the treatment plant. The strainer shall consist of a one-piece stainless-steel cylindrical screen with wedge-type slotted openings. A rotor shall be located within the drum, where the rotor shall be a hollow rotating shaft supporting two pads extended on each side. The pads shall be flush with the inside of the drum surface. The backwashing shall be accomplished by the rotor sweeping past the straining media to reverse the flow, flushing the suspended particles from the media into the rotor and out through the backwash opening. This reversal of flow is caused by a pressure differential between the interior of the strainer and atmosphere. The backwash flow rate will vary depending on the amount of suspended particles in the liquid. The backwash piping should discharge into an open funnel immediately after the backwash valve. The system shall have a manually operated valve on the backwash outlet line and an automatic control valve to permit intermittent backflushing. This control shall consist of a motor actuated by a timer and a pressure differential switch.
- C. Wetted components of the automatic self-cleaning strainer system shall be NSF61 certified.

2.02 MATERIALS

<u>Part</u>	<u>Material</u>
Body and cover	Fabricated carbon steel
Screen	Stainless steel type 316
Wetted parts	Stainless steel type 316
Flanges	Class 150 per ANSI B16.5

2.03 PERFORMANCE REQUIREMENTS

- A. Performance Requirements

<u>Criteria</u>	<u>Value</u>
Strainer inlet and outlet diameter, inches	10
Strainer backwash outlet diameter, inches ¹	2
Strainer drain outlet diameter, inches	1-1/2

<u>Criteria</u>	<u>Value</u>
Strainer manual vent outlet diameter, inches	1
Working pressure range, psig	1 to 20
Design pressure, psig	150
Maximum design flow rate through strainer, gpm	2,100
Backwash flow rate at design flow rate, gpm	70
Minimum pressure required for backwash, psi	2
Maximum allowable pressure drop through clean strainer at design flow rate, psig	2
Screen opening size, inches	0.032
Motor, hp	1/4

Note: ¹ Coordinate outlet orientation with Drawings.

2.04 FEATURES

- A. The design shall be in accordance with ASME Section VIII Division 1.
- B. The entire operating assembly, motor, gear reducer, cover, backwash arm assembly, bearing housing and element lift from the strainer body as a complete unit. Provide all components necessary for a complete and functioning system.
- C. The screen shall be a wedge-type, vee-shaped profile wire. The wide or flat section of the wedge wire shall face the direction of flow providing for a continuous smooth flat surface to trap debris. The screen element shall be a one-piece cartridge design. The element shall have stainless steel cap rings at both ends to prevent bypass of dirty fluid. Circumferential bands shall also be provided for structural reinforcement.
- D. The entire backwash arm shall have a full-port opening throughout the entire passage to the backwash piping. The backwash arm shall not contact or scrape the screen at any point.
- E. A jet spray assembly shall spray pressurized water across the entire face of the screen and into the hollow port along with any dislodged debris.
- F. The strainer shall have a single backwash outlet piping connection.
- G. The strainer tank drain shall be provided with a manual ball valve for isolation.
- H. The strainer tank vent shall be provided with a manual ball valve for isolation.
- I. The strainer shall be provided with electrically-actuated ball valves to automate backwashing. The valve sizes shall match the backwash outlet diameter and water inlet diameter and shall have female NPT connections. The valves shall have a type 316 stainless steel body and trim with reinforced polytetrafluoroethylene (PTFE) seat and seals. The actuators shall have a NEMA 4X housing and shall be provided with all features necessary to communicate with and be controlled by the manufacturer-furnished control panel.
- J. The strainer shall be provided with
- K. The strainer shall be provided with a diaphragm-type differential pressure switch. Pressure switch shall be factory-mounted on the strainer body with process connections to the strainer inlet and outlet.

- L. The strainer shall be complete with factory-supplied steel support legs for bolting to the equipment pad per the Contract Drawings.

2.05 STRAINER DRIVE MOTOR

- A. The strainer drive motor shall be a TEFC single-phase 120-volt with a gear reducer to drive the backwash shaft.

2.06 CONTROLS

- A. The system shall be capable of automatically controlling and monitoring the strainer's operation as follows:
 - 1. Backwash Operation: When a backwash operation is called for in either the manual or automatic control mode, the flushing water valve and backwash waste valves shall open and the strainer drive motor energized. The backwash status indicating light shall be illuminated whenever a backwash operation is active.
 - 2. Manual Control: When the Hand/Off/Auto selector switch is positioned to Hand a backwash operation shall be initiated and continue until the selector switch is returned to the Off or Auto position
 - 3. Automatic Control: When the Hand/Off/Auto selector switch is positioned to Auto a backwash cycle shall be initiated on an adjustable timed interval basis or upon detection of a differential pressure high condition.
 - a. Timed Interval Operation: The backwash operation shall be initiated upon expiration of an adjustable time interval and shall continue for an adjustable time period.
 - b. Differential Pressure High Operation: When a backwash operation is initiated upon detection of a differential pressure high condition, the backwash operation shall continue for an adjustable time period following the detection of a differential pressure normal condition.

2.07 EQUIPMENT CONTROL PANEL

- A. The raw water strainer shall be provided with a control panel in accordance with Specification 11 00 00 and the requirements specified herein.
- B. Control panel shall be NEMA 12 rated.
- C. The equipment control panel shall be a U.L. listed electrical control panel.
- D. The equipment control panel shall be furnished with the following operator control devices mounted in the panel door:
 - 1. Power on indicating light.
 - 2. Backwash status indicating light.
 - 3. Differential pressure high indicating light.
 - 4. Hand/Off/Auto selector switch.
- E. The equipment control panel shall house the following control system components:
 - 1. Combination motor starter with fused short circuit protection and thermal overload protection.

2. Ancillary control system components including relays, timers, and operator control devices.
- F. The following hardwire interface shall be provided at the equipment control panel for remote monitoring and control of the system.
1. Normally closed dry contact output that is opened to indicate the system alarm status.
 2. Normally open dry contact output that is closed to indicate system in backwash.
 3. Normally closed dry contact output that opens to indicate a differential pressure high condition.
 4. Normally open dry contact output that is closed to indicate the Hand/Off/Auto selector switch is in the Auto position.

2.08 FACTORY COATINGS

- A. Factory coatings shall comply with Section 09 90 00.
- B. Equipment shall be provided with a factory prime coating as appropriate. Prime coats shall be compatible with specified finished coatings in Section 09 90 00.

PART 3 EXECUTION

3.01 GENERAL

- A. Accurately place anchor bolts using templates furnished by the manufacturer.
- B. Lubricate before operating as per manufacturer's recommendations.

3.02 INSTALLATION AND FIELD TESTING

- A. After completion of the installation and manufacturer's certification, the equipment shall be field tested to demonstrate compliance with the requirements specified. Installation, start-up, and testing shall be conducted in accordance with Section 01 91 13 and Section 11 00 00.
- B. Functional Tests: Two complete backwash cycles.
- C. Performance (Leakage) Test
1. Under actual or Engineer-approved simulated operating conditions.
 2. For a continuous 3-hour time period without malfunction.
 3. Adjust, realign, or modify unit and retest if necessary.

3.03 TRAINING

- A. Training shall be conducted in accordance with Section 01 91 13 and Section 11 00 00. Training shall consist of a minimum of two 1-hour sessions addressing the theory of operation, testing, troubleshooting, and maintenance of the equipment.

3.04 FIELD SERVICE

- A. Provide the service of a qualified representative for two (2) trips, one (1) day each to inspect the equipment installation, assist in startup, and instruct plant personnel in the operation and maintenance of the equipment in the temporary and permanent locations.

END OF SECTION

SECTION 46 66 00

ULTRAVIOLET DISINFECTION EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide, install and test closed vessel, pressurized flow, high intensity medium pressure Ultraviolet Light (UV) disinfection systems including UV System vessel, UV lamps, ballasts with multiple power settings, System Control Center, Power Distribution Center, Support Racks, automatic mechanical/chemical cleaning system, UV intensity monitoring system, and all ancillary items and equipment necessary and required for a complete, fully functioning system, as indicated on the contract drawings, and as specified herein, capable of disinfecting treated drinking water to meet the capacity and water quality standards listed in this section.

1.02 QUALITY ASSURANCE

- A. All materials shall be new and of the best quality of their respective kinds.
- B. Industry standard references shall be noted, as applicable, in this specification and shall be considered a part of this specification.
- C. The UV equipment and all ancillary items shall be designed, supplied, and warranted as a complete system by a single manufacturer or vendor, who shall have unit responsibility for the entire system.
- D. The manufacturer shall have been regularly engaged in the furnishing of equipment of the type specified herein for at least 10 years, have at least 100 installations (minimum size of greater than or equal to 1 MGD) in North America, and have a service center located within two day's travel from the site.
- E. Performance of specified equipment/reactor shall be verified via Bioassay testing. Bioassay testing and results shall be validated by a qualified third party in full compliance with EPA 815-R-06-007, Ultraviolet Disinfection Guidance Manual for The Long Term 2 Enhanced Surface Water Treatment Rule, released November 2006. Bioassay testing shall evaluate reactor performance over range of specified flow rates, UV transmittance (UVT), and MS2 Reduction Equivalent Dose (RED). Additionally, the test results shall confirm headloss in the closed reactor vessel is equal or less than the value stated in this specification. Bioassay testing must encompass the design and operation conditions listed in this specification. Extrapolations to flow rates, UVT, or UV Dose are not acceptable.
- F. Any discrepancies between referenced specifications and this section should be brought to the immediate attention of the Engineer. In all cases, the more stringent requirement shall prevail unless otherwise determined by the Engineer in writing.
- G. The equipment furnished under this section shall be free of defects in material and workmanship, including damages that may be incurred during shipping, for a period defined in Section 11 00 00. The severity of the defect will determine the requirement of a site visit. All expenses, including travel costs, accommodations, etc. for a service visit due to a defect deemed severe by the manufacturer shall be included in the warranty.
- H. The UV lamps shall be warranted for a minimum of 5,000 hours of operation in automatic mode, prorated after 3,000 hours of operation.

- I. The UV manufacturer must have a 3rd party validation report meeting the requirements listed in Section 1.2.C of this specification. The validation report must substantiate that the UV system is capable of delivering a RED (reduction equivalent dose) mJ/cm², for the specified design conditions as follows:

$$\text{RED} = D_{\text{req'd}} * \text{VF}$$

Where $D_{\text{req'd}}$ (dose required) = 15 mJ/cm² for 3.5 log credit for *Cryptosporidium*

[Reference Table 1.4 Ultraviolet Disinfection Guidance Manual (UVDGM)]

VF = UV system validation factor calculated using the method outlined in UVDGM

1.03 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 and Section 11 00 00.
- B. Provide a complete, detailed proposal of the equipment offered, including a listing of any exceptions taken to these specifications, in sufficient detail to permit an item-by-item comparison with these specifications. Provide a written guarantee that the equipment will continuously meet the specified performance requirements for each unit as described in this Section.
- C. Shop drawings showing a complete description of all items to be furnished in sufficient detail to allow determination of conformance with these specifications, and including dimensions and installation requirements, descriptive information including catalog cuts and manufacturer's specifications for all components, and electrical schematics and layouts.
- D. Hydraulic calculations and results of tests done by an independent testing laboratory demonstrating compliance with the specified hydraulic characteristics.
- E. Bioassay test report validating the performance of the proposed UV equipment done in accordance with the requirements of Section 1.02.E and acceptable to the Engineer. Include headloss information in submitted report.
- F. Calculations based on the bioassay demonstrating that the proposed UV system design and number of lamps will deliver the specified dose. Additionally, provide a Validation Report per Sections 1.02.E and 2.02.B as part of the submittal package to substantiate the dose delivery (RED) and calculation of the Validation Factor.
- G. Independent certification of fouling factor and lamp aging factor if values other than the specified default values are proposed.
- H. Provide documentation of their experience stated in Section 1.02.D.
- I. Electrical gear schematics and layouts and wiring diagrams.

1.04 SERVICE CONDITIONS

- A. The equipment will be installed indoors at a water treatment plant near Silt, Colorado.
- B. Elevation: 5,460 feet above mean sea level.
- C. Liquid to be disinfected: Filtered drinking water that has not been previously disinfected.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Acceptable manufacturers include Trojan Technologies, Inc., UVSwift™ 12 or engineer approved equal. If other equipment is proposed, demonstrate to the Engineer and Owner that all requirements of materials, performance, and workmanship will be met or exceeded by the proposed equipment. The Contractor is responsible for any and all costs associated with system evaluation and redesign, including electrical, mechanical, structural and civil elements of the installation.

2.02 DESIGN AND PERFORMANCE REQUIREMENTS

- A. The UV System shall be comprised of the following components:
1. Number of treatment trains: 2
 2. Number of lamps per chamber: 6
 3. Control Power Panels: 2
 4. UV Intensity Sensors: 1/Chamber
 5. Automatic Cleaning System: Mechanical (e.g. Screw Drive)
- B. UV disinfection shall be capable of providing a 3 log removal of Cryptosporidium and Giardia at the Peak flow and Design UVT conditions specified below.
1. Average Daily Flow (per train): 0.7 US MGD
 2. Peak Flow (per train): 1.0 US MGD
 3. Design temperature range: 34° F to 104° F (1°C to 40°C).
 4. Turbidity: ≤ 1 NTU
 5. UV Transmissivity: 85 percent (minimum)
- C. Design Dose
1. The UV disinfection system shall be designed to deliver the Reduction Equivalent Dose (RED) defined in Section 1.2.I at the design conditions listed in Section 2.2.B .
 2. The RED shall be delivered under the Peak (Design) Flow and Design (UVT conditions listed in Section 2.2.B.
 3. Systems without an automatic on-line mechanical cleaning system shall include provisions to automatically chemically clean the lamps.
 4. RED must be verified by third party witnessed bioassay testing per Section 1.2.I
- D. Headloss through each reactor will not exceed 4.51 inches at peak flow conditions.
- E. The system will be able to continue providing disinfection while the automatic cleaning system is in operation and while the UV intensity sensor calibration is being checked.
- F. Reactor design shall allow for Plant Operations Staff to change lamps without draining reactor. Access ports will also be provided for easy access to quartz tubes and cleaning system. Reactor dry weight shall not exceed 275lbs (125 kg).

- G. Each reactor will be 8 inches in diameter, will be supplied with an 8 inch 150 # ANSI flanged inlet/outlet connection, and will be 66 inches long. Each reactor will be designed to handle a maximum operating pressure of 150 psig, and will be fully assembled and hydrotested to 1.5 times the design pressure in the factory prior to shipment.
- H. Reactor shall occupy no greater than 3.5 ft² (0.33 m²) and weigh no more than 300 pounds (136 kg) dry.

2.03 MATERIALS

- A. All metal components shall be of welded construction manufactured from Type 316 L stainless steel. The UV reactor will be pickled, passivated, and bead blasted for uniform external finish.
- B. Quartz Tubes shall be Type 214 quartz, fully annealed clear fused quartz tubing.
- C. All wiring exposed to UV light shall be Teflon coated.
- D. All wires connecting the lamps to the ballasts shall be enclosed inside the frame of the UV reactor and not exposed to the water.

2.04 EQUIPMENT FEATURES

A. UV Reactor

- 1. System shall be designed to operate in a pipe that will be full of water at all times.
- 2. Each UV reactor will be manufactured from 316 SS and with 8" 150 ANSI flanged inlet/outlet connections.

B. Lamp Array Configuration

- 1. Each reactor will contain 6 low pressure high output UV lamps arranged horizontally and parallel to the direction of flow.
- 2. The single array pattern shall be continuous and symmetrical throughout the reactor.

C. UV Lamps and Lamp Sleeves

- 1. UV lamps shall be high intensity, medium pressure with a filament designed for to withstand shock and vibration
- 2. UV lamps shall reach maximum UV output within three (3) minutes.
- 3. Each lamp will be enclosed in an individual quartz sleeve, one end of which will be closed and the other sealed with compressed o-rings.
- 4. Each quartz sleeve shall be independently sealed within the reactor.
- 5. Lamp bases shall be resistant to UV and ozone. Lamps will be operated by a variable output electronic ballast with power settings from 30 to 100%.
- 6. Lamps shall be enclosed in a lamp sleeve manufactured from Type 214, fully annealed clear fused quartz tubing.
- 7. The lamp sleeve shall be domed at one end and the other end open. The open end shall be sealed with an o-ring and a Type 316 stainless steel compression plate.

D. UV Intensity Sensor

1. UV intensity sensor(s) shall be located inside each reactor and contained within quartz sleeves.
2. Each lamp shall be provided with a UV intensity sensor
3. Each sensor sleeve will have an automatic cleaning system.

E. Cleaning System

1. The automatic cleaning shall provide both mechanical and chemical cleaning abilities for the lamp sleeves and UV sensor, complete with an automatically initiated and controlled cleaning cycle.
2. The cleaning system shall be driven by an internal screw drive with an electric motor. Cleaning cycles will be field adjustable via the operator interface. A cleaning cycle can also be initiated at the operator interface.
3. System will be provided with cleaning agents and solutions required for equipment testing and startup.
4. All cleaning reagents shall be NSF 60 approved.

F. Electrical

1. Shall accept 480Y/277V, 60 Hz, 3-phase, 4 wire + ground 13.5 kVA electrical supply. Power shall be provided to the control power panel.
2. The maximum total power consumption shall be no greater than 13 kVA, maximum current per phase (unbalanced load).
3. All required cabling between the Control Power Panel and the UV Reactor shall be provided by the UV system vendor.

G. Control Power Panel

1. Power distribution and control for each UV reactor will be through the Control Power Panel (CPP). The CPP will house all power supplies and control equipment. The CPP shall meet the requirements of Specification 40 61 00.
2. One (1) Control Power Panel (CPP) will be provided for each UV Reactor. Each UV reactor is controlled independently. Control of multiple reactors shall be accomplished through the plant process control system.
3. CPP dimensions shall not exceed 48" high by 36" wide x 16" deep and shall not weigh more than 350 lbs.
4. CPP shall be epoxy painted carbon steel, ventilated CSA Type 12, and force air cooled.
5. Each CPP will be provided with a lockable disconnect handle.

H. Instrumentation and Controls

1. Each reactor will be provided with a dose pacing system. The dose pacing system will modulate lamp power levels and the number of lamps in relationship to a 4-20 mA DC signal from the plants influent flow meter, and UV sensor signal in conjunction with the UV transmission values. The system will be dose-paced such that as flow, water quality, and lamp conditions change, the UV dose delivered is optimized while conserving power.
2. Each reactor shall come with a Temperature switch. The temperature switch will be integral to the unit and will prevent reactor from overheating. The switch will be wired to

the Control Panel, will shut the reactor down, and will initiate a critical alarm when activated.

3. Each UV Reactor will be equipped with a water level sensor to prevent operation of the UV lamps in air. The level sensor will be wired to the CPP and will shut the reactor down and initiate a critical alarm condition if low water level is detected.
4. For Operator safety, the protective cover will be equipped with a switch to disconnect power to the lamps when the cover is removed.

I. Programmable Logic Controller

1. Each UV reactor is controlled by an Allen Bradley Compact Logix, which continuously monitors and controls the UV reactor's functions. Custom electronics, an input flow signal (supplied by others), water level signal (provided by others) and the UV sensor, provide the PLC with the necessary indication of system parameters.
2. Operator Interface
 - a. Complete control and monitoring for each reactor shall be accomplished through the operator interface on the CPP.
 - b. Operator interface will be Allen Bradley Panel View 700+. Operator interface shall be menu driven, and display the following information at a minimum:
 - 1) Reactor status
 - 2) Individual lamp status
 - 3) Individual lamp operator hours.
 - 4) UV intensity and dose
 - 5) Power level
 - 6) Alarms and Alarm history. Most recent alarms shall display alarm type, date/time of occurrence, and date/time of correction.
3. Remote Monitoring/Control
 - a. Each system shall be capable of being placed in either Local or Remote mode.
 - b. Each system shall be provided with the following interface hardwired I/O:
 - 1) Discrete input for Reactor On/Off Control from remote location
 - 2) 4-20 mA Flow Signal Analog input
 - 3) 4-20 mA UV Dose Analog output
 - 4) 4-20 mA UV Intensity Analog output
 - 5) Discrete output indicating Critical Alarm
 - 6) Discrete output indicating Major Alarm
 - 7) Discrete output indicating Minor Alarm
 - 8) Discrete output indicating System Ready

2.05 SAFETY EQUIPMENT

- A. Two face shields which block UV light wavelengths between 200 and 400 nm shall be provided.

2.06 SPARE PARTS

A. The following spare parts shall be furnished:

1. 6 – UV Lamps
2. 2 – Reference Sensor
3. 2 – sets of seals and o-rings
4. 2 – sets of replacement wiper seals
5. 1 – Face shield, able to block UV light wavelengths between 200 and 400 nm

PART 3 EXECUTION

3.01 GENERAL

- A. The manufacturer shall assume responsibility for packaging to prevent transit and handling damage.
- B. Storage, installation, and start-up shall conform to the manufacturer's recommendations, the Drawings, and these specifications. Bring any discrepancies immediately to the attention of the Engineer.

3.02 SCHEDULING

- A. All certification of factory tests and materials shall be submitted and approved by the Engineer before shipping equipment. Any equipment shipped prior to approval of all required data and materials shall be returned to the manufacturer at his expense for modification or replacement as required.

3.03 INSTALLATION AND TRAINING

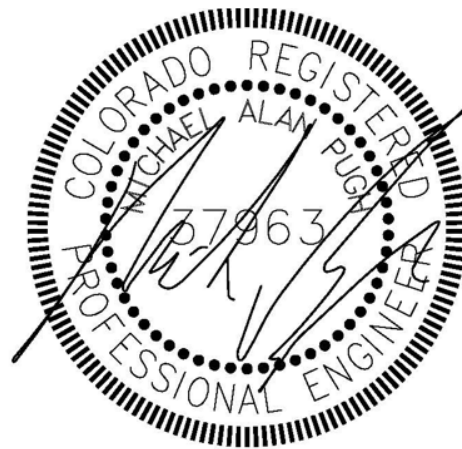
- A. Install the equipment and make any and all necessary changes, modifications, and/or adjustments required to assure satisfactory operation.
- B. Provide the service of a factory certified service technician for three (3) full days onsite to inspect the mechanism installation at temporary and permanent locations, assist in startup, and initial operation of the equipment; and one (1) full day onsite to instruct plant personnel in the operation and maintenance of the equipment. Minimum of 4 full days on site over two different trips, including travel expenses.
- C. Training of plant staff shall meet the requirements of Specification 01 79 00.
- D. Factory certified service technician shall provide a field report certifying that the equipment is properly installed, fully operational and ready for use. Copies of the report shall be provided in accordance with Section 01 33 00.
- E. The installation and initial operation of all components shall be certified as specified in Section 01 91 13.

3.04 TESTING

- A. After completion of the installation and manufacturer's certification, equipment shall be field tested to demonstrate compliance with the requirements specified. Testing of equipment shall be conducted in accordance with the requirements of Sections 01 91 13 and 11 00 00.

END OF SECTION

Structural Calculations for The Town of Silt, CO Water Treatment Plant Improvements



ENGINEER OF RECORD:

Mike Pugh, PE



Dewberry®

Calculation Summary:

The new water treatment building located in the town of Silt, CO is three buildings in one. There are two metal buildings with one "L-shaped" CMU building in between the two metal buildings. The metal buildings are delegated design. The foundations of the metal buildings and the associated calculations are included in this calculation package. During the submittal process in the construction phase, the calculations and design of the metal building will be submitted to the building department for review. The CMU building is a bearing wall design on a mat slab foundation. The lateral resisting system is fully grouted CMU shear walls connected to the mat slab and metal deck diaphragm. The controlling load cases are wind for lateral loading and snow for gravity loads. Per the Silt building department, a roof snow load of 40 psf was used, however in the center roof a roof snow load of 300 psf was used due to snow build up. Because this building is for water treatment the building and all its components are designed with a Risk Category of 4.

Thank you,

Mike Pugh (EOR)

Max Hardy (Design Engineer)

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Design Criteria

Wind Load Design Parameters:

- Risk Category: III
- Basic Wind Speed: 115 mph
- Exposure Category: C

Seismic Design Parameters:

- Importance Factor: 1.5
- SDS: 0.349
- S1: 0.078

Soil Properties:

- Allowable Bearing Pressure: 3,000 psf

Access Platform

- Live Load: 100psf
- Dead Load: 10psf
- Lateral Load: 2000 lb

Codes / Standards / References:

- ASCE 7-16

Chemical Room Loading

Dead Load: 25psf

Live Load: 20psf

Snow Load: 40psf

Wind Load: 26.34psf

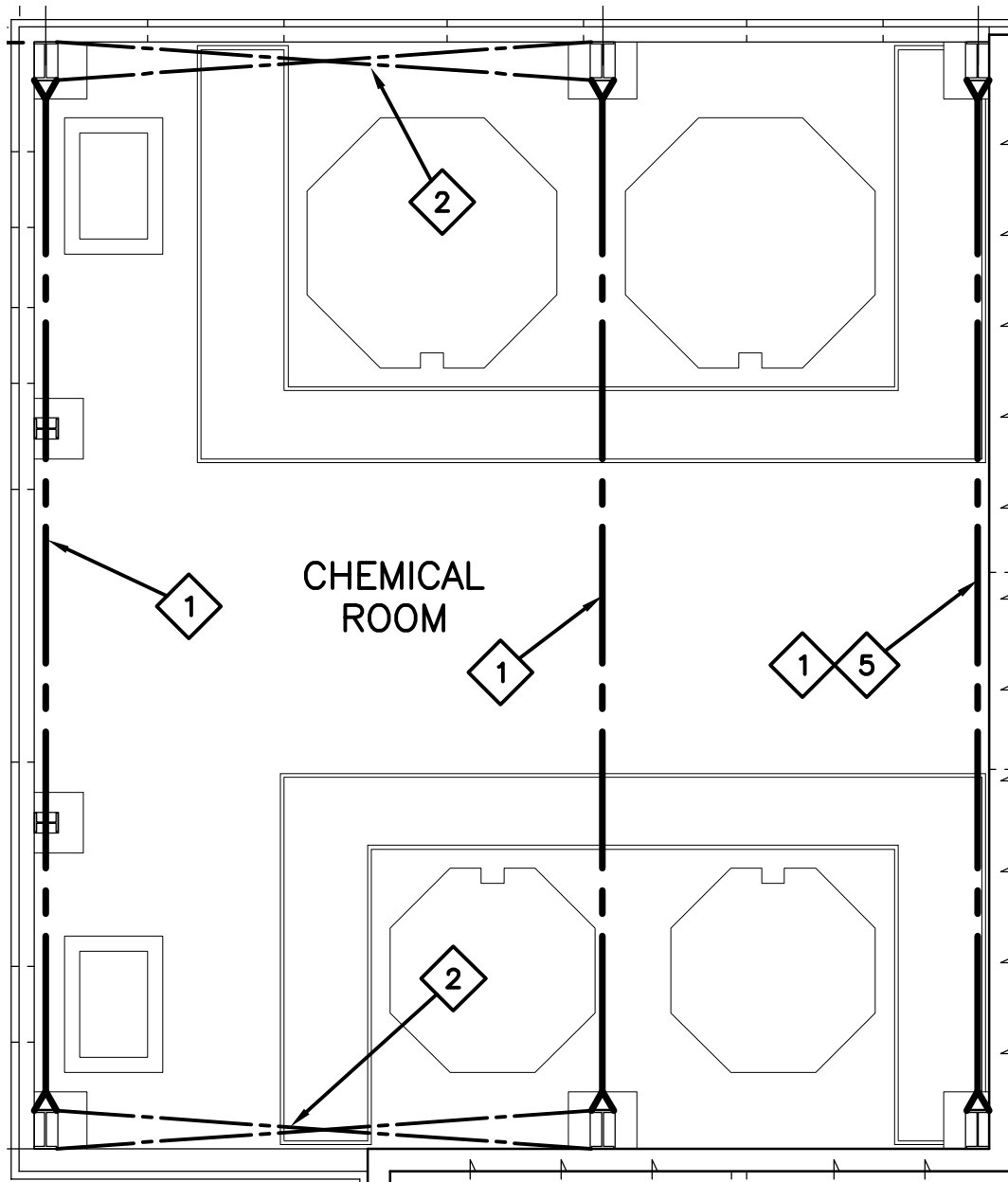


BUILDING REQUIREMENTS **RESIDENTIAL PROJECTS**

Effective: October 15, 2018

Reference Building Codes:	2015 IRC, IBC, IFGC, IMC, IPC 2009 IECC
Setbacks:	Check subdivision plat and/or Garfield Co. zone district regulations for setback requirements
Snowload: <i>(Measured at Roof, not Ground!)</i>	40 PSF Up to 7000 ft. elevation 50 PSF 7001 – 8000 ft. elevation 75 PSF 8001 – 9000 ft. elevation 100 PSF 9001–10000 ft. elevation
Roof Load (Wood):	Load Duration = 1.0
Seismic Design Category:	B or C – See IRC, Figure R301.2 (2)
Weathering Probability for Concrete:	Severe
Termite Infestation Probability:	None to slight
Wind Speed:	115 mph (Ultimate Design)
Wind Exposure:	B or C – See Section R301.2.1.4)
Frost Depth:	36 inches – Up to 8000 ft. elevation 42 inches – Over 8000 ft. elevation
Winter Design Temperature:	Minus 2 – Up to 7000 ft. elevation Minus 16 – Over 7000 ft. elevation
Air Freezing Index:	2500° F Days – Up to 7000 ft. elevation 7000+ ft. elevation – As determined by Building Official
Ice Barrier Underlayment:	Required
Mean Annual Temp:	Variable
Insulation:	<u>Minimum R-Values per 2009 IECC, Table 402.1.1*</u> <ul style="list-style-type: none">• Ceilings/Roofs = R-38• Exterior Walls = R-20 (or R-13 cavity + R-5 sheathing)• Floors = R-30 (or enough to fill joist cavity w/R-19 min.)• Basement & Crawl Space Walls = R-10 cont./R-13 cavity• Slab Perimeter = R-10, 24 in. min. depth below grade at unheated slabs, additional R-5 required at heated slabs

Chemical Room Wind Loading



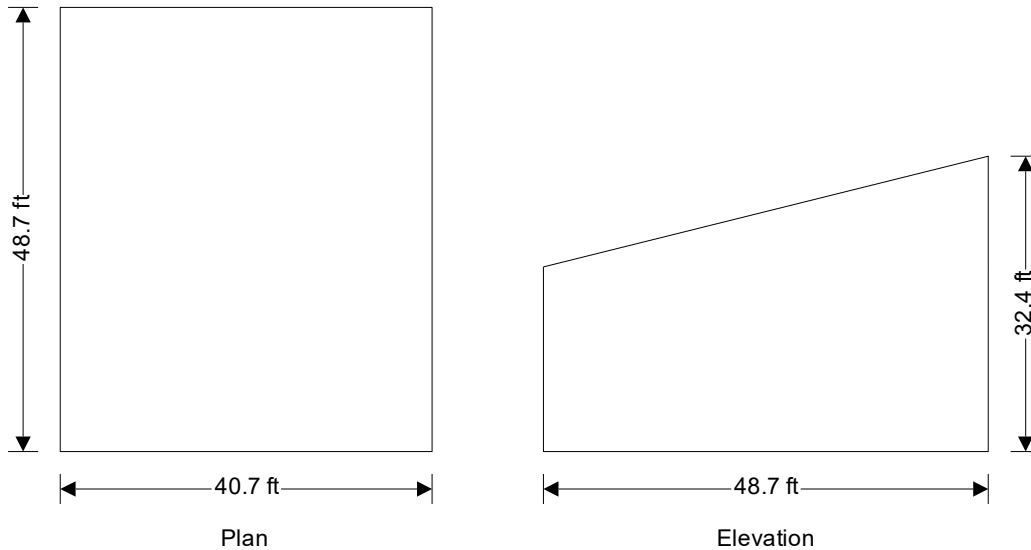
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WIND LOADING

In accordance with ASCE7-16

Using the directional design method

Tedds calculation version 2.1.07



Building data

Type of roof	Monoslope
Length of building	b = 40.67 ft
Width of building	d = 48.67 ft
Height to eaves	H = 20.23 ft
Pitch of roof	$\alpha_0 = 14.0$ deg
Mean height	h = 26.30 ft

General wind load requirements

Basic wind speed	V = 115.0 mph
Risk category	IV
Velocity pressure exponent coef (Table 26.6-1)	$K_d = 0.85$
Ground elevation above sea level	$z_{gl} = 0$ ft
Ground elevation factor	$K_e = \exp(-0.0000362 \times z_{gl}/1\text{ft}) = 1.00$
Exposure category (cl 26.7.3)	B
Enclosure classification (cl.26.12)	Partially enclosed buildings
Internal pressure coef +ve (Table 26.13-1)	$GC_{pi_p} = 0.55$
Internal pressure coef -ve (Table 26.13-1)	$GC_{pi_n} = -0.55$
Gust effect factor	$G_f = 0.85$
Minimum design wind loading (cl.27.4.7)	$p_{min_r} = 8$ lb/ft ²

Topography

Topography factor not significant	$K_{zt} = 1.0$
Velocity pressure equation	$q = 0.00256 \times K_z \times K_{zt} \times K_d \times V^2 \times 1\text{psf}/\text{mph}^2$

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Velocity pressures table

z (ft)	K _z (Table 26.10-1)	q _z (psf)
15.00	0.57	16.40
15.00	0.57	16.40
20.00	0.62	17.84
20.23	0.62	17.90
26.30	0.67	19.29
32.36	0.71	20.55

Peak velocity pressure for internal pressure

Peak velocity pressure – internal (as roof press.) $q_i = 19.29$ psf

Pressures and forces

Net pressure $p = q \times G_f \times C_{pe} - q_i \times GC_{pi}$

Net force $F_w = p \times A_{ref}$

Roof load case 1 - Wind 0, GC_{pi} 0.55, $-C_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient C_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (-ve)	26.30	-0.77	19.29	-23.17	2040.01	-47.26

Total vertical net force $F_{w,v} = -45.86$ kips

Total horizontal net force $F_{w,h} = -11.43$ kips

Walls load case 1 - Wind 0, GC_{pi} 0.55, $-C_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient C_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	0.54	610.05	0.33
A ₂	15.00	0.80	16.40	0.54	0.00	0.00
A ₃	20.23	0.80	17.90	1.56	212.70	0.33
B	26.30	-0.46	19.29	-18.16	1316.28	-23.91
C	26.30	-0.70	19.29	-22.09	1279.89	-28.27
D	26.30	-0.70	19.29	-22.09	1279.89	-28.27

Overall loading

Projected vertical plan area of wall $A_{vert,w,0} = b \times H = 822.75$ ft²

Projected vertical area of roof $A_{vert,r,0} = b \times d \times \tan(\alpha_0) = 493.52$ ft²

Minimum overall horizontal loading $F_{w,total_min} = p_{min,w} \times A_{vert,w,0} + p_{min,r} \times A_{vert,r,0} = 17.11$ kips

Leeward net force $F_l = F_{w,wB} = -23.9$ kips

Windward net force $F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 0.7$ kips

Overall horizontal loading $F_{w,total} = \max(F_w - F_l + F_{w,h}, F_{w,total_min}) = 17.1$ kips

Roof load case 2 - Wind 0, GC_{pi} -0.55, $-0C_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient C_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (+ve)	26.30	-0.18	19.29	7.66	2040.01	15.62

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Total vertical net force $F_{w,v} = 15.16$ kips

Total horizontal net force $F_{w,h} = 3.78$ kips

Walls load case 2 - Wind 0, $GC_{pi} -0.55$, $-0c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	21.76	610.05	13.28
A ₂	15.00	0.80	16.40	21.76	0.00	0.00
A ₃	20.23	0.80	17.90	22.78	212.70	4.85
B	26.30	-0.46	19.29	3.06	1316.28	4.02
C	26.30	-0.70	19.29	-0.87	1279.89	-1.11
D	26.30	-0.70	19.29	-0.87	1279.89	-1.11

Overall loading

Projected vertical plan area of wall

$$A_{vert_w_0} = b \times H = 822.75 \text{ ft}^2$$

Projected vertical area of roof

$$A_{vert_r_0} = b \times d \times \tan(\alpha_0) = 493.52 \text{ ft}^2$$

Minimum overall horizontal loading

$$F_{w,total_min} = p_{min_w} \times A_{vert_w_0} + p_{min_r} \times A_{vert_r_0} = 17.11 \text{ kips}$$

Leeward net force

$$F_l = F_{w,wB} = 4.0 \text{ kips}$$

Windward net force

$$F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 18.1 \text{ kips}$$

Overall horizontal loading

$$F_{w,total} = \max(F_w - F_l + F_{w,h}, F_{w,total_min}) = 17.9 \text{ kips}$$

Roof load case 3 - Wind 90, $GC_{pi} 0.55$, $-c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (-ve)	26.30	-0.96	19.29	-26.34	659.54	-17.37
B (-ve)	26.30	-0.84	19.29	-24.41	659.54	-16.10
C (-ve)	26.30	-0.56	19.29	-19.77	720.93	-14.25

Total vertical net force $F_{w,v} = -46.31$ kips

Total horizontal net force $F_{w,h} = 0.00$ kips

Walls load case 3 - Wind 90, $GC_{pi} 0.55$, $-c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	0.54	730.05	0.40
A ₂	20.00	0.80	17.84	1.52	243.35	0.37
A ₃	32.36	0.80	20.55	3.36	306.49	1.03
B	26.30	-0.50	19.29	-18.81	1279.89	-24.07
C	26.30	-0.70	19.29	-22.09	822.75	-18.17
D	26.30	-0.70	19.29	-22.09	1316.28	-29.08

Overall loading

Projected vertical plan area of wall

$$A_{vert_w_90} = d \times (H + d \times \tan(\alpha_0)) / 2 = 1279.89 \text{ ft}^2$$

Projected vertical area of roof

$$A_{vert_r_90} = 0.00 \text{ ft}^2$$

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Minimum overall horizontal loading $F_{w,total_min} = p_{min_w} \times A_{vert_w_90} + p_{min_r} \times A_{vert_r_90} = 20.48$ kips

Leeward net force $F_l = F_{w,wB} = -24.1$ kips

Windward net force $F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 1.8$ kips

Overall horizontal loading $F_{w,total} = \max(F_w - F_l + F_{w,h}, F_{w,total_min}) = 25.9$ kips

Roof load case 4 - Wind 90, $GC_{pi} -0.55, +c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (+ve)	26.30	-0.18	19.29	7.66	659.54	5.05
B (+ve)	26.30	-0.18	19.29	7.66	659.54	5.05
C (+ve)	26.30	-0.18	19.29	7.66	720.93	5.52

Total vertical net force $F_{w,v} = 15.16$ kips

Total horizontal net force $F_{w,h} = 0.00$ kips

Walls load case 4 - Wind 90, $GC_{pi} -0.55, +c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	21.76	730.05	15.89
A ₂	20.00	0.80	17.84	22.74	243.35	5.53
A ₃	32.36	0.80	20.55	24.59	306.49	7.54
B	26.30	-0.50	19.29	2.41	1279.89	3.09
C	26.30	-0.70	19.29	-0.87	822.75	-0.71
D	26.30	-0.70	19.29	-0.87	1316.28	-1.14

Overall loading

Projected vertical plan area of wall $A_{vert_w_90} = d \times (H + d \times \tan(\alpha_0) / 2) = 1279.89$ ft²

Projected vertical area of roof $A_{vert_r_90} = 0.00$ ft²

Minimum overall horizontal loading $F_{w,total_min} = p_{min_w} \times A_{vert_w_90} + p_{min_r} \times A_{vert_r_90} = 20.48$ kips

Leeward net force $F_l = F_{w,wB} = 3.1$ kips

Windward net force $F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 29.0$ kips

Overall horizontal loading $F_{w,total} = \max(F_w - F_l + F_{w,h}, F_{w,total_min}) = 25.9$ kips

Roof load case 5 - Wind 180, $GC_{pi} 0.55, -c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (-ve)	26.30	-0.51	19.29	-18.97	2040.01	-38.70

Total vertical net force $F_{w,v} = -37.55$ kips

Total horizontal net force $F_{w,h} = -9.36$ kips

Walls load case 5 - Wind 180, $GC_{pi} 0.55, -c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	0.54	610.05	0.33

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Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₂	20.00	0.80	17.84	1.52	203.35	0.31
A ₃	32.36	0.80	20.55	3.36	502.68	1.69
B	26.30	-0.46	19.29	-18.16	822.75	-14.94
C	26.30	-0.70	19.29	-22.09	1279.89	-28.27
D	26.30	-0.70	19.29	-22.09	1279.89	-28.27

Overall loading

Projected vertical plan area of wall

$$A_{vert_w_180} = b \times (H + d \times \tan(\alpha_0)) = 1316.28 \text{ ft}^2$$

Projected vertical area of roof

$$A_{vert_r_180} = b \times d \times \tan(\alpha_0) = 493.52 \text{ ft}^2$$

Minimum overall horizontal loading

$$F_{w,total_min} = p_{min_w} \times A_{vert_w_180} + p_{min_r} \times A_{vert_r_180} = 25.01 \text{ kips}$$

Leeward net force

$$F_l = F_{w,wB} = -14.9 \text{ kips}$$

Windward net force

$$F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 2.3 \text{ kips}$$

Overall horizontal loading

$$F_{w,total} = \max(F_w - F_l - F_{w,h}, F_{w,total_min}) = 26.6 \text{ kips}$$

Roof load case 6 - Wind 180, $GC_{pi} -0.55$, $-c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (+ve)	26.30	-0.51	19.29	2.25	2040.01	4.60

Total vertical net force

$$F_{w,v} = 4.46 \text{ kips}$$

Total horizontal net force

$$F_{w,h} = 1.11 \text{ kips}$$

Walls load case 6 - Wind 180, $GC_{pi} -0.55$, $-c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	21.76	610.05	13.28
A ₂	20.00	0.80	17.84	22.74	203.35	4.62
A ₃	32.36	0.80	20.55	24.59	502.68	12.36
B	26.30	-0.46	19.29	3.06	822.75	2.51
C	26.30	-0.70	19.29	-0.87	1279.89	-1.11
D	26.30	-0.70	19.29	-0.87	1279.89	-1.11

Overall loading

Projected vertical plan area of wall

$$A_{vert_w_180} = b \times (H + d \times \tan(\alpha_0)) = 1316.28 \text{ ft}^2$$

Projected vertical area of roof

$$A_{vert_r_180} = b \times d \times \tan(\alpha_0) = 493.52 \text{ ft}^2$$

Minimum overall horizontal loading

$$F_{w,total_min} = p_{min_w} \times A_{vert_w_180} + p_{min_r} \times A_{vert_r_180} = 25.01 \text{ kips}$$

Leeward net force

$$F_l = F_{w,wB} = 2.5 \text{ kips}$$

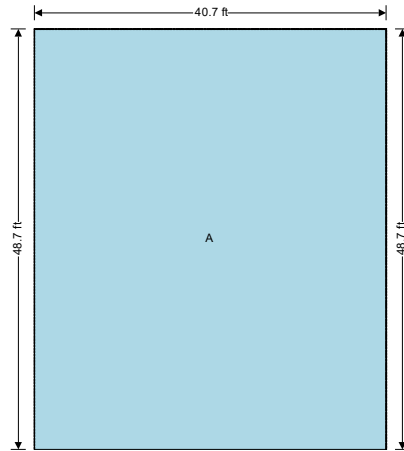
Windward net force

$$F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 30.3 \text{ kips}$$

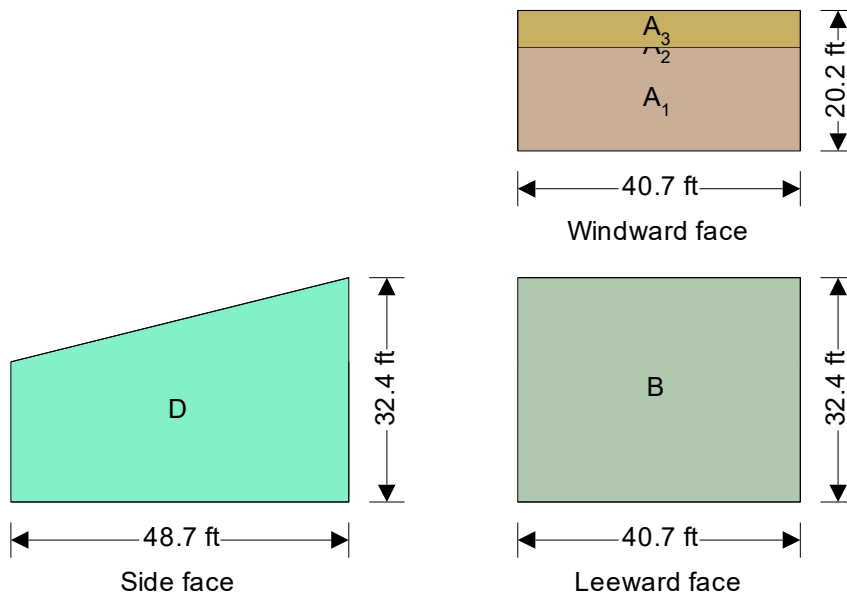
Overall horizontal loading

$$F_{w,total} = \max(F_w - F_l - F_{w,h}, F_{w,total_min}) = 26.6 \text{ kips}$$

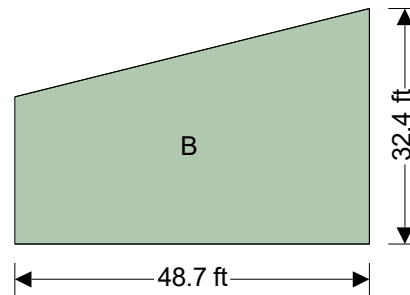
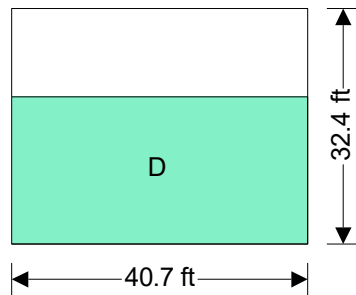
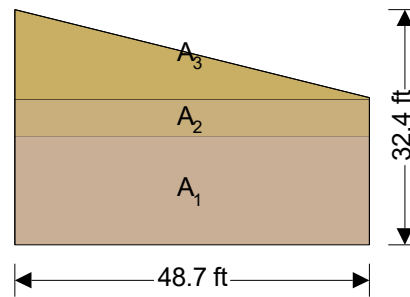
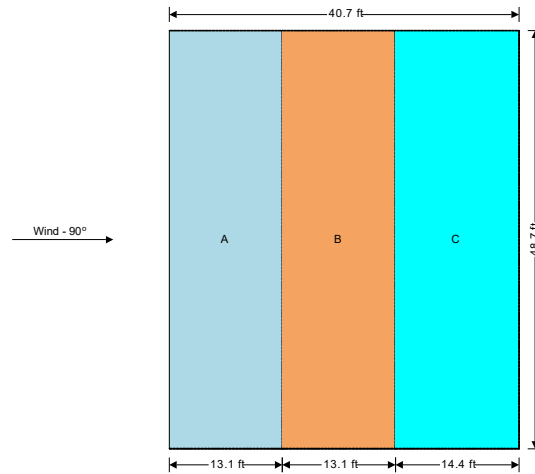
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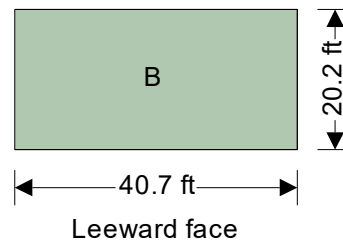
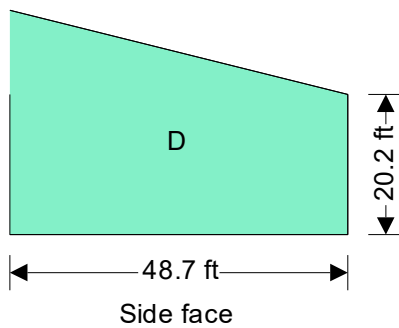
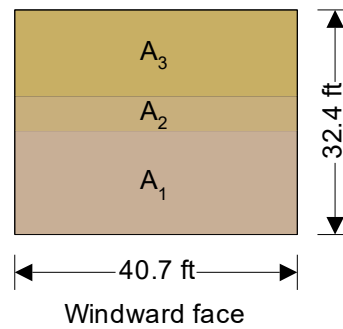
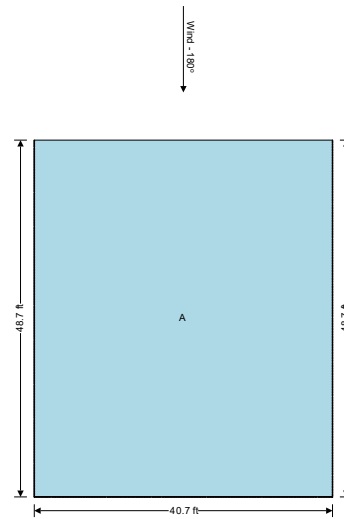


Wind - 0°
↑
Plan view - Monoslope roof



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Designer:

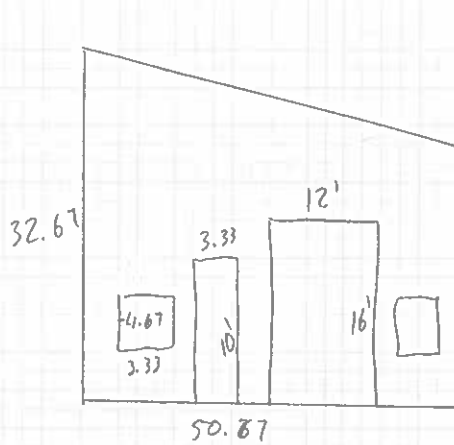
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Date:

Date:

Chemical room



$$A_o = 2(3.33 \times 4.67) + 3.33 \times 10 + 12 \times 16' \\ = 256.4 \text{ ft}^2$$

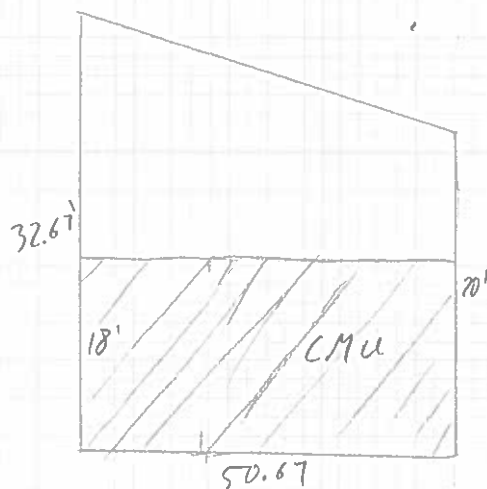
$$A_g = 20 \times 50.67 + \frac{1}{2} \times 50.67 \times (32.67 - 20) \\ = 1334.4 \text{ ft}^2$$

$$20' A_{oi} = 216 \text{ ft}^2$$

$$A_{gi} = 2238.5 \text{ ft}^2$$

Enclosed building $A_o < 0.01 A_g$
 $256.4 < 13.34$ X

Partially enclosed $A_o > 1.1 A_{oi}$ $A_o > 0.01 A_g$ $\frac{A_{oi}}{A_g} < 0.2$
 $256.4 > 237.6$ $256.4 > 13.3$ $0.096 < 0.2$
 ✓ ✓ ✓



$$A_o = 0$$

$$A_g = 2 \times 50.67 + \frac{1}{2} \times 50.67 \times (32.67 - 20)$$

$$A_g = 422.33$$

$$A_{oi} = 256.4 + 216 = 472.4 \text{ ft}^2$$

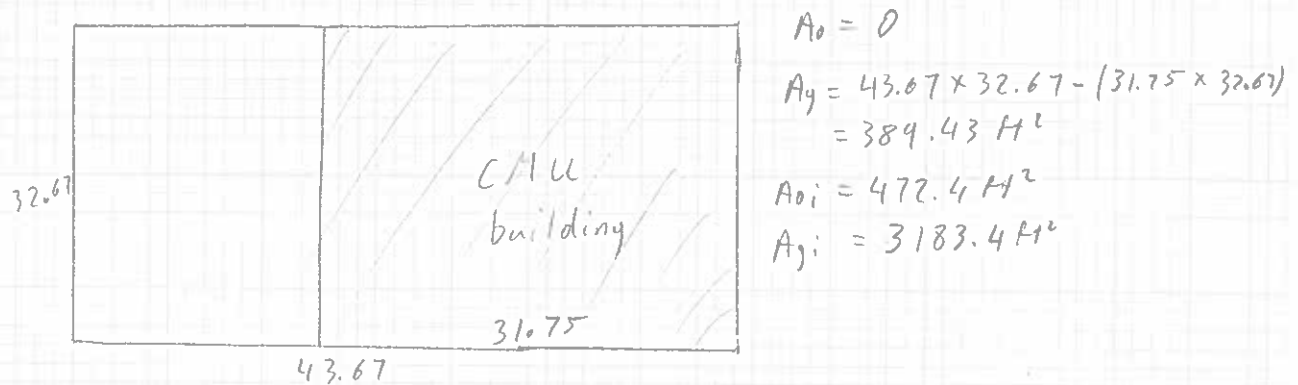
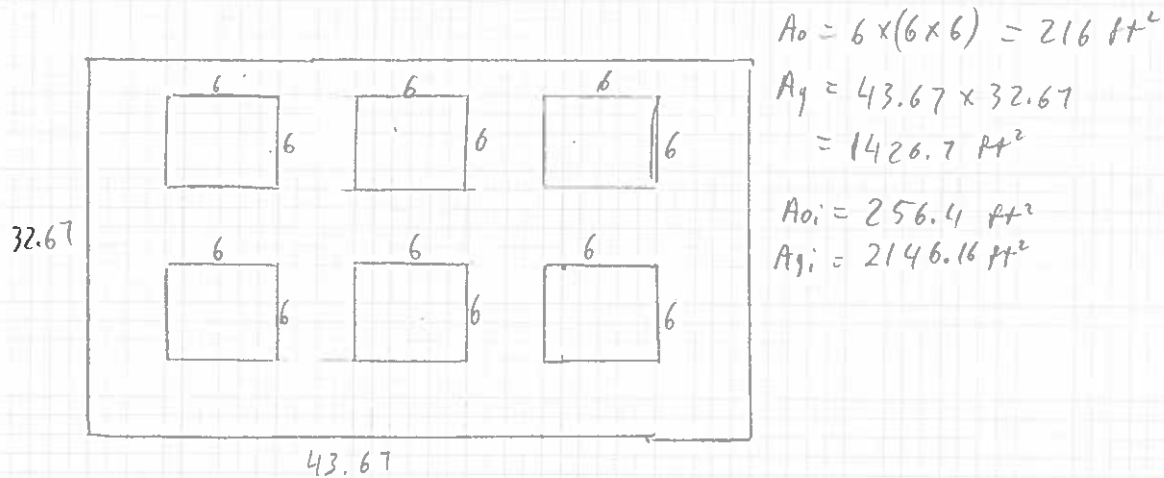
$$A_{gi} = 3150.5 \text{ ft}^2$$

Partially enclosed $A_o > 1.1 A_{oi}$

Project No. _____ Sheet: _____ of _____

Project: _____ Designer: _____ Date: _____

Item: _____ Checker: _____ Date: _____



Chemical Room Footing Reactions from STAAD



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CONNECTED User: Aram Danielyan

Job No

Sheet No

1

Rev

Part

Job Title Silt

Ref

By AD

Date 30-May-23

Chd

Client

File Structure1 Chemical Roo

Date/Time 27-Oct-2023 15:44

Job Information

	Engineer	Checked	Approved
Name:	AD		
Date:	30-May-23		

Project ID	
Project Name	

Structure Type	SPACE FRAME
----------------	-------------

Number of Nodes	12	Highest Node	12
Number of Elements	17	Highest Beam	17

Number of Basic Load Cases	9
Number of Combination Load Cases	21

Included in this printout are data for:

All	The Whole Structure
-----	---------------------

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55
Primary	2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55
Primary	3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55
Primary	4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55
Primary	5	LOAD CASE 5 WIND 180 DEG. GCPI 0.55
Primary	6	LOAD CASE 6 WIND 180 DEG. GCPI -0.55
Primary	7	LOAD CASE 7 ROOF DEAD LOAD
Primary	8	LOAD CASE 8 ROOF SNOW LOAD
Primary	9	LOAD CASE 9 ROOF LIVE LOAD
Combination	10	1.4D
Combination	11	1.2D+1.6L+.5RLL
Combination	12	1.2D+1.6L+.5S
Combination	13	1.2D+1.6S+.5W
Combination	14	1.2D+1.6S+.5W
Combination	15	1.2D+1.6S+.5W
Combination	16	1.2D+1.6S+.5W
Combination	17	1.2D+1.6S+.5W
Combination	18	1.2D+1.6S+.5W
Combination	19	1.2D+1W+L+.5S
Combination	20	1.2D+1W+L+.5S
Combination	21	1.2D+1W+L+.5S
Combination	22	1.2D+1W+L+.5S
Combination	23	1.2D+1W+L+.5S
Combination	24	1.2D+1W+L+.5S
Combination	25	.9D+1W



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Client

File Structure1 Chemical Roo

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Job Information Cont...

Type	L/C	Name
Combination	29	.9D+1W
Combination	30	.9D+1W

Nodes

Node	X (in)	Y (in)	Z (in)
1	0	0	0
2	584.040	0	0
3	0	0	282.000
4	584.040	0	282.000
5	0	0	488.040
6	584.040	0	488.040
7	0	242.760	0
8	584.040	388.800	0
9	0	242.760	282.000
10	584.040	388.800	282.000
11	0	242.760	488.040
12	584.040	388.800	488.040

Beams

Beam	Node A	Node B	Length (in)	Property	β (degrees)
1	5	11	242.760	3	0
2	3	9	242.760	3	0
3	1	7	242.760	3	0
4	6	12	388.800	3	0
5	4	10	388.800	3	0
6	2	8	388.800	3	0
7	8	7	602.022	1	0
8	10	9	602.022	1	0
9	12	11	602.022	1	0
10	7	3	372.097	2	0
11	9	1	372.097	2	0
12	8	4	480.301	2	0
13	10	2	480.301	2	0
14	9	11	206.040	1	0
15	7	9	282.000	1	0
16	8	10	282.000	1	0
17	10	12	206.040	1	0



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Chd

Client

File Structure1 Chemical Roo

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Section Properties

Prop	Section	Area (in ²)	I _{yy} (in ⁴)	I _{zz} (in ⁴)	J (in ⁴)	Material
1	W21X93	27.300	92.900	2.07E+3	6.030	STEEL
2	L505010	5.900	21.465	5.691	0.788	STEEL
3	Taper	26.750	156.307	5.14E+3	2.229	STEEL

Materials

Mat	Name	E (kip/in ²)	v	Density (kip/in ³)	α (/°F)
1	STEEL	29E+3	0.300	0.000283	6.5E -6
2	CONCRETE	3.15E+3	0.170	8.68e-05	5.5E -6
3	ALUMINUM	10E+3	0.330	9.8e-05	12.8E -6
4	STAINLESSSTEEL	28E+3	0.300	0.000283	9.9E -6
5	STEEL_36_KSI	29E+3	0.300	0.000283	6.5E -6
6	STEEL_50_KSI	29E+3	0.300	0.000283	6.5E -6
7	STEEL_275_NMM2	29.7E+3	0.300	0.000	6.67E -6
8	STEEL_355_NMM2	29.7E+3	0.300	0.000	6.67E -6

Supports

Node	X (kip/in)	Y (kip/in)	Z (kip/in)	rX (kip*ft/deg)	rY (kip*ft/deg)	rZ (kip*ft/deg)
1	Fixed	Fixed	Fixed	-	-	-
2	Fixed	Fixed	Fixed	-	-	-
3	Fixed	Fixed	Fixed	-	-	-
4	Fixed	Fixed	Fixed	-	-	-
5	Fixed	Fixed	Fixed	-	-	-
6	Fixed	Fixed	Fixed	-	-	-

Releases

Beam ends not shown in this table are fixed in all directions.

Beam	Node	x	y	z	rx	ry	rz
10	7	Fixed	Fixed	Fixed	Pin	Fixed	Pin
10	3	Fixed	Fixed	Fixed	Pin	Fixed	Pin
11	9	Fixed	Fixed	Fixed	Pin	Fixed	Pin
11	1	Fixed	Fixed	Fixed	Pin	Fixed	Pin
12	8	Fixed	Fixed	Fixed	Pin	Fixed	Pin
12	4	Fixed	Fixed	Fixed	Pin	Fixed	Pin
13	10	Fixed	Fixed	Fixed	Pin	Fixed	Pin
13	2	Fixed	Fixed	Fixed	Pin	Fixed	Pin
14	9	Fixed	Fixed	Fixed	Pin	Fixed	Fixed
14	11	Fixed	Fixed	Fixed	Pin	Fixed	Fixed

Releases Cont...

Beam	Node	x	y	z	rx	ry	rz
15	7	Fixed	Fixed	Fixed	Pin	Fixed	Fixed
15	9	Fixed	Fixed	Fixed	Pin	Fixed	Fixed
16	8	Fixed	Fixed	Fixed	Pin	Fixed	Fixed
16	10	Fixed	Fixed	Fixed	Pin	Fixed	Fixed
17	10	Fixed	Fixed	Fixed	Pin	Fixed	Fixed
17	12	Fixed	Fixed	Fixed	Pin	Fixed	Fixed

Primary Load Cases

Number	Name	Type
1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55	None
2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55	None
3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55	None
4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55	None
5	LOAD CASE 5 WIND 180 DEG. GCPI 0.55	None
6	LOAD CASE 6 WIND 180 DEG. GCPI -0.55	None
7	LOAD CASE 7 ROOF DEAD LOAD	None
8	LOAD CASE 8 ROOF SNOW LOAD	None
9	LOAD CASE 9 ROOF LIVE LOAD	None

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
10	1.4D	7	LOAD CASE 7 ROOF DEAD LOAD	1.40
11	1.2D+1.6L+.5RLL	7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		9	LOAD CASE 9 ROOF LIVE LOAD	0.50
12	1.2D+1.6L+.5S	7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
13	1.2D+1.6S+.5W	1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
14	1.2D+1.6S+.5W	2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
15	1.2D+1.6S+.5W	3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
16	1.2D+1.6S+.5W	4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
17	1.2D+1.6S+.5W	5	LOAD CASE 5 WIND 180 DEG. GCPI 0.55	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20

Combination Load Cases Cont...

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
18	1.2D+1.6S+.5W	6	LOAD CASE 6 WIND 180 DEG. GCPI -0.5	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
19	1.2D+1W+L+.5S	1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
20	1.2D+1W+L+.5S	2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
21	1.2D+1W+L+.5S	3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
22	1.2D+1W+L+.5S	4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
23	1.2D+1W+L+.5S	5	LOAD CASE 5 WIND 180 DEG. GCPI 0.5	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
24	1.2D+1W+L+.5S	6	LOAD CASE 6 WIND 180 DEG. GCPI -0.5	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
25	.9D+1W	1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
26	.9D+1W	2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
27	.9D+1W	3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
28	.9D+1W	4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
29	.9D+1W	5	LOAD CASE 5 WIND 180 DEG. GCPI 0.5	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
30	.9D+1W	6	LOAD CASE 6 WIND 180 DEG. GCPI -0.5	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90

Node Displacement Summary

	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
Max X	9	21:1.2D+1W+L	1.714	-0.010	-0.011	1.714	-0.000	-0.001	-0.007
Min X	10	6:LOAD CASE	-0.874	0.002	-0.000	0.874	-0.000	0.000	0.001
Max Y	10	4:LOAD CASE	-0.018	0.009	-0.063	0.067	-0.000	-0.000	-0.000
Min Y	10	13:1.2D+1.6S+	1.116	-0.028	0.012	1.117	-0.000	-0.000	0.002
Max Z	12	19:1.2D+1W+L	0.811	-0.007	0.016	0.811	-0.001	-0.002	0.000
Min Z	12	4:LOAD CASE	-0.005	-0.001	-0.067	0.067	0.001	0.000	-0.000
Max rX	6	19:1.2D+1W+L	0	0	0	0	0.013	-0.002	-0.004
Min rX	6	4:LOAD CASE	0	0	0	0	-0.015	0.000	0.000
Max rY	4	21:1.2D+1W+L	0	0	0	0	-0.000	0.005	-0.009
Min rY	6	21:1.2D+1W+L	0	0	0	0	-0.002	-0.003	-0.005
Max rZ	3	6:LOAD CASE	0	0	0	0	0.000	-0.001	0.004
Min rZ	4	21:1.2D+1W+L	0	0	0	0	-0.000	0.005	-0.009
Max Rst	9	21:1.2D+1W+L	1.714	-0.010	-0.011	1.714	-0.000	-0.001	-0.007

Beam Displacement Detail Summary

Displacements shown in *italic* indicate the presence of an offset

	Beam	L/C	d (in)	X (in)	Y (in)	Z (in)	Resultant (in)
Max X	8	21:1.2D+1W+L	361.213	2.027	-1.271	0.015509	2.393
Min X	8	6:LOAD CASE	421.415	-0.919	0.197	-0.008	0.940
Max Y	8	6:LOAD CASE	421.415	-0.919	0.197	-0.008	0.940
Min Y	8	15:1.2D+1.6S+	301.011	1.774	-1.611	0.006	2.397
Max Z	4	19:1.2D+1W+L	155.520	0.548	-0.003	1.270	1.383
Min Z	4	4:LOAD CASE	155.520	-0.015	-0.001	-1.449	1.449
Max Rst	8	15:1.2D+1.6S+	301.011	1.774	-1.611	0.006	2.397

Beam End Displacement Summary

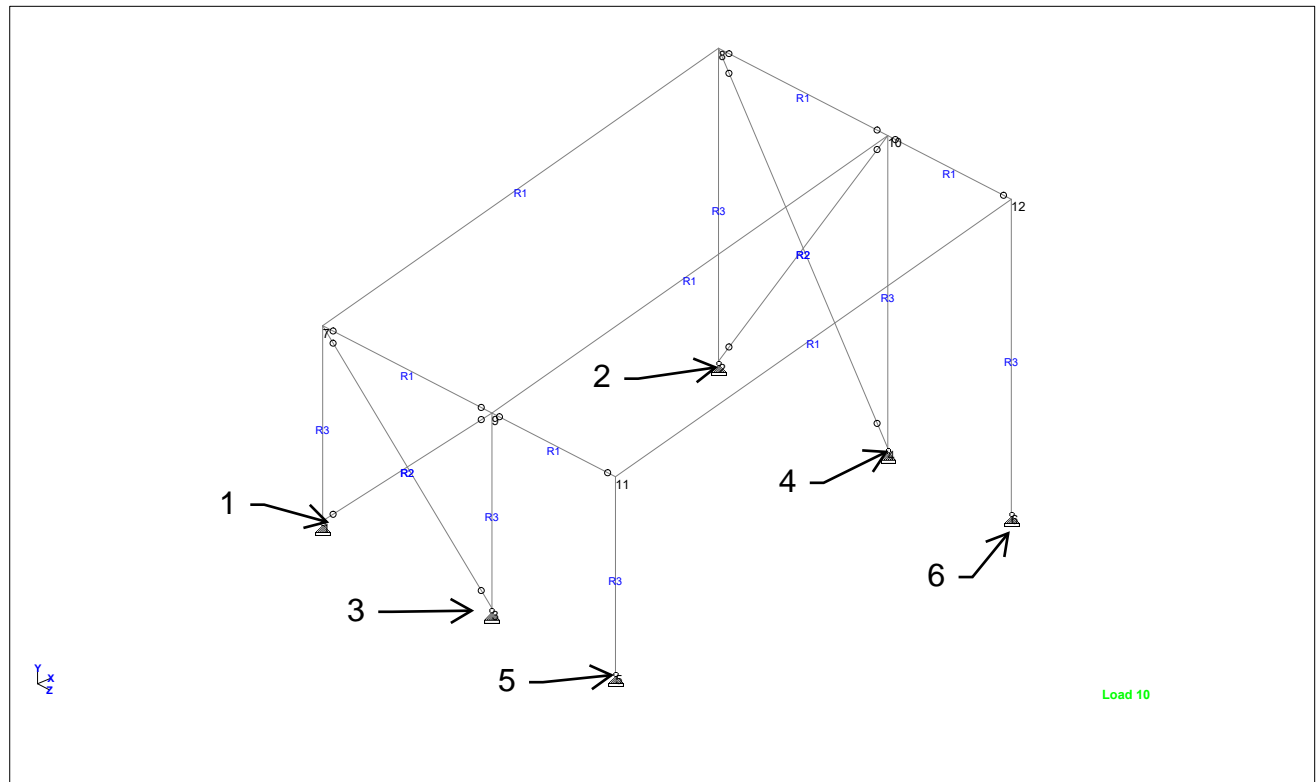
Displacements shown in *italic* indicate the presence of an offset

	Beam	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)
Max X	2	9	21:1.2D+1W+L	1.714	-0.010	-0.011	1.714
Min X	5	10	6:LOAD CASE	-0.874	0.002	-0.000	0.874
Max Y	5	10	4:LOAD CASE	-0.018	0.009	-0.063	0.067
Min Y	5	10	13:1.2D+1.6S+	1.116	-0.028	0.012	1.117
Max Z	4	12	19:1.2D+1W+L	0.811	-0.007	0.016	0.811
Min Z	4	12	4:LOAD CASE	-0.005	-0.001	-0.067	0.067
Max Rst	2	9	21:1.2D+1W+L	1.714	-0.010	-0.011	1.714

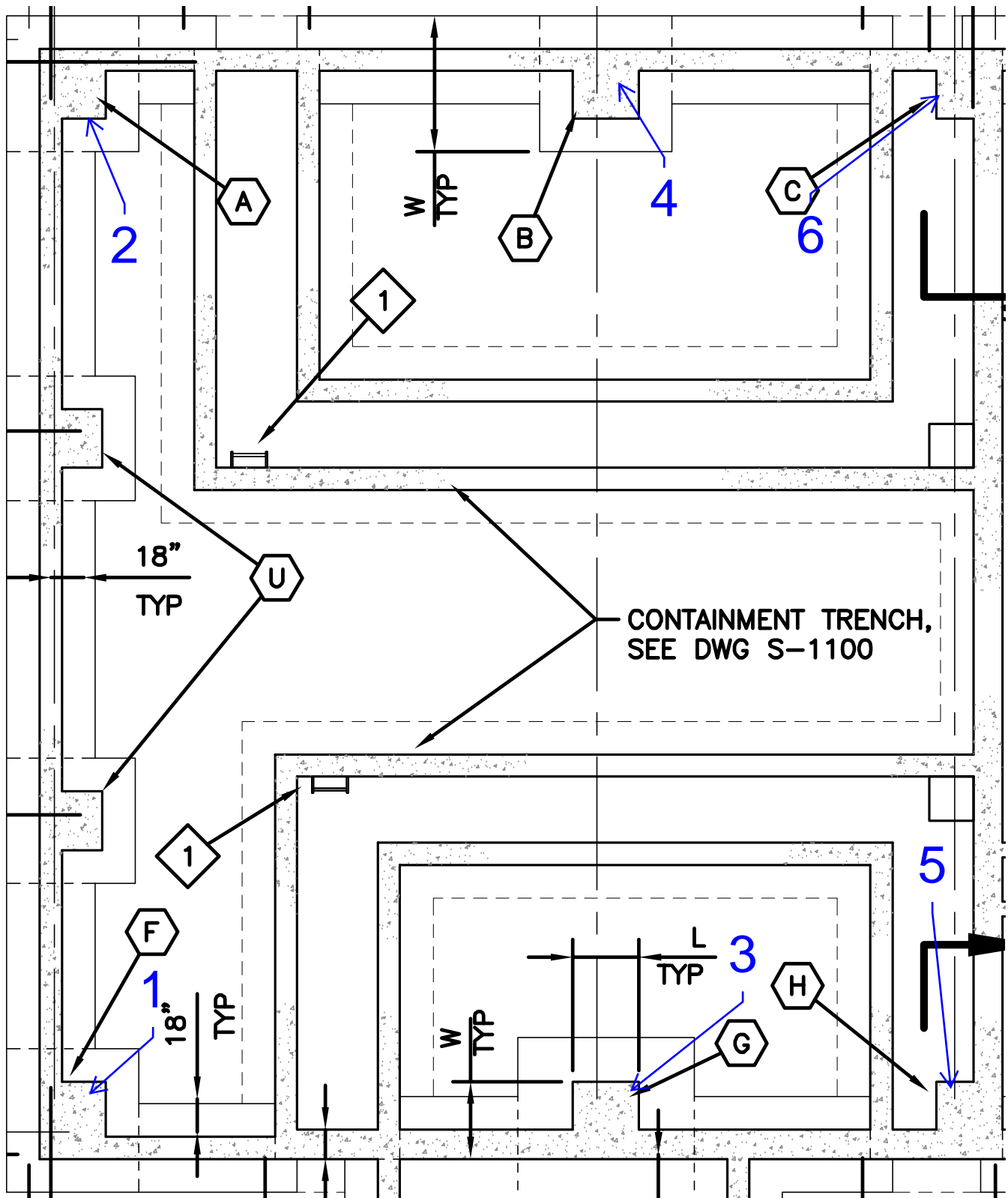
Reaction Summary

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (kip)	FY (kip)	FZ (kip)	MX (kip'in)	MY (kip'in)	MZ (kip'in)
Max FX	3	17:1.2D+1.6S+	18.059	56.108	-2.669	0	0	0
Min FX	4	21:1.2D+1W+L	-20.207	32.682	2.646	0	0	0
Max FY	4	13:1.2D+1.6S+	-17.520	59.758	-3.389	0	0	0
Min FY	4	28:.9D+1W	-2.327	-15.572	6.185	0	0	0
Max FZ	2	21:1.2D+1W+L	-12.672	38.621	13.621	0	0	0
Min FZ	6	19:1.2D+1W+L	-9.051	13.172	-6.626	0	0	0
Max MX	1	10:1.4D	2.614	10.296	0.953	0	0	0
Min MX	1	10:1.4D	2.614	10.296	0.953	0	0	0
Max MY	1	10:1.4D	2.614	10.296	0.953	0	0	0
Min MY	1	10:1.4D	2.614	10.296	0.953	0	0	0
Max MZ	1	10:1.4D	2.614	10.296	0.953	0	0	0
Min MZ	1	10:1.4D	2.614	10.296	0.953	0	0	0

← Max fy Force
← Max uplift Force



Whole Structure node number



Chemical Room Footing - spMats

Max loading from the reactions

Footing number	Load(kip)
1	-31.6
2	-39.7
3	-54.4
4	-59.7
5	-22.3
6	-25.3

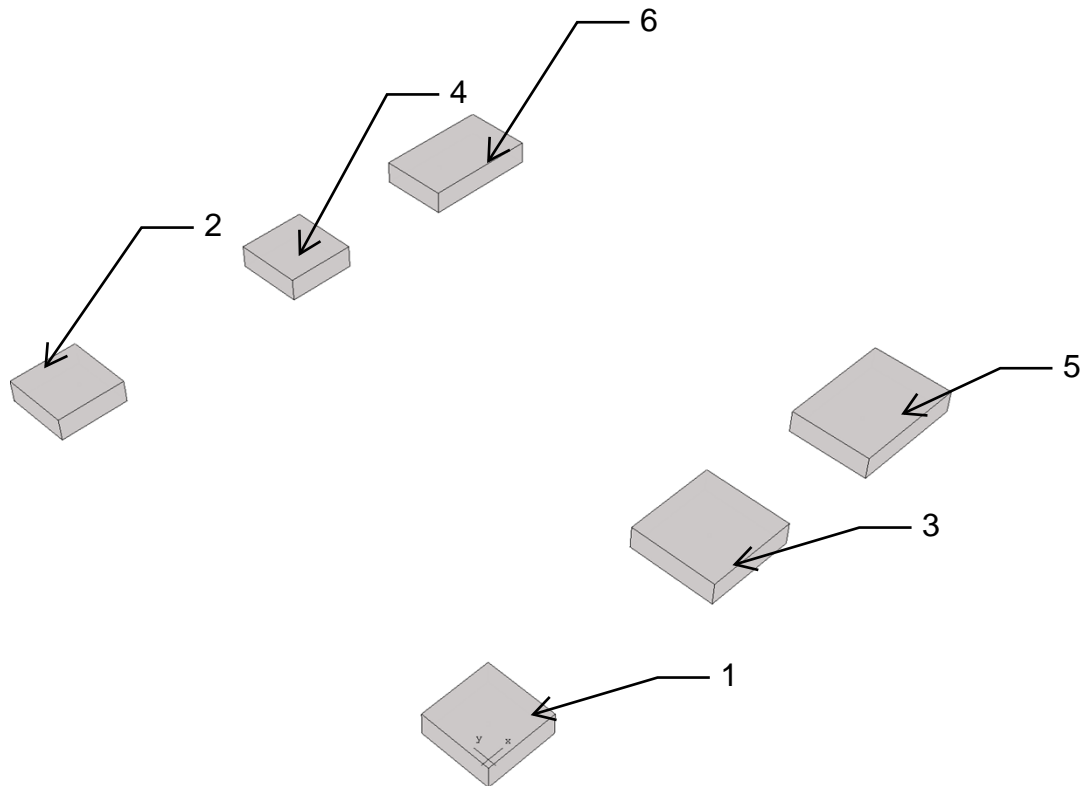
Allowable pressure 3ksf

Footing Dimension

1	6' x 6' x 2'
2	6' x 6' x 2'
3	8' x 7.5' x 2'
4	6' x 6' x 2'
5	10' x 7.5' x 2'
6	10' x 6' x 2'



spMats v10.00 (TM)
A Computer Program for Analysis and Design of Foundation Mats, Combined Footings, and Slabs on Grade
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1. Project

1.1. General Information

File Name	spMATS BUILDING 1 CHEMICAL ROOM.matx
Project	Chemical Room
Code	ACI 318-14
Units	English
Date	6/2/2023
Time	1:36 PM

1.2. Solver Options

Maximum number of iterations	10
Maximum allowed service displacement	11.00000 in
Minimum ratio of soil contact area w.r.t. initial soil-supported area	50 %
Minimum ratio of active springs and piles w.r.t. total number of springs and piles	0 %
Displacement limit of uplift	0.00000 in
Compute required reinforcement based on	Maximum moment within an element

2. Definitions

2.1. Grid Lines

2.1.1. Vertical

Label	Coordinate-X ft	Spacing ft
1	0.00	0.00
2	24.67	24.67
3	43.67	19.00

2.1.2. Horizontal

Label	Coordinate-Y ft	Spacing ft
A	0.00	0.00
B	49.33	49.33

2.2. Objects

2.2.1. Slabs

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Mat18	18.00	Clay	C3	Gr40	Gr40#4	No
Mat24	24.00	Clay	C3	Gr40	Gr40#4	No
Mat30	30.00	Clay	C3	Gr40	Gr40#4	No
Mat36	36.00	Clay	C3	Gr40	Gr40#4	No
Mat48	48.00	Clay	C3	Gr40	Gr40#4	No
Slab1	12.00	Clay	C3	Gr40	Gr40#4	No
Slab2	18.00	Clay	C3	Gr60	Gr40#4	No

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Slab3	18.00	Clay	C3	Gr60	Gr60#4	No
Slab4	18.00	- none -	C3	Gr60	Gr60#4	No
Slab5	18.00	silt	C3	Gr60	Gr60#4	No
Slab6	18.00	silt	C3	Gr60	GR60#7	No
Slab7	18.00	silt	C4	Gr60	Gr60#4	No
Slab8	18.00	silt	C4	Gr60	GR60#7	No
Slab9	18.00	silt	C4	Gr75	Gr60#4	No
Slab10	18.00	silt	C4	Gr75	GR60#7	No
Slab11	24.00	silt	C4	Gr60	GR60#7	Yes

2.2.2. Columns

Label	Type	D in	B in	Assigned
C20X20	Rectangle	20.00	20.00	No

2.2.3. Pile - Properties

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
R36	Round	2738.71	Concrete	4286.8	Bedrock	No
S30X30	Square	2570.13	Precast	4286.8	Bedrock	No
1H8X36	H-Type 1	273.29	Steel	29000.0	Bedrock	No
2H8X36	H-Type 2	273.29	Steel	29000.0	Bedrock	No
Pile1	Square	1058.91	Precast	4286.8	Bedrock	No

2.2.4. Pile - Geometry

Label	Length ft	Embedment in	D in	B in	tf in	tw in
R36	50.00	6.00	36.00			
S30X30	50.00	6.00	30.00			
1H8X36	50.00	6.00	8.02	8.16	0.45	0.45
2H8X36	50.00	6.00	8.02	8.16	0.45	0.45
Pile1	2.50	6.00	12.00			

2.3. Properties

2.3.1. Soil

Label	K _s kcf	Q _a ksf	Used	Label	K _s kcf	Q _a ksf	Used
Clay	75.000	1.500	Yes	Sand	100.000	2.000	No
Bedrock	600.000	12.000	Yes	silt	216.000	3.000	Yes

2.3.2. Concrete

Label	f' _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C3	3.0000	150.00	3320.6	0.200	-	Yes
C4	4.0000	150.00	3834.3	0.200	-	Yes
C5	5.0000	150.00	4286.8	0.200	-	No
C6	6.0000	150.00	4696.0	0.200	-	No
C7	7.0000	150.00	5072.2	0.200	-	No
C8	8.0000	150.00	5422.5	0.200	-	No

2.3.3. Reinforcement

Label	f _y ksi	E _s ksi	Used	Label	f _y ksi	E _s ksi	Used
Gr40	40.0000	29000.0	Yes	Gr50	50.0000	29000.0	No
Gr60	60.0000	29000.0	Yes	Gr75	75.0000	29000.0	Yes

2.3.4. Design Parameters

Label	Top layer X in	Top layer Y in	Bot. Layer X in	Bot. Layer Y in	Min. Reinf. Ratio %	Used
Gr40#4	3.25	3.75	3.25	3.75	0.10	Yes
Gr50#4	3.25	3.75	3.25	3.75	0.10	No
Gr60#4	3.25	3.75	3.25	3.75	0.09	Yes
Gr75#4	3.25	3.75	3.25	3.75	0.07	No
GR60#7	1.50	2.38	3.00	3.88	0.09	Yes

2.4. Restraints**2.4.1. Nodal Springs**

Label	K _{ns} klf	Assigned	Label	K _{ns} klf	Assigned
Spr1	100.00	No			

2.4.2. Slaved Nodes

Label	DOF	Assigned	Label	DOF	Assigned
SlvRx	Rx	No	SlvRy	Ry	No
SlvDz	Dz	No			

2.5. Load Case/Combo.**2.5.1. Load Cases**

NOTE: Self weight is included under Case A.

Case	Type	Case label	Load defined?
A	Dead	DL	Yes
B	Live	LL	No

2.5.2. Service Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
S1	1.000	0.000	-	-	-	-	-	-	-
S2	1.000	1.000	-	-	-	-	-	-	-

2.5.3. Ultimate Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
U1	1.400	0.000	-	-	-	-	-	-	-
U2	1.200	1.600	-	-	-	-	-	-	-

3. Assignments

3.1. Nodes

ID	X Coord. ft	Y Coord. ft	Column	Pile	Spring	Dz	Rx	Ry
N1	2.00	2.00	-	-	-	-	-	-
N2	3.00	46.33	-	-	-	-	-	-
N3	24.59	2.75	-	-	-	-	-	-
N4	24.67	46.42	-	-	-	-	-	-
N5	41.67	2.50	-	-	-	-	-	-
N6	41.17	46.83	-	-	-	-	-	-

3.2. Slabs

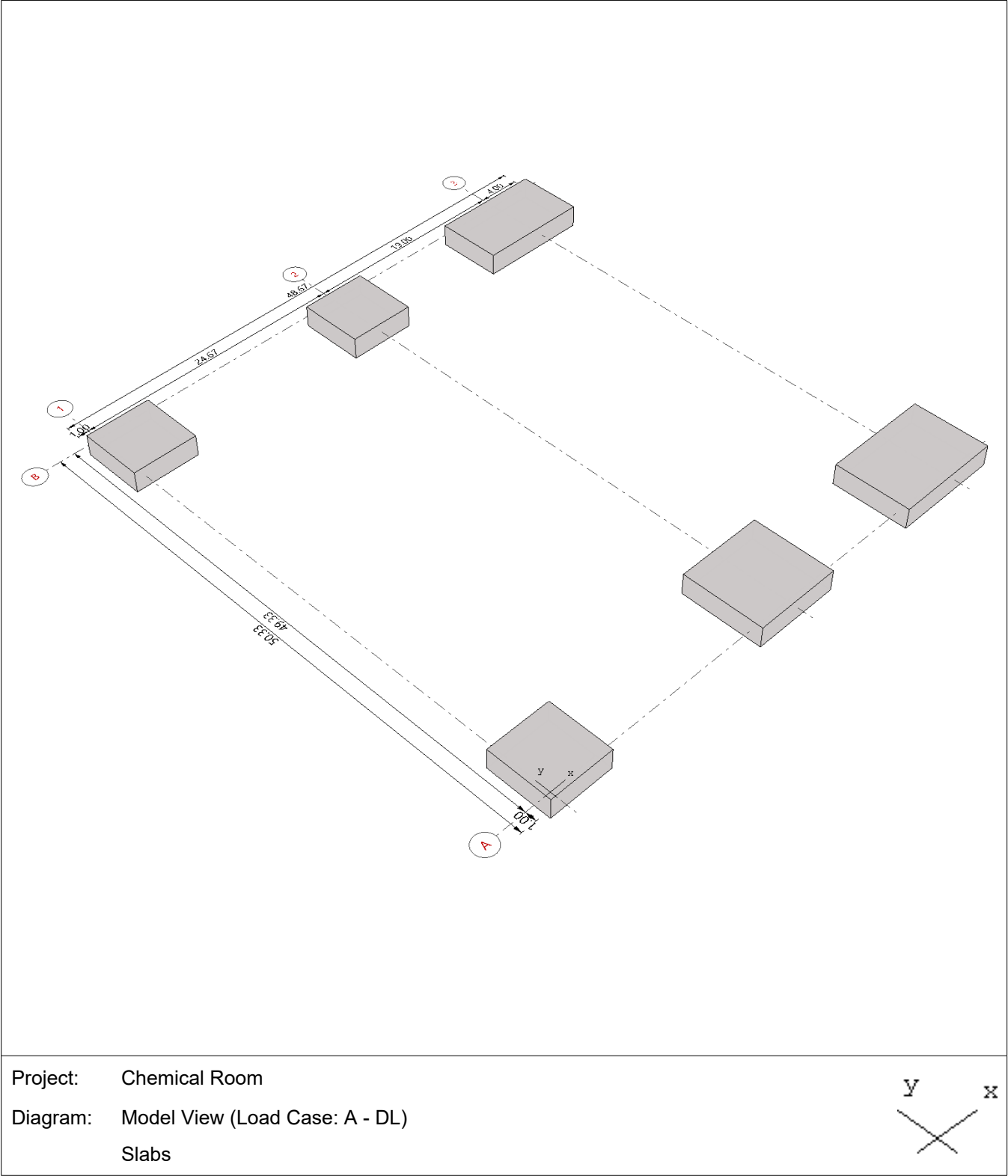
ID	Label	Shape	Top Left/Center X ft	Top Left/Center Y ft	Height (H)/Dia. (D) ft	Width (B) ft
S1	Slab11	Rectangular	-1.00	49.33	5.83	5.00
S2	Slab11	Rectangular	21.67	49.33	5.83	4.67
S3	Slab11	Rectangular	37.67	49.33	5.00	5.00
S4	Slab11	Rectangular	-1.00	5.00	5.83	5.00
S5	Slab11	Rectangular	37.67	6.00	5.00	5.00
S6	Slab11	Rectangular	20.59	6.50	6.67	6.50

3.3. Point Loads

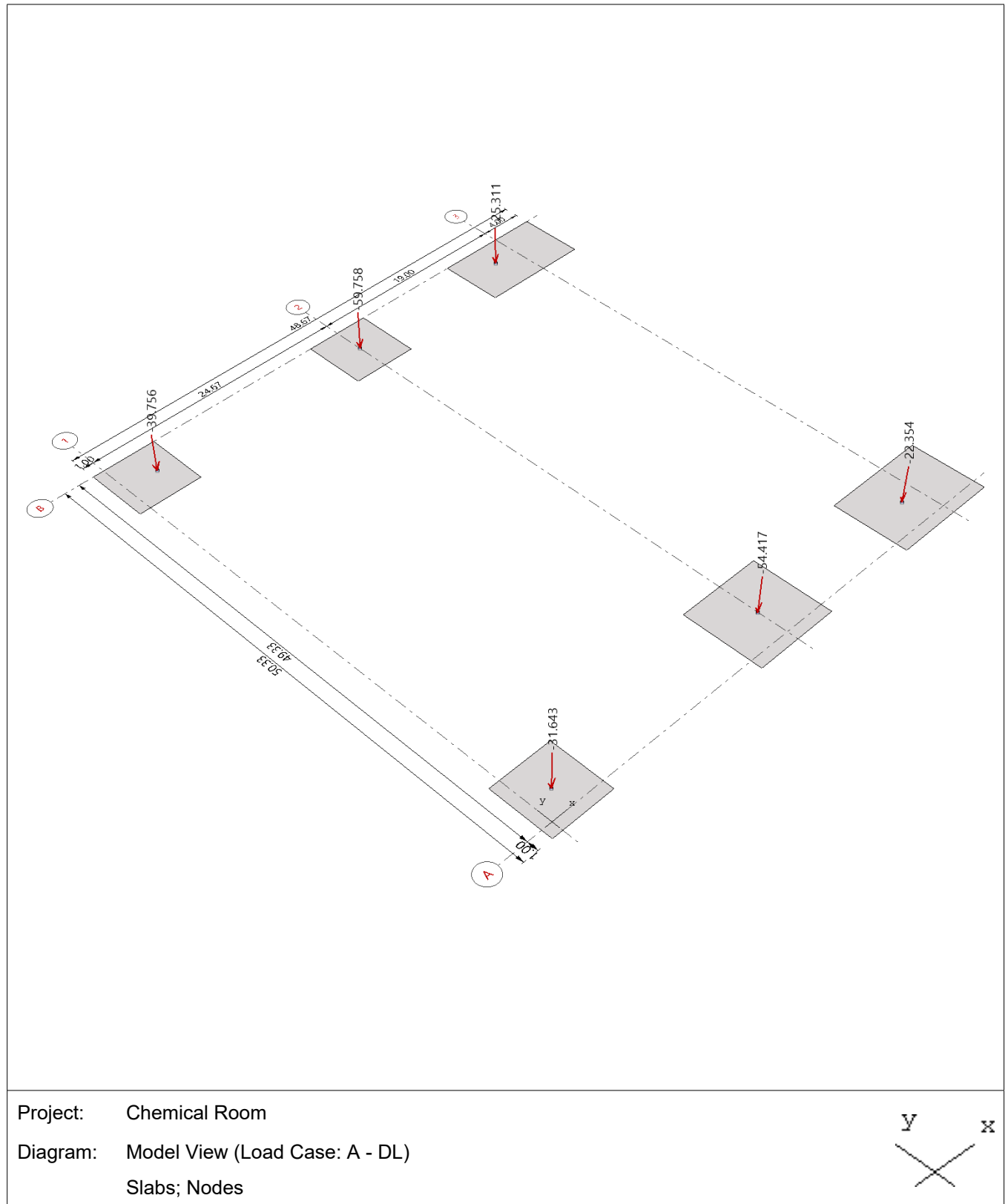
Nodes ID	Load Case	Pz kips	Mx kip-ft	My kip-ft
N1	A - DL	-31.643	-	-
N2	A - DL	-39.756	-	-
N3	A - DL	-54.417	-	-
N4	A - DL	-59.758	-	-
N5	A - DL	-22.354	-	-
N6	A - DL	-25.311	-	-

4. Screenshots

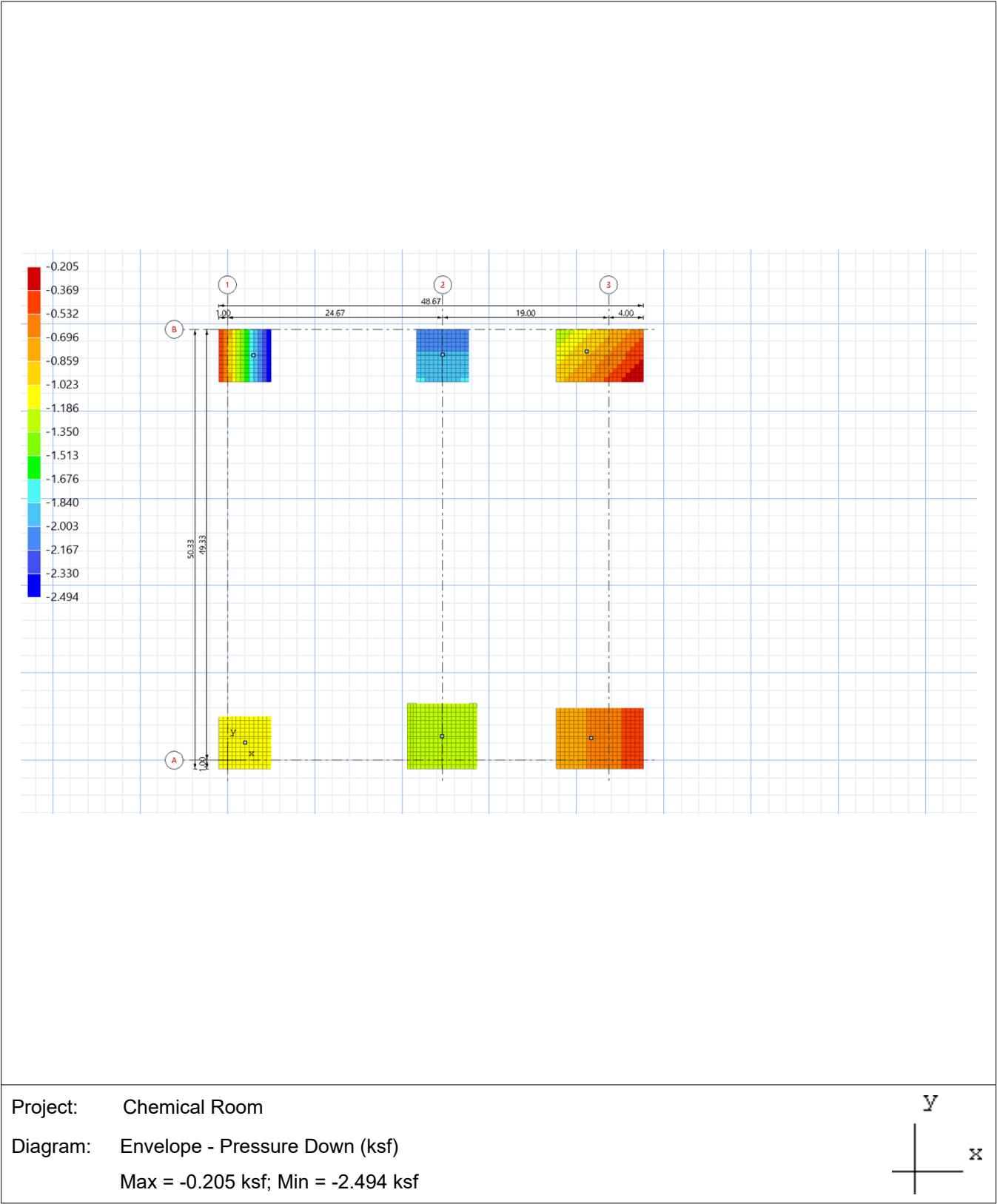
4.1. Extrude 3D view



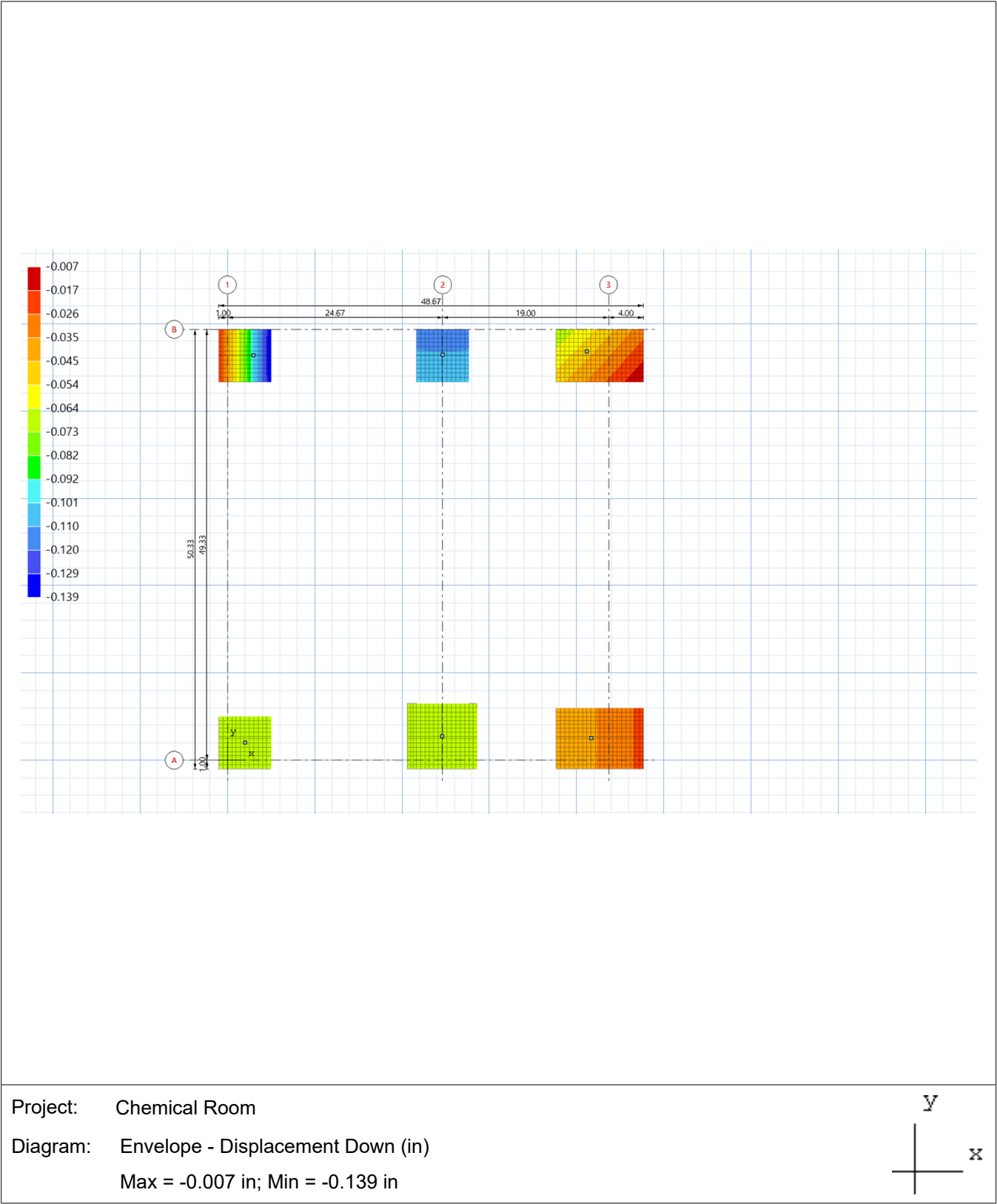
4.2. Loads - Case A - DL



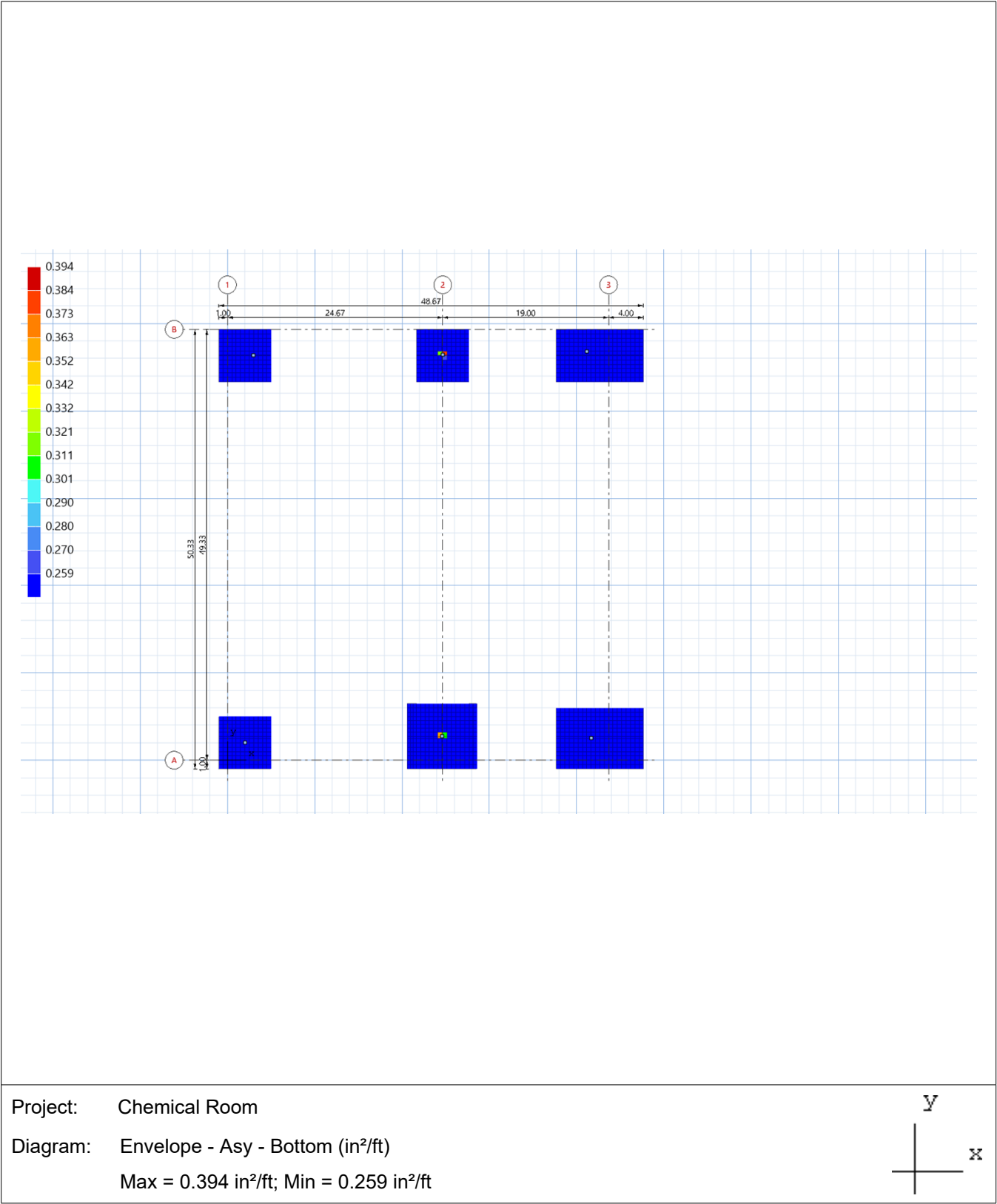
4.3. Envelope - Pressure Down (ksf)



4.4. Envelope - Displacement Down (in)



4.5. Envelope - Asy - Bottom (in²/ft)



Chemical room anchor

From STAAD reaction forces:

15572 lb uplift force
20201 lb shear force



Anchor Designer™
Software
Version 3.1.2209.3

Company:		Date:	9/8/2022
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Address:			
Phone:			
E-mail:			

1. Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description:
Location:
Fastening description:

2. Input Data & Anchor Parameters

General

Design method: ACI 318-19
Units: Imperial units

Anchor Information:

Anchor type: Bonded anchor
Material: A193 Grade B7
Diameter (inch): 0.750
Effective Embedment depth, h_{ef} (inch): 7.000
Code report: ICC-ES ESR-2508
Anchor category: -
Anchor ductility: Yes
 h_{min} (inch): 11.38
 c_{ac} (inch): 9.25
 c_{min} (inch): 1.75
 s_{min} (inch): 3.00

Base Material

Concrete: Normal-weight
Concrete thickness, h (inch): 36.00
State: Uncracked
Compressive strength, f'_c (psi): 4000
 $\Psi_{c,v}$: 1.4
Reinforcement condition: Supplementary reinforcement not present
Supplemental edge reinforcement: No
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Hole condition: Dry concrete
Inspection: Continuous
Temperature range, Short/Long: 150/110°F
Ignore 6do requirement: Not applicable
Build-up grout pad: Yes

Base Plate

Length x Width x Thickness (inch): 16.00 x 16.00 x 0.75
Yield stress: 36000 psi

Profile type/size: W12X50

Recommended Anchor

Anchor Name: SET-XP® - SET-XP w/ 3/4"Ø A193 Gr. B7
Code Report: ICC-ES ESR-2508





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Load and Geometry

Load factor source: ACI 318 Section 5.3

Load combination: not set

Seismic design: No

Anchors subjected to sustained tension: No

Apply entire shear load at front row: No

Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: 15572

V_{uax} [lb]: 2646

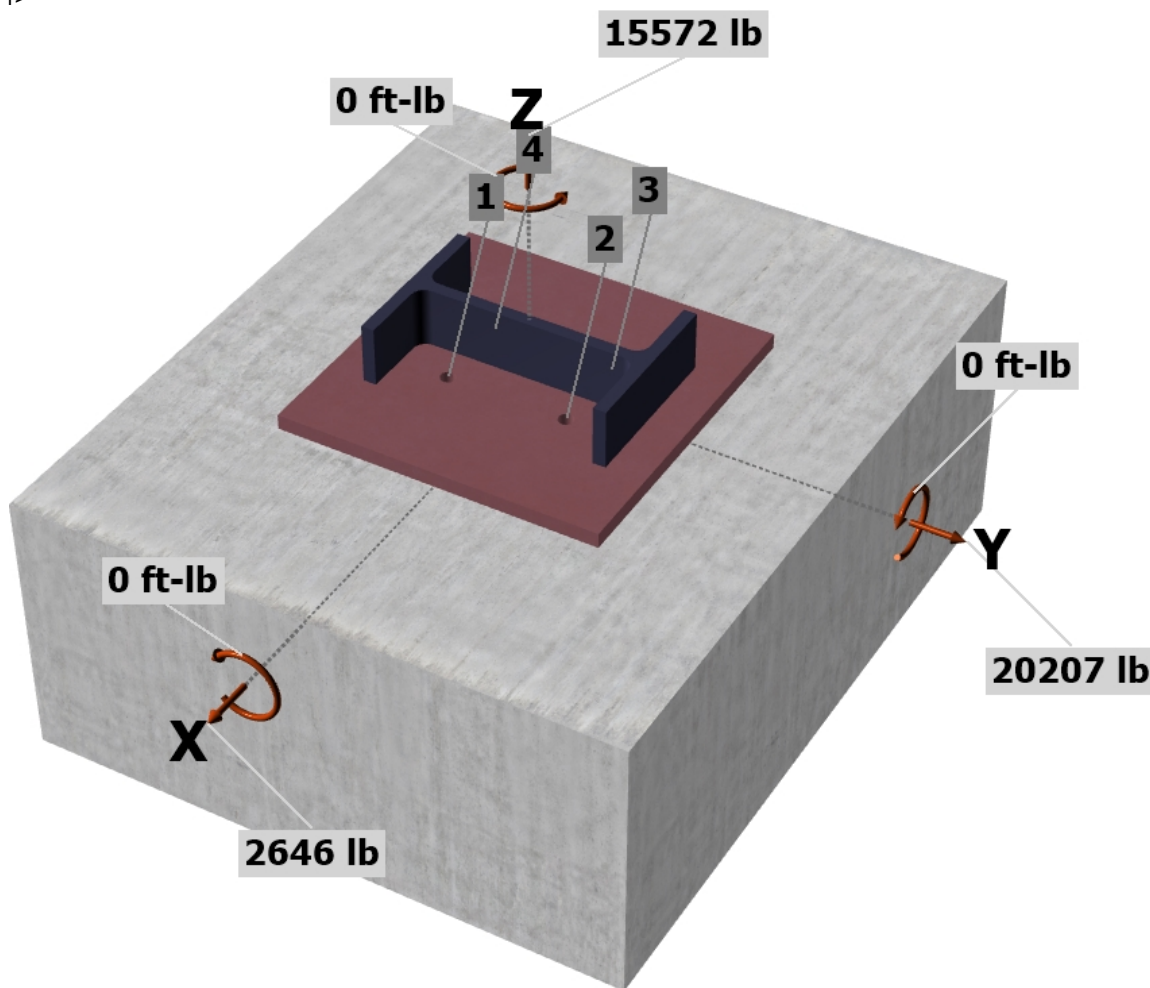
V_{uay} [lb]: 20207

M_{ux} [ft-lb]: 0

M_{uy} [ft-lb]: 0

M_{uz} [ft-lb]: 0

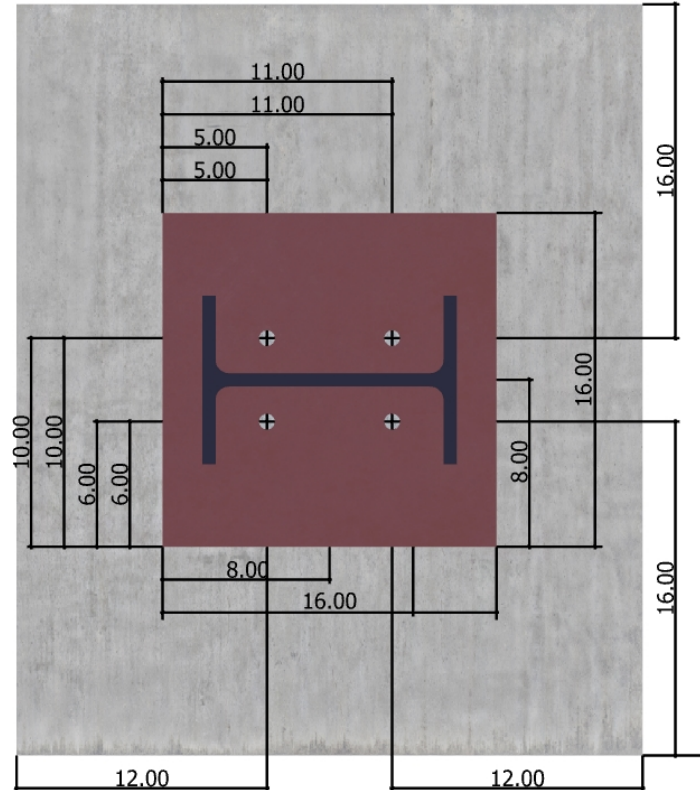
<Figure 1>





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<Figure 2>



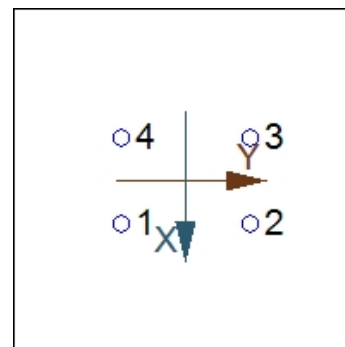
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3. Resulting Anchor Forces

Anchor	Tension load, N _{ua} (lb)	Shear load x, V _{uax} (lb)	Shear load y, V _{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2 + (V_{uay})^2}$ (lb)
1	3893.0	661.5	5051.8	5094.9
2	3893.0	661.5	5051.8	5094.9
3	3893.0	661.5	5051.8	5094.9
4	3893.0	661.5	5051.8	5094.9
Sum	15572.0	2646.0	20207.0	20379.5

Maximum concrete compression strain (%): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 15572
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. 17.6.1)

N _{sa} (lb)	φ	φN _{sa} (lb)
41750	0.75	31313

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.6.2)

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \text{ (Eq. 17.6.2.2.1)}$$

k _c	λ _a	f' _c (psi)	h _{ef} (in)	N _b (lb)
24.0	1.00	4000	7.000	28112

$$\phi N_{cbg} = \phi (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b \text{ (Sec. 17.5.1.2 \& Eq. 17.6.2.1a)}$$

A _{Nc} (in ²)	A _{Nco} (in ²)	C _{a,min} (in)	Ψ _{ec,N}	Ψ _{ed,N}	Ψ _{c,N}	Ψ _{cp,N}	N _b (lb)	φ	φN _{cbg} (lb)
675.00	441.00	12.00	1.000	1.000	1.00	1.000	28112	0.65	27968

6. Adhesive Strength of Anchor in Tension (Sec. 17.6.5)

$$\tau_{k,uncr} = \tau_{k,uncr} f_{short-term} K_{sat}$$

τ _{k,uncr} (psi)	f _{short-term}	K _{sat}	τ _{k,uncr} (psi)
970	1.00	1.00	970

$$N_{ba} = \lambda_a \tau_{uncr} \pi d_a h_{ef} \text{ (Eq. 17.6.5.2.1)}$$

λ _a	τ _{uncr} (psi)	d _a (in)	h _{ef} (in)	N _{ba} (lb)
1.00	970	0.75	7.000	15999

$$\phi N_{ag} = \phi (A_{Na} / A_{Na0}) \Psi_{ec,Na} \Psi_{ed,Na} \Psi_{cp,Na} N_{ba} \text{ (Sec. 17.5.1.2 \& Eq. 17.6.5.1b)}$$

A _{Na} (in ²)	A _{Na0} (in ²)	C _{Na} (in)	C _{a,min} (in)	Ψ _{ec,Na}	Ψ _{ed,Na}	Ψ _{cp,Na}	N _{ba} (lb)	φ	φN _{ag} (lb)
363.27	198.41	7.04	12.00	1.000	1.000	1.000	15999	0.65	19040

Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.

Simpson Strong-Tie Company Inc. 5956 W. Las Positas Boulevard Pleasanton, CA 94588 Phone: 925.560.9000 Fax: 925.847.3871 www.strongtie.com



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8. Steel Strength of Anchor in Shear (Sec. 17.7.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
25050	0.8	0.65	13026

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.7.2)

Shear perpendicular to edge in y-direction:

$$V_{by} = \min[7(l_e/d_a)^{0.2}\sqrt{d_a\lambda_a}\sqrt{f'_c}c_{a1}^{1.5}; 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}] \text{ (Eq. 17.7.2.2.1a \& Eq. 17.7.2.2.1b)}$$

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
6.00	0.750	1.00	4000	18.00	43469

$$\phi V_{cbgy} = \phi (A_{Vc} / A_{Vco}) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_{by} \text{ (Sec. 17.5.1.2 \& Eq. 17.7.2.1b)}$$

A_{Vc} (in ²)	A_{Vco} (in ²)	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{c,V}$	$\psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cbgy} (lb)
972.00	1458.00	1.000	0.878	1.400	1.000	43469	0.70	24929

Shear perpendicular to edge in x-direction:

$$V_{bx} = \min[7(l_e/d_a)^{0.2}\sqrt{d_a\lambda_a}\sqrt{f'_c}c_{a1}^{1.5}; 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}] \text{ (Eq. 17.7.2.2.1a \& Eq. 17.7.2.2.1b)}$$

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{bx} (lb)
6.00	0.750	1.00	4000	20.00	50912

$$\phi V_{cbgx} = \phi (A_{Vc} / A_{Vco}) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_{bx} \text{ (Sec. 17.5.1.2 \& Eq. 17.7.2.1b)}$$

A_{Vc} (in ²)	A_{Vco} (in ²)	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{c,V}$	$\psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cbgx} (lb)
900.00	1800.00	1.000	0.820	1.400	1.000	50912	0.70	20456

Shear parallel to edge in x-direction:

$$V_{by} = \min[7(l_e/d_a)^{0.2}\sqrt{d_a\lambda_a}\sqrt{f'_c}c_{a1}^{1.5}; 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}] \text{ (Eq. 17.7.2.2.1a \& Eq. 17.7.2.2.1b)}$$

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
6.00	0.750	1.00	4000	16.00	36429

$$\phi V_{cbgx} = \phi (2)(A_{Vc} / A_{Vco}) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_{by} \text{ (Sec. 17.5.1.2, 17.7.2.1(c) \& Eq. 17.7.2.1b)}$$

A_{Vc} (in ²)	A_{Vco} (in ²)	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{c,V}$	$\psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cbgx} (lb)
720.00	1152.00	1.000	1.000	1.400	1.000	36429	0.70	44626

Shear parallel to edge in y-direction:

$$V_{bx} = \min[7(l_e/d_a)^{0.2}\sqrt{d_a\lambda_a}\sqrt{f'_c}c_{a1}^{1.5}; 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}] \text{ (Eq. 17.7.2.2.1a \& Eq. 17.7.2.2.1b)}$$

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{bx} (lb)
6.00	0.750	1.00	4000	12.00	23662

$$\phi V_{cbgy} = \phi (2)(A_{Vc} / A_{Vco}) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_{bx} \text{ (Sec. 17.5.1.2, 17.7.2.1(c) \& Eq. 17.7.2.1b)}$$

A_{Vc} (in ²)	A_{Vco} (in ²)	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{c,V}$	$\psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cbgy} (lb)
648.00	648.00	1.000	1.000	1.400	1.000	23662	0.70	46377

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.7.3)

$$\phi V_{cp} = \phi \min[k_{cp}N_{ag}; k_{cp}N_{cbg}] = \phi \min[k_{cp}(A_{Na} / A_{Na0}) \psi_{ec,Na} \psi_{ed,Na} \psi_{cp,Na} N_{ba}; k_{cp}(A_{Nc} / A_{Nco}) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b] \text{ (Sec. 17.5.1.2 \& Eq. 17.7.3.1b)}$$

k_{cp}	A_{Na} (in ²)	A_{Na0} (in ²)	$\psi_{ed,Na}$	$\psi_{ec,Na}$	$\psi_{cp,Na}$	N_{ba} (lb)	N_a (lb)
2.0	363.27	198.41	1.000	1.000	1.000	15999	29292

A_{Nc} (in ²)	A_{Nco} (in ²)	$\psi_{ec,N}$	$\psi_{ed,N}$	$\psi_{c,N}$	$\psi_{cp,N}$	N_b (lb)	N_{cb} (lb)	ϕ
675.00	441.00	1.000	1.000	1.000	1.000	28112	43028	0.70



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ϕV_{cpq} (lb)
41008

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.8)

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status	
Steel	3893	31313	0.12	Pass	
Concrete breakout	15572	27968	0.56	Pass	
Adhesive	15572	19040	0.82	Pass (Governs)	
Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status	
Steel	5095	13026	0.39	Pass	
T Concrete breakout y+	20207	24929	0.81	Pass	
T Concrete breakout x+	2646	20456	0.13	Pass	
Concrete breakout x-	10104	44626	0.23	Pass	
Concrete breakout y+	1323	46377	0.03	Pass	
Concrete breakout, combined	-	-	0.82	Pass (Governs)	
Pryout	20380	41008	0.50	Pass	
Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.8.3	0.82	0.82	163.9%	1.2	Fail

FAIL! Selected anchor type and embedment do not meet the selected design criteria.

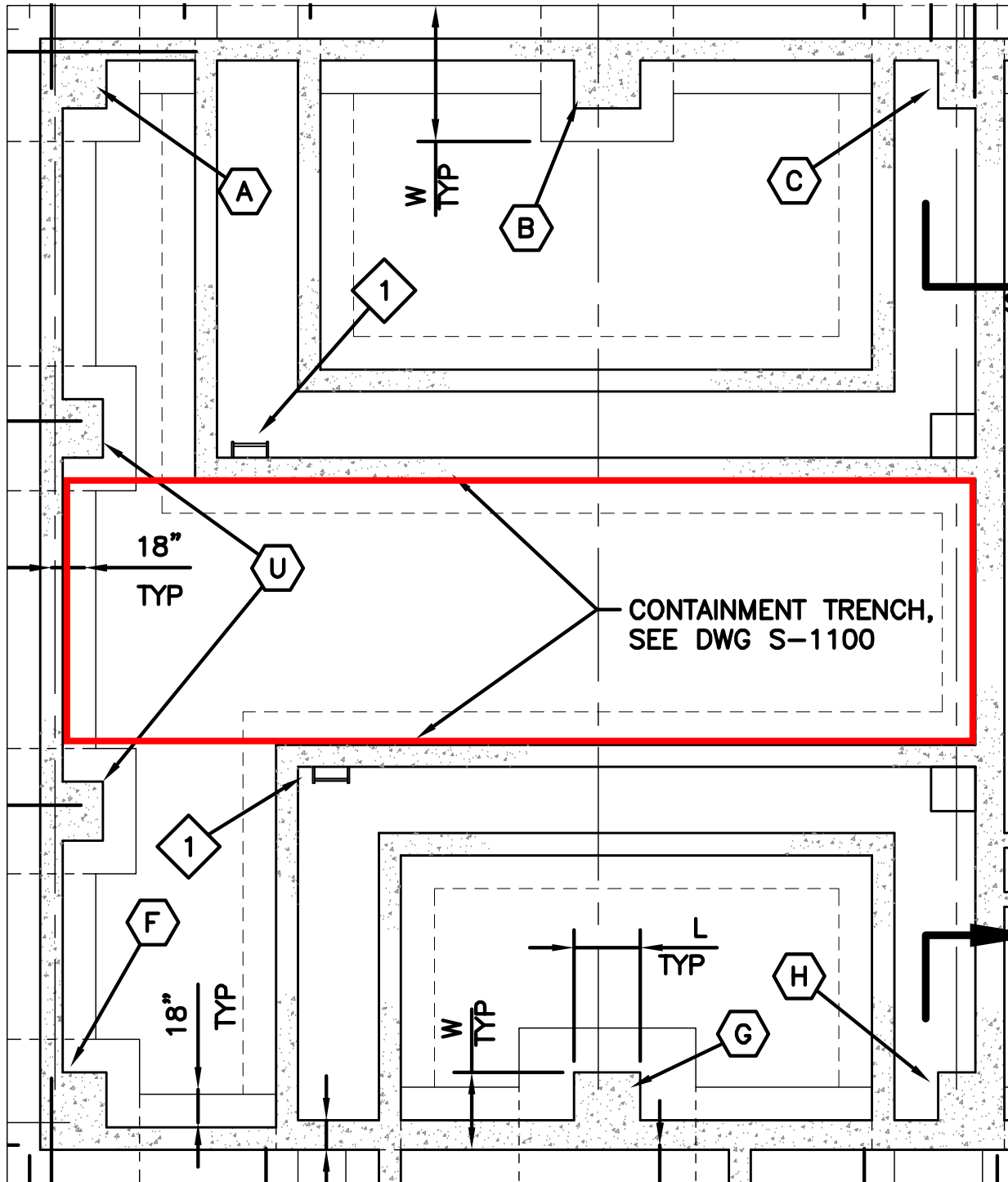
12. Warnings

- When cracked concrete is selected, concrete compressive strength used in concrete breakout strength in tension, adhesive strength in tension and concrete pryout strength in shear for SET-XP adhesive anchor is limited to 2,500 psi per ICC-ES ESR-2508 Section 5.3.
- Designer must exercise own judgement to determine if this design is suitable.
- Refer to manufacturer's product literature for hole cleaning and installation instructions.

Chemical room slab

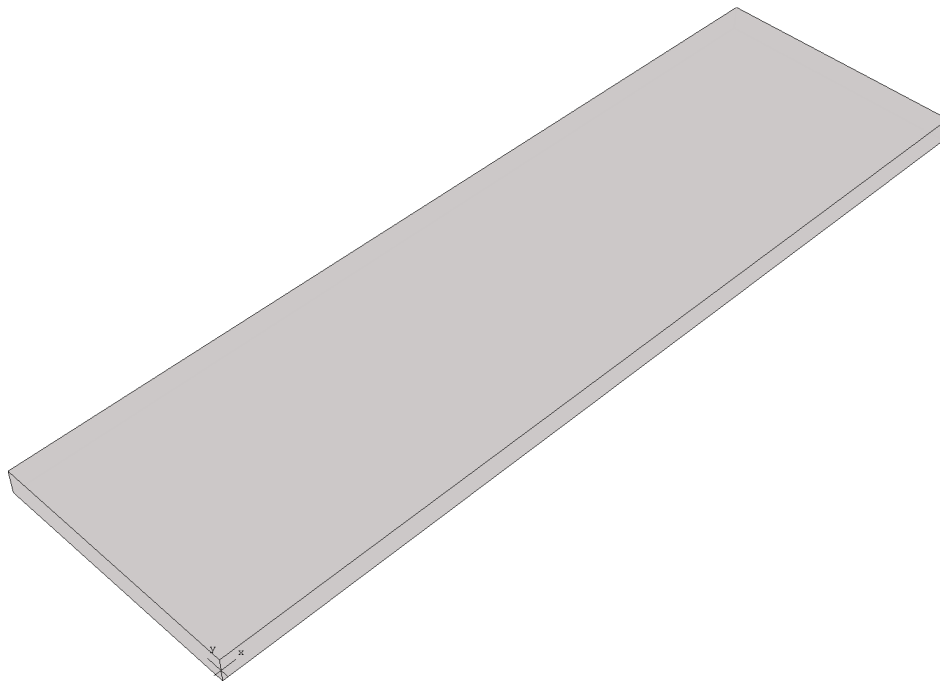
Load: 250psf

Allowable pressure: 3ksf





spMats v10.00 (TM)
A Computer Program for Analysis and Design of Foundation Mats, Combined Footings, and Slabs on Grade
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1. Project

1.1. General Information

File Name	spMats chemical room slab.matx
Project	Chemical room slab
Code	ACI 318-14
Units	English
Date	10/27/2023
Time	5:02 PM

1.2. Solver Options

Maximum number of iterations	10
Maximum allowed service displacement	11.00000 in
Minimum ratio of soil contact area w.r.t. initial soil-supported area	50 %
Minimum ratio of active springs and piles w.r.t. total number of springs and piles	0 %
Displacement limit of uplift	0.00000 in
Compute required reinforcement based on	Maximum moment within an element

2. Definitions

2.1. Objects

2.1.1. Slabs

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Mat18	18.00	Clay	C3	Gr40	Gr40#4	No
Mat24	24.00	Clay	C3	Gr40	Gr40#4	No
Mat30	30.00	Clay	C3	Gr40	Gr40#4	No
Mat36	36.00	Clay	C3	Gr40	Gr40#4	No
Mat48	48.00	Clay	C3	Gr40	Gr40#4	No
Slab1	18.00	Clay	C4	Gr40	Gr40#4	No
Slab2	18.00	Clay	C4	Gr60	Gr40#4	No
Slab3	18.00	Clay	C4	Gr60	Gr60#5	No
Slab4	14.00	Clay	C4	Gr60	Gr60#5	No
Slab5	14.00	Clay	C3	Gr40	Gr40#4	No
Slab6	14.00	Silt	C3	Gr40	Gr40#4	No
Slab7	14.00	Silt	C4	Gr40	Gr40#4	No
Slab8	14.00	Silt	C4	Gr60	Gr40#4	No
Slab9	14.00	Silt	C4	Gr60	Gr60#5	Yes

2.1.2. Columns

Label	Type	D in	B in	Assigned
C20X20	Rectangle	20.00	20.00	No

2.1.3. Pile - Properties

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
R36	Round	2738.71	Concrete	4286.8	Bedrock	No
S30X30	Square	2570.13	Precast	4286.8	Bedrock	No
1H8X36	H-Type 1	273.29	Steel	29000.0	Bedrock	No
2H8X36	H-Type 2	273.29	Steel	29000.0	Bedrock	No

2.1.4. Pile - Geometry

Label	Length ft	Embedment in	D in	B in	tf in	tw in
R36	50.00	6.00	36.00			
S30X30	50.00	6.00	30.00			
1H8X36	50.00	6.00	8.02	8.16	0.45	0.45
2H8X36	50.00	6.00	8.02	8.16	0.45	0.45

2.2. Properties**2.2.1. Soil**

Label	K _s kcf	Q _a ksf	Used	Label	K _s kcf	Q _a ksf	Used
Clay	75.000	1.500	Yes	Sand	100.000	2.000	No
Bedrock	600.000	12.000	Yes	Silt	216.000	3.000	Yes

2.2.2. Concrete

Label	f' _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C3	3.0000	150.00	3320.6	0.200	-	Yes
C4	4.0000	150.00	3834.3	0.200	-	Yes
C5	5.0000	150.00	4286.8	0.200	-	No
C6	6.0000	150.00	4696.0	0.200	-	No
C7	7.0000	150.00	5072.2	0.200	-	No
C8	8.0000	150.00	5422.5	0.200	-	No

2.2.3. Reinforcement

Label	f _y ksi	E _s ksi	Used	Label	f _y ksi	E _s ksi	Used
Gr40	40.0000	29000.0	Yes	Gr50	50.0000	29000.0	No
Gr60	60.0000	29000.0	Yes	Gr75	75.0000	29000.0	No

2.2.4. Design Parameters

Label	Top layer X in	Top layer Y in	Bot. Layer X in	Bot. Layer Y in	Min. Reinf. Ratio %	Used
Gr40#4	3.25	3.75	3.25	3.75	0.10	Yes
Gr50#4	3.25	3.75	3.25	3.75	0.10	No
Gr60#5	2.30	2.90	3.30	3.90	0.09	Yes
Gr75#4	3.25	3.75	3.25	3.75	0.07	No

2.3. Restraints

2.3.1. Nodal Springs

Label	K _{ns} klf	Assigned	Label	K _{ns} klf	Assigned
Spr1	100.00	No			

2.3.2. Slaved Nodes

Label	DOF	Assigned	Label	DOF	Assigned
SlvRx	Rx	No	SlvRy	Ry	No
SlvDz	Dz	No			

2.4. Load Case/Combo.

2.4.1. Load Cases

NOTE: Self weight is included under Case A.

Case	Type	Case label	Load defined?
A	Dead	DL	Yes
B	Live	LL	No

2.4.2. Service Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
S1	1.000	0.000	-	-	-	-	-	-	-
S2	1.000	1.000	-	-	-	-	-	-	-

2.4.3. Ultimate Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
U1	1.400	0.000	-	-	-	-	-	-	-
U2	1.200	1.600	-	-	-	-	-	-	-

3. Assignments

3.1. Slabs

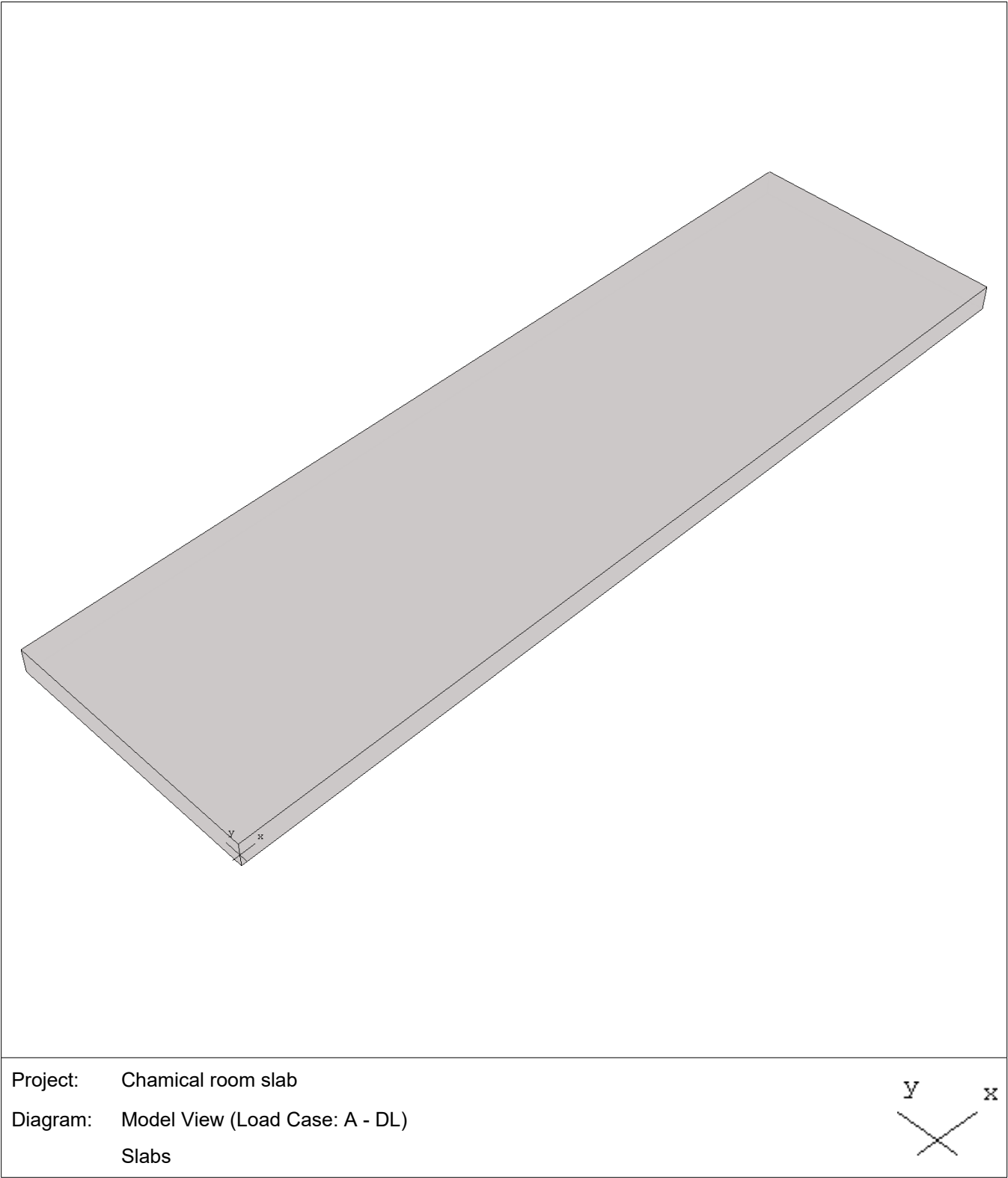
ID	Label	Shape	Top Left/Center X ft	Top Left/Center Y ft	Height (H)/Dia. (D) ft	Width (B) ft
S1	Slab9	Rectangular	0.00	11.90	11.90	41.00

3.2. Area Loads

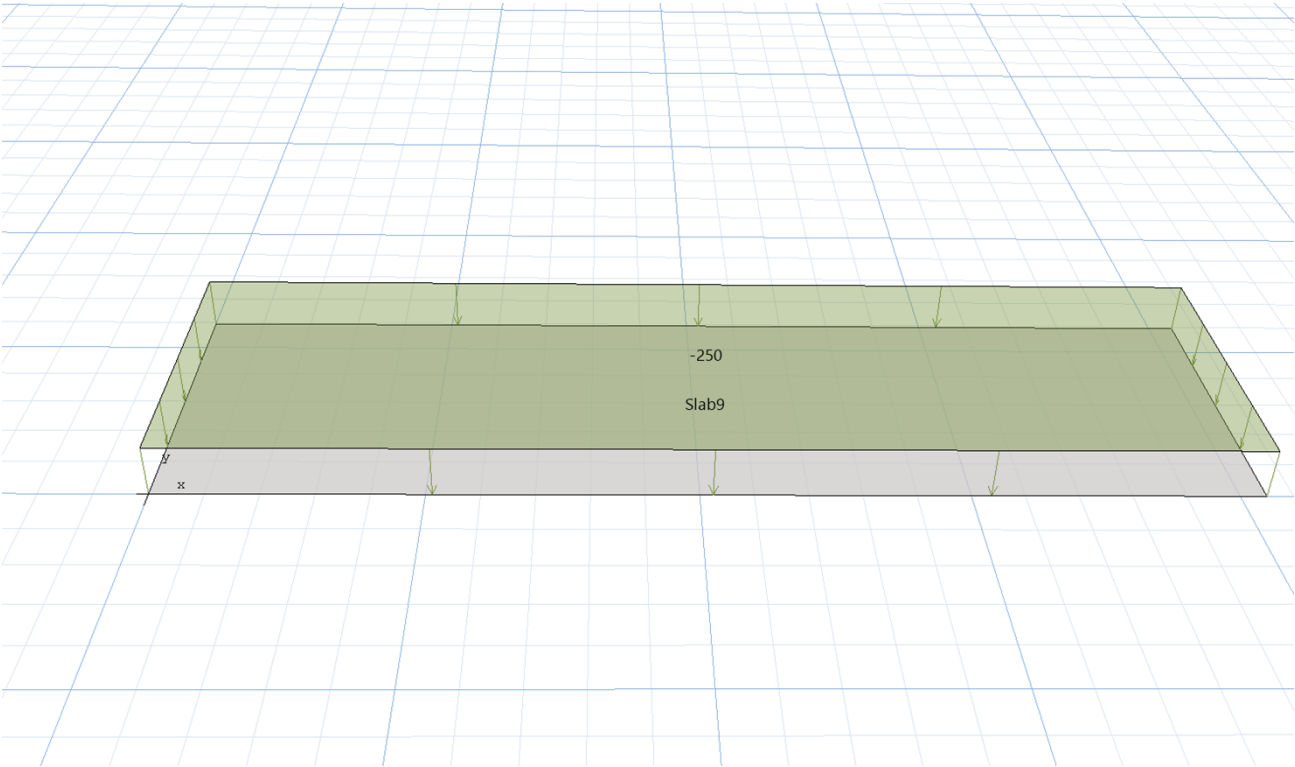
Slabs ID	Load Case	Wz psf
S1	A - DL	-250.0000

4. Screenshots

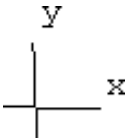
4.1. Extrude 3D view



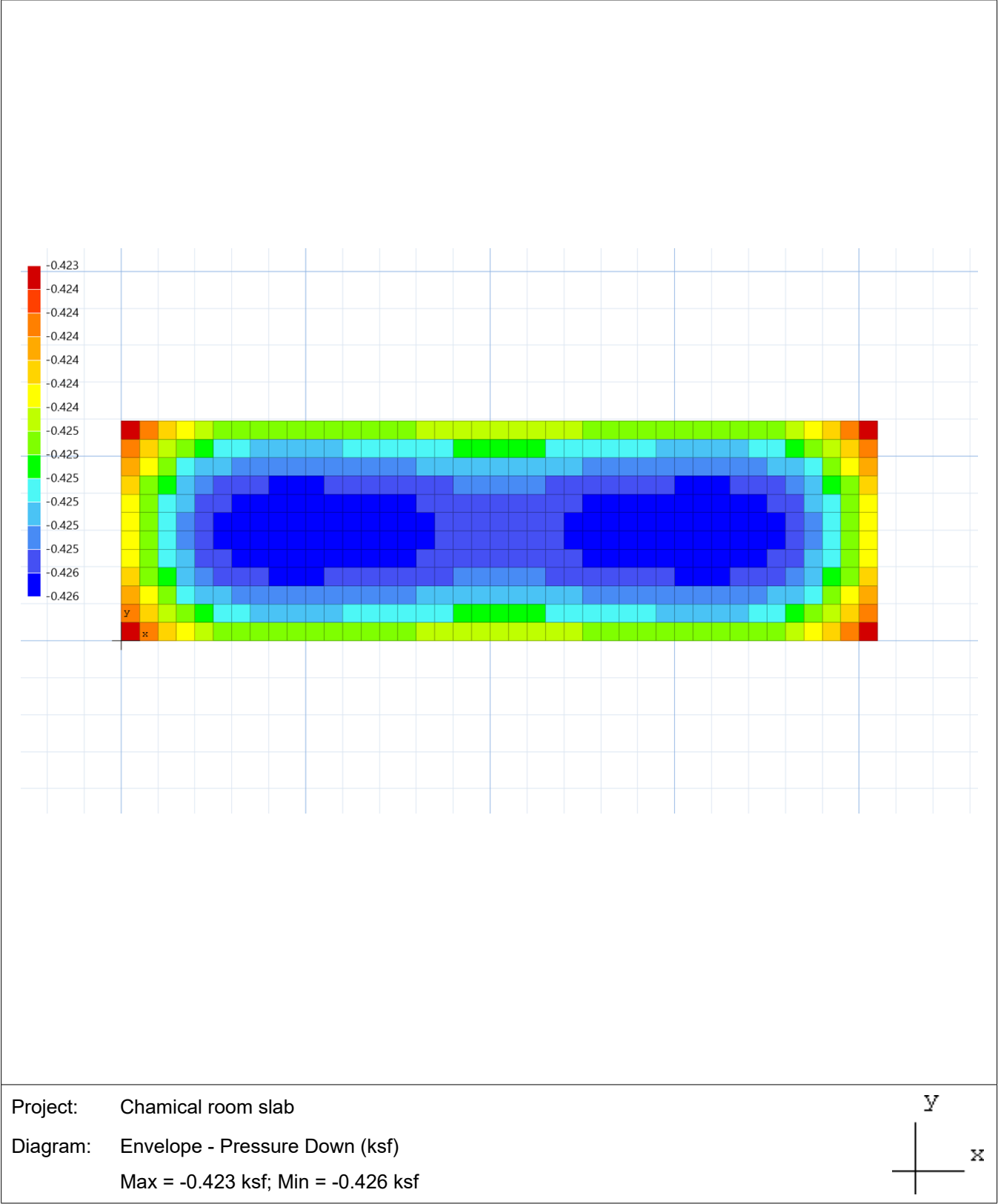
4.2. Model View (Load Case: A - DL)



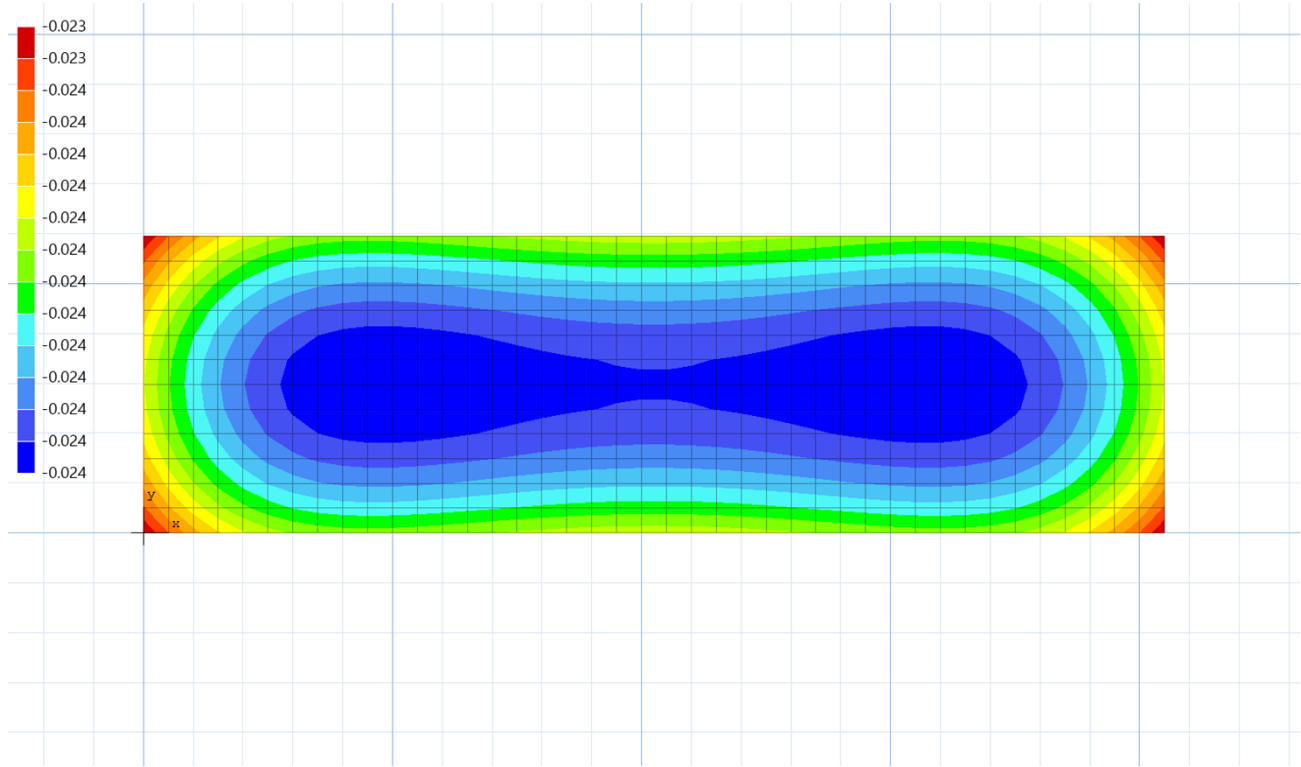
Project: Chemical room slab
Diagram: Model View (Load Case: A - DL)
Slabs (Label)



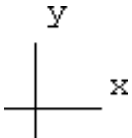
4.3. Envelope - Pressure Down (ksf)



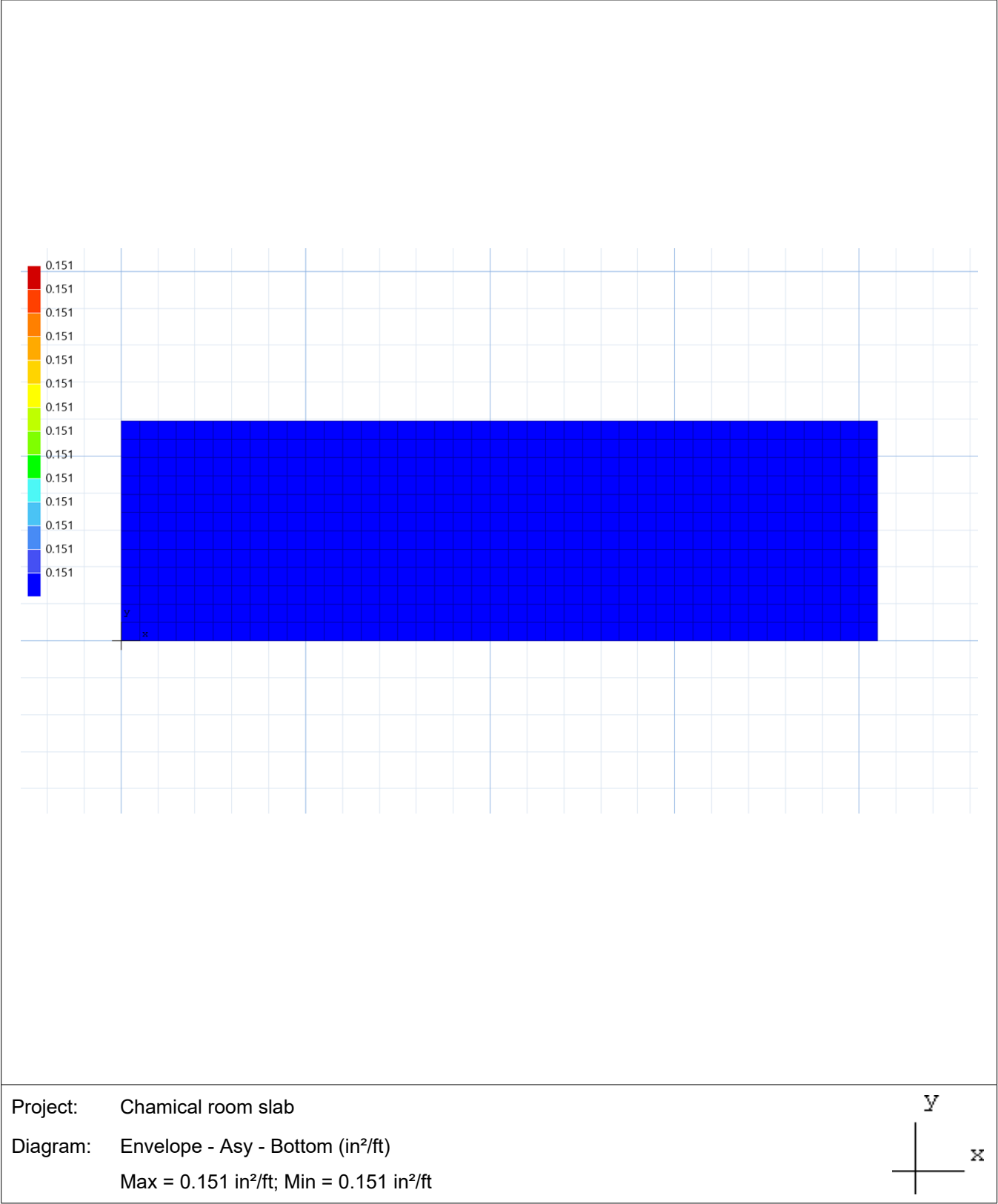
4.4. Envelope - Displacement Down (in)



Project: Chemical room slab
Diagram: Envelope - Displacement Down (in)
Max = -0.023 in; Min = -0.024 in



4.5. Envelope - Asy - Bottom (in²/ft)



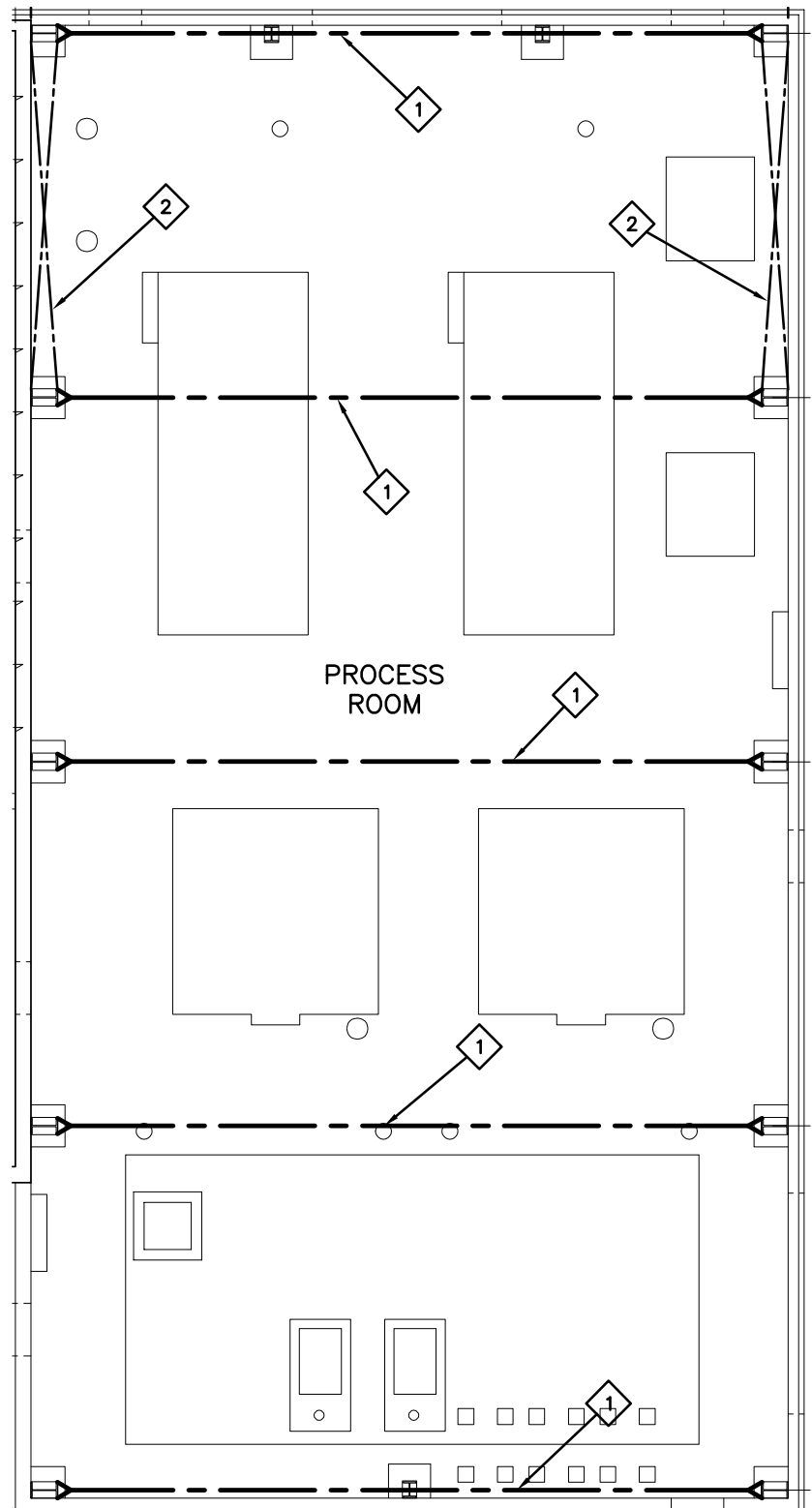
Process Room Loading

Dead Load :25psf

Live Load: 20psf

Snow Load: 40psf

Wind Load: 19.52psf



Process Room Wind Loading

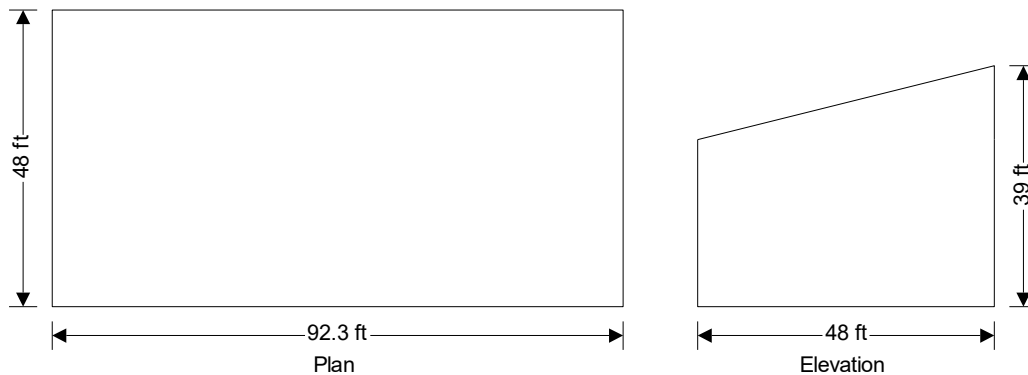
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WIND LOADING

In accordance with ASCE7-16

Using the directional design method

Tedds calculation version 2.1.07



Building data

Type of roof	Monoslope
Length of building	b = 92.32 ft
Width of building	d = 48.00 ft
Height to eaves	H = 27.00 ft
Pitch of roof	α_0 = 14.0 deg
Mean height	h = 32.98 ft

General wind load requirements

Basic wind speed	V = 115.0 mph
Risk category	IV
Velocity pressure exponent coef (Table 26.6-1)	K_d = 0.85
Ground elevation above sea level	z_{gl} = 0 ft
Ground elevation factor	$K_e = \exp(-0.0000362 \times z_{gl}/1\text{ft})$ = 1.00
Exposure category (cl 26.7.3)	B
Enclosure classification (cl.26.12)	Enclosed buildings
Internal pressure coef +ve (Table 26.13-1)	GC_{pi_p} = 0.18
Internal pressure coef -ve (Table 26.13-1)	GC_{pi_n} = -0.18
Gust effect factor	G_f = 0.85
Minimum design wind loading (cl.27.4.7)	p_{min_r} = 8 lb/ft ²

Topography

Topography factor not significant	K_{zt} = 1.0
Velocity pressure equation	$q = 0.00256 \times K_z \times K_{zt} \times K_d \times V^2 \times 1\text{psf}/\text{mph}^2$

Velocity pressures table

z (ft)	K_z (Table 26.10-1)	q_z (psf)
15.00	0.57	16.40
20.00	0.62	17.84
25.00	0.66	18.99
27.00	0.68	19.45

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z (ft)	K _z (Table 26.10-1)	q _z (psf)
32.98	0.72	20.66
38.97	0.75	21.69

Peak velocity pressure for internal pressure

Peak velocity pressure – internal (as roof press.) $q_i = 20.66$ psf

Pressures and forces

Net pressure

$$p = q \times G_f \times C_{pe} - q_i \times GC_{pi}$$

Net force

$$F_w = p \times A_{ref}$$

Roof load case 1 - Wind 0, GC_{pi} 0.18, -C_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient C _{pe}	Peak velocity pressure q _p (psf)	Net pressure p (psf)	Area A _{ref} (ft ²)	Net force F _w (kips)
A (-ve)	32.98	-0.86	20.66	-18.82	4567.02	-85.94

Total vertical net force $F_{w,v} = -83.39$ kips

Total horizontal net force $F_{w,h} = -20.79$ kips

Walls load case 1 - Wind 0, GC_{pi} 0.18, -C_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient C _{pe}	Peak velocity pressure q _p (psf)	Net pressure p (psf)	Area A _{ref} (ft ²)	Net force F _w (kips)
A ₁	15.00	0.80	16.40	7.44	1384.80	10.30
A ₂	20.00	0.80	17.84	8.41	461.60	3.88
A ₃	27.00	0.80	19.45	9.51	646.24	6.15
B	32.98	-0.50	20.66	-12.50	3597.50	-44.97
C	32.98	-0.70	20.66	-16.01	1583.23	-25.35
D	32.98	-0.70	20.66	-16.01	1583.23	-25.35

Overall loading

Projected vertical plan area of wall

$$A_{vert_w_0} = b \times H = 2492.64 \text{ ft}^2$$

Projected vertical area of roof

$$A_{vert_r_0} = b \times d \times \tan(\alpha_0) = 1104.86 \text{ ft}^2$$

Minimum overall horizontal loading

$$F_{w,total_min} = p_{min_w} \times A_{vert_w_0} + p_{min_r} \times A_{vert_r_0} = 48.72 \text{ kips}$$

Leeward net force

$$F_l = F_{w,wB} = -45.0 \text{ kips}$$

Windward net force

$$F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 20.3 \text{ kips}$$

Overall horizontal loading

$$F_{w,total} = \max(F_w - F_l + F_{w,h}, F_{w,total_min}) = 48.7 \text{ kips}$$

Roof load case 2 - Wind 0, GC_{pi} -0.18, -1C_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient C _{pe}	Peak velocity pressure q _p (psf)	Net pressure p (psf)	Area A _{ref} (ft ²)	Net force F _w (kips)
A (+ve)	32.98	-0.18	20.66	0.56	4567.02	2.55

Total vertical net force $F_{w,v} = 2.47$ kips

Total horizontal net force $F_{w,h} = 0.62$ kips

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Walls load case 2 - Wind 0, GC_{pi} -0.18, -1c_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient c _{pe}	Peak velocity pressure q _p (psf)	Net pressure p (psf)	Area A _{ref} (ft ²)	Net force F _w (kips)
A ₁	15.00	0.80	16.40	14.87	1384.80	20.60
A ₂	20.00	0.80	17.84	15.85	461.60	7.32
A ₃	27.00	0.80	19.45	16.95	646.24	10.95
B	32.98	-0.50	20.66	-5.06	3597.50	-18.21
C	32.98	-0.70	20.66	-8.57	1583.23	-13.57
D	32.98	-0.70	20.66	-8.57	1583.23	-13.57

Overall loading

Projected vertical plan area of wall

$$A_{\text{vert_w_0}} = b \times H = \mathbf{2492.64 \text{ ft}^2}$$

Projected vertical area of roof

$$A_{\text{vert_r_0}} = b \times d \times \tan(\alpha_0) = \mathbf{1104.86 \text{ ft}^2}$$

Minimum overall horizontal loading

$$F_{w,\text{total_min}} = p_{\text{min_w}} \times A_{\text{vert_w_0}} + p_{\text{min_r}} \times A_{\text{vert_r_0}} = \mathbf{48.72 \text{ kips}}$$

Leeward net force

$$F_l = F_{w,\text{WB}} = \mathbf{-18.2 \text{ kips}}$$

Windward net force

$$F_w = F_{w,\text{WA_1}} + F_{w,\text{WA_2}} + F_{w,\text{WA_3}} = \mathbf{38.9 \text{ kips}}$$

Overall horizontal loading

$$F_{w,\text{total}} = \max(F_w - F_l + F_{w,h}, F_{w,\text{total_min}}) = \mathbf{57.7 \text{ kips}}$$

Roof load case 3 - Wind 90, GC_{pi} 0.18, -c_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient c _{pe}	Peak velocity pressure q _p (psf)	Net pressure p (psf)	Area A _{ref} (ft ²)	Net force F _w (kips)
A (-ve)	32.98	-0.90	20.66	-19.52	815.85	-15.93
B (-ve)	32.98	-0.90	20.66	-19.52	815.85	-15.93
C (-ve)	32.98	-0.50	20.66	-12.50	1631.69	-20.39
D (-ve)	32.98	-0.30	20.66	-8.99	1303.63	-11.72

Total vertical net force

$$F_{w,v} = \mathbf{-62.07 \text{ kips}}$$

Total horizontal net force

$$F_{w,h} = \mathbf{0.00 \text{ kips}}$$

Walls load case 3 - Wind 90, GC_{pi} 0.18, -c_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient c _{pe}	Peak velocity pressure q _p (psf)	Net pressure p (psf)	Area A _{ref} (ft ²)	Net force F _w (kips)
A ₁	15.00	0.80	16.40	7.44	720.00	5.35
A ₂	25.00	0.80	18.99	9.20	480.00	4.41
A ₃	38.97	0.80	21.69	11.03	383.28	4.23
B	32.98	-0.32	20.66	-9.26	1583.23	-14.65
C	32.98	-0.70	20.66	-16.01	2492.64	-39.91
D	32.98	-0.70	20.66	-16.01	3597.50	-57.60

Overall loading

Projected vertical plan area of wall

$$A_{\text{vert_w_90}} = d \times (H + d \times \tan(\alpha_0) / 2) = \mathbf{1583.23 \text{ ft}^2}$$

Projected vertical area of roof

$$A_{\text{vert_r_90}} = \mathbf{0.00 \text{ ft}^2}$$

Minimum overall horizontal loading

$$F_{w,\text{total_min}} = p_{\text{min_w}} \times A_{\text{vert_w_90}} + p_{\text{min_r}} \times A_{\text{vert_r_90}} = \mathbf{25.33 \text{ kips}}$$

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Leeward net force $F_l = F_{w,wB} = -14.7$ kips
 Windward net force $F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 14.0$ kips
 Overall horizontal loading $F_{w,total} = \max(F_w - F_l + F_{w,h}, F_{w,total_min}) = 28.7$ kips

Roof load case 4 - Wind 90, $GC_{pi} -0.18, +c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (+ve)	32.98	-0.18	20.66	0.56	815.85	0.46
B (+ve)	32.98	-0.18	20.66	0.56	815.85	0.46
C (+ve)	32.98	-0.18	20.66	0.56	1631.69	0.91
D (+ve)	32.98	-0.18	20.66	0.56	1303.63	0.73

Total vertical net force $F_{w,v} = 2.47$ kips
 Total horizontal net force $F_{w,h} = 0.00$ kips

Walls load case 4 - Wind 90, $GC_{pi} -0.18, +c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	14.87	720.00	10.71
A ₂	25.00	0.80	18.99	16.63	480.00	7.98
A ₃	38.97	0.80	21.69	18.47	383.28	7.08
B	32.98	-0.32	20.66	-1.82	1583.23	-2.88
C	32.98	-0.70	20.66	-8.57	2492.64	-21.37
D	32.98	-0.70	20.66	-8.57	3597.50	-30.84

Overall loading

Projected vertical plan area of wall $A_{vert_w_90} = d \times (H + d \times \tan(\alpha_0) / 2) = 1583.23$ ft²
 Projected vertical area of roof $A_{vert_r_90} = 0.00$ ft²
 Minimum overall horizontal loading $F_{w,total_min} = p_{min_w} \times A_{vert_w_90} + p_{min_r} \times A_{vert_r_90} = 25.33$ kips
 Leeward net force $F_l = F_{w,wB} = -2.9$ kips
 Windward net force $F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 25.8$ kips
 Overall horizontal loading $F_{w,total} = \max(F_w - F_l + F_{w,h}, F_{w,total_min}) = 28.7$ kips

Roof load case 5 - Wind 180, $GC_{pi} 0.18, -c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (-ve)	32.98	-0.54	20.66	-13.29	4567.02	-60.69

Total vertical net force $F_{w,v} = -58.88$ kips
 Total horizontal net force $F_{w,h} = -14.68$ kips

Walls load case 5 - Wind 180, $GC_{pi} 0.18, -c_{pe}$

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	7.44	1384.80	10.30

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Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₂	25.00	0.80	18.99	9.20	923.20	8.49
A ₃	38.97	0.80	21.69	11.03	1289.61	14.23
B	32.98	-0.50	20.66	-12.50	2492.64	-31.16
C	32.98	-0.70	20.66	-16.01	1583.23	-25.35
D	32.98	-0.70	20.66	-16.01	1583.23	-25.35

Overall loading

Projected vertical plan area of wall

$$A_{vert_w_180} = b \times (H + d \times \tan(\alpha_0)) = 3597.50 \text{ ft}^2$$

Projected vertical area of roof

$$A_{vert_r_180} = b \times d \times \tan(\alpha_0) = 1104.86 \text{ ft}^2$$

Minimum overall horizontal loading

$$F_{w,total_min} = p_{min_w} \times A_{vert_w_180} + p_{min_r} \times A_{vert_r_180} = 66.40 \text{ kips}$$

Leeward net force

$$F_l = F_{w,wB} = -31.2 \text{ kips}$$

Windward net force

$$F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 33.0 \text{ kips}$$

Overall horizontal loading

$$F_{w,total} = \max(F_w - F_l - F_{w,h}, F_{w,total_min}) = 78.9 \text{ kips}$$

Roof load case 6 - Wind 180, GC_{pi} -0.18, -c_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A (+ve)	32.98	-0.54	20.66	-5.85	4567.02	-26.72

Total vertical net force

$$F_{w,v} = -25.93 \text{ kips}$$

Total horizontal net force

$$F_{w,h} = -6.46 \text{ kips}$$

Walls load case 6 - Wind 180, GC_{pi} -0.18, -c_{pe}

Zone	Ref. height (ft)	Ext pressure coefficient c_{pe}	Peak velocity pressure q_p (psf)	Net pressure p (psf)	Area A_{ref} (ft ²)	Net force F_w (kips)
A ₁	15.00	0.80	16.40	14.87	1384.80	20.60
A ₂	25.00	0.80	18.99	16.63	923.20	15.36
A ₃	38.97	0.80	21.69	18.47	1289.61	23.82
B	32.98	-0.50	20.66	-5.06	2492.64	-12.62
C	32.98	-0.70	20.66	-8.57	1583.23	-13.57
D	32.98	-0.70	20.66	-8.57	1583.23	-13.57

Overall loading

Projected vertical plan area of wall

$$A_{vert_w_180} = b \times (H + d \times \tan(\alpha_0)) = 3597.50 \text{ ft}^2$$

Projected vertical area of roof

$$A_{vert_r_180} = b \times d \times \tan(\alpha_0) = 1104.86 \text{ ft}^2$$

Minimum overall horizontal loading

$$F_{w,total_min} = p_{min_w} \times A_{vert_w_180} + p_{min_r} \times A_{vert_r_180} = 66.40 \text{ kips}$$

Leeward net force

$$F_l = F_{w,wB} = -12.6 \text{ kips}$$

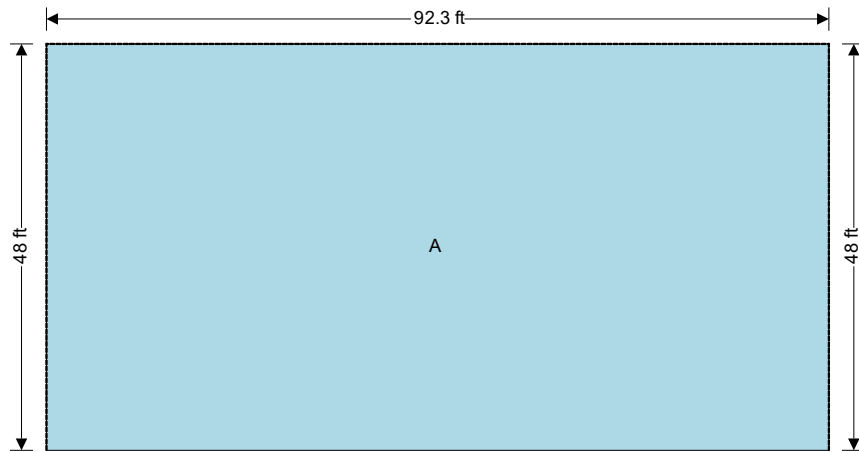
Windward net force

$$F_w = F_{w,wA_1} + F_{w,wA_2} + F_{w,wA_3} = 59.8 \text{ kips}$$

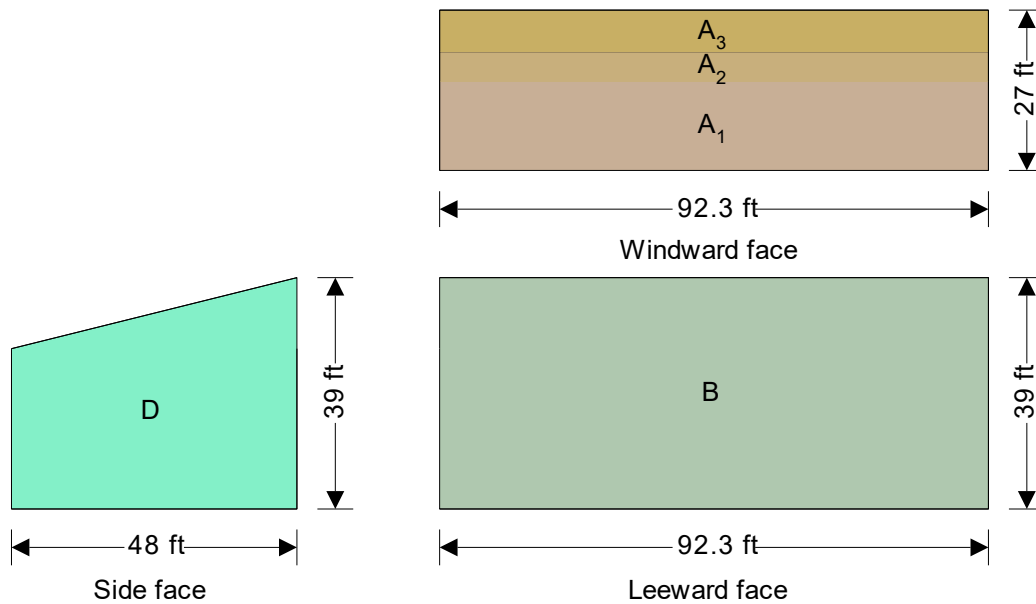
Overall horizontal loading

$$F_{w,total} = \max(F_w - F_l - F_{w,h}, F_{w,total_min}) = 78.9 \text{ kips}$$

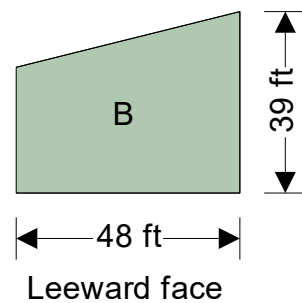
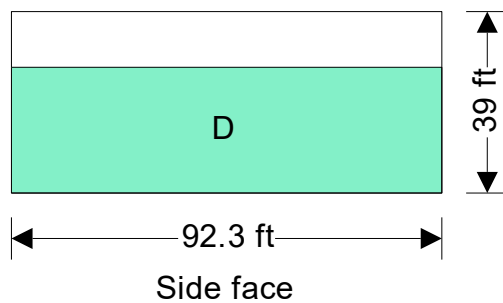
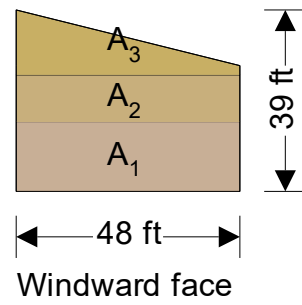
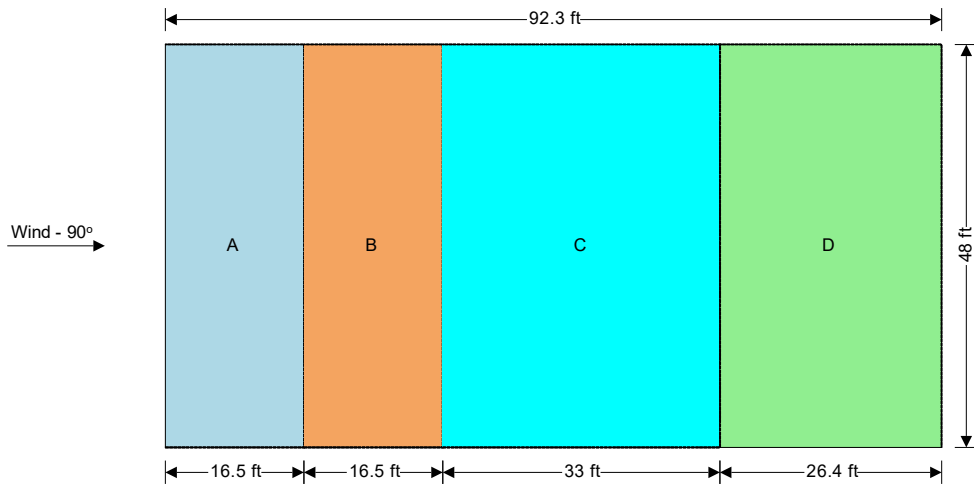
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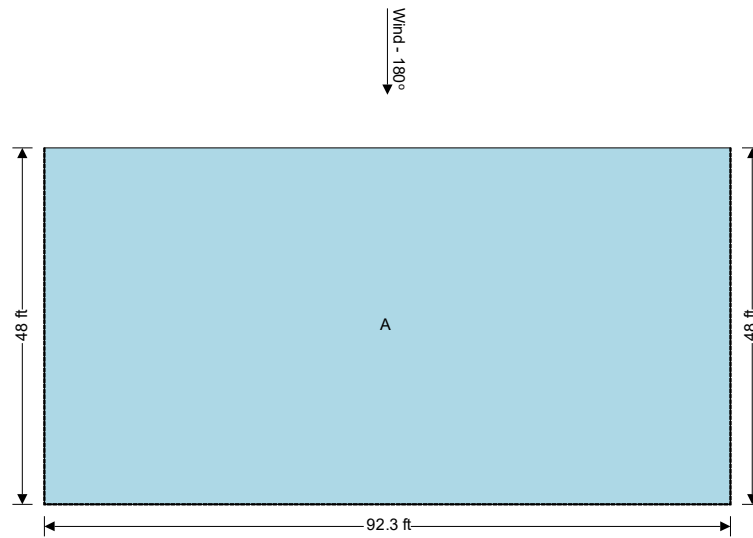
Wind - 0°
↑
Plan view - Monoslope roof



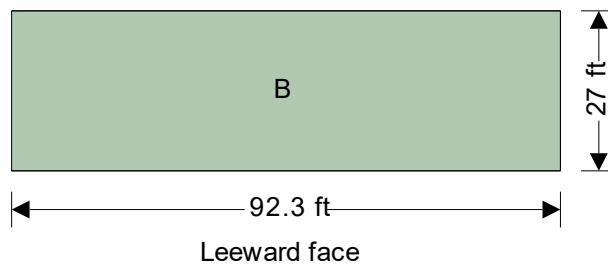
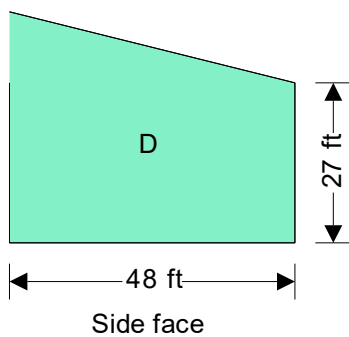
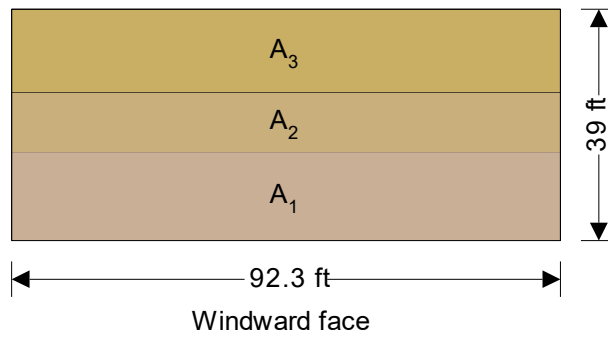
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Plan view - Monoslope roof



Project:

Item:

Project No.

Designer:

Checker:

Sheet: of

Date:

Date:

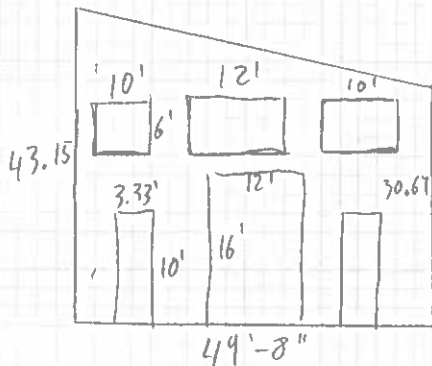
A_o - area of opening

A_g - gross area

A_{oi} - sum of areas of opening not included A_o

A_{gi} - sum of gross surface not included A_g

Front



$$A_o = 2 \times (10 \times 3.33) + 16' \times 12' + 2(10 \times 6) + 12(6)$$

$$= 450.6 \text{ ft}^2$$

$$A_g = 30.67(49.67) + \frac{1}{2}(49.67)(43.15 - 30.67)$$

$$= 1833.32 \text{ ft}^2$$

$$A_{oi} = 1176.3 \text{ ft}^2$$

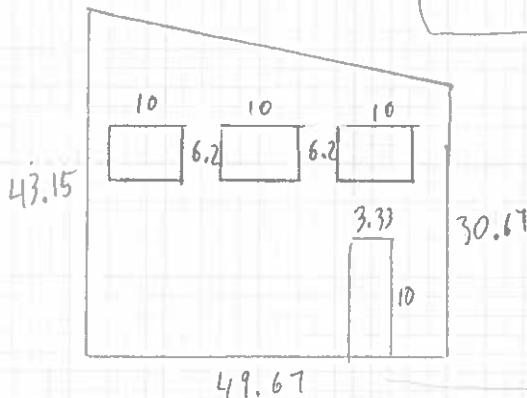
$$A_{gi} = 8821.82 \text{ ft}^2$$

Enclosed building $A_o < 0.01 A_g$ X
 $450.6 \neq 18.3$

Partially enclosed $A_o > 1.1 A_{oi}$
 $450.6 \neq 1293.93$ X

open building $A_o \geq .8 A_g$
 $450.6 \neq 1466.64$ X

Partially open building $\pm .18$ per 26.13-1
 $- .18$



$$A_o = 3(10 \times 6.2) + 3.33(10)$$

$$= 219.3 \text{ ft}^2$$

$$A_g = 30.67(49.67) + \frac{1}{2}(49.67)(43.15 - 30.67)$$

$$= 1833.32 \text{ ft}^2$$

$$A_{oi} = 1407.6 \text{ ft}^2$$

$$A_{gi} = 8821.82$$

Enclosed building $A_o < 0.01 A_g$
 $219.3 \neq 18.33$ X

open building $A_o > .8 A_g$
 $219.3 \neq 1466$ X

Partially enclosed $A_o > 1.1 A_{oi}$
 $219.3 \neq 1548.36$ X

Partially open building $\pm .18$
 $- .18$

Project:

Item:

Project No.

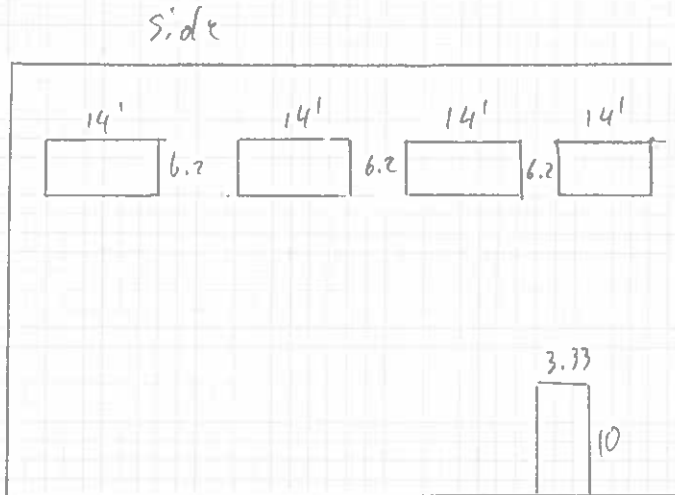
Designer:

Checker:

Sheet: of

Date:

Date:



$$A_o = 4(14(6.2)) + 3.33(10) = 380.5 \text{ ft}^2$$

$$A_g = 43.15 \times 94.67 = 4085.14 \text{ ft}^2$$

$$A_{oi} = 1246.4 \text{ ft}^2$$

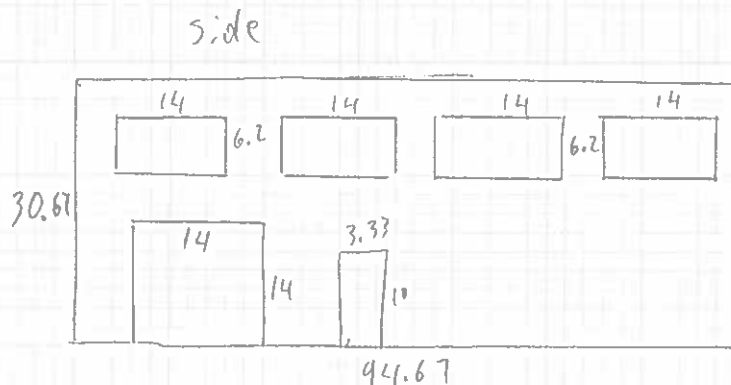
$$43.15 \quad A_{gi} = 6570.14$$

Enclosed building $A_o < 0.01 A_g$
 $380.5 < 4085 \times$

Partially enclosed $A_o > 1.1 A_{oi}$
 $380.5 > 1371.04 \times$

Open building $A_o > 0.8 A_g$
 $380.5 > 3268 \times$

Partially open building $+ .18$
 $- .18$
 ✓



$$A_o = 14(14) + 3.33(10) + 4(14(6.2)) = 576.5 \text{ ft}^2$$

$$A_g = 94.67(30.67) = 2903.5 \text{ ft}^2$$

$$A_{oi} = 1050.4 \text{ ft}^2$$

$$A_{gi} = 7751.64 \text{ ft}^2$$

Enclosed building $A_o < 0.01 A_g$
 $576.5 < 29.03 \times$

Partially enclosed $A_o > 1.1 A_{oi}$
 $576.5 > 1155.44 \times$

Open building $A_o > 0.8 A_g$
 $576.5 > 2322.8 \times$

Partially open building $+ .18$
 $- .18$

Process Room Footing Reactions from STAAD



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Sheet No
1

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Part

Job Title **Silt**

Ref

By Date **13-Jan-23** Chd

Client

File **BUILDING 2 Process Ro** Date/Time **30-Oct-2023 09:41**

Job Information

	Engineer	Checked	Approved
Name:			
Date:	13-Jan-23		

Project ID	
Project Name	

Structure Type	SPACE FRAME
----------------	-------------

Number of Nodes	21	Highest Node	21
Number of Elements	28	Highest Beam	29

Number of Basic Load Cases	12
Number of Combination Load Cases	23

Included in this printout are data for:

All	The Whole Structure
-----	---------------------

Included in this printout are results for load cases:

Type	L/C	Name
Combination	10	1.4D
Combination	11	1.2D+1.6L+.5RLL
Combination	12	1.2D+1.6L+.5S
Combination	13	1.2D+1.6S+.5W
Combination	14	1.2D+1.6S+.5W
Combination	15	1.2D+1.6S+.5W
Combination	16	1.2D+1.6S+.5W
Combination	17	1.2D+1.6S+.5W
Combination	18	1.2D+1.6S+.5W
Combination	19	1.2D+1W+L+.5S
Combination	20	1.2D+1W+L+.5S
Combination	21	1.2D+1W+L+.5S
Combination	22	1.2D+1W+L+.5S
Combination	23	1.2D+1W+L+.5S
Combination	24	1.2D+1W+L+.5S
Combination	25	.9D+1W
Combination	26	.9D+1W
Combination	27	.9D+1W
Combination	28	.9D+1W
Combination	29	.9D+1W
Combination	30	.9D+1W
Primary	31	LOAD CASE 10 CRANE LOAD
Primary	32	LOAD CASE 32 SEISMIC X
Primary	33	LOAD CASE 33 SEISMIC Z
Combination	34	(1.2+.2SDS)D+EMH+L+.2S



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Nodes

Node	X (in)	Y (in)	Z (in)
1	0	0	0
2	276.960	0	0
3	553.920	0	0
4	830.880	0	0
5	1.11E+3	0	0
6	0	0	576.000
7	276.960	0	576.000
8	553.920	0	576.000
9	830.880	0	576.000
10	1.11E+3	0	576.000
11	0	471.240	0
12	276.960	471.240	0
13	553.920	471.240	0
14	830.880	471.240	0
15	1.11E+3	471.240	0
16	0	324.000	576.000
17	276.960	324.000	576.000
18	553.920	324.000	576.000
19	830.880	324.000	576.000
20	1.11E+3	324.000	576.000
21	553.920	324.000	0

Beams

Beam	Node A	Node B	Length (in)	Property	β (degrees)
1	1	11	471.240	3	90
2	2	12	471.240	3	90
4	4	14	471.240	3	90
5	5	15	471.240	3	90
6	6	16	324.000	3	90
7	7	17	324.000	3	90
8	8	18	324.000	3	90
9	9	19	324.000	3	90
10	10	20	324.000	3	90
11	11	16	594.521	1	0
12	12	17	594.521	1	0
13	13	18	594.521	1	0
14	14	19	594.521	1	0
15	15	20	594.521	1	0
16	19	10	426.243	2	0
17	20	9	426.243	2	0
18	15	4	546.602	2	0
19	14	5	546.602	2	0

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	Part		
Job Title Silt	Ref		
	By	Date 13-Jan-23	Chd
Client	File BUILDING 2 Process Ro	Date/Time 30-Oct-2023 09:41	

Beams Cont...

Beam	Node A	Node B	Length (in)	Property	β (degrees)
20	11	12	276.960	1	0
21	12	13	276.960	1	0
22	13	14	276.960	1	0
23	14	15	276.960	1	0
24	16	17	276.960	1	0
25	17	18	276.960	1	0
26	18	19	276.960	1	0
27	19	20	276.960	1	0
28	3	21	324.000	3	90
29	21	13	147.240	3	90

Section Properties

Prop	Section	Area (in ²)	I_{yy} (in ⁴)	I_{zz} (in ⁴)	J (in ⁴)	Material
1	W27X102	30.000	139.000	3.62E+3	5.280	STEEL
2	L505010	5.900	21.465	5.691	0.788	STEEL
3	Taper	26.750	156.307	5.14E+3	2.229	STEEL

Materials

Mat	Name	E (kip/in ²)	ν	Density (kip/in ³)	α (/°F)
1	STEEL	29E+3	0.300	0.000283	6.5E -6
2	CONCRETE	3.15E+3	0.170	8.68e-05	5.5E -6
3	ALUMINUM	10E+3	0.330	9.8e-05	12.8E -6
4	STAINLESSSTEEL	28E+3	0.300	0.000283	9.9E -6
5	STEEL_36_KSI	29E+3	0.300	0.000283	6.5E -6
6	STEEL_50_KSI	29E+3	0.300	0.000283	6.5E -6
7	STEEL_275_NMM2	29.7E+3	0.300	0.000	6.67E -6
8	STEEL_355_NMM2	29.7E+3	0.300	0.000	6.67E -6



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By Date **13-Jan-23** Chd

Client

File **BUILDING 2 Process Roc** Date/Time **30-Oct-2023 09:41**

Supports

Node	X (kip/in)	Y (kip/in)	Z (kip/in)	rX (kip*ft/deg)	rY (kip*ft/deg)	rZ (kip*ft/deg)
1	Fixed	Fixed	Fixed	-	-	-
2	Fixed	Fixed	Fixed	-	-	-
3	Fixed	Fixed	Fixed	-	-	-
4	Fixed	Fixed	Fixed	-	-	-
5	Fixed	Fixed	Fixed	-	-	-
6	Fixed	Fixed	Fixed	-	-	-
7	Fixed	Fixed	Fixed	-	-	-
8	Fixed	Fixed	Fixed	-	-	-
9	Fixed	Fixed	Fixed	-	-	-
10	Fixed	Fixed	Fixed	-	-	-

Releases

Beam ends not shown in this table are fixed in all directions.

Beam	Node	x	y	z	rx	ry	rz
16	19	Fixed	Fixed	Fixed	Pin	Fixed	Pin
16	10	Fixed	Fixed	Fixed	Pin	Fixed	Pin
17	20	Fixed	Fixed	Fixed	Pin	Fixed	Pin
17	9	Fixed	Fixed	Fixed	Pin	Fixed	Pin
18	15	Fixed	Fixed	Fixed	Pin	Fixed	Pin
18	4	Fixed	Fixed	Fixed	Pin	Fixed	Pin
19	14	Fixed	Fixed	Fixed	Pin	Fixed	Pin
19	5	Fixed	Fixed	Fixed	Pin	Fixed	Pin
20	11	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
20	12	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
21	12	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
21	13	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
22	13	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
22	14	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
23	14	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
23	15	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
24	16	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
24	17	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
25	17	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
25	18	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
26	18	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
26	19	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
27	19	Fixed	Fixed	Fixed	Fixed	Fixed	Pin
27	20	Fixed	Fixed	Fixed	Fixed	Fixed	Pin

Primary Load Cases

Number	Name	Type
1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55, (None
2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55,	None
3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55,	None
4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55	None
5	LOAD CASE 5 WIND 180 DEG. GCPI 0.5!	None
6	LOAD CASE 6 WIND 180 DEG. GCPI -0.5	None
7	LOAD CASE 7 ROOF DEAD LOAD	None
8	LOAD CASE 8 ROOF SNOW LOAD	None
9	LOAD CASE 9 ROOF LIVE LOAD	None
31	LOAD CASE 10 CRANE LOAD	None
32	LOAD CASE 32 SEISMIC X	None
33	LOAD CASE 33 SEISMIC Z	None

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
10	1.4D	7	LOAD CASE 7 ROOF DEAD LOAD	1.40
11	1.2D+1.6L+.5RLL	7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		9	LOAD CASE 9 ROOF LIVE LOAD	0.50
12	1.2D+1.6L+.5S	7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
13	1.2D+1.6S+.5W	1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55, (0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
14	1.2D+1.6S+.5W	2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55,	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
15	1.2D+1.6S+.5W	3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55,	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
16	1.2D+1.6S+.5W	4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
17	1.2D+1.6S+.5W	5	LOAD CASE 5 WIND 180 DEG. GCPI 0.5!	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
18	1.2D+1.6S+.5W	6	LOAD CASE 6 WIND 180 DEG. GCPI -0.5	0.50
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	1.60
19	1.2D+1W+L+.5S	1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55, (1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
		31	LOAD CASE 10 CRANE LOAD	1.00



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Combination Load Cases Cont...

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
20	1.2D+1W+L+.5S	2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
		31	LOAD CASE 10 CRANE LOAD	1.00
21	1.2D+1W+L+.5S	3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
		31	LOAD CASE 10 CRANE LOAD	1.00
22	1.2D+1W+L+.5S	4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
		31	LOAD CASE 10 CRANE LOAD	1.00
23	1.2D+1W+L+.5S	5	LOAD CASE 5 WIND 180 DEG. GCPI 0.5,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
		31	LOAD CASE 10 CRANE LOAD	1.00
24	1.2D+1W+L+.5S	6	LOAD CASE 6 WIND 180 DEG. GCPI -0.5,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		8	LOAD CASE 8 ROOF SNOW LOAD	0.50
		31	LOAD CASE 10 CRANE LOAD	1.00
25	.9D+1W	1	LOAD CASE 1 WIND 0 DEG. GCPI 0.55, (1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
26	.9D+1W	2	LOAD CASE 2 WIND 0 DEG. GCPI -0.55,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
27	.9D+1W	3	LOAD CASE 3 WIND 90 DEG. GCPI 0.55,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
28	.9D+1W	4	LOAD CASE 4 WIND 90 DEG. GCPI -0.55,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
29	.9D+1W	5	LOAD CASE 5 WIND 180 DEG. GCPI 0.5,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
30	.9D+1W	6	LOAD CASE 6 WIND 180 DEG. GCPI -0.5,	1.00
		7	LOAD CASE 7 ROOF DEAD LOAD	0.90
34	(1.2+.2SDS)D+EMH+L+.2S	7	LOAD CASE 7 ROOF DEAD LOAD	1.20
		9	LOAD CASE 9 ROOF LIVE LOAD	1.00
		8	LOAD CASE 8 ROOF SNOW LOAD	0.20
35	(0.9-0.2SDS)D+EMH	7	LOAD CASE 7 ROOF DEAD LOAD	0.90

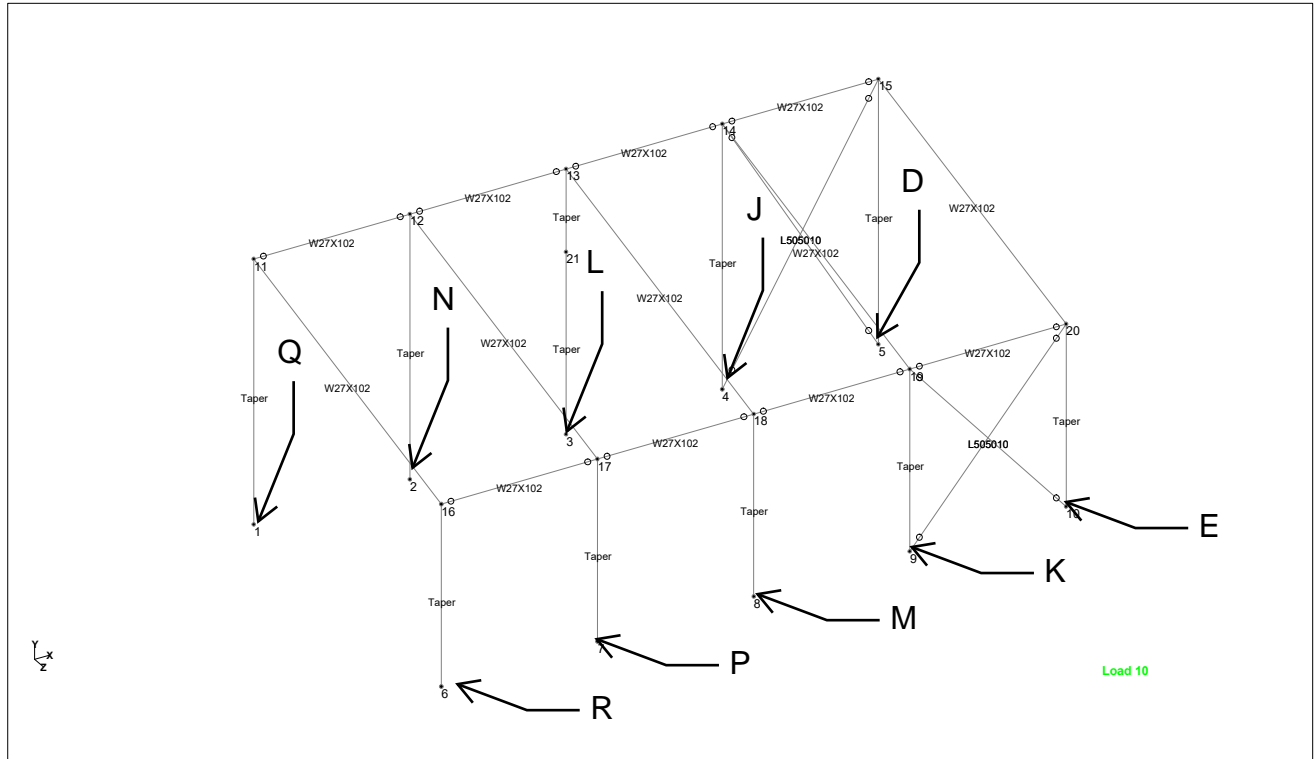
31 LOAD CASE 10 CRANE LOAD : Node Loads

Node	FX (kip)	FY (kip)	FZ (kip)	MX (kip'in)	MY (kip'in)	MZ (kip'in)
18	-	-	-1.200	-	-	-
	-	-1.500	-	-	-	-
	0.600	-	-	-	-	-
21	-	-	-1.200	-	-	-
	-	-1.500	-	-	-	-
	0.600	-	-	-	-	-

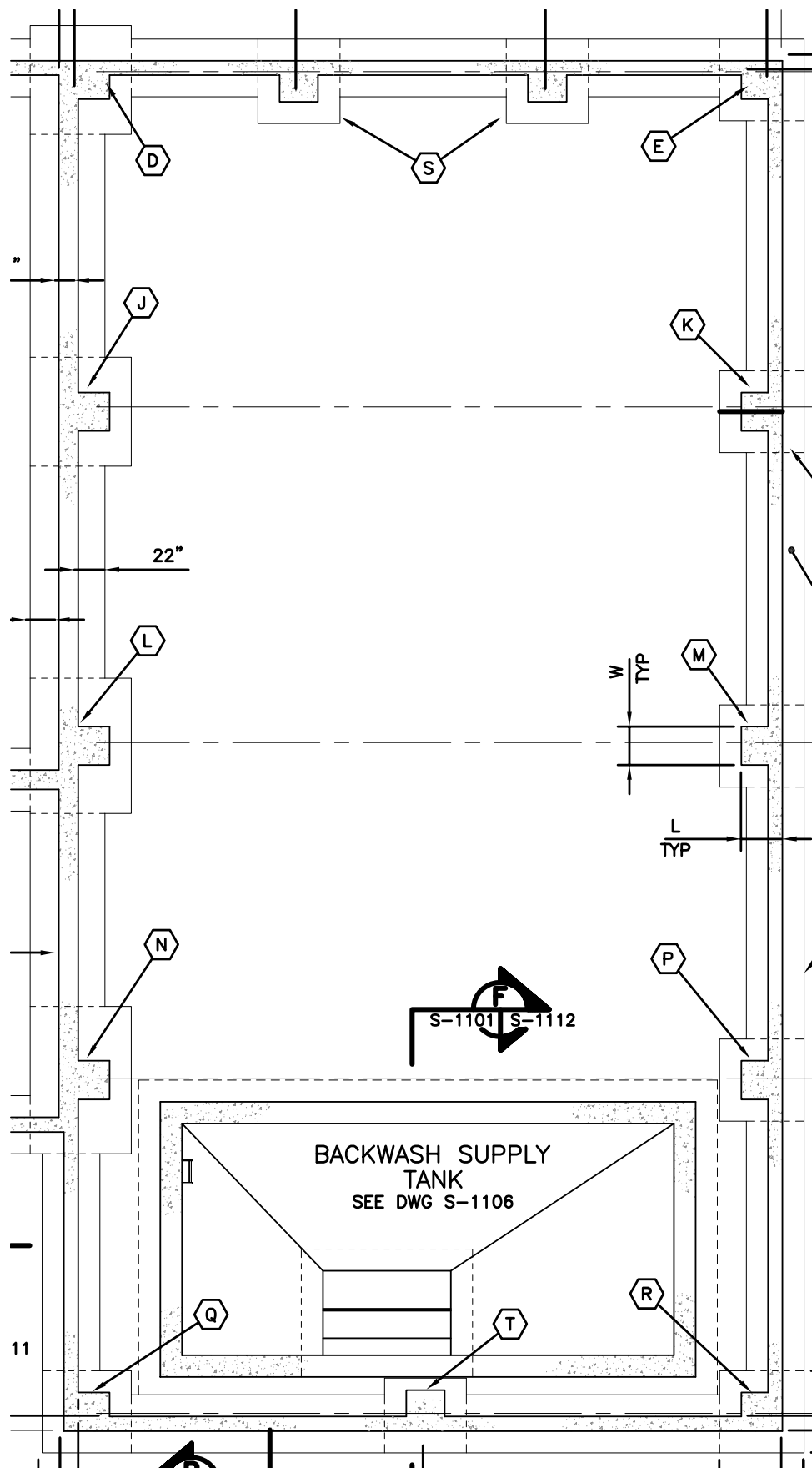
Reaction Summary

	Node	L/C	Horizontal FX (kip)	Vertical FY (kip)	Horizontal FZ (kip)	Moment MX (kip'in) MY (kip'in) MZ (kip'in)		
Max FX	1	19:1.2D+1W+L	7.509	22.924	7.792	0	0	0
Min FX	5	22:1.2D+1W+L	-12.004	35.215	2.672	0	0	0
Max FY	2	13:1.2D+1.6S+	0.028	62.281	14.852	0	0	0
Min FY	4	28:.9D+1W	-5.293	-7.259	2.844	0	0	0
Max FZ	2	19:1.2D+1W+L	0.038	45.994	15.609	0	0	0
Min FZ	8	17:1.2D+1.6S+	-0.000	61.911	-14.448	0	0	0
Max MX	1	10:1.4D	0.006	10.079	1.849	0	0	0
Min MX	1	10:1.4D	0.006	10.079	1.849	0	0	0
Max MY	1	10:1.4D	0.006	10.079	1.849	0	0	0
Min MY	1	10:1.4D	0.006	10.079	1.849	0	0	0
Max MZ	1	10:1.4D	0.006	10.079	1.849	0	0	0
Min MZ	1	10:1.4D	0.006	10.079	1.849	0	0	0

← Max fy force
← Max uplift force
← Max shear force



Whole Structure Node Number (Input data was modified after picture taken)













Process Room Footing - spMats

Max loading from the reactions

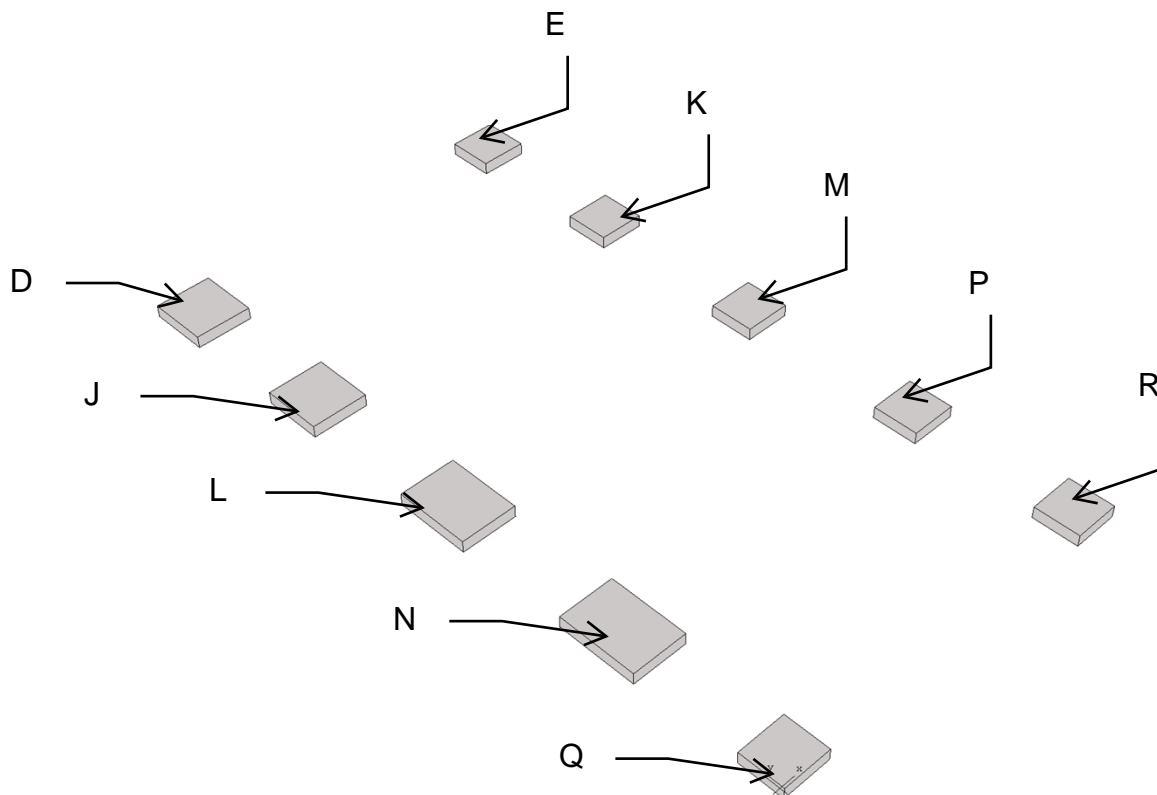
Footing letters	Load(kip)
D	-37.2
E	-32.1
J	-62.3
K	-61.0
L	-61.6
M	-61.9
N	-60.6
P	-61.0
Q	-31.4
R	-30.9

Allowable pressure 3ksf

Footing	Dimension
	7'-0"x7'-6"x2'-0"
	5'-10"x5'-8"x2'-0"
	7'-0"x7'-6"x2'-0"
	5'-10"x5'-8"x2'-0"
	7'-0"x9'-4"x2'-0"
	5'-10"x5'-8"x2'-0"
	7'-0"x10'-2"x2'-0"
	5'-10"x5'-8"x2'-0"
	6'-2"x5'-8"x2'-0"
	5'-10"x5'-8"x2'-0"



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A Computer Program for Analysis and Design of Foundation Mats, Combined Footings, and Slabs on Grade
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1. Project

1.1. General Information

File Name	SPMATS BUILDING 2 PROCESS ROOM.matx
Project	Untitled
Code	ACI 318-14
Units	English
Date	6/2/2023
Time	10:14 AM

1.2. Solver Options

Maximum number of iterations	10
Maximum allowed service displacement	11.00000 in
Minimum ratio of soil contact area w.r.t. initial soil-supported area	50 %
Minimum ratio of active springs and piles w.r.t. total number of springs and piles	0 %
Displacement limit of uplift	0.00000 in
Compute required reinforcement based on	Maximum moment within an element

2. Definitions

2.1. Grid Lines

2.1.1. Vertical

Label	Coordinate-X ft	Spacing ft
1	0.00	0.00
2	49.33	49.33

2.1.2. Horizontal

Label	Coordinate-Y ft	Spacing ft
A	0.00	0.00
B	23.08	23.08
C	46.16	23.08
D	69.24	23.08
E	92.32	23.08

2.2. Objects

2.2.1. Slabs

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Mat18	18.00	Clay	C3	Gr40	Gr40#4	No
Mat24	24.00	Clay	C3	Gr40	Gr40#4	No
Mat30	30.00	Clay	C3	Gr40	Gr40#4	No
Mat36	36.00	Clay	C3	Gr40	Gr40#4	No
Mat48	48.00	Clay	C3	Gr40	Gr40#4	No

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Slab1	12.00	Clay	C3	Gr40	Gr40#4	No
Slab2	1.00	Clay	C3	Gr40	Gr40#4	No
Slab3	2.00	Clay	C3	Gr40	Gr40#4	No
Slab4	3.00	Clay	C3	Gr40	Gr40#4	No
Slab5	4.00	Clay	C3	Gr40	Gr40#4	No
Slab6	5.00	Clay	C3	Gr40	Gr40#4	No
Slab7	12.00	Silt	C3	Gr40	Gr40#4	No
Slab8	12.00	Silt	C4	Gr40	Gr40#4	No
Slab9	12.00	Silt	C4	Gr60	Gr40#4	No
Slab10	12.00	Silt	C4	Gr60	Gr60#	No
Slab11	18.00	Silt	C4	Gr60	Gr60#	No
Slab12	18.00	Silt	C4	Gr60	Gr60#7	Yes

2.2.2. Columns

Label	Type	D in	B in	Assigned
C20X20	Rectangle	20.00	20.00	No
Col1	Rectangle	24.00	24.00	No

2.2.3. Pile - Properties

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
R36	Round	2738.71	Concrete	4286.8	Bedrock	No
S30X30	Square	2570.13	Precast	4286.8	Bedrock	No
1H8X36	H-Type 1	273.29	Steel	29000.0	Bedrock	No
2H8X36	H-Type 2	273.29	Steel	29000.0	Bedrock	No
Pile1	Square	1058.91	Precast	4286.8	Bedrock	No

2.2.4. Pile - Geometry

Label	Length ft	Embedment in	D in	B in	tf in	tw in
R36	50.00	6.00	36.00			
S30X30	50.00	6.00	30.00			
1H8X36	50.00	6.00	8.02	8.16	0.45	0.45
2H8X36	50.00	6.00	8.02	8.16	0.45	0.45
Pile1	2.50	6.00	12.00			

2.3. Properties

2.3.1. Soil

Label	K _s kcf	Q _a ksf	Used	Label	K _s kcf	Q _a ksf	Used
Clay	75.000	1.500	Yes	Sand	100.000	2.000	No
Bedrock	600.000	12.000	Yes	Silt	216.000	3.000	Yes

2.3.2. Concrete

Label	f' _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C3	3.0000	150.00	3320.6	0.200	-	Yes
C4	4.0000	150.00	3834.3	0.200	-	Yes
C5	5.0000	150.00	4286.8	0.200	-	No

Label	f _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C6	6.0000	150.00	4696.0	0.200	-	No
C7	7.0000	150.00	5072.2	0.200	-	No
C8	8.0000	150.00	5422.5	0.200	-	No

2.3.3. Reinforcement

Label	f _y ksi	E _s ksi	Used	Label	f _y ksi	E _s ksi	Used
Gr40	40.0000	29000.0	Yes	Gr50	50.0000	29000.0	No
Gr60	60.0000	29000.0	Yes	Gr75	75.0000	29000.0	No

2.3.4. Design Parameters

Label	Top layer X in	Top layer Y in	Bot. Layer X in	Bot. Layer Y in	Min. Reinf. Ratio %	Used
Gr40#4	3.25	3.75	3.25	3.75	0.10	Yes
Gr50#4	3.25	3.75	3.25	3.75	0.10	No
Gr60#7	2.43	3.31	3.43	4.30	0.09	Yes
Gr75#4	3.25	3.75	3.25	3.75	0.07	No
Gr60#	1.50	3.38	3.00	3.88	0.09	Yes

2.4. Restraints

2.4.1. Nodal Springs

Label	K _{ns} klf	Assigned	Label	K _{ns} klf	Assigned
Spr1	100.00	No			

2.4.2. Slaved Nodes

Label	DOF	Assigned	Label	DOF	Assigned
SlvRx	Rx	No	SlvRy	Ry	No
SlvDz	Dz	No			

2.5. Load Case/Combo.

2.5.1. Load Cases

NOTE: Self weight is included under Case A.

Case	Type	Case label	Load defined?
A	Dead	DL	Yes
B	Live	LL	No

2.5.2. Service Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
S1	1.000	0.000	-	-	-	-	-	-	-
S2	1.000	1.000	-	-	-	-	-	-	-

2.5.3. Ultimate Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead DL	B Live LL	C	D	E	F	G	H	I
U1	1.400	0.000	-	-	-	-	-	-	-
U2	1.200	1.600	-	-	-	-	-	-	-

3. Assignments

3.1. Nodes

ID	X Coord. ft	Y Coord. ft	Column	Pile	Spring	Dz	Rx	Ry
N1	3.33	89.03	-	-	-	-	-	-
N2	46.43	90.16	-	-	-	-	-	-
N3	3.17	69.24	-	-	-	-	-	-
N4	3.17	46.71	-	-	-	-	-	-
N5	3.34	23.08	-	-	-	-	-	-
N6	2.92	2.17	-	-	-	-	-	-
N7	46.42	69.74	-	-	-	-	-	-
N8	46.42	46.66	-	-	-	-	-	-
N9	46.42	23.08	-	-	-	-	-	-
N10	46.42	2.17	-	-	-	-	-	-

3.2. Slabs

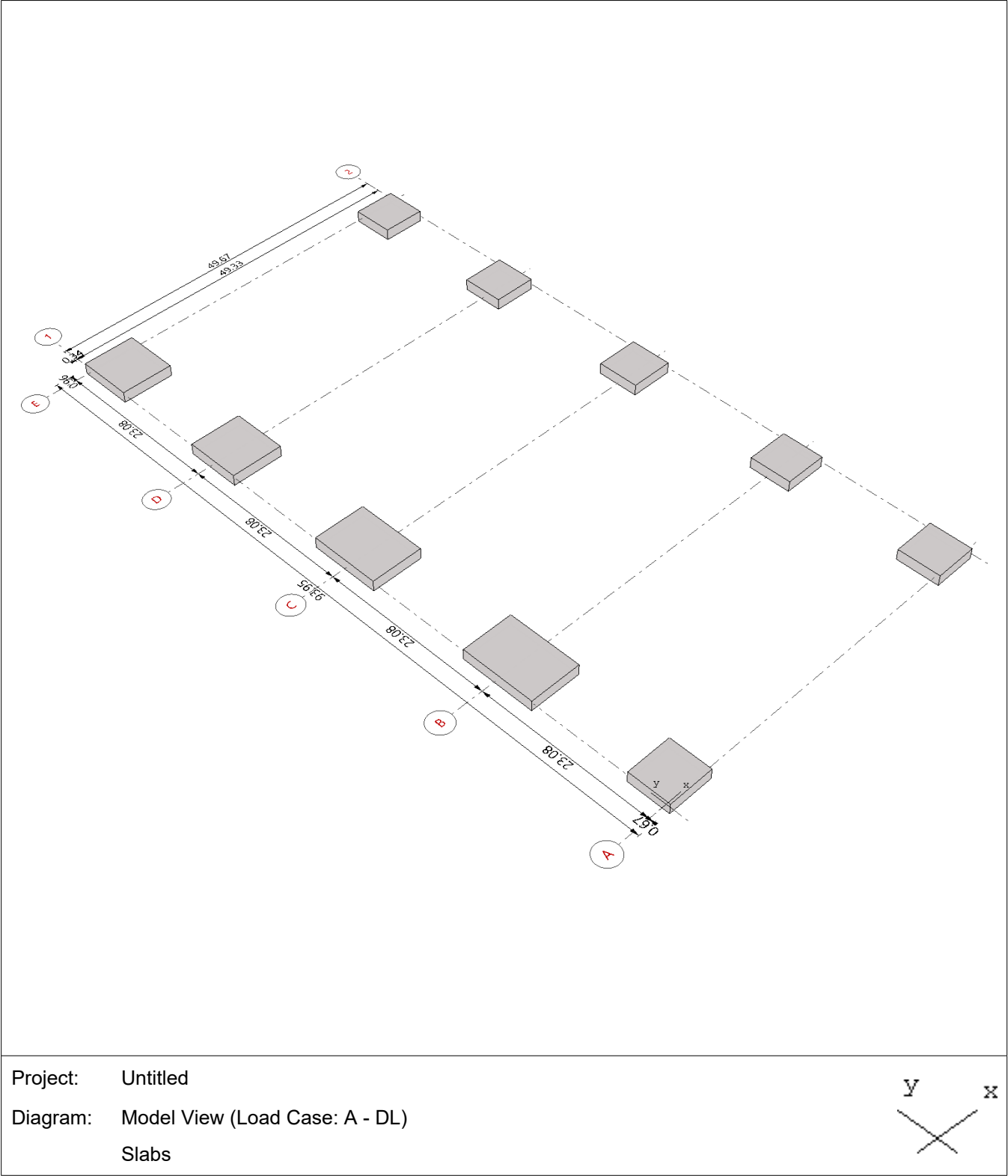
ID	Label	Shape	Top Left/Center X ft	Top Left/Center Y ft	Height (H)/Dia. (D) ft	Width (B) ft
S1	Slab12	Rectangular	-0.33	93.28	6.67	6.50
S2	Slab12	Rectangular	43.53	92.99	5.00	5.80
S3	Slab12	Rectangular	-0.33	72.99	6.50	6.67
S4	Slab12	Rectangular	43.50	72.57	4.67	5.83
S5	Slab12	Rectangular	43.50	49.50	4.67	5.83
S6	Slab12	Rectangular	43.50	25.92	4.67	5.83
S7	Slab12	Rectangular	43.50	5.00	5.00	5.83
S8	Slab12	Rectangular	-0.33	51.41	6.50	6.67
S9	Slab12	Rectangular	-0.33	28.08	6.50	6.67
S10	Slab12	Rectangular	-0.17	5.00	5.00	5.83

3.3. Point Loads

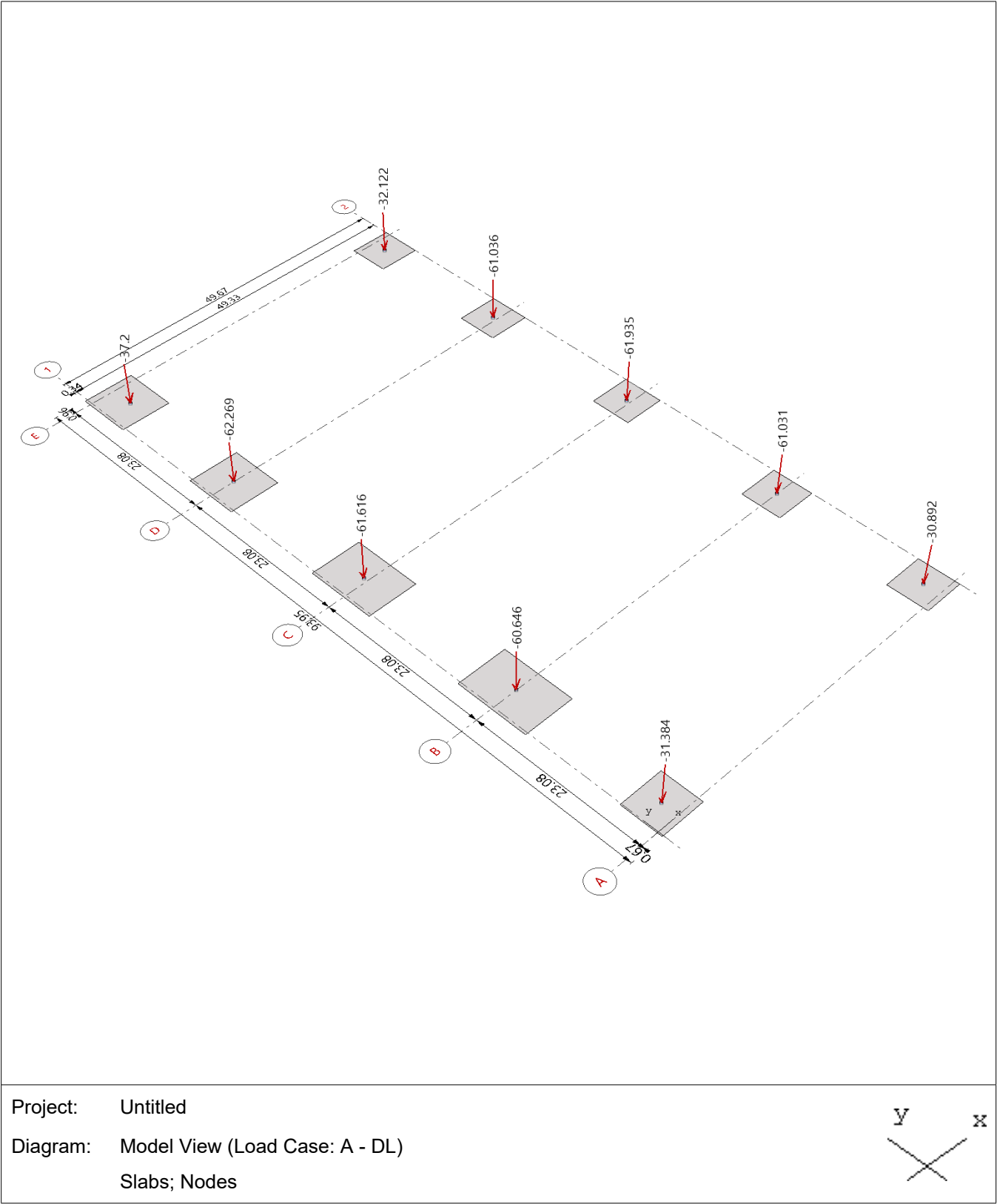
Nodes ID	Load Case	Pz kips	Mx kip-ft	My kip-ft
N1	A - DL	-37.200	-	-
N2	A - DL	-32.122	-	-
N3	A - DL	-62.269	-	-
N4	A - DL	-61.616	-	-
N5	A - DL	-60.646	-	-
N6	A - DL	-31.384	-	-
N7	A - DL	-61.036	-	-
N8	A - DL	-61.935	-	-
N9	A - DL	-61.031	-	-
N10	A - DL	-30.892	-	-

4. Screenshots

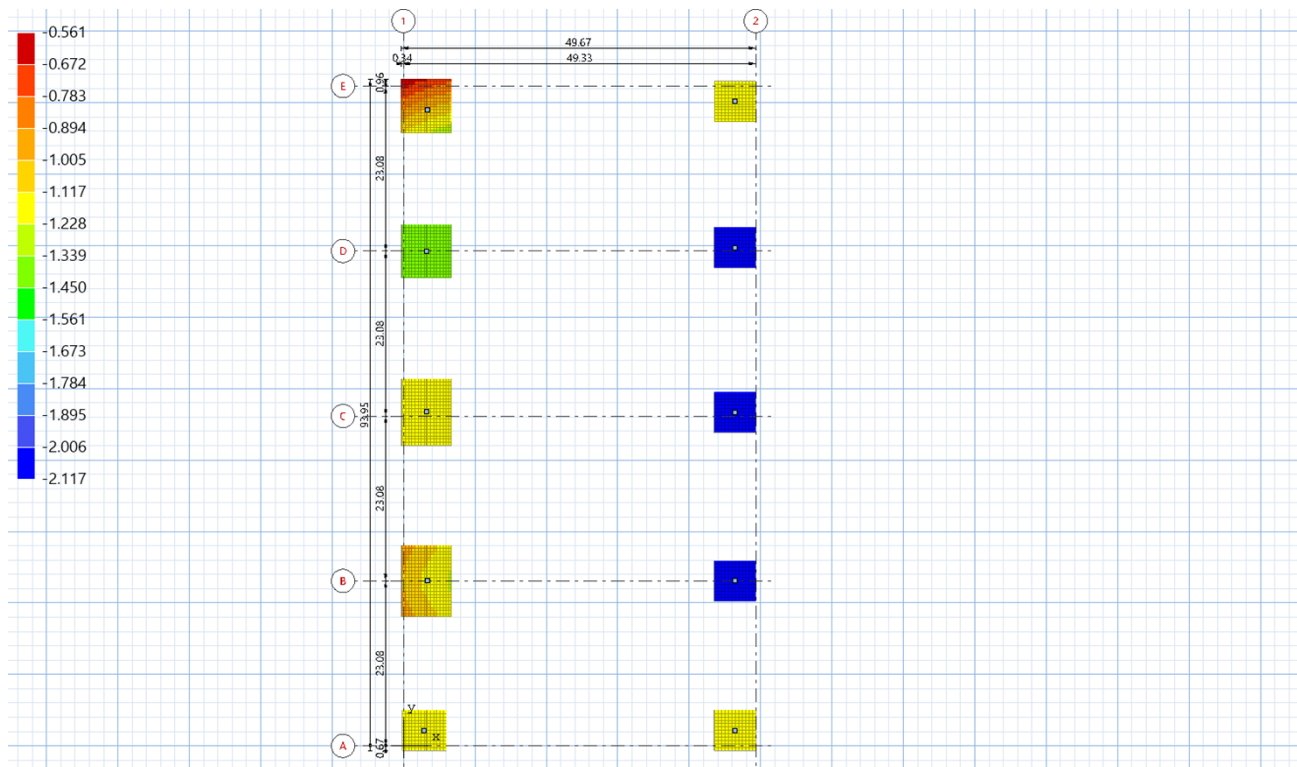
4.1. Extrude 3D view



4.2. Loads - Case A - DL



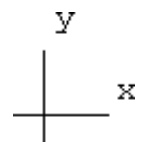
4.3. Envelope - Pressure Down (ksf)



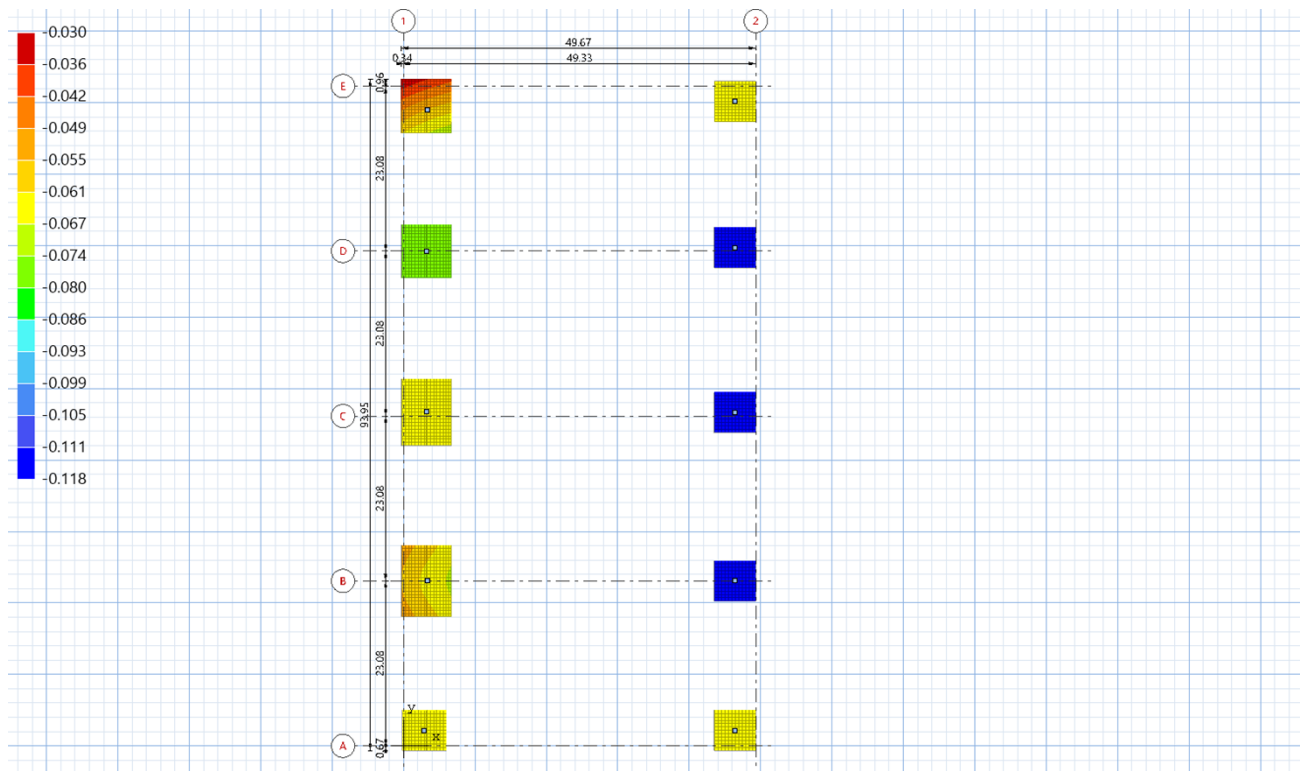
Project: Untitled

Diagram: Envelope - Pressure Down (ksf)

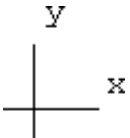
Max = -0.561 ksf; Min = -2.117 ksf



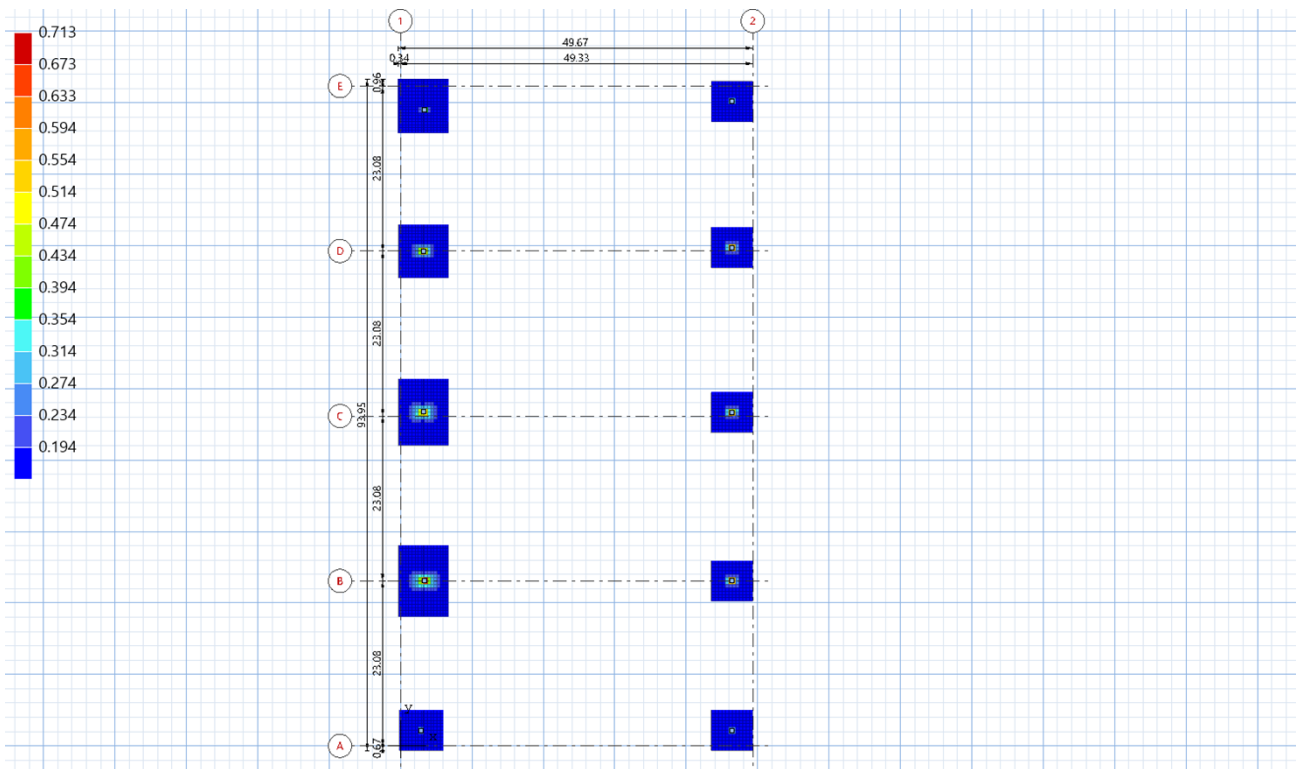
4.4. Envelope - Displacement Down (in)



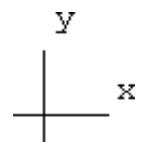
Project: Untitled
Diagram: Envelope - Displacement Down (in)
Max = -0.030 in; Min = -0.118 in



4.5. Envelope - Asy - Bottom (in²/ft)



Project: Untitled
 Diagram: Envelope - Asy - Bottom (in²/ft)
 Max = 0.713 in²/ft; Min = 0.194 in²/ft



Process Room Anchor Max Shear



Anchor Designer™
Software
Version 3.1.2209.3

Company:		Date:	9/8/2022
Engineer:		Page:	1/5
Project:			
Address:			
Phone:			
E-mail:			

1. Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description:
Location:
Fastening description:

2. Input Data & Anchor Parameters

General

Design method: ACI 318-19
Units: Imperial units

Anchor Information:

Anchor type: Bonded anchor
Material: A193 Grade B7
Diameter (inch): 0.750
Effective Embedment depth, h_{ef} (inch): 10.000
Code report: ICC-ES ESR-2508
Anchor category: -
Anchor ductility: Yes
 h_{min} (inch): 14.38
 c_{ac} (inch): 13.22
 c_{min} (inch): 1.75
 s_{min} (inch): 3.00

Base Material

Concrete: Normal-weight
Concrete thickness, h (inch): 36.00
State: Uncracked
Compressive strength, f'_c (psi): 4000
 $\Psi_{c,v}$: 1.4
Reinforcement condition: Supplementary reinforcement not present
Supplemental edge reinforcement: No
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Hole condition: Dry concrete
Inspection: Continuous
Temperature range, Short/Long: 150/110°F
Ignore 6do requirement: Not applicable
Build-up grout pad: Yes

Base Plate

Length x Width x Thickness (inch): 16.00 x 16.00 x 0.75
Yield stress: 36000 psi

Profile type/size: W12X50

Recommended Anchor

Anchor Name: SET-XP® - SET-XP w/ 3/4"Ø A193 Gr. B7
Code Report: ICC-ES ESR-2508





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Project:			
Address:			
Phone:			
E-mail:			

Load and Geometry

Load factor source: ACI 318 Section 5.3

Load combination: not set

Seismic design: No

Anchors subjected to sustained tension: No

Apply entire shear load at front row: No

Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: -45994

V_{uax} [lb]: 15609

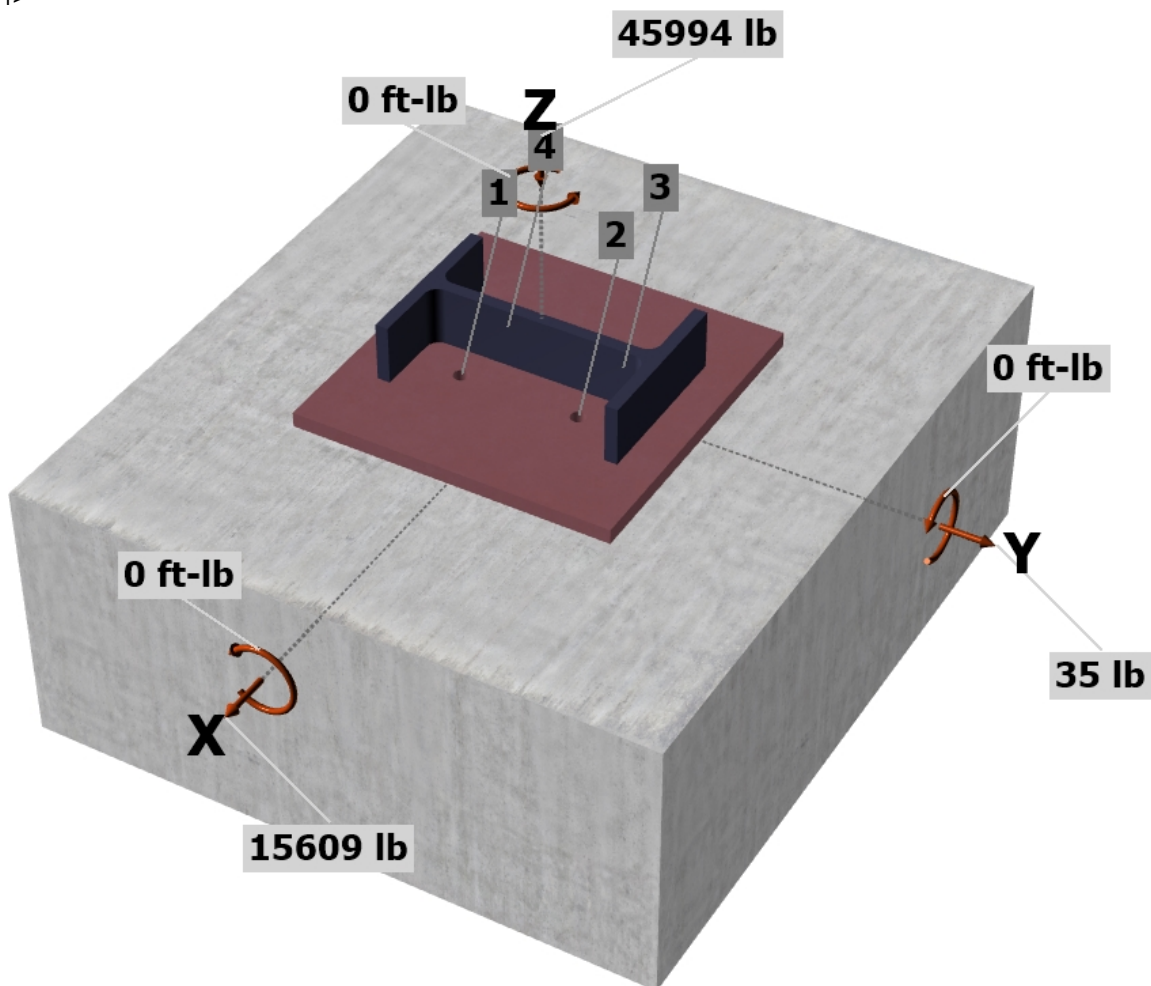
V_{uay} [lb]: 35

M_{ux} [ft-lb]: 0

M_{uy} [ft-lb]: 0

M_{uz} [ft-lb]: 0

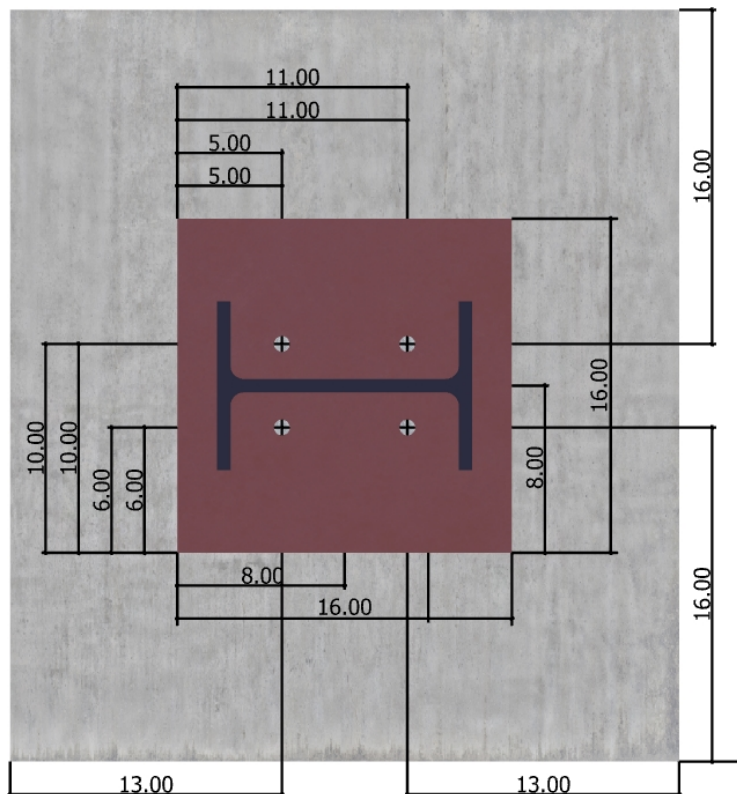
<Figure 1>



Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.

Simpson Strong-Tie Company Inc. 5956 W. Las Positas Boulevard Pleasanton, CA 94588 Phone: 925.560.9000 Fax: 925.847.3871 www.strongtie.com

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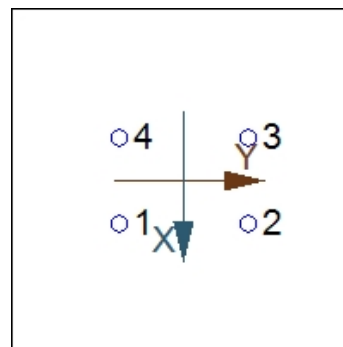


3. Resulting Anchor Forces

Anchor	Tension load, N _{ua} (lb)	Shear load x, V _{uax} (lb)	Shear load y, V _{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2 + (V_{uay})^2}$ (lb)
1	0.0	3902.3	8.8	3902.3
2	0.0	3902.3	8.8	3902.3
3	0.0	3902.3	8.8	3902.3
4	0.0	3902.3	8.8	3902.3
Sum	0.0	15609.0	35.0	15609.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 0
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



8. Steel Strength of Anchor in Shear (Sec. 17.7.1)

V _{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
25050	0.8	0.65	13026

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.7.2)

Shear perpendicular to edge in y-direction:

$V_{by} = \min[7(l_e / d_a)^{0.2} \sqrt{d_a \lambda_a} \sqrt{f'_c c_{a1}^{1.5}}; 9 \lambda_a \sqrt{f'_c c_{a1}^{1.5}}]$ (Eq. 17.7.2.2.1a & Eq. 17.7.2.2.1b)

l _e (in)	d _a (in)	λ_a	f' _c (psi)	c _{a1} (in)	V _{by} (lb)
6.00	0.750	1.00	4000	19.00	47141

$\phi V_{cbgy} = \phi (A_{Vc} / A_{Vco}) \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{by}$ (Sec. 17.5.1.2 & Eq. 17.7.2.1b)

A _{Vc} (in ²)	A _{Vco} (in ²)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V _{by} (lb)	ϕ	ϕV_{cbgy} (lb)
1026.00	1624.50	1.000	0.868	1.400	1.000	47141	0.70	25339

Shear perpendicular to edge in x-direction:

$V_{bx} = \min[7(l_e / d_a)^{0.2} \sqrt{d_a \lambda_a} \sqrt{f'_c c_{a1}^{1.5}}; 9 \lambda_a \sqrt{f'_c c_{a1}^{1.5}}]$ (Eq. 17.7.2.2.1a & Eq. 17.7.2.2.1b)

l _e (in)	d _a (in)	λ_a	f' _c (psi)	c _{a1} (in)	V _{bx} (lb)
6.00	0.750	1.00	4000	20.00	50912

$\phi V_{cbgx} = \phi (A_{Vc} / A_{Vco}) \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{bx}$ (Sec. 17.5.1.2 & Eq. 17.7.2.1b)

A _{Vc} (in ²)	A _{Vco} (in ²)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V _{bx} (lb)	ϕ	ϕV_{cbgx} (lb)
960.00	1800.00	1.000	0.830	1.400	1.000	50912	0.70	22086

Shear parallel to edge in x-direction:

$V_{by} = \min[7(l_e / d_a)^{0.2} \sqrt{d_a \lambda_a} \sqrt{f'_c c_{a1}^{1.5}}; 9 \lambda_a \sqrt{f'_c c_{a1}^{1.5}}]$ (Eq. 17.7.2.2.1a & Eq. 17.7.2.2.1b)

Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.

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Phone:			
E-mail:			

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)			
6.00	0.750	1.00	4000	16.00	36429			
$\phi V_{cbgx} = \phi (2)(A_{Vc} / A_{Vco}) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_{by}$ (Sec. 17.5.1.2, 17.7.2.1(c) & Eq. 17.7.2.1b)								
A_{Vc} (in ²)	A_{Vco} (in ²)	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{c,V}$	$\psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cbgx} (lb)
768.00	1152.00	1.000	1.000	1.400	1.000	36429	0.70	47601

Shear parallel to edge in y-direction:

$$V_{bx} = \min[7(l_e / d_a)^{0.2} \sqrt{d_a \lambda_a} \sqrt{f'_c c_{a1}^{1.5}}; 9 \lambda_a \sqrt{f'_c c_{a1}^{1.5}}] \text{ (Eq. 17.7.2.2.1a \& Eq. 17.7.2.2.1b)}$$

l_e (in)	d_a (in)	λ_a	f_c (psi)	c_{a1} (in)	V_{bx} (lb)			
6.00	0.750	1.00	4000	13.00	26680			
$\phi V_{cbgy} = \phi (2)(A_{Vc} / A_{Vco}) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_{bx}$ (Sec. 17.5.1.2, 17.7.2.1(c) & Eq. 17.7.2.1b)								
A_{Vc} (in ²)	A_{Vco} (in ²)	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{c,V}$	$\psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cbgy} (lb)
702.00	760.50	1.000	1.000	1.400	1.000	26680	0.70	48270

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.7.3)

$$\phi V_{cp} = \phi \min[k_{cp} N_{ag}; k_{cp} N_{cbg}] = \phi \min[k_{cp} (A_{Na} / A_{Na0}) \psi_{ec,Na} \psi_{ed,Na} \psi_{cp,Na} N_{ba}; k_{cp} (A_{Nc} / A_{Nco}) \psi_{ec,N} \psi_{ed,N} \psi_{cp,N} N_b] \text{ (Sec. 17.5.1.2 \& Eq. 17.7.3.1b)}$$

k_{cp}	A_{Na} (in ²)	A_{Na0} (in ²)	$\psi_{ed,Na}$	$\psi_{ec,Na}$	$\psi_{cp,Na}$	N_{ba} (lb)	N_a (lb)
2.0	363.27	198.41	1.000	1.000	0.983	22855	41151

A_{Nc} (in ²)	A_{Nco} (in ²)	$\psi_{ec,N}$	$\psi_{ed,N}$	$\psi_{c,N}$	$\psi_{cp,N}$	N_b (lb)	N_{cb} (lb)	ϕ
1088.00	900.00	1.000	0.960	1.000	1.000	48000	55706	0.70

$$\phi V_{cp} \text{ (lb)}$$

57611

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.8)

Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status
Steel	3902	13026	0.30	Pass
T Concrete breakout y+	35	25339	0.00	Pass
T Concrete breakout x+	15609	22086	0.71	Pass
Concrete breakout x-	18	47601	0.00	Pass
Concrete breakout y+	7805	48270	0.16	Pass
Concrete breakout, combined	-	-	0.71	Pass (Governs)
Pryout	15609	57611	0.27	Pass

SET-XP w/ 3/4"Ø A193 Gr. B7 with hef = 10.000 inch meets the selected design criteria.

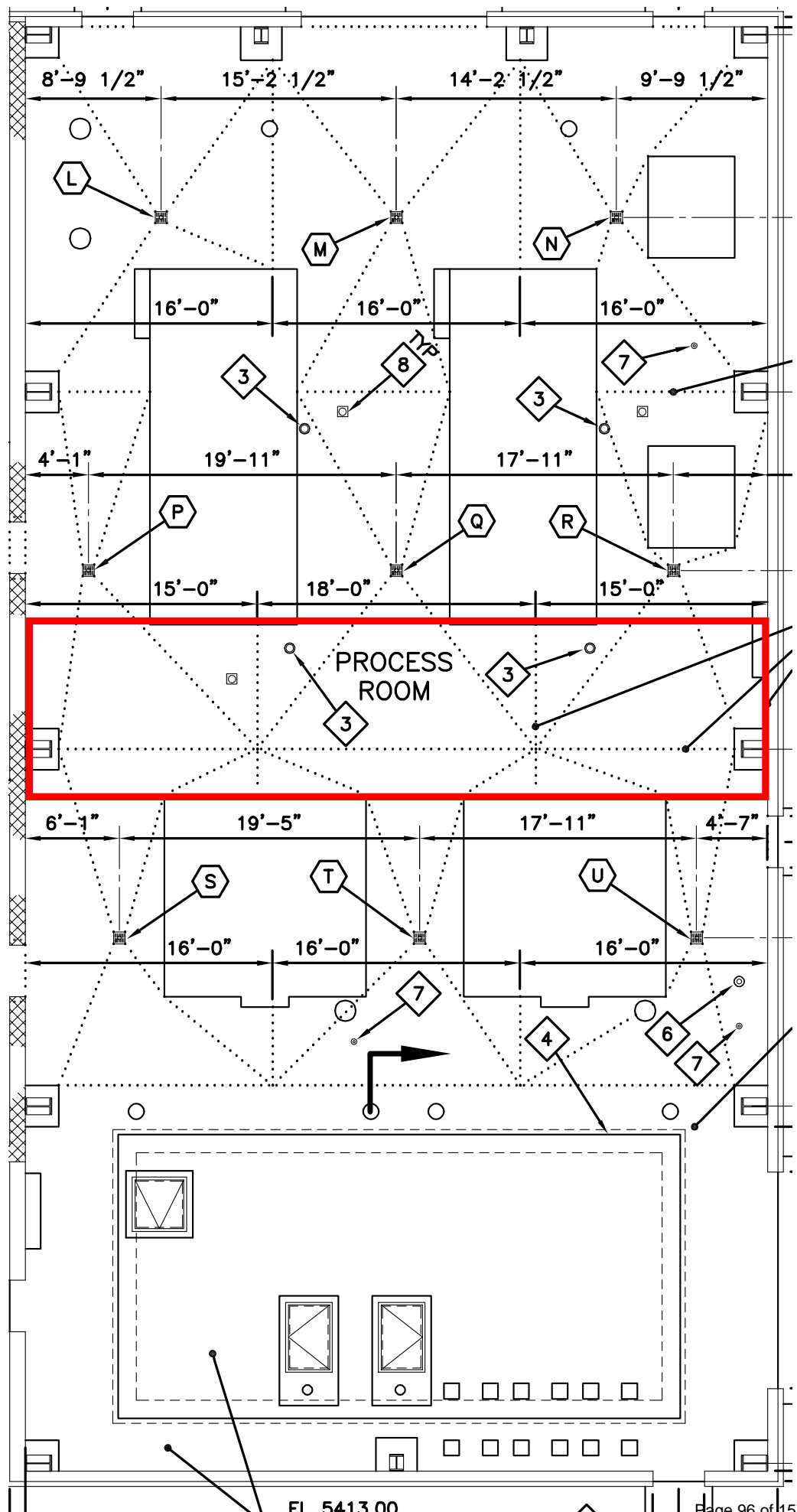
12. Warnings

- When cracked concrete is selected, concrete compressive strength used in concrete breakout strength in tension, adhesive strength in tension and concrete pryout strength in shear for SET-XP adhesive anchor is limited to 2,500 psi per ICC-ES ESR-2508 Section 5.3.
- Designer must exercise own judgement to determine if this design is suitable.
- Refer to manufacturer's product literature for hole cleaning and installation instructions.

Process Room slab

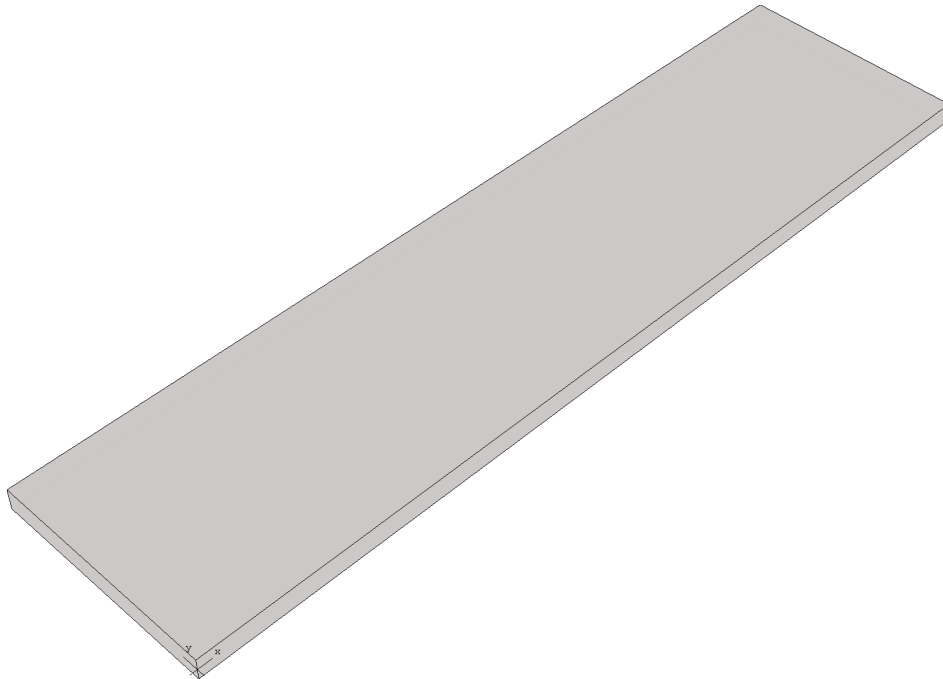
Load: 250psf

Allowable pressure: 3ksf





spMats v10.00 (TM)
A Computer Program for Analysis and Design of Foundation Mats, Combined Footings, and Slabs on Grade
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1. Project

1.1. General Information

File Name	spMats process room slab.matx
Project	Process room slab
Code	ACI 318-14
Units	English
Date	10/27/2023
Time	5:02 PM

1.2. Solver Options

Maximum number of iterations	10
Maximum allowed service displacement	11.00000 in
Minimum ratio of soil contact area w.r.t. initial soil-supported area	50 %
Minimum ratio of active springs and piles w.r.t. total number of springs and piles	0 %
Displacement limit of uplift	0.00000 in
Compute required reinforcement based on	Maximum moment within an element

2. Definitions

2.1. Objects

2.1.1. Slabs

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Mat18	18.00	Clay	C3	Gr40	Gr40#4	No
Mat24	24.00	Clay	C3	Gr40	Gr40#4	No
Mat30	30.00	Clay	C3	Gr40	Gr40#4	No
Mat36	36.00	Clay	C3	Gr40	Gr40#4	No
Mat48	48.00	Clay	C3	Gr40	Gr40#4	No
Slab1	18.00	Clay	C4	Gr40	Gr40#4	No
Slab2	18.00	Clay	C4	Gr60	Gr40#4	No
Slab3	18.00	Clay	C4	Gr60	Gr60#5	No
Slab4	14.00	Clay	C4	Gr60	Gr60#5	No
Slab5	14.00	Clay	C3	Gr40	Gr40#4	No
Slab6	14.00	Silt	C3	Gr40	Gr40#4	No
Slab7	14.00	Silt	C4	Gr40	Gr40#4	No
Slab8	14.00	Silt	C4	Gr60	Gr40#4	No
Slab9	14.00	Silt	C4	Gr60	Gr60#5	Yes

2.1.2. Columns

Label	Type	D in	B in	Assigned
C20X20	Rectangle	20.00	20.00	No

2.1.3. Pile - Properties

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
R36	Round	2738.71	Concrete	4286.8	Bedrock	No
S30X30	Square	2570.13	Precast	4286.8	Bedrock	No
1H8X36	H-Type 1	273.29	Steel	29000.0	Bedrock	No
2H8X36	H-Type 2	273.29	Steel	29000.0	Bedrock	No

2.1.4. Pile - Geometry

Label	Length ft	Embedment in	D in	B in	tf in	tw in
R36	50.00	6.00	36.00			
S30X30	50.00	6.00	30.00			
1H8X36	50.00	6.00	8.02	8.16	0.45	0.45
2H8X36	50.00	6.00	8.02	8.16	0.45	0.45

2.2. Properties**2.2.1. Soil**

Label	K _s kcf	Q _a ksf	Used	Label	K _s kcf	Q _a ksf	Used
Clay	75.000	1.500	Yes	Sand	100.000	2.000	No
Bedrock	600.000	12.000	Yes	Silt	216.000	3.000	Yes

2.2.2. Concrete

Label	f' _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C3	3.0000	150.00	3320.6	0.200	-	Yes
C4	4.0000	150.00	3834.3	0.200	-	Yes
C5	5.0000	150.00	4286.8	0.200	-	No
C6	6.0000	150.00	4696.0	0.200	-	No
C7	7.0000	150.00	5072.2	0.200	-	No
C8	8.0000	150.00	5422.5	0.200	-	No

2.2.3. Reinforcement

Label	f _y ksi	E _s ksi	Used	Label	f _y ksi	E _s ksi	Used
Gr40	40.0000	29000.0	Yes	Gr50	50.0000	29000.0	No
Gr60	60.0000	29000.0	Yes	Gr75	75.0000	29000.0	No

2.2.4. Design Parameters

Label	Top layer X in	Top layer Y in	Bot. Layer X in	Bot. Layer Y in	Min. Reinf. Ratio %	Used
Gr40#4	3.25	3.75	3.25	3.75	0.10	Yes
Gr50#4	3.25	3.75	3.25	3.75	0.10	No
Gr60#5	2.30	2.90	3.30	3.90	0.09	Yes
Gr75#4	3.25	3.75	3.25	3.75	0.07	No

2.3. Restraints

2.3.1. Nodal Springs

Label	K _{ns} klf	Assigned	Label	K _{ns} klf	Assigned
Spr1	100.00	No			

2.3.2. Slaved Nodes

Label	DOF	Assigned	Label	DOF	Assigned
SlvRx	Rx	No	SlvRy	Ry	No
SlvDz	Dz	No			

2.4. Load Case/Combo.

2.4.1. Load Cases

NOTE: Self weight is included under Case A.

Case	Type	Case label	Load defined?
A	Dead	DL	Yes
B	Live	LL	No

2.4.2. Service Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
S1	1.000	0.000	-	-	-	-	-	-	-
S2	1.000	1.000	-	-	-	-	-	-	-

2.4.3. Ultimate Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
U1	1.400	0.000	-	-	-	-	-	-	-
U2	1.200	1.600	-	-	-	-	-	-	-

3. Assignments

3.1. Slabs

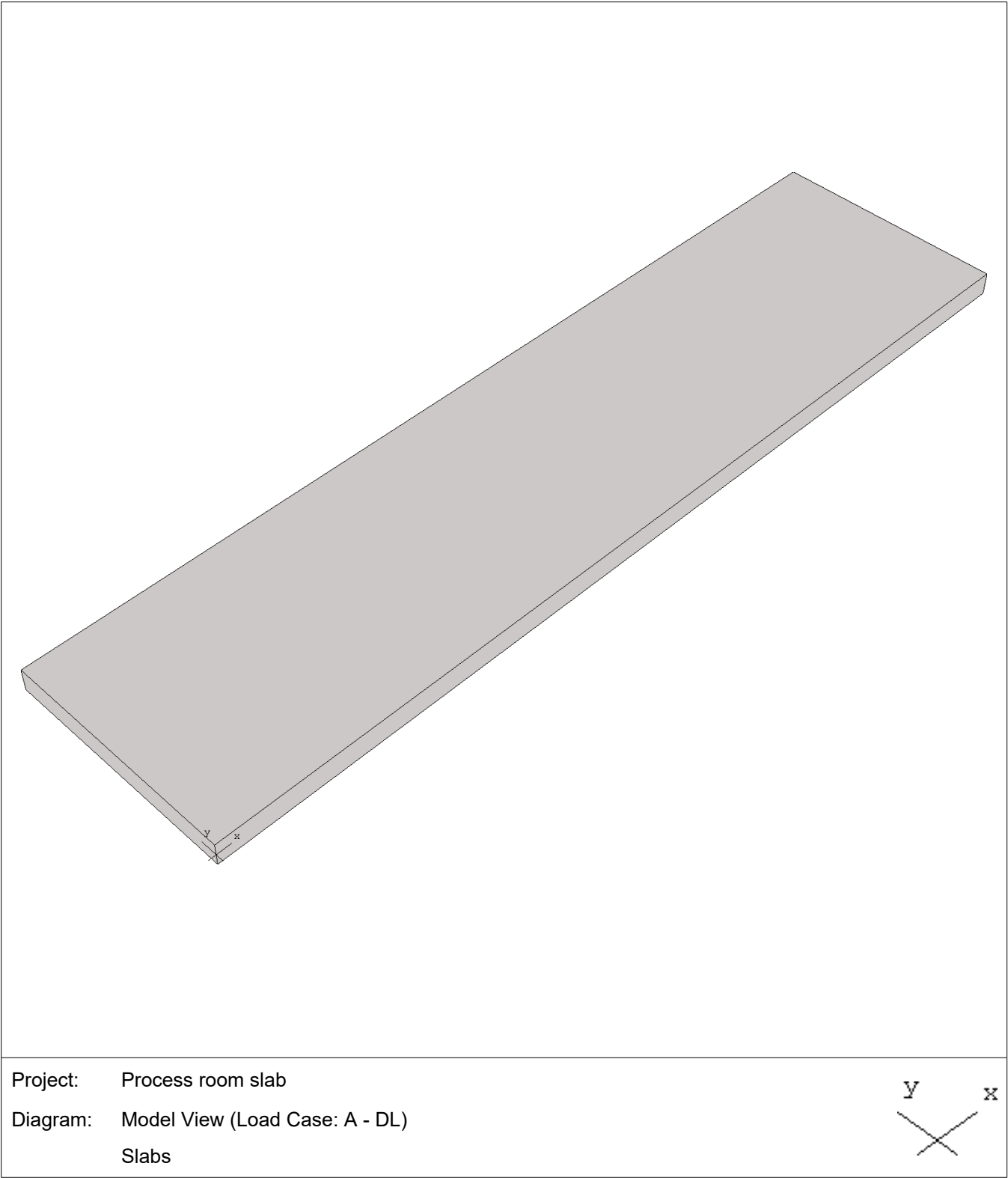
ID	Label	Shape	Top Left/Center X ft	Top Left/Center Y ft	Height (H)/Dia. (D) ft	Width (B) ft
S1	Slab9	Rectangular	0.00	11.90	11.90	41.00

3.2. Area Loads

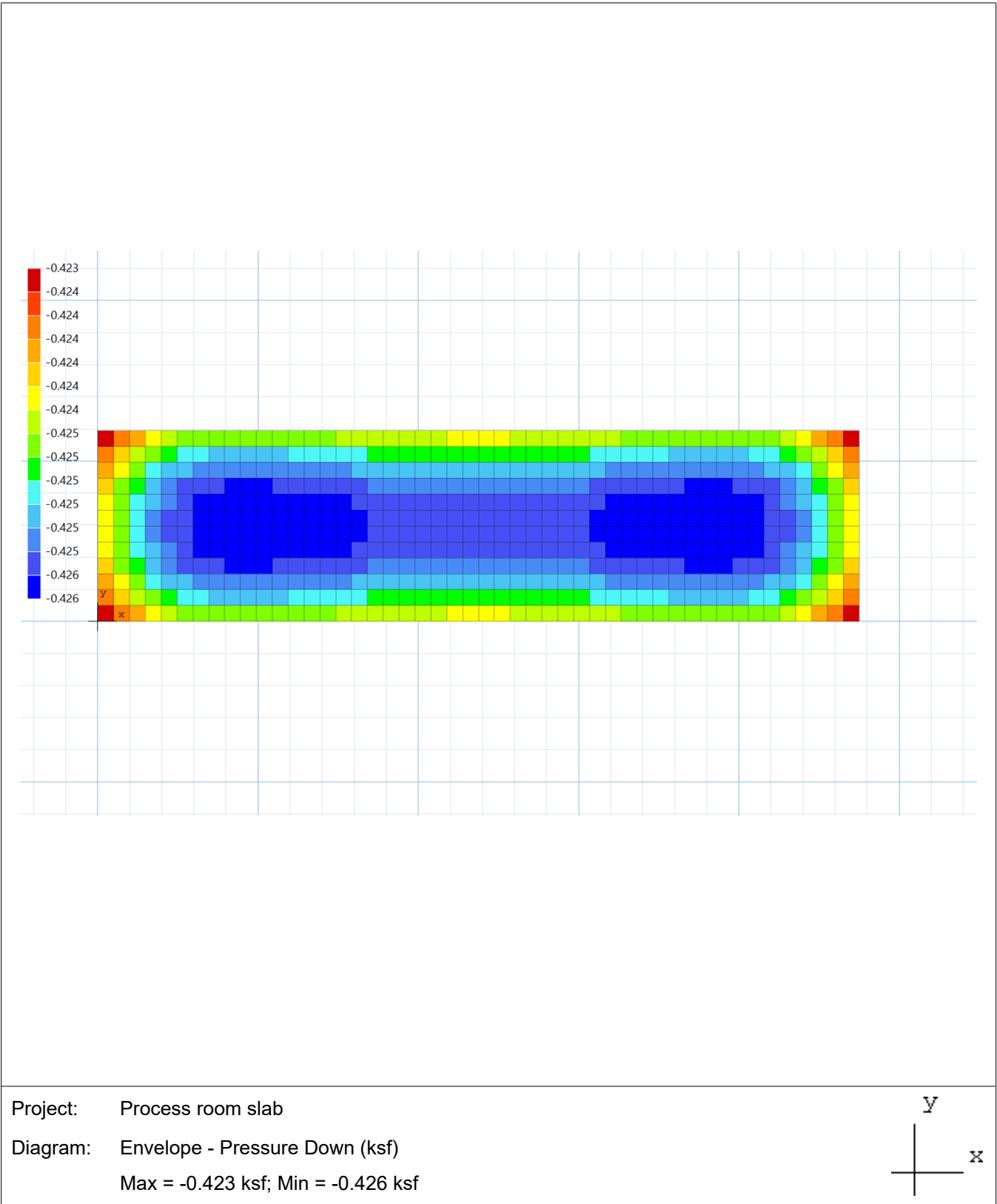
Slabs ID	Load Case	Wz psf
S1	A - DL	-250.0000

4. Screenshots

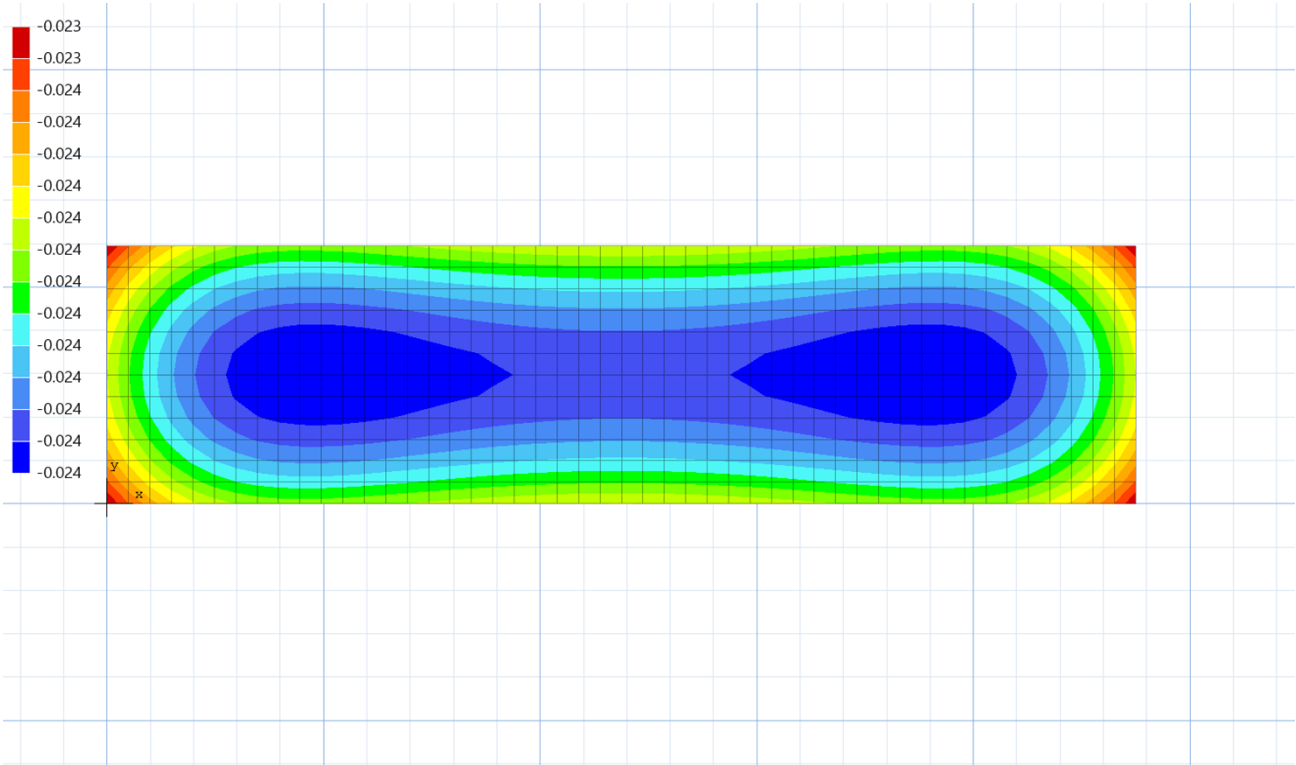
4.1. Extrude 3D view



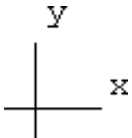
4.2. Envelope - Pressure Down (ksf)



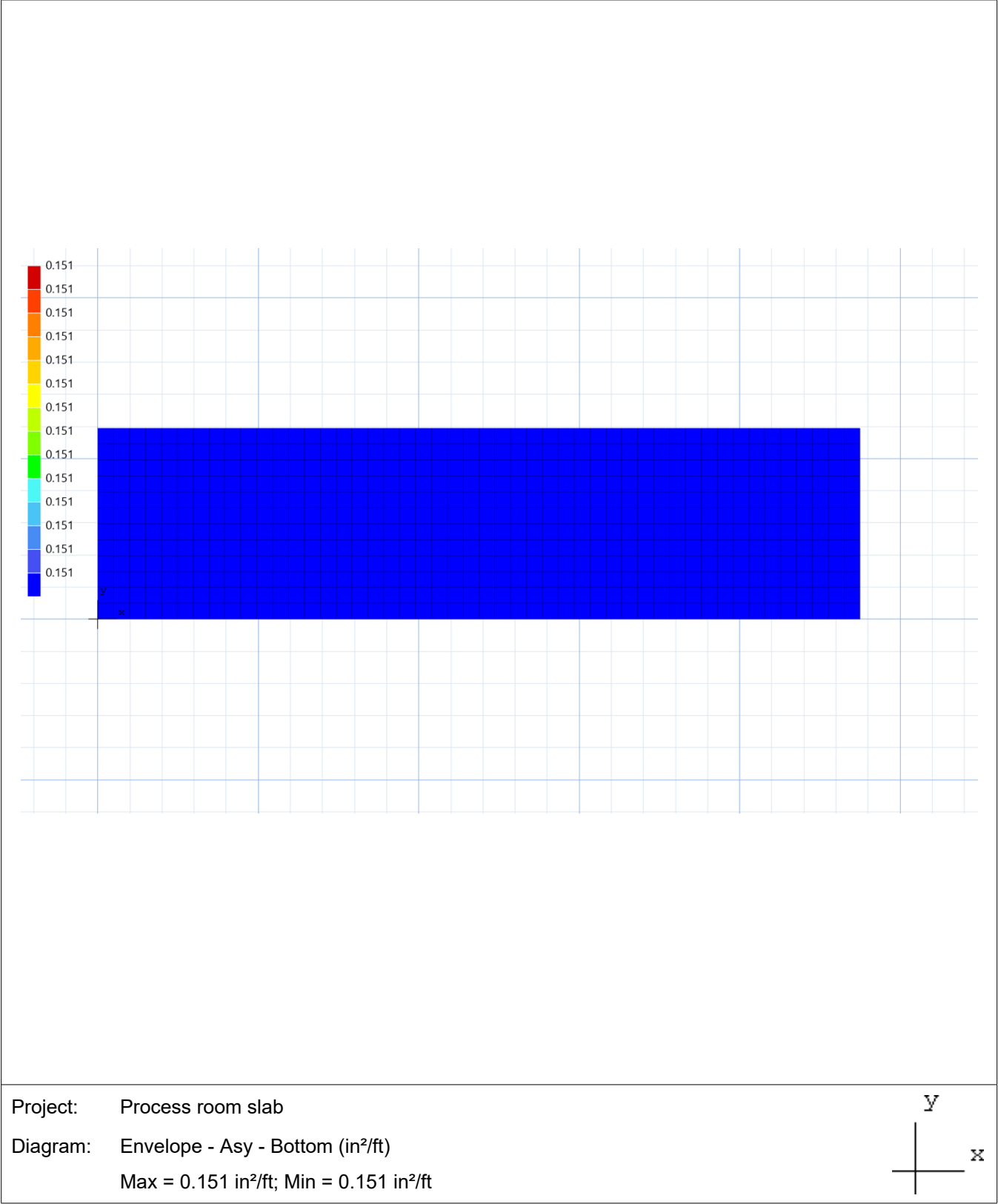
4.3. Envelope - Displacement Down (in)



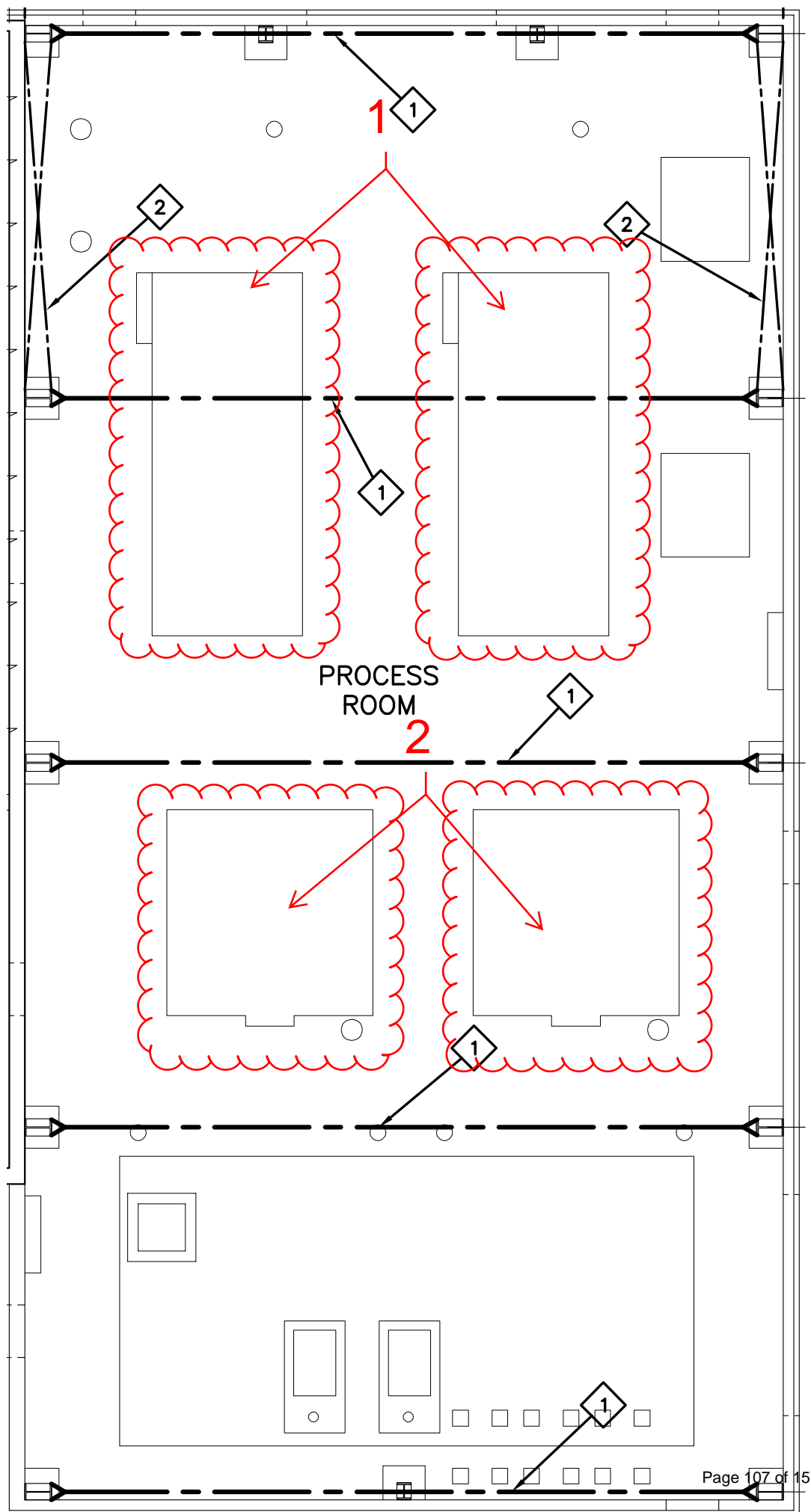
Project: Process room slab
Diagram: Envelope - Displacement Down (in)
Max = -0.023 in; Min = -0.024 in



4.4. Envelope - Asy - Bottom (in²/ft)



Process Room Concrete Pads



Process Building Equipment	Dry weight (lbs) (each)	With water/chemical (lbs) (each)	No. of units	Total dry weight (lbs)	Total wet weight (lbs)
Ballasted Flocculation	11,023	100,310	2	22,046	200,620
Filters	7,000	125,000	2	14,000	250,000

13' x13' Pad Loading

Self weight

Unit Weight of Concrete =

150 pcf

Pad Thickness =

24 in

Selfweight =

300 psf

Equipment Load

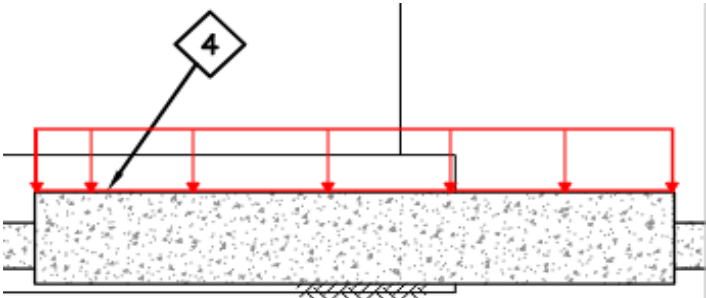
Equip. Load = 125000 lbs

Equip. Width = 12 ft

Equip. Length = 12 ft

Equip. Area Load =

868 psf



23' x 9 1/2' Pad Loading

Self weight

Unit Weight of Concrete =

150 pcf

Pad Thickness =

36 in

Selfweight =

450 psf

Equipment Load

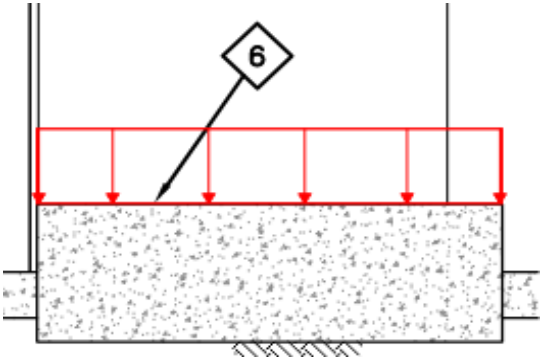
Equip. Load = 100310 lbs

Equip. Width = 22 ft

Equip. Length = 8.5 ft

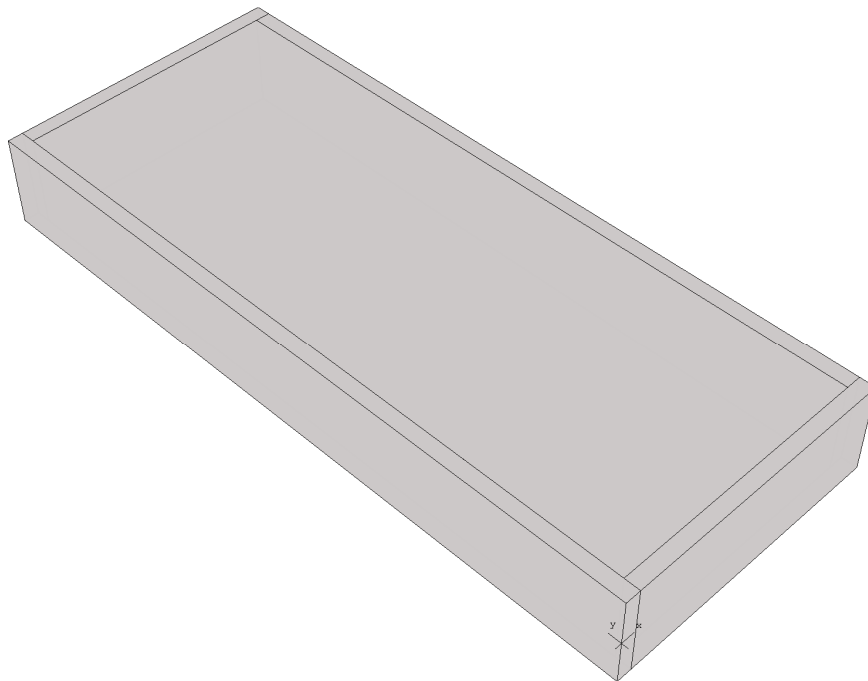
Equip. Area Load =

536 psf





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Concrete Pad 1

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1. Project

1.1. General Information

File Name	23' Mat.matx
Project	Untitled
Code	ACI 318-14
Units	English
Date	6/5/2023
Time	12:33 PM

1.2. Solver Options

Maximum number of iterations	10
Maximum allowed service displacement	11.00000 in
Minimum ratio of soil contact area w.r.t. initial soil-supported area	50 %
Minimum ratio of active springs and piles w.r.t. total number of springs and piles	0 %
Displacement limit of uplift	0.00000 in
Compute required reinforcement based on	Maximum moment within an element

2. Definitions

2.1. Objects

2.1.1. Slabs

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Mat18	18.00	Clay	C3	Gr40	Gr40#4	No
Mat24	24.00	Clay	C3	Gr40	Gr40#4	No
Mat30	30.00	Clay	C3	Gr40	Gr40#4	No
Mat36	36.00	Clay	C3	Gr40	Gr40#4	No
Mat48	48.00	Clay	C3	Gr40	Gr40#4	No
23x9Mat 36	36.00	Silt Soil	C4	Gr60	Gr60#7	Yes

2.1.2. Columns

Label	Type	D in	B in	Assigned
C20X20	Rectangle	20.00	20.00	No

2.1.3. Pile - Properties

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
R36	Round	2738.71	Concrete	4286.8	Bedrock	No
S30X30	Square	2570.13	Precast	4286.8	Bedrock	No
1H8X36	H-Type 1	273.29	Steel	29000.0	Bedrock	No
2H8X36	H-Type 2	273.29	Steel	29000.0	Bedrock	No

2.1.4. Pile - Geometry

Label	Length ft	Embedment in	D in	B in	tf in	tw in
R36	50.00	6.00	36.00			
S30X30	50.00	6.00	30.00			
1H8X36	50.00	6.00	8.02	8.16	0.45	0.45
2H8X36	50.00	6.00	8.02	8.16	0.45	0.45

2.2. Properties

2.2.1. Soil

Label	K _s kcf	Q _a ksf	Used	Label	K _s kcf	Q _a ksf	Used
Clay	75.000	1.500	Yes	Sand	100.000	2.000	No
Bedrock	600.000	12.000	Yes	Silt Soil	100.000	3.000	Yes

2.2.2. Concrete

Label	f' _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C3	3.0000	150.00	3320.6	0.200	-	Yes
C4	4.0000	150.00	3834.3	0.200	-	Yes
C5	5.0000	150.00	4286.8	0.200	-	No
C6	6.0000	150.00	4696.0	0.200	-	No
C7	7.0000	150.00	5072.2	0.200	-	No
C8	8.0000	150.00	5422.5	0.200	-	No

2.2.3. Reinforcement

Label	f _y ksi	E _s ksi	Used	Label	f _y ksi	E _s ksi	Used
Gr40	40.0000	29000.0	Yes	Gr50	50.0000	29000.0	No
Gr60	60.0000	29000.0	Yes	Gr75	75.0000	29000.0	No

2.2.4. Design Parameters

Label	Top layer X in	Top layer Y in	Bot. Layer X in	Bot. Layer Y in	Min. Reinf. Ratio %	Used
Gr40#4	3.25	3.75	3.25	3.75	0.10	Yes
Gr50#4	3.25	3.75	3.25	3.75	0.10	No
Gr60#4	3.25	3.75	3.25	3.75	0.09	No
Gr75#4	3.25	3.75	3.25	3.75	0.07	No
Gr60#7	3.00	3.88	2.00	2.88	0.09	Yes

2.3. Restraints

2.3.1. Nodal Springs

Label	K _{ns} klf	Assigned	Label	K _{ns} klf	Assigned
Spr1	100.00	No			

2.3.2. Slaved Nodes

Label	DOF	Assigned	Label	DOF	Assigned
SlvRx	Rx	No	SlvRy	Ry	No
SlvDz	Dz	No			

2.4. Load Case/Combo.

2.4.1. Load Cases

NOTE: Self weight is included under Case A.

Case	Type	Case label	Load defined?
A	Dead	DL	Yes
B	Live	LL	No

2.4.2. Service Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type Combo./Label	A Dead DL	B Live LL	C	D	E	F	G	H	I
S1	1.000	0.000	-	-	-	-	-	-	-
S2	1.000	1.000	-	-	-	-	-	-	-

2.4.3. Ultimate Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type Combo./Label	A Dead DL	B Live LL	C	D	E	F	G	H	I
U1	1.400	0.000	-	-	-	-	-	-	-
U2	1.200	1.600	-	-	-	-	-	-	-

3. Assignments

3.1. Slabs

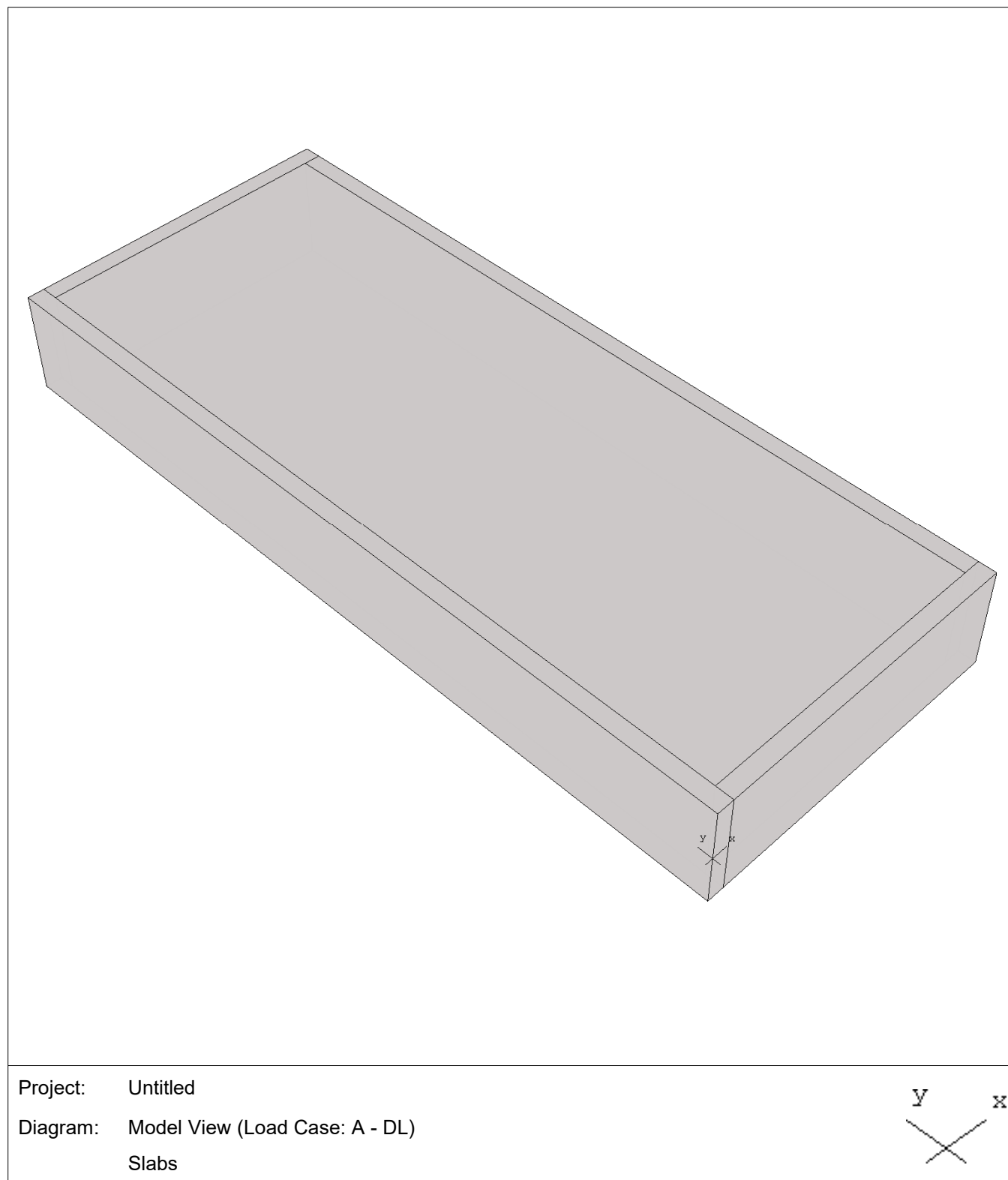
ID	Label	Shape	Top Left/Center X ft	Top Left/Center Y ft	Height (H)/Dia. (D) ft	Width (B) ft
S1	23x9Mat 36	Rectangular	0.00	23.50	23.50	0.50
S2	23x9Mat 36	Rectangular	0.50	0.50	0.50	9.00
S3	23x9Mat 36	Rectangular	0.50	23.50	0.50	9.00
S4	23x9Mat 36	Rectangular	9.00	23.00	22.50	0.50
S5	23x9Mat 36	Rectangular	0.50	23.00	22.50	8.50

3.2. Area Loads

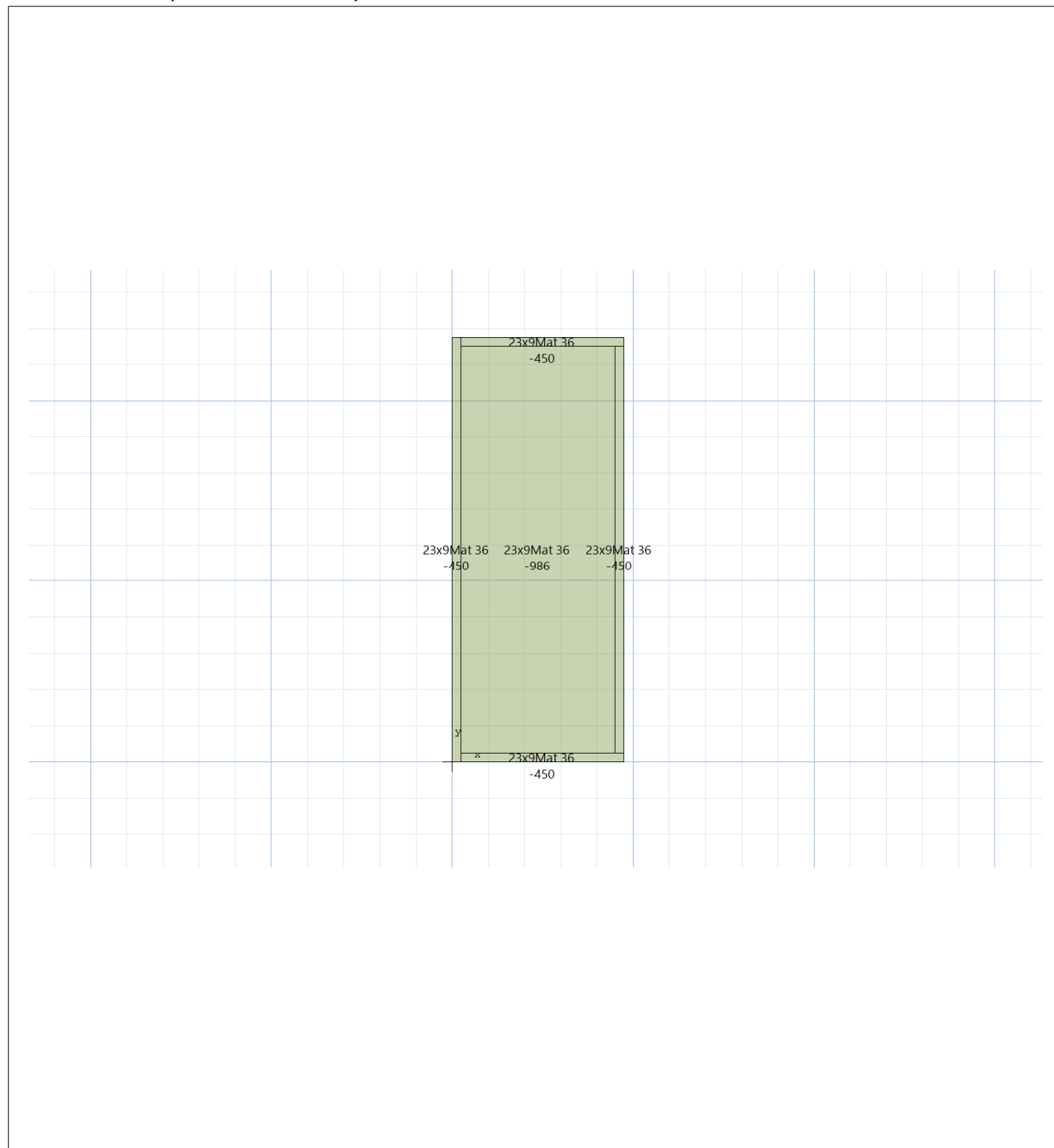
Slabs ID	Load Case	Wz psf
S1	A - DL	-450.0000
S2	A - DL	-450.0000
S3	A - DL	-450.0000
S4	A - DL	-450.0000
S5	A - DL	-986.0000

4. Screenshots

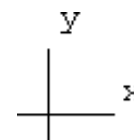
4.1. Extrude 3D view



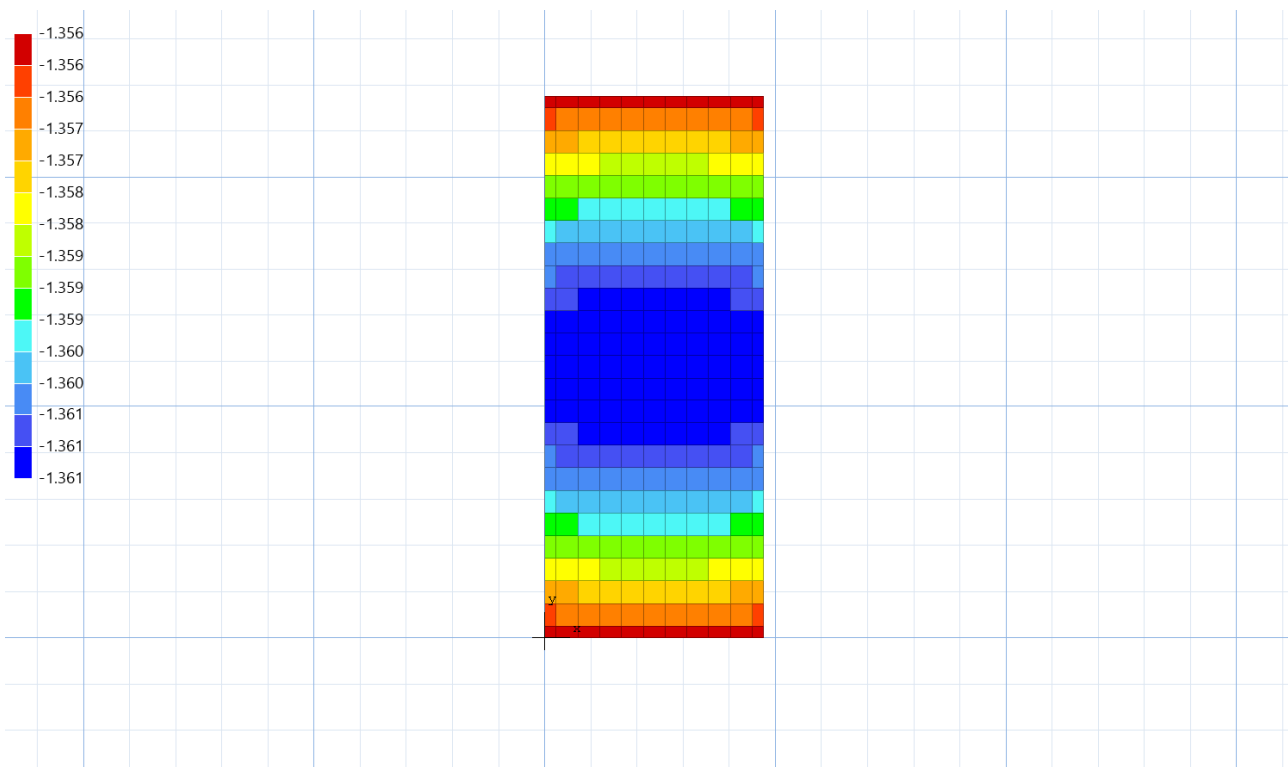
4.2. Model View (Load Case: A - DL)



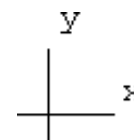
Project: Untitled
 Diagram: Model View (Load Case: A - DL)
 Slabs (Label)



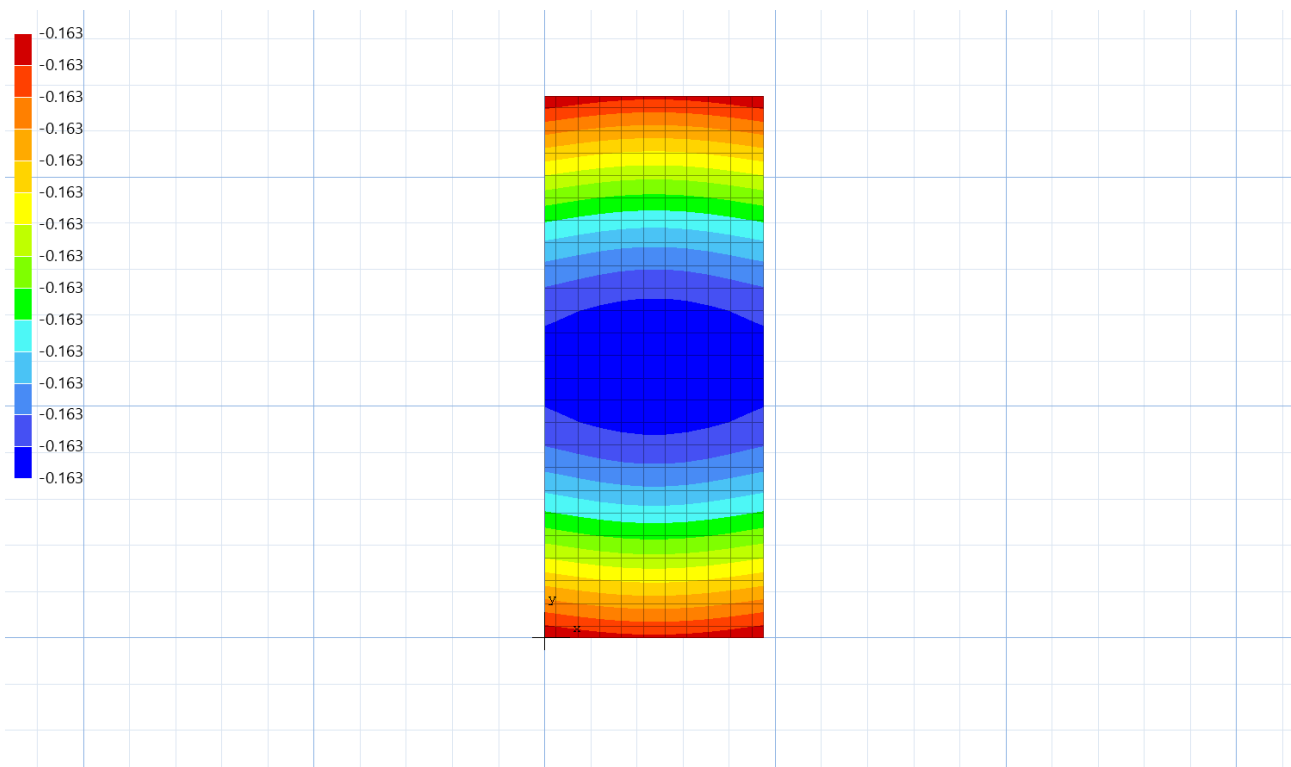
4.3. Envelope - Pressure Down (ksf)



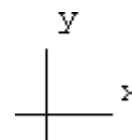
Project: Untitled
 Diagram: Envelope - Pressure Down (ksf)
 Max = -1.356 ksf; Min = -1.361 ksf



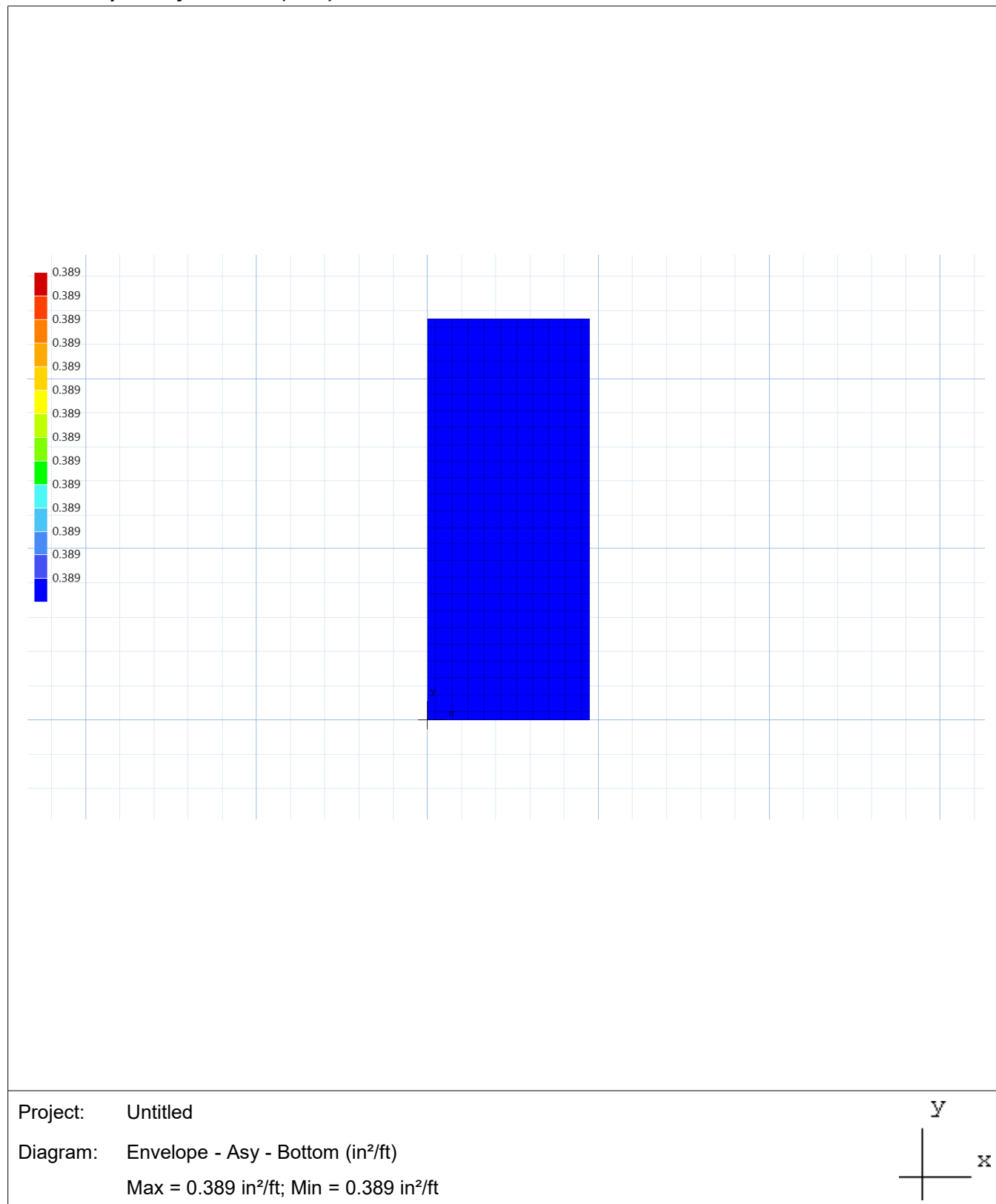
4.4. Envelope - Displacement Down (in)



Project: Untitled
Diagram: Envelope - Displacement Down (in)
Max = -0.163 in; Min = -0.163 in

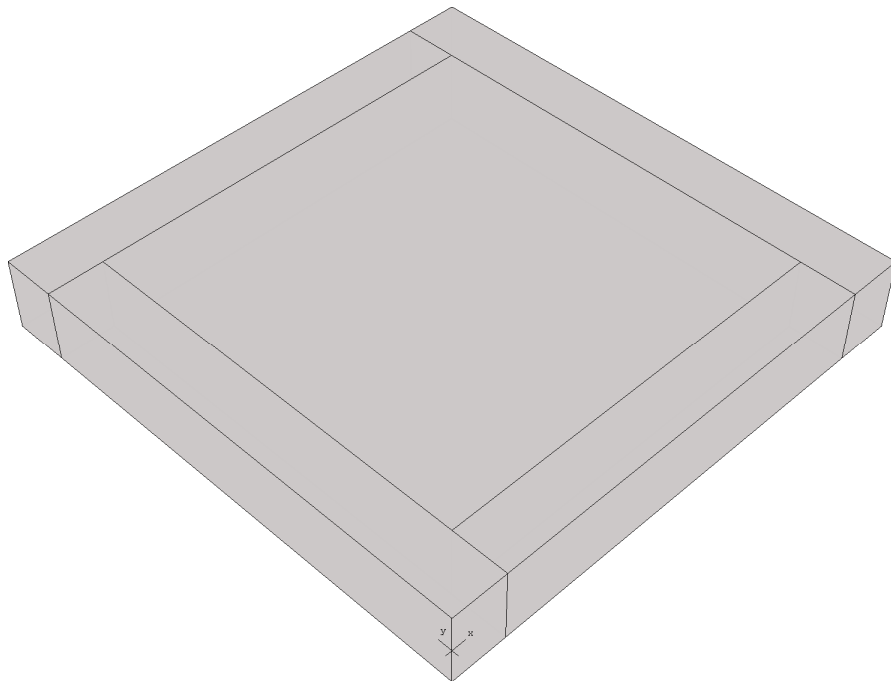


4.5. Envelope - Asy - Bottom (in²/ft)





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Concrete Pad 2

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1. Project

1.1. General Information

File Name	13' Mat.matx
Project	Untitled
Code	ACI 318-14
Units	English
Date	6/5/2023
Time	9:25 AM

1.2. Solver Options

Maximum number of iterations	10
Maximum allowed service displacement	11.00000 in
Minimum ratio of soil contact area w.r.t. initial soil-supported area	50 %
Minimum ratio of active springs and piles w.r.t. total number of springs and piles	0 %
Displacement limit of uplift	0.00000 in
Compute required reinforcement based on	Maximum moment within an element

2. Definitions

2.1. Objects

2.1.1. Slabs

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Mat18	18.00	Clay	C3	Gr40	Gr40#4	No
Mat24	24.00	Clay	C3	Gr40	Gr40#4	No
Mat30	30.00	Clay	C3	Gr40	Gr40#4	No
Mat36	36.00	Clay	C3	Gr40	Gr40#4	No
Mat48	48.00	Clay	C3	Gr40	Gr40#4	No
13'Mat 24	24.00	Silt Soil	C4	Gr60	Gr60#7	Yes

2.1.2. Columns

Label	Type	D in	B in	Assigned
C20X20	Rectangle	20.00	20.00	No

2.1.3. Pile - Properties

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
R36	Round	2738.71	Concrete	4286.8	Bedrock	No
S30X30	Square	2570.13	Precast	4286.8	Bedrock	No
1H8X36	H-Type 1	273.29	Steel	29000.0	Bedrock	No
2H8X36	H-Type 2	273.29	Steel	29000.0	Bedrock	No

2.1.4. Pile - Geometry

Label	Length ft	Embedment in	D in	B in	tf in	tw in
R36	50.00	6.00	36.00			
S30X30	50.00	6.00	30.00			
1H8X36	50.00	6.00	8.02	8.16	0.45	0.45
2H8X36	50.00	6.00	8.02	8.16	0.45	0.45

2.2. Properties

2.2.1. Soil

Label	K _s kcf	Q _a ksf	Used	Label	K _s kcf	Q _a ksf	Used
Clay	75.000	1.500	Yes	Sand	100.000	2.000	No
Bedrock	600.000	12.000	Yes	Silt Soil	100.000	3.000	Yes

2.2.2. Concrete

Label	f' _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C3	3.0000	150.00	3320.6	0.200	-	Yes
C4	4.0000	150.00	3834.3	0.200	-	Yes
C5	5.0000	150.00	4286.8	0.200	-	No
C6	6.0000	150.00	4696.0	0.200	-	No
C7	7.0000	150.00	5072.2	0.200	-	No
C8	8.0000	150.00	5422.5	0.200	-	No

2.2.3. Reinforcement

Label	f _y ksi	E _s ksi	Used	Label	f _y ksi	E _s ksi	Used
Gr40	40.0000	29000.0	Yes	Gr50	50.0000	29000.0	No
Gr60	60.0000	29000.0	Yes	Gr75	75.0000	29000.0	No

2.2.4. Design Parameters

Label	Top layer X in	Top layer Y in	Bot. Layer X in	Bot. Layer Y in	Min. Reinf. Ratio %	Used
Gr40#4	3.25	3.75	3.25	3.75	0.10	Yes
Gr50#4	3.25	3.75	3.25	3.75	0.10	No
Gr60#4	3.25	3.75	3.25	3.75	0.09	No
Gr75#4	3.25	3.75	3.25	3.75	0.07	No
Gr60#7	3.00	3.88	2.00	2.88	0.09	Yes

2.3. Restraints

2.3.1. Nodal Springs

Label	K _{ns} klf	Assigned	Label	K _{ns} klf	Assigned
Spr1	100.00	No			

2.3.2. Slaved Nodes

Label	DOF	Assigned	Label	DOF	Assigned
SlvRx	Rx	No	SlvRy	Ry	No
SlvDz	Dz	No			

2.4. Load Case/Combo.

2.4.1. Load Cases

NOTE: Self weight is included under Case A.

Case	Type	Case label	Load defined?
A	Dead	DL	Yes
B	Live	LL	No

2.4.2. Service Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type Combo./Label	A Dead DL	B Live LL	C	D	E	F	G	H	I
S1	1.000	0.000	-	-	-	-	-	-	-
S2	1.000	1.000	-	-	-	-	-	-	-

2.4.3. Ultimate Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type Combo./Label	A Dead DL	B Live LL	C	D	E	F	G	H	I
U1	1.400	0.000	-	-	-	-	-	-	-
U2	1.200	1.600	-	-	-	-	-	-	-

3. Assignments

3.1. Slabs

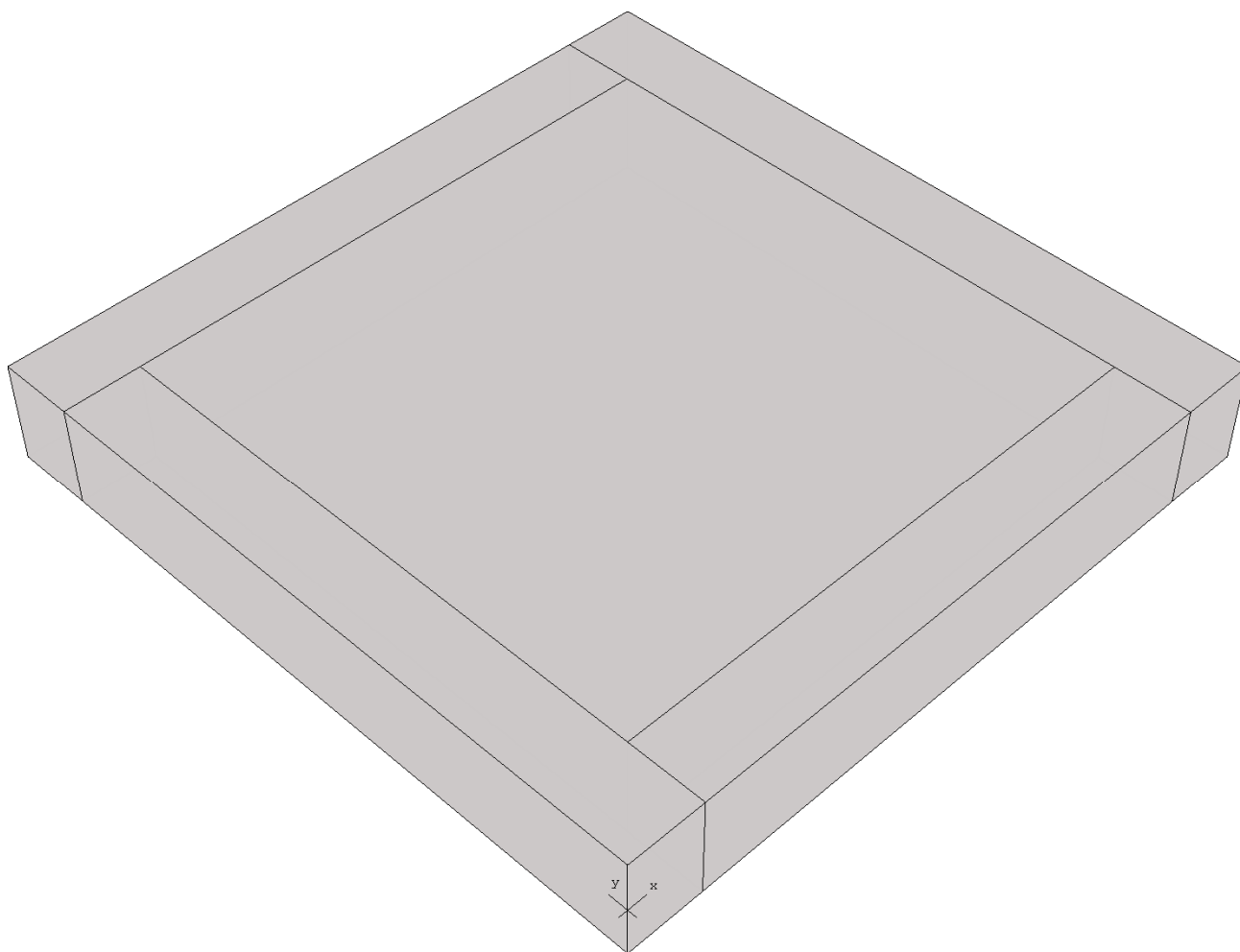
ID	Label	Shape	Top Left/Center X ft	Top Left/Center Y ft	Height (H)/Dia. (D) ft	Width (B) ft
S2	13'Mat 24	Rectangular	1.50	12.50	11.01	10.99
S3	13'Mat 24	Rectangular	0.00	12.50	12.50	1.50
S4	13'Mat 24	Rectangular	1.50	1.50	1.50	10.99
S5	13'Mat 24	Rectangular	12.49	14.00	14.00	1.51
S6	13'Mat 24	Rectangular	0.00	14.00	1.50	12.49

3.2. Area Loads

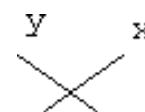
Slabs ID	Load Case	Wz psf
S2	A - DL	-1168.0000
S3	A - DL	-300.0000
S4	A - DL	-300.0000
S5	A - DL	-300.0000
S6	A - DL	-300.0000

4. Screenshots

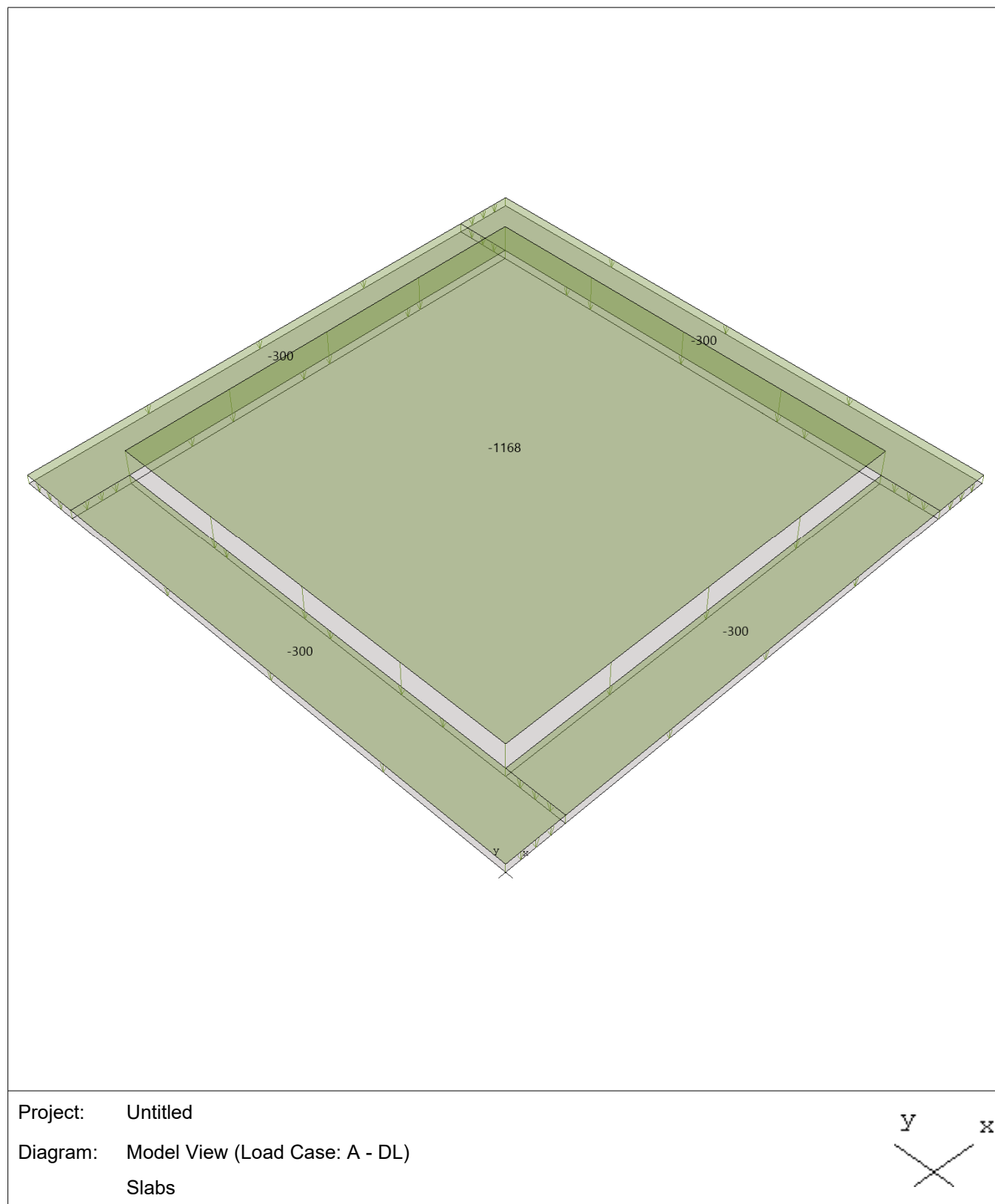
4.1. Extrude 3D view



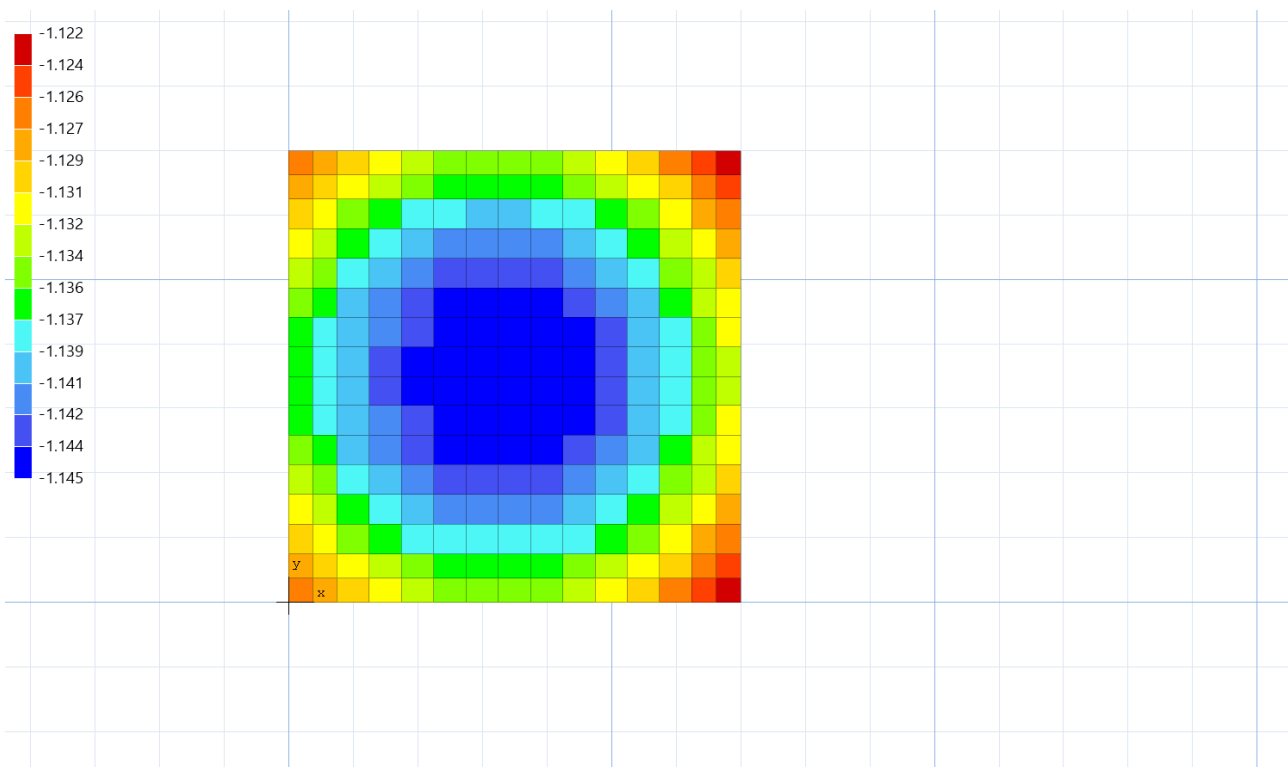
Project: Untitled
Diagram: Model View (Load Case: A - DL)
Slabs



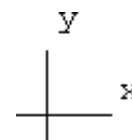
4.2. Loads - Case A - DL



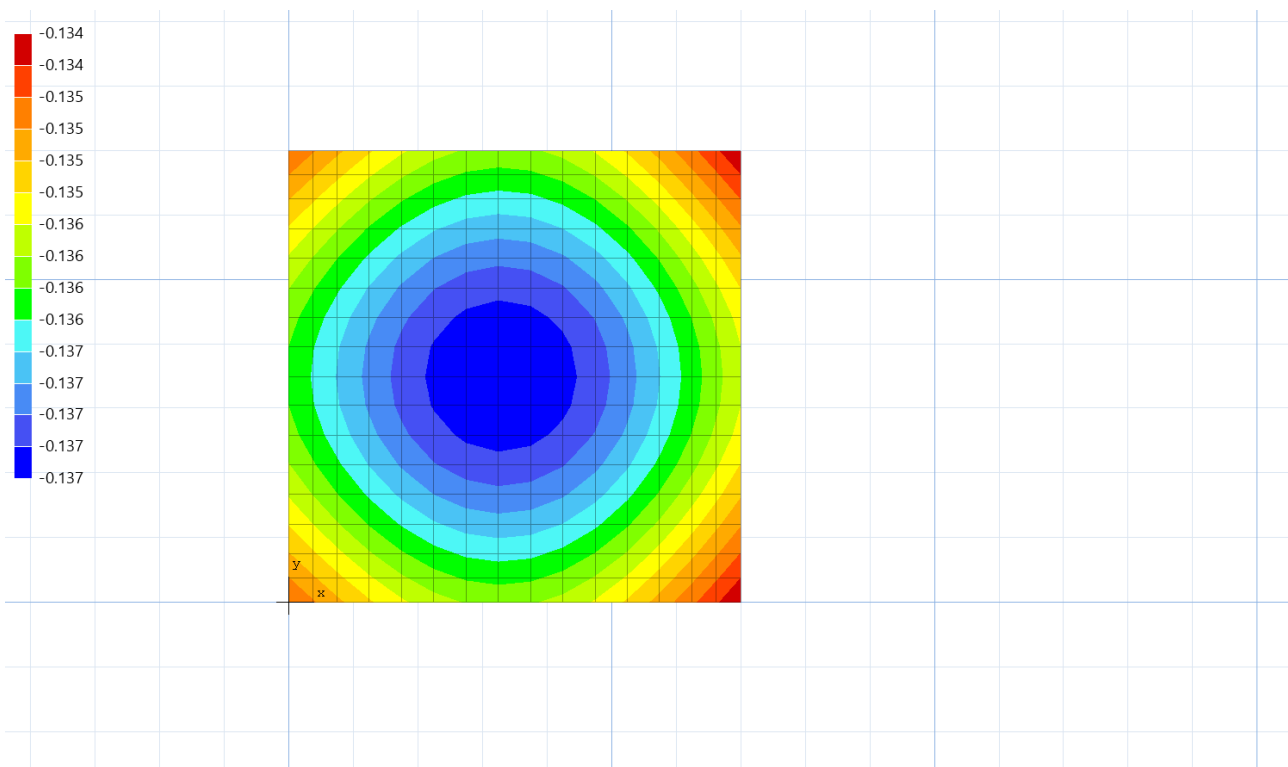
4.3. Envelope - Pressure Down (ksf)



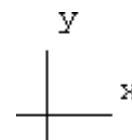
Project: Untitled
 Diagram: Envelope - Pressure Down (ksf)
 Max = -1.122 ksf; Min = -1.145 ksf



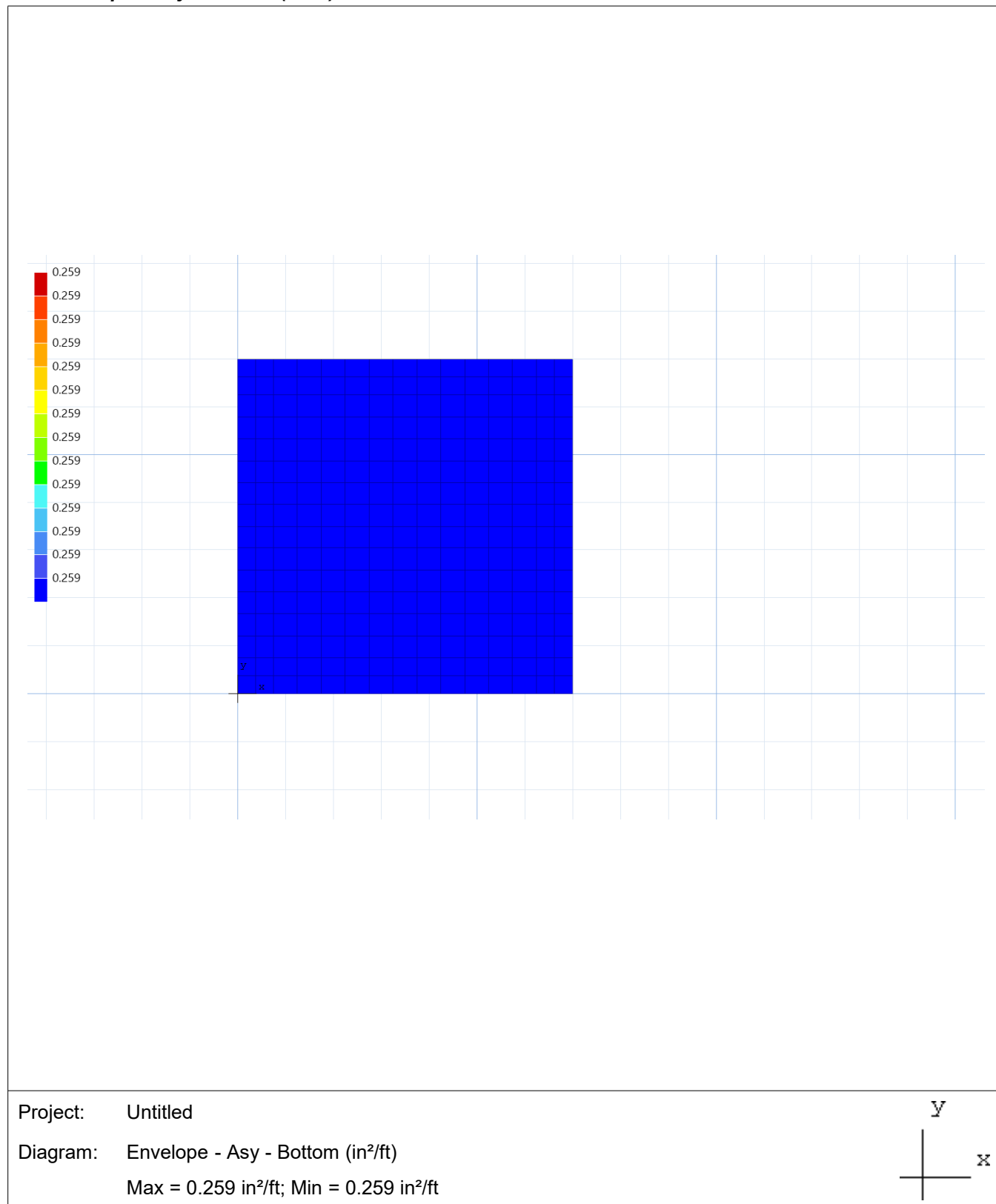
4.4. Envelope - Displacement Down (in)



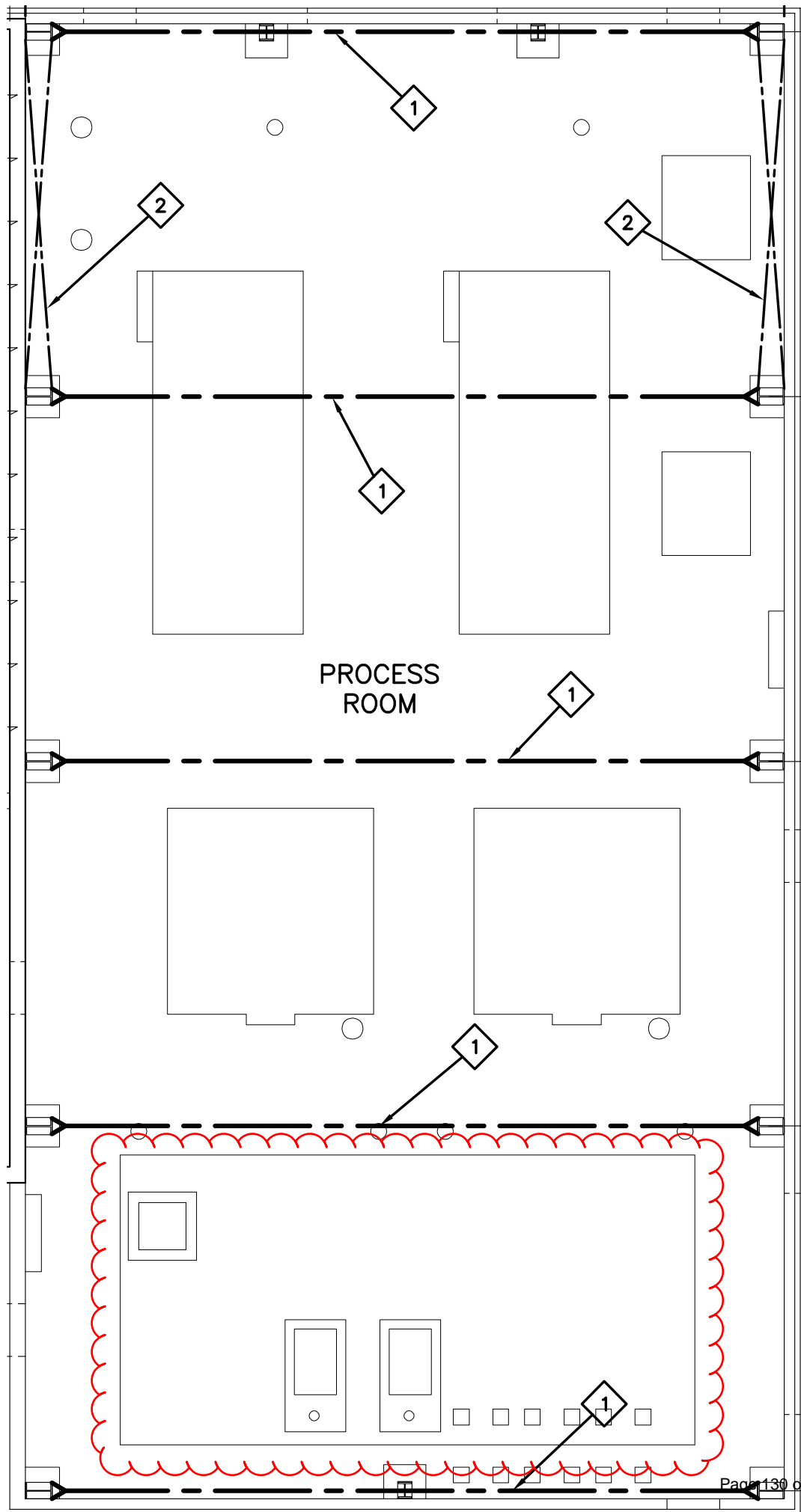
Project: Untitled
 Diagram: Envelope - Displacement Down (in)
 Max = -0.134 in; Min = -0.137 in



4.5. Envelope - Asy - Bottom (in²/ft)



Process Room Backwash Tank



Tank Mat Loading Calcs

Mat DL = 300 psf

Mat LL = 594 psf

Short Wall DL = 2850 psf

Short Wall LL = 867 psf

Tank Dimensions:

Length = 37 ft

Width = 19 ft

Depth = 12.5 ft

Wall Thickness = 18 in

Mat Thickness = 24 in

Volume of Concrete = 3619.5 ft³

Volume of Full Water Tank = 5168 ft³

Unit Wght of Concrete = 150 pcf

Unit Wght of Water = 62.43 pcf

Area Live Load of Water = 62.43 * Depth = 594 psf

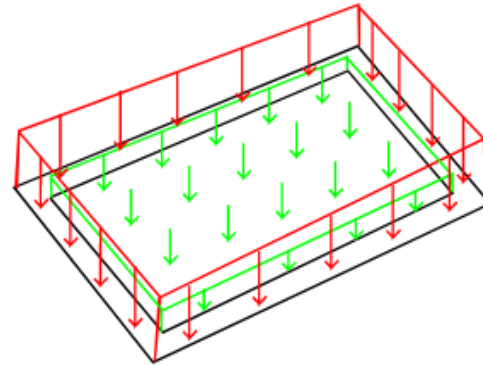
Area Load of Concrete Mat=150*Thickness= 300 psf

Trib Lngth of Concrete Roof on Short Walls= 6.5 ft

Trib Lngth of Concrete Roof on Long Walls= 8 ft

Area Load of Concrete Wall & Roof on Short Walls = 2850 psf

Area Load of Concrete Wall & Roof on Long Walls = 3075 psf



Long Wall DL = 3075 psf

Long Wall LL = 1067 psf

Truck Live Loading



Single Axle Load = 16000 lbs

Area Load of Truck Live Load on
Short Walls = 561 psf

Area Load of Truck Live Load on
Long Walls = 288 psf
(Single Axle Load/Wall Thickness/Wall Length)

200 psf Live Load

Live Load= 200 psf

Area Live Load on
Short Walls = 867 psf

(Live Load*Roof Trib/Wall Thickness)

Area Live Load on
Long Walls = 1067 psf

(Live Load*Roof Trib/Wall Thickness)

Soil Loading

Soil Unit Wght = 130 pcf

At Rest Pressure
Coefficient = 0.44

At-Rest Static Fluid
Pressure = 57.2 pcf

Soil Pressure = 629.2 psf

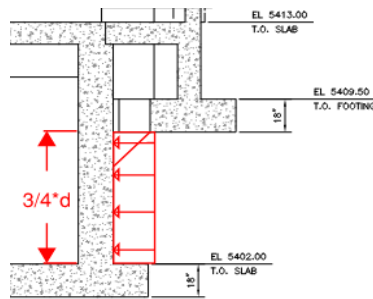
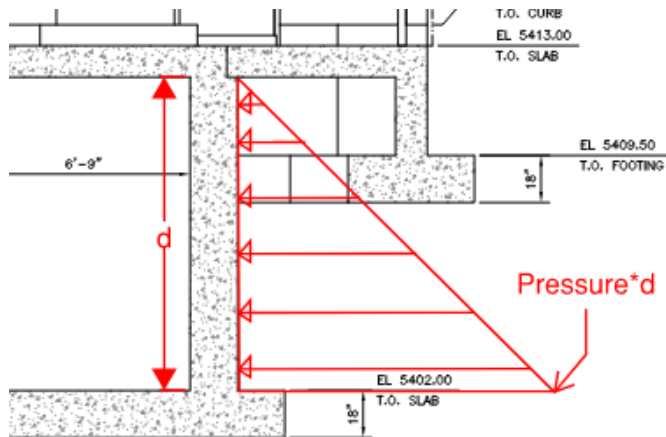
Designing for a 1' Strip, the design load
would be = **629.2 plf**

Surcharge

Surcharge Load = 100 psf

With 1' Strip Trib,
Surcharge Load = **100 plf**

Max Moment = 13.4 k-ft/ft
(From TEDDS)



Tank Roof Beam Loads

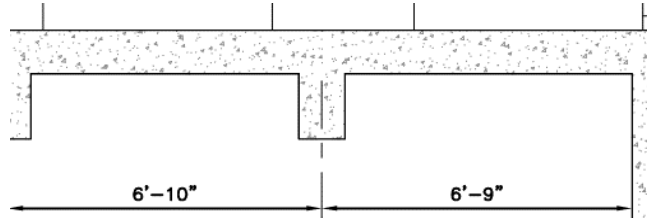
Dead Load (Concrete Self Weight)

$$DL = 150\text{pcf} * \text{Trib} * \text{Slab+Beam Width}$$

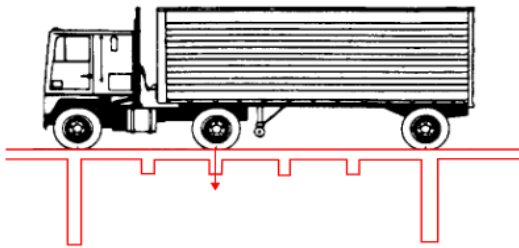
$$\text{Trib} = 6.833 \text{ ft}$$

$$\text{Beam Depth} = 12 \text{ in}$$

$$DL = 1400 \text{ plf}$$



Truck Live Loading



$$\text{Wheel Load} = 16000 \text{ lbs}$$

$$\text{Contact Area} = 10" \times 20"$$

$$\text{Unif Live Load} = \frac{\text{Wheel Load}}{\text{Contact Area} * \text{Beam Width}}$$

$$\text{Uniform Live Load} = 11520 \text{ plf}$$

200 psf Live Loading

$$\text{Live load} = 200 \text{ psf}$$

$$\text{Trib Width} = 6.833 \text{ ft}$$

$$\text{Uniform Live Load} = 1367 \text{ plf}$$

CMU Building

Load: 250psf
Bearing wall load: 465.5psf

Allowable pressure: 3ksf

Metal Deck & Steel Beam Analysis



11060 White Rock Road, Suite 200, Rancho Cordova, CA 95670

Project:

Item:

Project No.

Designer:

Checker:

Sheet: of

Date:

Date:

Silt metal deck Forces

$$\text{Snow } 300 \text{ PSF} \times 4 \text{ ft} = 1200 \text{ PLF}$$

$$\text{LLR } 20 \text{ PSF} \times 4 \text{ ft} = 80 \text{ PLF}$$

$$\text{DLR } 20 \text{ PSF} \times 4 \text{ ft} = 80 \text{ PLF}$$

$$\text{Wind } \underline{33.3 \text{ PSF}} \times 4 \text{ ft} = \underline{133.2 \text{ PLF}}$$

$$373.3 \text{ PSF}$$

$$1.5$$

$$1.2D + 1.6(S) + 0.5W$$

$$1.2(20) + 1.6(300) + 0.5(33.3)$$

$$= 520 \text{ PSF}$$

$\frac{36}{4}$ - fasteners
/ per panel width
width
of panel

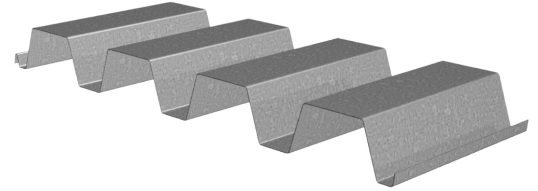
3NL-32/3NI-32/3PLN-32 ROOF DECKS

GRADE 50 STEEL

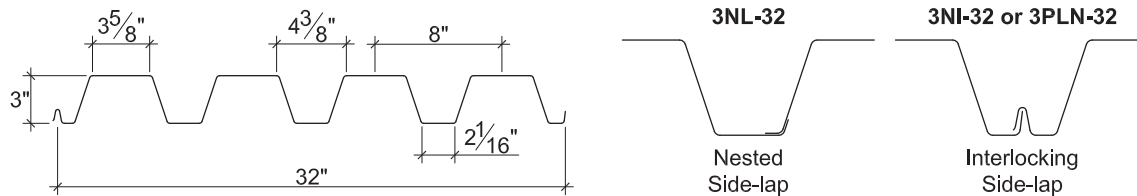
ASD

32" WIDE 3N ROOF DECKS

- 3NL-32 Deck used with Side-lap Screws
- 3NI-32 Deck used with TSWs or BPs
- 3PLN-32 Deck used with PunchLok® II System



Nominal Dimensions



Section Properties

Deck Gage	Deck Weight w_{dd} (psf)	Base Metal Thickness t (in.)	Yield Strength F_y (ksi)	Effective Moment of Inertia at Service Load $I_d = (2I_e + I_g)/3$		Effective Section Modulus at $F_y = 50$ ksi		Allowable Moment		Vertical Web Shear V_n/Ω (lb/ft)
				I_{d+} (in ⁴ /ft)	I_{d-} (in ⁴ /ft)	S_{e+} (in ³ /ft)	S_{e-} (in ³ /ft)	M_{n+}/Ω (lb-ft/ft)	M_{n-}/Ω (lb-ft/ft)	
22	1.8	0.0295	50	0.643	0.715	0.345	0.372	861	928	2176
20	2.2	0.0358	50	0.806	0.886	0.448	0.476	1118	1187	3761
19	2.6	0.0418	50	0.965	1.052	0.554	0.579	1382	1445	5127
18	2.9	0.0474	50	1.123	1.200	0.660	0.675	1647	1684	6598
16	3.7	0.0598	50	1.479	1.524	0.869	0.885	2168	2208	9064

Allowable Reactions at Supports Based on Web Crippling, R_n/Ω (lb/ft)

Deck Gage	Bearing Length of Webs											
	One-Flange Loading					Two-Flange Loading						
	End Bearing				Interior Bearing		End Bearing				Interior Bearing	
	1 1/2"	2"	3"	4"	4"	8"	1 1/2"	2"	3"	4"	4"	8"
22	536	589	678	753	1185	1377	508	547	613	669	1380	1620
20	774	848	972	1077	1697	2101	788	846	944	1026	2014	2529
19	1036	1132	1294	1430	2258	2842	1112	1190	1322	1433	2715	3471
18	1313	1432	1631	1799	2847	3565	1464	1563	1731	1872	3454	4397
16	2031	2206	2499	2746	4365	5416	2414	2568	2826	3043	5374	6781

Standard Features

- ASTM A653 SS GR50 Min., with G60 or G90, white or gray primer optional
- ASTM A1008 SS GR50 Min. with gray primer
- Standard lengths – 6'-0" to 42'-0"
- IAPMO UES ER-0652, UL, and FM Listed
- Tables conform to ANSI/SDI RD-2017

Optional Features

- Inquire regarding cost and lead times for:
 - Short cuts < 6'-0"
 - Sheet Lengths > 42'-0"
 - Alternative metallic and painted finishes
- Web Perforated Acoustical Versions

3NL-32/3NI-32/3PLN-32 ROOF DECKS

GRADE 50 STEEL

ASD

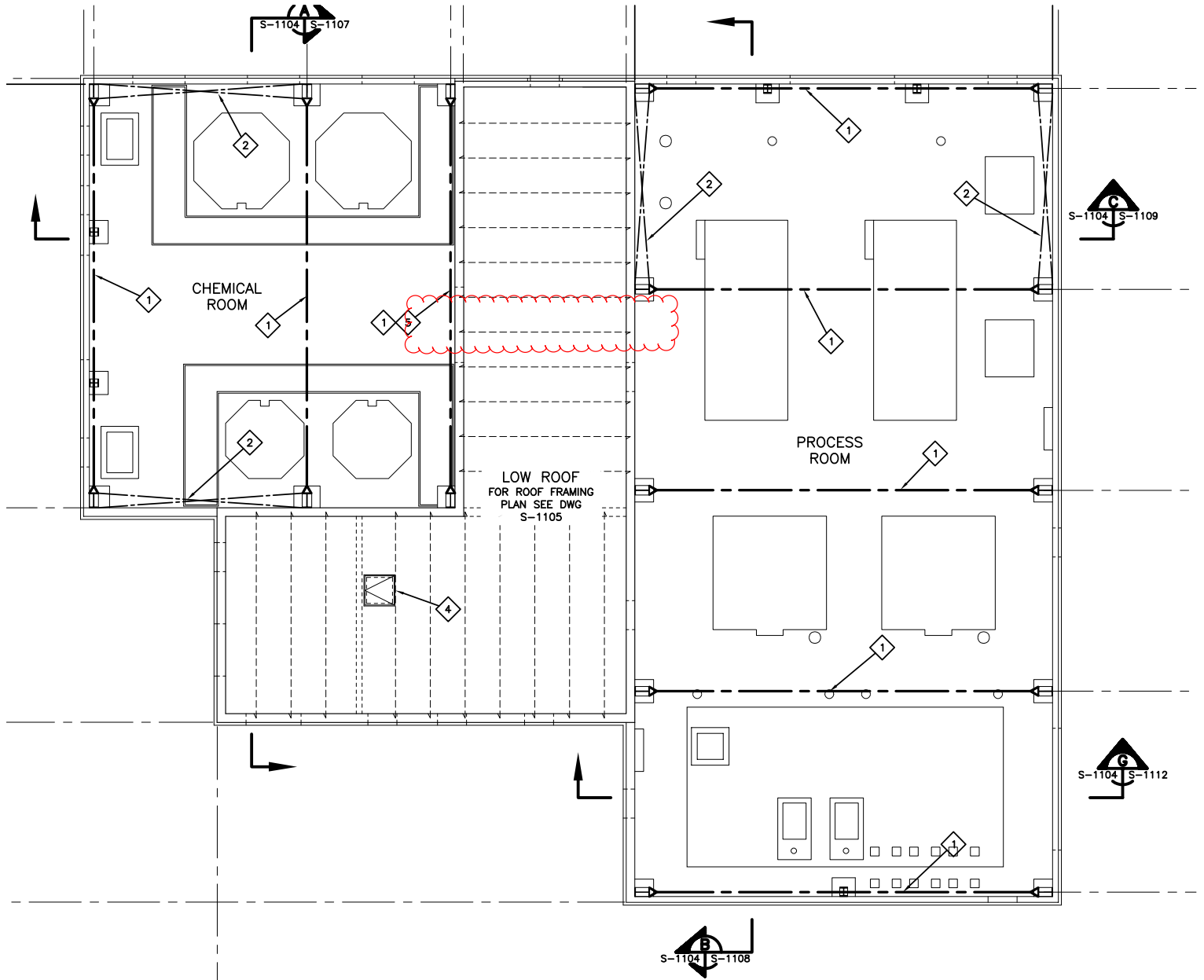
Inward Uniform Allowable Loads, ASD (psf)

Deck Gage	Spans	Criteria	Span (ft-in.)										
			4'-0"	6'-0"	8'-0"	9'-0"	10'-0"	11'-0"	12'-0"	14'-0"	16'-0"	18'-0"	20'-0"
22	Single	W_n / Ω	431	191	108	85	69	57	48	35	27	21	17
		L/240	---	---	82	58	42	32	24	15	10	7	5
	Double	W_n / Ω	409	194	112	89	73	60	51	37	29	23	18
		L/240	---	---	---	---	---	---	---	---	28	19	14
	Triple	W_n / Ω	489	237	138	110	90	75	63	47			
		L/240	---	---	---	---	88	66	51	32			
20	Single	W_n / Ω	559	248	140	110	89	74	62	46	35	28	22
		L/240	---	245	103	72	53	40	31	19	13	9	7
	Double	W_n / Ω	552	255	146	116	94	78	65	48	37	29	24
		L/240	---	---	---	---	---	---	---	---	34	24	17
	Triple	W_n / Ω	671	315	181	143	117	97	81	60			
		L/240	---	---	---	---	110	82	63	40			
19	Single	W_n / Ω	691	307	173	136	111	91	77	56	43	34	28
		L/240	---	293	124	87	63	48	37	23	15	11	8
	Double	W_n / Ω	681	313	178	141	114	95	80	59	45	36	29
		L/240	---	---	---	---	---	---	---	---	41	28	21
	Triple	W_n / Ω	832	386	221	175	142	118	99	73			
		L/240	---	---	---	---	130	98	75	47			
18	Single	W_n / Ω	823	366	206	163	132	109	91	67	51	41	33
		L/240	---	341	144	101	74	55	43	27	18	13	9
	Double	W_n / Ω	802	366	208	165	134	111	93	68	52	41	34
		L/240	---	---	---	---	---	---	---	---	46	32	24
	Triple	W_n / Ω	983	453	258	205	167	138	116	85			
		L/240	---	---	---	204	149	112	86	54			
16	Single	W_n / Ω	1084	482	271	214	173	143	120	89	68	54	43
		L/240	---	449	189	133	97	73	56	35	24	17	12
	Double	W_n / Ω	1056	481	273	216	175	145	122	90	69	54	44
		L/240	---	---	---	---	---	---	---	88	59	41	30
	Triple	W_n / Ω	1296	596	339	269	219	181	152	112			
		L/240	---	---	---	259	189	142	109	69			

Notes:

1. Table does not account for web crippling. Required bearing should be determined based on specific span conditions.
2. The symbol "—" indicates that the uniform allowable load based on deflection exceeds the allowable load based on stress.

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3

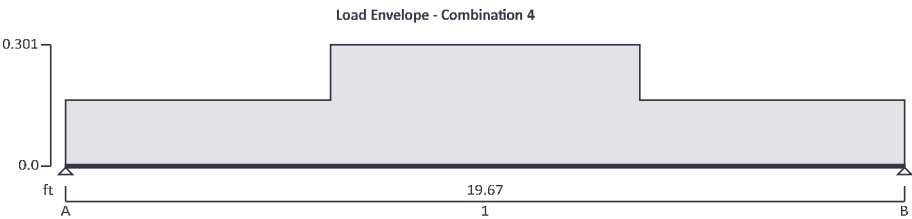
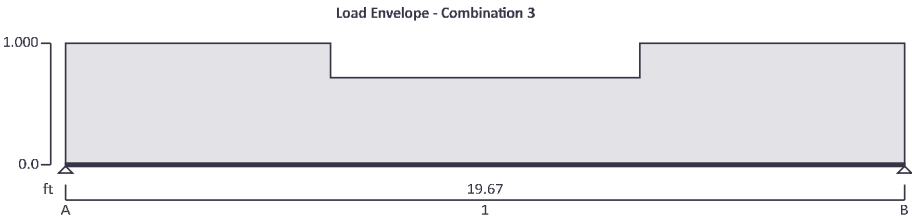
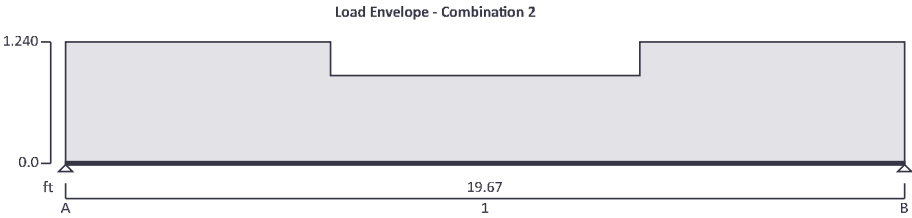
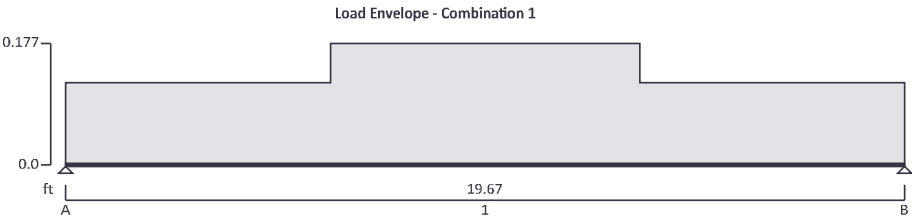
METAL BUILDING FRAMING PLAN

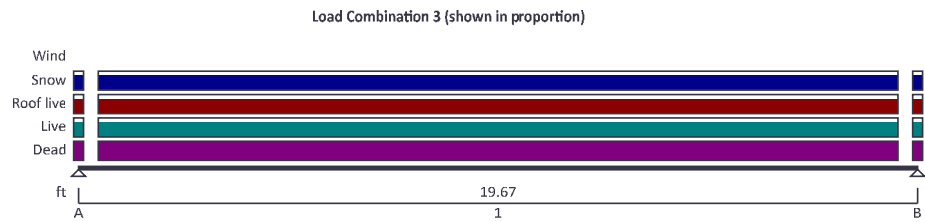
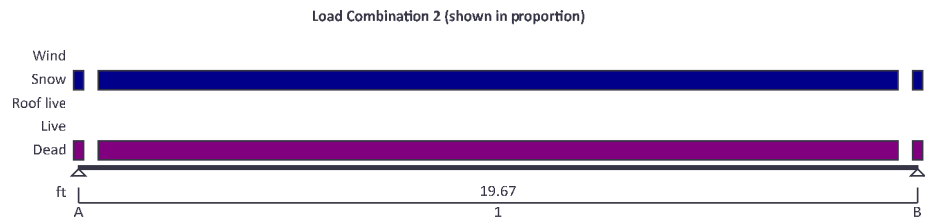
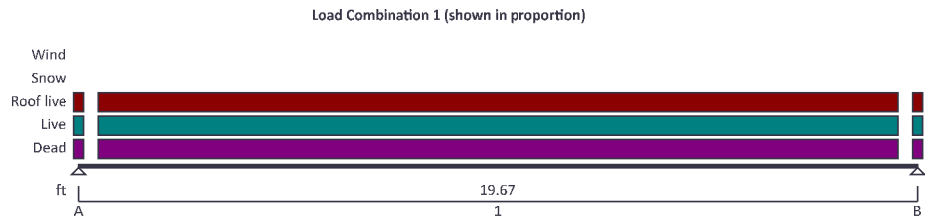
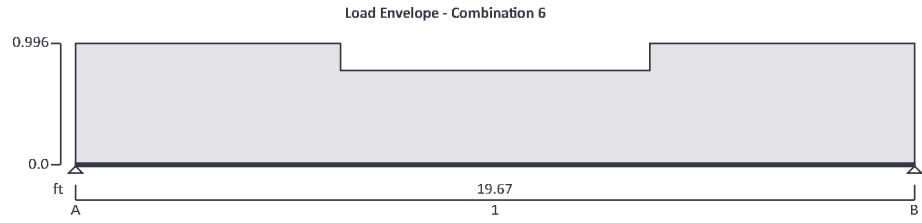
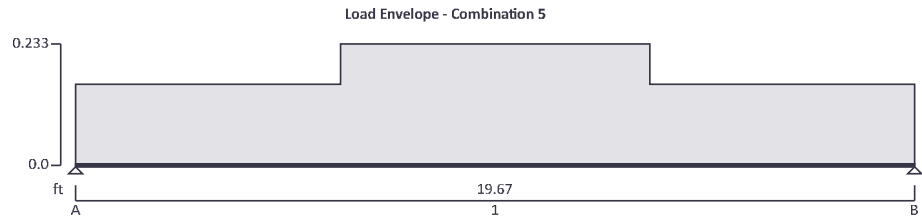
STEEL BEAM ANALYSIS & DESIGN (AISC360-16)

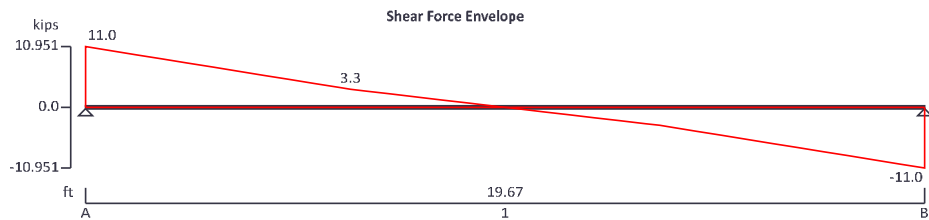
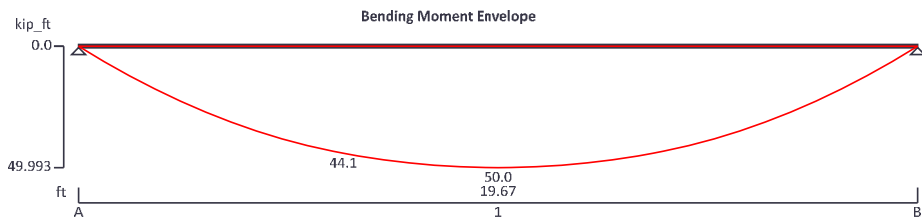
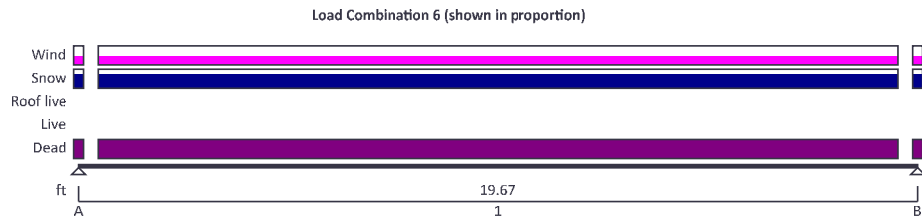
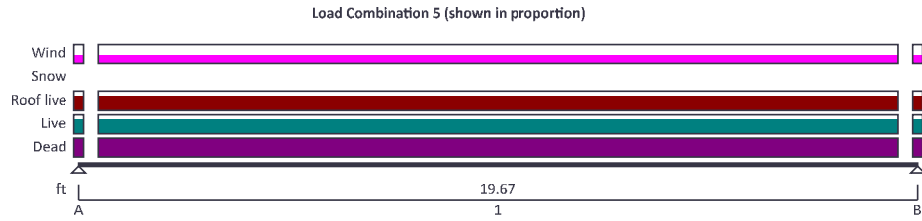
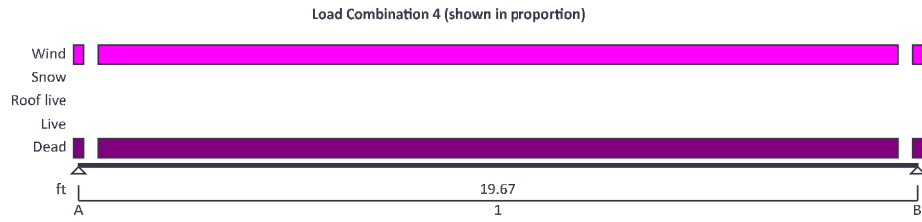
STEEL BEAM FOR CHEMICAL ROOM LOW ROOF CMU BUILDING

In accordance with AISC360-16 using the ASD method

Tedds calculation version 3.0.15







Support conditions

Support A

Vertically restrained

Support B	Rotationally free Vertically restrained Rotationally free	
Applied loading		
Beam loads	Dead full UDL 0 kips/ft Wind full UDL 0.124 kips/ft Snow partial UDL 0.72 kips/ft from 74.52 in to 161.52 in Snow partial UDL 1.2 kips/ft from 161.52 in to 236.04 in Snow partial UDL 1.2 kips/ft from 0.00 in to 74.52 in Dead partial UDL 0.137 kips/ft from 74.52 in to 161.52 in Roof live partial UDL 0.08 kips/ft from 161.52 in to 236.04 in Roof live partial UDL 0.08 kips/ft from 0.00 in to 74.52 in Dead self weight of beam $\times 1$	
Load combinations		
Load combination 1 - D+L	Support A	Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
		Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
		Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
	Support B	Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
		Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
		Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
Load combination 2 - D+S	Support A	Dead $\times 1.00$ Snow $\times 1.00$ Dead $\times 1.00$ Snow $\times 1.00$
		Dead $\times 1.00$ Snow $\times 1.00$ Dead $\times 1.00$ Snow $\times 1.00$
		Dead $\times 1.00$ Snow $\times 1.00$ Dead $\times 1.00$ Snow $\times 1.00$
	Support B	Dead $\times 1.00$ Snow $\times 1.00$ Dead $\times 1.00$ Snow $\times 1.00$
		Dead $\times 1.00$ Snow $\times 1.00$ Dead $\times 1.00$ Snow $\times 1.00$
		Dead $\times 1.00$ Snow $\times 1.00$ Dead $\times 1.00$ Snow $\times 1.00$
Load combination 3 - D+0.75L+.75S	Support A	Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
		Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
		Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
	Support B	Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
		Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
		Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
Load combination 4 - D+0.6W	Support A	Dead $\times 1.00$ Wind $\times 1.00$ Dead $\times 1.00$
		Dead $\times 1.00$ Wind $\times 1.00$ Dead $\times 1.00$
		Dead $\times 1.00$ Wind $\times 1.00$ Dead $\times 1.00$

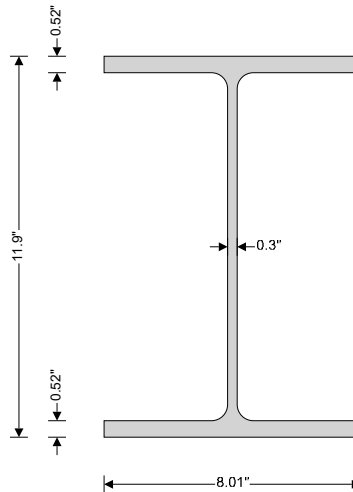
Load combination 5 - $D+0.75(0.6W)+.75L$	Support B	Wind $\times 1.00$
		Dead $\times 1.00$
		Wind $\times 1.00$
		Dead $\times 1.00$
		Live $\times 0.75$
	Support A	Roof live $\times 0.75$
		Wind $\times 0.45$
		Dead $\times 1.00$
		Live $\times 0.75$
		Roof live $\times 0.75$
Load combination 6 - $D+0.75(0.6W)+.75S$	Support B	Wind $\times 0.45$
		Dead $\times 1.00$
		Live $\times 0.75$
		Roof live $\times 0.75$
		Wind $\times 0.45$
	Support A	Dead $\times 1.00$
		Snow $\times 0.75$
		Wind $\times 0.45$
		Dead $\times 1.00$
		Snow $\times 0.75$
	Support B	Wind $\times 0.45$
		Dead $\times 1.00$
		Snow $\times 0.75$
		Wind $\times 0.45$

Analysis results

Maximum moment;	$M_{\max} = 50$ kips_ft;	$M_{\min} = 0$ kips_ft
Maximum shear;	$V_{\max} = 11$ kips;	$V_{\min} = -11$ kips
Deflection;	$\delta_{\max} = 0.5$ in;	$\delta_{\min} = 0$ in
Maximum reaction at support A;	$R_{A_{\max}} = 11$ kips;	$R_{A_{\min}} = 1.4$ kips
Unfactored dead load reaction at support A;	$R_{A_{\text{Dead}}} = 0.9$ kips	
Unfactored roof live load reaction at support A;	$R_{A_{\text{Roof live}}} = 0.5$ kips	
Unfactored snow load reaction at support A;	$R_{A_{\text{Snow}}} = 10.1$ kips	
Unfactored wind load reaction at support A;	$R_{A_{\text{Wind}}} = 1.2$ kips	
Maximum reaction at support B;	$R_{B_{\max}} = 11$ kips;	$R_{B_{\min}} = 1.4$ kips
Unfactored dead load reaction at support B;	$R_{B_{\text{Dead}}} = 0.9$ kips	
Unfactored roof live load reaction at support B;	$R_{B_{\text{Roof live}}} = 0.5$ kips	
Unfactored snow load reaction at support B;	$R_{B_{\text{Snow}}} = 10.1$ kips	
Unfactored wind load reaction at support B;	$R_{B_{\text{Wind}}} = 1.2$ kips	

Section details

Section type;	W 12x40 (AISC 15th Edn (v15.0))
ASTM steel designation;	A992
Steel yield stress;	$F_y = 50$ ksi
Steel tensile stress;	$F_u = 65$ ksi
Modulus of elasticity;	$E = 29000$ ksi



Safety factors

Safety factor for tensile yielding	$\Omega_{ty} = 1.67$
Safety factor for tensile rupture	$\Omega_{tr} = 2.00$
Safety factor for compression	$\Omega_c = 1.67$
Safety factor for flexure	$\Omega_b = 1.67$

Lateral bracing

Span 1 has lateral bracing at supports only

Classification of sections for local buckling - Section B4.1

Classification of flanges in flexure - Table B4.1b (case 10)

Width to thickness ratio;	$b_f / (2 \times t_f) = 7.78$	
Limiting ratio for compact section;	$\lambda_{pff} = 0.38 \times \sqrt{E / F_y} = 9.15$	
Limiting ratio for non-compact section;	$\lambda_{rff} = 1.0 \times \sqrt{E / F_y} = 24.08$;	Compact

Classification of web in flexure - Table B4.1b (case 15)

Width to thickness ratio;	$(d - 2 \times k) / t_w = 33.42$	
Limiting ratio for compact section;	$\lambda_{pwf} = 3.76 \times \sqrt{E / F_y} = 90.55$	
Limiting ratio for non-compact section;	$\lambda_{rwf} = 5.70 \times \sqrt{E / F_y} = 137.27$;	Compact

Section is compact in flexure

Design of members for shear - Chapter G

Required shear strength	$V_r = \max(\text{abs}(V_{\max}), \text{abs}(V_{\min})) = 10.951$ kips
Web area	$A_w = d \times t_w = 3.51$ in ²
Web plate buckling coefficient	$k_v = 5.34$
Web shear coefficient - eq G2-3	$C_{v1} = 1$
Nominal shear strength – eq G6-1	$V_n = 0.6 \times F_y \times A_w \times C_{v1} = 105.315$ kips
Safety factor for shear	$\Omega_v = 1.50$
Allowable shear strength	$V_c = V_n / \Omega_v = 70.210$ kips

PASS - Allowable shear strength exceeds required shear strength

Design of members for flexure in the major axis - Chapter F

Required flexural strength;	$M_r = \max(\text{abs}(M_{s1_max}), \text{abs}(M_{s1_min})) = 49.993$ kips_ft
-----------------------------	---

Yielding - Section F2.1

Nominal flexural strength for yielding - eq F2-1; $M_{nyld} = M_p = F_y \times Z_x = \mathbf{237.5 \text{ kips_ft}}$

Lateral-torsional buckling - Section F2.2

Unbraced length; $L_b = L_{s1} = \mathbf{236.04 \text{ in}}$

Limiting unbraced length for yielding - eq F2-5; $L_p = 1.76 \times r_y \times \sqrt{[E / F_y]} = \mathbf{82.23 \text{ in}}$

Distance between flange centroids; $h_o = d - t_f = \mathbf{11.385 \text{ in}}$

$$c = \mathbf{1}$$

$$r_{ts} = \sqrt{[(I_y \times C_w) / S_x]} = \mathbf{2.212 \text{ in}}$$

Limiting unbraced length for inelastic LTB - eq F2-6

$$L_r = 1.95 \times r_{ts} \times E / (0.7 \times F_y) \times \sqrt{[(J \times c / (S_x \times h_o)) + \sqrt{((J \times c / (S_x \times h_o))^2 + 6.76 \times (0.7 \times F_y / E)^2)}]} = \mathbf{253.807 \text{ in}}$$

Cross-section mono-symmetry parameter; $R_m = \mathbf{1.000}$

Moment at quarter point of segment; $M_A = \mathbf{38.861 \text{ kips_ft}}$

Moment at center-line of segment; $M_B = \mathbf{49.993 \text{ kips_ft}}$

Moment at three quarter point of segment; $M_C = \mathbf{38.861 \text{ kips_ft}}$

Maximum moment in segment; $M_{abs} = \mathbf{49.993 \text{ kips_ft}}$

Lateral torsional buckling modification factor - eq F1-1; $C_b = 12.5 \times M_{abs} / [2.5 \times M_{abs} + 3 \times M_A + 4 \times M_B + 3 \times M_C] = \mathbf{1.120}$

Nominal flexural strength for lateral torsional buckling - eq F2-2; $M_{ntlb} = C_b \times [M_p - (M_p - 0.7 \times F_y \times S_x) \times (L_b - L_p) / (L_r - L_p)] = \mathbf{178.305 \text{ kips_ft}}$

Nominal flexural strength; $M_n = \min(M_{nyld}, M_{ntlb}) = \mathbf{178.305 \text{ kips_ft}}$

Allowable flexural strength; $M_c = M_n / \Omega_b = \mathbf{106.770 \text{ kips_ft}}$

PASS - Allowable flexural strength exceeds required flexural strength

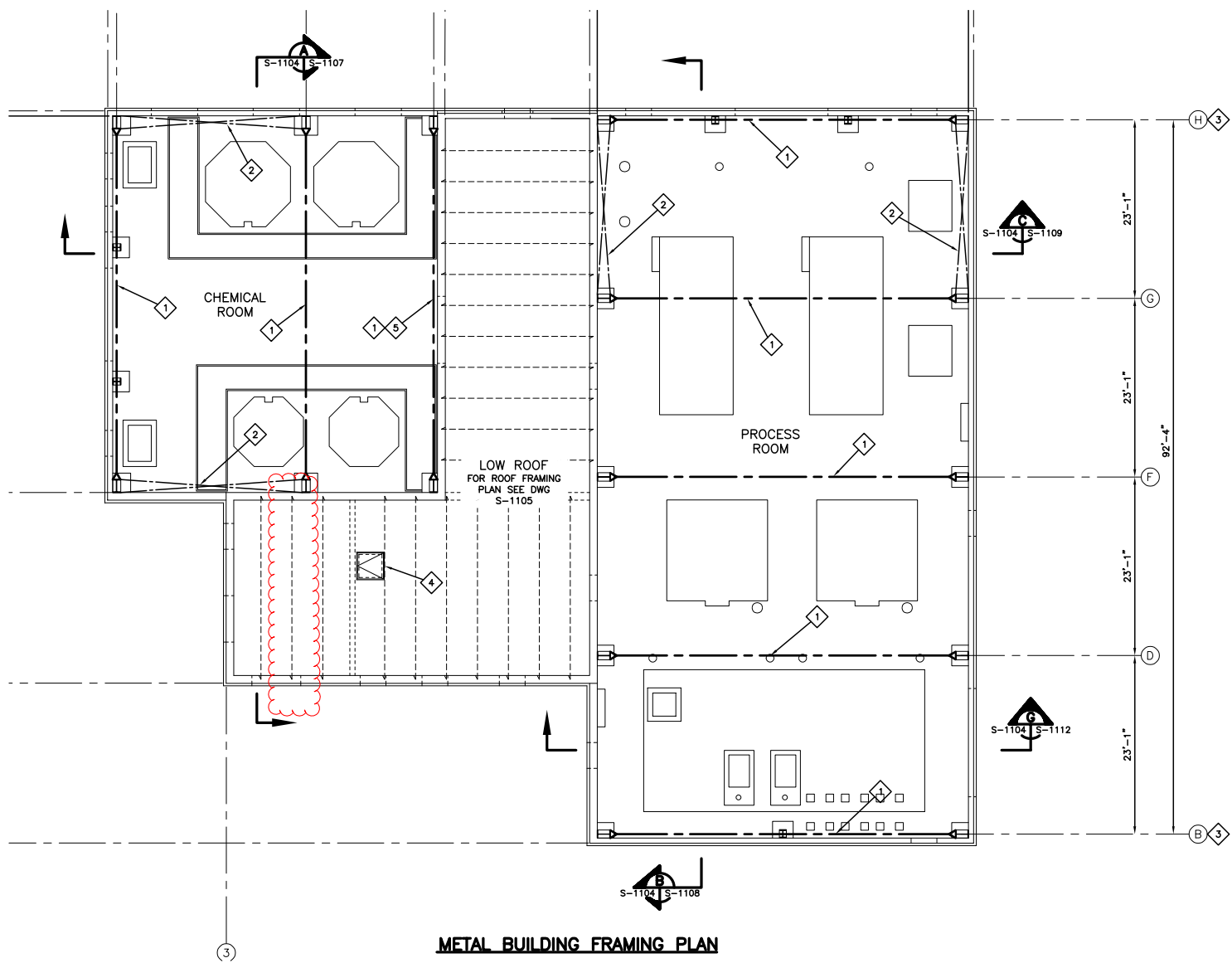
Design of members for vertical deflection

Consider deflection due to dead, live, roof live, snow and wind loads

Limiting deflection; $\delta_{lim} = L_{s1} / 360 = \mathbf{0.656 \text{ in}}$

Maximum deflection span 1; $\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min})) = \mathbf{0.458 \text{ in}}$

PASS - Maximum deflection does not exceed deflection limit



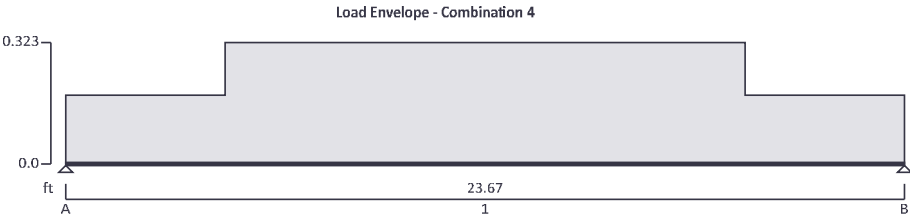
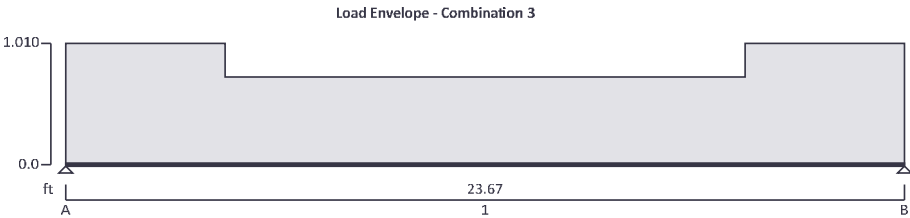
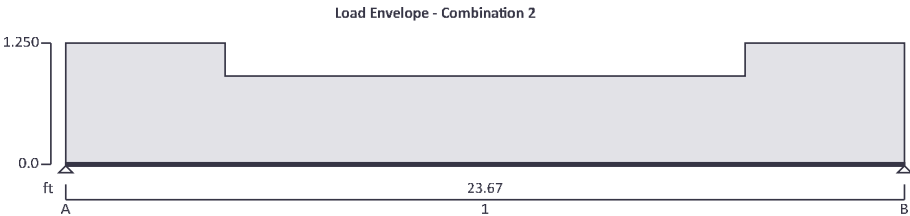
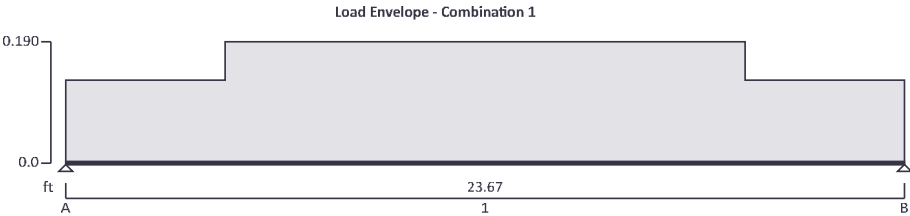
METAL BUILDING FRAMING PLAN

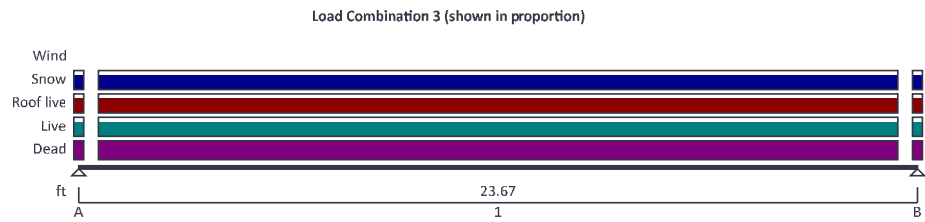
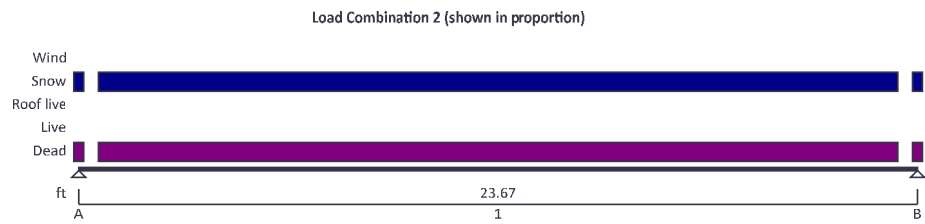
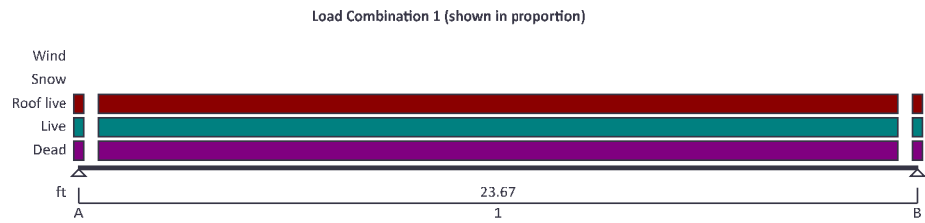
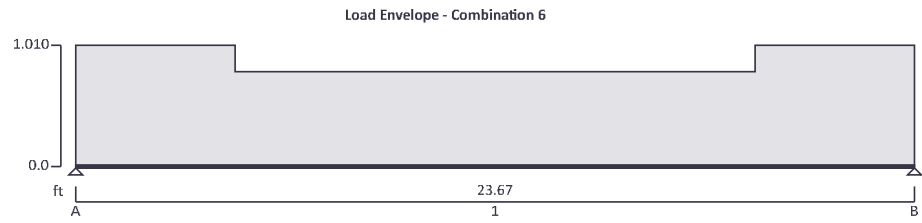
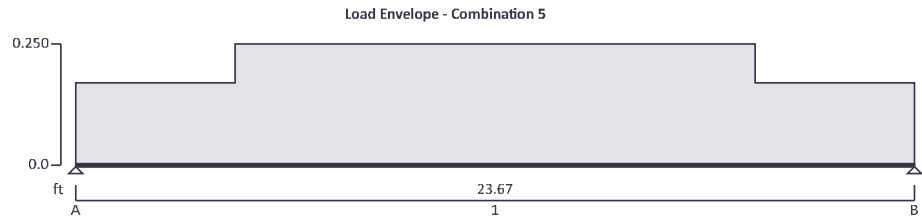
STEEL BEAM ANALYSIS & DESIGN (AISC360-16)

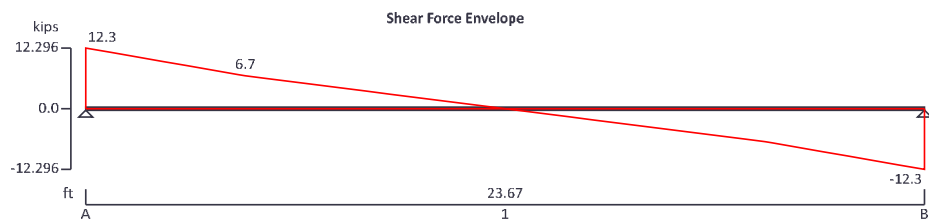
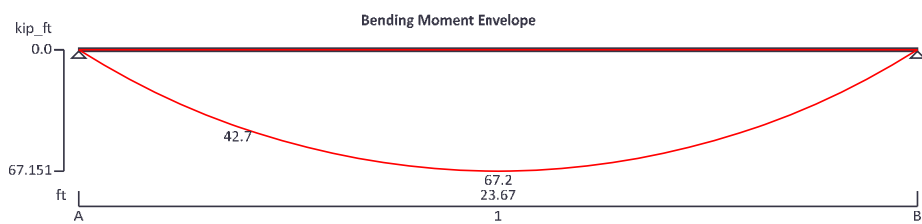
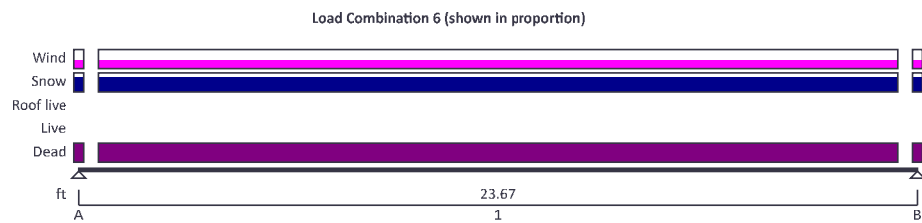
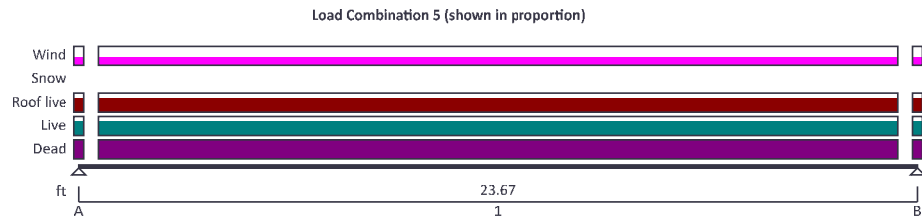
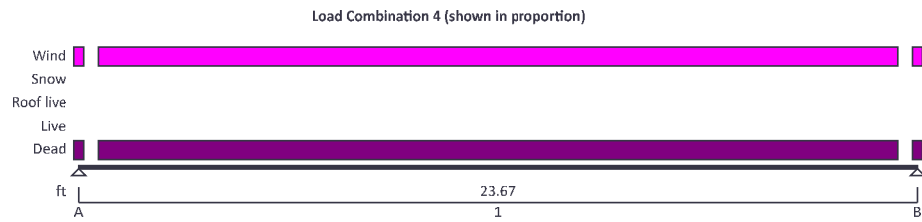
STEEL BEAM FOR BREAK ROOM LOW ROOF CMU BUILDING

In accordance with AISC360-16 using the ASD method

Tedds calculation version 3.0.15







Support conditions
Support A

Vertically restrained

Support B	Rotationally free Vertically restrained Rotationally free	
Applied loading		
Beam loads	Dead full UDL 0 kips/ft Wind full UDL 0.133 kips/ft Snow partial UDL 0.72 kips/ft from 54.00 in to 230.04 in Snow partial UDL 1.2 kips/ft from 230.04 in to 284.04 in Snow partial UDL 1.2 kips/ft from 0.00 in to 54.00 in Dead partial UDL 0.14 kips/ft from 54.00 in to 230.04 in Roof live partial UDL 0.08 kips/ft from 230.04 in to 284.04 in Roof live partial UDL 0.08 kips/ft from 0.00 in to 54.00 in Dead self weight of beam $\times 1$	
Load combinations		
Load combination 1 - D+L	Support A	Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$ Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
	Support B	Dead $\times 1.00$ Live $\times 1.00$ Roof live $\times 1.00$
Load combination 2 - D+S	Support A	Dead $\times 1.00$ Snow $\times 1.00$ Dead $\times 1.00$ Snow $\times 1.00$
	Support B	Dead $\times 1.00$ Snow $\times 1.00$
Load combination 3 - D+0.75L+.75S	Support A	Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$ Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
	Support B	Dead $\times 1.00$ Live $\times 0.75$ Roof live $\times 0.75$ Snow $\times 0.75$
Load combination 4 - D+0.6W	Support A	Dead $\times 1.00$ Wind $\times 1.00$ Dead $\times 1.00$

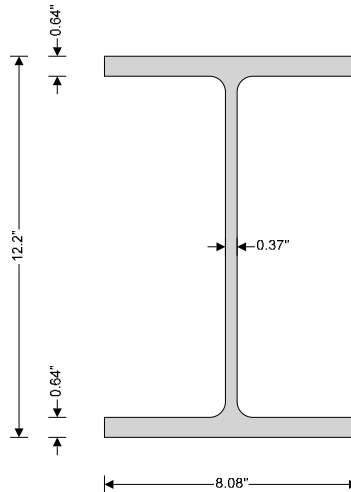
Load combination 5 - $D+0.75(0.6W)+.75L$	Support B	Wind $\times 1.00$
		Dead $\times 1.00$
		Wind $\times 1.00$
		Dead $\times 1.00$
		Live $\times 0.75$
	Support A	Roof live $\times 0.75$
		Wind $\times 0.45$
		Dead $\times 1.00$
		Live $\times 0.75$
		Roof live $\times 0.75$
Load combination 6 - $D+0.75(0.6W)+.75S$	Support B	Wind $\times 0.45$
		Dead $\times 1.00$
		Live $\times 0.75$
		Roof live $\times 0.75$
		Wind $\times 0.45$
	Support A	Dead $\times 1.00$
		Snow $\times 0.75$
		Wind $\times 0.45$
		Dead $\times 1.00$
		Snow $\times 0.75$
	Support B	Wind $\times 0.45$
		Dead $\times 1.00$
		Snow $\times 0.75$
		Wind $\times 0.45$

Analysis results

Maximum moment;	$M_{\max} = 67.2$ kips_ft;	$M_{\min} = 0$ kips_ft
Maximum shear;	$V_{\max} = 12.3$ kips;	$V_{\min} = -12.3$ kips
Deflection;	$\delta_{\max} = 0.7$ in;	$\delta_{\min} = 0$ in
Maximum reaction at support A;	$R_{A_{\max}} = 12.3$ kips;	$R_{A_{\min}} = 2$ kips
Unfactored dead load reaction at support A;	$R_{A_{\text{Dead}}} = 1.6$ kips	
Unfactored roof live load reaction at support A;	$R_{A_{\text{Roof live}}} = 0.4$ kips	
Unfactored snow load reaction at support A;	$R_{A_{\text{Snow}}} = 10.7$ kips	
Unfactored wind load reaction at support A;	$R_{A_{\text{Wind}}} = 1.6$ kips	
Maximum reaction at support B;	$R_{B_{\max}} = 12.3$ kips;	$R_{B_{\min}} = 2$ kips
Unfactored dead load reaction at support B;	$R_{B_{\text{Dead}}} = 1.6$ kips	
Unfactored roof live load reaction at support B;	$R_{B_{\text{Roof live}}} = 0.4$ kips	
Unfactored snow load reaction at support B;	$R_{B_{\text{Snow}}} = 10.7$ kips	
Unfactored wind load reaction at support B;	$R_{B_{\text{Wind}}} = 1.6$ kips	

Section details

Section type;	W 12x50 (AISC 15th Edn (v15.0))
ASTM steel designation;	A992
Steel yield stress;	$F_y = 50$ ksi
Steel tensile stress;	$F_u = 65$ ksi
Modulus of elasticity;	$E = 29000$ ksi



Safety factors

Safety factor for tensile yielding	$\Omega_{ty} = 1.67$
Safety factor for tensile rupture	$\Omega_{tr} = 2.00$
Safety factor for compression	$\Omega_c = 1.67$
Safety factor for flexure	$\Omega_b = 1.67$

Lateral bracing

Span 1 has lateral bracing at supports only

Classification of sections for local buckling - Section B4.1

Classification of flanges in flexure - Table B4.1b (case 10)

Width to thickness ratio;	$b_f / (2 \times t_f) = 6.31$	
Limiting ratio for compact section;	$\lambda_{pff} = 0.38 \times \sqrt{E / F_y} = 9.15$	
Limiting ratio for non-compact section;	$\lambda_{rff} = 1.0 \times \sqrt{E / F_y} = 24.08$;	Compact

Classification of web in flexure - Table B4.1b (case 15)

Width to thickness ratio;	$(d - 2 \times k) / t_w = 26.81$	
Limiting ratio for compact section;	$\lambda_{pwf} = 3.76 \times \sqrt{E / F_y} = 90.55$	
Limiting ratio for non-compact section;	$\lambda_{rwf} = 5.70 \times \sqrt{E / F_y} = 137.27$;	Compact

Section is compact in flexure

Design of members for shear - Chapter G

Required shear strength	$V_r = \max(\text{abs}(V_{\max}), \text{abs}(V_{\min})) = 12.296$ kips
Web area	$A_w = d \times t_w = 4.514$ in ²
Web plate buckling coefficient	$k_v = 5.34$
Web shear coefficient - eq G2-3	$C_{v1} = 1$
Nominal shear strength – eq G6-1	$V_n = 0.6 \times F_y \times A_w \times C_{v1} = 135.420$ kips
Safety factor for shear	$\Omega_v = 1.50$
Allowable shear strength	$V_c = V_n / \Omega_v = 90.280$ kips

PASS - Allowable shear strength exceeds required shear strength

Design of members for flexure in the major axis - Chapter F

Required flexural strength;	$M_r = \max(\text{abs}(M_{s1_max}), \text{abs}(M_{s1_min})) = 67.151$ kips_ft
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Yielding - Section F2.1

Nominal flexural strength for yielding - eq F2-1; $M_{nyld} = M_p = F_y \times Z_x = \mathbf{299.583 \text{ kips_ft}}$

Lateral-torsional buckling - Section F2.2

Unbraced length; $L_b = L_{s1} = \mathbf{284.04 \text{ in}}$

Limiting unbraced length for yielding - eq F2-5; $L_p = 1.76 \times r_y \times \sqrt{E / F_y} = \mathbf{83.077 \text{ in}}$

Distance between flange centroids; $h_o = d - t_f = \mathbf{11.56 \text{ in}}$

$$c = \mathbf{1}$$

$$r_{ts} = \sqrt{[(I_y \times C_w) / S_x]} = \mathbf{2.251 \text{ in}}$$

Limiting unbraced length for inelastic LTB - eq F2-6

$$L_r = 1.95 \times r_{ts} \times E / (0.7 \times F_y) \times \sqrt{[(J \times c / (S_x \times h_o)) + \sqrt{((J \times c / (S_x \times h_o))^2 + 6.76 \times (0.7 \times F_y / E)^2)}]} = \mathbf{286.325 \text{ in}}$$

Cross-section mono-symmetry parameter; $R_m = \mathbf{1.000}$

Moment at quarter point of segment; $M_A = \mathbf{51.224 \text{ kips_ft}}$

Moment at center-line of segment; $M_B = \mathbf{67.151 \text{ kips_ft}}$

Moment at three quarter point of segment; $M_C = \mathbf{51.224 \text{ kips_ft}}$

Maximum moment in segment; $M_{abs} = \mathbf{67.151 \text{ kips_ft}}$

Lateral torsional buckling modification factor - eq F1-1; $C_b = 12.5 \times M_{abs} / [2.5 \times M_{abs} + 3 \times M_A + 4 \times M_B + 3 \times M_C] = \mathbf{1.128}$

Nominal flexural strength for lateral torsional buckling - eq F2-2; $M_{ntlb} = C_b \times [M_p - (M_p - 0.7 \times F_y \times S_x) \times (L_b - L_p) / (L_r - L_p)] = \mathbf{212.732 \text{ kips_ft}}$

Nominal flexural strength; $M_n = \min(M_{nyld}, M_{ntlb}) = \mathbf{212.732 \text{ kips_ft}}$

Allowable flexural strength; $M_c = M_n / \Omega_b = \mathbf{127.384 \text{ kips_ft}}$

PASS - Allowable flexural strength exceeds required flexural strength

Design of members for vertical deflection

Consider deflection due to dead, live, roof live, snow and wind loads

Limiting deflection; $\delta_{lim} = L_{s1} / 360 = \mathbf{0.789 \text{ in}}$

Maximum deflection span 1; $\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min})) = \mathbf{0.694 \text{ in}}$

PASS - Maximum deflection does not exceed deflection limit

$f'm =$ 1900 psi

Gravity Loads:

Snow Load:	40 psf	Roof Snow Load per Garfield County Building Department
Roof Dead Load:	20 psf	
Live Load:	20 psf	
Metal building:	15 psf	this includes the steel beams and metal skin

Chemical Room:

Gridline E to I: 49.33 ft

Gridline 1 to 4: 29.75 ft

Gridline 4 to 5: 18.91 ft

Gridline 4 Trib: 24.33 ft

Snow Load:

$$p_f = 0.7 * C_e * C_t * I_s * p_g$$

$C_e =$ 0.7 Per table 7.3-1 Exposure Factor of ASCE 7 (above the treeline in windswept mountainous area)

$C_t =$ 1 Per table 7.3-2 Thermal Factor of ASCE 7

$I_s =$ 1.5 Per table 1.5-2 of ASCE 7, Importance Factors by Risk Category

$p_f =$ 40 psf

$$p_s = C_s * p_f =$$

$C_s =$ 1 (assume 1.0 to be conservative)

$p_s =$ 40 psf

Beam Loads:

$w_{snow} =$	973.2 plf	0.973 kip/ft
$w_{roof_live} =$	486.6 plf	0.487 kip/ft
$w_{roof_dead} =$	486.6 plf	0.487 kip/ft
$w_{metal_bld} =$	364.95 plf	0.365 kip/ft

See Tedds printout for reaction at gridline 4:

Max. Reaction = 71 kips (From Tedds printout)

Footing Size:

σ_{bearing} = 3 ksf

pressure = P/A *note: strength load used for allowable bearing at 60% to be conservative

$A =$ Max reaction/Allowable bearing

$A =$ 23.7 ft²

$B =$ 4.9 ft Footing Dimension

CMU Building Flate Roof foundation (Chem. Room):

Snow Load: 40 psf

Roof Dead Load: 20 psf

Live Load: 20 psf

Misc. Dead: 15 psf

Roof Snow Load per Garfield County Building Department

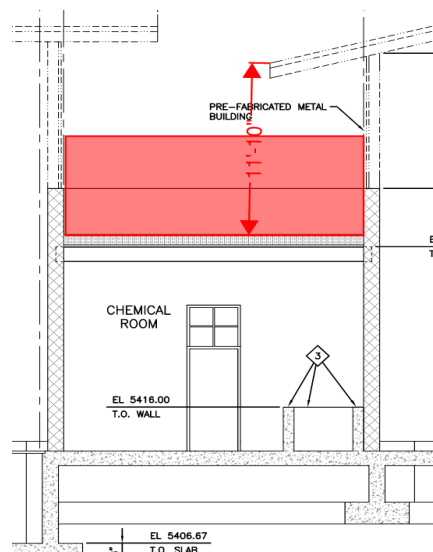
Building Width: 19 ft

Snow Density = 30 pcf

roof snow height: 10 ft

Flat roof build up: 300.0 psf

Trib = 4 ft



Beam Loads:

w_{snow} = 600.0 plf 0.600 kip/ft

$w_{\text{roof_live}}$ = 40 plf 0.040 kip/ft

$w_{\text{roof_dead}}$ = 40 plf 0.040 kip/ft

w_{misc} = 30 plf 0.030 kip/ft

Concentrated Load on CMU:

Tedds Reaction= 9 kips

bearing plate:

width= 7 in

length= 12 in

A1= 84 in²

A2= 176

A_br1= 121.6 in²

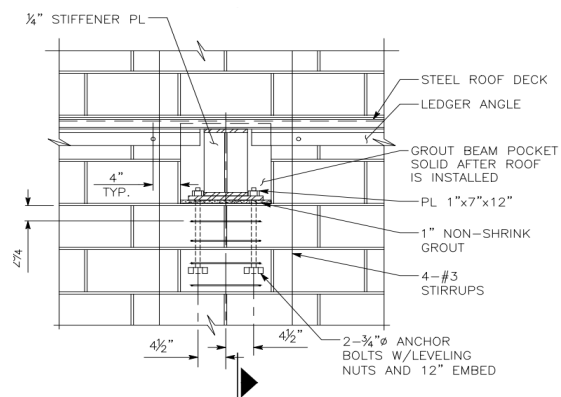
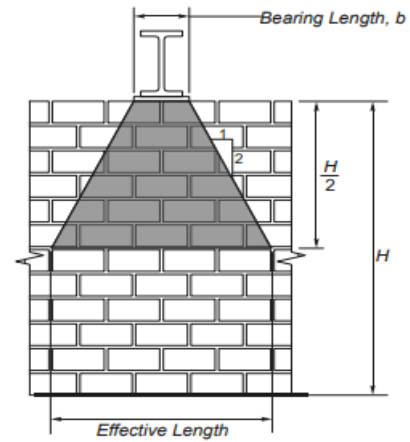
A_br2= 168 in²

Controls

f_br=P/A_br1= 74.02 psi

F_br=0.25f'm= 475 psi

bearing check= GOOD



SECTION A
NO SCALE

12" CMU WALL ROOF BEAM TO
EXTERIOR WALL CONNECTIONN

S453
TYP

Seismic Load:

Sds=	0.305	
Sd1=	0.078	
R_cmu=	5	
R_sp.mt=	5.5	
R_int.mt=	4	
H_cmu=	18 ft	Height of Cmu Building
H_sp.mt=	39.27 ft	Height of Process Room
H_int.mt=	32.4 ft	Height of Chemical Room
le=	1.5	

V=C_sW Per ASCE 7-16 equation 12.8-1

T_L= 4

x _{moment} =	0.8	Ct1=	0.028	Per table 12.8-2 of ASCE 7-16
x _{struc} =	0.75	Ct2=	0.02	

T _{sp.mt} =	0.314	Approximate Period for Process Room
T _{int.mt} =	0.272	Approximate Period for Chemical Room
T _{cmu} =	0.175	Approximate Period for CMU Building

T<T_L

CMU Building:

C _s =	0.092	
C _{s_max} =	0.134	C _s =0.092
C _{s_min} =	0.020	

Chem Building:

C _s =	0.114	
C _{s_max} =	0.108	C _{s_max} =0.114
C _{s_min} =	0.020	

Process Building:

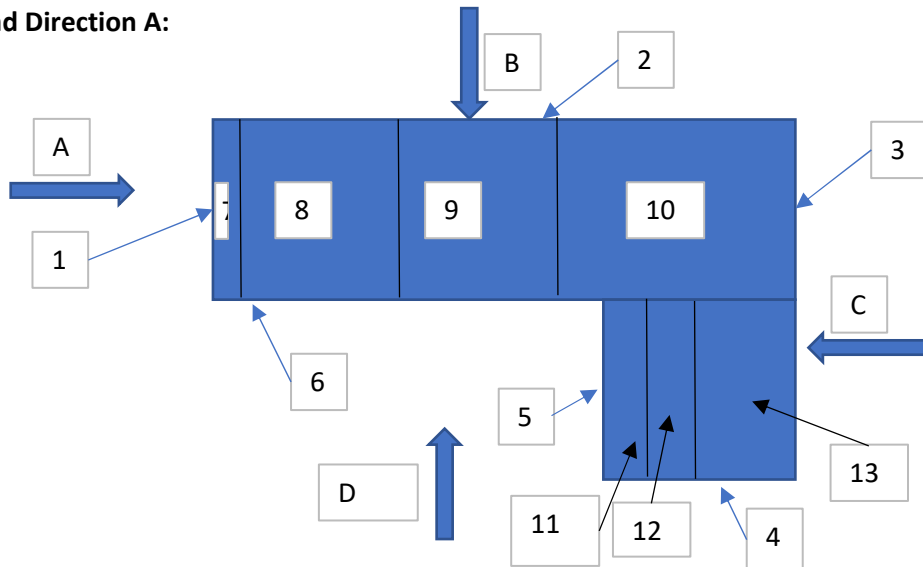
C _s =	0.083	
C _{s_max} =	0.068	C _s =0.068
C _{s_min} =	0.020	

Wind Speed= 115 mph
 Exposure= C
 Risk C.= 4 Risk Category
 I_w= 1 Wind importance factor

 K_{zt}= 1 Topographic Factor
 K_z= 0.9 Velocity Pressure Exposure Coefficients - Table 26.10-1 ASCE 7-16
 K_d= 0.85 Wind Directional Factor - Table 26.6-1 ASCE 7-16
 K_e= 1 Ground Elevation Factor - Table 26.9-1 ASCE 7-16

 q_z= 25.9 psf EQ 26.10-1 ASCE 7-16
 H= 18 feet
 G= 0.85 Gust Factor

Wind Direction A:



Because of asymmetry, all four wind directions are considered (normal to walls). The wall surfaces are numbered 1 through 6; roof surface are 7 and 8.

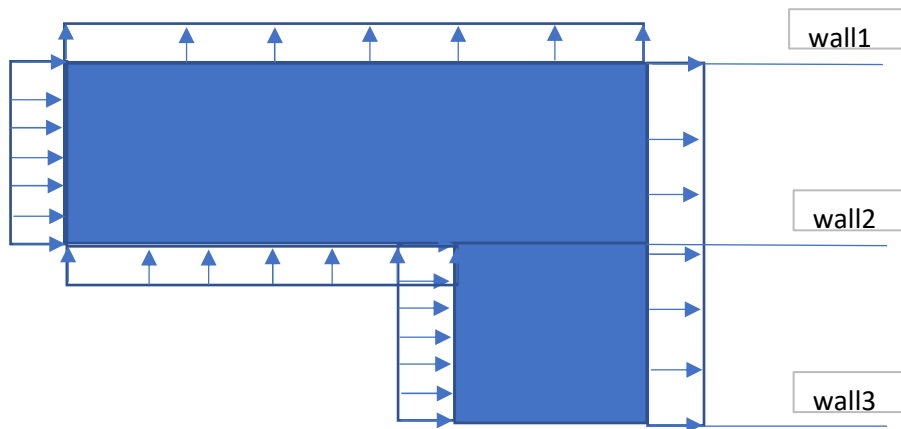
Wind Direction A:

Walls:

	G	L/B	C _p	(+)G _{cpi}	(-)G _{cpi}	q((+)G _{cpi})	q((-)G _{cpi})
surface 1=	0.85	side	0.8	0.18	-0.18	12.9	22.3
surface 2=	0.85	3.9	-0.7	0.18	-0.18	-20.1	-10.7
surface 3=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 4=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 5=	0.85	0.89	-0.5	0.18	-0.18	-15.7	-6.3
surface 6=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7

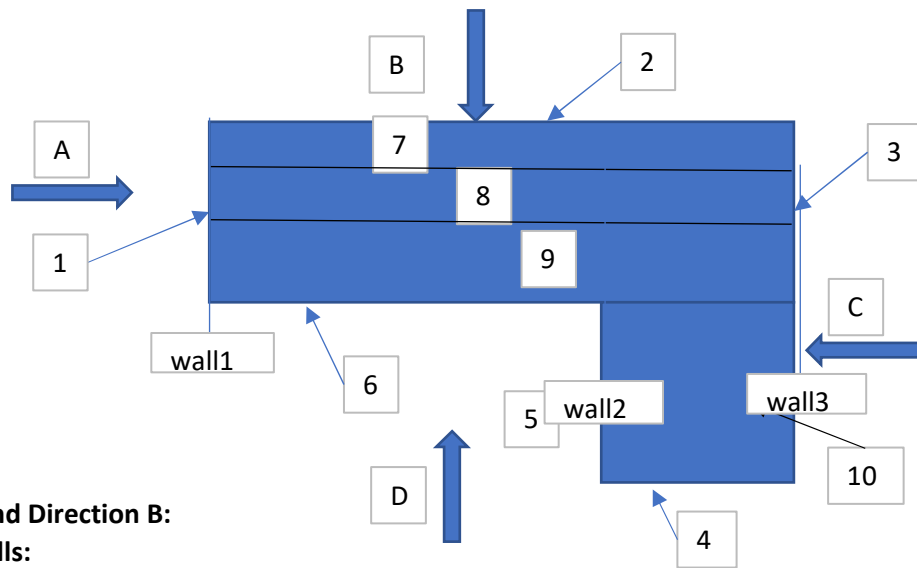
Roof:

	G	h/L	Cp	(+)Gcpi	(-)Gcpi	q((+)Gcpi)	q((-)Gcpi)
surface 7=	0.85	2	-1.3	0.18	-0.18	-33.3	-24.0
surface 8=	0.85	2	-1.3	0.18	-0.18	-33.3	-24.0
surface 9=	0.85	0.5	-0.18	0.18	-0.18	-8.6	0.7
surface 10=	0.85	0.5	-0.18	0.18	-0.18	-8.6	0.7
surface 11=	0.85	2	-1.3	0.18	-0.18	-33.3	-24.0
surface 12=	0.85	2	-1.3	0.18	-0.18	-33.3	-24.0
surface 13=	0.85	0.5	-0.18	0.18	-0.18	-8.6	0.7

Pressure Distribution:

Wall Force 1:	4196.01 lbs	Controls Design
Wall Force 2:	1874.35 lbs	
Wall Force 3:	5073.68 lbs	Controls Design

Wind Direction B:



Wind Direction B:

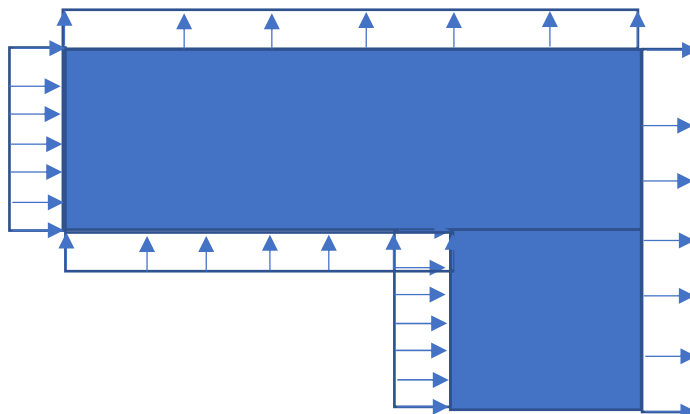
Walls:

	G	L/B	Cp	(+)Gcpi	(-)Gcpi	q((+)Gcpi)	q((-)Gcpi)
surface 1=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 2=	0.85	0.3	-0.5	0.18	-0.18	-15.7	-6.3
surface 3=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 4=	0.85	2.0	-0.3	0.18	-0.18	-11.3	-1.9
surface 5=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 6=	0.85	0.75	-0.3	0.18	-0.18	-11.3	-1.9

Roof:

	G	h/L	Cp	(+)Gcpi	(-)Gcpi	q((+)Gcpi)	q((-)Gcpi)
surface 7=	0.85	0.33	-0.18	0.18	-0.18	-8.6	0.7
surface 8=	0.85	0.33	-0.18	0.18	-0.18	-8.6	0.7
surface 9=	0.85	3	-1.3	0.18	-0.18	-33.3	-24.0
surface 10=	0.85	0.5	-0.18	0.18	-0.18	-8.6	0.7

Pressure distribution



Wall Force 1: 2534.95 lbs

Wall Force 2: 948.07 lbs

Wall Force 3: 948.07 lbs

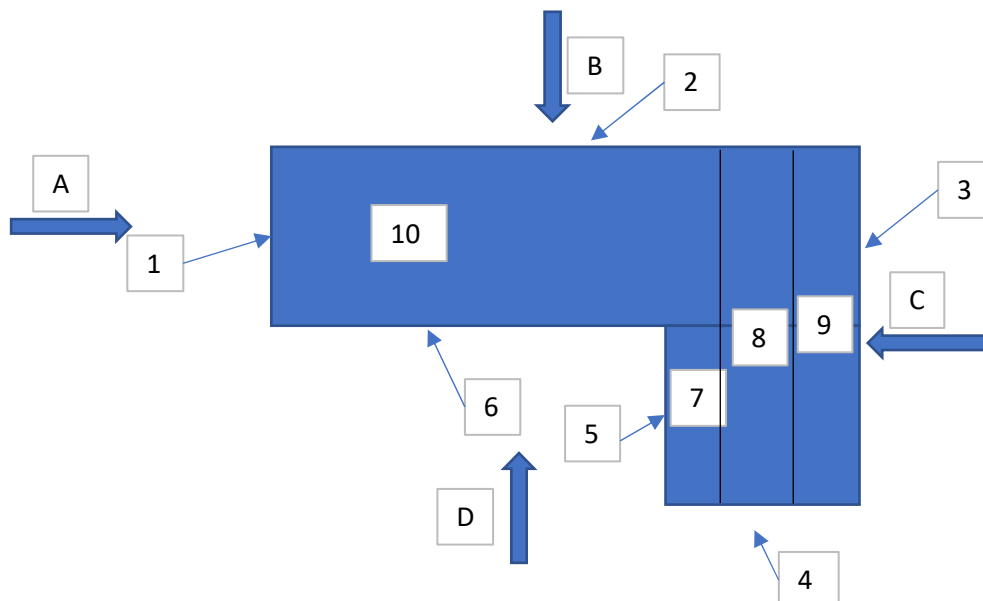
Wind Direction C:

Walls:

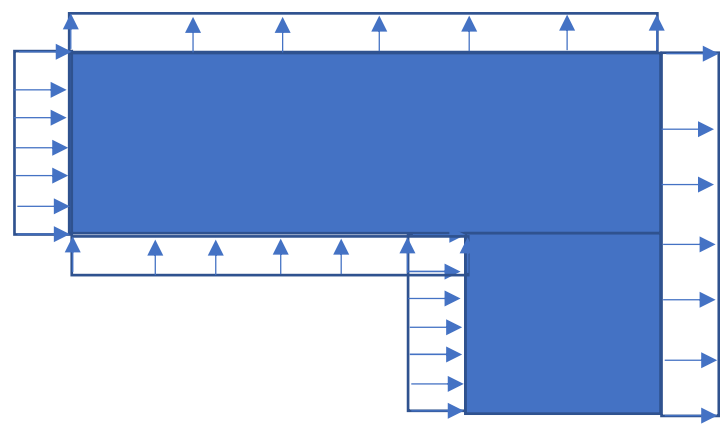
	G	L/B	Cp	(+)Gcpi	(-)Gcpi	q((+)Gcpi)	q((-)Gcpi)
surface 1=	0.85	3.5	-0.2	0.18	-0.18	-9.1	0.3
surface 2=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 3=	0.85	2.00	0.8	0.18	-0.18	12.9	22.3
surface 4=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 5=	0.85	1.2	-0.3	0.18	-0.18	-11.3	-1.9
surface 6=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7

Roof:

	G	h/L	Cp	(+)Gcpi	(-)Gcpi	q((+)Gcpi)	q((-)Gcpi)
surface 7=	0.85	1.36	-1.3	0.18	-0.18	-33.3	-24.0
surface 8=	0.85	1.36	-1.3	0.18	-0.18	-33.3	-24.0
surface 9=	0.85	0.32	-0.18	0.18	-0.18	-8.6	0.7
surface 10=	0.85	0.6	-0.18	0.18	-0.18	-8.6	0.7

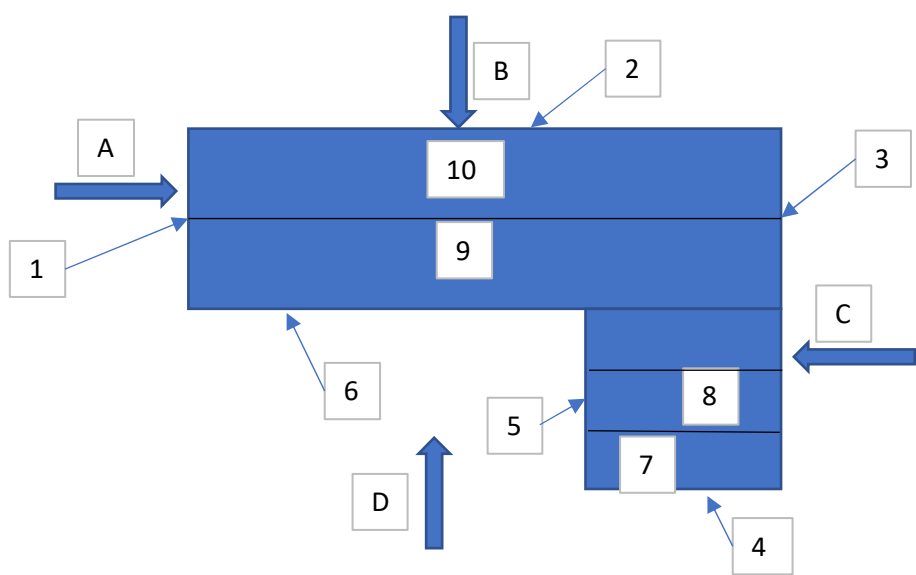


Pressure distribution



Wall Force 1: 3832.37 lbs

Wind Direction D:



Wind Direction D:

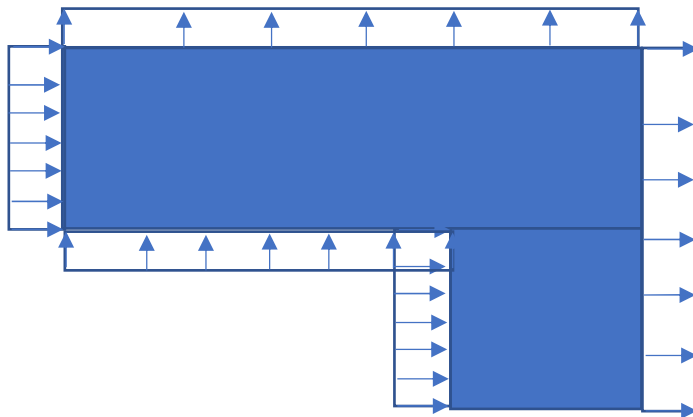
Walls:

	G	L/B	Cp	(+)Gcpi	(-)Gcpi	q((+)Gcpi)	q((-)Gcpi)
surface 1=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 2=	0.85	0.6	-0.3	0.18	-0.18	-11.3	-1.9
surface 3=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 4=	0.85	0.8	0.8	0.18	-0.18	12.9	22.3
surface 5=	0.85	side	-0.7	0.18	-0.18	-20.1	-10.7
surface 6=	0.85	1.6	0.8	0.18	-0.18	12.9	22.3

Roof:

	G	h/L	Cp	(+)Gcpi	(-)Gcpi	q((+)Gcpi)	q((-)Gcpi)
surface 7=	0.85	1.36	-1.3	0.18	-0.18	-33.3	-24.0
surface 8=	0.85	1.36	-1.3	0.18	-0.18	-33.3	-24.0
surface 9=	0.85	0.32	-0.18	0.18	-0.18	-8.6	0.7
surface 10=	0.85	0.6	-0.18	0.18	-0.18	-8.6	0.7

Pressure distribution



MASONRY WALL PANEL DESIGN TO TMS 402/602-16

WIND SHEAR LOADING AND OUT OF PLANE LOADING ON CMU BUILDING

Using the allowable stress design method

Tedds calculation version 2.2.07

Masonry wall panel details

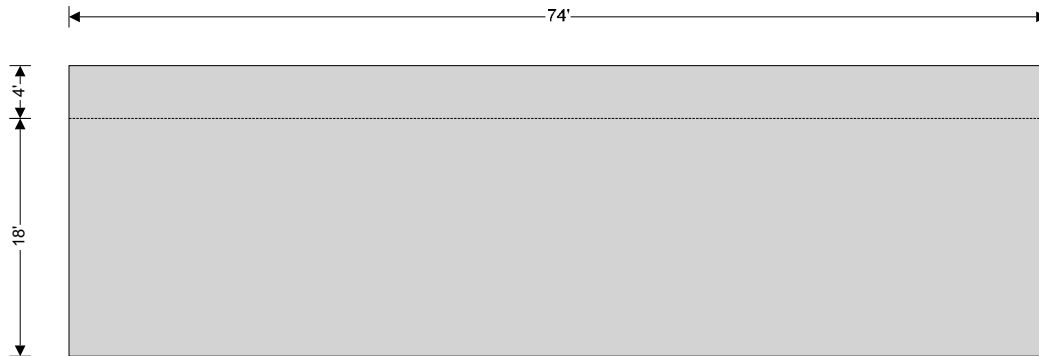
Wall Force 1 - Reinforced single-wythe wall with a parapet, the wall is pinned at the top and at the bottom for out of plane loads

The wall is fixed at the bottom and free at the top for in plane loads

Panel length; $L = 74$ ft

Panel height; $h = 18$ ft

Parapet height; $h_p = 4$ ft



Seismic properties

Seismic design category; C

Seismic importance factor (ASCE7 Table 1.5-2); $I_e = 1.5$

Design spectral response acceleration parameter, short periods (ASCE7 11.4.4)

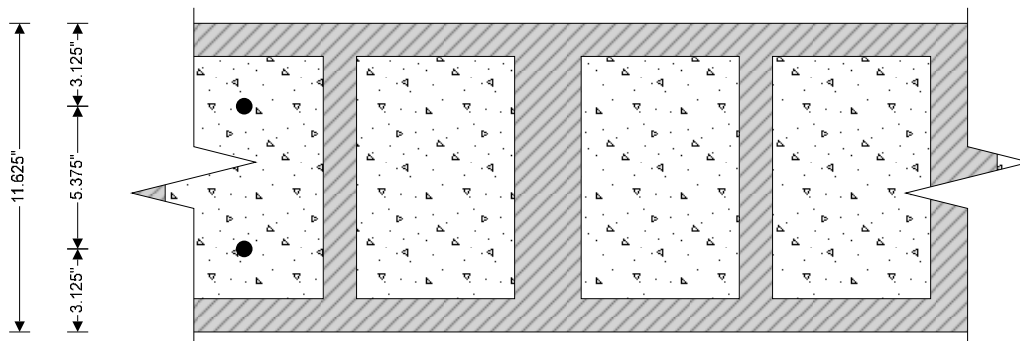
$S_{DS} = 0.02$

Seismic wall classification; Nonparticipating

Redundancy factor, on out-of-plane load; $\rho_E = 1.0$

Construction details

Wall thickness; $t = 11.625$ in



Masonry details

Hollow concrete units fully grouted in running bond fully bedded with PCL class M mortar

Compressive strength of unit; $f'_{cu} = 2800$ psi

Density of masonry units;

$$\gamma_{\text{block}} = 115 \text{ lb/ft}^3$$

Height of masonry units;

$$h_b = 7.625 \text{ in}$$

Length of masonry units;

$$l_b = 15.625 \text{ in}$$

Number of internal webs;

$$N_{\text{web}} = 1$$

Number of end webs;

$$N_{\text{end}} = 2$$

Internal web thickness;

$$t_{bw} = 1.25 \text{ in}$$

Face shell thickness;

$$t_{bf} = 1.25 \text{ in}$$

End web thickness;

$$t_{be} = 1.25 \text{ in}$$

Area of block;

$$A_{\text{block}} = [t \times l_b - (l_b - N_{\text{web}} \times t_{bw} - N_{\text{end}} \times t_{be}) \times (t - 2 \times t_{bf})] / l_b =$$

$$56.28 \text{ in}^2/\text{ft}$$

Area of grout;

$$A_{\text{grout}} = [(l_b - N_{\text{web}} \times t_{bw} - N_{\text{end}} \times t_{be}) \times (t - 2 \times t_{bf})] / l_b = 83.22$$

in²/ft

Density of grout;

$$\gamma_{\text{grout}} = 140 \text{ lb/ft}^3$$

Self weight of wall construction;

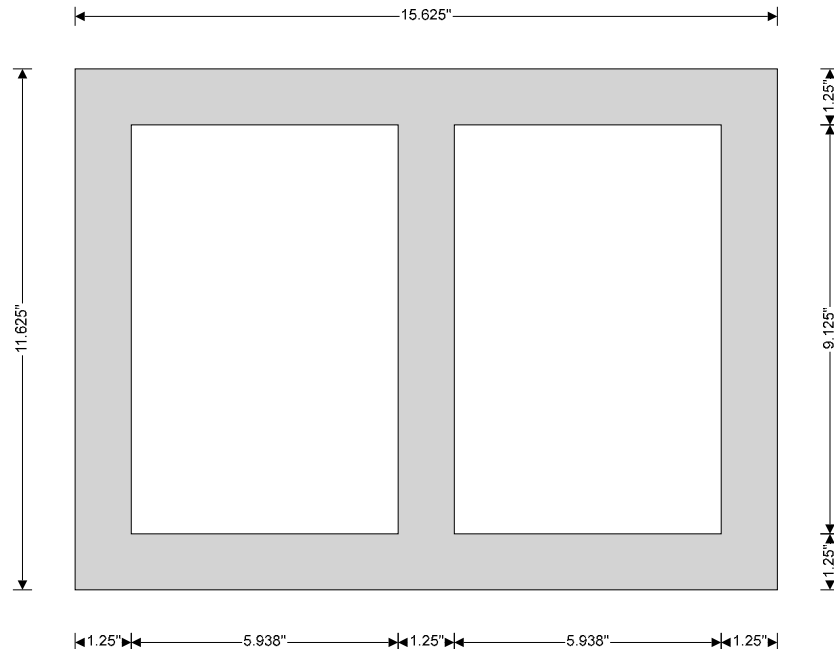
$$WSW_w = A_{\text{block}} \times \gamma_{\text{block}} + A_{\text{grout}} \times \gamma_{\text{grout}} = 125.85 \text{ psf}$$

Self weight of bond beam;

$$WSW_b = 2 \times t_{bf} \times \gamma_{\text{block}} + (t - 2 \times t_{bf}) \times \gamma_{\text{grout}} = 130.42 \text{ psf}$$

Self weight of wall;

$$WSW = ((s_v - h_b) \times WSW_w + h_b \times WSW_b) / s_v = 126.58 \text{ psf}$$



From TMS 602-16 Table 2 - Compressive strength of masonry

Net compressive strength of masonry;

$$f'_m = 2250 \text{ psi}$$

Modulus of elasticity for masonry;

$$E_m = 900 \sqrt{f'_m} = 2025000 \text{ psi}$$

Shear modulus of masonry;

$$G_v = 0.4 \sqrt{E_m} = 810000 \text{ psi}$$

From TMS 402 -16 Table 8.2.4.2 - Allowable flexural tensile stresses for clay and concrete masonry

Allowable flexural tensile stress normal to bed;

$$F_{t_{\text{norm}}} = 65 \text{ psi}$$

Allowable flexural tensile stress parallel to bed;

$$F_{t_{\text{para}}} = 106 \text{ psi}$$

Reinforcement details

Yield strength of reinforcement;

$$f_y = 60000 \text{ psi}$$

Allowable tensile stress in reinforcement;	$F_s = 32000$ psi
Modulus of elasticity for reinforcement;	$E_s = 29000000$ psi
Vertical reinforcement provided;	No.5 bars at 48 in centers
Area of vertical reinforcement, per face;	$A_s = \pi \times \text{Dia}^2 / (4 \times s) = 0.08$ in ² /ft
Yield strength of horizontal reinforcement;	$f_{yv} = 60000$ psi
Allowable tensile stress in horizontal reinforcement;	$F_{sv} = 32000$ psi
Horizontal reinforcement provided;	(2) No. 5 bars at 48 in centers
Area of horizontal reinforcement;	$A_v = 2 \times \pi \times \text{HDia}^2 / (4 \times s_v) = 0.15$ in ² /ft
Minimum area of vertical reinf. (8.3.5.2.2);	$A_{s_min} = A_v / 3 = 0.05$ in ² /ft

PASS - Area of vertical reinforcement provided exceeds the minimum

Seismic reinforcement requirements

Minimum vertical reinf., seismic (Ch. 7);	No. 4 bars at 120 in
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PASS - Vertical distributed reinforcement meets minimum seismic requirements

Lateral out-of-plane loads

Wind load on panel;	$W = 20.1$ psf
Wind load on parapet;	$W_p = 45.225$ psf
Seismic load factor (ASCE7 12.11.1);	$F_p = 0.4 \times S_{DS} \times I_e = 0.012$
Seismic load from wall;	$E_{wall} = \max(F_p, 0.1) \times w_{SW} = 12.7$ psf
Additional seismic load;	$E_{add} = 0$ psf
Seismic lateral load on panel;	$E = E_{wall} + E_{add} = 12.7$ psf

Lateral in-plane loads

Wind shear load on wall;	$V_W = 4196$ lbs
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Vertical loading details

Live roof load at supported level;	$LL_r = -486$ lb/ft;
Snow load at supported level;	$SL = -973$ lb/ft;
Wind load at supported level;	$WL = -333$ lb/ft;
Vertical seismic load factor applied to dead load;	$F_{Ev} = 0.2 \times S_{DS} = 0.004$

From ASCE 7-16 cl.2.4 - Combining nominal loads using allowable stress design (Utilization)

Load combination no.1;	DL; (0.045)
Load combination no.2;	DL + LL ; (0.045)
Load combination no.3;	DL + (LL _r or SL or RL); (0.045)
Load combination no.4;	DL + 0.75 × LL + 0.75 × (LL _r or SL or RL); (0.045)
Load combination no.5;	DL + 0.6 × W; (0.165)
Load combination no.7;	DL + 0.75 × LL + 0.45 × W + 0.75 × (LL _r or SL or RL); (0.123)
Load combination no.8;	DL + 0.75 × LL + 0.525 × E _h + 0.525 × E _v + 0.75 × SL; (0.117)
Load combination no.9;	0.6 × DL + 0.6 × W; (0.190)

Properties of masonry section

Cross-sectional area;	$A = t = 139.5$ in ² /ft
Properties for walls loaded out-of-plane:	
Moment of inertia;	$I = t^3 / 12 = 1571$ in ⁴ /ft
Section modulus;	$S = I / c = 270.3$ in ³ /ft
Radius of gyration;	$r = \sqrt{I / A} = 3.356$ in
Effective height factor;	$K = 1$
Properties for walls loaded in-plane:	

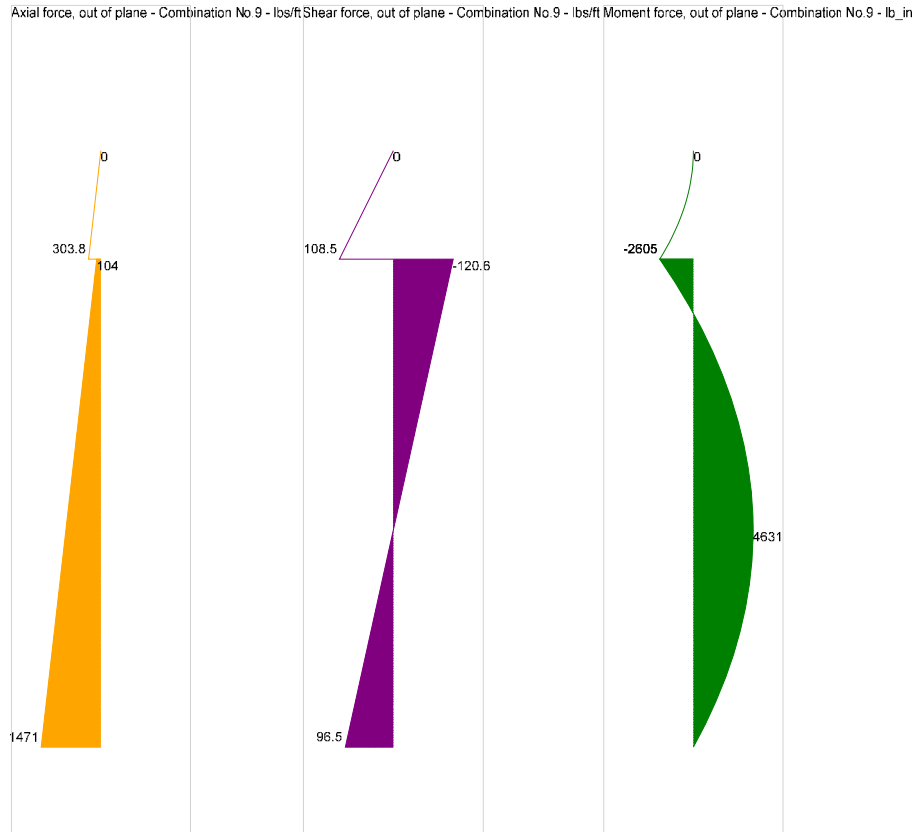
Gross moment of inertia;

$$I_{x_gross} = t \times L^3 / 12 = \mathbf{678344976 \text{ in}^4}$$

Gross section modulus;

$$S_{x_gross} = I_{x_gross} / (L / 2) = \mathbf{1527804 \text{ in}^3}$$

Consider wall at maximum moment location under load combination no.9



Maximum moment location;

8 ft

Axial load at max moment loc. of panel;

$P = \mathbf{863 \text{ lb/ft}}$

Compressive stress due to axial load;

$$f_a = P / A = \mathbf{6.2 \text{ psi}}$$

Slenderness ratio;

$$(K \times h) / r = \mathbf{64.365} < 99$$

Allowable compressive stress due to axial load;

$$F_a = (1 / 4) \times f_m \times [1 - ((K \times h) / (140 \times r))^2] = \mathbf{443.6 \text{ psi}}$$

$$f_a / F_a = \mathbf{0.014}$$

PASS - Allowable compressive stress exceeds compressive stress due to axial loads

Allowable compressive force;

$$P_a = 0.25 \times f_m \times (A - 2 \times A_s) \times [1 - ((K \times h) / (140 \times r))^2] =$$

61815 lb/ft

$$P / P_a = \mathbf{0.014}$$

PASS - Allowable compressive force exceeds axial load

Bending moment at max. moment loc. of panel;

$M = \mathbf{4631 \text{ lb_in/ft}}$

Depth of reinforcement;

$d = \mathbf{8.5 \text{ in}}$

Effective width per bar;

$$b_{eff} = \min(s, 6 \times t_{nom}, 72 \text{ in}) = \mathbf{48 \text{ in}}$$

Modular ratio;

$$n = E_s / E_m = \mathbf{14.321}$$

Allowable compressive stress due to flexural load;

$$F_b = (0.45) \times f_m = \mathbf{1013 \text{ psi}}$$

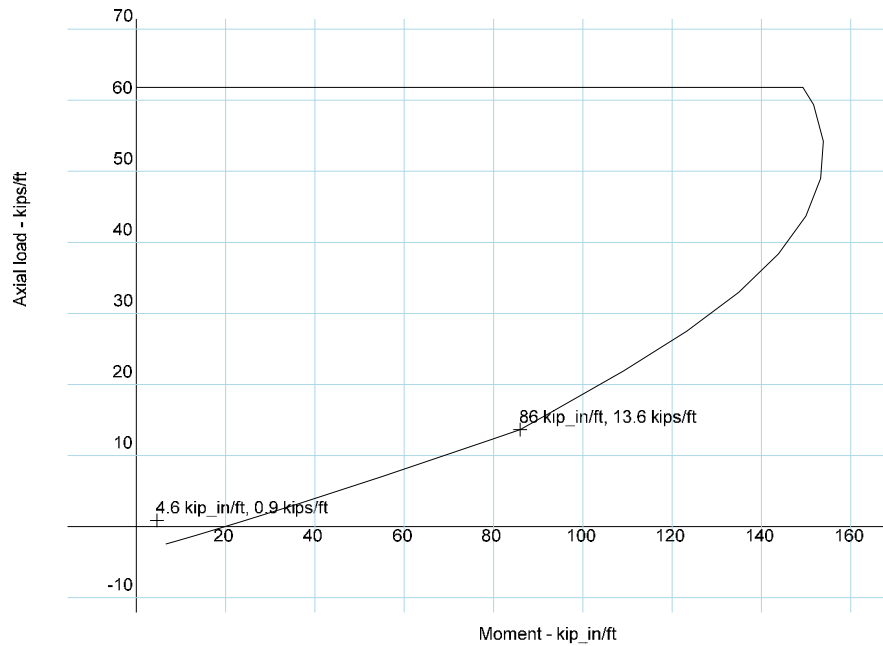
Balance point;

$$k_{bal} = n / (F_s / F_b + n) = \mathbf{0.312}$$

Tensile strain in reinforcement;
 Compressive strain in masonry;
 Compressive stress at balance point;
 Tension at balance point;
 Compression at balance point;
 Axial load at balance point;
 Moment at balance point;

$$\begin{aligned}\epsilon_s &= F_s / E_s = \mathbf{0.001103} \\ \epsilon_m &= \epsilon_s \times k_{bal} / (1 - k_{bal}) = \mathbf{0.000500} \\ f_{bal} &= \epsilon_m \times E_m = \mathbf{1012.5 \text{ psi}} \\ T_{bal} &= A_s \times F_s = \mathbf{2454 \text{ lb/ft}} \\ C_{bal} &= k_{bal} \times d \times f_{bal} / 2 = \mathbf{16102 \text{ lb/ft}} \\ P_{bal} &= C_{bal} - T_{bal} = \mathbf{13648 \text{ lb/ft}} \\ M_{bal} &= T_{bal} \times (d - t / 2) + C_{bal} \times (t / 2 - k_{bal} \times d / 3) = \mathbf{85963 \text{ lb_in/ft}} \\ M_c &= \mathbf{24380 \text{ lb_in/ft}} \\ M / M_c &= \mathbf{0.19}\end{aligned}$$

Maximum moment from interaction diagram;



Allowable stress interaction diagram

Consider wall at top under load combination no.9

Shear force;
 Net shear area;
 Shear stress;
 Compressive force;
 Moment;
 Allowable masonry shear stress;
 Allowable shear stress;
 Shear utilization;

$$\begin{aligned}V &= \mathbf{120.6 \text{ lb/ft}} \\ A_{nv} &= d = \mathbf{102 \text{ in}^2/\text{ft}} \\ f_v &= V / A_{nv} = \mathbf{1.2 \text{ psi}} \\ N_v &= 0.60 \times P_{DL,t,out} / 1 \text{ ft} = \mathbf{303.8 \text{ lb/ft}} \\ M &= \mathbf{2605 \text{ lb_in/ft}} \\ F_{vm} &= 0.5 \times [4 - 1.75 \times \min((M / (V \times d)), 1.0)] \times \sqrt{(f'_m \times 1 \text{ psi})} \\ &\quad + 0.25 \times N_v / A = \mathbf{53.9 \text{ psi}} \\ F_v &= \min(F_{vm}, 2 \times \sqrt{(f'_m \times 1 \text{ psi})}) = \mathbf{53.9 \text{ psi}} \\ f_v / F_v &= \mathbf{0.022}\end{aligned}$$

PASS - Allowable shear stress exceeds applied shear stress

MASONRY WALL PANEL DESIGN TO TMS 402/602-16

WIND SHEAR LOADING AND OUT OF PLANE LOADING ON CMU BUILDING

Using the allowable stress design method

Tedds calculation version 2.2.07

Masonry wall panel details

Wall Force 3 - Reinforced single-wythe wall with a parapet, the wall is pinned at the top and at the bottom for out of plane loads

The wall is fixed at the bottom and free at the top for in plane loads

Panel length; $L = 24.7$ ft

Panel height; $h = 18$ ft

Parapet height; $h_p = 4$ ft



Seismic properties

Seismic design category; C

Seismic importance factor (ASCE7 Table 1.5-2); $I_e = 1.5$

Design spectral response acceleration parameter, short periods (ASCE7 11.4.4)

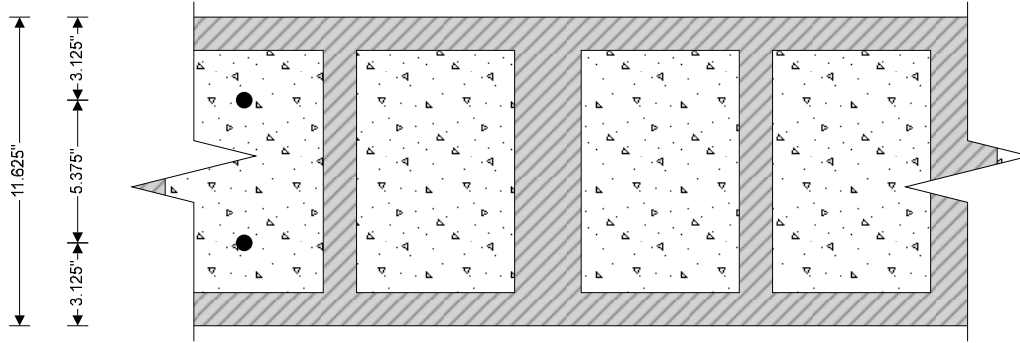
$S_{DS} = 0.02$

Seismic wall classification; Nonparticipating

Redundancy factor, on out-of-plane load; $\rho_E = 1.0$

Construction details

Wall thickness; $t = 11.625$ in



Masonry details

Hollow concrete units fully grouted in running bond fully bedded with PCL class M mortar

Compressive strength of unit;

$$f_{cu} = 2800 \text{ psi}$$

Density of masonry units;

$$\gamma_{block} = 115 \text{ lb/ft}^3$$

Height of masonry units;

$$h_b = 7.625 \text{ in}$$

Length of masonry units;

$$l_b = 15.625 \text{ in}$$

Number of internal webs;

$$N_{web} = 1$$

Number of end webs;

$$N_{end} = 2$$

Internal web thickness;

$$t_{bw} = 1.25 \text{ in}$$

Face shell thickness;

$$t_{bf} = 1.25 \text{ in}$$

End web thickness;

$$t_{be} = 1.25 \text{ in}$$

Area of block;

$$A_{block} = [t \times l_b - (l_b - N_{web} \times t_{bw} - N_{end} \times t_{be}) \times (t - 2 \times t_{bf})] / l_b =$$

$$56.28 \text{ in}^2/\text{ft}$$

Area of grout;

$$A_{grout} = [(l_b - N_{web} \times t_{bw} - N_{end} \times t_{be}) \times (t - 2 \times t_{bf})] / l_b = 83.22$$

in²/ft

Density of grout;

$$\gamma_{grout} = 140 \text{ lb/ft}^3$$

Self weight of wall construction;

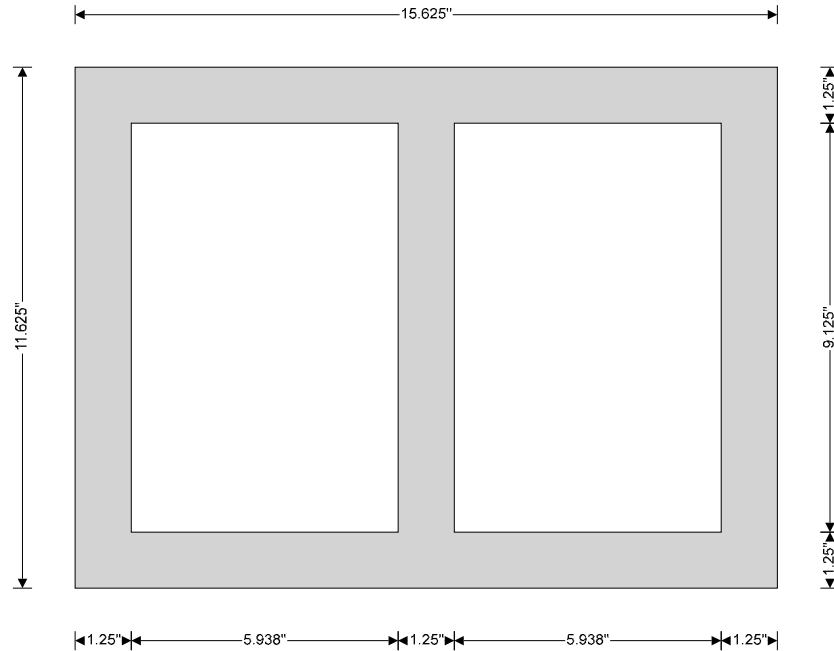
$$WSW_w = A_{block} \times \gamma_{block} + A_{grout} \times \gamma_{grout} = 125.85 \text{ psf}$$

Self weight of bond beam;

$$WSW_b = 2 \times t_{bf} \times \gamma_{block} + (t - 2 \times t_{bf}) \times \gamma_{grout} = 130.42 \text{ psf}$$

Self weight of wall;

$$WSW = ((s_v - h_b) \times WSW_w + h_b \times WSW_b) / s_v = 126.58 \text{ psf}$$



From TMS 602-16 Table 2 - Compressive strength of masonry

Net compressive strength of masonry; $f'_m = 2250$ psi

Modulus of elasticity for masonry; $E_m = 900 \sqrt{f'_m} = 2025000$ psi

Shear modulus of masonry; $G_v = 0.4 \sqrt{E_m} = 810000$ psi

From TMS 402 -16 Table 8.2.4.2 - Allowable flexural tensile stresses for clay and concrete masonry

Allowable flexural tensile stress normal to bed; $F_{t_norm} = 65$ psi

Allowable flexural tensile stress parallel to bed; $F_{t_para} = 106$ psi

Reinforcement details

Yield strength of reinforcement; $f_y = 60000$ psi

Allowable tensile stress in reinforcement; $F_s = 32000$ psi

Modulus of elasticity for reinforcement; $E_s = 29000000$ psi

Vertical reinforcement provided; No.5 bars at 48 in centers

Area of vertical reinforcement, per face; $A_s = \pi \times \text{Dia}^2 / (4 \times s) = 0.08$ in²/ft

Yield strength of horizontal reinforcement; $f_{yv} = 60000$ psi

Allowable tensile stress in horizontal reinforcement; $F_{sv} = 32000$ psi

Horizontal reinforcement provided; (2) No. 5 bars at 48 in centers

Area of horizontal reinforcement; $A_v = 2 \times \pi \times \text{HDia}^2 / (4 \times s_v) = 0.15$ in²/ft

Minimum area of vertical reinf. (8.3.5.2.2); $A_{s_min} = A_v / 3 = 0.05$ in²/ft

PASS - Area of vertical reinforcement provided exceeds the minimum

Seismic reinforcement requirements

Minimum vertical reinf., seismic (Ch. 7); No. 4 bars at 120 in

PASS - Vertical distributed reinforcement meets minimum seismic requirements

Lateral out-of-plane loads

Wind load on panel; $W = 20.1$ psf

Wind load on parapet; $W_p = 45.225$ psf

Seismic load factor (ASCE7 12.11.1);

$$F_p = 0.4 \times S_{DS} \times I_e = \mathbf{0.012}$$

Seismic load from wall;

$$E_{wall} = \max(F_p, 0.1) \times w_{SW} = \mathbf{12.7 \text{ psf}}$$

Additional seismic load;

$$E_{add} = \mathbf{0 \text{ psf}}$$

Seismic lateral load on panel;

$$E = E_{wall} + E_{add} = \mathbf{12.7 \text{ psf}}$$

Lateral in-plane loads

Wind shear load on wall;

$$V_W = \mathbf{5074 \text{ lbs}}$$

Vertical loading details

Live roof load at supported level;

$$LL_r = \mathbf{-80 \text{ lb/ft;}}$$

Snow load at supported level;

$$SL = \mathbf{-1200 \text{ lb/ft;}}$$

Wind load at supported level;

$$WL = \mathbf{-333 \text{ lb/ft;}}$$

Vertical seismic load factor applied to dead load;

$$F_{Ev} = 0.2 \times S_{DS} = \mathbf{0.004}$$

From ASCE 7-16 cl.2.4 - Combining nominal loads using allowable stress design (Utilization)

Load combination no.1; DL; (0.045)

Load combination no.2; DL + LL ; (0.045)

Load combination no.3; DL + (LL_r or SL or RL); (0.045)

Load combination no.4; DL + 0.75 × LL + 0.75 × (LL_r or SL or RL); (0.045)

Load combination no.5; DL + 0.6 × W; (0.165)

Load combination no.7; DL + 0.75 × LL + 0.45 × W + 0.75 × (LL_r or SL or RL); (0.123)

Load combination no.8; DL + 0.75 × LL + 0.525 × E_h + 0.525 × E_v + 0.75 × SL; (0.121)

Load combination no.9; 0.6 × DL + 0.6 × W; (0.190)

Properties of masonry section

Cross-sectional area;

$$A = t = \mathbf{139.5 \text{ in}^2/\text{ft}}$$

Properties for walls loaded out-of-plane:

Moment of inertia;

$$I = t^3 / 12 = \mathbf{1571 \text{ in}^4/\text{ft}}$$

Section modulus;

$$S = I / c = \mathbf{270.3 \text{ in}^3/\text{ft}}$$

Radius of gyration;

$$r = \sqrt{I / A} = \mathbf{3.356 \text{ in}}$$

Effective height factor;

$$K = \mathbf{1}$$

Properties for walls loaded in-plane:

Gross moment of inertia;

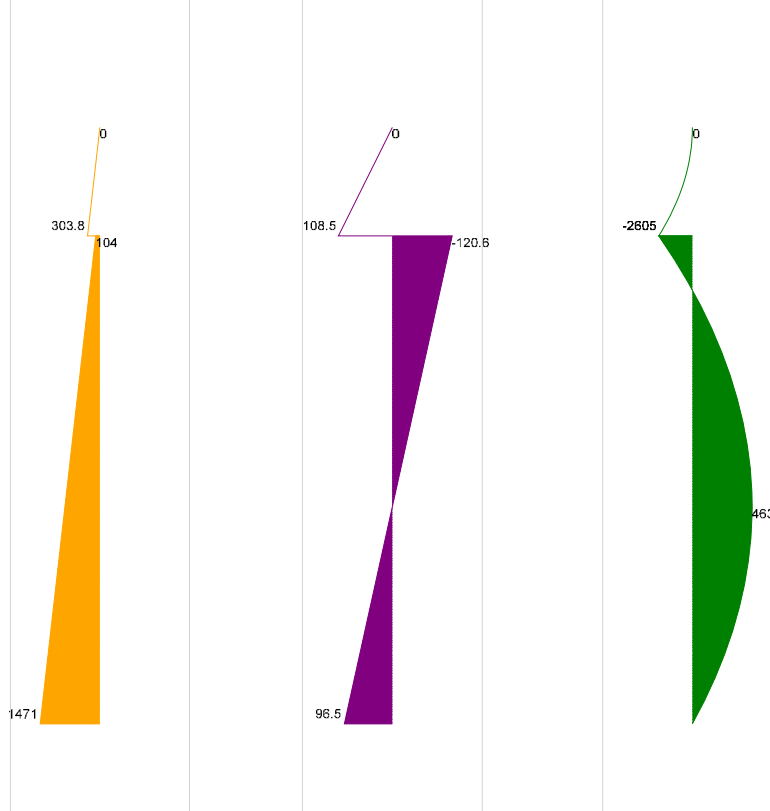
$$I_{x_gross} = t \times L^3 / 12 = \mathbf{25225879 \text{ in}^4}$$

Gross section modulus;

$$S_{x_gross} = I_{x_gross} / (L / 2) = \mathbf{170215 \text{ in}^3}$$

Consider wall at maximum moment location under load combination no.9

Axial force, out of plane - Combination No.9 - lbs/ft Shear force, out of plane - Combination No.9 - lbs/ft Moment force, out of plane - Combination No.9 - lb_in



Maximum moment location;

8 ft

Axial load at max moment loc. of panel;

$P = 863 \text{ lb/ft}$

Compressive stress due to axial load;

$f_a = P / A = 6.2 \text{ psi}$

Slenderness ratio;

$(K \times h) / r = 64.365; < 99$

Allowable compressive stress due to axial load;

$F_a = (1 / 4) \times f_m \times [1 - ((K \times h) / (140 \times r))^2] = 443.6 \text{ psi}$

$f_a / F_a = 0.014$

PASS - Allowable compressive stress exceeds compressive stress due to axial loads

Allowable compressive force;

$P_a = 0.25 \times f_m \times (A - 2 \times A_s) \times [1 - ((K \times h) / (140 \times r))^2] =$

61815 lb/ft

$P / P_a = 0.014$

PASS - Allowable compressive force exceeds axial load

Bending moment at max. moment loc. of panel;

$M = 4631 \text{ lb_in/ft}$

Depth of reinforcement;

$d = 8.5 \text{ in}$

Effective width per bar;

$b_{eff} = \min(s, 6 \times t_{nom}, 72 \text{ in}) = 48 \text{ in}$

Modular ratio;

$n = E_s / E_m = 14.321$

Allowable compressive stress due to flexural load;

$F_b = (0.45) \times f_m = 1013 \text{ psi}$

Balance point;

$k_{bal} = n / (F_s / F_b + n) = 0.312$

Tensile strain in reinforcement;

$\epsilon_s = F_s / E_s = 0.001103$

Compressive strain in masonry;

$\epsilon_m = \epsilon_s \times k_{bal} / (1 - k_{bal}) = 0.000500$

Compressive stress at balance point;

$f_{bal} = \epsilon_m \times E_m = 1012.5 \text{ psi}$

Tension at balance point;

$T_{bal} = A_s \times F_s = 2454 \text{ lb/ft}$

Compression at balance point;

$C_{bal} = k_{bal} \times d \times f_{bal} / 2 = 16102 \text{ lb/ft}$

Axial load at balance point;

$$P_{bal} = C_{bal} - T_{bal} = \mathbf{13648 \text{ lb/ft}}$$

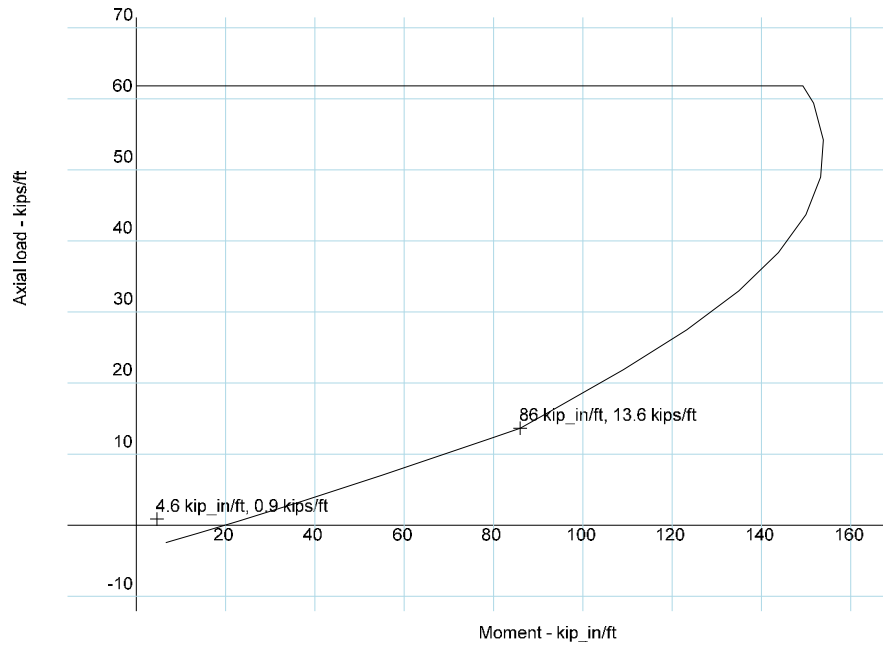
Moment at balance point;

$$M_{bal} = T_{bal} \times (d - t / 2) + C_{bal} \times (t / 2 - k_{bal} \times d / 3) = \mathbf{85963 \text{ lb_in/ft}}$$

Maximum moment from interaction diagram;

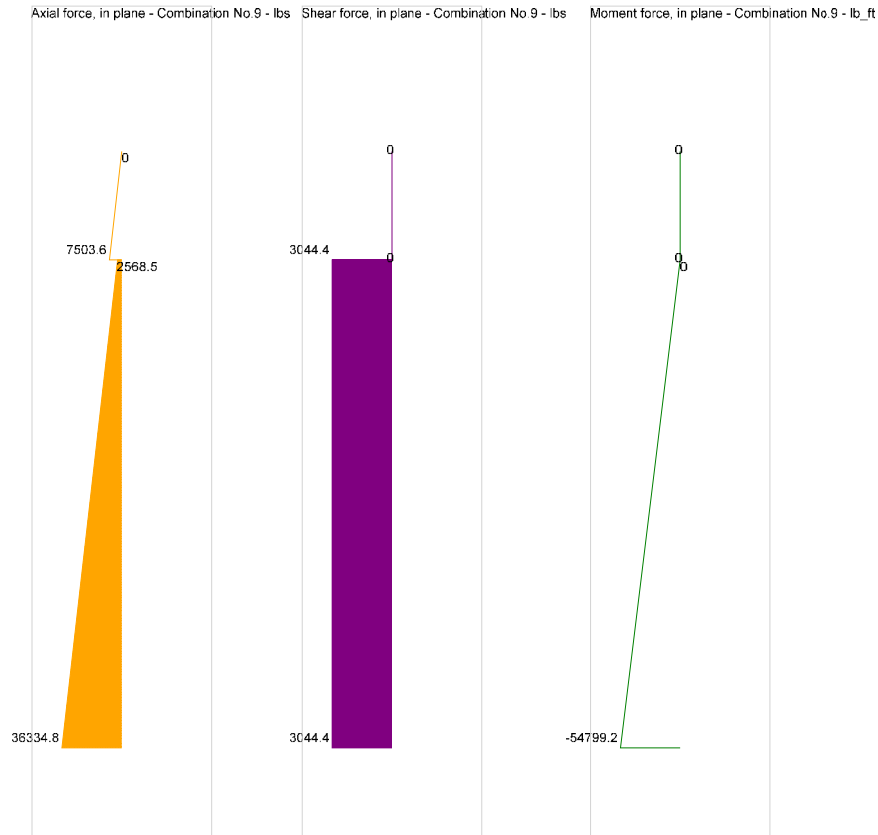
$$M_c = \mathbf{24380 \text{ lb_in/ft}}$$

$$M / M_c = \mathbf{0.19}$$



Allowable stress interaction diagram

Consider wall at top under load combination no.9



Shear force;
 Depth to reinforcement;
 Net shear area;
 Shear stress;
 Compressive force;
 Moment;
 Allowable masonry shear stress;

$$V = 3044.4 \text{ lbs}$$

$$d_{in} = L - l_b / 4 = 24.4 \text{ ft}$$

$$A_{nv} = d_{in} \times t = 3400.2 \text{ in}^2$$

$$f_v = V / A_{nv} = 0.9 \text{ psi}$$

$$N_v = 0.6 \times P_{DL,t,in} = 7503.6 \text{ lbs}$$

$$M_v = 0 \text{ lb_ft}$$

$$F_{vm} = 0.5 \times [4 - 1.75 \times \min((M_v / (V \times d_{in})), 1.0)] \times \sqrt{(f'_m \times 1 \text{ psi})} + 0.25 \times N_v / (A \times L) = 95.4 \text{ psi}$$

$$F_v = \min(F_{vm}, 3 \times \sqrt{(f'_m \times 1 \text{ psi})}) = 95.4 \text{ psi}$$

$$f_v / F_v = 0.009$$

Shear reinforcement is not required for strength

Allowable steel shear stress;
 Allowable shear stress;
 Shear utilization;

$$F_{vs} = 0.5 \times (A_v \times F_{sv} \times d_{in} / (A_{nv} / d_{in} \times 1 \text{ ft})) = 428.8 \text{ psi}$$

$$F_v = \min(F_{vm} + F_{vs}, 3 \times \sqrt{(f'_m \times 1 \text{ psi})}) = 142.3 \text{ psi}$$

$$f_v / F_v = 0.006$$

PASS - Allowable shear stress exceeds applied shear stress

Coefficient of friction;
 Allowable shear friction stress;
 Shear friction utilization;

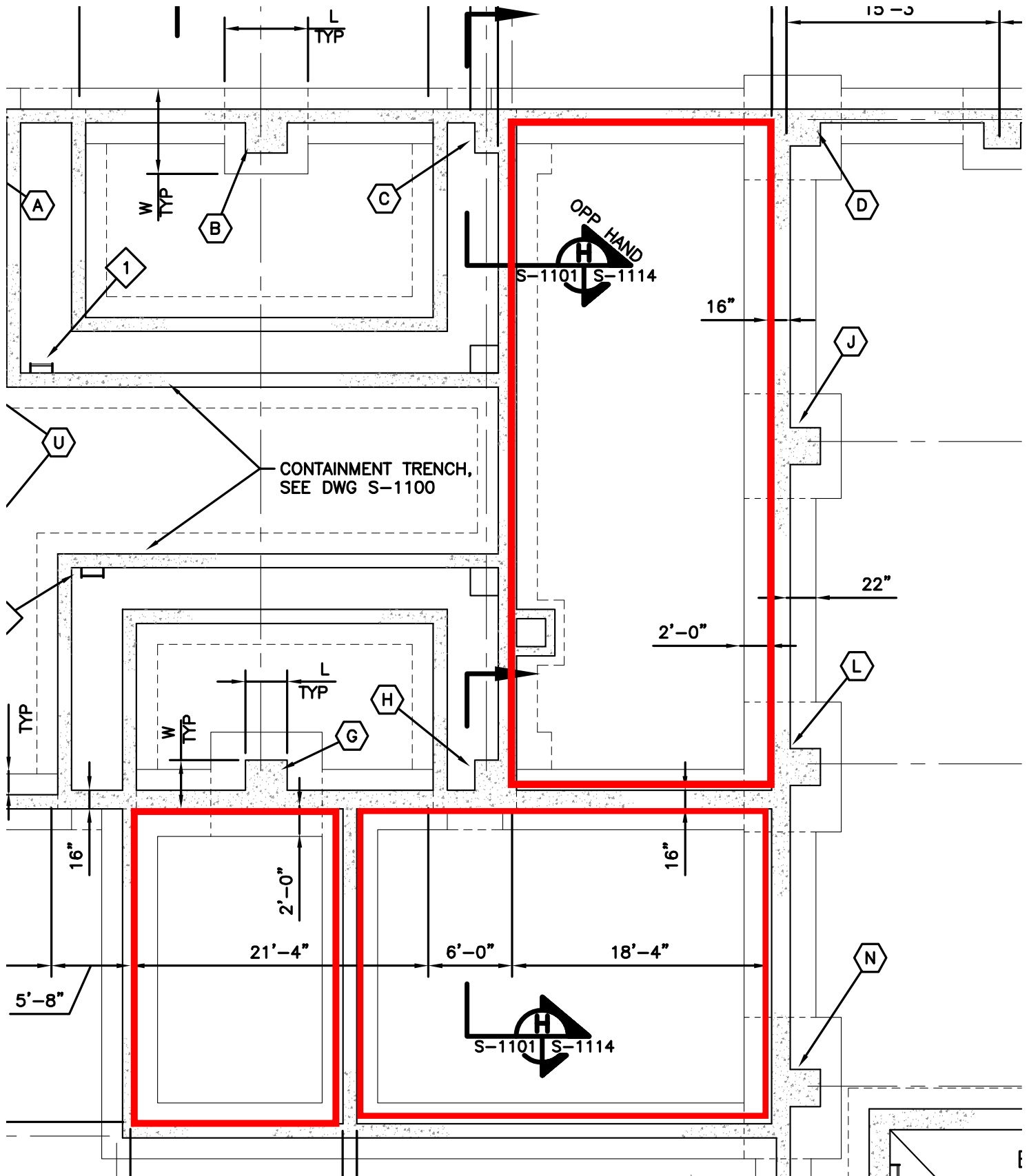
$$\mu = 0.7$$

$$F_f = \max(\mu \times (A_s \times d_{in} \times F_s + N_v) / (A_{nv}), 0 \text{ psi}) = 13.9 \text{ psi}$$

$$f_v / F_f = 0.065$$

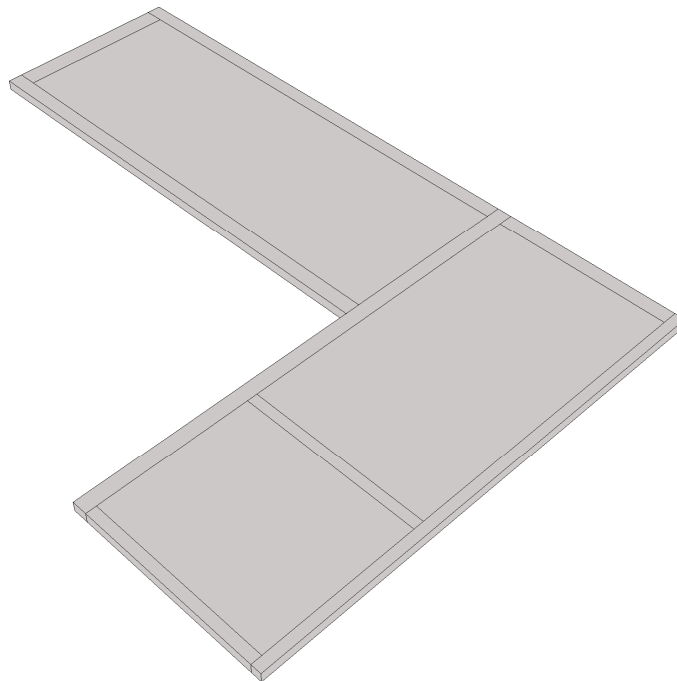
PASS - Allowable shear friction stress exceeds applied shear stress

CMU Building Foundation Design





spMats v10.00 (TM)
A Computer Program for Analysis and Design of Foundation Mats, Combined Footings, and Slabs on Grade
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1. Project

1.1. General Information

File Name	Cmu slab.matx
Project	Cmu slab
Code	ACI 318-14
Units	English
Date	6/16/2023
Time	11:09 AM

1.2. Solver Options

Maximum number of iterations	10
Maximum allowed service displacement	11.00000 in
Minimum ratio of soil contact area w.r.t. initial soil-supported area	50 %
Minimum ratio of active springs and piles w.r.t. total number of springs and piles	0 %
Displacement limit of uplift	0.00000 in
Compute required reinforcement based on	Maximum moment within an element

2. Definitions

2.1. Objects

2.1.1. Slabs

Label	Thickness in	Soil	Concrete	Reinforcement	Design parameters	Assigned
Mat18	18.00	Clay	C3	Gr40	Gr40#4	No
Mat24	24.00	Clay	C3	Gr40	Gr40#4	No
Mat30	30.00	Clay	C3	Gr40	Gr40#4	No
Mat36	36.00	Clay	C3	Gr40	Gr40#4	No
Mat48	48.00	Clay	C3	Gr40	Gr40#4	No
Slab1	18.00	Clay	C4	Gr40	Gr40#4	No
Slab2	18.00	Clay	C4	Gr60	Gr40#4	No
Slab3	18.00	Clay	C4	Gr60	Gr60#5	No
Slab4	18.00	Silt	C4	Gr60	Gr60#5	No
Slab5	12.00	Silt	C4	Gr60	Gr60#5	Yes

2.1.2. Columns

Label	Type	D in	B in	Assigned
C20X20	Rectangle	20.00	20.00	No

2.1.3. Pile - Properties

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
R36	Round	2738.71	Concrete	4286.8	Bedrock	No
S30X30	Square	2570.13	Precast	4286.8	Bedrock	No
1H8X36	H-Type 1	273.29	Steel	29000.0	Bedrock	No

Label	Type	K _p klf	Material	E ksi	Soil	Assigned
2H8X36	H-Type 2	273.29	Steel	29000.0	Bedrock	No

2.1.4. Pile - Geometry

Label	Length ft	Embedment in	D in	B in	tf in	tw in
R36	50.00	6.00	36.00			
S30X30	50.00	6.00	30.00			
1H8X36	50.00	6.00	8.02	8.16	0.45	0.45
2H8X36	50.00	6.00	8.02	8.16	0.45	0.45

2.2. Properties

2.2.1. Soil

Label	K _s kcf	Q _a ksf	Used	Label	K _s kcf	Q _a ksf	Used
Clay	75.000	1.500	Yes	Sand	100.000	2.000	No
Bedrock	600.000	12.000	Yes	Silt	216.000	3.000	Yes

2.2.2. Concrete

Label	f' _c ksi	W _c pcf	E _c ksi	v -	Precast	Used
C3	3.0000	150.00	3320.6	0.200	-	Yes
C4	4.0000	150.00	3834.3	0.200	-	Yes
C5	5.0000	150.00	4286.8	0.200	-	No
C6	6.0000	150.00	4696.0	0.200	-	No
C7	7.0000	150.00	5072.2	0.200	-	No
C8	8.0000	150.00	5422.5	0.200	-	No

2.2.3. Reinforcement

Label	f _y ksi	E _s ksi	Used	Label	f _y ksi	E _s ksi	Used
Gr40	40.0000	29000.0	Yes	Gr50	50.0000	29000.0	No
Gr60	60.0000	29000.0	Yes	Gr75	75.0000	29000.0	No

2.2.4. Design Parameters

Label	Top layer X in	Top layer Y in	Bot. Layer X in	Bot. Layer Y in	Min. Reinf. Ratio %	Used
Gr40#4	3.25	3.75	3.25	3.75	0.10	Yes
Gr50#4	3.25	3.75	3.25	3.75	0.10	No
Gr60#5	2.30	2.90	3.30	3.90	0.09	Yes
Gr75#4	3.25	3.75	3.25	3.75	0.07	No

2.3. Restraints

2.3.1. Nodal Springs

Label	K _{ns} klf	Assigned	Label	K _{ns} klf	Assigned
Spr1	100.00	No			

2.3.2. Slaved Nodes

Label	DOF	Assigned	Label	DOF	Assigned
SlvRx	Rx	No	SlvRy	Ry	No
SlvDz	Dz	No			

2.4. Load Case/Combo.

2.4.1. Load Cases

NOTE: Self weight is included under Case A.

Case	Type	Case label	Load defined?
A	Dead	DL	Yes
B	Live	LL	Yes

2.4.2. Service Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
S1	1.000	0.000	-	-	-	-	-	-	-
S2	1.000	1.000	-	-	-	-	-	-	-

2.4.3. Ultimate Load Combinations

NOTE: Factors listed only for cases with defined loads.

Combo./Case Type	A Dead	B Live	C	D	E	F	G	H	I
Combo./Label	DL	LL							
U1	1.400	0.000	-	-	-	-	-	-	-
U2	1.200	1.600	-	-	-	-	-	-	-

3. Assignments

3.1. Slabs

ID	Label	Shape	Top Left/Center X ft	Top Left/Center Y ft	Height (H)/Dia. (D) ft	Width (B) ft
S1	Slab5	Rectangular	3.00	1.00	4.00	51.00
S2	Slab5	Rectangular	3.00	19.00	15.00	4.00
S3	Slab5	Rectangular	19.00	19.00	15.00	4.00
S4	Slab5	Rectangular	49.50	19.00	15.00	4.50
S5	Slab5	Rectangular	3.00	20.50	4.50	51.00
S6	Slab5	Rectangular	49.50	68.50	49.00	4.50
S7	Slab5	Rectangular	31.50	68.50	49.00	4.00
S8	Slab5	Rectangular	33.00	68.50	4.00	14.50
S9	Slab5	Rectangular	4.00	19.00	18.00	15.00
S10	Slab5	Rectangular	20.00	19.00	18.00	29.50
S11	Slab5	Rectangular	33.00	66.50	46.00	16.50

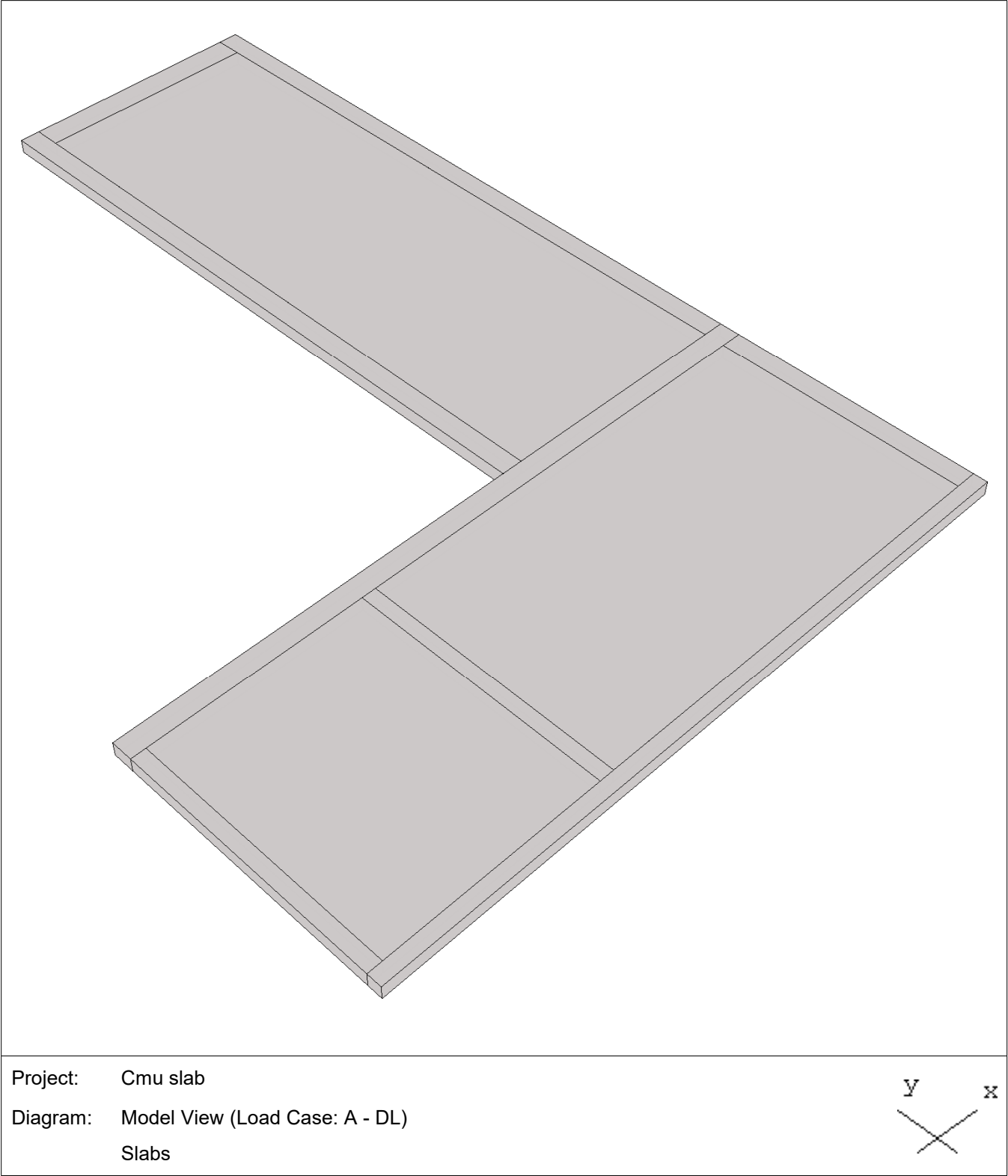
3.2. Area Loads

Slabs ID	Load Case	Wz psf
S1	A - DL	-465.5000
	B - LL	-907.2000

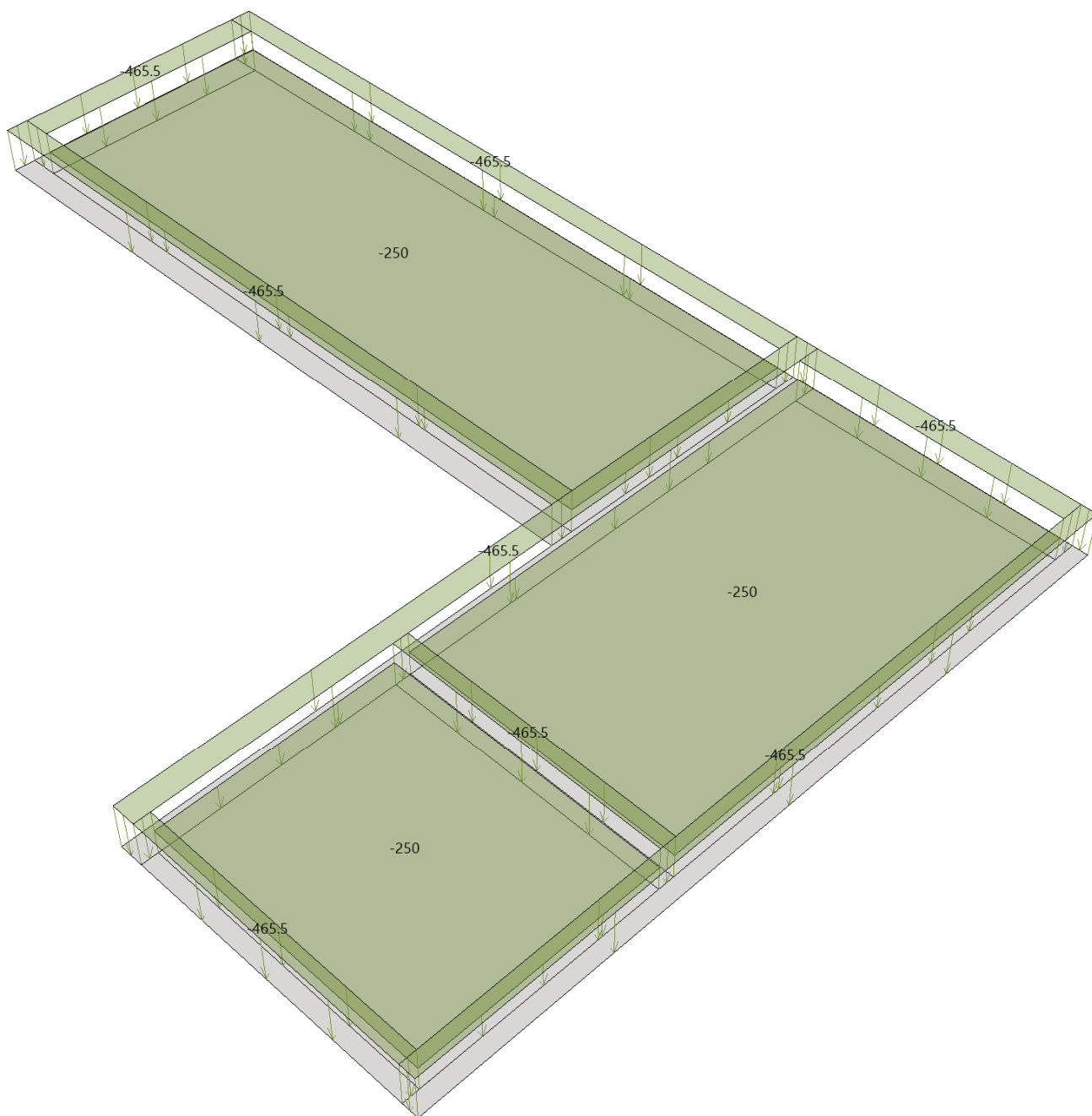
Slabs ID	Load Case	Wz psf
S2	A - DL	-465.5000
S3	A - DL	-465.5000
S4	A - DL	-465.5000
S5	A - DL	-465.5000
	B - LL	-907.2000
S6	A - DL	-465.5000
	B - LL	-747.2000
S7	A - DL	-465.5000
	B - LL	-747.2000
S8	A - DL	-465.5000
S9	A - DL	-250.0000
S10	A - DL	-250.0000
S11	A - DL	-250.0000

4. Screenshots

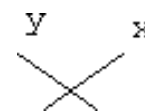
4.1. Extrude 3D view



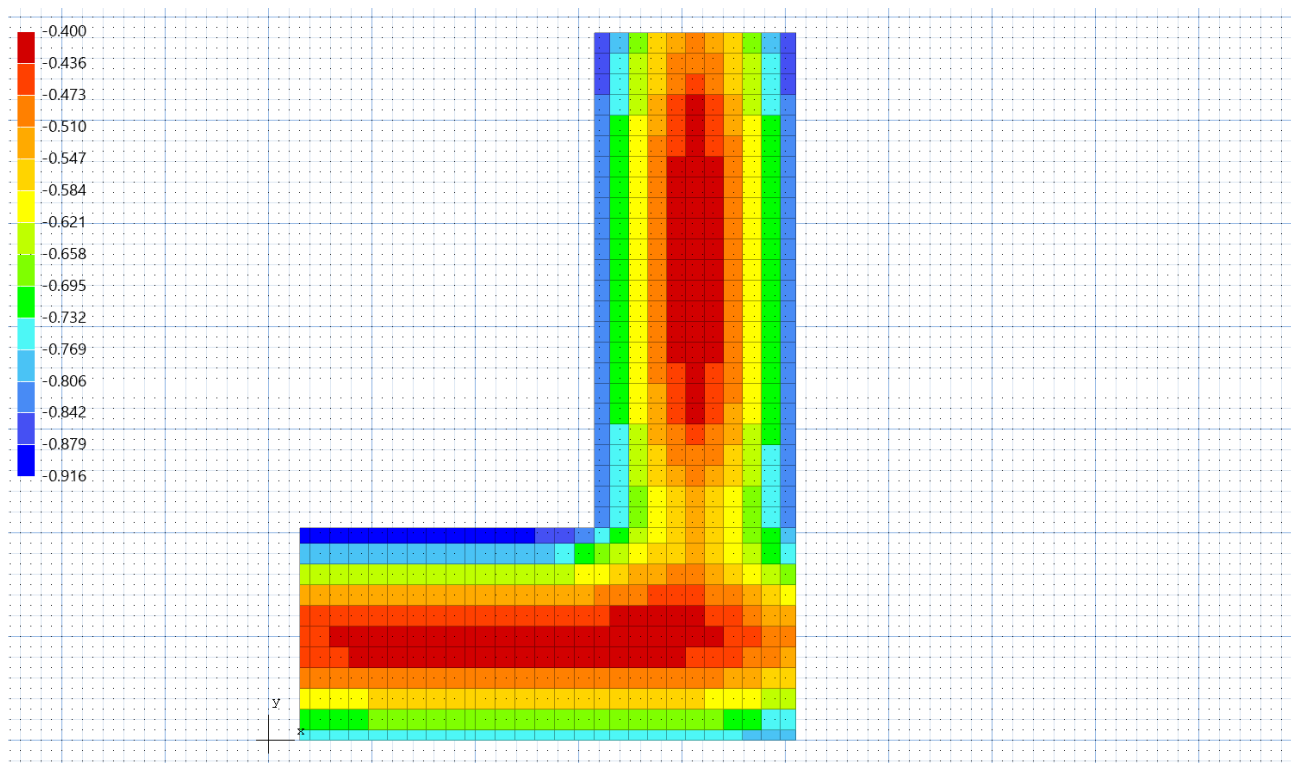
4.2. Loads - Case A - DL



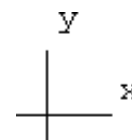
Project: Cmu slab
Diagram: Model View (Load Case: A - DL)
Slabs



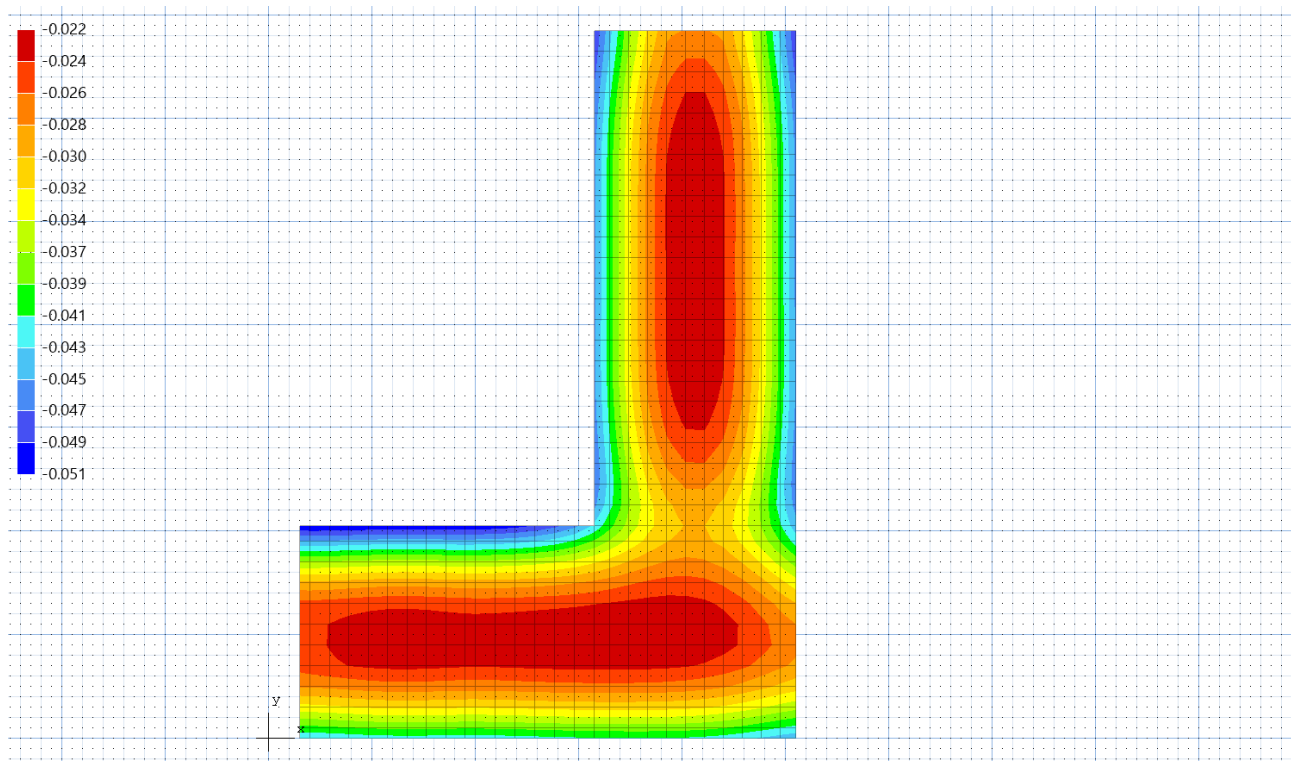
4.3. Envelope - Pressure Down (ksf)



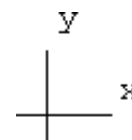
Project: Cmu slab
 Diagram: Envelope - Pressure Down (ksf)
 Max = -0.400 ksf; Min = -0.916 ksf



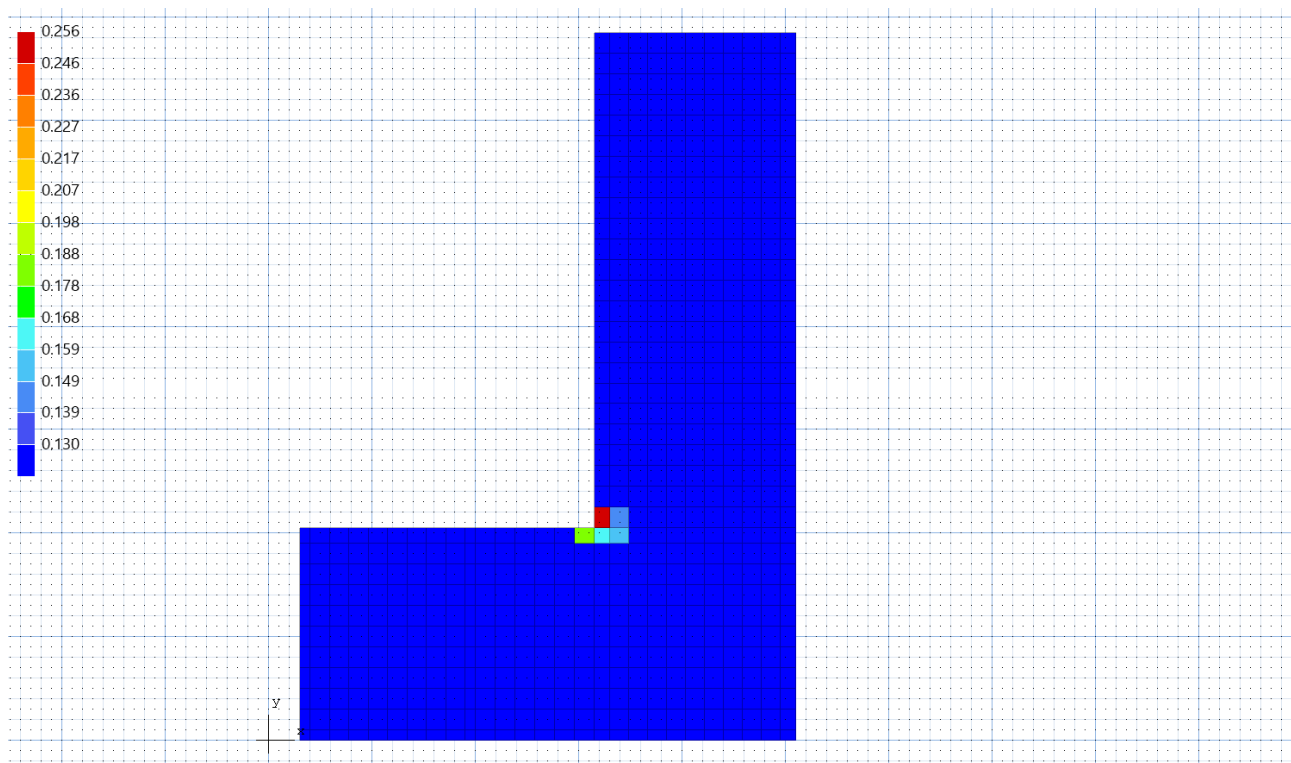
4.4. Envelope - Displacement Down (in)



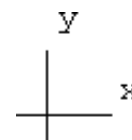
Project: Cmu slab
 Diagram: Envelope - Displacement Down (in)
 Max = -0.022 in; Min = -0.051 in



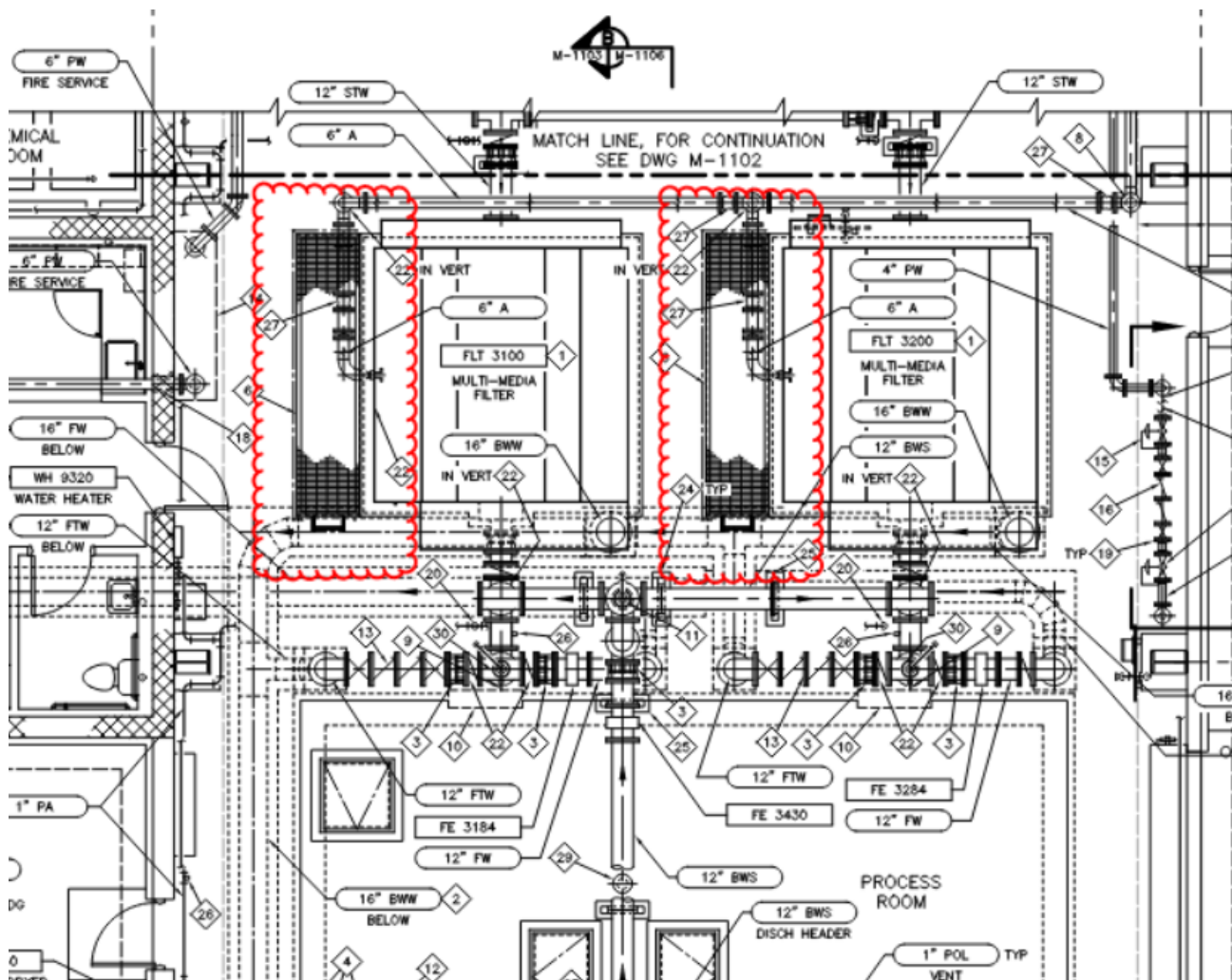
4.5. Envelope - Asy - Bottom (in²/ft)



Project: Cmu slab
 Diagram: Envelope - Asy - Bottom (in²/ft)
 Max = 0.256 in²/ft; Min = 0.130 in²/ft



Access Platform



See Sheet S-1119 of the drawings to see structural details.



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Job No

Sheet No

1

Rev

Part

Job Title

Ref

By

Date 25-Jul-23

Chd

Client

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Date/Time 25-Jul-2023 15:41

Job Information

	Engineer	Checked	Approved
Name:			
Date:	25-Jul-23		

Project ID	
Project Name	

Structure Type	SPACE FRAME
----------------	-------------

Number of Nodes	12	Highest Node	14
Number of Elements	21	Highest Beam	31

Number of Basic Load Cases	2
Number of Combination Load Cases	1

Included in this printout are data for:

All	The Whole Structure
-----	---------------------

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	LL
Primary	2	DL
Combination	3	1.2D+1.6L

Nodes

Node	X (in)	Y (in)	Z (in)
3	0	0	160.500
4	36.000	0	160.500
5	0	94.560	0
6	36.000	94.560	0
7	0	94.560	160.500
8	36.000	94.560	160.500
9	0	0	75.720
10	36.000	0	75.720
11	0	94.560	75.720
12	36.000	94.560	75.720
13	0	0	0
14	36.000	0	0



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2

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Part

Job Title

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Beams

Beam	Node A	Node B	Length (in)	Property	β (degrees)
3	5	6	36.000	1	0
4	9	11	94.560	2	0
5	10	12	94.560	2	0
6	3	7	94.560	2	0
7	4	8	94.560	2	0
8	11	12	36.000	1	0
13	8	7	36.000	1	0
15	6	12	75.720	1	0
17	12	8	84.780	1	0
18	7	11	84.780	1	0
19	11	5	75.720	1	0
20	13	5	94.560	2	0
21	14	6	94.560	2	0
22	7	4	101.181	3	0
23	8	3	101.181	3	0
24	6	13	101.181	3	0
25	5	14	101.181	3	0
28	5	9	121.141	3	0
29	13	11	121.141	3	0
30	6	10	121.141	3	0
31	14	12	121.141	3	0

Section Properties

Prop	Section	Area (in ²)	I_{yy} (in ⁴)	I_{zz} (in ⁴)	J (in ⁴)	Material
1	MC8X22	6.700	7.010	63.800	0.572	STEEL
2	HSST3X3X0.25	2.440	3.020	3.020	4.936	STEEL
3	L30304	1.440	1.982	0.506	0.030599	STEEL

Materials

Mat	Name	E (kip/in ²)	ν	Density (kip/in ³)	α (/°F)
1	STEEL	29E+3	0.300	0.000283	6.5E -6
2	CONCRETE	3.15E+3	0.170	8.68e-05	5.5E -6
3	ALUMINUM	10E+3	0.330	9.8e-05	12.8E -6
4	STAINLESSSTEEL	28E+3	0.300	0.000283	9.9E -6
5	STEEL_36_KSI	29E+3	0.300	0.000283	6.5E -6
6	STEEL_50_KSI	29E+3	0.300	0.000283	6.5E -6
7	STEEL_275_NMM2	29.7E+3	0.300	0.000	6.67E -6
8	STEEL_355_NMM2	29.7E+3	0.300	0.000	6.67E -6

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	Part		
	Ref		
	By	Date 25-Jul-23	Chd
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Supports

Node	X (kip/in)	Y (kip/in)	Z (kip/in)	rX (kip*ft/deg)	rY (kip*ft/deg)	rZ (kip*ft/deg)
3	Fixed	Fixed	Fixed	-	-	-
4	Fixed	Fixed	Fixed	-	-	-
9	Fixed	Fixed	Fixed	-	-	-
10	Fixed	Fixed	Fixed	-	-	-
13	Fixed	Fixed	Fixed	-	-	-
14	Fixed	Fixed	Fixed	-	-	-

Releases

There is no data of this type.

Primary Load Cases

Number	Name	Type
1	LL	None
2	DL	None

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
3	1.2D+1.6L	1	LL	1.60
		2	DL	1.20

Load Generators

There is no data of this type.

1 LL : Beam Loads

Beam	Type	Direction	Fa	Da (in)	Fb	Db	Ecc. (in)
3	CON kip	GZ	0.200	-	-	-	-
13	CON kip	GZ	0.200	-	-	-	-
15	UNI lbf/ft	GY	-150.000	-	-	-	-
	UNI lbf/ft	GX	-48.000	-	-	-	-
17	UNI lbf/ft	GY	-150.000	-	-	-	-
	UNI lbf/ft	GX	-48.000	-	-	-	-
18	UNI lbf/ft	GY	-150.000	-	-	-	-
	UNI lbf/ft	GX	-48.000	-	-	-	-
19	UNI lbf/ft	GY	-150.000	-	-	-	-
	UNI lbf/ft	GX	-48.000	-	-	-	-

2 DL : Beam Loads

Beam	Type	Direction	Fa	Da (in)	Fb	Db	Ecc. (in)
15	UNI lbf/ft	GY	-15.000	-	-	-	-
17	UNI lbf/ft	GY	-15.000	-	-	-	-
18	UNI lbf/ft	GY	-15.000	-	-	-	-
19	UNI lbf/ft	GY	-15.000	-	-	-	-

Node Displacement Summary

	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
Max X	8	2:DL	0.000	-0.000	0.000	0.000	-0.000	-0.000	-0.000
Min X	11	3:1.2D+1.6L	-0.079	-0.003	0.002	0.079	0.000	-0.000	0.000
Max Y	6	3:1.2D+1.6L	-0.014	0.001	0.004	0.014	0.000	-0.000	0.000
Min Y	11	3:1.2D+1.6L	-0.079	-0.003	0.002	0.079	0.000	-0.000	0.000
Max Z	6	3:1.2D+1.6L	-0.014	0.001	0.004	0.014	0.000	-0.000	0.000
Min Z	3	1:LL	0	0	0	0	0.000	0.000	0.000
Max rX	3	3:1.2D+1.6L	0	0	0	0	0.000	0.000	0.000
Min rX	8	3:1.2D+1.6L	-0.014	0.001	0.004	0.014	-0.000	0.000	0.000
Max rY	8	3:1.2D+1.6L	-0.014	0.001	0.004	0.014	-0.000	0.000	0.000
Min rY	13	3:1.2D+1.6L	0	0	0	0	-0.000	-0.001	0.000
Max rZ	9	3:1.2D+1.6L	0	0	0	0	0.000	-0.001	0.001
Min rZ	3	2:DL	0	0	0	0	0.000	0.000	-0.000
Max Rst	12	3:1.2D+1.6L	-0.079	-0.003	0.004	0.079	0.000	-0.000	0.000

Beam End Displacement Summary

Displacements shown in *italic* indicate the presence of an offset

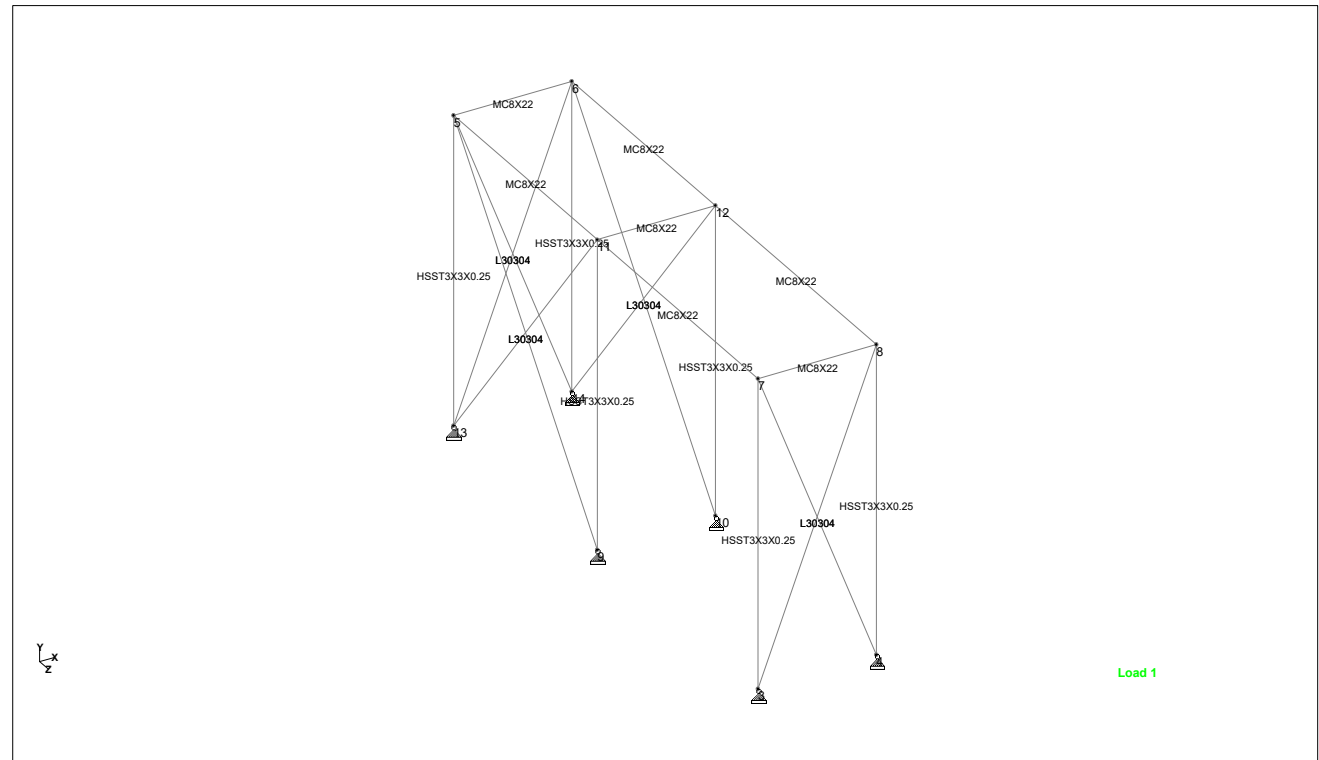
	Beam	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)
Max X	4	9	1:LL	0	0	0	0
Min X	5	12	3:1.2D+1.6L	-0.079	-0.003	0.004	0.079
Max Y	3	6	3:1.2D+1.6L	-0.014	0.001	0.004	0.014
Min Y	4	11	3:1.2D+1.6L	-0.079	-0.003	0.002	0.079
Max Z	3	6	3:1.2D+1.6L	-0.014	0.001	0.004	0.014
Min Z	4	9	1:LL	0	0	0	0
Max Rst	5	12	3:1.2D+1.6L	-0.079	-0.003	0.004	0.079

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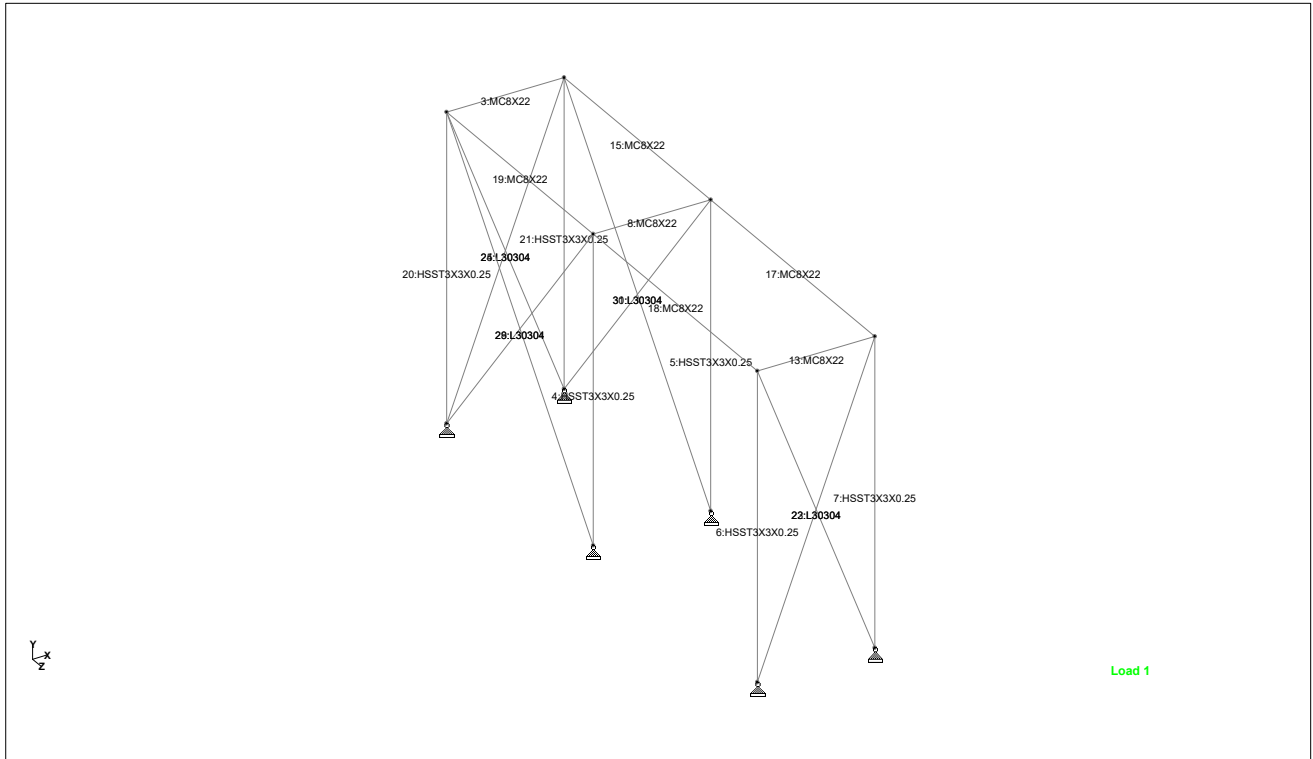
Beam End Force Summary

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the largest tension value for an beam.

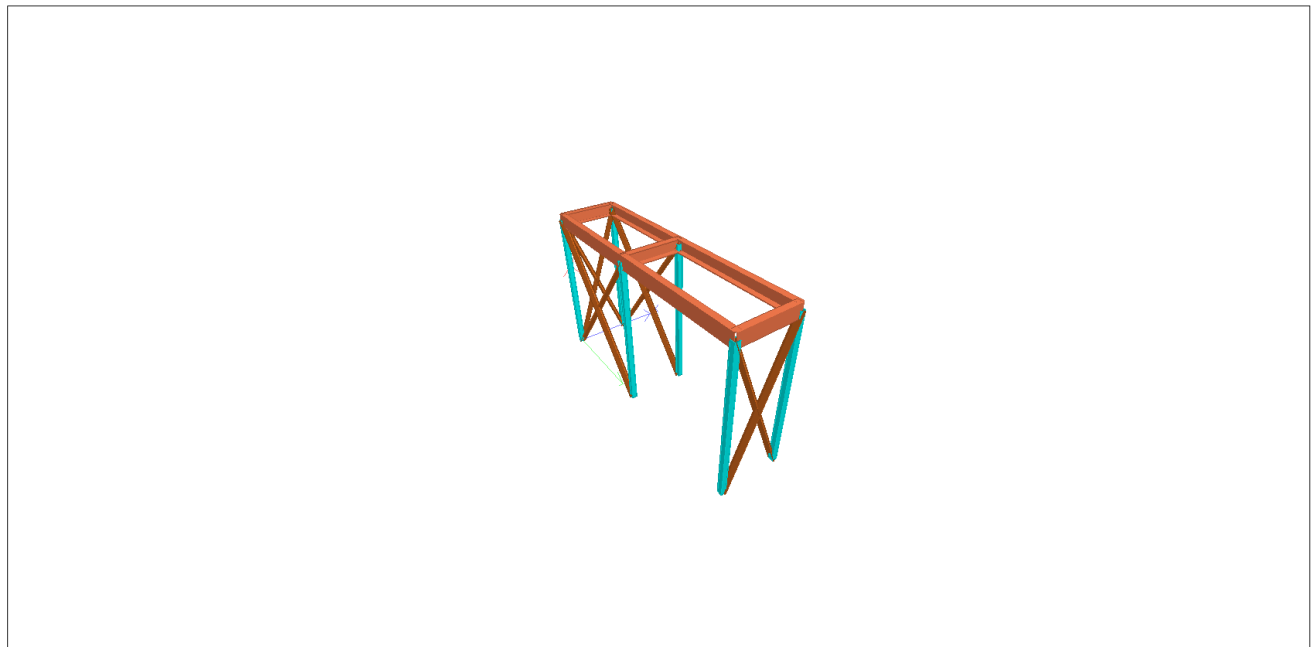
	Beam	Node	L/C	Axial	Shear		Torsion	Bending	
				Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip'in)	My (kip'in)	Mz (kip'in)
Max Fx	4	9	3:1.2D+1.6L	2.037	-0.030	-0.000	-0.291	0.030	-0.366
Min Fx	25	5	3:1.2D+1.6L	-1.350	0.001	0.008	-0.000	-0.370	0.015
Max Fy	17	12	3:1.2D+1.6L	0.524	1.049	-0.058	-0.005	-6.501	13.182
Min Fy	18	11	3:1.2D+1.6L	-0.823	-1.100	-0.042	-0.005	6.718	16.422
Max Fz	3	6	3:1.2D+1.6L	-0.007	0.007	0.797	-0.007	12.103	-0.074
Min Fz	13	7	3:1.2D+1.6L	-0.100	-0.009	-0.823	0.008	-12.608	0.157
Max Mx	13	8	3:1.2D+1.6L	-0.100	-0.009	-0.503	0.008	11.248	-0.150
Min Mx	5	10	3:1.2D+1.6L	1.939	-0.030	-0.001	-0.298	0.031	-0.376
Max My	15	6	3:1.2D+1.6L	0.517	0.656	-0.501	0.006	12.242	1.209
Min My	18	7	3:1.2D+1.6L	-0.823	0.723	0.500	-0.005	-12.686	0.438
Max Mz	19	11	3:1.2D+1.6L	-0.957	1.034	0.004	0.006	7.107	16.436
Min Mz	8	12	3:1.2D+1.6L	-0.003	0.184	0.089	-0.001	1.856	-3.312



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Part		
Ref		
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Whole Structure Beam Number



3D Rendered View



Mechanical Compliance Certificate

Project Information

Energy Code: 2018 IECC
Project Title: Silt Water Treatment Plant Improvements
Location: Silt, Colorado
Climate Zone: 5b
Project Type: New Construction

Construction Site:
Silt, CO

Owner/Agent:
Town of Silt

Designer/Contractor:
B. Gerard Toomer
Engineered Solutions, Inc.
9368 W. Plymouth Ave.
Littleton, CO 80128
303-942-0340
gtoomer@eng-sol-inc.com

Additional Efficiency Package(s)

Credits: 1.0 Required 1.0 Proposed
Reduced Lighting Power, 1.0 credit

Mechanical Systems List

Quantity System Type & Description

- 1 MAU 1101 (Single Zone):
Heating: 1 each - Central Furnace, Gas, Capacity = 216 kBtu/h
Proposed Efficiency = 80.00% Et, Required Efficiency: 80.00 % Et or 80% AFUE
Cooling: 1 each - Single Package DX Unit, Capacity = 97 kBtu/h, Air-Cooled Condenser, Air Economizer
Proposed Efficiency = 11.20 EER, Required Efficiency: 11.00 EER + 12.6 IEER
Fan System: MAU 1101 | CHEM AREA -- Compliance (Motor nameplate HP method) : Passes

Fans:
FAN 1 Supply, Constant Volume, 2950 CFM, 2.0 motor nameplate hp, 0.0 fan efficiency grade
FAN 2 Exhaust, Constant Volume, 2950 CFM, 1.0 motor nameplate hp, 0.0 fan efficiency grade
- 1 RTU 1110 (Single Zone):
Heating: 1 each - Central Furnace, Electric, Capacity = 2 kBtu/h
No minimum efficiency requirement applies
Cooling: 1 each - Single Package DX Unit, Capacity = 56 kBtu/h, Air-Cooled Condenser, Air Economizer
Proposed Efficiency = 15.00 SEER, Required Efficiency: 14.00 SEER
Fan System: RTU 1110 | ELEC RM -- Compliance (Motor nameplate HP method) : Passes

Fans:
FAN 4 Supply, Constant Volume, 2000 CFM, 1.0 motor nameplate hp, 0.0 fan efficiency grade
- 1 RTU 1120 (Single Zone):
Heating: 1 each - Central Furnace, Gas, Capacity = 38 kBtu/h
Proposed Efficiency = 80.00% Et, Required Efficiency: 80.00 % Et or 80% AFUE
Cooling: 1 each - Single Package DX Unit, Capacity = 24 kBtu/h, Air-Cooled Condenser, Air Economizer
Proposed Efficiency = 15.00 SEER, Required Efficiency: 14.00 SEER
Fan System: RTU 1120 | BREAK RM -- Compliance (Motor nameplate HP method) : Passes

Fans:
FAN 5 Supply, Constant Volume, 880 CFM, 0.5 motor nameplate hp, 0.0 fan efficiency grade
- 1 RTU 1121 (Single Zone):
Heating: 1 each - Central Furnace, Gas, Capacity = 72 kBtu/h
Proposed Efficiency = 80.00% Et, Required Efficiency: 80.00 % Et or 80% AFUE
Cooling: 1 each - Single Package DX Unit, Capacity = 127 kBtu/h, Air-Cooled Condenser, Air Economizer

Quantity System Type & Description

Proposed Efficiency = 11.00 EER, Required Efficiency: 11.00 EER + 12.6 IEER
Fan System: RTU 1121 | FILTRATION AREA -- Compliance (Motor nameplate HP method) : Passes

Fans:

FAN 6 Supply, Constant Volume, 3320 CFM, 2.0 motor nameplate hp, 0.0 fan efficiency grade
FAN 7 Return, Constant Volume, 3320 CFM, 1.5 motor nameplate hp, 0.0 fan efficiency grade

1 RTU 1122 (Single Zone):

Heating: 1 each - Central Furnace, Gas, Capacity = 72 kBtu/h

Proposed Efficiency = 80.00% Et, Required Efficiency: 80.00 % Et or 80% AFUE

Cooling: 1 each - Single Package DX Unit, Capacity = 151 kBtu/h, Air-Cooled Condenser, Air Economizer

Proposed Efficiency = 11.00 EER, Required Efficiency: 10.80 EER + 12.2 IEER

Fan System: RTU 1122 | PRETREATMENT AREA -- Compliance (Motor nameplate HP method) : Passes

Fans:

FAN 8 Supply, Constant Volume, 3900 CFM, 3.0 motor nameplate hp, 0.0 fan efficiency grade

FAN 9 Return, Constant Volume, 3900 CFM, 1.5 motor nameplate hp, 0.0 fan efficiency grade

1 WH 8491:

Electric Instantaneous Water Heater, Capacity: 0 gallons

No minimum efficiency requirement applies

1 WH 9001:

Electric Instantaneous Water Heater, Capacity: 0 gallons

No minimum efficiency requirement applies

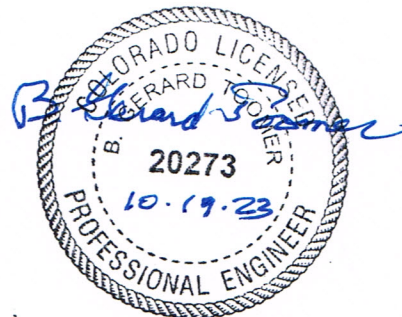
Mechanical Compliance Statement

Compliance Statement: The proposed mechanical design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2018 IECC requirements in COMcheck Version 4.1.5.5 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

B. Gerard Toomer / Designer
Name - Title

B. Gerard Toomer
Signature

10.19.23
Date





Inspection Checklist

Energy Code: 2018 IECC

Requirements: 92.0% were addressed directly in the COMcheck software

Text in the "Comments/Assumptions" column is provided by the user in the COMcheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
C103.2 [PR2] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the mechanical systems and equipment and document where exceptions to the standard are claimed. Load calculations per acceptable engineering standards and handbooks.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C103.2 [PR3] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the service water heating systems and equipment and document where exceptions to the standard are claimed. Hot water system sized per manufacturer's sizing guide.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C406 [PR9] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the additional energy efficiency package options.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Re: Architectural and Electrical.

Additional Comments/Assumptions:

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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Section # & Req.ID	Footing / Foundation Inspection	Complies?	Comments/Assumptions
C403.12.2 , C403.12.3 [FO9] ³	Snow/ice melting system and freeze protection systems have sensors and controls configured to limit service for pavement temperature and outdoor temperature. future connection to controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Re: Electrical

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)
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Section # & Req.ID	Plumbing Rough-In Inspection	Complies?	Comments/Assumptions
C404.5, C404.5.1, C404.5.2 [PL6] ³	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.5, C404.5.1, C404.5.2 [PL6] ³	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.5, C404.5.1, C404.5.2 [PL6] ³	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.5, C404.5.1, C404.5.2 [PL6] ³	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.5, C404.5.1, C404.5.2 [PL6] ³	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.5, C404.5.1, C404.5.2 [PL6] ³	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception (For WH 8491): The piping between the water heater and shower and eyewash exceeds the length designated in Table C404.5.1. The pipe length is approximately 15 feet, the pipe diameter is 1.5", and the maximum length per the table is 6 feet. However, this system will only be used infrequently for emergencies so the energy lost due to water sitting in pipe will be minimal.
C404.5, C404.5.1, C404.5.2 [PL6] ³	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Comment Applies to WH 9001.
C404.6.3 [PL7] ³	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to <= 5 minutes after end of heating cycle.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Comment applies to WH 8491.
C404.6.3 [PL7] ³	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to <= 5 minutes after end of heating cycle.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Comment applies to WH 9001.
C404.6.3 [PL7] ³	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to <= 5 minutes after end of heating cycle.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.6.3 [PL7] ³	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to <= 5 minutes after end of heating cycle.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).

☐ 1 High Impact (Tier 1)
 ☐ 2 Medium Impact (Tier 2)
 ☒ 3 Low Impact (Tier 3)

Section # & Req.ID	Plumbing Rough-In Inspection	Complies?	Comments/Assumptions
C404.6.3 [PL7] ³	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to ≤ 5 minutes after end of heating cycle.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.6.3 [PL7] ³	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to ≤ 5 minutes after end of heating cycle.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.6.3 [PL7] ³	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to ≤ 5 minutes after end of heating cycle.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.7 [PL8] ³	Demand recirculation water systems have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Comment applies to WH 8491.
C404.7 [PL8] ³	Demand recirculation water systems have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Comment applies to WH 9001.
C404.7 [PL8] ³	Demand recirculation water systems have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.7 [PL8] ³	Demand recirculation water systems have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.7 [PL8] ³	Demand recirculation water systems have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).
C404.7 [PL8] ³	Demand recirculation water systems have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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Section # & Req.ID	Plumbing Rough-In Inspection	Complies?	Comments/Assumptions
C404.7 [PL8] ³	Demand recirculation water systems have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Repeated Item (N/A).

Additional Comments/Assumptions:

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C402.2.6 [ME41] ³	Thermally ineffective panel surfaces of sensible heating panels have insulation $\geq R-3.5$.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.8.4 [ME142] ²	Motors for fans that are not less than 1/12 hp and less than 1 hp are electronically commutated motors or have a minimum motor efficiency of 70 percent. These motors have the means to adjust motor speed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.8.4 [ME142] ²	Motors for fans that are not less than 1/12 hp and less than 1 hp are electronically commutated motors or have a minimum motor efficiency of 70 percent. These motors have the means to adjust motor speed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Motors in space-conditioning equipment that comply with Section C403.3.2 or Sections C403.8.1. through C403.8.3.
C403.8.4 [ME142] ²	Motors for fans that are not less than 1/12 hp and less than 1 hp are electronically commutated motors or have a minimum motor efficiency of 70 percent. These motors have the means to adjust motor speed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Motors in space-conditioning equipment that comply with Section C403.3.2 or Sections C403.8.1. through C403.8.3.
C403.8.4 [ME142] ²	Motors for fans that are not less than 1/12 hp and less than 1 hp are electronically commutated motors or have a minimum motor efficiency of 70 percent. These motors have the means to adjust motor speed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.8.4 [ME142] ²	Motors for fans that are not less than 1/12 hp and less than 1 hp are electronically commutated motors or have a minimum motor efficiency of 70 percent. These motors have the means to adjust motor speed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.8.5 [ME143] ²	Each DX cooling system > 65 kBtu and chiller water/evaporative cooling system with fans > 1/4 hp are designed to vary the indoor fan airflow as a function of load and comply with detailed requirements of this section.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Where the volume of outdoor air required to comply with the ventilation requirements of the IMC at low speed exceeds the air that would be delivered.
C403.8.5 [ME143] ²	Each DX cooling system > 65 kBtu and chiller water/evaporative cooling system with fans > 1/4 hp are designed to vary the indoor fan airflow as a function of load and comply with detailed requirements of this section.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.8.5 [ME143] ²	Each DX cooling system > 65 kBtu and chiller water/evaporative cooling system with fans > 1/4 hp are designed to vary the indoor fan airflow as a function of load and comply with detailed requirements of this section.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.8.5 [ME143] ²	Each DX cooling system > 65 kBtu and chiller water/evaporative cooling system with fans > 1/4 hp are designed to vary the indoor fan airflow as a function of load and comply with detailed requirements of this section.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Location on plans/spec: Variance Requested

☐ 1 High Impact (Tier 1)
 ☐ 2 Medium Impact (Tier 2)
 ☒ 3 Low Impact (Tier 3)

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C403.8.5 [ME143] ²	Each DX cooling system > 65 kBtu and chiller water/evaporative cooling system with fans > 1/4 hp are designed to vary the indoor fan airflow as a function of load and comply with detailed requirements of this section.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Location on plans/spec: Variance requested
C403.12.1 [ME71] ²	Systems that heat outside the building envelope are radiant heat systems controlled by an occupancy sensing device or timer switch.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.2.3 [ME55] ²	HVAC equipment efficiency verified.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See the Mechanical Systems list for values.
C403.5.5 [ME113] ²	Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C403.5.5 [ME113] ²	Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C403.5.5 [ME113] ²	Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C403.5.5 [ME113] ²	Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C403.2.2 [ME59] ¹	Natural or mechanical ventilation is provided in accordance with International Mechanical Code Chapter 4. Mechanical ventilation has capability to reduce outdoor air supply to minimum per IMC Chapter 4.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: See separate ventilation calc submittal
C403.7.1 [ME59] ¹	Demand control ventilation provided for spaces >500 ft ² and >25 people/1000 ft ² occupant density and served by systems with air side economizer, auto modulating outside air damper control, or design airflow >3,000 cfm.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.7.2 [ME115] ³	Enclosed parking garage ventilation has automatic contaminant detection and capacity to stage or modulate fans to 50% or less of design capacity.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.7.6 [ME141] ³	HVAC systems serving guestrooms in Group R-1 buildings with > 50 guestrooms: Each guestroom is provided with controls that automatically manage temperature setpoint and ventilation (see sections C403.7.6.1 and C403.7.6.2).	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.

☐ 1 High Impact (Tier 1)
 ☐ 2 Medium Impact (Tier 2)
 ☐ 3 Low Impact (Tier 3)

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C403.7.4 [ME57] ¹	Exhaust air energy recovery on systems meeting Table C403.7.4(1) and C403.7.4(2).	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.7.5 [ME116] ³	Kitchen exhaust systems comply with replacement air and conditioned supply air limitations, and satisfy hood rating requirements and maximum exhaust rate criteria.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.11.1, C403.11.2 [ME60] ²	HVAC ducts and plenums insulated in accordance with C403.11.1 and constructed in accordance with C403.11.2, verification may need to occur during Foundation Inspection.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification Section 23 30 00
C403.5, C403.5.1, C403.5.2 [ME62] ¹	Air economizers provided where required, meet the requirements for design capacity, control signal, ventilation controls, high-limit shut-off, integrated economizer control, and provide a means to relieve excess outside air during operation.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.5, C403.5.1, C403.5.2 [ME62] ¹	Air economizers provided where required, meet the requirements for design capacity, control signal, ventilation controls, high-limit shut-off, integrated economizer control, and provide a means to relieve excess outside air during operation.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130
C403.5, C403.5.1, C403.5.2 [ME62] ¹	Air economizers provided where required, meet the requirements for design capacity, control signal, ventilation controls, high-limit shut-off, integrated economizer control, and provide a means to relieve excess outside air during operation.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131 and Specification Section 23 75 00
C403.5, C403.5.1, C403.5.2 [ME62] ¹	Air economizers provided where required, meet the requirements for design capacity, control signal, ventilation controls, high-limit shut-off, integrated economizer control, and provide a means to relieve excess outside air during operation.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131 and Specification Section 23 75 00
C403.5.3.3 [ME124] ¹	Air economizers automatically reduce outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will not reduce cooling energy usage. See Table C403.5.3.3 for applicable device types and climate zones.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.5.3.3 [ME124] ¹	Air economizers automatically reduce outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will not reduce cooling energy usage. See Table C403.5.3.3 for applicable device types and climate zones.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130

1 High Impact (Tier 1) 2 Medium Impact (Tier 2) 3 Low Impact (Tier 3)

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C403.5.3.3 [ME124] ¹	Air economizers automatically reduce outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will not reduce cooling energy usage. See Table C403.5.3.3 for applicable device types and climate zones.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131
C403.5.3.3 [ME124] ¹	Air economizers automatically reduce outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will not reduce cooling energy usage. See Table C403.5.3.3 for applicable device types and climate zones.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131
C403.5.3.4 [ME125] ¹	System capable of relieving excess outdoor air during air economizer operation to prevent overpressurizing the building. The relief air outlet located to avoid recirculation into the building.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130
C403.5.3.4 [ME125] ¹	System capable of relieving excess outdoor air during air economizer operation to prevent overpressurizing the building. The relief air outlet located to avoid recirculation into the building.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130 and H-1102
C403.5.3.4 [ME125] ¹	System capable of relieving excess outdoor air during air economizer operation to prevent overpressurizing the building. The relief air outlet located to avoid recirculation into the building.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131 and H-1102
C403.5.3.4 [ME125] ¹	System capable of relieving excess outdoor air during air economizer operation to prevent overpressurizing the building. The relief air outlet located to avoid recirculation into the building.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131 and H-1102
C403.5.3.5 [ME126] ¹	Return, exhaust/relief and outdoor air dampers used in economizers have motorized dampers that automatically shut when not in use and meet maximum leakage rates. Reference section C403.7.7 for details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.5.3.5 [ME126] ¹	Return, exhaust/relief and outdoor air dampers used in economizers have motorized dampers that automatically shut when not in use and meet maximum leakage rates. Reference section C403.7.7 for details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Location on plans/spec: Barometric Relief ok for 3 stories
C403.5.3.5 [ME126] ¹	Return, exhaust/relief and outdoor air dampers used in economizers have motorized dampers that automatically shut when not in use and meet maximum leakage rates. Reference section C403.7.7 for details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Barometric relief ok for 3 stories
C403.5.3.5 [ME126] ¹	Return, exhaust/relief and outdoor air dampers used in economizers have motorized dampers that automatically shut when not in use and meet maximum leakage rates. Reference section C403.7.7 for details.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply. Location on plans/spec: Barometric relief ok for 3 stories

☐ 1 High Impact (Tier 1)
 ☐ 2 Medium Impact (Tier 2)
 ☒ 3 Low Impact (Tier 3)

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C403.4.1.4 [ME63] ²	Heating for vestibules and air curtains with integral heating include automatic controls that shut off the heating system when outdoor air temperatures > 45F. Vestibule heating and cooling systems controlled by a thermostat in the vestibule with heating setpoint ≤ 60F and cooling setpoint ≥ 80F.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Re: Electrical
C403.3.3 [ME35] ¹	Hot gas bypass limited to: ≤240 kBtu/h - 50% >240 kBtu/h - 25%	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification Section 23 75 00
C403.3.3 [ME35] ¹	Hot gas bypass limited to: ≤240 kBtu/h - 50% >240 kBtu/h - 25%	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification Section 23 80 00
C403.3.3 [ME35] ¹	Hot gas bypass limited to: ≤240 kBtu/h - 50% >240 kBtu/h - 25%	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification Section 23 80 00
C403.3.3 [ME35] ¹	Hot gas bypass limited to: ≤240 kBtu/h - 50% >240 kBtu/h - 25%	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification Section 23 75 00
C403.3.3 [ME35] ¹	Hot gas bypass limited to: ≤240 kBtu/h - 50% >240 kBtu/h - 25%	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification 23 75 00
C408.2.2.1 [ME53] ³	Air outlets and zone terminal devices have means for air balancing.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-2
C403.5, C403.5.1, C403.5.2 [ME123] ³	Refrigerated display cases, walk-in coolers or walk-in freezers served by remote compressors and remote condensers not located in a condensing unit, have fan-powered condensers that comply with Sections C403.5.1 and refrigeration compressor systems that comply with C403.5.2..	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.

Additional Comments/Assumptions:

1 High Impact (Tier 1) 2 Medium Impact (Tier 2) 3 Low Impact (Tier 3)

Section # & Req.ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
C405.6 [EL26] ²	Low-voltage dry-type distribution electric transformers meet the minimum efficiency requirements of Table C405.6.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. (Re: Electrical)
C405.7 [EL27] ²	Electric motors meet the minimum efficiency requirements of Tables C405.7(1) through C405.7(4). Efficiency verified through certification under an approved certification program or the equipment efficiency ratings shall be provided by motor manufacturer (where certification programs do not exist).	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. (Re: Electrical)
C405.8.2, C405.8.2.1 [EL28] ²	Escalators and moving walks comply with ASME A17.1/CSA B44 and have automatic controls configured to reduce speed to the minimum permitted speed in accordance with ASME A17.1/CSA B44 or applicable local code when not conveying passengers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Not Applicable.
C405.9 [EL29] ²	Total voltage drop across the combination of feeders and branch circuits $\leq 5\%$.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. (Re: Electrical)

Additional Comments/Assumptions:

1 High Impact (Tier 1) 2 Medium Impact (Tier 2) 3 Low Impact (Tier 3)

Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
C303.3, C408.2.5.3 [FI8] ³	Furnished O&M manuals for HVAC systems within 90 days of system acceptance.	<input checked="" type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification Section 23 00 00.
C403.2.2 [FI27] ³	HVAC systems and equipment capacity does not exceed calculated loads.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Re: Separate Load Calcs Submittal
C403.2.4.1 [FI47] ³	Heating and cooling to each zone is controlled by a thermostat control. Minimum one humidity control device per installed humidification/dehumidification system.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130
C403.2.4.1 [FI47] ³	Heating and cooling to each zone is controlled by a thermostat control. Minimum one humidity control device per installed humidification/dehumidification system.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130
C403.2.4.1 [FI47] ³	Heating and cooling to each zone is controlled by a thermostat control. Minimum one humidity control device per installed humidification/dehumidification system.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131
C403.2.4.1 [FI47] ³	Heating and cooling to each zone is controlled by a thermostat control. Minimum one humidity control device per installed humidification/dehumidification system.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131
C403.2.4.1 [FI47] ³	Heating and cooling to each zone is controlled by a thermostat control. Minimum one humidity control device per installed humidification/dehumidification system.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1131
C403.4.1.2 [FI38] ³	Thermostatic controls have a 5 °F deadband.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130 - H-1131
C403.2.4.1.3 [FI20] ³	Temperature controls have setpoint overlap restrictions.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Drawing H-1130 - H-1131
C403.2.4.2 [FI39] ³	Each zone equipped with setback controls using automatic time clock or programmable control system.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Zones operated continuously.
C403.2.4.2.1, C403.2.4.2.2 [FI40] ³	Automatic Controls: Setback to 55°F (heat) and 85°F (cool); 7-day clock, 2-hour occupant override, 10-hour backup	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.

☐ 1 High Impact (Tier 1)
 ☐ 2 Medium Impact (Tier 2)
 ☒ 3 Low Impact (Tier 3)

Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
C403.2.4.2.3 [FI41] ³	Systems include optimum start controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.2.4.2.3 [FI41] ³	Systems include optimum start controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.2.4.2.3 [FI41] ³	Systems include optimum start controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.2.4.2.3 [FI41] ³	Systems include optimum start controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C403.2.4.2.3 [FI41] ³	Systems include optimum start controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C404.3 [FI11] ³	Heat traps installed on supply and discharge piping of non-circulating systems.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C404.3 [FI11] ³	Heat traps installed on supply and discharge piping of non-circulating systems.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C404.4 [FI25] ²	All piping insulated in accordance with section details and Table C403.11.3.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C404.4 [FI25] ²	All piping insulated in accordance with section details and Table C403.11.3.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C408.1.1 [FI57] ¹	Building operations and maintenance documents will be provided to the owner. Documents will cover manufacturers' information, specifications, programming procedures and means of illustrating to owner how building, equipment and systems are intended to be installed, maintained, and operated.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Specification Section 23 00 00
C408.2.1 [FI28] ¹	Commissioning plan developed by registered design professional or approved agency.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: This requirement included in Specification Section 23 08 00 - Commissioning of HVAC Systems
C408.2.3.1 [FI31] ¹	HVAC equipment has been tested to ensure proper operation.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: This requirement is included in specification section 23 05 93.

☐ 1 High Impact (Tier 1)
 ☐ 2 Medium Impact (Tier 2)
 ☒ 3 Low Impact (Tier 3)

Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
C408.2.3.2 [FI10] ¹	HVAC control systems have been tested to ensure proper operation, calibration and adjustment of controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: This requirement is included in specification section 23 08 00
C408.2.3.3 [FI32] ¹	Economizers have been tested to ensure proper operation.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: This requirement is included in Specification Section 23 08 00 - Commissioning of HVAC Systems
C408.2.4 [FI29] ¹	Preliminary commissioning report completed and certified by registered design professional or approved agency.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: This requirement is included in Specification Section 23 08 00 - Commissioning of HVAC Systems
C408.2.5.1 [FI7] ³	Furnished HVAC as-built drawings submitted within 90 days of system acceptance.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C408.2.5.3 [FI43] ¹	An air and/or hydronic system balancing report is provided for HVAC systems.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: This requirement is included in specification section 23 05 93.
C408.2.5.4 [FI30] ¹	Final commissioning report due to building owner within 90 days of receipt of certificate of occupancy.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: This requirement is included in specification section 23 08 00

Additional Comments/Assumptions:

1 High Impact (Tier 1) 2 Medium Impact (Tier 2) 3 Low Impact (Tier 3)

MEMORANDUM

TO: Sam Franzen, Dewberry
FM: Gerry Toomer, ESI
DT: 10/13/2023
RE: Silt WTP Improvements Project – 2018 IECC Mechanical Variance Request

Per 2018 IECC 403.8.5, DX cooling units with a mechanical cooling capacity greater than or equal to 65,000 Btu/h shall be designed to vary the indoor fan airflow as a function of load. And, where the cooling capacity is controlled directly based on space temperature, the minimum speed shall not be greater than 66 percent of full speed.

We request a variance from this requirement for RTU 1121 and RTU 1122 based on the following rationale.

These two units provide minimal cooling to high bay process spaces (only cool down to 95 deg F). Distribution ductwork is high in the spaces (above a bridge crane needed to access process equipment). We are concerned that reducing airflow at less than full load will result in the development of “hot spots” in the served area as distribution air velocities will be commensurately reduced, and vulnerability to short circuiting of air paths increased. Because these cooling units are only cooling down to 95 deg F, the tolerance level for hot spots is limited.

We believe this design is still significantly more energy efficient than if we were to design to a cooler space temperature, more resilient to hot spot development, and vary the supply air flow per 403.8.5.

Furthermore, based on manufacturer feedback regarding a change to VAV operation, this would increase the achievable coil leaving air temperature such that unit airflow would necessarily increase by over 40%, and equipment footprint and weight would increase significantly. This would significantly affect the design and energy efficiency of the system.

VENTILATION CODE COMPLIANCE SUMMARY

Space ID	HVAC System Tag	Area SF	Code Ventilation Requirement			Design OA CFM
			Reference	CFM	Notes	
Chemical Storage	MAU 1101/EF 1170	2,944	IMC 502.8.1	2,944	1	2,950
Restroom	EBB 1146/EF 1171	48	IMC 403.3.1.1	50	2	100
Electrical Equipment	RTU 1110	340	IMC 403.3	0	3	0
Break Room	RTU 1120	595	IMC 403.1.1.1	99	4	100
Filtration Room	RTU 1121	2,394	IMC 403.3	0	3	0
Pretreatment Room	RTU 1122	2,080	IMC 403.3	0	3	0
Vestibule	EBB 1145	41	IMC 402.2	0	5	0

Notes:

1. Code requirement is for 1 cfm/sf.
2. Code requirement is for 50 cfm/wc. Extra in design for relief from Break Room.
3. Proces space. Not normally occupied.
4. Re: separate calculation based on IMC 403.1.1.1
5. Based on openable area to outdoors exceeding 4% of floor area, natural ventilation is sufficient.

PROJECT INFORMATION

Location
Building owner
Program user
Company
Comments

By
Dataset name

Engineered Solutions, Inc
C:\Users\Jerry Toomer\Documents\TRACE 700
Projects\23-001\New Bldg\03\PROCESS03.TRC

Calculation time
TRACE® 700 version

04:04 PM on 10/12/2023
6.3.5

Location
Latitude
Longitude
Time Zone
Elevation
Barometric pressure

Rifle CO
39.5 deg
107.7 deg
7
4,991 ft
24.9 in. Hg

Air density
Air specific heat
Density-specific heat product
Latent heat factor
Enthalpy factor

0.0631 lb/cu ft
0.2444 Btu/lb·°F
0.9253 Btu/h·cfm·°F
4,073.1 Btu·min/h·cu ft
3.7854 lb·min/hr·cu ft

Summer design dry bulb
Summer design wet bulb
Winter design dry bulb
Summer clearness number
Winter clearness number
Summer ground reflectance
Winter ground reflectance
Carbon Dioxide Level

99.6 °F
65.5 °F
-8.9 °F
1.00
1.00
0.20
0.20
400 ppm

Design simulation period
Cooling load methodology
Heating load methodology

January - December
TETD-TA1
UATD



ENTERED VALUES

ROOM BY ROOM

By Engineered Solutions, Inc

Room Description: Chem Feed Room

Zone Description: No Zone

System Description: MAU-1101

GENERAL INFORMATION		PEOPLE	AIRFLOW INFORMATION	
Floor Area: 900 ft ² Flr-Flr Height: 10.0 ft Plenum Height: 0.0 ft Height Above Flr: Slab Cnstr Type: 12" HW Concrete Room Mass: Time delay based on actual mass Ceiling R-Value: 1.786 hr-ft ² ·°F/Btu Is There Carpet?: NO Design Clg DB / Drift Point: 95.0 °F / 97.0 °F Design Htg DB / Drift Point: 55.0 °F / 52.0 °F Design Relative Humidity: 50 % Moisture Capacitance: Medium Clg Tstat: None Htg Tstat: None Thermostat Location:Room Floor Multiplier: 1 Humidistat Location:Room Room Multiplier: 1 CO2 Sensor Location:None Room Type:Conditioned		People Type: None # of People: 0 sq ft/person People Sensible: 250 Btu/h People Latent : 250 Btu/h People Schedule: Cooling Only (Design) Workstation: 1.0 workstation/person LIGHTS Lighting Type: LED Lighting 100% load to space Fixture Type: LED Lighting % Load to RA: 0 % Lighting Schedule: Cooling Only (Design) Lighting Amount: 0.650 W/sq ft Ballast Factor: 1.0	Cooling Vent Type: 100 Percent Outdoor Air Vent Value: 100.00 % Clg Airflow Vent Schedule: Available (100%) Infil Type: None Infil Value: 0.00 air changes/hr Infil Schedule: Available (100%) Vav Airflow: Vav Sched: Available (100%) Supply: 900.00 cfm Aux Supply: To be calculated Room Exhaust: 900.00 cfm Rm Exh Sched: Available (100%)	Heating 100 Percent Outdoor Air 100.00 % Htg Airflow None 0.00 air changes/hr 900.00 cfm To be calculated

Description	Area/ Amount	Dir	Tilt	Const Type / Schedule	U Value Btu/h·ft ² ·°F Alpha	Type / Energy Type	Area ft ²	Glass			External Shading	Internal Shading	Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
								Shade Coef	U Value Btu/h·ft ² ·°F	Shading							
Roof - 1	900 ft ²	0	90	SiltRoof	0.0312	0.90	0			Overhang - None	None						
North Wall	261 ft ²	0	0	12" CMU grouted w	0.0270	0.90											
Man-Door				Door		Hollow Metal Man-Door	24	0.00	0.36	Overhang - None	None	0.00					
Man-Dr Lite				Window		ASHRAE Std 90	10	0.34	0.45	Overhang - None	None	0.00					
Process Load	7.00 kW			Cooling Only (Design)		None								100	100	0	60.00
Floor - 1																19	0.50

ENTERED VALUES

ROOM BY ROOM

By Engineered Solutions, Inc

Room Description: Chem Stg Room

Zone Description: No Zone

System Description: MAU-1101

GENERAL INFORMATION		PEOPLE		AIRFLOW INFORMATION		
Floor Area: 2,044 ft² Plenum Height: 0.0 ft Slab Cnstr Type: 12* HW Concrete Room Mass: Time delay based on actual mass Ceiling R-Value: 1.786 hr-ft²-°F/Btu Is There Carpet?: NO Design Clg DB / Drift Point: 95.0 °F / 97.0 °F Design Htg DB / Drift Point: 55.0 °F / 52.0 °F Design Relative Humidity: 50 % Moisture Capacitance: Medium Clg Tstat: None Htg Tstat: None Thermostat Location:Room Humidistat Location:Room CO2 Sensor Location:None Room Type:Conditioned		Flr-Flr Height: 10.0 ft Height Above Flr: People Type: None # of People: 0 sq ft/person People Sensible: 250 Btu/h People Latent : 250 Btu/h People Schedule: Cooling Only (Design) Workstation: 1.0 workstation/person <u>LIGHTS</u> Lighting Type: LED Lighting 100% load to space Fixture Type: LED Lighting % Load to RA: 0 % Lighting Schedule: Cooling Only (Design) Lighting Amount: 0.650 W/sq ft Ballast Factor: 1.0		<u>Cooling</u> Vent Type: 100 Percent Outdoor Air Vent Value: 100.00 % Clg Airflow Vent Schedule: Available (100%) Infil Type: None Infil Value: 0.00 air changes/hr Infil Schedule: Available (100%) Vav Airflow: Vav Sched: Available (100%) Supply: 2,044.00 cfm Aux Supply: To be calculated Room Exhaust: 2,044.00 cfm Rm Exh Sched: Available (100%)		<u>Heating</u> 100 Percent Outdoor Air 100.00 % Htg Airflow None 0.00 air changes/hr 2,044.00 cfm To be calculated

Description	Area/ Amount	Dir	Tilt	Const Type / Schedule	U Value Btu/h-ft²-°F	Alpha	Glass					Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
							Type / Energy Type	Area ft²	Shade Coef	U Value Btu/h-ft²-°F	External Shading	Internal Shading				
Roof - 1	2,107 ft²	180		76 4* R48 Insulated Metal	0.0205	0.90		0			Overhang - None	None				
North Wall	1,361 ft²	0		0 4* R32 Insul Wall Panel	0.0301	0.90										
Translucent North				Window			Kalwall Translucent	108	0.10	0.10	Overhang - None	None	0.00			
Window North				Window			90.1 Window Zone 4-6	108	0.46	0.55	Overhang - None	None	0.00			
East Wall	551 ft²	90		0 4* R32 Insul Wall Panel	0.0301	0.90										
South Wall	308 ft²	180		0 4* R32 Insul Wall Panel	0.0301	0.90										
West Wall	1,282 ft²	270		0 4* R32 Insul Wall Panel	0.0301	0.90										
Man-Door				Door			Hollow Metal Man-Door	24	0.00	0.36	Overhang - None	None	0.00			
Man-Door Lite				Window			ASHRAE Std 90	10	0.34	0.45	Overhang - None	None	0.00			
Overhead Door				Door			Coiling Overhead Door	192	0.00	0.16	Overhang - None	None	0.00			
Process Load	7.90 kW			Cooling Only (Design)			None							100	100	0 60.00
Floor - 1																155 0.73

ENTERED VALUES

ROOM BY ROOM

By Engineered Solutions, Inc

Room Description: Restroom

Zone Description: No Zone

System Description: Restroom Baseboard

GENERAL INFORMATION				PEOPLE		AIRFLOW INFORMATION			
Floor Area: 48 ft²	Flr-Flr Height: 10.0 ft	People Type: None				Cooling	Heating		
Plenum Height: 0.0 ft	Height Above Flr:	# of People: 0 sq ft/person				Vent Type: None	None		
Slab Cnstr Type: 12" HW Concrete		People Sensible: 250 Btu/h				Vent Value: 0.00 cfm	0.00 cfm		
Room Mass: Time delay based on actual mass		People Latent : 250 Btu/h				Vent Schedule: Available (100%)			
Ceiling R-Value: 1.786 hr·ft²·°F/Btu		People Schedule: Cooling Only (Design)				Infil Type: None	None		
Is There Carpet?: NO						Infil Value: 0.00 air changes/hr	0.00 air changes/hr		
Design Clg DB / Drift Point: 95.0 °F / 97.0 °F		Workstation: 1.0 workstation/person				Infil Schedule: Available (100%)			
Design Htg DB / Drift Point: 55.0 °F / 52.0 °F						Vav Airflow:			
Design Relative Humidity: 50 %						Vav Sched: Available (100%)			
Moisture Capacitance: Medium						Supply: To be calculated	To be calculated		
Clg Tstat: None						Aux Supply: To be calculated	To be calculated		
Htg Tstat: None						Room Exhaust: 100.00 cfm			
Thermostat Location:Room	Floor Multiplier: 1					Rm Exh Sched: Available (100%)			
Humidistat Location:Room	Room Multiplier: 1								
CO2 Sensor Location:None									
Room Type:Conditioned									

Description	Area/ Amount	Dir	Const Type / Tilt Schedule	U Value Btu/h·ft²·°F Alpha	Type / Energy Type	Area ft²	Glass			External Shading	Internal Shading	Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
							Shade Coef	U Value Btu/h·ft²·°F								
Roof - 1	48 ft²	0	90 SiltRoof	0.0312	0.90	0				Overhang - None	None					
South Wall	84 ft²	0	0 8" HW CMU PartGrout	0.3120	0.90											
Floor - 1																6 0.73

ENTERED VALUES

ROOM BY ROOM

By Engineered Solutions, Inc

Room Description: Electrical Room

Zone Description: No Zone

System Description: RTU-1110

GENERAL INFORMATION		PEOPLE	AIRFLOW INFORMATION	
Floor Area: 340 ft²	Flr-Flr Height: 10.0 ft	People Type: None	Cooling	Heating
Plenum Height: 0.0 ft	Height Above Flr:	# of People: 0 sq ft/person	Vent Type: None	None
Slab Cnstr Type: 12" HW Concrete		People Sensible: 250 Btu/h	Vent Value: 0.00 cfm	0.00 cfm
Room Mass: Time delay based on actual mass		People Latent : 250 Btu/h	Vent Schedule: Available (100%)	
Ceiling R-Value: 1.786 hr-ft²-°F/Btu		People Schedule: Cooling Only (Design)	Infil Type: None	None
Is There Carpet?: NO			Infil Value: 0.00 air changes/hr	0.00 air changes/hr
Design Clg DB / Drift Point: 95.0 °F / 97.0 °F		Workstation: 1.0 workstation/person	Infil Schedule: Available (100%)	
Design Htg DB / Drift Point: 55.0 °F / 52.0 °F			Vav Airflow:	
Design Relative Humidity: 50 %		LIGHTS	Vav Sched: Available (100%)	
Moisture Capacitance: Medium		Lighting Type: LED Lighting 100% load to space	Supply: 2,000.00 cfm	2,000.00 cfm
Clg Tstat: None		Fixture Type: LED Lighting	Aux Supply: To be calculated	To be calculated
Htg Tstat: None		% Load to RA: 0 %	Room Exhaust:	
Thermostat Location:Room	Floor Multiplier: 1	Lighting Schedule: Cooling Only (Design)	Rm Exh Sched: Available (100%)	
Humidistat Location:Room	Room Multiplier: 1	Lighting Amount: 1.530 W/sq ft		
CO2 Sensor Location:None		Ballast Factor: 1.0		
Room Type:Conditioned				

Description	Area/ Amount	Dir	Const Type / Tilt Schedule	U Value Btu/h-ft²-°F Alpha	Type / Energy Type	Area ft²	Glass			External Shading	Internal Shading	Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
							Shade Coef	U Value Btu/h-ft²-°F								
Roof - 1	340 ft²	0	90 SiltRoof	0.0312	0.90	0				Overhang - None	None					
South Wall	210 ft²	0	0 12" CMU grouted w	0.0270	0.90											
Man-Drs			Door		Hollow Metal Man-Door	49	0.00	0.36		Overhang - None	None	0.00				
Man-Dr Lites			Window		Kalwall Translucent	19	0.10	0.10		Overhang - None	None	0.00				
West Wall	327 ft²	270	0 12" CMU grouted w	0.0270	0.90											
Electrical Gear	14.90 kW		Cooling Only (Design)		None								100	100		0 60.00
Floor - 1																15 0.73

ENTERED VALUES

ROOM BY ROOM

By Engineered Solutions, Inc

Room Description: Break Room

Zone Description: No Zone

System Description: RTU-1120

GENERAL INFORMATION		PEOPLE	AIRFLOW INFORMATION	
Floor Area: 595 ft ²	Flr-Flr Height: 14.0 ft	People Type: None	Cooling	Heating
Plenum Height: 4.0 ft	Height Above Flr:	# of People: 6 People	Vent Type: None	None
Slab Cnstr Type: 12" HW Concrete		People Sensible: 245 Btu/h	Vent Value: 100.00 cfm	100.00 cfm
Room Mass: Time delay based on actual mass		People Latent : 155 Btu/h	Vent Schedule: Available (100%)	
Ceiling R-Value: 1.786 hr-ft ² ·°F/Btu		People Schedule: Cooling Only (Design)	Infil Type: None	None
Is There Carpet?: NO			Infil Value: 0.00 air changes/hr	0.00 air changes/hr
Design Clg DB / Drift Point: 73.0 °F / 75.0 °F		Workstation: 1.0 workstation/person	Infil Schedule: Available (100%)	
Design Htg DB / Drift Point: 68.0 °F / 66.0 °F			Vav Airflow:	
Design Relative Humidity: 50 %		LIGHTS	Vav Sched: Available (100%)	
Moisture Capacitance: Medium		Lighting Type: LED Lighting 100% load to space	Supply: 880.00 cfm	880.00 cfm
Clg Tstat: None		Fixture Type: LED Lighting	Aux Supply: To be calculated	To be calculated
Htg Tstat: None		% Load to RA: 0 %	Room Exhaust: 100.00 cfm	
Thermostat Location:Room	Floor Multiplier: 1	Lighting Schedule: Cooling Only (Design)	Rm Exh Sched: Available (100%)	
Humidistat Location:Room	Room Multiplier: 1	Lighting Amount: 0.650 W/sq ft		
CO2 Sensor Location:None		Ballast Factor: 1.0		
Room Type:Conditioned				

Description	Area/ Amount	Dir	Tilt	Const Type / Schedule	U Value Btu/h·ft ² ·°F	Alpha	Glass					Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
							Type / Energy Type	Area ft ²	Shade Coef	U Value Btu/h·ft ² ·°F	External Shading	Internal Shading				
Roof - 1	595 ft ²	0	90	SiltRoof	0.0312	0.90		0			Overhang - None	None				
South Wall	413 ft ²	180	0	12* CMU grouted w	0.0270	0.90										
South Windows				Window			ASHRAE Std 90	40	0.34	0.45	Overhang - None	None	0.00			
Microwave	110.0 W			Cooling Only (Design)			None						100	100	0	0.00
Dishwasher	0.80 kW			Cooling Only (Design)			None						100	100	0	60.00
Workstations (2)	0.50 kW			Cooling Only (Design)			None						100	100	0	10.00
Cooktop	1,760 Btuh			Cooling Only (Design)			None						100	100	0	60.00
Refrigerator (Small)	59.00 W			Cooling Only (Design)			None						100	100	0	0.00
Refrigerator (large)	248.0 W			Cooling Only (Design)			None						100	100	0	0.00
Block Walls to Proc S	1,078 ft ²			8* CMU w 3-5/8* furring	0.1368								Prorated	95	55	
Floor - 1																30 0.50

By Engineered Solutions, Inc

System Description: RTU-1121

[illegible]

ENTERED VALUES

ROOM BY ROOM

By Engineered Solutions, Inc

Room Description: Pretreatment Room

Zone Description: No Zone

System Description: RTU-1122

GENERAL INFORMATION		PEOPLE	AIRFLOW INFORMATION	
Floor Area: 2,080 ft²	Fir-Fir Height: 10.0 ft	People Type: None	Cooling	Heating
Plenum Height: 0.0 ft	Height Above Fir:	# of People: 0 sq ft/person	Vent Type: None	None
Slab Cnstr Type: 12" HW Concrete		People Sensible: 250 Btu/h	Vent Value: 0.00 cfm	0.00 cfm
Room Mass: Time delay based on actual mass		People Latent : 250 Btu/h	Vent Schedule: Available (100%)	
Ceiling R-Value: 1.786 hr-ft²-°F/Btu		People Schedule: Cooling Only (Design)	Infil Type: None	None
Is There Carpet?: NO			Infil Value: 0.00 air changes/hr	0.00 air changes/hr
Design Clg DB / Drift Point: 95.0 °F / 97.0 °F		Workstation: 1.0 workstation/person	Infil Schedule: Available (100%)	
Design Htg DB / Drift Point: 55.0 °F / 52.0 °F			Vav Airflow:	
Design Relative Humidity: 50 %		LIGHTS	Vav Sched: Available (100%)	
Moisture Capacitance: Medium		Lighting Type: LED Lighting 100% load to space	Supply: To be calculated	To be calculated
Clg Tstat: None			Aux Supply: To be calculated	To be calculated
Htg Tstat: None		Fixture Type: LED Lighting	Room Exhaust:	
Thermostat Location:Room	Floor Multiplier: 1	% Load to RA: 0 %	Rm Exh Sched: Available (100%)	
Humidistat Location:Room	Room Multiplier: 1	Lighting Schedule: Cooling Only (Design)		
CO2 Sensor Location:None		Lighting Amount: 0.650 W/sq ft		
Room Type:Conditioned		Ballast Factor: 1.0		

Description	Area/ Amount	Dir	Const Type / Tilt Schedule	U Value Btu/h-ft²-°F	Alpha	Glass					Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
						Type / Energy Type	Area ft²	Shade Coef	U Value Btu/h-ft²-°F	External Shading	Internal Shading				
Roof - 1	2,132 ft²	90	76 4* R48 Insulated Metal	0.0205	0.90		0			Overhang - None	None				
North Wall	1,772 ft²	0	0 4* R32 Insul Wall Panel	0.0301	0.90										
Transluscent North			Window			Kalwall Translucent	117	0.10	0.10	Overhang - None	None	0.00			
Transluscent North			Window			Kalwall Translucent	72	0.10	0.10	Overhang - None	None	0.00			
Man-Dr			Door			Hollow Metal Man-Door	49	0.00	0.36	Overhang - None	None	0.00			
Man-Dr-lite			Window			ASHRAE Std 90	19	0.34	0.45	Overhang - None	None	0.00			
Overhead Dr			Door			Coiling Overhead Door	192	0.00	0.16	Overhang - None	None	0.00			
East Wall	2,018 ft²	90	0 4* R32 Insul Wall Panel	0.0301	0.90										
Transluscent East			Window			Kalwall Translucent	168	0.10	0.10	Overhang - None	None	0.00			
West Wall	1,226 ft²	270	0 4* R32 Insul Wall Panel	0.0301	0.90										
Transluscent West			Window			Kalwall Translucent	168	0.10	0.10	Overhang - None	None	0.00			
Process Load	38.60 kW		Cooling Only (Design)			None							100	100	0 60.00
Floor - 1															135 0.50

ENTERED VALUES

ROOM BY ROOM

By Engineered Solutions, Inc

Room Description: Vestibule

Zone Description: No Zone

System Description: Vestibule Baseboard

GENERAL INFORMATION			PEOPLE		AIRFLOW INFORMATION	
Floor Area: 41 ft²	Flr-Flr Height: 10.0 ft		People Type: None		Cooling	Heating
Plenum Height: 0.0 ft	Height Above Flr:		# of People: 0 sq ft/person		Vent Type: None	None
Slab Cnstr Type: 12" HW Concrete			People Sensible: 250 Btu/h		Vent Value: 0.00 cfm	0.00 cfm
Room Mass: Time delay based on actual mass			People Latent : 250 Btu/h		Vent Schedule: Available (100%)	
Ceiling R-Value: 1.786 hr-ft²-°F/Btu			People Schedule: Cooling Only (Design)		Infil Type: None	None
Is There Carpet?: NO					Infil Value: 0.00 air changes/hr	0.00 air changes/hr
Design Clg DB / Drift Point: 95.0 °F / 97.0 °F			Workstation: 1.0 workstation/person		Infil Schedule: Available (100%)	
Design Htg DB / Drift Point: 55.0 °F / 52.0 °F					Vav Airflow:	
Design Relative Humidity: 50 %					Vav Sched: Available (100%)	
Moisture Capacitance: Medium					Supply: To be calculated	To be calculated
Clg Tstat: None					Aux Supply: To be calculated	To be calculated
Htg Tstat: None					Room Exhaust:	
Thermostat Location:Room	Floor Multiplier: 1				Rm Exh Sched: Available (100%)	
Humidistat Location:Room	Room Multiplier: 1					
CO2 Sensor Location:None						
Room Type:Conditioned						

Description	Area/ Amount	Dir	Const Type / Tilt Schedule	U Value Btu/h-ft²-°F Alpha	Type / Energy Type	Area ft²	Glass			External Shading	Internal Shading	Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
							Shade Coef	U Value Btu/h-ft²-°F								
Roof - 1	41 ft²	0	90 SiltRoof	0.0312	0.90	0				Overhang - None	None					
South Wall	77 ft²	0	0 8" HW CMU PartGrout	0.3120	0.90											
Man-Dr			Door		Hollow Metal Man-Door	24	0.00	0.36		Overhang - None	None	0.00				
Man-Dr Lite			Window		ASHRAE Std 90	10	0.34	0.45		Overhang - None	None	0.00				
Floor - 1																6 0.73

System Checksums

By Engineered Solutions, Inc

MAU-1101

Single Zone

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES		
Peaked at Time: Mo/Hr: 7 / 15					Mo/Hr: Sum of					Mo/Hr: Heating Design							
Outside Air: OADB/WB/HR: 100 / 66 / 59					OADB: Peaks					OADB: -9							
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total		Space Sensible	Percent Of Total				Space Peak	Coil Peak	Percent					
Btu/h	Btu/h	Btu/h	(%)		Btu/h	(%)				Space Sens	Tot Sens	Of Total					
Envelope Loads					Envelope Loads					Envelope Loads							
Skylite Solar	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	SADB	Cooling 71.1	Heating 64.8
Skylite Cond	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	Ra Plenum	95.0	55.0
Roof Cond	3,518	0	3,518	-12	3,371	5	0	0	0	-4,552	-4,552	2.27	0	0.00	Return	95.0	55.0
Glass Solar	2,553	0	2,553	-8	2,454	4	0	0	0	0	0	0.00	0	0.00	Ret/OA	99.6	-8.9
Glass/Door Cond	-27	0	-27	0	135	0	0	0	0	-7,988	-7,988	3.98	0	0.00	Fn MtrTD	0.1	0.0
Wall Cond	1,521	0	1,521	-5	1,798	3	0	0	0	-6,285	-6,285	3.13	0	0.00	Fn BldTD	0.3	0.0
Partition/Door	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	Fn Frict	0.9	0.0
Floor	0	0	0	0	0.00	0	0	0	0	-7,815	-7,815	3.89	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0.00	0.00	0.00	0	0.00			
Infiltration	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Sub Total ==>	7,566	0	7,566	-25	7,759	12	0	0	0	-26,639	-26,639	13.27	0	0.00			
Internal Loads					Internal Loads					Internal Loads							
Lights	6,531	0	6,531	-21	6,531	10	0	0	0	0	0	0.00	0	0.00			
People	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Misc	50,854	0	50,854	-167	50,854	78	0	0	0	0	0	0.00	0	0.00			
Sub Total ==>	57,385	0	57,385	-188	57,385	88	0	0	0	0	0	0.00	0	0.00			
Ceiling Load					Ceiling Load					Ceiling Load							
Ventilation Load	0	0	-98,889	325	0	0	0	0	0	0	-174,069	86.73	0	0.00			
Adj Air Trans Heat	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00			
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Ov/Undr Sizing	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Exhaust Heat	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Sup. Fan Heat	0	0	3,489	-11	0	0	0	0	0	0	0	0.00	0	0.00			
Ret. Fan Heat	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Duct Heat Pkup	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Supply Air Leakage	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Grand Total ==>	64,950	0	-30,450	100.00	65,144	100.00	0	0	0	-26,639	-200,709	100.00	0	0.00			

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR	Leave DB/WB/HR						Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg	
ton	MBh	cfm	°F °F	gr/lb	°F °F	gr/lb		°F °F	gr/lb		ft² (%)		MBh	cfm	°F	°F	
Main Clg	6.8	80.9	80.9	2,944	99.6	65.5	58.7	69.8	56.0	58.7	Floor	2,944	Main Htg	-200.7	2,944	-8.9	64.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	-214.4	2,944	-8.9	69.8
											ExFlr	173					
Total	6.8	80.9									Roof	3,007	Humidif	0.0	0	0.0	0.0
											Wall	3,523	Opt Vent	0.0	0	0.0	0.0
												235	Total	-200.7			
											Ext Door	241					
												0					

System Checksums

By Engineered Solutions, Inc

Restroom Baseboard

Radiation (Heating Only)

COOLING COIL PEAK					CLG SPACE PEAK			HEATING COIL PEAK				TEMPERATURES		
Peaked at Time: Mo/Hr: 0 / 0					Mo/Hr: 0 / 0			Mo/Hr: Heating Design				Cooling Heating		
Outside Air: OADB/WB/HR: 0 / 0 / 0					OADB: 0			OADB: -9				SADB	0.0	55.0
Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)		Space Sensible Btu/h	Percent Of Total (%)		Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)		Ra Plenum	0.0	55.0
Envelope Loads								Envelope Loads				Return	0.0	55.0
Skylite Solar	0	0	0	0	0	0		0	0	0.00		Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	0		0	0	0.00		Fn BldTD	0.0	0.0
Roof Cond	0	0	0	0	0	0		-96	-96	4.67		Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	0		0	0	0.00		AIRFLOWS		
Glass/Door Cond	0	0	0	0	0	0		0	0	0.00		Cooling Heating		
Wall Cond	0	0	0	0	0	0		-1,675	-1,675	81.68		Diffuser	0	0
Partition/Door	0	0	0	0	0	0		0	0	0.00		Terminal	0	0
Floor	0	0	0	0	0.00	0		-280	-280	13.65		Main Fan	0	0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00		Sec Fan	0	0
Infiltration	0	0	0	0	0	0		0	0	0.00		Nom Vent	0	0
Sub Total ==>	0	0	0	0	0	0		-2,050	-2,050	100.00		AHU Vent	0	0
Internal Loads								Internal Loads				Infil	0	0
Lights	0	0	0	0	0	0		0	0	0.00		MinStop/Rh	0	0
People	0	0	0	0	0	0		0	0	0.00		Return	0	0
Misc	0	0	0	0	0	0		0	0	0.00		Exhaust	0	0
Sub Total ==>	0	0	0	0	0	0		0	0	0.00		Rm Exh	0	0
Ceiling Load								Ceiling Load				Auxiliary	0	0
Ventilation Load	0	0	0	0	0	0		0	0	0.00		Leakage Dwn	0	0
Adj Air Trans Heat	0	0	0	0	0	0		0	0	0		Leakage Ups	0	0
Dehumid. Ov Sizing			0	0				0	0	0.00		ENGINEERING CKS		
Ov/Undr Sizing	0		0	0	0	0		0	0	0.00		Cooling Heating		
Exhaust Heat		0	0	0				0	0	0.00		% OA	0.0	0.0
Sup. Fan Heat			0	0				0	0	0.00		cfm/ft²	0.00	0.00
Ret. Fan Heat		0	0	0				0	0	0.00		cfm/ton	0.00	
Duct Heat Pkup		0	0	0				0	0	0.00		ft²/ton	0.00	
Underflr Sup Ht Pkup			0	0				0	0	0.00		Btu/hr-ft²	0.00	-42.72
Supply Air Leakage		0	0	0				0	0	0.00		No. People	0	
Grand Total ==>	0	0	0	100.00	0	100.00		-2,050	-2,050	100.00				

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity ton	MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/°F	WB/°F	HR gr/lb	Leave DB/°F	WB/°F	HR gr/lb	Gross Total	Glass ft² (%)	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F	
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Floor	48	-2.1	0	0.0	0.0	Main Htg
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0	Aux Htg
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0	Preheat
											ExFlr	6					
Total	0.0	0.0									Roof	48	0.0	0	0.0	0.0	Humidif
											Wall	84	0	0	0.0	0.0	Opt Vent
											Ext Door	0	0	0			Total
													-2.1				

System Checksums

By Engineered Solutions, Inc

RTU-1110

Single Zone

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 16		Mo/Hr: Sum of		Mo/Hr: Heating Design		Mo/Hr: Heating Design		Mo/Hr: Heating Design				
Outside Air:		OADB/WB/HR: 99 / 65 / 59		OADB: Peaks		OADB: -9		OADB: -9		OADB: -9				
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total	Space Sensible	Percent Of Total	Space Peak	Coil Peak	Percent	Space Sens	Tot Sens	Of Total			
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)			
Envelope Loads				Envelope Loads				Envelope Loads						
Skylite Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	SADB	Cooling	Heating
Skylite Cond	0	0	0	0	0	0	0	0.00	0	0	0.00	Ra Plenum	66.3	56.9
Roof Cond	473	0	473	1	473	1	-679	19.85	-679	-679	19.85	Return	95.0	55.0
Glass Solar	66	0	66	0	66	0	0	0.00	0	0	0.00	Ret/OA	95.0	55.0
Glass/Door Cond	-22	0	-22	0	-22	0	-1,234	36.09	-1,234	-1,234	36.09	Fn MtrTD	0.1	0.0
Wall Cond	-71	0	-71	0	-71	0	-807	23.60	-807	-807	23.60	Fn BldTD	0.3	0.0
Partition/Door	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn Frict	1.0	0.0
Floor	0	0	0	0.00	0	0.00	-700	20.46	-700	-700	20.46			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Infiltration	0	0	0	0	0	0	0	0.00	0	0	0.00			
Sub Total ==>	446	0	446	1	446	1	-3,420	100.00	-3,420	-3,420	100.00			
Internal Loads				Internal Loads				Internal Loads						
Lights	1,775	0	1,775	3	1,775	3	0	0.00	0	0	0.00			
People	0	0	0	0	0	0	0	0.00	0	0	0.00			
Misc	50,854	0	50,854	91	50,854	96	0	0.00	0	0	0.00			
Sub Total ==>	52,629	0	52,629	95	52,629	99	0	0.00	0	0	0.00			
Ceiling Load				Ceiling Load				Ceiling Load						
Ventilation Load	0	0	0	0	0	0	0	0.00	0	0	0.00			
Adj Air Trans Heat	0	0	0	0	0	0	0	0	0	0	0			
Dehumid. Ov Sizing			0	0			0	0.00	0	0	0.00			
Ov/Undr Sizing	0		0	0	0	0	0	0.00	0	0	0.00			
Exhaust Heat		0	0	0			0	0.00	0	0	0.00			
Sup. Fan Heat			2,607	5			0	0.00	0	0	0.00			
Ret. Fan Heat		0	0	0			0	0.00	0	0	0.00			
Duct Heat Pkup		0	0	0			0	0.00	0	0	0.00			
Underflr Sup Ht Pkup			0	0			0	0.00	0	0	0.00			
Supply Air Leakage		0	0	0			0	0.00	0	0	0.00			
Grand Total ==>	53,075	0	55,683	100.00	53,075	100.00	-3,420	100.00	-3,420	-3,420	100.00			

AIRFLOWS		
	Cooling	Heating
Diffuser	2,000	2,000
Terminal	2,000	2,000
Main Fan	2,000	2,000
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	2,000	2,000
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	5.88	5.88
cfm/ton	431.01	
ft²/ton	73.27	
Btu/hr-ft²	163.77	-10.06
No. People	0	

COOLING COIL SELECTION										AREAS				HEATING COIL SELECTION				
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR	Leave DB/WB/HR				Gross Total	Glass			CapacityCoil Airflow	Ent	Lvg		
	ton	MBh	MBh	cfm	°F °F	gr/lb	°F °F	gr/lb			ft²	(%)		MBh	cfm	°F	°F	
Main Clg	4.6	55.7	55.7	2,000	95.0 68.6	84.1	64.9 59.7	84.1		Floor	340			Main Htg	-3.4	2,000	55.0	56.9
Aux Clg	0.0	0.0	0.0	0	0.0 0.0	0.0	0.0 0.0	0.0		Part	0			Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0 0.0	0.0	0.0 0.0	0.0		Int Door	1			Preheat	-18.3	2,000	55.0	64.9
										ExFlr	15							
Total	4.6	55.7								Roof	340	0	0	Humidif	0.0	0	0.0	0.0
										Wall	488	19	4	Opt Vent	0.0	0	0.0	0.0
										Ext Door	49	0	0	Total	-3.4			

System Checksums

By Engineered Solutions, Inc

RTU-1120

Single Zone

COOLING COIL PEAK					CLG SPACE PEAK			HEATING COIL PEAK			TEMPERATURES		
Peaked at Time: Mo/Hr: 8 / 15					Mo/Hr: Sum of			Mo/Hr: Heating Design					
Outside Air: OADB/WB/HR: 99 / 65 / 55					OADB: Peaks			OADB: -9					
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)		Space Sensible	Percent Of Total (%)		Space Peak Space Sens	Coil Peak Tot Sens	Percent Of Total (%)		Cooling	Heating
Btu/h	Btu/h	Btu/h			Btu/h			Btu/h	Btu/h				
Envelope Loads					Envelope Loads			Envelope Loads					
Skylite Solar	0	0	0	0	0	0		0	0	0.00	SADB	54.9	74.5
Skylite Cond	0	0	0	0	0	0		0	0	0.00	Ra Plenum	74.3	66.2
Roof Cond	0	1,167	1,167	6	0	0		0	-1,396	10.17	Return	74.3	66.2
Glass Solar	1,409	0	1,409	7	2,148	15		0	0	0.00	Ret/OA	77.2	57.7
Glass/Door Cond	363	0	363	2	258	2		-1,365	-1,365	9.94	Fn MtrTD	0.1	0.0
Wall Cond	127	54	181	1	99	1		-529	-768	5.59	Fn BldTD	0.3	0.0
Partition/Door	2,042		2,042	10	1,670	11		-1,917	-1,917	13.97	Fn Frict	0.9	0.0
Floor	0		0	0	0.00	0		-1,166	-1,166	8.50			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00			
Infiltration	0		0	0	0	0		0	0	0.00			
Sub Total ==>	3,941	1,222	5,162	26	4,176	28		-4,977	-6,612	48.17			
Internal Loads					Internal Loads			Internal Loads					
Lights	1,320	0	1,320	7	1,320	9		0	0	0.00			
People	2,400	0	2,400	12	1,470	10		0	0	0.00			
Misc	7,620	0	7,620	38	7,620	52		0	0	0.00			
Sub Total ==>	11,340	0	11,340	57	10,410	70		0	0	0.00			
Ceiling Load					Ceiling Load			Ceiling Load					
Ventilation Load	253	-253	0	0	189	1		-339	0	0.00			
Adj Air Trans Heat	0	0	2,366	12	0	0		0	-7,116	51.83			
Dehumid. Ov Sizing	0		0	0	0	0		0	0	0			
Ov/Undr Sizing	0		0	0	0	0		0	0	0.00			
Exhaust Heat		0	0	0				0	0	0.00			
Sup. Fan Heat			1,043	5				0	0	0.00			
Ret. Fan Heat		0	0	0				0	0	0.00			
Duct Heat Pkup		0	0	0				0	0	0.00			
Underflr Sup Ht Pkup			0	0				0	0	0.00			
Supply Air Leakage		0	0	0				0	0	0.00			
Grand Total ==>	15,534	969	19,911	100.00	14,775	100.00		-5,316	-13,728	100.00			

TEMPERATURES		
	Cooling	Heating
SADB	54.9	74.5
Ra Plenum	74.3	66.2
Return	74.3	66.2
Ret/OA	77.2	57.7
Fn MtrTD	0.1	0.0
Fn BldTD	0.3	0.0
Fn Frict	0.9	0.0

AIRFLOWS		
	Cooling	Heating
Diffuser	880	880
Terminal	880	880
Main Fan	880	880
Sec Fan	0	0
Nom Vent	100	100
AHU Vent	100	100
Infil	0	0
MinStop/Rh	0	0
Return	780	780
Exhaust	0	0
Rm Exh	100	100
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	11.4	11.4
cfm/ft²	1.48	1.48
cfm/ton	530.35	
ft²/ton	358.59	
Btu/hr-ft²	33.46	-23.07
No. People	6	

COOLING COIL SELECTION										AREAS				HEATING COIL SELECTION				
	Total Capacity ton	MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F °F	gr/lb	Leave DB/WB/HR °F °F	gr/lb		Gross Total	Glass ft² (%)			CapacityCoil Airflow MBh cfm	Ent °F	Lvg °F		
Main Clg	1.7	19.9	19.1	880	77.2	58.1	56.3	53.6	49.0	54.9	Floor	595		Main Htg	-13.7	880	57.7	74.5
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	1,078		Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		Preheat	0.0	0	0.0	0.0
											ExFlr	30						
Total	1.7	19.9									Roof	595	0	Humidif	0.0	0	0.0	0.0
											Wall	413	40	Opt Vent	0.0	0	0.0	0.0
											Ext Door	0	0	Total	-13.7			

System Checksums

By Engineered Solutions, Inc

RTU-1121

Single Zone

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES		
Peaked at Time: Mo/Hr: 8 / 14					Mo/Hr: Sum of					Mo/Hr: Heating Design							
Outside Air: OADB/WB/HR: 98 / 65 / 59					OADB: Peaks					OADB: -9							
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total		Space Sensible	Percent Of Total				Space Peak	Coil Peak	Percent					
Btu/h	Btu/h	Btu/h	(%)		Btu/h	(%)				Space Sens	Tot Sens	Of Total					
Envelope Loads					Envelope Loads					Envelope Loads							
Skylite Solar	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	SADB	Cooling	Heating
Skylite Cond	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	Ra Plenum	55.0	62.7
Roof Cond	2,132	0	2,132	2	2,132	2	0	0	-3,211	-3,211	13.65	0	0	0.00	Return	95.0	55.0
Glass Solar	4,480	0	4,480	4	4,480	4	0	0	0	0	0.00	0	0	0.00	Ret/OA	95.0	55.0
Glass/Door Cond	-260	0	-260	0	-260	0	0	0	-5,850	-5,850	24.86	0	0	0.00	Fn MtrTD	0.2	0.0
Wall Cond	3,255	0	3,255	3	3,255	3	0	0	-9,742	-9,742	41.41	0	0	0.00	Fn BldTD	0.4	0.0
Partition/Door	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn Frict	1.1	0.0
Floor	0	0	0	0	0.00	0	0	0	-4,725	-4,725	20.08	0	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0.00	0	0.00			
Infiltration	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Sub Total ==>	9,607	0	9,607	8	9,607	8	0	0	-23,528	-23,528	100.00	0	0	0.00			
Internal Loads					Internal Loads					Internal Loads							
Lights	5,311	0	5,311	4	5,311	4	0	0	0	0	0.00	0	0	0.00			
People	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Misc	107,851	0	107,851	84	107,851	88	0	0	0	0	0.00	0	0	0.00			
Sub Total ==>	113,162	0	113,162	89	113,162	92	0	0	0	0	0.00	0	0	0.00			
Ceiling Load					Ceiling Load					Ceiling Load							
Ventilation Load	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Adj Air Trans Heat	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Ov/Undr Sizing	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Exhaust Heat	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Sup. Fan Heat	0	4,914	0	4	0	0	0	0	0	0	0.00	0	0	0.00			
Ret. Fan Heat	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Duct Heat Pkup	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Supply Air Leakage	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00			
Grand Total ==>	122,768	0	127,682	100.00	122,768	100.00	0	0	-23,528	-23,528	100.00	0	0	0.00			

AIRFLOWS		
	Cooling	Heating
Diffuser	3,317	3,317
Terminal	3,317	3,317
Main Fan	3,317	3,317
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	3,317	3,317
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	1.39	1.39
cfm/ton	311.74	
ft²/ton	225.00	
Btu/hr-ft²	53.33	-9.83
No. People	0	

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR	Leave DB/WB/HR						Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg	
ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb		ft²	(%)	MBh	cfm	°F	°F	
Main Clg	10.6	127.7	127.7	3,317	95.0	60.5	39.7	53.4	44.8	39.2	Floor	2,394	-23.5	3,317	55.0	62.7	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0	
											ExFlr	148					
Total	10.6	127.7									Roof	2,457	0.0	0	0.0	0.0	
											Wall	5,584	526	9	0.0	0.0	
											Ext Door	220	0	0			
													-23.5				

System Checksums

By Engineered Solutions, Inc

RTU-1122

Single Zone

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES		
Peaked at Time: Mo/Hr: 7 / 15					Mo/Hr: Sum of					Mo/Hr: Heating Design							
Outside Air: OADB/WB/HR: 100 / 66 / 59					OADB: Peaks					OADB: -9							
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total		Space Sensible	Percent Of Total				Space Peak	Coil Peak	Percent					
Btu/h	Btu/h	Btu/h	(%)		Btu/h	(%)				Space Sens	Tot Sens	Of Total					
Envelope Loads					Envelope Loads					Envelope Loads							
Skylite Solar	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	SADB	Cooling	Heating
Skylite Cond	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	Ra Plenum	55.0	61.2
Roof Cond	2,156	0	2,156	1	2,156	1	0	0	0	-2,787	-2,787	12.58	0	0.00	Return	95.0	55.0
Glass Solar	3,385	0	3,385	2	3,385	2	0	0	0	0	0	0.00	0	0.00	Ret/OA	95.0	55.0
Glass/Door Cond	17	0	17	0	17	0	0	0	0	-6,910	-6,910	31.20	0	0.00	Fn MtrTD	0.2	0.0
Wall Cond	2,172	0	2,172	1	2,172	2	0	0	0	-8,148	-8,148	36.79	0	0.00	Fn BldTD	0.4	0.0
Partition/Door	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00	Fn Frict	1.1	0.0
Floor	0	0	0	0	0.00	0	0	0	0	-4,304	-4,304	19.43	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0.00	0.00	0.00	0	0.00			
Infiltration	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Sub Total ==>	7,729	0	7,729	5	7,729	5	0	0	0	-22,150	-22,150	100.00	0	0.00			
Internal Loads					Internal Loads					Internal Loads							
Lights	4,614	0	4,614	3	4,614	3	0	0	0	0	0	0.00	0	0.00			
People	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Misc	131,742	0	131,742	88	131,742	91	0	0	0	0	0	0.00	0	0.00			
Sub Total ==>	136,356	0	136,356	91	136,356	95	0	0	0	0	0	0.00	0	0.00			
Ceiling Load					Ceiling Load					Ceiling Load							
Ventilation Load	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Adj Air Trans Heat	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Dehumid. Ov Sizing			0	0			0	0	0	0	0	0.00	0	0.00			
Ov/Undr Sizing	0		0	0	0	0	0	0	0	0	0	0.00	0	0.00			
Exhaust Heat		0	0	0			0	0	0	0	0	0.00	0	0.00			
Sup. Fan Heat			5,767	4			0	0	0	0	0	0.00	0	0.00			
Ret. Fan Heat		0	0	0			0	0	0	0	0	0.00	0	0.00			
Duct Heat Pkup		0	0	0			0	0	0	0	0	0.00	0	0.00			
Underflr Sup Ht Pkup			0	0			0	0	0	0	0	0.00	0	0.00			
Supply Air Leakage		0	0	0			0	0	0	0	0	0.00	0	0.00			
Grand Total ==>	144,086	0	149,853	100.00	144,086	100.00				-22,150	-22,150	100.00					

TEMPERATURES		
	Cooling	Heating
SADB	55.0	61.2
Ra Plenum	95.0	55.0
Return	95.0	55.0
Ret/OA	95.0	55.0
Fn MtrTD	0.2	0.0
Fn BldTD	0.4	0.0
Fn Frict	1.1	0.0

AIRFLOWS		
	Cooling	Heating
Diffuser	3,893	3,893
Terminal	3,893	3,893
Main Fan	3,893	3,893
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	3,893	3,893
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	1.87	1.87
cfm/ton	311.74	
ft²/ton	166.56	
Btu/hr-ft²	72.04	-10.65
No. People	0	

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR	Leave DB/WB/HR						Gross Total	Glass		CapacityCoil Airflow	Ent	Lvg		
ton MBh	MBh	cfm	°F °F	gr/lb	°F °F	gr/lb		°F °F	gr/lb		ft² (%)		MBh cfm	°F	°F		
Main Clg	12.5	149.9	149.9	3,893	95.0	60.5	39.7	53.4	44.8	39.2			Main Htg	-22.2	3,893	55.0	61.2
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0			Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0			Preheat	0.0	0	0.0	0.0
Total	12.5	149.9											Humidif	0.0	0	0.0	0.0
													Opt Vent	0.0	0	0.0	0.0
													Total	-22.2			

System Checksums

By Engineered Solutions, Inc

Vestibule Baseboard

Radiation (Heating Only)

COOLING COIL PEAK					CLG SPACE PEAK			HEATING COIL PEAK				TEMPERATURES		
Peaked at Time: Mo/Hr: 0 / 0					Mo/Hr: 0 / 0			Mo/Hr: Heating Design				Cooling Heating		
Outside Air: OADB/WB/HR: 0 / 0 / 0					OADB: 0			OADB: -9				SADB	0.0	55.0
Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)		Space Sensible Btu/h	Percent Of Total (%)		Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)		Ra Plenum	0.0	55.0
Envelope Loads								Envelope Loads				Return	0.0	55.0
Skylite Solar	0	0	0	0	0	0		0	0	0.00		Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	0		0	0	0.00		Fn BldTD	0.0	0.0
Roof Cond	0	0	0	0	0	0		-82	-82	4.05		Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	0		0	0	0.00		AIRFLOWS		
Glass/Door Cond	0	0	0	0	0	0		-822	-822	40.65		Cooling Heating		
Wall Cond	0	0	0	0	0	0		-862	-862	42.62		Diffuser	0	0
Partition/Door	0	0	0	0	0	0		0	0	0.00		Terminal	0	0
Floor	0	0	0	0	0.00	0		-257	-257	12.68		Main Fan	0	0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00		Sec Fan	0	0
Infiltration	0	0	0	0	0	0		0	0	0.00		Nom Vent	0	0
Sub Total ==>	0	0	0	0	0	0		-2,023	-2,023	100.00		AHU Vent	0	0
Internal Loads								Internal Loads				Infil	0	0
Lights	0	0	0	0	0	0		0	0	0.00		MinStop/Rh	0	0
People	0	0	0	0	0	0		0	0	0.00		Return	0	0
Misc	0	0	0	0	0	0		0	0	0.00		Exhaust	0	0
Sub Total ==>	0	0	0	0	0	0		0	0	0.00		Rm Exh	0	0
Ceiling Load								Ceiling Load				Auxiliary	0	0
Ventilation Load	0	0	0	0	0	0		0	0	0.00		Leakage Dwn	0	0
Adj Air Trans Heat	0	0	0	0	0	0		0	0	0		Leakage Ups	0	0
Dehumid. Ov Sizing			0	0				0	0	0.00		ENGINEERING CKS		
Ov/Undr Sizing	0		0	0	0	0		0	0	0.00		Cooling Heating		
Exhaust Heat		0	0	0				0	0	0.00		% OA	0.0	0.0
Sup. Fan Heat			0	0				0	0	0.00		cfm/ft²	0.00	0.00
Ret. Fan Heat		0	0	0				0	0	0.00		cfm/ton	0.00	
Duct Heat Pkup		0	0	0				0	0	0.00		ft²/ton	0.00	
Underflr Sup Ht Pkup			0	0					0	0.00		Btu/hr-ft²	0.00	-49.35
Supply Air Leakage		0	0	0					0	0.00		No. People	0	
Grand Total ==>	0	0	0	100.00	0	100.00		-2,023	-2,023	100.00				

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity ton	MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/°F	WB/°F	HR gr/lb	Leave DB/°F	WB/°F	HR gr/lb	Gross Total	Glass ft² (%)	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F	
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Floor	41	-2.0	0	0.0	0.0	Main Htg
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0	Aux Htg
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0	Preheat
											ExFlr	6					
Total	0.0	0.0									Roof	41	0	0	0.0	0.0	Humidif
											Wall	53	10	18	0.0	0.0	Opt Vent
											Ext Door	24	0	0	-2.0		Total

RTU 1120 VENTILATION CALCULATIONS

Job: Silt WTP Improvements

Date:10/12/2023

Engr:BGT

ENTERED VALUE

CALCULATED VALUE

Table 403.3.1.1.2.3.2

System Vent Efficiency

Max Zp

Ev

0.15

1.00

0.25

0.90

0.35

0.80

0.45

0.70

0.55

0.60

0.65

0.50

0.75

0.40

SUMMARY

Ventilation Calculation Method.....2015 IMC 403.3.1.1.1

Design Condition.....(ceiling heating)

Uncorrected Vent. Air Flow Rate (Vou).....92 [cfm] (Vou = SUM of Vou)

System Ventilation Efficiency (Ev).....0.92 [0.0 - 1.0 (Table 403.3.1.1.2.3.2)

System Diversity (D).....1.00

REQUIRED VENT. AIR FLOW RATE (Vot)99 [cfm] (Vot = Vou / Ev*D)

*1 Pz = Az*Den/1000

*2 Vbz = Rp*Pz + Ra*Az

*3 Voz = Vbz/Ez

*4 Zp = Voz/Vpz

*5 Vou = D*Rp*Pz + Ra*Az

Zone Name / Space Name	Occupancy Classification (Table 6-1)	(Az) Zone Area [sf]	(Vpz(max)) Zone Max. Airflow [cfm]	Full Occ. VAV Mult. [0.0 - 1.0]	(Vpz) Zone Min. Airflow [cfm]	(D) Occupant Diversity 0.0 - 1.0	(Den) Occupant Density #/1000 sf	(Rp) People Vent. Rate cfm/person	(Ra) Area Vent. Rate [cfm/sf]	(Ez) Zone Effectiveness [0.0 - 1.0]	(Pz)*1 Zone Max. Population [people]	(Vbz)*2 Breathing Zone Vent. Airflow [cfm]	(Voz)*3 Zone Vent. Airflow [cfm]	(Zp)*4 Zone Prim. Vent. Fract. [0.0 - 1.0]	(Vou)*5 Uncorrected Outdoor Airflow [cfm]
Break Room - Conf portion	Conference	98	246	1.0	246	1.0	50	5	0.06	0.8	4.9	30	38	0.15	30
Break Room - Lab portion	Science Lab	55	141	1.0	141	1.0	25	10	0.18	0.8	1.4	24	30	0.21	24
Break Room - Kitchenette portion	Office	168	79	1.0	79	1.0	5	5	0.06	0.8	0.8	14	18	0.23	14
Break Room - Office portion	Office	275	414	1.0	414	1.0	5	5	0.06	0.8	1.4	23	29	0.07	23
					0	1.0	0	0	0.06	0.8	0.0	0	0	0.00	0
					0	1.0	0	0	0.06	0.8	0.0	0	0	0.00	0
					0	1.0	0	0	0.12	0.8	0.0	0	0	0.00	0
Max Zp															
TOTALS:		596	880		880						8	92	115	0.23	92

- *1 Pz = Az*Den/1000
- *2 Vbz = Rp*Pz + Ra*Az
- *3 Voz = Vbz/Ez
- *4 Zp = Voz/Vpz
- *5 Vou = D*Rp*Pz + Ra*Az



Interior Lighting Compliance Certificate

Project Information

Energy Code: 2018 IECC
Project Title: Silt Water Treatment Plant
Project Type: New Construction

Construction Site:
500 Front Street
Silt, CO 81652

Owner/Agent:
Town of Silt
Silt, CO

Designer/Contractor:

Additional Efficiency Package(s)

Credits: 1.0 Required 1.0 Proposed
Reduced Lighting Power, 1.0 credit

Allowed Interior Lighting Power

A Area Category	B Floor Area (ft ²)	C Allowed Watts / ft ²	D Allowed Watts (B X C)
1-Water Treatment Plant - Process Areas (Manufacturing Facility)	7701	0.81	6238
2-Break Room (Office)	677	0.71	481
Total Allowed Watts =			6719

Proposed Interior Lighting Power

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
<u>1-Water Treatment Plant - Process Areas (Manufacturing Facility)</u>				
Process Area: A: Indust High Bay: LED Other Fixture Unit 125W:	1	15	131	1965
Chemical Room - West: D: Indust High Bay: LED Other Fixture Unit 90W:	1	9	83	747
Chemical Room - East: C: Indust Strip: LED Linear 33W:	1	10	42	420
Electrical Room: H: Indust Strip: LED Linear 33W:	1	6	26	156
<u>2-Break Room (Office)</u>				
Break Room: G: Recessed Troffer: LED Linear 33W:	1	12	27	324
Total Proposed Watts =				3612

Interior Lighting PASSES: Design 46% better than code

Interior Lighting Compliance Statement

Compliance Statement: The proposed interior lighting design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed interior lighting systems have been designed to meet the 2018 IECC requirements in COMcheck Version 4.1.5.5 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

Robert Martin

Name - Title

Signature

10/16/2023

Date



Exterior Lighting Compliance Certificate

Project Information

Energy Code: 2018 IECC
Project Title: Silt Water Treatment Plant
Project Type: New Construction
Exterior Lighting Zone: 2 (Light industrial area with limited nighttime use (LZ2))

Construction Site: 500 Front Street
Silt, CO 81652
Owner/Agent: Town of Silt
Silt, CO
Designer/Contractor:

Allowed Exterior Lighting Power

A Area/Surface Category	B Quantity	C Allowed Watts / Unit	D Tradable Wattage	E Allowed Watts (B X C)
Personnel Doors (Pedestrian and vehicular entrances and exits)	10 ft of door	14	Yes	140
Total Tradable Watts (a) =				140
Total Allowed Watts =				140
Total Allowed Supplemental Watts (b) =				400

(a) Wattage tradeoffs are only allowed between tradable areas/surfaces.

(b) A supplemental allowance equal to 400 watts may be applied toward compliance of both non-tradable and tradable areas/surfaces.

Proposed Exterior Lighting Power

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
<u>Personnel Doors (Pedestrian and vehicular entrances and exits 10 ft of door width): Tradable Wattage</u>				
LED 1: B: LED Wall Pack: LED Other Fixture Unit 16W:	1	10	15	150
Total Tradable Proposed Watts =				150

Exterior Lighting PASSES: Design 72% better than code**Exterior Lighting Compliance Statement**

Compliance Statement: The proposed exterior lighting design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed exterior lighting systems have been designed to meet the 2018 IECC requirements in COMcheck Version 4.1.5.5 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

Name - Title _____ Signature _____ Date _____



Inspection Checklist

Energy Code: 2018 IECC

Requirements: 46.0% were addressed directly in the COMcheck software

Text in the "Comments/Assumptions" column is provided by the user in the COMcheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
C103.2 [PR4] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the interior lighting and electrical systems and equipment and document where exceptions to the standard are claimed. Information provided should include interior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Dwgs E-21, E-1107 thru E-1110 Spec 26 50 50 Supplements
C103.2 [PR8] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the exterior lighting and electrical systems and equipment and document where exceptions to the standard are claimed. Information provided should include exterior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Dwgs E-21, E-1107 thru E-1110 Spec 26 50 00 Supplements
C406 [PR9] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the additional energy efficiency package options.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)
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Section # & Req.ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
C405.2.2.2 [EL22] ¹	Spaces required to have light-reduction controls have a manual control that allows the occupant to reduce the connected lighting load in a reasonably uniform illumination pattern ≥ 50 percent.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Dwgs E-304, E-1107 thru E-1110
C405.2.1, C405.2.1.1 [EL18] ¹	Occupancy sensors installed in classrooms/lecture/training rooms, conference/meeting/multipurpose rooms, copy/print rooms, lounges/breakrooms, enclosed offices, open plan office areas, restrooms, storage rooms, locker rooms, warehouse storage areas, and other spaces ≤ 300 sqft that are enclosed by floor-to-ceiling height partitions. Reference section language C405.2.1.2 for control function in warehouses and section C405.2.1.3 for open plan office spaces.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Dwgs E-304, E-1110 Spec 26 50 00
C405.2.1.2 [EL19] ¹	Occupancy sensors control function in warehouses: In warehouses, the lighting in aisleways and open areas is controlled with occupant sensors that automatically reduce lighting power by 50% or more when the areas are unoccupied. The occupant sensors control lighting in each aisleway independently and do not control lighting beyond the aisleway being controlled by the sensor.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C405.2.1.3 [EL20] ¹	Occupant sensor control function in open plan office areas: Occupant sensor controls in open office spaces ≥ 300 sq.ft. have controls 1) configured so that general lighting can be controlled separately in control zones with floor areas ≤ 600 sq.ft. within the space, 2) automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the space, 3) are configured so that general lighting power in each control zone is reduced by $\geq 80\%$ of the full zone general lighting power within 20 minutes of all occupants leaving that control zone, and 4) are configured such that any daylight responsive control will activate space general lighting or control zone general lighting only when occupancy for the same area is detected.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Dwgs E-304, E-1110 Spec 26 50 00
C405.2.2, C405.2.2.1, C405.2.2.2 [EL21] ²	Each area not served by occupancy sensors (per C405.2.1) have time-switch controls and functions detailed in sections C405.2.2.1 and C405.2.2.2.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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Section # & Req.ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
C405.2.3, C405.2.3.1, C405.2.3.2 [EL23] ²	Daylight zones provided with individual controls that control the lights independent of general area lighting. See code section C405.2.3 Daylight-responsive controls for applicable spaces, C405.2.3.1 Daylight responsive control function and section C405.2.3.2 Sidelit zone.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C405.2.4 [EL26] ¹	Separate lighting control devices for specific uses installed per approved lighting plans.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C405.2.4 [EL27] ¹	Additional interior lighting power allowed for special functions per the approved lighting plans and is automatically controlled and separated from general lighting.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C405.2.5 [EL28] ^{null}	Manual controls required by the energy code are in a location with ready access to occupants and located where the controlled lights are visible, or identify the area served and their status.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C405.2.6 [EL30] ^{null}	Automatic lighting controls for exterior lighting installed. Controls will be daylight controlled, set based on business operation time-of-day, or reduce connected lighting > 30%.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Dwgs E-21, E-1107 thru E-1110
C405.3 [EL6] ¹	Exit signs do not exceed 5 watts per face.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: E-21
C405.6 [EL26] ²	Low-voltage dry-type distribution electric transformers meet the minimum efficiency requirements of Table C405.6.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Spec 26 22 13
C405.7 [EL27] ²	Electric motors meet the minimum efficiency requirements of Tables C405.7(1) through C405.7(4). Efficiency verified through certification under an approved certification program or the equipment efficiency ratings shall be provided by motor manufacturer (where certification programs do not exist).	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Spec 11 05 13
C405.8.2, C405.8.2.1 [EL28] ²	Escalators and moving walks comply with ASME A17.1/CSA B44 and have automatic controls configured to reduce speed to the minimum permitted speed in accordance with ASME A17.1/CSA B44 or applicable local code when not conveying passengers.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Exception: Requirement does not apply.
C405.9 [EL29] ²	Total voltage drop across the combination of feeders and branch circuits <= 5%.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met. Location on plans/spec: Supplements - Refer to voltage drop calculations for major feeders

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)
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1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)
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Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
C303.3, C408.2.5.2 [FI17] ³	Furnished O&M instructions for systems and equipment to the building owner or designated representative.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C405.4.1 [FI18] ¹	Interior installed lamp and fixture lighting power is consistent with what is shown on the approved lighting plans, demonstrating proposed watts are less than or equal to allowed watts.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See the Interior Lighting fixture schedule for values.
C405.5.1 [FI19] ¹	Exterior lighting power is consistent with what is shown on the approved lighting plans, demonstrating proposed watts are less than or equal to allowed watts.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See the Exterior Lighting fixture schedule for values.
C408.1.1 [FI57] ¹	Building operations and maintenance documents will be provided to the owner. Documents will cover manufacturers' information, specifications, programming procedures and means of illustrating to owner how building, equipment and systems are intended to be installed, maintained, and operated.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C408.2.5.1 [FI16] ³	Furnished as-built drawings for electric power systems within 90 days of system acceptance.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.
C408.3 [FI33] ¹	Lighting systems have been tested to ensure proper calibration, adjustment, programming, and operation.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	Requirement will be met.

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)
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Silt Water Treatment Plant Project
2018 IECC Lighting Compliance Clarifications

General

Area Type: The “manufacturing” building area type is used for the purpose of validating code compliance. Of all of the Building Area Types listed in Table C405.3.2(1), manufacturing most closely relates to the process of water purification.

This water treatment facility purifies raw non-potable water to provide a municipal water supply through a process of pumping, agitation/mixing, chemical application and water quality monitoring and testing. Operation and maintenance staff that support this process are required to navigate around operating equipment and piping and perform detail-oriented tasks in every area of the facility. In addition to accessing equipment and related systems at floor level, operation and maintenance staff are required to climb and descend ladders to access narrow elevated walkways on the perimeter of process tanks.

Interior Lighting

C405.2.1, Occupant Sensor Controls: Other than the Break Room and the Laboratory in this facility there are no other space types in this facility that appear in this list. The light fixtures in the Break Room are controlled by ceiling-mounted motion sensors. The light fixtures in the Laboratory are controlled by a wall-mounted occupancy sensing switch.

C405.2.2, Time Switch Controls: Exception number 2 is applied as an automatic shutoff could endanger maintenance and operations staff.

C405.2.2.1, Time Switch Control Function: None of the spaces in this facility have a lighting power density of greater than 0.6 watts/sq ft as indicated in the following table. Consequently, no time-controlled lighting functions have been implemented.

Area		Total Lighting Wattage (watts)	Area Power Density (watts/sq ft)
Description	Square Footage		
Break Room	677	324	0.48
Chemical Room West	2042	747	0.37
Chemical Room East	851	420	0.49
Electrical Room	380	156	0.47
Process Area	4480	1965	0.44

C405.2.2.2, Light Reduction Controls: With the exception of the Break Room, each space in this facility is provided with manual light reduction control via dual switching of alternate rows of luminaires complying with C405.2.2.2, Item 2. The Break Room and Laboratory have dimming switches to control light levels in those spaces.

C405.2.3, Daylight Responsive Controls: No daylight harvesting controls have been provided.

Exterior Lighting

C405.2.5, Manual Controls: No manual control of the exterior light fixtures has been provided. Each exterior light fixture is furnished with an integral control unit to provide the control functions specified by C405.2.6.

C405.2.6.1 and C405.2.6.3, Exterior Lighting Controls: Each exterior light fixture is equipped with an integral photocell and motion control unit to energize the light fixture in a dimmed state when the ambient lighting falls to 1 footcandle. Once energized, if motion is detected the fixture is modulated to full brightness.

C405.2.6.4, Exterior Time Switch Control: This facility is operated 7 days per week so the fixture photocell and motion control features are always enabled regardless of the day of the week.

Visual - Interior Tool



Design Information

Project Name Silt Water Treatment Plant
Project Description Break Room

Wednesday, October 04, 2023

Your Name Martin
Company Name Integrated Solutions Engineering
Your Phone
Your Email

Calculation Results

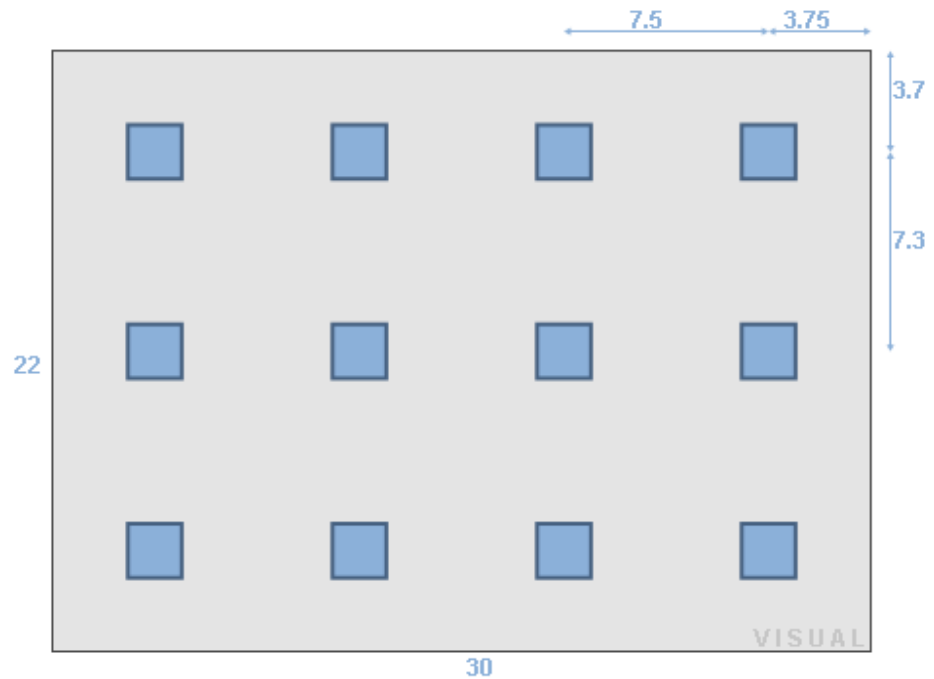
Illuminance 47 fc
Power Density 0.48 W/ft²
Quantity 12

Spacing Results

Spacing 7.5 x 7.3 ft
Arrangement 4 x 3
Offset X 2.76 ft
Offset Y 2.71 ft

Room Summary

Length 30 ft
Width 22 ft
Height 10 ft
Workplane 2.5 ft
Reflectances
Ceiling 80 %
Walls 50 %
Floor 20 %



Lithonia Lighting [G] - 2BLT2 33L SDSM LP835



Light Loss Factor	1	Lamp Lumens	3313	Wattage	26.5 Watts
Suspension Length	0 ft	Lamp Quantity	1	CU	0.78

These lighting calculation results are for general informational purposes only and are provided without warranty as to accuracy, completeness, reliability or otherwise. Results are based on user provided data and data provided from publicly available sources; actual field conditions may affect calculated output. Visit www.Visual-3D.com.

Visual - Interior Tool



Design Information

Project Name Silt Water Treatment Plant
Project Description Chemical Room A (West)

Wednesday, October 04, 2023
Your Name Robert Martin
Company Name Integrated Solutions Engineering
Your Phone
Your Email

Calculation Results

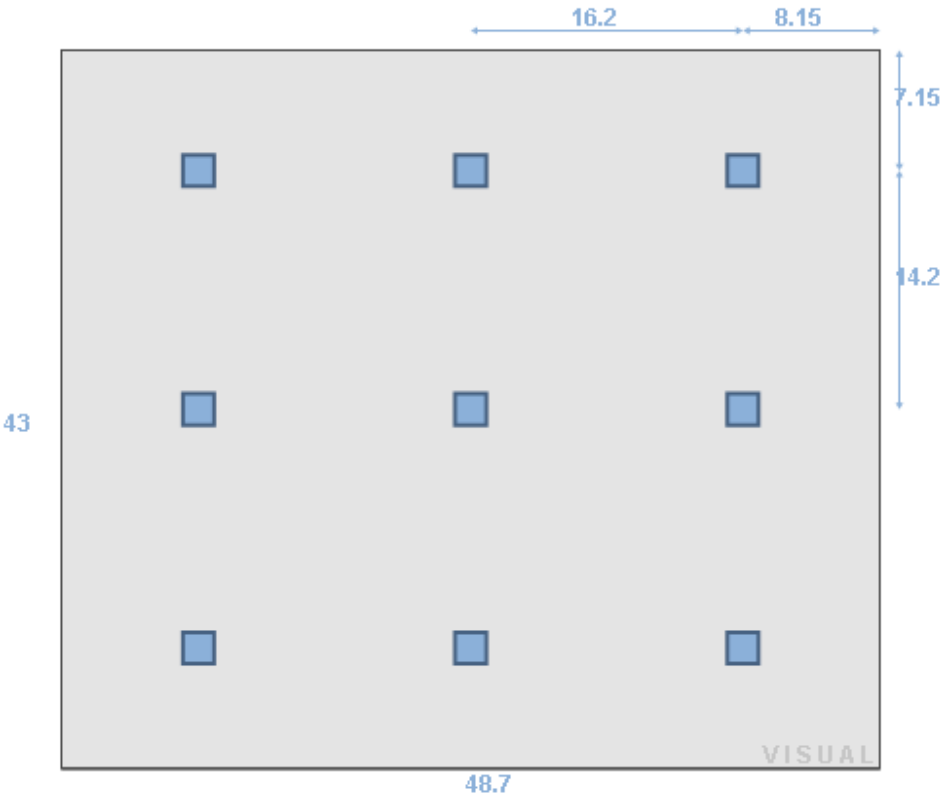
Illuminance 38 fc
Power
Density 0.36 W/ft²
Quantity 9

Spacing Results

Spacing 16.2 x
 14.2 ft
Arrangement 3 x 3
Offset X 7.22 ft
Offset Y 6.22 ft

Room Summary

Length 48.7 ft
Width 42.7 ft
Height 25 ft
Workplane 2.5 ft
Reflectances
Ceiling 80 %
Walls 50 %
Floor 20 %



Lithonia Lighting [D] - JHBL 12000LM ACL WD 35K 70CRI



Light Loss Factor	1	Lamp Lumens	13422	Wattage	82.8 Watts
Suspension Length	5 ft	Lamp Quantity	1	CU	0.65

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Design Information

Project Name Silt Water Treatment Plant
Project Description Chemical Room B (East)

Wednesday, October 04, 2023

Your Name Robert Martin
Company Name Integrated Solutions Engineering
Your Phone
Your Email

Calculation Results

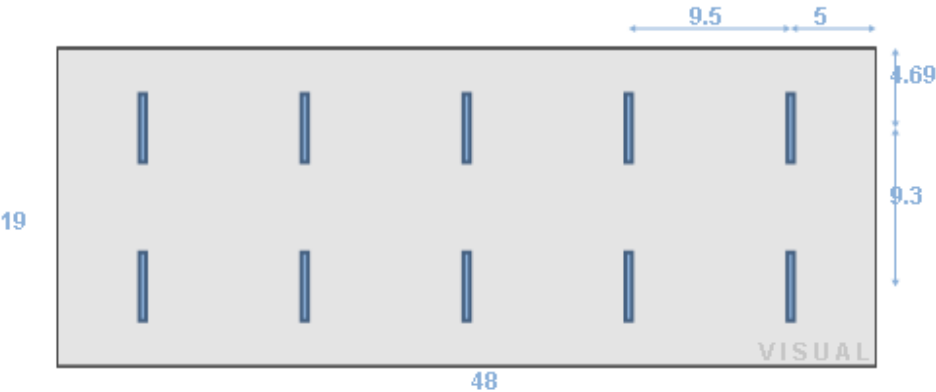
Illuminance 37 fc
Power Density 0.54 W/ft²
Quantity 10

Spacing Results

Spacing 9.5 x 9.3 ft
Arrangement 5 x 2
Offset X 4.81 ft
Offset Y 2.69 ft

Room Summary

Length 48 ft
Width 18.67 ft
Height 14 ft
Workplane 2.5 ft
Reflectances
Ceiling 80 %
Walls 50 %
Floor 20 %



Lithonia Lighting [C] - CSVT L48 5000LM 347 3500K 80CRI



Light Loss Factor	1	Lamp Lumens	4829	Wattage	48.8 Watts
Suspension Length	2 ft	Lamp Quantity	1	CU	0.68

These lighting calculation results are for general informational purposes only and are provided without warranty as to accuracy, completeness, reliability or otherwise. Results are based on user provided data and data provided from publicly available sources; actual field conditions may affect calculated output. Visit www.Visual-3D.com .

Visual - Interior Tool



Design Information

Project Name Silt Water Treatment Plant
Project Description Electrical Room

Wednesday, October 04, 2023

Your Name Robert Martin
Company Name Integrated Solutions Engineering
Your Phone
Your Email

Calculation Results

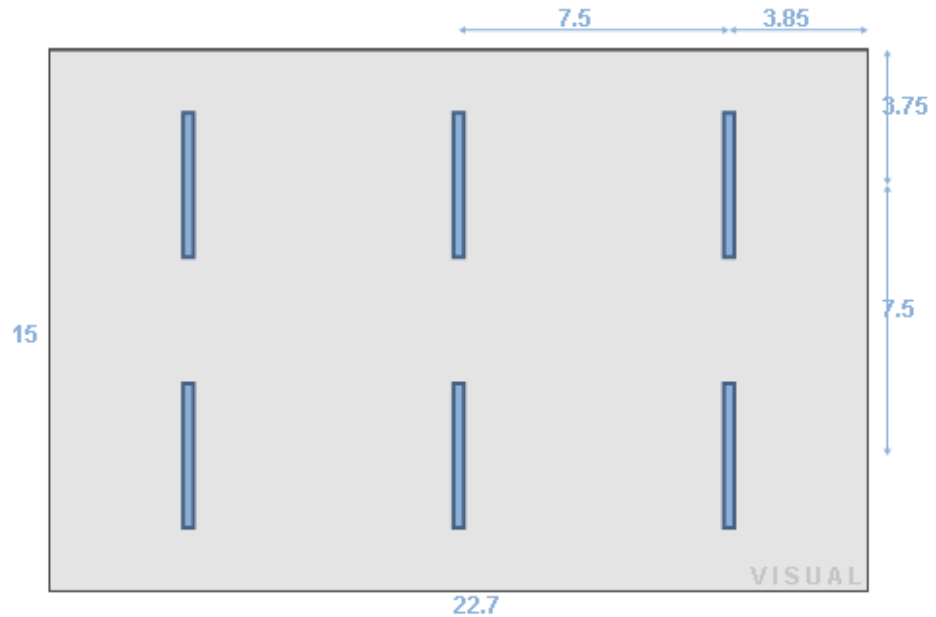
Illuminance 41 fc
Power Density 0.45 W/ft²
Quantity 6

Spacing Results

Spacing 7.5 x 7.5 ft
Arrangement 3 x 2
Offset X 3.71 ft
Offset Y 1.76 ft

Room Summary

Length 22.7 ft
Width 15 ft
Height 13 ft
Workplane 2.5 ft
Reflectances
Ceiling 80 %
Walls 50 %
Floor 20 %



Lithonia Lighting [H] - CLX L48 4000LM SEF RDL MVOLT 35K 80CRI



Light Loss Factor	1	Lamp Lumens	3906	Wattage	25.5 Watts
Suspension Length	2 ft	Lamp Quantity	1	CU	0.59

These lighting calculation results are for general informational purposes only and are provided without warranty as to accuracy, completeness, reliability or otherwise. Results are based on user provided data and data provided from publicly available sources; actual field conditions may affect calculated output. Visit www.Visual-3D.com.

Visual - Interior Tool



Design Information

Project Name Silt Water Treatment Plant
Project Description Process Area

Wednesday, October 04, 2023

Your Name Robert Martin
Company Name Integrated Solutions Engineering
Your Phone
Your Email

Calculation Results

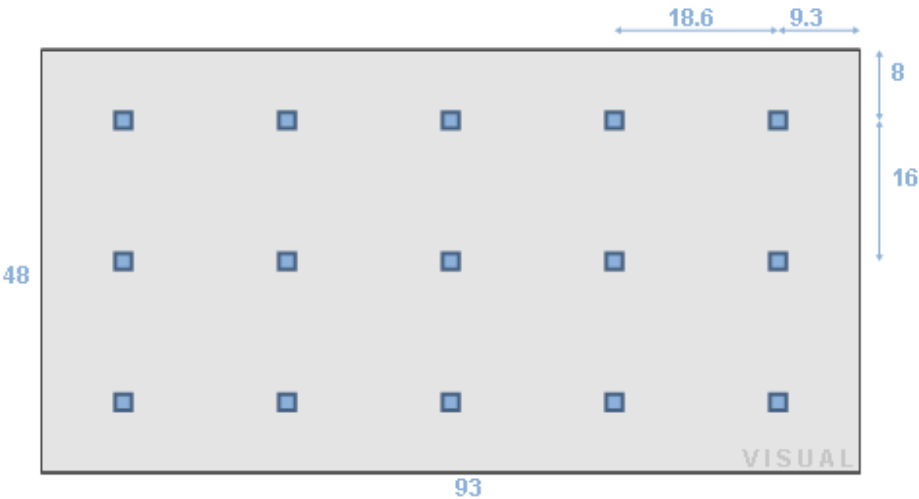
Illuminance 42 fc
Power Density 0.44 W/ft²
Quantity 15

Spacing Results

Spacing 18.6 x 16 ft
Arrangement 5 x 3
Offset X 8.37 ft
Offset Y 7.07 ft

Room Summary

Length 93 ft
Width 48 ft
Height 34 ft
Workplane 2.5 ft
Reflectances
Ceiling 80 %
Walls 50 %
Floor 20 %



Lithonia Lighting [A] - JHBL 18000LM ACL WD 50K 70CRI



Light Loss Factor	1	Lamp Lumens	20103	Wattage	131 Watts
Suspension Length	5 ft	Lamp Quantity	1	CU	0.63

These lighting calculation results are for general informational purposes only and are provided without warranty as to accuracy, completeness, reliability or otherwise. Results are based on user provided data and data provided from publicly available sources; actual field conditions may affect calculated output. Visit www.Visual-3D.com .

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	Utility Transformer
Destination:	MCC9000
Circuit Number:	MCC9000-1
Length (feet):	110
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	1195.0
Allowable Voltage Drop:	3%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	12.15
Percentage:	2.53%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	9.90
Percentage:	2.06%

Feeder Size:

	Conductor	Ampacity
Based on Design Ampacity:	4[350]	1240
Based on Voltage Drop:	4[500]	1520

Notes:

Use 4 sets of 500 kcmil for this feeder

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	DP9010
Circuit Number:	MCC9000-7
Length (feet):	25
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	185.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	0.70
Percentage:	0.15%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	0.60
Percentage:	0.12%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	3/0	200
Based on Voltage Drop:	4/0	230

Notes:

Use #4/0 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	ECP1100
Circuit Number:	MCC9000-5
Length (feet):	110
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	22.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	7.24
Percentage:	1.51%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	2.89
Percentage:	0.60%

Feeder Size:

	Conductor	Ampacity
Based on Design Ampacity:	12	25
Based on Voltage Drop:	8	50

Notes:

Use #8 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	ECP1200
Circuit Number:	MCC9000-6
Length (feet):	130
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	22.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	8.56
Percentage:	1.78%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	3.42
Percentage:	0.71%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	12	25
Based on Voltage Drop:	8	50

Notes:

Use #8 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	Blower B3810
Circuit Number:	MCC9000-11
Length (feet):	155
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	96.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	6.11
Percentage:	1.27%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	3.91
Percentage:	0.81%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	3	100
Based on Voltage Drop:	1	130

Notes:

Use #1 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	Pump P3410
Circuit Number:	MCC9000-13
Length (feet):	100
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	77.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	3.85
Percentage:	0.80%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	2.02
Percentage:	0.42%

Feeder Size:

	Conductor	Ampacity
Based on Design Ampacity:	4	85
Based on Voltage Drop:	1	130

Notes:

Use #4 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	TFR9020
Circuit Number:	MCC9000-8
Length (feet):	25
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	54.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	1.04
Percentage:	0.22%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	0.43
Percentage:	0.09%

Feeder Size:

	Conductor	Ampacity
Based on Design Ampacity:	6	65
Based on Voltage Drop:	2	115

Notes:

Use #2 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	TFR9021
Circuit Number:	MCC9000-10
Length (feet):	25
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	54.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	1.04
Percentage:	0.22%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	0.43
Percentage:	0.09%

Feeder Size:

	Conductor	Ampacity
Based on Design Ampacity:	6	65
Based on Voltage Drop:	2	115

Notes:

Use #2 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	TFR9210
Circuit Number:	MCC9000-9
Length (feet):	30
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	32.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	1.74
Percentage:	0.36%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	0.74
Percentage:	0.15%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	10	35
Based on Voltage Drop:	6	65

Notes:

Use #6 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	TFR9210
Destination:	LP9210
Circuit Number:	MCC9000-9
Length (feet):	200
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	1
Current:	63.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	12.39
Percentage:	2.58%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	7.79
Percentage:	1.62%

Feeder Size:

	Conductor	Ampacity
Based on Design Ampacity:	6	65
Based on Voltage Drop:	4	85

Notes:

Use #4 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	HTR8401
Circuit Number:	MCC9000-18
Length (feet):	100
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	11.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	3.29
Percentage:	0.69%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	3.29
Percentage:	0.69%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	12	25
Based on Voltage Drop:	12	25

Notes:

Use #12 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	MCC9000
Destination:	WH9320
Circuit Number:	MCC9000-20
Length (feet):	75
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	65.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	2.44
Percentage:	0.51%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	2.44
Percentage:	0.51%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	4	85
Based on Voltage Drop:	4	85

Notes:

Use #4 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	DP9010
Destination:	MAU1101
Circuit Number:	DP9010-4
Length (feet):	60
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	23.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	4.13
Percentage:	0.86%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	2.50
Percentage:	0.52%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	12	25
Based on Voltage Drop:	10	35

Notes:

Use #10 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	DP9010
Destination:	RTU1110
Circuit Number:	DP9010-5
Length (feet):	25
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	12.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	0.90
Percentage:	0.19%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	0.90
Percentage:	0.19%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	12	25
Based on Voltage Drop:	12	25

Notes:

Use #12 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	DP9010
Destination:	RTU1121
Circuit Number:	DP9010-6
Length (feet):	40
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	35.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	1.67
Percentage:	0.35%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	1.67
Percentage:	0.35%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	8	50
Based on Voltage Drop:	8	50

Notes:

Use #8 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	DP9010
Destination:	RTU1122
Circuit Number:	DP9010-7
Length (feet):	100
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	480
Phase:	3
Current:	42.0
Allowable Voltage Drop:	2%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	5.02
Percentage:	1.05%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	3.23
Percentage:	0.67%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	8	50
Based on Voltage Drop:	6	65

Notes:

Use #6 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

Feeder Voltage Drop Calculation Silt Water Treatment Plant

Description:

Origin:	LP 9020
Destination:	Access Gate
Circuit Number:	LP9020 27
Length (feet):	300
Temperature Rating:	75
Conduit Type:	PVC

Load Characteristics:

Voltage:	120
Phase:	1
Current:	6.0
Allowable Voltage Drop:	3%
Estimated Power Factor:	85%

Calculated Voltage Drop (Based on *Design Ampacity* Recommendation)

Volts:	7.11
Percentage:	5.93%

Calculated Voltage Drop (Based on *Voltage Drop* Recommendation)

Volts:	2.81
Percentage:	2.34%

Feeder Size:	Conductor	Ampacity
Based on Design Ampacity:	12	25
Based on Voltage Drop:	8	50

Notes:

Use #8 AWG conductors for this feeder.

Designer: Martin

Date: October 14, 2023

November 15, 2023

Mr. Trey H. Fonner
Public Works Director
Town of Silt
231 N 7th St,
Silt, CO 81652

Re: Silt Water Treatment Plant Drainage Letter

Dear Mr. Fonner,

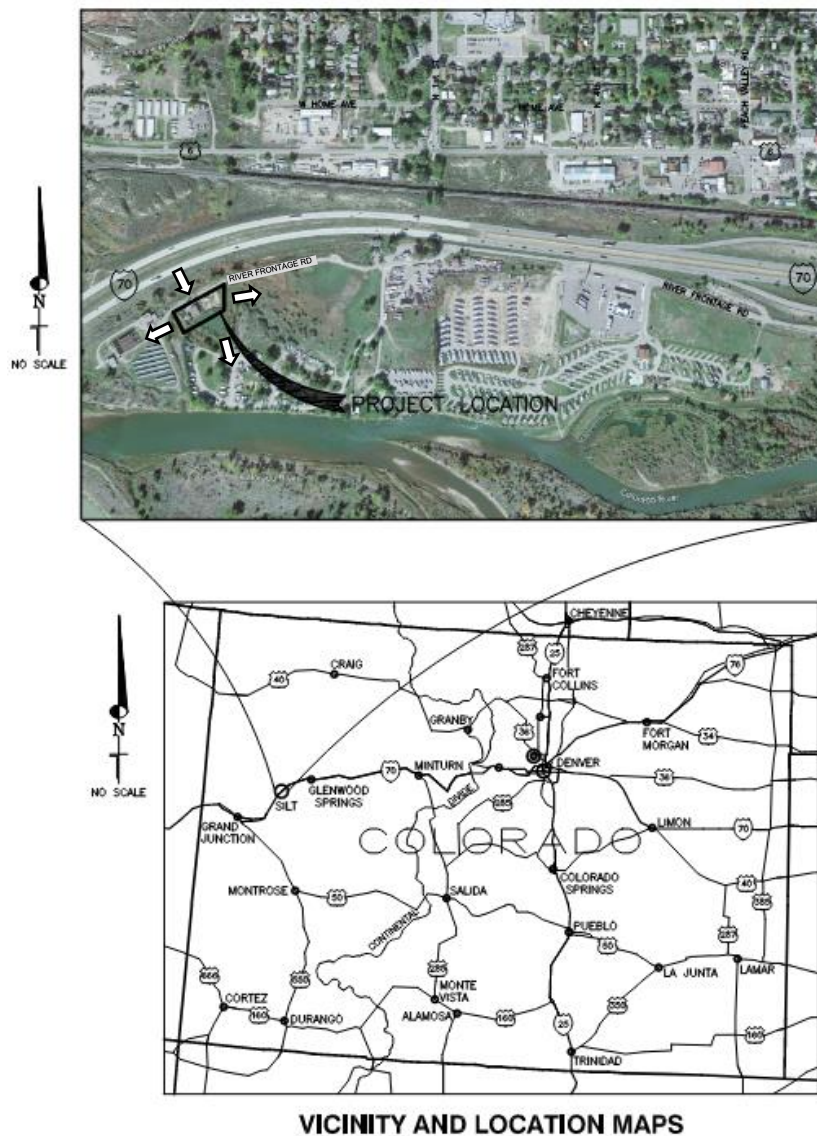
Dewberry Engineers Inc. (Dewberry) respectfully submits this Drainage Letter for the Town of Silt Water Treatment Plant Improvements for review and approval.

Existing and Proposed Site and Drainage Patterns

The proposed water treatment facility will be located adjacent to the existing building on an approximately 17.25 acre property which is owned by the Town of Silt (Reception No. 560805) and which is zoned Public Facility. The subject 17.25-acre property is bordered on the east by property owned by Casas Investment LLC (Reception No. 503455), on the north by Interstate 70, and on the south by the Colorado River.

The existing site, as shown in **Figure 1**, receives offsite drainage from Interstate 70 and River Frontage Road from the north, which drains across the property to the east, south, and west. Drainage continues west through the existing Silt Wastewater Treatment Plant or to the east pooling and overtopping the depression adjacent to the existing water treatment plant building. Flows from the east and west ultimately discharge to the Colorado River. The flow entering the existing backwash pond to the south of proposed improvements overflows through a pipe at the top of the pond and flows into the Colorado River.

Figure 1: Project Vicinity and Location Maps



The proposed water treatment building will be located near the eastern boundary of the site, adjacent to the existing water treatment plant building. No drainage features will be created as part of the project as the increase in peak runoff flows from the site are negligible and downstream properties should not be affected. The areas of the three basins will be adjusted to account for the new building and demolition of an existing building.

Offsite Drainage Evaluation

The Rational Method was used to calculate peak stormwater runoff rates resulting from the minor (5-year frequency) and major (100-year frequency) storm events for the three catchment areas (**Attachment A**). UD-Rational-2.00.xls, developed by Mile High Flood District (formerly Urban Drainage and Flood Control District), was used to estimate the peak runoff rates for the design storm events and to calculate the times of concentration for each catchment. Values

for P1 (one-hour rainfall depth) were obtained from the NOAA website utilizing the coordinates of the improvement site (39.5,-107.7).

Table 1 shows the area, weighted percent imperviousness, and time of concentration for each catchment that were used to estimate peak runoff rates for the design storm events. The calculated time of concentration value was selected in agreement with Mile High Flood District (MHFD) criteria. Complete calculations of peak runoff using the Rational Method are included in **Attachment B**.

Table 1: Tabulation of Proposed Catchment Hydrology

Catchment	Y	B	R
Undisturbed/Native Area (2% Impervious), sf	8,405	7,039	8,259
Roof Area (90% Impervious), sf	4,668	6,746	-
Concrete Area (100% Impervious), sf	175	945	1,117
Gravel Area (40% Impervious), sf	3,957	2,903	8,749
Total Area, sf	17,205	17,633	18,125
Total Area, acre	0.395	0.405	0.416
Weighted Imperviousness, %	35.61%	47.18%	26.38%
Calculated Time of Concentration t_c , min	7.57	5.55	14.92
Minor (5-year) Peak Flow, cfs	0.22	0.32	0.14
Major (100-year) Peak Flow, cfs	0.89	1.07	0.67

For a comparison with the existing runoff peak flows, an additional set of rational method calculations was prepared to model the existing condition with catchment areas imperviousness calculated based on existing structures and site conditions. For the calculations, gravel was 40% impervious, both concrete and flooded areas were 100% impervious, roof tops 90% impervious, and undeveloped areas 20% impervious. A comparison of existing and proposed peak runoff values is summarized in **Table 2**. The total increase in runoff from the project area is 0.13 cfs from the 100-year frequency rainfall event. This increase is negligible relative to the overall size of and runoff from the site and will not impact downstream properties.

Table 2: Comparison of Existing and Proposed Minor and Major Flows

Catchment	Y	B	R
Existing Conditions			
5 Year Minor Peak Flow (CFS)	0.27	0.10	0.11
100 Year Major Peak Flow (CFS)	1.35	0.55	0.6
Proposed Conditions			
5 Year Minor Peak Flow (CFS)	0.22	0.32	0.14
100 Year Major Peak Flow (CFS)	0.89	1.07	0.67
Overall Changes in Flow			
Change in Minor Peak Flows (CFS)	-0.05	0.22	0.03
Change in Major Peak Flows (CFS)	-0.47	0.52	0.08

The altered areas of the catchments due to the proposed water treatment plant additions are displayed in **Table 3**. The proposed building modifies runoff patterns, basin boundaries, and sizes with little change in peak flows. No proposed drainage improvements to reduce flows are necessary due to the negligible changes in runoff.

Table 3: Comparison of Existing and Proposed Catchment Areas

Catchment	Y	B	R
Existing Area, ac	0.68	0.24	0.33
Proposed Area, ac	0.4	0.41	0.42
% Difference	-41%	71%	27%

Conclusion

The project has a small impact on the drainage with an expected increase in overall peak flow of 0.13 cfs. No stormwater collection or conveyance facilities will be needed to negate the improvement project impact. The overall effect on neighboring properties and the flow in the Colorado River will be negligible. We do not expect the small increase in stormwater runoff will adversely affect the downstream areas.

Please don't hesitate to contact me at 303-951-0618 or at sfranzen@dewberry.com should you have any questions.

Sincerely,
Dewberry Engineers Inc.



Sam Franzen, PE

Attachments:
Attachment A – Catchment Areas Figure
Attachment B – Proposed and Existing Rational Method Calculations

Attachment A

Catchment Areas and Figures

Town of Silt Water Treatment Plant Improvements

Table of Contents

Figure A1: Silt Existing Catchments

Figure A2: Silt Proposed Catchments

Table A1: Proposed and Existing Catchment Areas

Figure A1: Silt Existing Catchments

The site plan illustrates the existing silt catchments, categorized by color and labeled with various codes. The red-shaded area, located in the lower-left, includes labels such as SAN-D, FIB-B, WAT-B, ELE-B, FM-D, and RW-D. The yellow-shaded area, occupying the upper-right, is labeled with SAN-D, FIB-B, WAT-B, ELE-D, and RW-D. The blue-shaded area, situated in the lower-right, is labeled with SAN-D, FIB-B, WAT-B, ELE-D, RW-D, UNK-D, and OF-D. The plan also shows topographic contours, a network of roads including RIVER FRONTAGE ROAD, and various utility lines. A scale bar at the bottom right indicates a scale of 1" = 30' ORIGINAL SCALE, with markings at 0, 15, 30, and 60 feet. A north arrow is positioned near the top right. The text 'INTERSTATE 70 (R/W VARIES)' is located in the upper-left quadrant. Specific elevation points are marked throughout the plan, such as 5413.00, 5403.67, 5412.60, 5412.73, 5412.80, 5412.87, 5412.96, 5411.03, 5411.34, and 5411.67. The plan also includes labels for 'SAN-D', 'FIB-B', 'WAT-B', 'ELE-D', 'RW-D', 'UNK-D', and 'OF-D'.

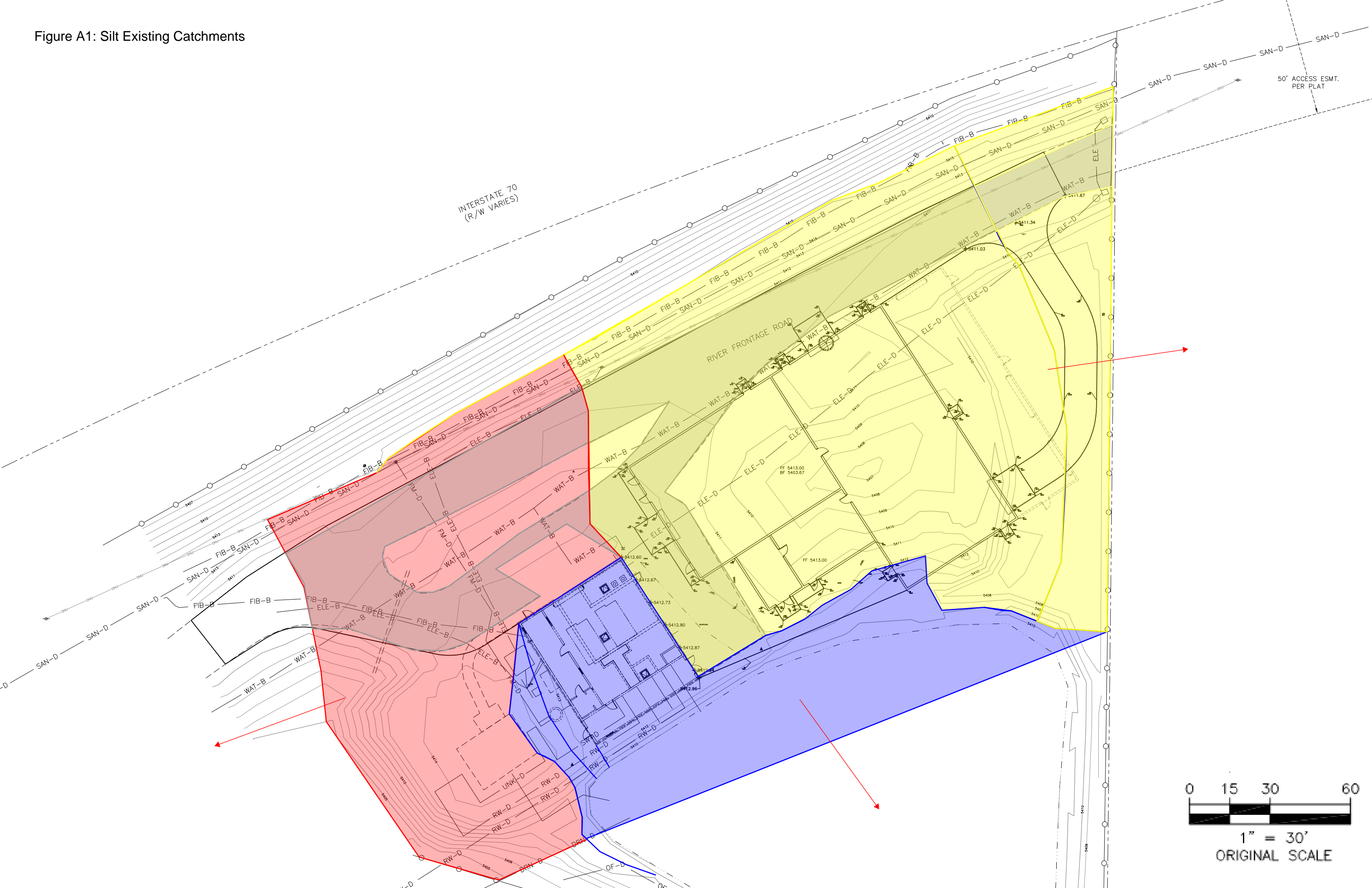


Figure A2: Silt Proposed Catchments

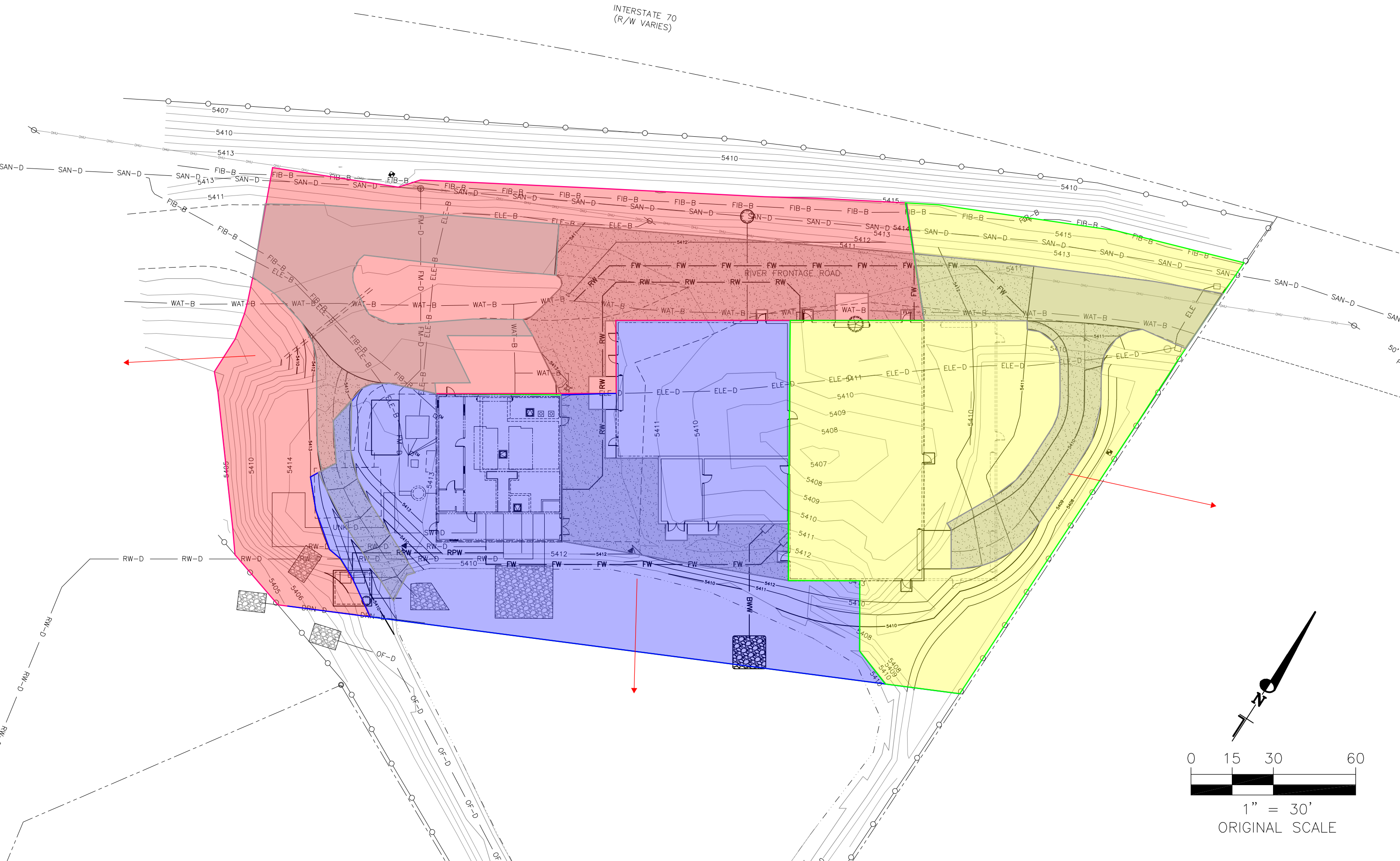


Table A1: Proposed and Existing Catchment Areas

Existing	Catchment	Area, sf	Area, ac
	Y	29475	0.677
	B	10538	0.242
	R	14249	0.327
	Total Area	54262	1.2
Proposed	Catchment	Area, sf	Area, ac
	Y	17205	0.395
	B	17633	0.405
	R	18125	0.416
	Total Area	52963	1.2

Attachment B

Proposed and Existing Rational Method Calculations

Town of Silt Water Treatment Plant Improvements

Table of Contents

Figure B1: Silt Existing Percent Impervious Calculations

Figure B2: Silt Existing Rational Method Calculations

Figure B3: Silt Proposed Percent Impervious Calculations

Figure B4: Silt Proposed Rational Method Calculations

Figure B1: Existing Percent Impervious Calculations

Catchment	Area, sf	Area, ac
Y	29475	0.677
B	10538	0.242
R	14249	0.327
Total Area	54262	1.246
Conversion	43,560	acres

Description	Area, ac	Imperviousness (%)	Weighted Imperviousness (%)
Roof	0.066	90%	4.757%
Concrete	0.022	100%	1.797%
Gravel	0.267	40%	8.561%
Flooded Area	0.100	100%	8.065%
Undisturbed	0.790	2%	1.269%

Imperviousness of Total Area	24.448%
------------------------------	---------

Weighted Imperviousness

Catchment	Area, sf					Weighted Imperviousness
	Roof	Concrete	Gravel	Flooded Area	Undisturbed	
Y	-	-	7310	4376	17,789	25.97%
B	2437	-	-	-	8,101	22.35%
R	431	975	4303	-	8,540	22.84%

Catchment	Area, ac						QC
	Roof	Concrete	Gravel	Flooded Area	Undisturbed	Total Area	
Y	-	-	0.1678	0.1005	0.4084	0.67665	0.00000
B	0.0559	-	-	-	0.1860	0.24192	0.00000
R	0.0099	0.0224	0.0988	-	0.1961	0.32711	0.00000

Figure B2: Silt Existing Rational Method Calculations

[illegible]

Figure B3: Proposed Percent Impervious Calculations

Catchment	Area, sf	Area, ac
Y	17205	0.395
B	17633	0.405
R	18125	0.416
Total Area	52963	1.216
Conversion	43,560	acres

Description	Area, ac	Imperviousness (%)	Weighted Imperviousness (%)
Roof	0.262	90%	19.396%
Concrete	0.051	100%	4.224%
Gravel	0.358	40%	11.789%
Undisturbed	0.544	2%	0.895%

Imperviousness of Total Area	36.303%
------------------------------	---------

Weighted Imperviousness

Catchment	Area, af				Weighted Imperviousness (%)
	Roof	Concrete	Gravel	Undisturbed	
Y	4668	175	3957	8,405	35.61%
B	6746	945	2903	7,039	47.18%
R	0	1117	8749	8,259	26.38%

Catchment	Area, ac				Total Area	QC
	Roof	Concrete	Gravel	Undisturbed		
Y	0.1072	0.0040	0.0908	0.1930	0.39497	0.00000
B	0.1549	0.0217	0.067	0.1616	0.40480	0.00000
R	0	0.0256	0.2008	0.1896	0.41609	0.00000

Figure B4: Silt Proposed Rational Method Calculations

TOWN OF SILT
PLANNING COMMISSION STAFF REPORT
Marioni Annexation and Zoning
Tuesday, December 5, 2023 6:30 PM

Project:	Marioni Annexation
Location:	129 West Home Avenue
Applicant:	Israel and Jorge Marioni
Owner:	Israel and Jorge Marioni
Current Zoning:	County
Proposed Zoning:	R-2
Present Land Use:	Vacant Lot- Storage for Construction Company
Proposed Land Use:	Single Family House

Description of Request

Israel and Jorge Marioni have applied to annex their property at 129 West Home Avenue. They initially applied for a building permit through Garfield County, however, were re-directed to the Town, as neither the county nor the Town want a septic tank and leech field installed at that location. The most viable option would be for the Marioni's to annex their property into Town limits and connect to the Town's water and wastewater system.

The Marioni's are proposing an R-2 zoning designation, which matches the surrounding areas to the North and East. This designation also allows for their proposal of a single-family dwelling.

West of the property, there is an R-2 Mixed Use Designation and that property will be developed as a PUD, which will include commercial and residential units.

The Property

The property is located on West Home Avenue, off of 1st Street.

129 West Home Avenue meets the requirements to petition for annexation, as the adjacent properties to the North, East and West are all in Town Limits. The adjacent property to the south is in the County, so the property is not enclaved.

Legal Description

Section: 9 Township: 6 Range: 92 BEG. AT A POINT WHENCE THE INTERSECTION OF THE N. LINE OF U.S. 6 & 24 WITH THE W. LINE OF NENE BEARS S. 85 DEG.23'W. 1121.8 FT. THENCE N. 89 DEG.22'W.72.5 FT. THENCE N. 0 DEG.38'E. 112.5 FT. THENCE S. 89 DEG. 22' E. 72.5 F



Comprehensive Plan

The Comprehensive Plan, as amended in 2017, designates the adjacent properties as Service and Commercial Support.

Given that there are two existing single-family houses to the east, with an R-2 designation, and a vacant lot with an R-2 Mixed Use Designation to the west, this designation in the Comprehensive Plan does not align with existing structures or current zoning.

Town Staff believes that even though the Comprehensive Plan does not align with the proposal, it does align with existing zoning and uses.

Land Use Designation	Description/Characteristics	Locational Criteria
<p>Service and Commercial Support Zone Districts: B-1, B-2 and B-3 Create new Industrial Zone District</p>	<p>Those properties within the Comprehensive Plan Land Use Designation of “Service and Commercial Support” are outside of the Town’s Downtown area, but are expected to have good visibility from Main Street and/or the I-70 corridor. The “Service and Commercial Support” designation is not expected to extend more than two blocks north of Highway 6. For this reason, it is appropriate to expect that these properties will provide the Town with solid retail and service commercial businesses, such as construction related businesses like supply companies, office-type businesses such as real estate offices, craftsmen-type businesses such as cabinet makers, and other services such as auto repair and small appliance repair, hotels, and convenience stores. These properties should look inviting and aesthetically professional, and the structures should have a western appeal or theme if possible. This area is crucial for the Town’s employment picture, providing local jobs within the core of the community, and keeping the residents close to enjoy the time not spent working with their families and friends. While retail businesses may not be the main focus in the “Service and Commercial Support” area, it is important for the Town to encourage any business that provides clean commercial without air pollution, noise, undesired odor, vibration or wasted resources. As the Town and/or businesses grow(s), this Comprehensive Plan Land Use Designation will have to shrink in order to accommodate a larger “Downtown” area.</p> <p>The Town should carefully scrutinize marijuana applications in this land use designation.</p>	<p>Along the railroad I-70 corridor (extending west of Ukele) and north and south of the river thereby limiting traffic impacts on residential areas. Service and Commercial Support sites should have adequate access to one or more major arterial and highway access capable of handling heavy truck traffic.</p> <p>Industrial uses have access to major highways through the Town’s arterial street system with minimal travel through other less intense land uses.</p> <p>Compatibility with nearby land uses and proximity to other industries are relevant criteria for siting industrial uses.</p>

Staff Findings and Conclusions

Overall, staff finds that this application and proposal for annexation meet the criteria to petition.

The Marioni's do not have any designated water rights to give the Town, however, Town Staff believes this particular annexation to be crucial for the well being of the adjacent neighbors and Town as a whole. It will not benefit anyone to keep this parcel in the county, allowing for a septic tank and leech field, or other possible scenarios that arise from not being held to the standard of the Silt Municipal Code.

Staff also believes that the R-2 zoning designation is what best fits for this property, as it will align with surrounding properties.

Planner Recommendation

The Planning and Zoning Commission is voting on a recommendation tonight, for substantial compliance and zoning. This recommendation will be taken to the Board of Trustees for a resolution of substantial compliance, then the annexation process and zoning will continue at the Board of Trustees level.

Planning staff recommends approval of the Annexation and Initial zoning to the R-2 District with the following conditions:

1. That all statements made by the applicant both in the application and in any meetings before the Planning and Zoning Commission be considered conditions of approval, unless modified in any subsequent conditions.
2. That the applicant provides any additional requested documents and pay any remaining fees, prior to proceeding to the next step in the process of annexation and/or building.

Recommended Motion: I move to recommend approval the annexation and initial zoning of 129 West Home Avenue, with the conditions noted above or verbally added during this meeting.



Community Development Department
231 N. 7th Street, Silt, CO 81652
(970) 876-2353 (office) (970) 876-2937 (fax)
www.TownOfSilt.org

Land Use Application Form

JJJ construction 0812@gmail.com

<input type="checkbox"/> Amended Plat	<input type="checkbox"/> Boundary Adjustment	<input type="checkbox"/> Subdivision Exemption
<input checked="" type="checkbox"/> Annexation	<input type="checkbox"/> Sketch Plan	<input type="checkbox"/> Floodplain Development
<input type="checkbox"/> Final Plan	<input type="checkbox"/> Planned Unit Development	<input type="checkbox"/> Vacation of Right-of-Way
<input type="checkbox"/> Text Amendment	<input type="checkbox"/> Site Plan Review	<input type="checkbox"/> Metro District or Special District
<input type="checkbox"/> Easement Agreement	<input type="checkbox"/> Zoning or Rezoning	<input type="checkbox"/> Subdivision Improvement Agreement
<input type="checkbox"/> Preliminary Plan	<input type="checkbox"/> Special Use Permit	<input type="checkbox"/> ADA or ADA Amendment
<input type="checkbox"/> Zoning Variance	<input type="checkbox"/> Intergovernmental Agreement	<input type="checkbox"/> Other: _____

Project Name: Marion? Res

Project Description / Property Information:

Address: 129 West Home Ave Silt Parcel ID Number: _____

Legal Description (attach additional sheets if necessary): _____

Access to Property: _____

Acreage or Square Footage: 8156 sq Existing Land Use Designation: _____

Proposed Land Use Designation: _____

Existing Zoning: _____ Proposed Zoning: R2

Proposed Use / Intensity of Use: _____

Submittal Requirements:

- A completed original application with original signatures and two copies (3 sets total) shall be submitted to the department for review. The application shall include three sets of 24" x 36" plans, plats and other appropriate drawings. Application must also be submitted in electronic format (MS Word).
- In addition to this application, all information on the supplemental checklist must be submitted.
- Incomplete applications will not be accepted and will delay processing.
- When the documents are deemed adequate, additional copies as required by the department shall be submitted ten (10) days before the public hearing.
- All documents submitted for public hearing shall be hole-punched, collated and paper-clipped (no staples). All plans, plats or drawings shall be folded to 8 1/2" x 11" and inserted into the collated application. Each individual application shall be banded together and ready for public distribution.

STAFF USE ONLY

Pre-app conference: _____ (date) Application received: _____ (date)

Application complete: _____ (date) File Number: _____

Fees: _____ Referrals Sent: _____ (date)

Deposits: _____ PZC approval: _____ (date)

Paid: _____ (date) BOT approval: _____ (date)

Project Team Information (fill in all that apply) (add additional sheets if needed):

Property Owner(s): Name: Jorge and Israel Marioni Phone: 970-274-6559

Company: JJJ Construction Fax: _____

Address: 42 Grass Mesa Drive Rifle Co 81650

Authorized Rep.: Name: Israel Marioni Phone: 970-274-6559

Company: JJJ Const Fax: _____

Address: _____

Engineer/Designer: Name: Structural Design Consultant LLC Phone: 970 945-4742

Company: James Jackson Romeo Fax: _____

Address: 131 River Vista Glenwood SP CO 81601

Billable Party: Owner _____ Representative _____ Engineer ☒

The Billable Party, by signing below, hereby agrees to reimburse the Town the actual costs to the Town plus the administrative fees for all contact services, including, but not limited to, planning, engineering, surveying and legal services rendered in connection with the review of the Application. The Billable Party shall also reimburse the Town for the cost of making any corrections or additions to the master copy of the official Town map and for any fees for recording any plats and accompanying documents with the County Clerk and Recorder of Garfield County. The Billable Party agrees that interest shall be imposed at a rate of 1.5% per month on all balances not paid within thirty (30) days of the date of the statement. In addition to any and all remedies available to the Town and in the event the Town is forced to pursue collection of any amounts due and unpaid, the Town shall be entitled to collect attorney's fees and costs incurred in said collection efforts in addition to the amount due and unpaid.

Jorge Marioni
Name (printed)

27653 Highway 6 #1208 Rifle CO 81650
Address

970-274-3641
Phone Fax

[Signature]
Signature

CDL
Type of Identification

County of Garfield

State of CO §

Sworn to and subscribed before me this 26 day of January, 2023
(fill in day) (fill in month) (fill in year)

By Nicole Centeno
(name printed)

Witness my hand and official seal.

[Signature]
Notary Public
My Commission Expires 2-19-24

NICOLE MARIE CENTENO
NOTARY PUBLIC - STATE OF COLORADO
(seal)
Notary ID #20204007103
My Commission Expires 2/19/2024

Disclosure of Property Ownership

- ☒ If owner is an individual, indicate name exactly as it appears on the deed.
☐ If owner is a corporation, partnership, limited partnership or other business entity, name principals on a separate page. Please include articles of organization, partnership agreement, etc., as applicable.
☐ If owner is a land trust, name beneficiaries on a separate page.
☐ If applicant is a lessee, indicate the owner(s) on a separate page.
☐ If applicant is a contract purchaser, attach a copy of the contract and indicate the owner(s) on a separate page.

Please provide the name(s), mailing address(es), street address(es) and phone number(s) for all owners.

Property Owner Affidavit

I/We, Jorge & Israel Marion?, being first duly sworn, depose and state under penalties of perjury that I am (we are) the owner(s) of the property described herein and which is the subject of the application and proposed hearings; that all answers provided to the questions in this application, and all sketches, data and all other supplementary matter attached hereto and made part of this application are honest and true to the best of my (our) knowledge and belief. I (we) understand that this application must be complete and accurate prior to a hearing being scheduled. I (we) authorize Town staff to visit the site as necessary for proper review of this application.

(If there are special conditions such as guard dogs, locked gates, restricted hours, etc., please give the name and phone number of the person(s) who can provide access to the site)

Israel Marion?
Name (printed)

27653 HWY 6 #1208

Rifle Co 81650
Address

970-274-6559
Phone

Fax
[Signature]
Signature

Co DL
Type of Identification

Garfield
County of

Co
State of

Sworn to and subscribed before me this 26 day of January, 2023
(fill in day) (fill in month) (fill in year)

By Nicole Centeno
(name printed)

Witness my hand and official seal.
[Signature]
Notary Public

My Commission expires: 2-19-24

Jorge Marion?
Name (printed)

27653 HWY 6 #1208

Rifle Co 81650
Address

970-274-3641
Phone

Fax
[Signature]
Signature

ss.
January, 2023
(fill in month) (fill in year)



Authorized Representative

I/We further permit Jorge Marion to act as my/our representative in any manner regarding this application, to answer any questions and to represent me/us at any meeting(s) and public hearing(s) which may be held on this application.

NOTE: All correspondence will be sent to the authorized representative. It will be the representative's responsibility to keep the owner(s) adequately informed as to the status of the application.

Jorge Marion
Name (printed)

27653 Hwy 6 #1208
Rifle CO 81650
Address

970-274-3641
Phone

Fax
[Signature]

Signature
CO DL

Type of Identification

County of Garfield

State of CO

ss.

Sworn to and subscribed before me this 26 day of January, 2023.
(fill in day) (fill in month) (fill in year)

By Nicole Centeno
(name printed)

Witness my hand and official seal.
[Signature]

Notary Public

My Commission expires: 2-19-24



Town of Silt Community Development

231 N. 7th Street, Silt Colorado 81652; (970)876-2353 ext. 110



LAND USE ACTIVITY IMPACT STATEMENT

Name of Applicant: Isaac Yaroni Date: 9/23/23
Location of Property: 129 W. Home Ave. Silt Co. 81652
Land Use Request: Build a Single Family Home

Please answer the following questions to the best of your ability. Attach additional pages as needed.

1. Is your request compatible with the Silt Municipal Code? Yes/No

2. Is your request compatible with the Silt Comprehensive Plan? Yes/No

If not, how is your request useful to the Town of Silt?

3. Explain how your request is compatible with the immediate area surrounding the site. A Single Family Home will fit in with other homes in the area.

4. How is your request desirable for the Town of Silt? More housing is essential for the area.

5. Detail any real or possible environmental, town service, or other impacts your request may have.

None

6. Are there or have there ever been any landfills on any part of the property included in your request? Yes/ No

7. Please mark all the concerns or impacts listed below which apply to your request and give a brief statement about how you have addressed them.

- a. ☐ traffic
- b. ☒ town services (water, sewer, etc.)
- c. ☐ signage
- d. ☐ open space
- e. ☒ schools
- f. ☒ emergency services (police, fire, medical)
- g. ☐ other utilities (electrical, etc.)
- h. ☐ other (pollution, etc.)

Please list any other items or information which you feel would be of help in assessing your application.

To the Town of Silt,

Re: Parcel number 2190910000006.

The above listed property and parcel belonging to Israel and Jorge Marioni was previously a construction storage site. Israel and Jorge have removed the storage and are proposing to build a single-family home on the site of approx. 2000 SF.

They have filed an annexation form to bring this parcel into the township, as the proposed site currently has no water or sewer hook ups available and they would have to build a septic system with a leach field that could present a danger to the area.

With annexation they would be able to tap into the township water and sewage system thereby eliminating the septic and leach field and hence the hazard it would introduce to the area.

We are in the process of doing our due diligence to notify all home or landowners within 200 feet of the property boundaries, not including the eased areas, of their proposed intent for the property.

Please accept this letter of our intent to let the township know of the plans for the parcel. We are seeking an R2 Zoning for this property.

Sincerely,

Israel and Jorge Marioni
JJJ Construction.

FLAT TOPS COWBOY CHURCH CORP
PO BOX 1501
RIFLE CO 81650

WAKEFIELD, KEVIN S & SAMANTHA L
7303 COUNTY ROAD 233
SILT CO 81652

KERALSA, LLC
3950 MIDLAND AVENUE, SUITE F2
GLENWOOD SPRINGS CO 81601

OSEGUERA, ELVIN MISAEL & YOVANI
794 CASTLE VALLEY BOULEVARD, UNIT 1
NEW CASTLE CO 81647

VINCE SILT MOBILE LLC
325 OAK LANE
ASPEN CO 81611

FRITZLAN, KASANDRA
111 W HOME AVE APT 1
SILT CO 81652

MARIONI, ISRAEL & JORGE
PO BOX 772
SILT CO 81652

MAIN STREET PLAZA LLC
711 MAIN STREET
CARBONDALE CO 81623

COOKMAN, WILLIAM THOMAS
335 WEST 6TH STREET
GRAFTON ND 582171370

ANDERSON, BEVERLY
PO BOX 1813
RIFLE CO 81650

LEE, DANIEL THOMAS & DEZARAE SUE
105 GRAND AVENUE
SILT CO 81652

HENRY, LONNY L & MELISSA
236 BIRCH COURT
SILT CO 81652

PONCE, NANCY & ALFREDO
5033 COUNTY ROAD 335 # 139
NEW CASTLE CO 81647

LOVELACE, JODY
111 WEST MAIN STREET
SILT CO 81652

SNIDER, CHARLES A & PHYLLIS D
PO BOX 294
SILT CO 81652-0294

D & B LIMITED
1407 HIWAN COURT
FORT COLLINS CO 80525

(no subject)

1 message

Steve Wiseley <steve.wiseley@gmail.com>
To: Steve Wiseley <steve.wiseley@gmail.com>

Fri, Sep 15, 2023 at 7:38 AM

ber
R350195
Parcel Number
217910209005
Owner
OSEGUERA, ELVIN MISAEL & YOVANI
Address
102 MAIN ST SILT 81652
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R350231
Parcel Number
217909104001
Owner
LEE, DANIEL THOMAS & DEZARAE SUE
Address
110 W MAIN ST SILT 81652
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R200003
Parcel Number
217909100010
Owner
ANDERSON, BEVERLY
Address
6524 6 & 24 HWY SILT 81652
Acres - 0.319999992847443
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R200181
Parcel Number
217909100024
Owner
COOKMAN, WILLIAM THOMAS
Address
150 W MAIN ST SILT 81652
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R083659
Parcel Number
217909100045
Owner
MAIN STREET PLAZA LLC
Address
0 SILT 81652
Acres - 1.32200002670288
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R043122
Parcel Number
217910228003
Owner
KERALSA, LLC
Address
125 HOME AVE SILT 81652
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R350318
Parcel Number
217909104002
Owner
VINCE SILT MOBILE LLC
Address
101 HOME AVE SILT 81652
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R350154
Parcel Number
217909104003
Owner
FRITZLAN, KASANDRA
Address
111 HOME AVE SILT 81652
[View: Property Record Card](#) | [Google Maps](#) opens in a new tab

Account Number
R200174
Parcel Number
217909100006
Owner
MARIONI, ISRAEL & JORGE

Address

129 W HOME AVE SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R042829

Parcel Number

217909101010

Owner

PONCE, NANCY & ALFREDO

Address

200 W HOME AVE SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R350391

Parcel Number

217910208009

Owner

WAKEFIELD, KEVIN S & SAMANTHA L

Address

102 HOME AVE SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R042830

Parcel Number

217909101011

Owner

HENRY, LONNY L & MELISSA

Address

236 BIRCH CT SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R007558

Parcel Number

217909101009

Owner

HARRIS, KATHLEEN ELIZABETH

Address

258 BIRCH CT SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R350898

Parcel Number

217909101005

Owner

LONG, JOHN ROBERT & ELLEN GAIL

Address

260 BIRCH CT SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R200057

Parcel Number

217904400006

Owner

FLAT TOPS COWBOY CHURCH CORP

Address

289 N 1ST ST SILT 81652

Acres - 4.88000011444092

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R200108

Parcel Number

217909100012

Owner

LOVELACE, JODY

Address

111 W MAIN ST SILT 81652

Acres - 0.529999971389771

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R200510

Parcel Number

217909100025

Owner

SNIDER, CHARLES A & PHYLLIS D

Address

171 W MAIN ST SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**

R200505

Parcel Number

217909100014

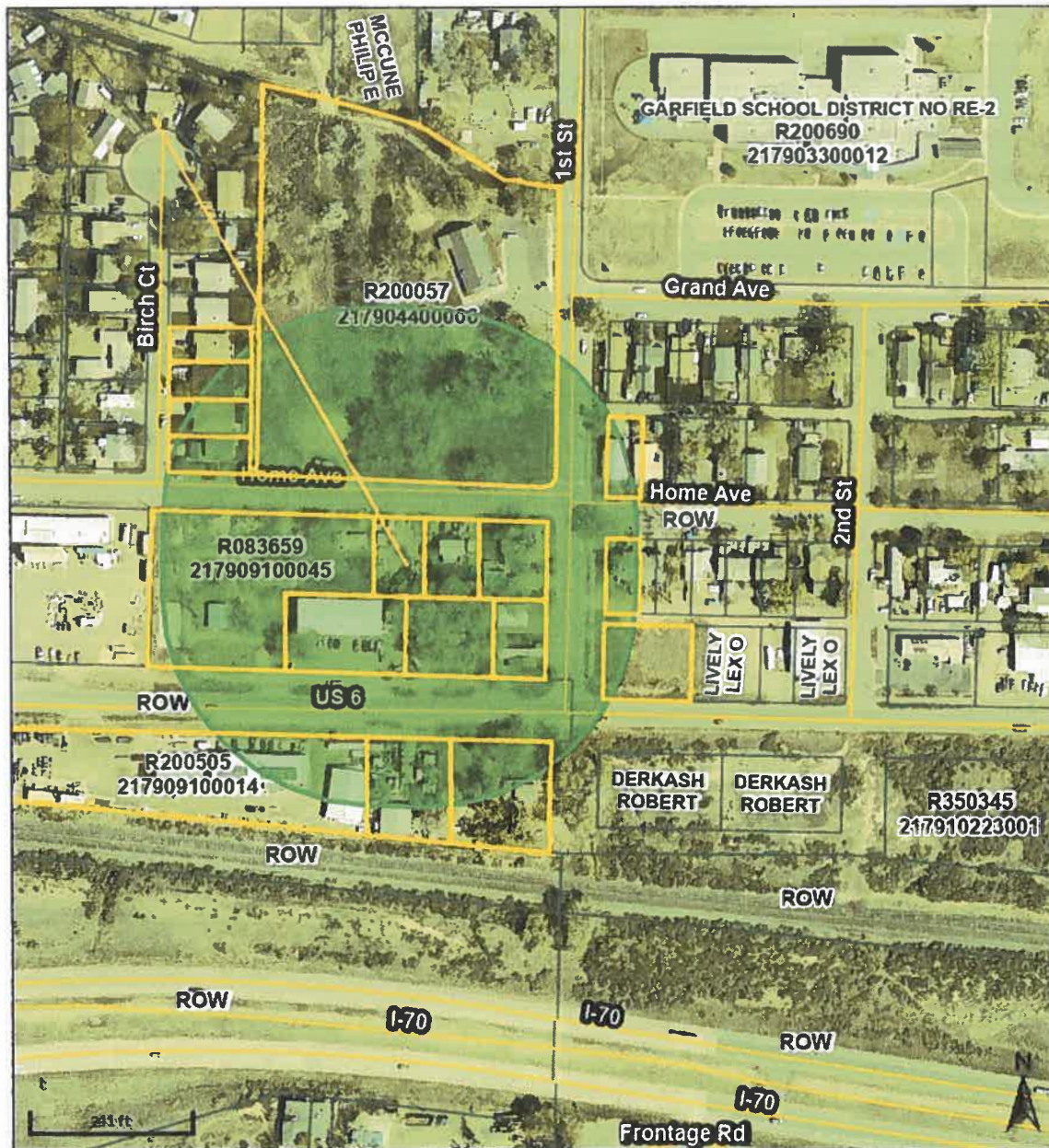
Owner

D & B LIMITED

Address

145 W MAIN ST SILT 81652

View: [Property Record Card](#) | [Google Maps](#)opens in a new tab**Account Number**



Overview



Legend

- Parcels
- Roads
- Parcel/Account Numbers
- Owner Name
- Lakes & Rivers
- County Boundary Line

Date created: 9/15/2023
Last Data Uploaded: 9/15/2023 2:11:06 AM

Developed by  **Schneider**
GEOSPATIAL

AFFIDAVIT OF CIRCULATOR

STATE OF COLORADO)

) §

COUNTY OF GARFIELD)

Affiant, Isaac, being of lawful age and first being duly sworn under oath, deposes and states:

1. Affiant is the circulator of the foregoing Petition for Annexation consisting of _____ pages, including this page;
2. Affiant provided the signatory with both a copy of the Petition for Annexation and the attached Annexation Map, to be filed with the Town of Silt, as referred to in said Petition;
3. Affiant personally witnessed the signatures appearing on the foregoing Petition for Annexation and the signatures appearing thereon is the signature of the person whose name it purports to be.

Further, Affiant sayeth not.

Dated this 13 day of OCT, 2023.

Isaac

Affiant/Circulator Printed

[Signature]

Affiant/Circulator Signature

STATE OF COLORADO)

) §

COUNTY OF GARFIELD)

Acknowledged, subscribed, and sworn to before me this 13 day of October, 2023, by _____.

WITNESS my hand and official seal.

[Signature]
My Commission expires: 2-19-24

NICOLE MARIE CENTENO
NOTARY PUBLIC - STATE OF COLORADO
Notary ID #20204007103
My Commission Expires 2/19/2024

PETITION FOR ANNEXATION

TO: THE TOWN CLERK AND THE BOARD OF TRUSTEES OF THE TOWN OF SILT,
COLORADO

The undersigned, in compliance with the "Municipal Annexation Act of 1965," C.R.S. §31-12-101 et seq., as amended, hereby petition(s) the Board of Trustees of the Town of Silt, Colorado, for annexation to the Town of Silt, the following described unincorporated territory located in the County of Garfield, State of Colorado, and more particularly described in Exhibit A, attached hereto and incorporated herein by this reference. In support of said Petition for Annexation, the undersigned submits the attached annexation map, and states and alleges as follows:

1. It is desirable and necessary that the property described in Exhibit A be annexed to the Town of Silt, Colorado.
2. The requirements of C.R.S. §§31.12-104 and 31-12-105, as amended, exist and have been met as follows:
 - a. Not less than one-sixth (1/6) of the perimeter of the area proposed to be annexed is contiguous with the Town of Silt, Colorado.
 - b. A community of interest exists between the Town and the area proposed to be annexed to the Town of Silt, Colorado.
 - c. The area proposed to be annexed is urban or will be urbanized in the near future.
 - d. The area proposed to be annexed is integrated or is capable of being integrated with the Town of Silt, Colorado.
 - e. In establishing the boundaries of the area proposed to be annexed, no real property held in identical ownership, whether consisting of one tract or parcel of real estate or two or more contiguous tracts or parcels of real estate, will be divided into separate parts or parcels without the written consent of the landowners.
 - f. In establishing the boundaries of the area proposed to be annexed, no real property held in identical ownership, whether consisting of one tract or parcel of real estate or two or more contiguous tracts or parcels of real estate, comprising twenty (20) acres or more (which together with the buildings and improvements situated thereon has a valuation for assessment in excess of \$200,000.00 for ad valorem tax purposes for the year next preceding the annexation) shall be included without the written consent of the landowners.
 - g. The property proposed for annexation is not presently part of any incorporated city or town, nor have annexation proceedings been commenced for the annexation of part of all of such property to another municipality.

h. The proposed annexation will not result in the detachment of real property from any school district and the attachment of same to another school district.

i. The proposed annexation will not have the effect of extending the municipal boundary more than three (3) miles in any direction in one (1) year.

3. The undersigned is the owner of 100 percent of the real property proposed to be annexed, and hereby consents to the establishment of the boundaries of this property as shown on the annexation plat submitted herewith.

4. No election for annexation to the Town of Silt, Colorado, has been initiated for the real property to be annexed hereunder within the preceding twelve (12) months.

5. The mailing address of the Petitioner is as follows:

129 West Home Ave Silt CO 81652

WHEREFORE, the undersigned requests that the Town approve the annexation of the territory to be annexed.

Signed this 13 day of Oct, 2023.

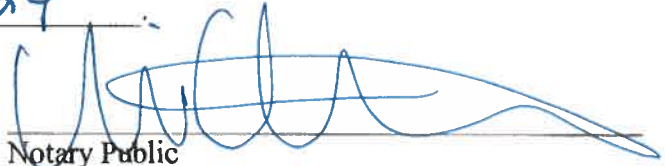
STATE OF COLORADO)
) §
COUNTY OF GARFIELD)

Acknowledged, subscribed, and sworn to before me this 13 day of October, 2023
by _____ and _____

WITNESS my hand and official seal.

My Commission expires: 2-19-24

NICOLE MARIE CENTENO
NOTARY PUBLIC - STATE OF COLORADO
Notary ID #20204007103
My Commission Expires 2/19/2024


Notary Public

Town of Silt

Attention: Zoning Board

Re: Parcel Number 2190910000006

Address: 129 W. Home Ave.

Members,

We are seeking Annexation for the above listed property to formally bring it into the Town of Silt. Once this is done, we would like to have the property rezoned R2 so that a single-family home can be erected.

Its current use had been as a storage facility for JJJ Construction.

We feel the impact of a new home with the surrounding homes would make better use of the property and also be a better fit for the community. It would beautify the area and create a better environment than the current use of trucks and equipment being stored.

Thank you for your consideration,

Israel & Jorge Marioni

JJJ Construction



Community Development Department
231 N. 7th Street, Silt, CO 81652
(970) 876-2353 (office) (970) 876-2937 (fax)
www.TownOfSilt.org

Land Use Application Form

<input type="checkbox"/> Suggested Plat	<input type="checkbox"/> Boundary Adjustment	<input type="checkbox"/> Subdivision Exemption
<input type="checkbox"/> Annexation	<input type="checkbox"/> Sketch Plan	<input type="checkbox"/> Floodplain Development
<input type="checkbox"/> Final Plan	<input type="checkbox"/> Planned Unit Development	<input type="checkbox"/> Vacation of Right-of-Way
<input type="checkbox"/> Text Amendment	<input checked="" type="checkbox"/> Site Plan Review	<input type="checkbox"/> Metro District or Special District
<input type="checkbox"/> Easement Agreement	<input type="checkbox"/> Zoning or Rezoning	<input type="checkbox"/> Subdivision Improvement Agreement
<input type="checkbox"/> Preliminary Plan	<input type="checkbox"/> Special Use Permit	<input type="checkbox"/> ADA or ADA Amendment
<input type="checkbox"/> Zoning Variance	<input type="checkbox"/> Intergovernmental Agreement	<input type="checkbox"/> Other: _____

Project Name: MARIODI Project Description: Build Single Family Home
Owner's Name: ISRAEL MARIODI Owner's Number: 970-274-6557 Owner's Email Address: IT CONSTRUCTION0812@GMAIL.COM
Address: 129 W. HOME AVE. S.I.T CO Parcel ID Number: 2190910000006
Legal Description (attach additional sheets if necessary): Section 9 Township: 6 Range: 92 BGS. AT A POINT WHERE (PLEASE SEE ATTACHED FOR LEGAL)
Access to Property: STREET ACCESS
Acreage or Square Footage: 7840 SF Existing Land Use Designation: Storage
Proposed Land Use Designation: R2 SINGLE FAMILY HOME
Existing Zoning: _____ Proposed Zoning: R2
Proposed Use / Intensity of Use: SINGLE FAMILY HOME

Submittal Requirements:

- A completed original application with original signatures and two copies (2 full sets) shall be submitted to the department for review. The application shall include two sets of 24" x 36" plans, plats and other appropriate drawings. Full application must also be submitted in electronic format.
- In addition to this application, all information on the supplemental checklist must be submitted.
- Incomplete applications will not be accepted and will delay processing.
- When the documents are deemed adequate, additional copies as required by the department shall be submitted no less than ten (10) days before the public hearing.
- All documents submitted for Land Use Applications shall be collated and paper-clipped (no staples). All plans, plats or drawings shall be organized and submitted ready for review, to avoid delays in processing. Fees and Deposits are collected at the time of submittal.

STAFF USE ONLY

Pre-app conference: _____ (date) Fees: _____
Application Received: _____ (date) Deposits: _____
PZC approval: _____ (date) Date Fees Collected: _____
BOT approval: _____ (date)

Billable Party Agreement

Property Owner(s) Name: Israel YARIBOI Phone: 970-274-6559
Company: JJI Construction Fax: _____
Address: 129 W. Howe Ave. Ste C
Authorized Rep.: Name: Steve Wiskey Phone: 970-710-0360
Company: _____ Fax: _____
Address: 53 VALLEY OF CARBONDAKE CO 81623
Billable Party: Owner Israel YARIBOI Representative SAUC

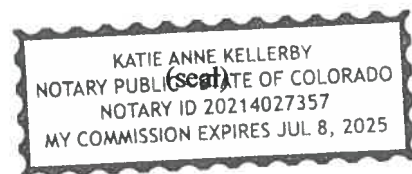
The Billable Party, by signing below, hereby agrees to reimburse the Town the actual costs to the Town plus 15% administrative fees for all billable staff time and contract services, including, but not limited to, planning, reviewing, inspecting, engineering, surveying and legal services rendered in connection with the applicant's request. A deposit will be required if deemed necessary by Town Staff. The Billable Party shall also reimburse the Town for the cost of making any corrections or additions to the master copy of the official Town map and for any fees for recording any plats and accompanying documents with the County Clerk and Recorder of Garfield County. The Billable Party agrees that interest shall be imposed at a rate of 5% per month on all balances not paid within thirty (30) days of the date of the statement. In addition to any and all remedies available to the Town and in the event the Town is forced to pursue collection of any amounts due and unpaid, the Town shall be entitled to collect attorney's fees and costs incurred in said collection efforts in addition to the amount due and unpaid.

Name (printed): Israel YARIBOI
Address: 129 W. Howe Ave. Ste C
Phone: 970-274-6559 Email: JJI Construction 0812 @ GHA1.COM
Type of Identification: Colorado Drivers License Identification Number & Expiration: 95-181-0543 exp 2/21/24
Signature: [Signature] Date: Sept 26 2023
County of Garfield)
State of Colorado) §

Sworn to and subscribed before me this 26 day of Sept 2023
(Day) (Month) (Year)

By Katie Kellerby Witness my hand and official seal Katie Kellerby
(Notary Name) (Notary Signature)

Notary Public
My Commission Expires July 8th 2025



Disclosure of Property Ownership

- ☒ If owner is an individual, indicate name exactly as it appears on the deed.
☐ If owner is a corporation, partnership, limited partnership or other business entity, name principals on a separate page. Please include articles of organization, partnership agreement, etc., as applicable.
☐ If owner is a land trust, name beneficiaries on a separate page.
☐ If applicant is a lessee, indicate the owner(s) on a separate page.
☐ If applicant is a contract purchaser, attach a copy of the contract and indicate the owner(s) on a separate page.

Please provide the name(s), mailing address(es), street address(es) and phone number(s) for all owners.

Property Owner Affidavit

I/We, Israel Marioni / Jorge Marioni, being first duly sworn, depose and state under penalties of perjury that I am (we are) the owner(s) of the property described herein and which is the subject of the application and proposed hearings; that all answers provided to the questions in this application, and all sketches, data and all other supplementary matter attached hereto and made part of this application are honest and true to the best of my (our) knowledge and belief. I (we) understand that this application must be complete and accurate prior to a hearing being scheduled. I (we) authorize Town staff to visit the site as necessary for proper review of this application.

(If there are special conditions such as guard dogs, locked gates, restricted hours, etc., please give the name and phone number of the person(s) who can provide access to the site)

Israel Marioni
Name (printed)

Jorge Marioni
Name (printed)

129 W. Howe Ave. Silt Co
Address

Same -
Address

970-274-6559
Phone

970-274-3641
Phone

N/A
Fax

N/A
Fax

[Signature]
Signature

[Signature]
Signature

Colorado Drivers license
Type of Identification

County of Garfield

State of Colorado

SS.

Sworn to and subscribed before me this 26th day of September, 2023
(fill in day) (fill in month) (fill in year)

By Israel Marioni and Jorge Marioni
(name printed)

Witness my hand and official seal.
Katie Kellerby

Notary Public Katie Kellerby

My Commission expires: July 8th 2025



Authorized Representative

I/We further permit Israel Marion / Jorge Marion / Steve Wecker to act as my/our representative in any manner regarding this application, to answer any questions and to represent me/us at any meeting(s) and public hearing(s) which may be held on this application.

NOTE: All correspondence will be sent to the authorized representative. It will be the representative's responsibility to keep the owner(s) adequately informed as to the status of the application.

Steve Wecker
Name (printed)

53 Valley Ct. CARBONATE CO 81623
Address

970.710.0360
Phone

N/A
Fax

[Signature]
Signature

Colorado Drivers license
Type of Identification

County of Garfield)

State of Colorado)

SS.

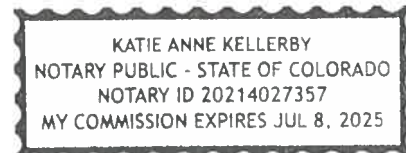
Sworn to and subscribed before me this 26th day of September, 2023
(fill in day) (fill in month) (fill in year)

By Israel Marion
(name printed)

Witness my hand and official seal.

Katie Kellerby
Notary Public

My Commission expires: July 8th 2025



FLAT TOPS COWBOY CHURCH CORP
PO BOX 1501
RIFLE CO 81650

WAKEFIELD, KEVIN S & SAMANTHA L
7303 COUNTY ROAD 233
SILT CO 81652

KERALSA, LLC
3950 MIDLAND AVENUE, SUITE F2
GLENWOOD SPRINGS CO 81601

OSEGUERA, ELVIN MISAEL & YOVANI
794 CASTLE VALLEY BOULEVARD, UNIT 1
NEW CASTLE CO 81647

VINCE SILT MOBILE LLC
325 OAK LANE
ASPEN CO 81611

FRITZLAN, KASANDRA
111 W HOME AVE APT 1
SILT CO 81652

MARIONI, ISRAEL & JORGE
PO BOX 772
SILT CO 81652

MAIN STREET PLAZA LLC
711 MAIN STREET
CARBONDALE CO 81623

COOKMAN, WILLIAM THOMAS
335 WEST 6TH STREET
GRAFTON ND 582171370

ANDERSON, BEVERLY
PO BOX 1813
RIFLE CO 81650

LEE, DANIEL THOMAS & DEZARAE SUE
105 GRAND AVENUE
SILT CO 81652

HENRY, LONNY L & MELISSA
236 BIRCH COURT
SILT CO 81652

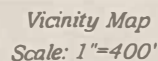
PONCE, NANCY & ALFREDO
5033 COUNTY ROAD 335 # 139
NEW CASTLE CO 81647

LOVELACE, JODY
111 WEST MAIN STREET
SILT CO 81652

SNIDER, CHARLES A & PHYLLIS D
PO BOX 294
SILT CO 81652-0294

D & B LIMITED
1407 HIWAN COURT
FORT COLLINS CO 80525

*A Parcel of Land Situate in the NE1/4 of the NE1/4 Section 9,
Township 6 South, Range 92 West of the 6th P.M.
County of Garfield, State of Colorado*



KNOW ALL MEN BY THESE PRESENTS THAT THE UNDERSIGNED, BEING THE SOLE OWNER OF THE A-1 REAL PROPERTY DESCRIBED AS FOLLOWS:

A TRACT OF LAND SITUATE IN THE R111 & R112-1 OF SECTION 9, TOWNSHIP 4 SOUTH RANGE 12 WEST OF THE 6TH P.M., 34 WITH AN AREA AS SHOWN ON A POINT WHICH THE DISTRICT OFFICE OF THE U.S. DEPT. OF THE INTERIOR, U.S. GEOLOGICAL SURVEY, HAS DETERMINED TO BE THE CORNER OF THE 1/4 SECTION 9, TOWNSHIP 4 SOUTH RANGE 12 WEST OF THE 6TH P.M., 34 WITH THE WEST LINE OF SAID R111 & R112-1 BEING SOUTH 82°12' WEST 112.1 FEET; THENCE SOUTH 82°12' WEST 112.1 FEET; THENCE SOUTH 82°12' WEST 112.1 FEET; THENCE SOUTH 82°12' WEST 112.1 FEET TO THE EAST OF SECTION 9.

CITY OF GARFIELD, STATE OF COLORADO

COPIES OF THESE CHARTS CORRELATE TO THE AERIAL PHOTOGRAPH TAKEN AT THE TOWN OF B...

JOSE MARINO
PO BOX 773
SELT CO 81652

STATE OF COLORADO)
COUNTY OF GARFIELD)

THE FOREGOING DECLARATION WAS ACKNOWLEDGED BEFORE ME THIS _____ DAY OF _____,
2022 BY ORAL MARRAS AND JAMES MARSH.

BY CONSIDERING ELATED
FEELING BY HAND AND HEAL

POT-487 PUBLIC

AS AGENT AUTHORIZED BY A TITLE INSURANCE COMPANY IN MY BEST JUDGMENT
 THAT I HAVE EXAMINED THE TITLE TO ALL SAID LANDS SHOWS UPON THIS PLAT AND THAT TITLE TO SAID LANDS IS VESTED IN
 FREE AND CLEAR OF ALL LIENS AND ENCUMBRANCES
 EXCEPT SUCH EASES OF WAY, RIGHTS OF WAY, EASEMENTS, EASEMENTS, EASEMENTS AND EASEMENTS
 AFFECTING THE REAL PROPERTY IN THIS PLAT, EXCEPT AS FOLLOWS

DATE OF _____ DAY OF _____

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1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

ANNEXATION DEPICTED ON THIS MAP WAS APPROVED BY ORDINANCE NO. _____ OF 2022.
ON THE _____ DAY OF _____, 2022.

BY _____
MATOR

WITNESS MY HAND.

ATTZST

CITY CLERK

PROOF THAT PARCEL TO BE ANNEXED HAS AT LEAST
1/6TH BORDER CONTINUITY WITH EXISTING TOWN OF SILT
BOUNDARY:

LENGTH OF PARCEL PERIMETER: 376.00'
MINIMUM 1/6 PERIMETER CONTINUITY: 61.67'
ACTUAL PERIMETER CONTINUITY TO CITY: 297.50'

PARCEL MEETS 1/6TH CONTINUITY REQUIREMENT FOR ANNEXATION

1.1 DATE OF ENTRY WAS JANUARY 23, 2011

- 1) BASIS OF RECOVERY: THIS SUIT IS A BASIS OF 100% OF THE FIRST LUMP SUM OF THE SUBJECT PAPERS AS DESCRIBED BY THE RECOVERED RECEIPTS NO. 444 IN THE SUBJECT PAGE 1; PAPER 1 AND 1 / 1; ORANGE PLASTIC CUP STAMPED "TROP COASTS FLA 34377".
- 2) THIS ASSIGNEE WAS 100% BASED ON:
 - a) "RECOVERY DEED RECORDING MAP 1, 2014 AS RECEIVED" NO. 444 IN THE SUBJECT OF THIS GAVELINA COUNTY COMMISSION CLEAR AFTER RECEIVING OFFICE.
 - b) RESEARCH FOR MONTHS OF MAY AND EARLIEREST OF JUNE WAS BASED ON TOTAL COMPLEY OF THE RECOVERED COMBUSTION NO. 444 C DATED March 04, 2014.
 - c) COMBUSTION PAPERS IN PLACE AS DELETED HISTORY
- 3) ALL DOCUMENTS SHOWN BEFORE AND AFTER AND AN ASSIGNED LENSES OVERVIEWED RECOVERED
- 4) ALL PAGES OF MY RECOVERY AND PLAYS SHOWED HISTORY AS FOLLOWS HISTORY:
- 5) THE LENSES LISTED IN THE PREPARATION OF THIS PLAY IS THE 10% SUITTY PAPER AS SHOWN BY THE LIMITED DEFENDERS LAWYER OF COMMISSION, ALL NATIONAL OFFICES OF STANDARD AND RECOVERY.
- 6) RECOVERED TO GAVELINA LAFF YOU MUST COMBUSTION ACTI MESH ACTIEN BASED UPON ACTI DEFECT OF THE SUITTY WRITTEN THESE PLAYS AFTER YOU FIRST RECOVERED GLASS SHIELD NO. 50 SUITTY MAY LAY ACTIEN BASED UPON ACTI DEFECT IN THIS SUITTY IN COMBUSTION HOURS THAN THESE PLAYS FROM THE

I, MICHAEL J. LAFORCE, A REGISTERED LAND SURVEYOR, LICENSED UNDER THE LAWS OF THE STATE OF COLORADO, DO HEREBY CERTIFY THAT THIS INFORMATION WAS ACCURATELY REPRESENTED SURVEY, PERFORMED EITHER BY ME OR UNDER MY SUPERVISION AND IS BASED ON MY KNOWLEDGE, INFORMATION AND BELIEF. THIS CERTIFICATE IS NOT EXTENDED TO BE AN EVIDENCE OR DULY WARRANTED OR GUARANTEED AS TO MATTERS EXCEPT THOSE STATED IN THE FOREGOING SENTENCE.

IN WITNESS WHEREOF, I HAVE SET MY HAND AND SEAL:

DATE _____

MICHAEL J. LARSON, P.E. & J.D.

APPROVED FOR CONTENT AND FORM ONLY AND NOT THE ACCURACY OF
SOMEONE'S CALCULATIONS AND DRAFTED FLIGHTS TO C.E.S. 10-01-1981 BY NED

QUALITÄT. GEHT ES UM DEN NACHSCHLAG.

4678

THIS PLAY IS ACCEPTED FOR FILING IN THE OFFICE OF THE CLERK AND SHERIFFS OF GARFIELD COUNTY
 REGISTERED AT _____ O'CLOCK _____ A.M. ON THE _____ DAY OF _____, 2002, AS RECEIVED
 BY _____

ONLY A FEW REMAIN

3

[illegible]

BOOKCLIFF
Survey Services, Inc.

AN INDEXATION MAP

129 WEST MOORE AVENUE
SALT LAKE CITY, UT 84119
TEL: 801/462-1111

FILE	CC
DIR	NA
IN	NA
DATE 01/26/22	
PROJECT N.J.	
21172-01	
SHEET 3	



WESTCOR

LAND TITLE INSURANCE COMPANY

ALTA COMMITMENT FOR TITLE INSURANCE

issued by

WESTCOR LAND TITLE INSURANCE COMPANY

(ALTA Adopted 07-01-2021)

NOTICE

IMPORTANT—READ CAREFULLY: THIS COMMITMENT IS AN OFFER TO ISSUE ONE OR MORE TITLE INSURANCE POLICIES. ALL CLAIMS OR REMEDIES SOUGHT AGAINST THE COMPANY INVOLVING THE CONTENT OF THIS COMMITMENT OR THE POLICY MUST BE BASED SOLELY IN CONTRACT.

THIS COMMITMENT IS NOT AN ABSTRACT OF TITLE, REPORT OF THE CONDITION OF TITLE, LEGAL OPINION, OPINION OF TITLE, OR OTHER REPRESENTATION OF THE STATUS OF TITLE. THE PROCEDURES USED BY THE COMPANY TO DETERMINE INSURABILITY OF THE TITLE, INCLUDING ANY SEARCH AND EXAMINATION, ARE PROPRIETARY TO THE COMPANY, WERE PERFORMED SOLELY FOR THE BENEFIT OF THE COMPANY, AND CREATE NO EXTRACTIONAL LIABILITY TO ANY PERSON, INCLUDING A PROPOSED INSURED.

THE COMPANY'S OBLIGATION UNDER THIS COMMITMENT IS TO ISSUE A POLICY TO A PROPOSED INSURED IDENTIFIED IN SCHEDULE A IN ACCORDANCE WITH THE TERMS AND PROVISIONS OF THIS COMMITMENT. THE COMPANY HAS NO LIABILITY OR OBLIGATION INVOLVING THE CONTENT OF THIS COMMITMENT TO ANY OTHER PERSON.

COMMITMENT TO ISSUE POLICY

Subject to the Notice; Schedule B, Part I—Requirements; Schedule B, Part II—Exceptions; and the Commitment Conditions, Westcor Land Title Insurance Company, a South Carolina Corporation (the "Company"), commits to issue the Policy according to the terms and provisions of this Commitment. This Commitment is effective as of the Commitment Date shown in Schedule A for each Policy described in Schedule A, only when the Company has entered in Schedule A both the specified dollar amount as the Proposed Amount of Insurance and the name of the Proposed Insured.

If all of the Schedule B, Part I—Requirements have not been met within (6) months after the Commitment Date, this Commitment terminates and the Company's liability and obligation end.

Issued By:

**WESTCOR LAND TITLE INSURANCE
COMPANY**

Title Company of the Rockies, LLC

111 E. 3rd Street
Floor 1, Suite 101
Rifle, CO 81650
Phone: 970-625-5426



By:

Mary O'Donnell

Mary O'Donnell - President

Attest:

Donald A. Berube

Donald A. Berube - Secretary

This page is only a part of a 2021 ALTA Commitment for Title Insurance issued by Westcor Land Title Insurance Company. This Commitment is not valid without the Notice; the Commitment to Issue Policy; Schedule A; Schedule B, Part I-Requirements; and Schedule B, Part II-Exceptions; and a counter-signature by the Company or its issuing agent that may be in electronic form.

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COMMITMENT CONDITIONS

1. DEFINITIONS

- a. “Discriminatory Covenant”: Any covenant, condition, restriction, or limitation that is unenforceable under applicable law because it illegally discriminates against a class of individuals based on personal characteristics such as race, color, religion, sex, sexual orientation, gender identity, familial status, disability, national origin, or other legally protected class.
- b. “Knowledge” or “Known”: Actual knowledge or actual notice, but not constructive notice imparted by the Public Records.
- c. “Land”: The land described in Item 5 of Schedule A and improvements located on that land that by State law constitute real property. The term “Land” does not include any property beyond that described in Schedule A, nor any right, title, interest, estate, or easement in any abutting street, road, avenue, alley, lane, right-of-way, body of water, or waterway, but does not modify or limit the extent that a right of access to and from the Land is to be insured by the Policy.
- d. “Mortgage”: A mortgage, deed of trust, trust deed, security deed, or other real property security instrument, including one evidenced by electronic means authorized by law.
- e. “Policy”: Each contract of title insurance, in a form adopted by the American Land Title Association, issued or to be issued by the Company pursuant to this Commitment.
- f. “Proposed Amount of Insurance”: Each dollar amount specified in Schedule A as the Proposed Amount of Insurance of each Policy to be issued pursuant to this Commitment.
- g. “Proposed Insured”: Each person identified in Schedule A as the Proposed Insured of each Policy to be issued pursuant to this Commitment.
- h. “Public Records”: The recording or filing system established under State statutes in effect at the Commitment Date under which a document must be recorded or filed to impart constructive notice of matters relating to the Title to a purchaser for value without Knowledge. The term “Public Records” does not include any other recording or filing system, including any pertaining to environmental remediation or protection, planning, permitting, zoning, licensing, building, health, public safety, or national security matters.
- i. “State”: The state or commonwealth of the United States within whose exterior boundaries the Land is located. The term “State” also includes the District of Columbia, the Commonwealth of Puerto Rico, the U.S. Virgin Islands, and Guam.
- j. “Title”: The estate or interest in the Land identified in Item 3 of Schedule A.

2. If all of the Schedule B, Part I—Requirements have not been met within the time period specified in the Commitment to Issue Policy, this Commitment terminates and the Company’s liability and obligation end.

3. The Company’s liability and obligation is limited by and this Commitment is not valid without:

- a. the Notice;
- b. the Commitment to Issue Policy;
- c. the Commitment Conditions;
- d. Schedule A;
- e. Schedule B, Part I—Requirements; and
- f. Schedule B, Part II—Exceptions; and
- g. a signature by the Company or its issuing agent that may be in electronic form.

4. COMPANY’S RIGHT TO AMEND

The Company may amend this Commitment at any time. If the Company amends this Commitment to add a defect, lien, encumbrance, adverse claim, or other matter recorded in the Public Records prior to the Commitment

This page is only a part of a 2021 ALTA Commitment for Title Insurance issued by Westcor Land Title Insurance Company. This Commitment is not valid without the Notice; the Commitment to Issue Policy; Schedule A; Schedule B, Part I-Requirements; and Schedule B, Part II-Exceptions; and a counter-signature by the Company or its issuing agent that may be in electronic form.

Date, any liability of the Company is limited by Commitment Condition 5. The Company is not liable for any other amendment to this Commitment.

5. LIMITATIONS OF LIABILITY

- a. The Company's liability under Commitment Condition 4 is limited to the Proposed Insured's actual expense incurred in the interval between the Company's delivery to the Proposed Insured of the Commitment and the delivery of the amended Commitment, resulting from the Proposed Insured's good faith reliance to:
 - i. comply with the Schedule B, Part I—Requirements;
 - ii. eliminate, with the Company's written consent, any Schedule B, Part II—Exceptions; or
 - iii. acquire the Title or create the Mortgage covered by this Commitment.
- b. The Company is not liable under Commitment Condition 5.a. if the Proposed Insured requested the amendment or had Knowledge of the matter and did not notify the Company about it in writing.
- c. The Company is only liable under Commitment Condition 4 if the Proposed Insured would not have incurred the expense had the Commitment included the added matter when the Commitment was first delivered to the Proposed Insured.
- d. The Company's liability does not exceed the lesser of the Proposed Insured's actual expense incurred in good faith and described in Commitment Condition 5.a. or the Proposed Amount of Insurance.
- e. The Company is not liable for the content of the Transaction Identification Data, if any.
- f. The Company is not obligated to issue the Policy referred to in this Commitment unless all of the Schedule B, Part I—Requirements have been met to the satisfaction of the Company.
- g. The Company's liability is further limited by the terms and provisions of the Policy to be issued to the Proposed Insured.

6. LIABILITY OF THE COMPANY MUST BE BASED ON THIS COMMITMENT; CHOICE OF LAW AND CHOICE OF FORUM

- a. Only a Proposed Insured identified in Schedule A, and no other person, may make a claim under this Commitment.
- b. Any claim must be based in contract under the State law of the State where the Land is located and is restricted to the terms and provisions of this Commitment. Any litigation or other proceeding brought by the Proposed Insured against the Company must be filed only in a State or federal court having jurisdiction.
- c. This Commitment, as last revised, is the exclusive and entire agreement between the parties with respect to the subject matter of this Commitment and supersedes all prior commitment negotiations, representations, and proposals of any kind, whether written or oral, express or implied, relating to the subject matter of this Commitment.
- d. The deletion or modification of any Schedule B, Part II—Exception does not constitute an agreement or obligation to provide coverage beyond the terms and provisions of this Commitment or the Policy.
- e. Any amendment or endorsement to this Commitment must be in writing and authenticated by a person authorized by the Company.
- f. When the Policy is issued, all liability and obligation under this Commitment will end and the Company's only liability will be under the Policy.

7. IF THIS COMMITMENT IS ISSUED BY AN ISSUING AGENT

The issuing agent is the Company's agent only for the limited purpose of issuing title insurance commitments and policies. The issuing agent is not the Company's agent for closing, settlement, escrow, or any other purpose.

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8. PRO-FORMA POLICY

The Company may provide, at the request of a Proposed Insured, a pro-forma policy illustrating the coverage that the Company may provide. A pro-forma policy neither reflects the status of Title at the time that the pro-forma policy is delivered to a Proposed Insured, nor is it a commitment to insure.

9. CLAIMS PROCEDURES

This Commitment incorporates by reference all Conditions for making a claim in the Policy to be issued to the Proposed Insured. Commitment Condition 9 does not modify the limitations of liability in Commitment Conditions 5 and 6.

10. CLASS ACTION

ALL CLAIMS AND DISPUTES ARISING OUT OF OR RELATING TO THIS COMMITMENT, INCLUDING ANY SERVICE OR OTHER MATTER IN CONNECTION WITH ISSUING THIS COMMITMENT, ANY BREACH OF A COMMITMENT PROVISION, OR ANY OTHER CLAIM OR DISPUTE ARISING OUT OF OR RELATING TO THE TRANSACTION GIVING RISE TO THIS COMMITMENT, MUST BE BROUGHT IN AN INDIVIDUAL CAPACITY. NO PARTY MAY SERVE AS PLAINTIFF, CLASS MEMBER, OR PARTICIPANT IN ANY CLASS OR REPRESENTATIVE PROCEEDING. ANY POLICY ISSUED PURSUANT TO THIS COMMITMENT WILL CONTAIN A CLASS ACTION CONDITION.

11. ARBITRATION

The Policy contains an arbitration clause. All arbitrable matters when the Proposed Amount of Insurance is \$2,000,000 or less may be arbitrated at the election of either the Company or the Proposed Insured as the exclusive remedy of the parties. A Proposed Insured may review a copy of the arbitration rules at <http://www.alta.org/arbitration>.

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COMMITMENT FOR TITLE INSURANCE

Issued by



as agent for

Westcor Land Title Insurance Company

SCHEDULE A

Reference:

Commitment Number: 1205779-C

1. Effective Date: **February 17, 2502, 7:00 am** Issue Date: **March 03, 2023**

2. Policy (or Policies) to be issued:

ALTA® 2021 Owner's Policy

Policy Amount:
Premium:

Amount to be Determined
Amount to be Determined

Proposed Insured: **Purchaser with contractual rights under a purchaser agreement with the vested owner identified at Item 4 below**

3. The estate or interest in the Land at the Commitment Date is **Fee Simple**.

4. The Title is, at the Commitment Date, vested in:
Isreal Marioni and Jorge Marioni

5. The Land is described as follows:

FOR LEGAL DESCRIPTION SEE SCHEDULE A CONTINUED ON NEXT PAGE

For Informational Purposes Only - APN: **217909100006**

Countersigned

Title Company of the Rockies, LLC

By:

Mike Mulligan

SCHEDULE A (continued)**LEGAL DESCRIPTION**

The Land referred to herein is located in the County of Garfield, State of Colorado, and described as follows:

A tract of land situate in the NE1/4NE1/4. of Section 9, Township 6 South Range 92 West of the 6th P.M., described as:

beginning at a point whence the intersection of the North line of U.S. Highway No. 24 with the West line of said NE1/4NE1/4 bears South 85°23' West 1121.8 feet; thence North 89°22' West 72.5 feet and thence North 00°38' East 112.5 feet; thence South 89°22' East 72.5 feet; and thence South 00°38' West 112.5 feet to the Point of Beginning.

EXCEPTING that part conveyed out by Reception No. 157718.

For each policy to be issued as identified in Schedule A, Item 2, the Company shall not be liable under this commitment until it receives a specific designation of a Proposed Insured, and has revised this commitment identifying that Proposed Insured by name. As provided in Commitment Condition 4, the Company may amend this commitment to add, among other things, additional exceptions or requirements after the designation of the Proposed Insured.

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Commitment No: 1205779-C

COMMITMENT FOR TITLE INSURANCE

Issued by

Westcor Land Title Insurance Company

**SCHEDULE B, PART I
Requirements**

All of the following Requirements must be met:

1. The Proposed Insured must notify the Company in writing of the name of any party not referred to in this Commitment who will obtain an interest in the Land or who will make a loan on the Land. The Company may then make additional Requirements or Exceptions.
2. Pay the agreed amount for the estate or interest to be insured.
3. Pay the premiums, fees, and charges for the Policy to the Company.
4. Documents satisfactory to the Company that convey the Title or create the Mortgage to be insured, or both, must be properly authorized, executed, delivered, and recorded in the Public Records.

NOTE: Please be advised that our search did not disclose any open Deeds of Trust of record. If you should have knowledge of any outstanding obligation, please contact the Title Department immediately for further review prior to closing.

5. Deed from Isreal Marioni and Jorge Marioni to Purchaser with contractual rights under a purchaser agreement with the vested owner identified at Item 4 below.

NOTE: Duly executed real property transfer declaration, executed by either the Grantor or Grantee, to accompany the Deed mentioned above, pursuant to Article 14 of House Bill No. 1288-CRA 39-14-102.

THE COMPANY RESERVES THE RIGHT TO CONDUCT AN ADDITIONAL SEARCH OF THE RECORDS IN THE OFFICE OF THE CLERK AND RECORDER FOR GARFIELD COUNTY, COLORADO FOR JUDGMENT LIENS, TAX LIENS OR OTHER SIMILAR OR

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Commitment No: 1205779-C

DISSIMILAR INVOLUNTARY MATTERS AFFECTING THE GRANTEE OR GRANTEES, AND TO MAKE SUCH ADDITIONAL REQUIREMENTS AS IT DEEMS NECESSARY, AFTER THE IDENTITY OF THE GRANTEE OR GRANTEES HAS BEEN DISCLOSED TO THE COMPANY.

NOTE: THIS COMMITMENT IS ISSUED UPON THE EXPRESS AGREEMENT AND UNDERSTANDING THAT THE APPLICABLE PREMIUMS, CHARGES AND FEES SHALL BE PAID BY THE APPLICANT IF THE APPLICANT AND/OR ITS DESIGNEE OR NOMINEE CLOSES THE TRANSACTION CONTEMPLATED BY OR OTHERWISE RELIES UPON THE COMMITMENT, ALL IN ACCORDANCE WITH THE RULES AND SCHEDULES OF RATES ON FILE WITH THE COLORADO DEPARTMENT OF INSURANCE.

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Commitment No: 1205779-C

SCHEDULE B, PART II Exceptions

Some historical land records contain Discriminatory Covenants that are illegal and unenforceable by law. This Commitment and the Policy treat any Discriminatory Covenant in a document referenced in Schedule B as if each Discriminatory Covenant is redacted, repudiated, removed, and not republished or recirculated. Only the remaining provisions of the document will be excepted from coverage.

The Policy will not insure against loss or damage resulting from the terms and conditions of any lease or easement identified in Schedule A, and will include the following Exceptions unless cleared to the satisfaction of the Company:

1. Any facts, right, interests, or claims which are not shown by the Public Records but which could be ascertained by an inspection of said Land or by making inquiry of persons in possession thereof.
2. Easements or claims of easements, not shown by the Public Records.
3. Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land.
4. Any lien, or right to a lien for services, labor or material heretofore or hereafter furnished, imposed by law and not shown by the Public Records.
5. Defects, liens, encumbrances, adverse claims or other matters, if any created, first appearing in the Public Records or attaching subsequent to the effective date hereof, but prior to the date of the proposed insured acquires of record for value the estate or interest or mortgage thereon covered by this Commitment.
6. (a) Taxes or assessments that are not shown as existing liens by the records of any taxing authority that levies taxes or assessments on real property or by the Public Records; (b) proceedings by a public agency that may result in taxes or assessments, or notices of such proceedings, whether or not shown by the records of such agency or by the Public Records.
7. Right of the Proprietor of a vein or lode to extract and remove his ore therefrom, should the same be found to penetrate or intersect the premises hereby granted, as reserved in United States Patent recorded August 31, 1893 in Book 12 at Page 244.
8. Right of way for ditches or canals constructed by the authority of the United States, as reserved in

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Commitment No: 1205779-C

United States Patent recorded August 31, 1893 in Book 12 at Page 244.

9. Any and all water and water rights, reservoir and reservoir rights, ditches and ditch rights, and the enlargements and extensions thereof, and all laterals, flumes and headgates used in connection therewith.
10. Terms, agreements, provisions, conditions and obligations as contained in Ordinance No. 11, Series of 2012 recorded March 4, 2013 at Reception No. 832123.

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DISCLOSURE STATEMENTS

Note 1: Colorado Division of Insurance Regulations 3-5-1, Paragraph C of Article VII, requires that "Every Title entity shall be responsible for all matters which appear of record prior to the time of recording whenever the Title entity conducts the closing and is responsible for recording or filing of legal documents resulting from the transaction which was closed." (Gap Protection)

Note 2: Exception No. 4 of Schedule B, Section 2 of this Commitment may be deleted from the Owner's Policy to be issued hereunder upon compliance with the following conditions:

1. The Land described in Schedule A of this commitment must be a single-family residence, which includes a condominium or townhouse unit.
2. No labor or materials may have been furnished by mechanics or materialmen for purpose of construction on the Land described in Schedule A of this Commitment within the past 13 months.
3. The Company must receive an appropriate affidavit indemnifying the Company against unfilled mechanic's and materialmen's liens.
4. Any deviation from conditions A through C above is subject to such additional requirements or Information as the Company may deem necessary, or, at its option, the Company may refuse to delete the exception.
5. Payment of the premium for said coverage.

Note 3: The following disclosures are hereby made pursuant to §10-11-122, C.R.S.:

- (i) The subject real property may be located in a special taxing district;
- (ii) A certificate of taxes due listing each taxing jurisdiction shall be obtained from the County Treasurer or the County Treasurer's authorized agent; and
- (iii) Information regarding special districts and the boundaries of such districts may be obtained from the County Commissioners, the County Clerk and Recorder, or the County Assessor.

Note 4: If the sales price of the subject property exceeds \$100,000.00, the seller shall be required to comply with the disclosure or withholding provisions of C.R.S. §39-22-604.5 (Non-resident withholding).

Note 5: Pursuant to C.R.S. §10-11-123 Notice is hereby given:

- (a) If there is recorded evidence that a mineral estate has been severed, leased or otherwise conveyed from the surface estate then there is a substantial likelihood that a third party holds some or all interest in oil, gas, other minerals, or geothermal energy in the property, and
- (b) That such mineral estate may include the right to enter and use the property without the surface owner's permission.

Note 6: Effective September 1, 1997, C.R.S. §30-10-406 requires that all documents received for recording or filing in the clerk and recorder's office shall contain a top margin of at least one inch and a left, right and bottom margin of at least one-half inch the clerk and recorder may refuse to record or file any document that does not conform.

Note 7: Our Privacy Policy:

We will not reveal nonpublic personal customer information to any external non-affiliated organization unless we have been authorized by the customer, or are required by law.

Note 8: Records:

Regulation 3-5-1 Section 7 (N) provides that each title entity shall maintain adequate documentation and

records sufficient to show compliance with this regulation and Title 10 of the Colorado Revised Statutes for a period of not less than seven (7) years, except as otherwise permitted by law.

Note 9: Pursuant Regulation 3-5-1 Section 9 (F) notice is hereby given that “A title entity shall not earn interest on fiduciary funds unless disclosure is made to all necessary parties to a transaction that interest is or has been earned. Said disclosure must offer the opportunity to receive payment of any interest earned on such funds beyond any administrative fees as may be on file with the division. Said disclosure must be clear and conspicuous, and may be made at any time up to and including closing.”

Be advised that the closing agent will or could charge an Administrative Fee for processing such an additional services request and any resulting payee will also be subjected to a W-9 or other required tax documentation for such purpose(s).

Be further advised that, for many transactions, the imposed Administrative Fee associated with such an additional service may exceed any such interest earned.

Therefore, you may have the right to some of the interest earned over and above the Administrative Fee, if applicable (e.g., any money over any administrative fees involved in figuring the amounts earned).

Note 10: Pursuant to Regulation 3-5-1 Section 9 (G) notice is hereby given that “Until a title entity receives written instructions pertaining to the holding of fiduciary funds, in a form agreeable to the title entity, it shall comply with the following:

1. The title entity shall deposit funds into an escrow, trust, or other fiduciary account and hold them in a fiduciary capacity.
2. The title entity shall use any funds designated as “earnest money” for the consummation of the transaction as evidenced by the contract to buy and sell real estate applicable to said transaction, except as otherwise provided in this section. If the transaction does not close, the title entity shall:
 - (a) Release the earnest money funds as directed by written instructions signed by both the buyer and seller; or
 - (b) If acceptable written instructions are not received, uncontested funds shall be held by the title entity for 180 days from the scheduled date of closing, after which the title entity shall return said funds to the payor.
3. In the event of any controversy regarding the funds held by the title entity (notwithstanding any termination of the contract), the title entity shall not be required to take any action unless and until such controversy is resolved. At its option and discretion, the title entity may:
 - (a) Await any proceeding; or
 - (b) Interplead all parties and deposit such funds into a court of competent jurisdiction, and recover court costs and reasonable attorney and legal fees; or
 - (c) Deliver written notice to the buyer and seller that unless the title entity receives a copy of a summons and complaint or claim (between buyer and seller), containing the case number of the lawsuit or lawsuits, within 120 days of the title entity's written notice delivered to the parties, title entity shall return the funds to the depositing party. ”

Title Company of the Rockies

Disclosures

All documents received for recording or filing in the Clerk and Recorder's office shall contain a top margin of at least one inch and a left, right and bottom margin of at least one half of an inch. The Clerk and Recorder will refuse to record or file any document that does not conform to the requirements of this section. Pursuant to C.R.S. 30-10-406(3)(a).

The company will not issue its policy or policies of title insurance contemplated by this commitment until it has been provided a Certificate of Taxes due or other equivalent documentation from the County Treasurer or the County Treasurer's authorized agent; or until the Proposed Insured has notified or instructed the company in writing to the contrary. Pursuant to C.R.S. 10-11-122.

No person or entity that provides closing and settlement services for a real estate transaction shall disburse funds as a part of such services until those funds have been received and are available for immediate withdrawals as a matter of right. Pursuant to C.R.S. 38-35-125(2).

The Company hereby notifies the proposed buyer in the current transaction that there may be recorded evidence that the mineral estate, or portion thereof, has been severed, leased, or otherwise conveyed from the surface estate. If so, there is a substantial likelihood that a third party holds some or all interest in the oil, gas, other minerals, or geothermal energy in the subject property. Such mineral estate may include the right to enter and use the property without the surface owner's permission. Pursuant to C.R.S. 10-11-123.

If this transaction includes a sale of property and the sales price exceeds \$100,000.00, the seller must comply with the disclosure/withholding requirements of said section. (Nonresident withholding) Pursuant to C.R.S. 39-22-604.5.

Notice is hereby given that: The subject property may be located in a special taxing district. A Certificate of Taxes due listing each taxing jurisdiction shall be obtained from the County Treasurer or the County Treasurer's authorized agent. Information regarding special districts and the boundaries of such districts may be obtained from the Board of County Commissioners, the County Clerk and Recorder, or the County Assessor. Pursuant to C.R.S. 10-11-122.

Notice is hereby given that: Pursuant to Colorado Division of Insurance Regulation 8-1-2;

"Gap Protection" - When this Company conducts the closing and is responsible for recording or filing the legal documents resulting from the transaction, the Company shall be responsible for all matters which appear on the record prior to such time or recording or filing; and

"Mechanic's Lien Protection" - If you are the buyer of a single family residence, you may request mechanic's lien coverage to be issued on your policy of Insurance. If the property being purchased has not been the subject of construction, improvements or repairs in the last six months prior to the date of this commitment, the requirements will be payment of the appropriate premium and the completion of an Affidavit and Indemnity by the seller. If the property being purchased was constructed, improved or repaired within six months prior to the date of this commitment the requirements may involve disclosure of certain financial information, payment of premiums, and indemnity, among others. The general requirements stated above are subject to revision and approval by the Company. Pursuant to C.R.S. 10-11-122.

Notice is hereby given that an ALTA Closing Protection Letter is available, upon request, to certain parties to the transaction as noted in the title commitment. Pursuant to Colorado Division of Insurance Regulation 8-1.

Nothing herein contained will be deemed to obligate the Company to provide any of the coverages referred to herein unless the above conditions are fully satisfied.



WESTCOR
LAND TITLE INSURANCE COMPANY

**ALTA Commitment For Title Insurance
(Adopted 06-17-06) (Revised 08-01-2016)**

**COMMITMENT FOR TITLE INSURANCE
ISSUED BY
WESTCOR LAND TITLE INSURANCE COMPANY**

NOTICE

IMPORTANT-READ CAREFULLY: THIS COMMITMENT IS AN OFFER TO ISSUE ONE OR MORE TITLE INSURANCE POLICIES. ALL CLAIMS OR REMEDIES SOUGHT AGAINST THE COMPANY INVOLVING THE CONTENT OF THIS COMMITMENT OR THE POLICY MUST BE BASED SOLELY IN CONTRACT.

THIS COMMITMENT IS NOT AN ABSTRACT OF TITLE, REPORT OF THE CONDITION OF TITLE, LEGAL OPINION, OPINION OF TITLE, OR OTHER REPRESENTATION OF THE STATUS OF TITLE. THE PROCEDURES USED BY THE COMPANY TO DETERMINE INSURABILITY OF THE TITLE, INCLUDING ANY SEARCH AND EXAMINATION, ARE PROPRIETARY TO THE COMPANY, WERE PERFORMED SOLELY FOR THE BENEFIT OF THE COMPANY, AND CREATE NO EXTRACONTRACTUAL LIABILITY TO ANY PERSON, INCLUDING A PROPOSED INSURED.

THE COMPANY'S OBLIGATION UNDER THIS COMMITMENT IS TO ISSUE A POLICY TO A PROPOSED INSURED IDENTIFIED IN SCHEDULE A IN ACCORDANCE WITH THE TERMS AND PROVISIONS OF THIS COMMITMENT. THE COMPANY HAS NO LIABILITY OR OBLIGATION INVOLVING THE CONTENT OF THIS COMMITMENT TO ANY OTHER PERSON.

COMMITMENT TO ISSUE POLICY

Subject to the Notice; Schedule B, Part I-Requirements; Schedule B, Part II-Exceptions; and the Commitment Conditions, WESTCOR LAND TITLE INSURANCE COMPANY, a South Carolina Corporation (the "Company"), commits to issue the Policy according to the terms and provisions of this Commitment. This Commitment is effective as of the Commitment Date shown in Schedule A for each Policy described in Schedule A, only when the Company has entered in Schedule A both the specified dollar amount as the Proposed Policy Amount and the name of the Proposed Insured.

If all of the Schedule B, Part I-Requirements have not been met within six (6) months after the Commitment Date, this Commitment terminates and the Company's liability and obligation end.

IN WITNESS WHEREOF, WESTCOR LAND TITLE INSURANCE COMPANY has caused its corporate name and seal to be hereunto affixed and by these presents to be signed in facsimile under authority of its by-laws, effective as of the date of Commitment shown in Schedule A.

Issued By:



TITLE COMPANY
of the rockies

The Title Company of the Rockies
1620 Grand Avenue Bldg Main, Floor 1
Glenwood Springs, CO 81601
Phone: 970-945-1169

WESTCOR LAND TITLE INSURANCE COMPANY



By:

Mary O'Donnell

President

Attest:

[Signature]

Secretary

CONDITIONS

1. The term mortgage, when used herein, shall include deed of trust, trust deed, or other security instrument.
2. If the proposed Insured has or acquired actual knowledge of any defect, lien, encumbrance, adverse claim or other matter affecting the estate or interest or mortgage thereon covered by this Commitment other than those shown in Schedule B hereof, and shall fail to disclose such knowledge to the Company in writing, the Company shall be relieved from liability for any loss or damage resulting from any act of reliance hereon to the extent the Company is prejudiced by failure to so disclose such knowledge. If the proposed Insured shall disclose such knowledge to the Company, or if the Company otherwise acquires actual knowledge of any such defect, lien, encumbrance, adverse claim or other matter, the Company at its option may amend Schedule B of this Commitment accordingly, but such amendment shall not relieve the Company from liability previously incurred pursuant to paragraph 3 of these Conditions and Stipulations.
3. Liability of the Company under this Commitment shall be only to the named proposed Insured and such parties included under the definition of Insured in the form of policy or policies committed for and only for actual loss incurred in reliance hereon in undertaking in good faith (a) to comply with the requirements hereof, or (b) to eliminate exceptions shown in Schedule B, or (c) to acquire or create the estate or interest or mortgage thereon covered by this Commitment. In no event shall such liability exceed the amount stated in Schedule A for the policy or policies committed for and such liability is subject to the insuring provisions and Conditions and Stipulations and the Exclusions from Coverage of the form of policy or policies committed for in favor of the proposed Insured which are hereby incorporated by reference and are made a part of this Commitment except as expressly modified herein.
4. This Commitment is a contract to issue one or more title insurance policies and is not an abstract of title or a report of the condition of title. Any action or actions or rights of action that the proposed Insured may have or may bring against the Company arising out of the status of the title to the estate or interest or the status of the mortgage thereon covered by this Commitment must be based on and are subject to the provisions of this Commitment.
5. *The policy to be issued contains an arbitration clause. All arbitrable matters when the Amount of Insurance is \$2,000,000 or less shall be arbitrated at the option of either the Company or the Insured as the exclusive remedy of the parties. You may review a copy of the arbitration rules at < <http://www.alta.org/>>.*

Joint Notice of Privacy Policy
of
Westcor Land Title Insurance Company
and
The Title Company of the Rockies

Westcor Land Title Insurance Company ("WLTIC") and **The Title Company of the Rockies** value their customers and are committed to protecting the privacy of personal information. In keeping with that philosophy, we each have developed a Privacy Policy, set out below, that will endure the continued protection of your nonpublic personal information and inform you about the measures WLTIC and **The Title Company of the Rockies** take to safeguard that information. This notice is issued jointly as a means of paperwork reduction and is not intended to create a joint privacy policy. Each company's privacy policy is separately instituted, executed, and maintained.

Who is Covered

We provide our Privacy Policy to each customer when they purchase a WLTIC title insurance policy. Generally, this means that the Privacy Policy is provided to the customer at the closing of the real estate transaction.

Information Collected

In the normal course of business and to provide the necessary services to our customers, we may obtain nonpublic personal information directly from the customer, from customer-related transactions, or from third parties such as our title insurance agent, lenders, appraisers, surveyors and other similar entities.

Access to Information

Access to all nonpublic personal information is limited to those employees who have a need to know in order to perform their jobs. These employees include, but are not limited to, those in departments such as closing, legal, underwriting, claims and administration and accounting.

Information Sharing

Generally, neither WLTIC nor **The Title Company of the Rockies** shares nonpublic personal information that it collects with anyone other than those individuals necessary needed to complete the real estate settlement services and issue its title insurance policy as requested by the consumer. WLTIC or **The Title Company of the Rockies** may share nonpublic personal information as permitted by law with entities with whom WLTIC or **The Title Company of the Rockies** has a joint marketing agreement. Entities with whom WLTIC or **The Title Company of the Rockies** have a joint marketing agreement have agreed to protect the privacy of our customer's nonpublic personal information by utilizing similar precautions and security measures as WLTIC and **The Title Company of the Rockies** use to protect this information and to use the information for lawful purposes. WLTIC or **The Title Company of the Rockies**, however, may share information as required by law in response to a subpoena, to a government regulatory agency or to prevent fraud.

Information Security

WLTIC and **The Title Company of the Rockies**, at all times, strive to maintain the confidentiality and integrity of the personal information in its possession and has instituted measures to guard against its unauthorized access. We maintain physical, electronic and procedural safeguards in compliance with federal standards to protect that information.

The WLTIC Privacy Policy can be found on WLTIC's website at www.wltic.com



WESTCOR
LAND TITLE INSURANCE COMPANY

**ALTA Commitment For Title Insurance
(Adopted 06-17-06) (Revised 08-01-2016)**

**COMMITMENT FOR TITLE INSURANCE
ISSUED BY
WESTCOR LAND TITLE INSURANCE COMPANY**

NOTICE

IMPORTANT—READ CAREFULLY: THIS COMMITMENT IS AN OFFER TO ISSUE ONE OR MORE TITLE INSURANCE POLICIES. ALL CLAIMS OR REMEDIES SOUGHT AGAINST THE COMPANY INVOLVING THE CONTENT OF THIS COMMITMENT OR THE POLICY MUST BE BASED SOLELY IN CONTRACT.

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THE COMPANY'S OBLIGATION UNDER THIS COMMITMENT IS TO ISSUE A POLICY TO A PROPOSED INSURED IDENTIFIED IN SCHEDULE A IN ACCORDANCE WITH THE TERMS AND PROVISIONS OF THIS COMMITMENT. THE COMPANY HAS NO LIABILITY OR OBLIGATION INVOLVING THE CONTENT OF THIS COMMITMENT TO ANY OTHER PERSON.

COMMITMENT TO ISSUE POLICY

Subject to the Notice; Schedule B, Part I—Requirements; Schedule B, Part II—Exceptions; and the Commitment Conditions, WESTCOR LAND TITLE INSURANCE COMPANY, a South Carolina Corporation (the "Company"), commits to issue the Policy according to the terms and provisions of this Commitment. This Commitment is effective as of the Commitment Date shown in Schedule A for each Policy described in Schedule A, only when the Company has entered in Schedule A both the specified dollar amount as the Proposed Policy Amount and the name of the Proposed Insured.

If all of the Schedule B, Part I—Requirements have not been met within six (6) months after the Commitment Date, this Commitment terminates and the Company's liability and obligation end.

IN WITNESS WHEREOF, WESTCOR LAND TITLE INSURANCE COMPANY has caused its corporate name and seal to be hereunto affixed and by these presents to be signed in facsimile under authority of its by-laws, effective as of the date of Commitment shown in Schedule A.

Issued By:

WESTCOR LAND TITLE INSURANCE COMPANY

The Title Company of the Rockies

1620 Grand Avenue Bldg Main, Floor 1
Glenwood Springs, CO 81601
Phone: 970-945-1169



By:

Mary O'Donnell

President

Attest:

[Signature]

Secretary

This Commitment is not valid without the Notice; the Commitment to Issue Policy; the Commitment Conditions; Schedule A; Schedule B, Part I—Requirements; and Schedule B, Part II—Exceptions; and signed by the Company or its issuing agent that may be in electronic form.



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COMMITMENT CONDITIONS

1. DEFINITIONS

- (a) "Knowledge" or "Known": Actual or imputed knowledge, but not constructive notice imparted by the Public Records.
- (b) "Land": The land described in Schedule A and affixed improvements that by law constitute real property. The term "Land" does not include any property beyond the lines of the area described in Schedule A, nor any right, title, interest, estate, or easement in abutting streets, roads, avenues, alleys, lanes, ways, or waterways, but this does not modify or limit the extent that a right of access to and from the Land is to be insured by the Policy.
- (c) "Mortgage": A mortgage, deed of trust, or other security instrument, including one evidenced by electronic means authorized by law.
- (d) "Policy": Each contract of title insurance, in a form adopted by the American Land Title Association, issued or to be issued by the Company pursuant to this Commitment.
- (e) "Proposed Insured": Each person identified in Schedule A as the Proposed Insured of each Policy to be issued pursuant to this Commitment.
- (f) "Proposed Policy Amount": Each dollar amount specified in Schedule A as the Proposed Policy Amount of each Policy to be issued pursuant to this Commitment.
- (g) "Public Records": Records established under state statutes at the Commitment Date for the purpose of imparting constructive notice of matters relating to real property to purchasers for value and without Knowledge.
- (h) "Title": The estate or interest described in Schedule A.

2. If all of the Schedule B, Part I—Requirements have not been met within the time period specified in the Commitment to Issue Policy, this Commitment terminates and the Company's liability and obligation end.

3. The Company's liability and obligation is limited by and this Commitment is not valid without:

- (a) the Notice;
- (b) the Commitment to Issue Policy;
- (c) the Commitment Conditions;
- (d) Schedule A;
- (e) Schedule B, Part I—Requirements; and
- (f) Schedule B, Part II—Exceptions; and
- (g) signed by the Company or its issuing agent that may be in electronic form.

4. COMPANY'S RIGHT TO AMEND

The Company may amend this Commitment at any time. If the Company amends this Commitment to add a defect, lien, encumbrance, adverse claim, or other matter recorded in the Public Records prior to the Commitment Date, any liability of the Company is limited by Commitment Condition 5. The Company shall not be liable for any other amendment to this Commitment.

5. LIMITATIONS OF LIABILITY

- (a) The Company's liability under Commitment Condition 4 is limited to the Proposed Insured's actual expense incurred in the interval between the Company's delivery to the Proposed Insured of the Commitment and the delivery of the amended Commitment, resulting from the Proposed Insured's good faith reliance to:
 - (i) comply with the Schedule B, Part I—Requirements;
 - (ii) eliminate, with the Company's written consent, any Schedule B, Part II—Exceptions; or
 - (iii) acquire the Title or create the Mortgage covered by this Commitment.
- (b) The Company shall not be liable under Commitment Condition 5(a) if the Proposed Insured requested the amendment or had Knowledge of the matter and did not notify the Company about it in writing.
- (c) The Company will only have liability under Commitment Condition 4 if the Proposed Insured would not have incurred the expense had the Commitment included the added matter when the Commitment was first delivered to the Proposed Insured.
- (d) The Company's liability shall not exceed the lesser of the Proposed Insured's actual expense incurred in good faith and described in Commitment Conditions 5(a)(i) through 5(a)(iii) or the Proposed Policy Amount.
- (e) The Company shall not be liable for the content of the Transaction Identification Data, if any.
- (f) In no event shall the Company be obligated to issue the Policy referred to in this Commitment unless all of the Schedule B, Part I—Requirements have been met to the satisfaction of the Company.
- (g) In any event, the Company's liability is limited by the terms and provisions of the Policy.

This page is only a part of a 2016 ALTA Commitment for Title Insurance. This Commitment is not valid without the Notice; the Commitment to Issue Policy; the Commitment Conditions; Schedule A; Schedule B, Part I—Requirements; and Schedule B, Part II—Exceptions; and signed by the Company or its issuing agent that may be in electronic form.

6. LIABILITY OF THE COMPANY MUST BE BASED ON THIS COMMITMENT

- (a) Only a Proposed Insured identified in Schedule A, and no other person, may make a claim under this Commitment.
- (b) Any claim must be based in contract and must be restricted solely to the terms and provisions of this Commitment.
- (c) Until the Policy is issued, this Commitment, as last revised, is the exclusive and entire agreement between the parties with respect to the subject matter of this Commitment and supersedes all prior commitment negotiations, representations, and proposals of any kind, whether written or oral, express or implied, relating to the subject matter of this Commitment.
- (d) The deletion or modification of any Schedule B, Part II—Exception does not constitute an agreement or obligation to provide coverage beyond the terms and provisions of this Commitment or the Policy.
- (e) Any amendment or endorsement to this Commitment must be in writing.
- (f) When the Policy is issued, all liability and obligation under this Commitment will end and the Company's only liability will be under the Policy.

7. IF THIS COMMITMENT HAS BEEN ISSUED BY AN ISSUING AGENT

The issuing agent is the Company's agent only for the limited purpose of issuing title insurance commitments and policies. The issuing agent is not the Company's agent for the purpose of providing closing or settlement services.

8. PRO-FORMA POLICY

The Company may provide, at the request of a Proposed Insured, a pro-forma policy illustrating the coverage that the Company may provide. A pro-forma policy neither reflects the status of Title at the time that the pro-forma policy is delivered to a Proposed Insured, nor is it a commitment to insure.

9. ARBITRATION

The Policy contains an arbitration clause. All arbitrable matters when the Proposed Policy Amount is \$2,000,000 or less shall be arbitrated at the option of either the Company or the Proposed Insured as the exclusive remedy of the parties. A Proposed Insured may review a copy of the arbitration rules at <http://www.alta.org/arbitration>.

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Joint Notice of Privacy Policy

of

Westcor Land Title Insurance Company

and

The Title Company of the Rockies

Westcor Land Title Insurance Company (“WLTIC”) and **The Title Company of the Rockies** value their customers and are committed to protecting the privacy of personal information. In keeping with that philosophy, we each have developed a Privacy Policy, set out below, that will endure the continued protection of your nonpublic personal information and inform you about the measures WLTIC and **The Title Company of the Rockies** take to safeguard that information. This notice is issued jointly as a means of paperwork reduction and is not intended to create a joint privacy policy. Each company’s privacy policy is separately instituted, executed, and maintained.

Who is Covered

We provide our Privacy Policy to each customer when they purchase a WLTIC title insurance policy. Generally, this means that the Privacy Policy is provided to the customer at the closing of the real estate transaction.

Information Collected

In the normal course of business and to provide the necessary services to our customers, we may obtain nonpublic personal information directly from the customer, from customer-related transactions, or from third parties such as our title insurance agent, lenders, appraisers, surveyors and other similar entities.

Access to Information

Access to all nonpublic personal information is limited to those employees who have a need to know in order to perform their jobs. These employees include, but are not limited to, those in departments such as closing, legal, underwriting, claims and administration and accounting.

Information Sharing

Generally, neither WLTIC nor **The Title Company of the Rockies** shares nonpublic personal information that it collects with anyone other than those individuals necessary needed to complete the real estate settlement services and issue its title insurance policy as requested by the consumer. WLTIC or **The Title Company of the Rockies** may share nonpublic personal information as permitted by law with entities with whom WLTIC or **The Title Company of the Rockies** has a joint marketing agreement. Entities with whom WLTIC or **The Title Company of the Rockies** have a joint marketing agreement have agreed to protect the privacy of our customer’s nonpublic personal information by utilizing similar precautions and security measures as WLTIC and **The Title Company of the Rockies** use to protect this information and to use the information for lawful purposes. WLTIC or **The Title Company of the Rockies**, however, may share information as required by law in response to a subpoena, to a government regulatory agency or to prevent fraud.

Information Security

WLTIC and **The Title Company of the Rockies**, at all times, strive to maintain the confidentiality and integrity of the personal information in its possession and has instituted measures to guard against its unauthorized access. We maintain physical, electronic and procedural safeguards in compliance with federal standards to protect that information.

The WLTIC Privacy Policy can be found on WLTIC’s website at www.wltic.com

COMMITMENT FOR TITLE INSURANCE

Issued by



TITLE COMPANY
of the rockies

as agent for

Westcor Land Title Insurance Company

SCHEDULE A

Reference:

Commitment Number: 0601562-C2

1. Effective Date: **July 23, 2018, 7:00 am** Issue Date: **August 03, 2018**

2. Policy (or Policies) to be issued:

ALTA Loan Policy (6-17-06)

Policy Amount: **\$135,000.00**

Premium: **\$463.00**

Proposed Insured: **Weinberg Servicing LLC, its Successors and/or Assigns as their interests may appear**

3. The estate or interest in the land described or referred to in this Commitment is **Fee Simple**.

4. The Title is, at the Commitment Date, vested in:
Parcel A: Israel Marioni

Parcel B: Israel Marioni and Jorge Marioni, as joint tenants

Parcel C: Jorge Marioni

Parcel D: Jorge Marioni

5. The land referred to in this Commitment is described as follows:

FOR LEGAL DESCRIPTION SEE SCHEDULE A CONTINUED ON NEXT PAGE

Countersigned

The Title Company of the Rockies

This page is only a part of a 2016 ALTA® Commitment for Title Insurance issued by Westcor Land Title Insurance Company. This Commitment is not valid without the Notice; the Commitment to Issue Policy; the Commitment Conditions; Schedule A; Schedule B, Part I-Requirements; and Schedule B, Part II-Exceptions.

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By: *Emily Rank*

Emily Rank

This page is only a part of a 2016 ALTA® Commitment for Title Insurance issued by Westcor Land Title Insurance Company. This Commitment is not valid without the Notice; the Commitment to Issue Policy; the Commitment Conditions; Schedule A; Schedule B, Part I-Requirements; and Schedule B, Part II-Exceptions.

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LEGAL DESCRIPTION

The Land referred to herein is located in the County of **Garfield**, State of **Colorado**, and described as follows:

Parcel A:

The South 22 feet of Lot 24, all of Lot 25 and the North one-half of Lot 26, Block 2, KRUGER SUBDIVISION

Parcel B:

A tract of land situate in the NE 1/4 NE 1/4 of Section 9, Township 6 South, Range 92 West of the 6th P.M., described as beginning at a point whence the intersection of the North line of U.S. Highway No. 24 with the West line of said NE 1/4 NE 1/4 bears South 85°23' West 1121.8 feet; thence North 89°22' West 72.5 feet and thence North 00°38' East 112.5 feet; thence South 89°22' East 72.5 feet; and thence South 00°38' West 112.5 feet to the Point of Beginning, Excepting that part conveyed by Warranty Deed recorded June 24, 1946 at Reception No. 157718

Parcel C:

Lot 24, SPRUCE MEADOWS SUBDIVISION, according to the Plat thereof filed January 15, 2003, at Reception No. 618730, and re-filed January 29, 2003 at Reception No. 619609

Parcel D:

Lot 23, SPRUCE MEADOWS SUBDIVISION, according to the Plat thereof filed January 15, 2003, at Reception No. 618730, and re-filed January 29, 2003 at Reception No. 619609

This page is only a part of a 2016 ALTA® Commitment for Title Insurance issued by Westcor Land Title Insurance Company. This Commitment is not valid without the Notice; the Commitment to Issue Policy; the Commitment Conditions; Schedule A; Schedule B, Part I-Requirements; and Schedule B, Part II-Exceptions.

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COMMITMENT FOR TITLE INSURANCE

Issued by

Westcor Land Title Insurance Company

SCHEDULE B, PART I Requirements

The following are the requirements to be complied with prior to the issuance of said policy or policies. Any other instrument recorded subsequent to the effective date hereof may appear as an exception under Schedule B of the policy to be issued. Unless otherwise noted, all documents must be recorded in the office of the clerk and recorded of the county in which said property is located.

All of the following Requirements must be met:

1. The Proposed Insured must notify the Company in writing of the name of any party not referred to in this Commitment who will obtain an interest in the Land or who will make a loan on the Land. The Company may then make additional Requirements or Exceptions.
2. Pay the agreed amount for the estate or interest to be insured.
3. Pay the premiums, fees, and charges for the Policy to the Company.
4. Documents satisfactory to the Company that convey the Title or create the Mortgage to be insured, or both, must be properly authorized, executed, delivered, and recorded in the Public Records.
5. **Release of Assessment Lien of Grass Mesa Homeowner's Association in the amount of \$1,041.06, recorded August 23, 2017 at Reception No. 896454.**
6. **Deed of Trust from Israel Marioni and Jorge Marioni to the Public Trustee of Garfield County for the use of Weinberg Servicing LLC, to secure \$135,000.00.**

The Mortgage Policy, when issued, will not contain Exceptions No. 1, 2, 3 and 4, provided that:

(A) The enclosed form of indemnity agreement or final affidavit and agreement is properly executed and acknowledged by the party(ies) indicated and returned to the Company or its duly authorized agent, and

(B) Applicable scheduled charges in the amount of \$70.00 are paid to the Company or its duly authorized agent.

(C) Intentionally Deleted.

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The Mortgage Policy, when issued, will contain the following Endorsement Form(s), provided that applicable scheduled charges in the amount(s) following each endorsement are paid to the Company or its duly authorized agent.

8.1	\$50.00
115.2	\$61.00

24-month Chain of Title: The only conveyance(s) affecting said land recorded within the 24 months preceding the date of this commitment is (are) as follows:

Parcel A: SPECIAL WARRANTY DEED recorded November 14, 2011 at Reception No. 810706

Parcel B: WARRANTY DEED recorded May 1, 2014 at Reception No. 848780

Parcel C: WARRANTY DEED recorded October 6, 2016 at Reception No. 883495

Parcel D: WARRANTY DEED recorded October 6, 2016 at Reception No. 883496

NOTE: If no conveyances were found in that 24 month period, the last recorded conveyance is reported. If the subject land is a lot in a subdivision plat less than 24 months old, only the conveyances subsequent to the plat are reported.

EXCEPTION NO. 5 UNDER SCHEDULE B, SECTION 2 OF THIS COMMITMENT WILL NOT APPEAR IN THE POLICY OR POLICIES TO BE ISSUED PURSUANT HERETO, PROVIDED THAT (A) THE DOCUMENTS CONTEMPLATED BY THE REQUIREMENTS SET FORTH IN SCHEDULE B, SECTION 1 OF THIS COMMITMENT ARE SUBMITTED TO AND APPROVED AND RECORDED BY THE COMPANY OR ITS DULY AUTHORIZED AGENT, AND (B) AN EXAMINATION OF THE RECORDS IN THE OFFICE OF THE CLERK AND RECORDER FOR GARFIELD COUNTY, COLORADO BY THE COMPANY OR ITS DULY AUTHORIZED AGENT DISCLOSES THAT NO DEFECTS, LIENS, ENCUMBRANCES, ADVERSE CLAIMS OR OTHER MATTERS HAVE BEEN RECORDED IN SUCH RECORDS SUBSEQUENT TO THE EFFECTIVE DATE HEREOF.

SCHEDULE B, PART II

Exceptions

THIS COMMITMENT DOES NOT REPUBLISH ANY COVENANT, CONDITION, RESTRICTION, OR LIMITATION CONTAINED IN ANY DOCUMENT REFERRED TO IN THIS COMMITMENT TO THE EXTENT THAT THE SPECIFIC COVENANT, CONDITION, RESTRICTION, OR LIMITATION VIOLATES STATE OR FEDERAL LAW BASED ON RACE, COLOR, RELIGION, SEX, SEXUAL ORIENTATION, GENDER IDENTITY, HANDICAP, FAMILIAL STATUS, OR NATIONAL ORIGIN.

Schedule B of the policy or policies to be issued will contain exceptions to the following matters unless the same are disposed of to the satisfaction of the Company.

This page is only a part of a 2016 ALTA® Commitment for Title Insurance issued by Westcor Land Title Insurance Company. This Commitment is not valid without the Notice; the Commitment to Issue Policy; the Commitment Conditions; Schedule A; Schedule B, Part I-Requirements; and Schedule B, Part II-Exceptions.

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Any loss or damage, including attorney fees, by reason of the matters shown below:

1. Any facts, right, interests, or claims which are not shown by the Public Records but which could be ascertained by an inspection of said Land or by making inquiry of persons in possession thereof.
2. Easements or claims of easements, not shown by the Public Records.
3. Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land.
4. Any lien, or right to a lien for services, labor or material heretofore or hereafter furnished, imposed by law and not shown by the Public Records.
5. Defects, liens, encumbrances, adverse claims or other matters, if any created, first appearing in the Public Records or attaching subsequent to the effective date hereof, but prior to the date of the proposed insured acquires of record for value the estate or interest or mortgage thereon covered by this Commitment.
6. (a) Taxes or assessments that are not shown as existing liens by the records of any taxing authority that levies taxes or assessments on real property or by the Public Records; (b) proceedings by a public agency that may result in taxes or assessments, or notices of such proceedings, whether or not shown by the records of such agency or by the Public Records.
7. Any and all recorded rights of way and easements including, but not limited to the following: roads, highways, ditches, creeks, laterals, canals, reservoirs, drainage ways, flumes, pipelines, utilities, guy line/anchors, railroads, aircraft overflight, power and telephone lines.
8. All Restrictions, Covenants, Declarations, Conditions, Leases, Agreements and Mineral Reservations of record, and any modification thereof, if any.
9. Water rights or claims of title to water.
10. Unpatented mining claims; reservations or exceptions in patents or in Acts authorizing the issuance thereof.
11. Any loss or damage due to or resulting from any and all outstanding dues and/or assessments levied by the Homeowners Association.

This page is only a part of a 2016 ALTA® Commitment for Title Insurance issued by Westcor Land Title Insurance Company. This Commitment is not valid without the Notice; the Commitment to Issue Policy; the Commitment Conditions; Schedule A; Schedule B, Part I-Requirements; and Schedule B, Part II-Exceptions.

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DISCLOSURE STATEMENTS

Note 1: Colorado Division of Insurance Regulations 3-5-1, Paragraph C of Article VII, requires that

"Every Title entity shall be responsible for all matters which appear of record prior to the time of recording whenever the Title entity conducts the closing and is responsible for recording or filing of legal documents resulting from the transaction which was closed." (Gap Protection)

Note 2: Exception No. 4 of Schedule B, Section 2 of this Commitment may be deleted from the Owner's Policy to be issued hereunder upon compliance with the following conditions:

A. The Land described in Schedule A of this commitment must be a single-family residence, which includes a condominium or townhouse unit.

B. No labor or materials may have been furnished by mechanics or materialmen for purpose of construction on the Land described in Schedule A of this Commitment within the past 13 months.

C. The Company must receive an appropriate affidavit indemnifying the Company against unfilled mechanic's and materialmen's liens.

D. Any deviation from conditions A through C above is subject to such additional requirements or Information as the Company may deem necessary, or, at its option, the Company may refuse to delete the exception.

E. Payment of the premium for said coverage.

Note 3: The following disclosures are hereby made pursuant to §10-11-122, C.R.S.:

(i) The subject real property may be located in a special taxing district;

(ii) A certificate of taxes due listing each taxing jurisdiction shall be obtained from the County Treasurer or the County Treasurer's authorized agent; and

(iii) Information regarding special districts and the boundaries of such districts may be obtained from the County Commissioners, the County Clerk and Recorder, or the County Assessor.

Note 4: If the sales price of the subject property exceeds \$100,000.00, the seller shall be required to comply with the disclosure or withholding provisions of C.R.S. §39-22-604.5 (Non-resident withholding).

Note 5: Pursuant to C.R.S. §10-11-123 Notice is hereby given:

(a) If there is recorded evidence that a mineral estate has been severed, leased or otherwise conveyed from the surface estate then there is a substantial likelihood that a third party holds some or all interest in oil, gas, other minerals, or geothermal energy in the property, and

(b) That such mineral estate may include the right to enter and use the property without the surface owner's permission.

Note 6: Effective September 1, 1997, C.R.S. §30-10-406 requires that all documents received for recording or filing in the clerk and recorder's office shall contain a top margin of at least one inch and a left, right and bottom margin of at least one-half inch the clerk and recorder may refuse to record or file any document that does not conform.

Note 7: Our Privacy Policy:

We will not reveal nonpublic personal customer information to any external non-affiliated organization unless we have been authorized by the customer, or are required by law.

Note 8: Records:

Regulation 3-5-1 Section 7 (N) provides that each title entity shall maintain adequate documentation and records sufficient to show compliance with this regulation and Title 10 of the Colorado Revised Statutes for a period of not less than seven (7) years, except as otherwise permitted by law.

Note 9: Pursuant Regulation 3-5-1 Section 9 (F) notice is hereby given that

"A title entity shall not earn interest on fiduciary funds unless disclosure is made to all necessary parties to a transaction that interest is or has been earned. Said disclosure must offer the opportunity to receive payment of any interest earned on such funds beyond any administrative fees as may be on file with the division. Said disclosure must be clear and conspicuous, and may be made at any time up to and including closing."

Be advised that the closing agent will or could charge an Administrative Fee for processing such an additional services request and any resulting payee will also be subjected to a W-9 or other required tax documentation for such purpose(s).

Be further advised that, for many transactions, the imposed Administrative Fee associated with such an additional service may exceed any such interest earned.

Therefore, you may have the right to some of the interest earned over and above the Administrative Fee, if applicable (e.g., any money over any administrative fees involved in figuring the amounts earned).

Note 10: Pursuant to Regulation 3-5-1 Section 9 (G) notice is hereby given that

“Until a title entity receives written instructions pertaining to the holding of fiduciary funds, in a form agreeable to the title entity, it shall comply with the following:

1. The title entity shall deposit funds into an escrow, trust, or other fiduciary account and hold them in a fiduciary capacity.
2. The title entity shall use any funds designated as “earnest money” for the consummation of the transaction as evidenced by the contract to buy and sell real estate applicable to said transaction, except as otherwise provided in this section. If the transaction does not close, the title entity shall:
 - a. Release the earnest money funds as directed by written instructions signed by both the buyer and seller; or
 - b. If acceptable written instructions are not received, uncontested funds shall be held by the title entity for 180 days from the scheduled date of closing, after which the title entity shall return said funds to the payor.
3. In the event of any controversy regarding the funds held by the title entity (notwithstanding any termination of the contract), the title entity shall not be required to take any action unless and until such controversy is resolved. At its option and discretion, the title entity may:
 - a. Await any proceeding; or
 - b. Interplead all parties and deposit such funds into a court of competent jurisdiction, and recover court costs and reasonable attorney and legal fees; or
 - c. Deliver written notice to the buyer and seller that unless the title entity receives a copy of a summons and complaint or claim (between buyer and seller), containing the case number of the lawsuit or lawsuits, within 120 days of the title entity's written notice delivered to the parties, title entity shall return the funds to the depositing party.”

Title Company of the Rockies

Disclosures

All documents received for recording or filing in the Clerk and Recorder's office shall contain a top margin of at least one inch and a left, right and bottom margin of at least one half of an inch. The Clerk and Recorder will refuse to record or file any document that does not conform to the requirements of this section. Pursuant to C.R.S. 30-10-406(3)(a).

The company will not issue its policy or policies of title insurance contemplated by this commitment until it has been provided a Certificate of Taxes due or other equivalent documentation from the County Treasurer or the County Treasurer's authorized agent: or until the Proposed Insured has notified or instructed the company in writing to the contrary. Pursuant to C.R.S. 10-11-122.

No person or entity that provides closing and settlement services for a real estate transaction shall disburse funds as a part of such services until those funds have been received and are available for immediate withdrawals as a matter of right. Pursuant to C.R.S. 38-35-125(2).

The Company hereby notifies the proposed buyer in the current transaction that there may be recorded evidence that the mineral estate, or portion thereof, has been severed, leased, or otherwise conveyed from the surface estate. If so, there is a substantial likelihood that a third party holds some or all interest in the oil, gas, other minerals, or geothermal energy in the subject property. Such mineral estate may include the right to enter and use the property without the surface owner's permission. Pursuant to C.R.S. 10-11-123.

If this transaction includes a sale of property and the sales price exceeds \$100,000.00, the seller must comply with the disclosure/withholding requirements of said section. (Nonresident withholding) Pursuant to C.R.S. 39-22-604.5.

Notice is hereby given that: The subject property may be located in a special taxing district. A Certificate of Taxes due listing each taxing jurisdiction shall be obtained from the County Treasurer or the County Treasurer's authorized agent. Information regarding special districts and the boundaries of such districts may be obtained from the Board of County Commissioners, the County Clerk and Recorder, or the County Assessor. Pursuant to C.R.S. 10-11-122.

Notice is hereby given that: Pursuant to Colorado Division of Insurance Regulation 8-1-2;

"Gap Protection" - When this Company conducts the closing and is responsible for recording or filing the legal documents resulting from the transaction, the Company shall be responsible for all matters which appear on the record prior to such time or recording or filing; and

"Mechanic's Lien Protection" - If you are the buyer of a single family residence, you may request mechanic's lien coverage to be issued on your policy of Insurance. If the property being purchased has not been the subject of construction, improvements or repairs in the last six months prior to the date of this commitment, the requirements will be payment of the appropriate premium and the completion of an Affidavit and Indemnity by the seller. If the property being purchased was constructed, improved or repaired within six months prior to the date of this commitment the requirements may involve disclosure of certain financial information, payment of premiums, and indemnity, among others. The general requirements stated above are subject to revision and approval by the Company. Pursuant to C.R.S. 10-11-122.

Notice is hereby given that an ALTA Closing Protection Letter is available, upon request, to certain parties to the transaction as noted in the title commitment. Pursuant to Colorado Division of Insurance Regulation 8-1.

Nothing herein contained will be deemed to obligate the Company to provide any of the coverages referred to herein unless the above conditions are fully satisfied.

Town of Silt Planning Commission Meeting

Tuesday December 5, 2023 6:30 PM

Rislende PUD Preliminary Subdivision Plan

Planners Staff Report

11/29/2023

Name of Project	Rislende – PUD Zoning and Subdivision Sketch Plan
Applicant	August Group LLC, DBA Rislende Mitchell Weimer, Cole Buerger 121 Polo Rd. Glenwood Springs, CO 81601 202.215.1576
Owner	Silt 70 LLC 10106 W San Juna Way, Ste 205 Littleton, CO 80127
Owner Representative/ Land Planner	The Land Studio, Inc. Doug & Julie Pratte 365 River Bend Way Glenwood Springs, CO 81601 970.927.3690
Civil Engineer	High Country Engineering 1517 Lake Avenue, Suite 101 Carbondale, CO 81623 970.945.8676
Project Attorney	Balcomb and Green Chad Lee, Esq. 818 Colorado Avenue Glenwood Springs, CO 81601 970.945.6546
Project Architect	NA
Water Engineer	NA
Property Location	West of BLM regional office South of I 70 East of County Road 311 (Divide Creek Road)
Existing Zoning	PUD
Surrounding Land Uses	West – commercial (Holiday Inn)– Light Industrial, North – I-70, South – River and agate/rural uses East – Government Offices
Surrounding Zoning	North –R2, East – Unincorporated Garfield County, South – Unincorporated Garfield County, West – Commercial PUD

Proposed Use	Event center, multifamily residential, accommodations, mixed-use
Area of Parcel Subject to application	51.131 acres
Existing Use	Vacant
Silt Comprehensive Plan	Service and Commercial Support
Parcel & Reception Numbers	217911200007
Legal Description	Parcel Letter a of the BLM exemption plat, recorded at reception # 741836

I. Major Subdivision Amended Preliminary Plan

Before you tonight is a public hearing for an amendment to the Rislende Preliminary Plan for their major subdivision application. As you know, Rislende that has been coming through the land-use entitlement process for the last year and ½. A PUD rezoning and a subdivision sketch plan was approved in September 2022. You reviewed the Major Subdivision Preliminary Plan in August of this year and the Board of Trustees approve this at their May 22 meeting.

This is a relatively minor change to the preliminary plan. What is being proposed is to enlarge Tract 1 at the northeast corner of the property. This would make that lot slightly larger (from 3.7 acres to 4 acres in size). Tract 2 would be slightly smaller and proposed to be split into two separate lots. One lot would accommodate some additional multifamily housing and the other portion of tract two would still be commercial/mixed-use. The other change is to reduce the depth of the loop road and eliminate one of the access points onto the frontage Road (Rippling Way).

The basic engineering would remain the same. The other change is Tract 8 - the Island Area - is also proposed to be split into 2 separate lots. One would still be reserved for exclusive use with the event Center and the other portion, closer to the County Road and the bridge being proposed for maintenance etc. by the Homeowners Association.

There is no guidance in the Silt Municipal Code Title 16 regarding amendments for preliminary plans. Often times, jurisdictions have the ability to “find” an application is a minor amendment and can be approved by one-stop shopping in front of the Planning Commission or even at a staff level. A major amendment, is usually where a lot of configuration and rights-of-way are changing significantly or there are major changes in the size of the project or engineering. They go through a major amendment process which often times is basically a new application.

II. Relevant Sections of Municipal Code

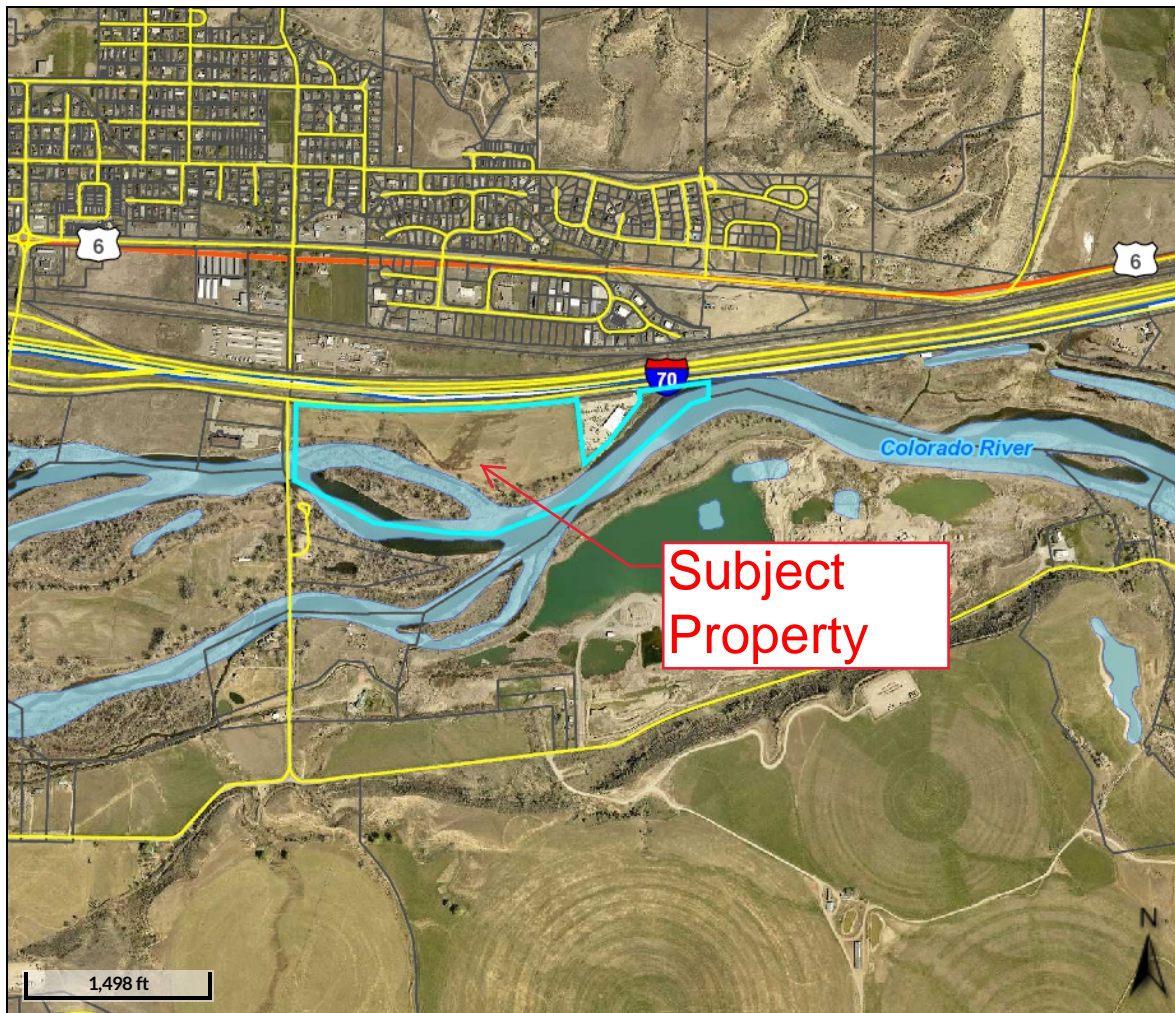
The Preliminary Plan portion of the Major Subdivision procedures is contained in section 16.04.090 through 16.04.190. As noted before, code is silent on the scope of amendments and how to handle them. Because this change is minor, the applicant is already working on putting together their Final Subdivision Plat Documents so that an application can be made later in the winter and initial portions of infrastructure be provided in the spring.

III. The Application

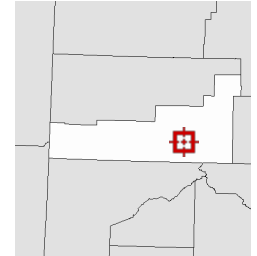
Location Map

Rislende








Created by: Chain



Overview



Legend

-  Parcels
-  Roads
- Parcel/Account Numbers
- Highways
 -  Limited Access
 -  Highway
 -  Major Road
 -  Local Road
 -  Minor Road
 -  Other Road
 -  Ramp
 -  Ferry
 -  Pedestrian Way
- Owner Name
-  Lakes & Rivers
-  County Boundary Line

Account Number	R044679	Physical Address	54 311 COUNTY RD	2019 Total Actual Value	\$23,570	Last 2 Sales
Parcel Number	217911200007	Address	SILT	81652		Date Price
Acres	51	Owner Address	SILT 70 LLC			1/6/2015 \$0
Land SqFt	0		10106 W SAN JUNA WAY SUITE			1/6/2015 \$0
Tax Area	035		205			
2019 Mill Levy	83.6550		LITTLETON CO 80127			

Date created: 4/27/2022

Last Data Uploaded: 4/27/2022 2:12:05 AM

Developed by 

The application is relatively lengthy. That is because the applicants are making a complete application and are including exhibits which contain the PUD, sketch plan and original preliminary plan resolutions of approval as well as an updated Traffic Impact Study. The application is over 250 pages in length. However, immediately after my staff report I am including the two-page letter from the applicant which summarizes the proposal, include the original preliminary plan sheets as well as the updated Preliminary Plat. I will also include the last page of the conclusion from the traffic Impact study as well as a letter from the project engineer which summarizes the roadway analysis. These 12 to 15 pages are the key to the application. Please feel free to examine the entire application of course. (I meant to get a link out to you prior to Thanksgiving which would contain the application but time ran out and I was traveling over the holidays).

IV. *Engineering*

I have reviewed the engineering portions of the application and the Town Engineer is also review the information. The general engineering including drainage and especially issues related to the deep utilities have undergone no change. The removal of one access point on to the frontage Road is actually a favorable change. There were no engineering issues that require more analysis at this time.

Attached is a diagram which shows the conceptual layout now on the north side of that loop road. And you can also see how the depth of the loop road has been reduced – the depth is approximately 30 or 50 feet less than the previous depth.

V. *Land use and Zoning*

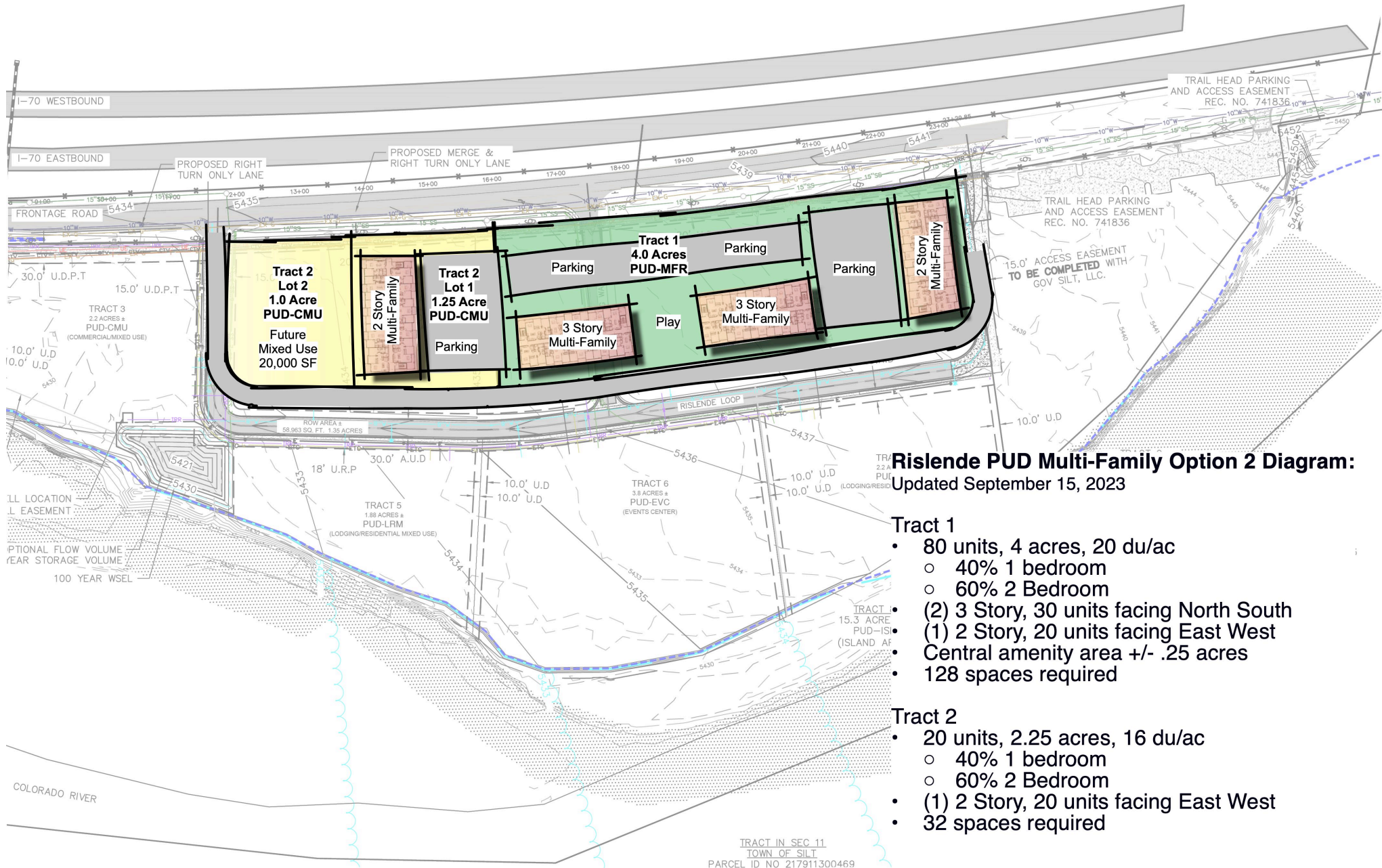
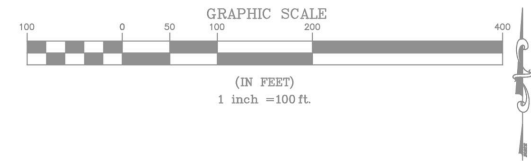
Even though this is not an application to amend the zoning I did undertake a review of the land-use elements and compare it to the existing, approved PUD zoning guide another regulations. There will need to be some minor changes made in the PUD zoning in the future. The overall density and number of proposed residential units is not changing. What has changed is that the PUD zoning called out a max the number of units that could be put into the PUD – MFR (Residential Multifamily) zone district at 72 units. The PUD guide allowed the density to be 20 units per acre for this area. Please note that the multifamily residential tract has increased slightly in size so the 20 units per acre allow total of 80 units. So we have a conflict in the guide and that will need to be rectified. This can be as simple matter and it can be taken up at the time of Final Plat. This can be a condition of approval.

There was another inconsistency in the makeup of the PUD Lodging/residential Mixed Use zone districts. The PUD Guide allowed 16 units in this area at 4 units per acre. These two tracts are now slightly larger and while the density still proposed to be the same – at 4 units per acre, those two tracts now equal 5 acres. So, that information will also have to be massaged and adjusted. Finally, the Amended and Restated Annexation and Development Agreement had specific residential unit counts attached to these areas and that also will need to be amended. I have talked to the Town Attorney about this and it is a simple thing to amend the agreement.

OVERALL SITE MAP

Rislende Planned Unit Development

Situated in Section's 10 and 11, Township 6 South,
Range 92 West, of the 6TH Principal Meridian
Town of Silt, County of Garfield, State of Colorado.



Rislende PUD Multi-Family Option 2 Diagram:
Updated September 15, 2023

Tract 1

- 80 units, 4 acres, 20 du/ac
 - 40% 1 bedroom
 - 60% 2 Bedroom
- (2) 3 Story, 30 units facing North South
- (1) 2 Story, 20 units facing East West
- Central amenity area +/- .25 acres
- 128 spaces required

Tract 2

- 20 units, 2.25 acres, 16 du/ac
 - 40% 1 bedroom
 - 60% 2 Bedroom
- (1) 2 Story, 20 units facing East West
- 32 spaces required

TRACT IN SEC 11
TOWN OF SILT
PARCEL ID NO 217911300469

VI. *Staff Findings*

Staff finds that the application is complete, the engineering is consistent with previous approvals and meets the town design and engineering specifications and the project meets the Comprehensive Plan. Staff acknowledges that the ARADA Agreement and the PUD Guide will need to be adjusted in the future. Staff finds the preliminary plan amendment to be acceptable to the town and for the project and should be approved.

Staff Recommendation: **Approve** the Rislende the Preliminary Plan Amendment with the following conditions:

1. All representations made in the application, in writing and during the public hearing process are to be considered conditions of approval.
2. That the Town Attorney prepare a new resolution which includes the previous conditions of approval (the previous resolution is in the application).
3. That as part of the Final Plat application the ARADA and the PUD Zoning Guide be adjusted after a public hearing process to make sure all total residential unit counts and density requirements are in conformance with the original plan.

Recommended Motion: I move to recommend that the Board approve the Amended Preliminary Plan for Rislende by adoption of a new Resolution which includes the conditions noted above. (Add any additional conditions discussed by the Planning Commission)



365 River Bend Way • Glenwood Springs, CO 81601 • Tel 970 927 3690 • landstudio2@comcast.net

November 2, 2023

Mr. Mark Chain
Town of Silt Community Development
231 N. 7th Street
Silt, Colorado 81652
mchain@sopris.net

Re: Updated Rislende Major Subdivision Preliminary Plan Amendment

Dear Mark:

The Land Studio, Inc. has been working with representatives of Silt 70 LLC, August Group LLC, DBA Rislende, and its consultant team to prepare the Rislende Major Subdivision Preliminary Plan Amendment per our team discussions with you. The intent of this Application is to update the Preliminary Plat for Garfield County Parcel No. 217911200007. Currently the Preliminary Plat includes 9 Tracts within the 51.13± acre property. The proposed amendment to the Preliminary Plat still includes 9 Tracts with slightly varying acreages from the currently approved Preliminary Plat. The primary change to the Preliminary Plat is the elimination of Rippling Way as an access point into the property and the resulting adjustment to Rislende Loop. The Rislende PUD Approved Preliminary Plat and Rislende PUD Amended Preliminary Plat are both attached as Exhibits. The following matrix illustrates the changes in acreages to each of the tracts and the slight variation in acreages for each of the Rislende PUD zone districts.

Rislende Planned Unit Development							
Approved Preliminary Plan Land Use Summary				Amended Preliminary Plan Land Use Summary			
	Acres		Zoning		Acres		Zoning
Tract 1	3.7	PUD-MFR	Multi-Family Residential	Tract 1	4.0	PUD-MFR	Multi-Family Residential
Tract 2	3.7	PUD-CMU	Commercial/Mixed Use	Tract 2 Lot 1	1.3	PUD-CMU	Commercial/Mixed Use
				Tract 2 Lot 2	1.0	PUD-CMU	Commercial/Mixed Use
Tract 3	2.2	PUD-CMU	Commercial/Mixed Use	Tract 3	2.7	PUD-CMU	Commercial/Mixed Use
Tract 4	4.3	PUD-CMU	Commercial/Mixed Use	Tract 4	4.3	PUD-CMU	Commercial/Mixed Use
Tract 5	1.9	PUD-LRM	Lodging/Residential Mixed Use	Tract 5	2.3	PUD-LRM	Lodging/Residential Mixed Use
Tract 6	3.8	PUD-EVC	Events Center	Tract 6	4.4	PUD-EVC	Events Center
Tract 7	2.2	PUD-LRM	Lodging/Residential Mixed Use	Tract 7	2.6	PUD-LRM	Lodging/Residential Mixed Use
Tract 8	15.8	PUD-ISL	Island Area	Tract 8A	2.6	PUD-ISL	Island Area
				Tract 8B	12.7	PUD-ISL	Island Area
Tract 9	12.2	PUD-RIV	River	Tract 9	12.2	PUD-RIV	River
ROW	1.4			ROW	1.1		
Total	51.1			Total	51.1		
Zoning	Acres			Zoning	Acres		
PUD-MFR	3.7			PUD-MFR	4.0		
PUD-CMU	10.2			PUD-CMU	9.2		
PUD-LRM	4.1			PUD-LRM	4.9		
PUD-EVC	3.8			PUD-EVC	4.4		
PUD-ISL	15.8			PUD-ISL	15.3		
PUD-RIV	12.2			PUD-RIV	12.2		
ROW	1.4			ROW	1.1		
Total	51.1			Total	51.1		

The Town of Silt Ordinance No. 13 Series of 2022 (Reception #980003) established Planned Unit Development Zoning for Annexed land formerly known as Divide Creek Center and now commonly known as Rislende Planned Unit Development. The Town of Silt Resolution No. 16 Series of 2022 (Reception #980004) approved the Second Amended and Restated Annexation and Development Agreement for the Dixon Annexation (formerly known as Divide Creek Center) and now known as Rislende, within the Town of Silt, Garfield County, Colorado. Ordinance 2022-13 and Resolution 2022-16 are attached as Exhibits to this Application. The Town of Silt Resolution No. 16 Series of 2023 approving the Major Subdivision Preliminary Plan for the Rislende PUD is also attached as an Exhibit. The proposed Amended Rislende Major Subdivision Preliminary Plan still conforms to the provisions of Ordinance 13 and Resolution 16 Series of 2022 as approved by the Town of Silt.

Due to the elimination of Rippling Way as an access point to this subdivision, the Rislende PUD Traffic Impact Study prepared by Fox Tuttle Transportation Group, LLC has been updated to reflect this change and is attached as an Exhibit. Additionally, High Country Engineering has provided a brief analysis of the proposed roadway changes and determined that the proposed modification to the road system of the Rislende project does not have any significant impact to the approved project. The High Country Engineering Letter is also attached as an Exhibit.

Rislende Major Subdivision Preliminary Plan Amendment Exhibits

- A. The Rislende PUD Approved Preliminary Plat
- B. The Rislende PUD Amended Preliminary Plat
- C. Town of Silt Ordinance No. 13 Series of 2022
- D. Town of Silt Resolution No. 16 Series of 2022
- E. Town of Silt Resolution No. 16 Series of 2023
- F. Rislende PUD Traffic Impact Study
- G. High Country Engineering Roadway Analysis Letter

We look forward to continued work with you on this project and please email or call with discussion related to this Application as needed.

Sincerely,

THE LAND STUDIO, INC

By:



Douglas J. Gratte

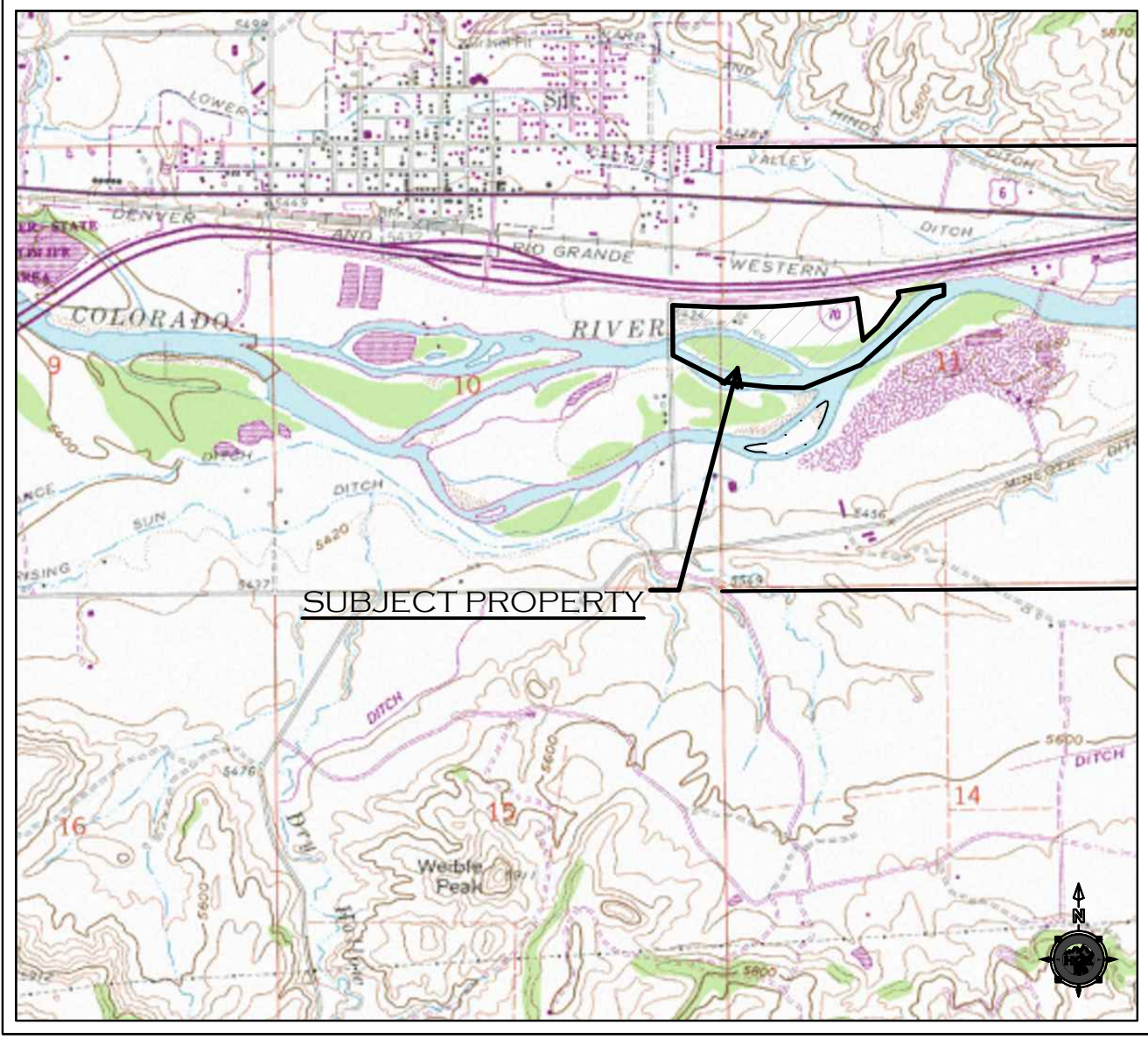
Exhibit A
The Rislende PUD Approved Preliminary Plat

PRELIMINARY PLAT
RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO

PLAT NOTES

1. BASIS OF BEARINGS FOR THIS SURVEY IS A BEARING OF N00°34'13"W BETWEEN A FOUND 3/4in REBAR WITH 3.25in ALUMINUM CAP LS NO. 36572 (40" WITNESS CORNER) NORTHWEST CORNER OF SECTION 11 AND A FOUND 3/4in REBAR WITH 3.25in BRASS CAP LS NO. 19698 (REF POINT) AT THE SOUTHWEST CORNER OF SECTION 10.
2. THIS PLAT IS BASED ON THE BLM EXEMPTION PLAT, RECEPTION NO. 741836 PREPARED BY HIGH COUNTRY ENGINEERING, INC., AND CORNERS FOUND IN PLACE.
3. THIS PROPERTY IS SUBJECT TO RESERVATIONS, RESTRICTIONS AND COVENANTS OF RECORD OR IN PLACE AND EXCEPTIONS TO TITLE SHOWN IN THE TITLE COMMITMENT PREPARED BY LAND TITLE GUARANTEE COMPANY DATED EFFECTIVE NOVEMBER 18, 2022 (ORDER NO. GW63017116-3).
4. DATE OF SURVEY BY HIGH COUNTRY ENGINEERING, INC. WAS SEPTEMBER 2022.
6. AS A CONDITION OF APPROVAL OF THIS PLAT BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, AND TO MEET THE REQUIREMENTS OF THE SILT MUNICIPAL CODE SECTION 16.04.280, AS AMENDED, NO CONSTRUCTION ON THE PUBLIC IMPROVEMENTS WITHIN THE SUBDIVISION AND NO CONVEYANCE OR TRANSFER OF TITLE OF ANY LOT, LOTS, TRACT OR TRACTS OF LAND WITHIN THE SUBDIVISION SHALL BE MADE UNTIL THE TOWN HAS GRANTED A CERTIFICATE OF COMPLIANCE CERTIFYING THAT THE OWNER HAS DEPOSITED AND THE TOWN HAS ACCEPTED MONETARY SECURITY EQUAL TO ONE HUNDRED AND TEN PERCENT (110%) OF THE ESTIMATED COSTS OF COMPLETION FOR THE PUBLIC IMPROVEMENTS WHICH CERTIFICATE OF COMPLIANCE HAS BEEN DULY RECORDED BY THE CLERK AND RECORDER OF GARFIELD COUNTY.
7. UNDERGROUND OR ABOVE GROUND UTILITY INFRASTRUCTURE SHALL BE MAINTAINED BY THE RESPECTIVE UTILITY OR RESPONSIBLE PARTY, DRAINAGE, TRAIL, AND ROAD FACILITIES LOCATED IN TOWN EASEMENTS SHALL BE MAINTAINED BY THE TOWN.
8. THIS PROPERTY IS SUBJECT TO, WITHOUT LIMITATION, THE MASTER DECLARATION OF COVENANTS, CONDITIONS AND RESTRICTIONS FOR RISLENDE P.U.D. AS RECORDED IN THE RECORDS OF THE GARFIELD COUNTY CLERK AND RECORDERS OFFICE AT RECEPTION NUMBER _____.
9. WETLANDS IN RISLENDE PUD WERE DELINEATED BY BIRCH ECOLOGY, LLC AND DAVID BUSCHER A CERTIFIED SOIL SCIENTIST ON MAY 16, 2022, WITH CONFIRMATION BY THE U.S. ARMY CORPS OF ENGINEERS NUMBER SPA-2022-00348 DATED DECEMBER 8, 2022.
10. NOXIOUS WEEDS. IT IS THE INDIVIDUAL LOT OWNER'S RESPONSIBILITY, ACCORDING TO THE COLORADO NOXIOUS WEED ACT AND THE TOWN OF SILT ORDINANCES, TO MANAGE ANY NOXIOUS WEEDS ON THE LOT OWNER'S PROPERTY.
12. ALL SIDEWALK, TRAIL AND PEDESTRIAN EASEMENTS ARE FOR NON-MOTORIZED USE BY THE PUBLIC, WITH THE EXCEPTION OF EMERGENCY USE AND/OR MAINTENANCE PURPOSES.



VICINITY MAP
SCALE: 1" = 2000'

LEGEND

U = UTILITY EASEMENT
D = DRAINAGE EASEMENT
A = ACCESS EASEMENT
R = ROAD MAINTENANCE EASEMENT
P = PEDESTRIAN ACCESS EASEMENT
T = TRAIL ACCESS EASEMENT
SQ. FT. = SQUARE FEET

LAND USE SUMMARY

TRACT #	ACRES	ADDRESS	LAND USE
TRACT 1	3.7	0001 RIVER FRONTAGE ROAD	PUD-MFR (MULTI-FAMILY RESIDENTIAL)
TRACT 2	3.8	0002 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 3	2.2	0003 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 4	4.3	0004 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 5	2.0	0005 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 6	3.9	0001 RISLENDE LOOP	PUD-EVC (EVENTS CENTER)
TRACT 7	2.2	0002 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 8	15.8		PUD-ISL (ISLAND AREA)
TRACT 9	12.2		PUD-RIV (RIVER)
TRACT 10	0.2	RIPPLING WAY	
TRACT 11	0.7	RISLENDE LOOP	
TOTAL	51.1		

TITLE INSURANCE COMPANY OR ATTORNEYS CERTIFICATE

_____ DOES HEREBY CERTIFY THAT _____ HAS EXAMINED THE TITLE TO ALL LANDS HEREIN DEDICATED AND SHOWN UPON THIS PLAT AND TITLE TO SUCH LAND IS IN THE DEDICATOR FREE AND CLEAR OF ALL LIENS, TAXES AND ENCUMBRANCES, EXCEPT AS FOLLOWS:

Signature and Title _____ Date _____

SURVEYOR'S CERTIFICATE

I, _____ DO HEREBY CERTIFY THAT I AM A REGISTERED LAND SURVEYOR LICENSED UNDER THE LAWS OF THE STATE OF COLORADO, THAT THIS PLAT IS A TRUE, CORRECT AND COMPLETE PLAT OF THE (SUBDIVISION OR CONDOMINIUM PROJECT NAME) AS LAID OUT, PLATTED, DEDICATED AND SHOWN HEREON, THAT SUCH PLAT WAS MADE FROM AN ACCURATE SURVEY OF SAID PROPERTY BY ME OR UNDER MY SUPERVISION AND CORRECTLY SHOWS THE LOCATION AND DIMENSIONS OF THE LOTS, EASEMENTS AND STREETS OF SAID SUBDIVISION AS THE SAME ARE STAKED UPON THE GROUND IN COMPLIANCE WITH APPLICABLE REGULATIONS GOVERNING THE SUBDIVISION OF LAND.

BILL W.A. BAKER, COLORADO PROFESSIONAL LAND SURVEYOR #23875
CERTIFIED FEDERAL SURVEYOR #1699

UTILITY COMPANIES CERTIFICATE

BY THE SIGNING OF THIS PLAT, EACH UTILITY COMPANY AGREES AND ACKNOWLEDGES ANY AND ALL ACCESS AND UTILITY EASEMENTS DEDICATED TO THE TOWN AND EACH UTILITY COMPANY HEREBY WARRANTS THAT NO ABOVE GROUND VAULT, SPLICE BOX, TRANSFORMER, PEDESTAL OR OTHER ABOVE GROUND OR BELOW GROUND FACILITY WILL DIMINISH OR ALTER TOWN EASEMENTS.

CENTURYLINK

XCEL ENERGY

COMCAST CABLE

CLERK AND RECORDER'S CERTIFICATE

THIS PLAT WAS FILED FOR RECORD IN THE OFFICE OF THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO, AT _____ O'CLOCK _____ M., THIS _____ DAY OF _____, 20_____.
IN BOOK _____, AT PAGE _____, RECEPTION NO. _____.

BOARD OF TRUSTEES CERTIFICATE

THIS PLAT APPROVED BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, COLORADO THIS _____ DAY OF _____, A.D. 20_____, FOR FILING WITH THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO AND FOR CONVEYANCE TO THE TOWN OF SILT FOR THE PUBLIC DEDICATIONS SHOWN HEREON, SUBJECT TO THE PROVISION THAT APPROVAL IN NO WAY OBLIGATES THE TOWN OF SILT FOR FINANCING OR CONSTRUCTION OF IMPROVEMENTS ON LANDS, STREETS OR EASEMENTS DEDICATED TO THE PUBLIC EXCEPT AS SPECIFICALLY AGREED TO BY THE BOARD OF TRUSTEES AND FURTHER THAT SAID APPROVAL SHALL IN NO WAY OBLIGATE THE TOWN OF SILT FOR MAINTENANCE OF STREETS AND UTILITIES DEDICATED TO THE PUBLIC UNTIL CONSTRUCTION OF IMPROVEMENTS THEREON HAVE BEEN COMPLETED TO THE SATISFACTION OF THE BOARD OF TRUSTEES, AND THE APPLICABLE WARRANTY PERIOD HAS ENDED.

TOWN OF SILT

BY: _____
MAYOR

WITNESS MY HAND AND SEAL OF THE TOWN OF SILT, COLORADO

ATTEST: _____
TOWN CLERK

CERTIFICATE OF DEDICATION AND OWNERSHIP

KNOW ALL MEN BY THESE PRESENTS THAT SILT 70 LLC, BEING SOLE OWNER IN FEE SIMPLE OF ALL THAT REAL PROPERTY DESCRIBED AS FOLLOWS: A TRACT OF LAND SITUATED IN THE EAST HALF OF SECTION 10 AND THE WEST HALF OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 89 WEST OF THE SIXTH PRINCIPAL MERIDIAN, COUNTY OF GARFIELD, STATE OF COLORADO, TO WIT:

A TRACT OF LAND SITUATED IN THE EAST HALF OF SECTION 10 AND THE WEST HALF OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 89 WEST OF THE SIXTH PRINCIPAL MERIDIAN, COUNTY OF GARFIELD, STATE OF COLORADO, TO WIT:

COMMENCING AT THE NORTHWEST CORNER OF THE SAID SECTION 11, MONUMENTED S 00°00'42" W, 40.00 FEET BY A FOUND 3/4IN. IRON PIN WITH 3.25IN. ALLOY CAP MARKED "WC" LS 36572; THENCE, ALONG THE WESTERLY BOUNDARY LINE OF THE NORTHWEST QUARTER OF THE SAID SECTION 11, WITH ALL BEARINGS CONTAINED HEREIN RELATIVE THERETO, S 00°34'13" E, A DISTANCE OF 1902.59 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE 60-FOOT-WIDE FRONTAGE ROAD ADJOINING INTERSTATE HIGHWAY 1-70, AS DELINEATED ON THAT COLORADO DEPARTMENT OF HIGHWAYS RIGHT-OF-WAY MAP OF THE FEDERAL AID PROJECT NO. 1-70-1(12)89SEC. 1 & 1-70-1(12)89 SEC. 2 (SHEET 14), DATED 24 APRIL, 1972, FROM WHENCE THE SOUTHWEST CORNER OF THE SAID SECTION 11 BEARS S 00°34'13" E, 3381.22 FEET DISTANT, THE SAID CORNER MONUMENTED BY A FOUND 2.5IN. IRON PIPE WITH 3IN. BRASS CAP MARKED GARFIELD COUNTY SURVEYOR (1972), THE SAID POINT OF INTERSECTION OF THE SAID WESTERLY BOUNDARY LINE OF THE SAID SECTION 11 AND THE SOUTHERLY RIGHT-OF-WAY OF THE SAID FRONTAGE ROAD IS REFERENCED 0.41 FEET NORTH AND 0.51 FEET WEST BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710, THE SAID POINT OF INTERSECTION BEING THE TRUE POINT OF BEGINNING;

THENCE, ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, 1650.44 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS N 88°16'44" E, 1648.58 FEET) TO THE NORTHWEST CORNER OF THAT TRACT OF LAND DESCRIBED IN THAT INSTRUMENT RECORDED UNDER RECEPTION NUMBER 871298 IN THE PUBLIC RECORDS OF THE SAID COUNTY, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE SAID SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD AND ALONG THE WESTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), S 07°56'11" E, A DISTANCE OF 504.89 FEET TO THE SOUTHWEST CORNER THEREOF, THE SAID CORNER MONUMENTED N 07°56'11" W, 20.00 FEET DISTANT BY A SET 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 47°27'23" E, A DISTANCE OF 246.25 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 36°34'25" E, A DISTANCE OF 415.01 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 08°48'32" W, A DISTANCE OF 76.53 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, N 81°10'10" E, A DISTANCE OF 550.81 FEET TO ITS INTERSECTION WITH THE EASTERLY BOUNDARY LINE OF THE NORTHEAST QUARTER OF THE SAID SECTION 11, FROM WHENCE THE NORTH QUARTER CORNER THEREOF BEARS N 00°02'50" E, 1647.82 FEET DISTANT, THE SAID QUARTER CORNER THEREOF BEING MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875, THE SAID POINT OF INTERSECTION BEING MONUMENTED N 00°02'50" E, 39.08 FEET DISTANT BY A FOUND 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID NORTHWEST QUARTER OF THE SAID SECTION 11, S 00°02'50" W, A DISTANCE OF 124.98 FEET TO THE CENTERLINE OF THE COLORADO RIVER FROM WHENCE THE SOUTH QUARTER CORNER OF THE SAID SECTION 11 BEARS S 00°02'50" W, 3504.03 FEET DISTANT, THE SAID QUARTER CORNER MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE CENTERLINE OF THE COLORADO RIVER THE FOLLOWING SEVEN (7) COURSES:

1. S 71°19'19" W, A DISTANCE OF 144.81 FEET;
2. S 46°55'17" W, A DISTANCE OF 664.55 FEET;
3. S 48°11'32" W, A DISTANCE OF 491.93 FEET;
4. S 67°52'01" W, A DISTANCE OF 731.09 FEET;
5. N 88°54'33" W, A DISTANCE OF 370.16 FEET;
6. N 83°50'18" W, A DISTANCE OF 563.90 FEET;
7. N 63°04'31" W, A DISTANCE OF 705.68 FEET TO A POINT ON THE SOUTHERLY EXTENSION OF THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, THE SAID POINT MONUMENTED N 00°04'28" W, 237.15 FEET DISTANT BY A SET 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, N 00°04'28" W, A DISTANCE OF 598.19 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 497.51 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 11634.21 FEET, (LONG CHORD BEARS S 87°24'24" E, 497.47 FEET) TO A POINT OF COMPOUND CURVATURE, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP (ILLEGIBLE);

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 54.45 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS S 88°51'03" E, 54.45 FEET) TO THE POINT OF BEGINNING.

THE SAID TRACT OF LAND IS COMPRISED OF 2,227,694 SQUARE FEET, (51.14 ACRES), MORE OR LESS.

HAVE BY THESE PRESENTS LAID OUT, PLATTED AND SUBDIVIDED THE SAME INTO TRACTS, AS SHOWN HEREON AND DESIGNATE THE SAME AS RISLENDE PLANNED UNIT DEVELOPMENT, IN THE TOWN OF SILT, COUNTY OF COLORADO, AND DO HEREBY GRANT TO THE TOWN OF SILT, COLORADO, FOR PUBLIC USE THE STREETS SHOWN HEREON INCLUDING LOOPS, DRIVES AND LANES, THE PUBLIC LANDS SHOWN HEREON FOR THEIR INDICATED PUBLIC USE, IF ANY, AND THE UTILITY AND DRAINAGE EASEMENTS SHOWN HEREON FOR UTILITY AND DRAINAGE PURPOSES ONLY; TRAIL AND PEDESTRIAN EASEMENTS SHOWN HEREON FOR PEDESTRIAN AND TRAIL PURPOSES; AND DO FURTHER STATE THAT THIS PUD SHALL BE SUBJECT TO THE PROTECTIVE COVENANTS FILED AND RECORDED FOR THIS PUD IN THE OFFICE OF THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO AS RECEPTION NO. _____.

EXECUTED THIS _____ DAY OF _____, A.D., 20_____.

OWNER SILT 70 LLC

STATE OF COLORADO)

COUNTY OF GARFIELD) §§

THE FOREGOING CERTIFICATE OF DEDICATION AND OWNERSHIP WAS ACKNOWLEDGED BEFORE ME THIS _____ DAY OF _____, A.D., 20_____, BY _____.

MY COMMISSION EXPIRES: _____

WITNESS MY HAND AND SEAL _____
NOTARY PUBLIC

NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.

S- 10-11
T- 6S
R- 92W
C- GARFIELD

REVISION	BY	DATE	NO.

DRAWN BY: DMC	CHECKED BY: BB
DATE: 01/30/2023	FILE: RISLENDEPUD

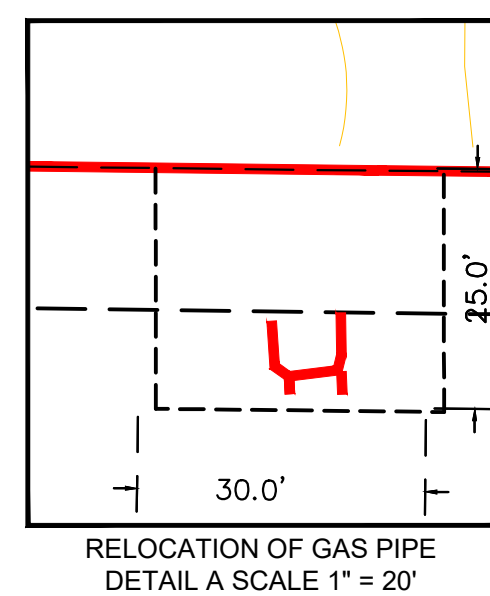
HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101,
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-8676 FAX (970) 945-2555
WWW.HCENG.COM



SILT 70 LLC,
RISLENDE PLANNED UNIT DEVELOPMENT
TOWN OF SILT,
GARFIELD COUNTY
COLORADO

PROJECT NO.
2211047

SHEET NUMBER
3

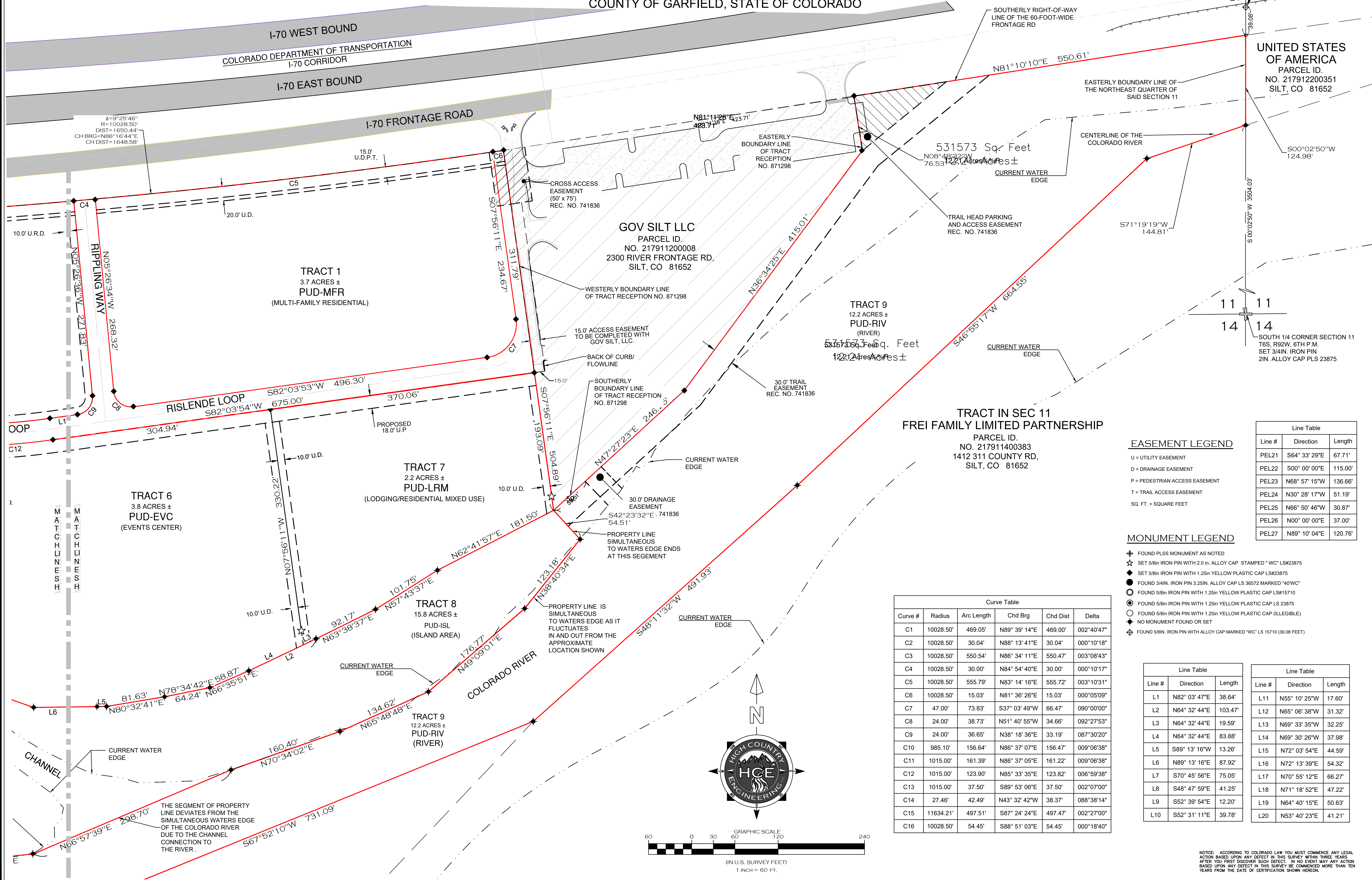


A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO



PRELIMINARY PLAT RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO



EASEMENT LEGEND

U = UTILITY EASEMENT
D = DRAINAGE EASEMENT
P = PEDESTRIAN ACCESS EASEMENT
T = TRAIL ACCESS EASEMENT
SQ. FT. = SQUARE FEET

MONUMENT LEGEND

✚ FOUND PLSS MONUMENT AS NOTED
★ SET 5/8in IRON PIN WITH 2.0 in. ALLOY CAP STAMPED "WC" LS#23875
◆ SET 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP LS#23875
● FOUND 3/4in. IRON PIN 3.25in. ALLOY CAP LS 38572 MARKED "40"WC"
○ FOUND 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP LS#15710
⊙ FOUND 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP LS 23875
○ FOUND 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP (ILLEGIBLE)
◆ NO MONUMENT FOUND OR SET
✚ FOUND 5/8in. IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710 (39.08 FEET)

Line Table		
Line #	Direction	Length
PEL21	S64° 33' 29"E	67.71'
PEL22	S00° 00' 00"E	115.00'
PEL23	N68° 57' 15"W	136.66'
PEL24	N30° 28' 17"W	51.19'
PEL25	N66° 50' 46"W	30.87'
PEL26	N00° 00' 00"E	37.00'
PEL27	N89° 10' 04"E	120.76'

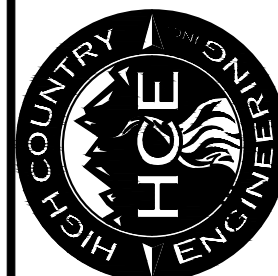
Curve Table					
Curve #	Radius	Arc Length	Chd Brg	Chd Dist	Delta
C1	10028.50'	469.05'	N89° 39' 14"E	469.00'	002°40'47"
C2	10028.50'	30.04'	N88° 13' 41"E	30.04'	000°10'18"
C3	10028.50'	550.54'	N86° 34' 11"E	550.47'	003°08'43"
C4	10028.50'	30.00'	N84° 54' 40"E	30.00'	000°10'17"
C5	10028.50'	555.79'	N83° 14' 16"E	555.72'	003°10'31"
C6	10028.50'	15.03'	N81° 36' 26"E	15.03'	000°05'09"
C7	47.00'	73.83'	S37° 03' 49"W	66.47'	090°00'00"
C8	24.00'	38.73'	N51° 40' 55"W	34.66'	092°27'53"
C9	24.00'	36.65'	N38° 18' 36"E	33.19'	087°30'20"
C10	985.10'	156.64'	N86° 37' 07"E	156.47'	009°06'38"
C11	1015.00'	161.39'	N86° 37' 05"E	161.22'	009°06'38"
C12	1015.00'	123.90'	N85° 33' 35"E	123.82'	006°59'38"
C13	1015.00'	37.50'	S89° 53' 06"E	37.50'	002°07'00"
C14	27.46'	42.49'	N43° 32' 42"W	38.37'	088°38'14"
C15	11634.21'	497.51'	S87° 24' 24"E	497.47'	002°27'00"
C16	10028.50'	54.45'	S88° 51' 03"E	54.45'	000°18'40"

Line Table		
Line #	Direction	Length
L1	N82° 03' 47"E	38.64'
L2	N64° 32' 44"E	103.47'
L3	N64° 32' 44"E	19.59'
L4	N64° 32' 44"E	83.88'
L5	S89° 13' 16"W	13.26'
L6	N89° 13' 16"E	87.92'
L7	S70° 45' 56"E	75.05'
L8	S48° 47' 59"E	41.25'
L9	S52° 39' 54"E	12.20'
L10	S52° 31' 11"E	39.78'

Line Table		
Line #	Direction	Length
L11	N55° 10' 25"W	17.60'
L12	N65° 06' 38"W	31.32'
L13	N69° 33' 35"W	32.25'
L14	N69° 30' 26"W	37.98'
L15	N72° 03' 54"E	44.59'
L16	N72° 13' 39"E	54.32'
L17	N70° 55' 12"E	66.27'
L18	N71° 18' 52"E	47.22'
L19	N64° 40' 15"E	50.63'
L20	N53° 40' 23"E	41.21'

NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.

HIGH COUNTRY ENGINEERING, INC.



SILT 70 LLC,
RISLENDE PLANNED UNIT DEVELOPMENT

TOWN OF SILT,
GARFIELD COUNTY
COLORADO

PROJECT NO.
2211047

SHEET NUMBER
5

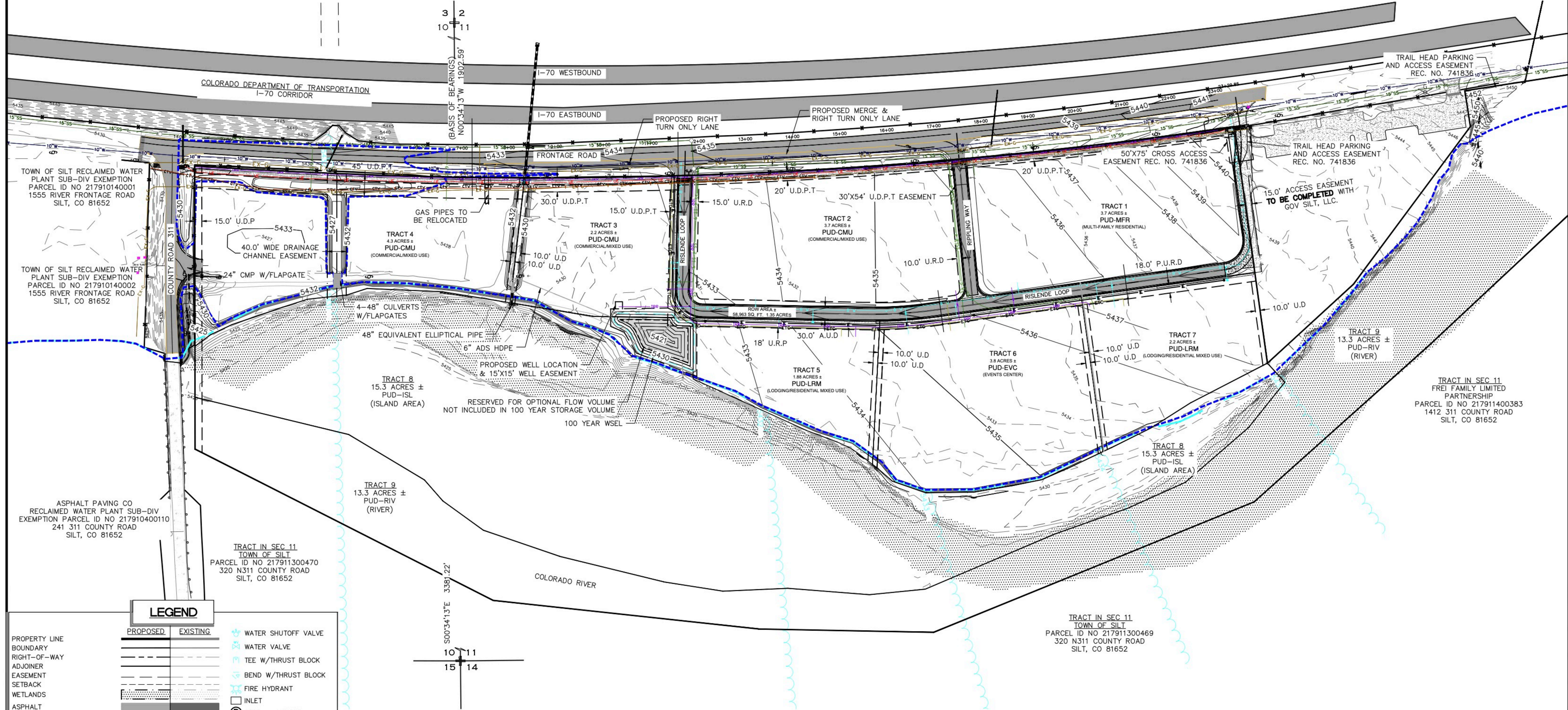
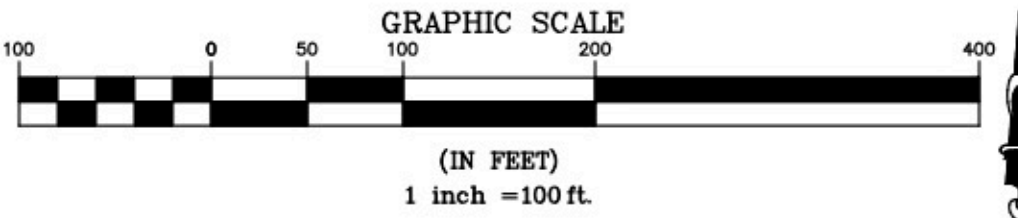
BY: S-10-11

REVISION

NO. DATE

DRAWN BY: DMC
CHECKED BY: BB
DATE: 01/30/2023
FILE: RISLENDEPUD

OVERALL SITE MAP
Rislende Planned Unit Development
Situated in Section's 10 and 11, Township 6 South,
Range 92 West, of the 6TH Principal Meridian
Town of Silt, County of Garfield, State of Colorado.



LEGEND

PROPOSED	EXISTING	
PROPERTY LINE		WATER SHUTOFF VALVE
BOUNDARY		WATER VALVE
RIGHT-OF-WAY		TEE W/THRUST BLOCK
ADJOINER		BEND W/THRUST BLOCK
EASEMENT		FIRE HYDRANT
SETBACK		INLET
WETLANDS		STORM MANHOLE
ASPHALT		SANITARY MANHOLE
GRAVEL		SANITARY CLEANOUT
CONCRETE		OVERHEAD POWER POLE
WETLANDS		STREET LIGHT
RIPRAP		SEDIMENT CONTROL LOG
CENTERLINE ROAD		INLET PROTECTION
FEMA CROSS SECTIONS		EROSION CONTROL BLANKET
FLOODWAY		VEHICLE TRACKING PAD
FLOODPLAIN		
BASE FLOOD ELEVATION		
BASIN BOUNDARY		
PAVEMENT STRIPING		
PROPOSED WATER MAIN		
PROPOSED SEWER MAIN		
PROPOSED IRRIGATION		
UNDERGROUND ELECTRIC		
ELECTRIC, TELEPHONE, CABLE		
PROPOSED GAS		
STORM SEWER		
CONTOUR		
SPOT ELEVATION		
SLOPE OR GRADE		
SEDIMENT CONTROL FENCE		
FLOWLINE		
FENCE		

ABBREVIATIONS:
1. UDPT = UTILITY, DRAINAGE, PEDESTRIAN (SIDEWALK) & TRAIL (BIKE PATH)
2. AUD = ACCESS, UTILITY, & DRAINAGE
3. UD = UTILITY & DRAINAGE
4. URP = UTILITY, ROAD MAINTENANCE, & PEDESTRIAN (SIDEWALK)



BY	REVISION	DATE	NO.

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101,
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-8676 • FAX (970) 945-2555
WWW.HCENG.COM



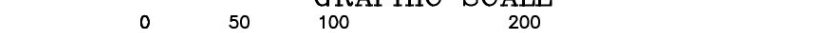
SILT 70 LLC
RISLENDE PLANNED UNIT DEVELOPMENT
DIVIDE CREEK CENTER
SITE MAP
GARFIELD COUNTY, COLORADO

PROJECT NO.
2211047

Exhibit B
The Rislende PUD Amended Preliminary Plat

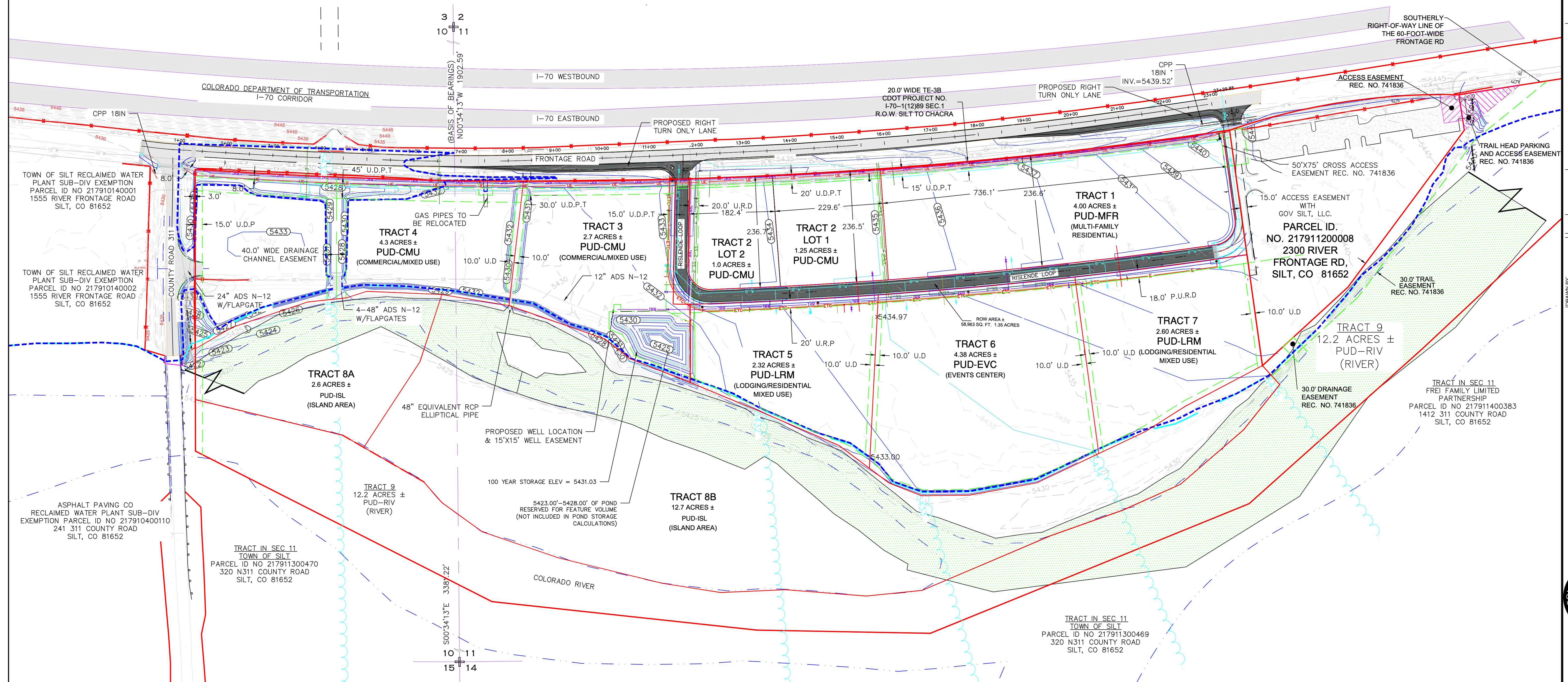
Rislende Planned Unit Development
Situated in Section's 10 and 11, Township 6 South,
Range 92 West, of the 6TH Principal Meridian
Town of Silt, County of Garfield, State of Colorado.

GRAPHIC SCALE




















(IN FEET)
1 inch = 100 ft.

PRELIMINARY
NOT FOR
CONSTRUCTION



SYMBOL LEGEND

	UTILITY POLE/POWER POLE
	SANITARY MANHOLE
	WATER VALVE
	FIRE HYDRANT
	WELL
	WATER MANHOLE
	FIBER OPTIC MARKER
	STREET SIGN
	CATV PEDESTAL
	UTILITY PEDESTAL
	CULVERT/FES/RIPRAP
	STREET SIGN
	SANITARY SEWER MANHOLE
	WATER VALVE
	FIRE HYDRANT
	WATER SHUTOFF
	WATER WFL

LINE LEGEND

BOUNDARY OR LOT LINE

ADJOINER LINE

MAJOR CONTOUR LINE

MINOR CONTOUR LINE

MAJOR CONTOUR LINE

MINOR CONTOUR LINE

PLSS LINE

ASPHALT

CONCRETE

EDGE OF WATER +/-
FLOODWAY LIMITS

GUARD RAIL

WIRE FENCE LINE

EASEMENT

8" SEWER LINE

8" WATER LINE

ELECTRIC / TELEPHONE/ CABLE LINE

IRRIGATION LINE

2" IRRIGATION SERVICE LINE

GAS LINE

FLOODPLAIN

WETLANDS

HCE 100 YR FLOODPLAIN

100 YR WATER SURFACE ELEV.

ABBREVIATIONS:

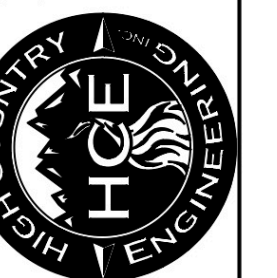
1. UDPT = UTILITY, DRAINAGE, PEDESTRIAN (SIDEWALK) & TRAIL (BIKE PATH)
2. AUD = ACCESS, UTILITY, & DRAINAGE
3. UD = UTILITY & DRAINAGE
4. URP = UTILITY, ROAD MAINTENANCE, & PEDESTRIAN (SIDEWALK)



COLORADO 811
CALL BEFORE
YOU DIG
 Utility Notification
 Center of Colorado

CHECKED BY:	HCE	NO.	DATE	REVISION	BY
DATE:	HCE				
FILE:	10/2023				

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101,
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-8676 • FAX (970) 945-2555
WWW.HCENG.COM



**RISLENDE
PLANNED UNIT DEVELOPMENT
OVERALL SITE PLAN
GARFIELD COUNTY, COLORADO**

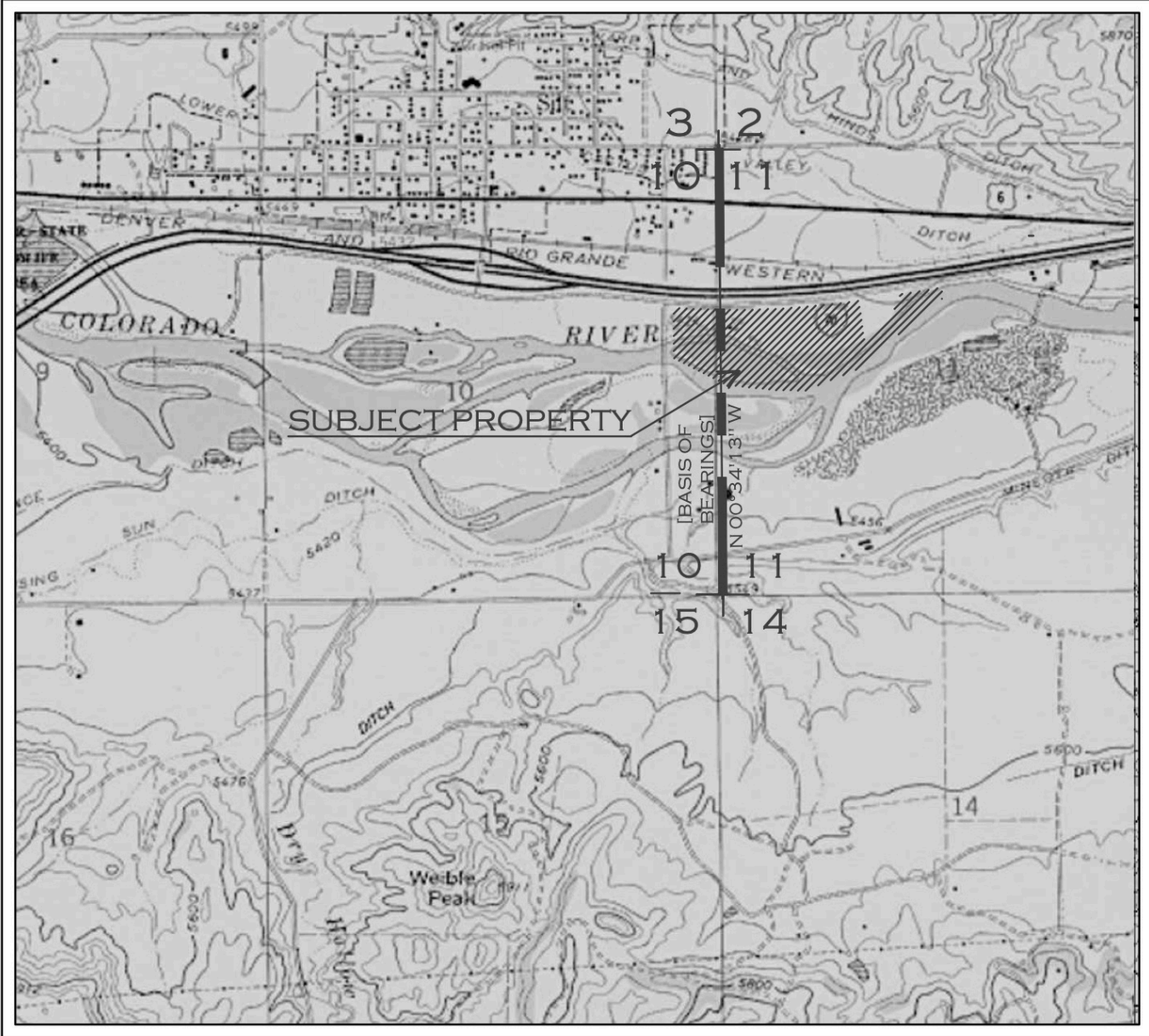
PROJECT NO.
2211047

PRELIMINARY PLAT
RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO

PLAT NOTES

- BASIS OF BEARINGS FOR THIS SURVEY IS A BEARING OF N00°34'13"W BETWEEN A FOUND 3/4in REBAR WITH 3.25in ALUMINUM CAP LS NO. 36572 (40' WITNESS CORNER) NORTHWEST CORNER OF SECTION 11 AND A FOUND 2.5IN. IRON PIPE 3IN. BRASS CAP GARCO (1972) SOUTHWEST CORNER OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 89 WEST OF THE 6TH. PRINCIPAL MERIDIAN.
- THIS PLAT IS BASED ON THE BLM EXEMPTION PLAT, RECEPTION NO. 741836 PREPARED BY HIGH COUNTRY ENGINEERING, INC., AND CORNERS FOUND IN PLACE.
- THIS PROPERTY IS SUBJECT TO RESERVATIONS, RESTRICTIONS AND COVENANTS OF RECORD OR IN PLACE AND EXCEPTIONS TO TITLE SHOWN IN THE TITLE COMMITMENT PREPARED BY LAND TITLE GUARANTEE COMPANY DATED FEBRUARY 06, 2023 (ORDER NO. GW63017116-3).
- DATE OF SURVEY BY HIGH COUNTRY ENGINEERING, INC. WAS SEPTEMBER 2022.
- AS A CONDITION OF APPROVAL OF THIS PLAT BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, AND TO MEET THE REQUIREMENTS OF THE SILT MUNICIPAL CODE SECTION 16.04.280, AS AMENDED, NO CONSTRUCTION ON THE PUBLIC IMPROVEMENTS WITHIN THE SUBDIVISION AND NO CONVEYANCE OR TRANSFER OF TITLE OF ANY LOT, LOTS, TRACT OR TRACTS OF LAND WITHIN THE SUBDIVISION SHALL BE MADE UNTIL THE TOWN HAS GRANTED A CERTIFICATE OF COMPLIANCE. CERTIFYING THAT THE OWNER HAS DEPOSITED AND THE TOWN HAS ACCEPTED MONETARY SECURITY EQUAL TO ONE HUNDRED AND TEN PERCENT (110%) OF THE ESTIMATED COSTS OF COMPLETION FOR THE PUBLIC IMPROVEMENTS WHICH CERTIFICATE OF COMPLIANCE HAS BEEN DULY RECORDED BY THE CLERK AND RECORDER OF GARFIELD COUNTY.
- UNDERGROUND OR ABOVE GROUND UTILITY INFRASTRUCTURE SHALL BE MAINTAINED BY THE RESPECTIVE UTILITY OR RESPONSIBLE PARTY. DRAINAGE, TRAIL, AND ROAD FACILITIES LOCATED IN TOWN EASEMENTS SHALL BE MAINTAINED BY THE TOWN.
- THIS PROPERTY IS SUBJECT TO, WITHOUT LIMITATION, THE MASTER DECLARATION OF COVENANTS, CONDITIONS AND RESTRICTIONS FOR RISLENDE P.U.D. AS RECORDED IN THE RECORDS OF THE GARFIELD COUNTY CLERK AND RECORDERS OFFICE AT RECEPTION NUMBER _____.
- WETLANDS IN RISLENDE PUD WERE DELINEATED BY BIRCH ECOLOGY, LLC AND DAVID BUSCHER A CERTIFIED SOIL SCIENTIST ON MAY 16, 2022, WITH CONFIRMATION BY THE U.S. ARMY CORPS OF ENGINEERS NUMBER SPA-2022-00348 DATED DECEMBER 8, 2022.
- NOXIOUS WEEDS. IT IS THE INDIVIDUAL LOT OWNER'S RESPONSIBILITY, ACCORDING TO THE COLORADO NOXIOUS WEED ACT AND THE TOWN OF SILT ORDINANCES, TO MANAGE ANY NOXIOUS WEEDS ON THE LOT OWNER'S PROPERTY.
- ALL SIDEWALK, TRAIL AND PEDESTRIAN EASEMENTS ARE FOR NON-MOTORIZED USE BY THE PUBLIC, WITH THE EXCEPTION OF EMERGENCY USE AND/OR MAINTENANCE PURPOSES.
- STORMWATER MITIGATION AND POLLUTANT TREATMENT SYSTEMS SHALL BE DESIGNED FOR EACH INDIVIDUAL TRACT AT THE TIME OF SITE PLAN AND/OR BUILDING PERMIT APPLICATION. TREATMENT SHALL COMPLY WITH MILE HIGH FLOOD DISTRICT (AKA URBAN DRAINAGE FLOOD CONTROL DISTRICT) STANDARDS, LATEST EDITION.
- NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.



VICINITY MAP
SCALE: 1" = 2000'

LEGEND

U = UTILITY EASEMENT
D = DRAINAGE EASEMENT
R = ROAD MAINTENANCE EASEMENT
P = PEDESTRIAN ACCESS EASEMENT
A = ACCESS EASEMENT
T = TRAIL ACCESS EASEMENT
SQ. FT. = SQUARE FEET

LAND USE SUMMARY

TRACT #	ACRES	ADDRESS	LAND USE
TRACT 1	4.0	0000 RIVER FRONTAGE ROAD	PUD-MFR (MULTI-FAMILY RESIDENTIAL)
TRACT 2 LOT 1	1.2	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 2 LOT 2	1.0	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 3	2.7	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 4	4.3	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 5	2.3	0000 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 6	4.4	0000 RISLENDE LOOP	PUD-EVC (EVENTS CENTER)
TRACT 7	2.6	0000 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 8A	2.6		PUD-ISL (ISLAND AREA)
TRACT 8B	12.7		PUD-ISL (ISLAND AREA)
TRACT 9	12.2		PUD-RIV (RIVER)
TRACT 10	1.1		RISLENDE LOOP
TOTAL	51.1		

TITLE INSURANCE COMPANY OR ATTORNEY'S CERTIFICATE

_____ DOES HEREBY CERTIFY THAT _____ HAS EXAMINED THE TITLE TO ALL LANDS HEREIN DEDICATED AND SHOWN UPON THIS PLAT AND TITLE TO SUCH LAND IS IN THE DEDICATOR FREE AND CLEAR OF ALL LIENS, TAXES AND ENCUMBRANCES, EXCEPT AS FOLLOWS:

Signature and Title _____ Date _____

SURVEYOR'S CERTIFICATE

I, _____, DO HEREBY CERTIFY THAT I AM A REGISTERED LAND SURVEYOR LICENSED UNDER THE LAWS OF THE STATE OF COLORADO, THAT THIS PLAT IS A TRUE, CORRECT AND COMPLETE PLAT OF THE (RISLENDE PLANNED UNIT DEVELOPMENT AS Laid OUT, PLATTED, DEDICATED AND SHOWN HEREON, THAT SUCH PLAT WAS MADE FROM AN ACCURATE SURVEY OF SAID PROPERTY BY ME OR UNDER MY SUPERVISION AND CORRECTLY SHOWS THE LOCATION AND DIMENSIONS OF THE LOTS, EASEMENTS AND STREETS OF SAID SUBDIVISION AS THE SAME ARE STAKED UPON THE GROUND IN COMPLIANCE WITH APPLICABLE REGULATIONS GOVERNING THE SUBDIVISION OF LAND.

BILL W.A. BAKER, COLORADO PROFESSIONAL LAND SURVEYOR #23875
CERTIFIED FEDERAL SURVEYOR #1699

UTILITY COMPANIES CERTIFICATE

BY THE SIGNING OF THIS PLAT, EACH UTILITY COMPANY AGREES AND ACKNOWLEDGES ANY AND ALL ACCESS AND UTILITY EASEMENTS DEDICATED TO THE TOWN AND EACH UTILITY COMPANY HEREBY WARRANTS THAT NO ABOVE GROUND VAULT, SPLICE BOX, TRANSFORMER, PEDESTAL OR OTHER ABOVE GROUND OR BELOW GROUND FACILITY WILL DIMINISH OR ALTER TOWN EASEMENTS.

CENTURYLINK

XCEL ENERGY

COMCAST CABLE

CLERK AND RECORDER'S CERTIFICATE

THIS PLAT WAS FILED FOR RECORD IN THE OFFICE OF THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO, AT _____ O'CLOCK _____ M., THIS _____ DAY OF _____, 20_____, IN BOOK _____, AT PAGE _____, RECEPTION NO. _____.

BOARD OF TRUSTEES CERTIFICATE

THIS PLAT APPROVED BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, COLORADO THIS _____ DAY OF _____, A.D. 20_____, FOR FILING WITH THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO AND FOR CONVEYANCE TO THE TOWN OF SILT FOR THE PUBLIC DEDICATIONS SHOWN HEREON: SUBJECT TO THE PROVISION THAT APPROVAL IN NO WAY OBLIGATES THE TOWN OF SILT FOR FINANCING OR CONSTRUCTION OF IMPROVEMENTS ON LANDS, STREETS OR EASEMENTS DEDICATED TO THE PUBLIC EXCEPT AS SPECIFICALLY AGREED TO BY THE BOARD OF TRUSTEES AND FURTHER THAT SAID APPROVAL SHALL IN NO WAY OBLIGATE THE TOWN OF SILT FOR MAINTENANCE OF STREETS AND UTILITIES DEDICATED TO THE PUBLIC UNTIL CONSTRUCTION OF IMPROVEMENTS THEREON HAVE BEEN COMPLETED TO THE SATISFACTION OF THE BOARD OF TRUSTEES, AND THE APPLICABLE WARRANTY PERIOD HAS ENDED.

TOWN OF SILT

BY: _____
MAYOR

WITNESS MY HAND AND SEAL OF THE TOWN OF SILT, COLORADO

ATTEST: _____
TOWN CLERK

CERTIFICATE OF DEDICATION AND OWNERSHIP

KNOW ALL MEN BY THESE PRESENTS THAT SILT 70 LLC, BEING SOLE OWNER IN FEE SIMPLE OF ALL THAT REAL PROPERTY DESCRIBED AS FOLLOWS: A TRACT OF LAND SITUATED IN THE EAST HALF OF SECTION 10 AND THE WEST HALF OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST OF THE SIXTH PRINCIPAL MERIDIAN, COUNTY OF GARFIELD, STATE OF COLORADO, TO WIT;

COMMENCING AT THE NORTHWEST CORNER OF THE SAID SECTION 11, MONUMENTED S 00°00'42" W, 40.00 FEET BY A FOUND 3/4IN. IRON PIN WITH 3.25IN. ALLOY CAP MARKED "WC" LS 36572; THENCE, ALONG THE WESTERLY BOUNDARY LINE OF THE NORTHWEST QUARTER OF THE SAID SECTION 11, WITH ALL BEARINGS CONTAINED HEREIN RELATIVE THERETO, S 00°34'13" E, A DISTANCE OF 1902.59 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE 60-FOOT-WIDE FRONTAGE ROAD ADJOINING INTERSTATE HIGHWAY 170, AS DELINEATED ON THAT COLORADO DEPARTMENT OF HIGHWAYS RIGHT-OF-WAY MAP OF THE FEDERAL AID PROJECT NO. I-70-1(12)89SEC. 1 & I-70-1(12)89 SEC 2 (SHEET 14), DATED 24 APRIL, 1972, FROM WHENCE THE SOUTHWEST CORNER OF THE SAID SECTION 11 BEARS S 00°34'13" E, 3381.22 FEET DISTANT, THE SAID CORNER MONUMENTED BY A FOUND 2.5IN. IRON PIPE WITH 3IN. BRASS CAP MARKED GARFIELD COUNTY SURVEYOR (1972), THE SAID POINT OF INTERSECTION OF THE SAID WESTERLY BOUNDARY LINE OF THE SAID SECTION 11 AND THE SOUTHERLY RIGHT-OF-WAY OF THE SAID FRONTAGE ROAD IS REFERENCED 0.41 FEET NORTH AND 0.51 FEET WEST BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710, THE SAID POINT OF INTERSECTION BEING THE TRUE POINT OF BEGINNING;

THENCE, ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, 1650.44 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS N 86°16'44" E, 1648.58 FEET) TO THE NORTHWEST CORNER OF THAT TRACT OF LAND DESCRIBED IN THAT INSTRUMENT RECORDED UNDER RECEPTION NUMBER 871298 IN THE PUBLIC RECORDS OF THE SAID COUNTY, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE SAID SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD AND ALONG THE WESTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), S 07°56'11" E, A DISTANCE OF 504.89 FEET TO THE SOUTHWEST CORNER THEREOF, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 47°27'23" E, A DISTANCE OF 246.25 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 36°34'25" E, A DISTANCE OF 415.01 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 08°48'32" W, A DISTANCE OF 76.53 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, N 81°10'10" E, A DISTANCE OF 550.61 FEET TO ITS INTERSECTION WITH THE EASTERLY BOUNDARY LINE OF THE NORTHEAST QUARTER OF THE SAID SECTION 11, FROM WHENCE THE NORTH QUARTER CORNER THEREOF BEARS N 00°02'50" E, 1647.82 FEET DISTANT, THE SAID QUARTER CORNER THEREOF BEING MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875, THE SAID POINT OF INTERSECTION BEING MONUMENTED N 00°02'50" E, 39.08 FEET DISTANT BY A FOUND 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID NORTHWEST QUARTER OF THE SAID SECTION 11, S 00°02'50" W, A DISTANCE OF 124.98 FEET TO THE CENTERLINE OF THE COLORADO RIVER FROM WHENCE THE SOUTH QUARTER CORNER OF THE SAID SECTION 11 BEARS S 00°02'50" W, 3504.03 FEET DISTANT, THE SAID QUARTER CORNER MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE CENTERLINE OF THE COLORADO RIVER THE FOLLOWING SEVEN (7) COURSES:

- S 71°19'19" W, A DISTANCE OF 144.81 FEET;
- S 46°55'17" W, A DISTANCE OF 664.55 FEET;
- S 48°11'32" W, A DISTANCE OF 491.93 FEET;
- S 67°52'10" W, A DISTANCE OF 731.09 FEET;
- N 88°54'33" W, A DISTANCE OF 370.16 FEET;
- N 83°50'18" W, A DISTANCE OF 563.90 FEET;
- N 63°04'31" W, A DISTANCE OF 705.68 FEET TO A POINT ON THE SOUTHERLY EXTENSION OF THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, THE SAID POINT MONUMENTED N 00°04'28" W, 237.15 FEET DISTANT BY A SET 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, N 00°04'28" W, A DISTANCE OF 598.19 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 497.51 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 11634.21 FEET, (LONG CHORD BEARS S 87°24'24" E, 497.47 FEET) TO A POINT OF COMPOUND CURVATURE, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP (ILLEGIBLE);

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 54.45 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS S 88°51'03" E, 54.45 FEET) TO THE POINT OF BEGINNING.

THE SAID TRACT OF LAND IS COMPRISED OF 2,227,694 SQUARE FEET, (51.14 ACRES), MORE OR LESS

S- 10-11
BY
REVISION
T- 6S
R- 92W
C- GARFIELD

NO. DATE

DRAWN BY: DMC
CHECKED BY: BB
DATE: 10/31/2023
FILE: RISLENDEPUD

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101
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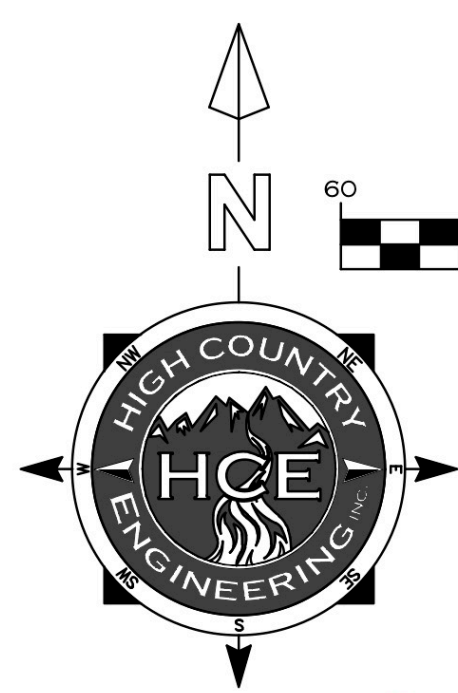


SILT 70 LLC.
RISLENDE
PLANNED UNIT DEVELOPMENT
GARFIELD COUNTY, COLORADO.

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2211047

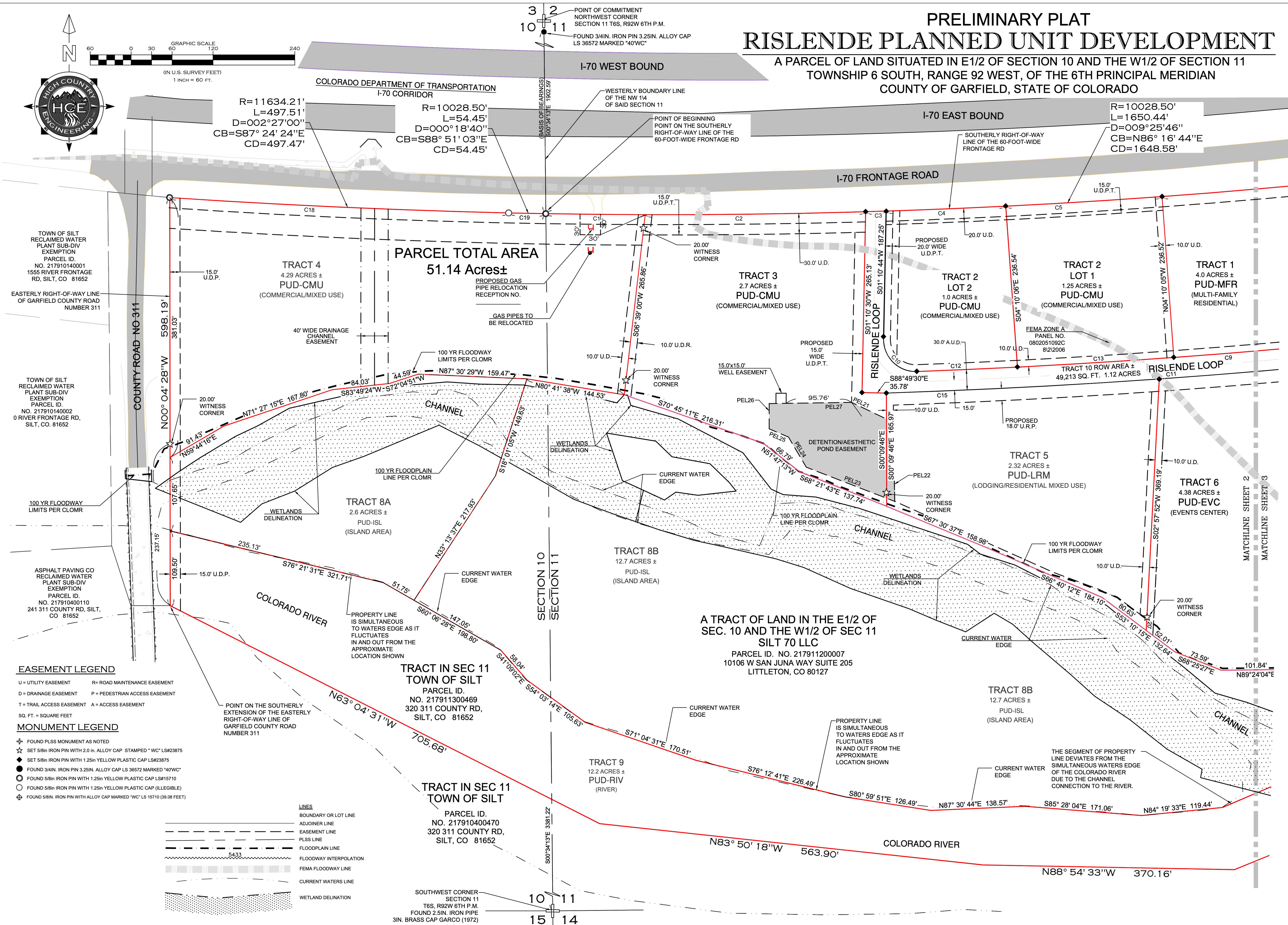
SHEET NUMBER
1

NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.



PRELIMINARY PLAT RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO



EASEMENT LEGEND

U = UTILITY EASEMENT R = ROAD MAINTENANCE EASEMENT
D = DRAINAGE EASEMENT P = PEDESTRIAN ACCESS EASEMENT
T = TRAIL ACCESS EASEMENT A = ACCESS EASEMENT
SQ. FT. = SQUARE FEET

MONUMENT LEGEND

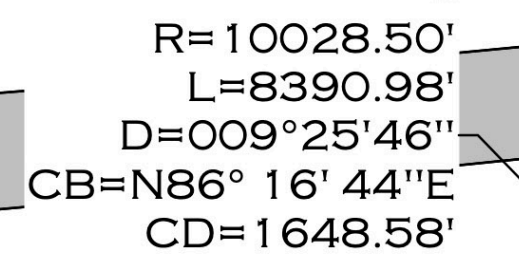
FOUND PLSS MONUMENT AS NOTED
SET 5/8" IRON PIN WITH 2.0" IN. ALLOY CAP STAMPED "WC" LS#23875
SET 5/8" IRON PIN WITH 1.25" IN. YELLOW PLASTIC CAP LS#23875
FOUND 3/4" IRON PIN 3.25" IN. ALLOY CAP LS 36572 MARKED "40WC"
FOUND 5/8" IRON PIN WITH 1.25" IN. YELLOW PLASTIC CAP LS#15710
FOUND 5/8" IRON PIN WITH 1.25" IN. YELLOW PLASTIC CAP (ILLEGIBLE)
FOUND 5/8" IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710 (39.08 FEET)

LINES

BOUNDARY OR LOT LINE
ADJOINER LINE
EASEMENT LINE
PLSS LINE
FLOODPLAIN LINE
FLOODWAY INTERPOLATION
FEMA FLOODWAY LINE
CURRENT WATERS LINE
WETLAND DELINEATION

BY	NO.	DATE	REVISION	S-10-11
BY	NO.	DATE	REVISION	T-6S
BY	NO.	DATE	REVISION	R-92W
BY	NO.	DATE	REVISION	C-GARFIELD
DRAWN BY	DMC	CHECKED BY	BB	
DATE	10/31/2023	FILE	RISLENDEPUD	
HIGH COUNTRY ENGINEERING, INC.				
1517 BLAKE AVENUE, STE 101				
GLENWOOD SPRINGS, CO 81601				
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WWW.HCE.ENG.COM				
SILT 70 LLC.				
RISLENDE				
PLANNED UNIT DEVELOPMENT				
GARFIELD COUNTY, COLORADO				
PROJECT NO.				
2211047				
SHEET NUMBER				
2				

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO

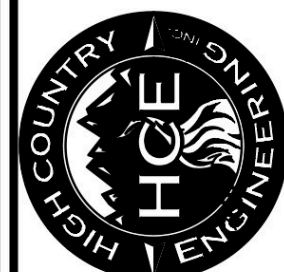


Curve Table					
Curve #	Radius	Arc Length	Chd Brg	Chd Dist	Delta
C1	10036.90'	145.89'	S89° 25' 23"E	145.89'	000°49'58"
C2	10016.93'	323.16'	N89° 14' 13"E	323.15'	001°50'54"
C3	10029.33'	30.03'	N88° 13' 41"E	30.03'	000°01'18"
C4	10029.40'	175.37'	N87° 38' 29"E	175.37'	001°00'07"
C5	10029.40'	229.65'	N86° 29' 04"E	229.64'	001°18'43"
C6	9974.82'	731.31'	N83° 44' 21"E	731.15'	004°12'02"
C7	10028.50'	15.03'	N81° 36' 26"E	15.03'	000°05'09"
C8	47.00'	73.94'	N37° 07' 49"E	66.54'	090°07'56"
C9	10525.22'	1077.13'	N84° 57' 26"E	1076.66'	005°51'54"
C10	47.00'	76.50'	S45° 27' 02"E	68.33'	093°15'31"
C11	10625.51'	1187.95'	N84° 54' 51"E	1187.33'	006°24'21"
C12	8849.74'	147.71'	N87° 28' 13"E	147.71'	000°57'23"
C13	9595.39'	228.65'	N86° 28' 47"E	229.64'	001°22'17"
C14	10585.27'	699.77'	N83° 55' 29"E	699.64'	003°47'16"
C15	10600.25'	400.60'	N87° 02' 31"E	400.58'	002°09'55"
C16	10600.25'	418.89'	N84° 49' 38"E	418.86'	002°15'51"
C17	10600.25'	368.47'	N82° 41' 58"E	368.45'	001°59'30"
C18	11634.21'	497.51'	S87° 24' 24"E	497.47'	002°27'00"

Line Table		
Line #	Direction	Length
PEL21	S64° 33' 52"E	67.91'
PEL22	S00° 59' 53"E	115.92'
PEL23	N68° 54' 04"W	139.07'
PEL24	N30° 28' 17"W	51.19'
PEL25	N66° 50' 46"W	30.87'
PEL26	N00° 00' 00"E	37.00'
PEL27	N89° 10' 04"E	120.76'

NO.	DATE	REVISION	BY
			S- 10-11
			T- 6S
			R- 92W
			C- GARFIELD

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RISLENDE
PLANNED UNIT DEVELOPMENT
GARFIELD COUNTY, COLORADO.

PROJECT NO.
2211047

SHEET NUMBER
3

7.0 Conclusions

The Rislende Planned Unit Development (PUD) project proposes to develop a currently vacant site with mixed-use commercial and residential uses. The property is located on the north side of River Frontage Road just east of Divide Creek Road (County Road 311). Access to the project is proposed at two (2) locations along River Frontage Road, one of which exists and will be shared with the existing BLM office, and one (1) new access along CR 311 south of River Frontage Road. The proposed site access plan is consistent with the recommendations of the US 6/River Frontage Road Access Control Plan.

The project is estimated to generate approximately 3,472 daily trips with 171 trips in the AM peak hour and 370 trips in the PM peak hour at full build-out of all land uses and tracts. **It was determined that the proposed roadway system can adequately accommodate the projected traffic volumes for buildout conditions with planned improvements.**

The following recommendations should be considered:

Background Conditions (Non-Project Related):

- **9th Street at I-70 Ramps:** Signalize the I-70 ramp terminal intersections or construct roundabouts, consistent with the I-70 Exit 97 Silt Interchange Study recommended designs. The eastbound ramp terminal eastbound left-turn is currently projected to operate at LOS F based on existing volumes in the AM peak hour. A roundabout at the I-70 eastbound ramps should incorporate the River Frontage Road & 9th Street intersection, as proposed in the conceptual designs.

Project Conditions:

- **River Frontage Road:** Construct eastbound right-turn deceleration lanes (435' total minimum length, inclusive of a 13.5:1 taper) at both proposed access points east of CR 311, one of which is the existing access that will be shared with the adjacent BLM office.

Since this study will serve the entire PUD and current land uses are projected based on density and assumed commercial/residential splits for mixed-use, traffic conformance memos may need to be prepared in the future with each individual site plan submittal as specific uses are proposed. This is anticipated to occur over a period of years as the site will develop in stages.

Exhibit G
High Country Engineering Roadway Analysis Letter



October 24, 2023

Mark Chain
Mark Chain Consulting LLC
Town of Silt

Re: Rislende PUD Preliminary Plan Revision– Town of Silt, Garfield County, Colorado
HCE Project No. 2211047.01

Dear Mark:

The proposed modification to the road system of the Rislende project does not have any significant impact to the approved project. The approved project had three access points with a potential connection loop of all three access points. The connection is now proposed between two of the three access points and one access is eliminated. The looped internal road was also moved northerly to work with the proposed development entities. Utilities essentially follow the same path as the approved submittal. Drainage will also follow the same paths as the approved submittal but will flow in curb lines instead of a swale. Traffic is reduced to two access points and was reviewed by the traffic engineer to see what modifications may be required by the proposed two access points instead of the three approved access points.

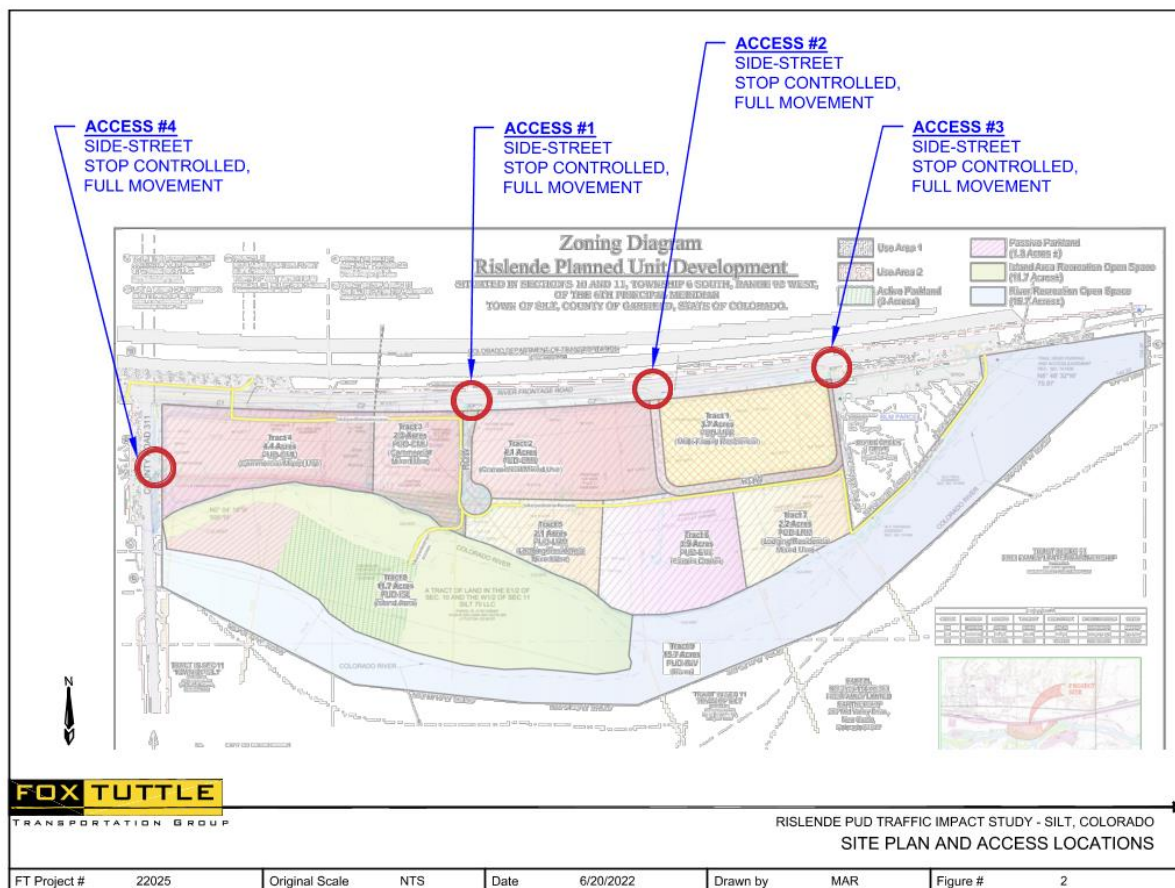
Below are the bullet points of the current approval vs. the proposed modification.

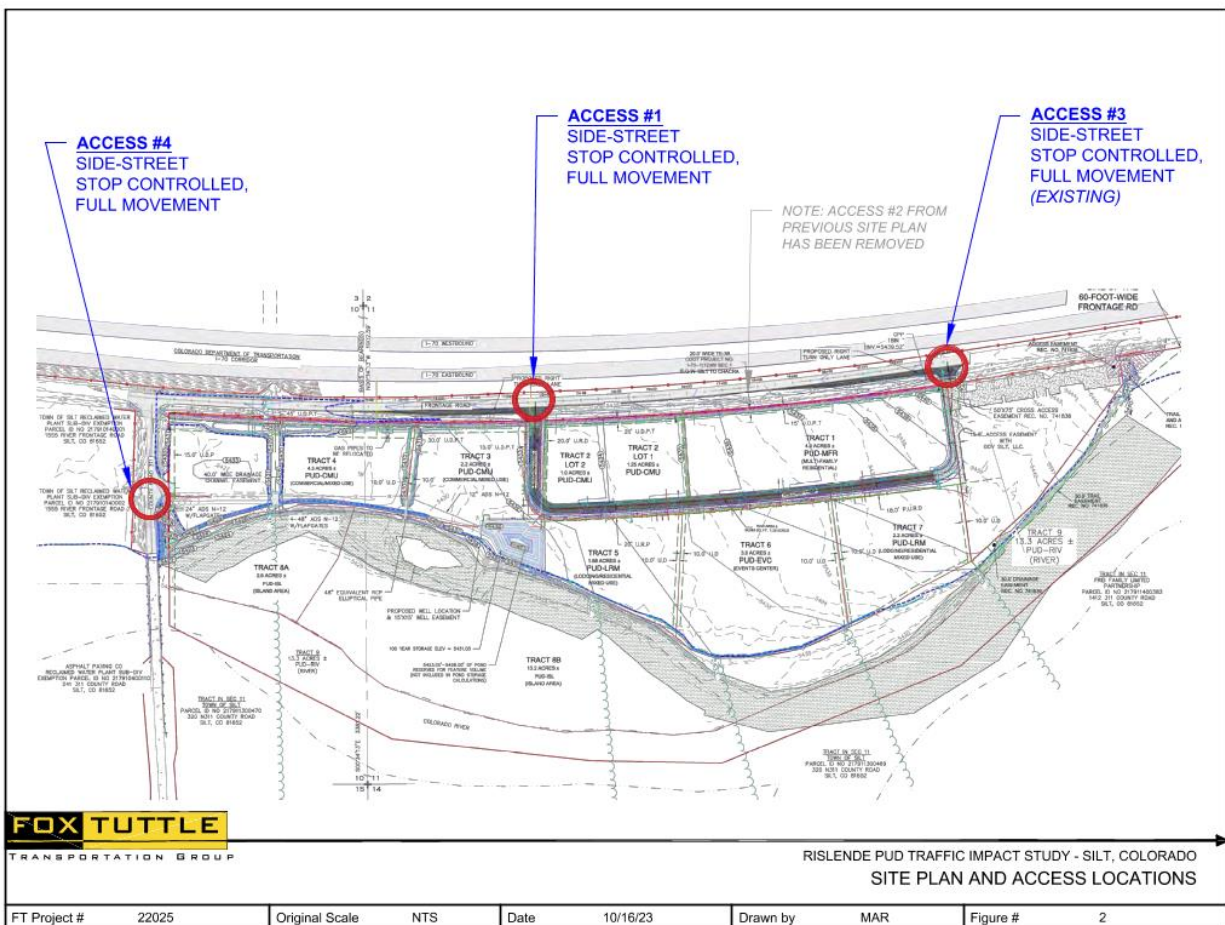
Traffic

- The project, as approved, was estimated to generate approximately 3,425 daily trips with 166 trips in the AM peak hour and 363 trips in the PM peak hour at full build-out of all land uses and tracts.
- The revision, as proposed, is essentially the same estimate to generate approximately 3,472 daily trips with 171 trips in the AM peak hour and 370 trips in the PM peak hour at full build-out of all land uses and tracts.
- For the project, as approved, it was recommended by Fox Tuttle Transportation Group that at River Frontage Road: Construct eastbound right-turn deceleration lane (435' total minimum length, inclusive of a 13.5:1 taper) at all three proposed access points.
- For the revision proposed, it is recommended by Fox Tuttle Transportation Group that at River Frontage Road: Construct eastbound right-turn deceleration lane (435' total minimum length, inclusive of a 13.5:1 taper) at the first and second access points east of CR 311.

- For both options it was determined that the proposed roadway system can adequately accommodate the projected traffic volumes for buildout conditions with planned improvements. The CR 311 access was not impacted.

Exhibits of the previous layout and the proposed layout are shown below with recommendations from the Traffic Engineer.





If you have any questions, please contact me to discuss.

Sincerely,

HIGH COUNTRY ENGINEERING, INC.

Roger Neal, P.E.
Project Manager

RDN/blc



365 River Bend Way • Glenwood Springs, CO 81601 • Tel 970 927 3690 • landstudio2@comcast.net

November 2, 2023

Mr. Mark Chain
Town of Silt Community Development
231 N. 7th Street
Silt, Colorado 81652
mchain@sopris.net

Re: Updated Rislende Major Subdivision Preliminary Plan Amendment

Dear Mark:

The Land Studio, Inc. has been working with representatives of Silt 70 LLC, August Group LLC, DBA Rislende, and its consultant team to prepare the Rislende Major Subdivision Preliminary Plan Amendment per our team discussions with you. The intent of this Application is to update the Preliminary Plat for Garfield County Parcel No. 217911200007. Currently the Preliminary Plat includes 9 Tracts within the 51.13± acre property. The proposed amendment to the Preliminary Plat still includes 9 Tracts with slightly varying acreages from the currently approved Preliminary Plat. The primary change to the Preliminary Plat is the elimination of Rippling Way as an access point into the property and the resulting adjustment to Rislende Loop. The Rislende PUD Approved Preliminary Plat and Rislende PUD Amended Preliminary Plat are both attached as Exhibits. The following matrix illustrates the changes in acreages to each of the tracts and the slight variation in acreages for each of the Rislende PUD zone districts.

Rislende Planned Unit Development							
Approved Preliminary Plan Land Use Summary				Amended Preliminary Plan Land Use Summary			
	Acres		Zoning		Acres		Zoning
Tract 1	3.7	PUD-MFR	Multi-Family Residential	Tract 1	4.0	PUD-MFR	Multi-Family Residential
Tract 2	3.7	PUD-CMU	Commercial/Mixed Use	Tract 2 Lot 1	1.3	PUD-CMU	Commercial/Mixed Use
				Tract 2 Lot 2	1.0	PUD-CMU	Commercial/Mixed Use
Tract 3	2.2	PUD-CMU	Commercial/Mixed Use	Tract 3	2.7	PUD-CMU	Commercial/Mixed Use
Tract 4	4.3	PUD-CMU	Commercial/Mixed Use	Tract 4	4.3	PUD-CMU	Commercial/Mixed Use
Tract 5	1.9	PUD-LRM	Lodging/Residential Mixed Use	Tract 5	2.3	PUD-LRM	Lodging/Residential Mixed Use
Tract 6	3.8	PUD-EVC	Events Center	Tract 6	4.4	PUD-EVC	Events Center
Tract 7	2.2	PUD-LRM	Lodging/Residential Mixed Use	Tract 7	2.6	PUD-LRM	Lodging/Residential Mixed Use
Tract 8	15.8	PUD-ISL	Island Area	Tract 8A	2.6	PUD-ISL	Island Area
				Tract 8B	12.7	PUD-ISL	Island Area
Tract 9	12.2	PUD-RIV	River	Tract 9	12.2	PUD-RIV	River
ROW	1.4			ROW	1.1		
Total	51.1			Total	51.1		
Zoning	Acres			Zoning	Acres		
PUD-MFR	3.7			PUD-MFR	4.0		
PUD-CMU	10.2			PUD-CMU	9.2		
PUD-LRM	4.1			PUD-LRM	4.9		
PUD-EVC	3.8			PUD-EVC	4.4		
PUD-ISL	15.8			PUD-ISL	15.3		
PUD-RIV	12.2			PUD-RIV	12.2		
ROW	1.4			ROW	1.1		
Total	51.1			Total	51.1		

The Town of Silt Ordinance No. 13 Series of 2022 (Reception #980003) established Planned Unit Development Zoning for Annexed land formerly known as Divide Creek Center and now commonly known as Rislende Planned Unit Development. The Town of Silt Resolution No. 16 Series of 2022 (Reception #980004) approved the Second Amended and Restated Annexation and Development Agreement for the Dixon Annexation (formerly known as Divide Creek Center) and now known as Rislende, within the Town of Silt, Garfield County, Colorado. Ordinance 2022-13 and Resolution 2022-16 are attached as Exhibits to this Application. The Town of Silt Resolution No. 16 Series of 2023 approving the Major Subdivision Preliminary Plan for the Rislende PUD is also attached as an Exhibit. The proposed Amended Rislende Major Subdivision Preliminary Plan still conforms to the provisions of Ordinance 13 and Resolution 16 Series of 2022 as approved by the Town of Silt.

Due to the elimination of Rippling Way as an access point to this subdivision, the Rislende PUD Traffic Impact Study prepared by Fox Tuttle Transportation Group, LLC has been updated to reflect this change and is attached as an Exhibit. Additionally, High Country Engineering has provided a brief analysis of the proposed roadway changes and determined that the proposed modification to the road system of the Rislende project does not have any significant impact to the approved project. The High Country Engineering Letter is also attached as an Exhibit.

Rislende Major Subdivision Preliminary Plan Amendment Exhibits

- A. The Rislende PUD Approved Preliminary Plat
- B. The Rislende PUD Amended Preliminary Plat
- C. Town of Silt Ordinance No. 13 Series of 2022
- D. Town of Silt Resolution No. 16 Series of 2022
- E. Town of Silt Resolution No. 16 Series of 2023
- F. Rislende PUD Traffic Impact Study
- G. High Country Engineering Roadway Analysis Letter

We look forward to continued work with you on this project and please email or call with discussion related to this Application as needed.

Sincerely,

THE LAND STUDIO, INC

By:



Douglas J. Gratte

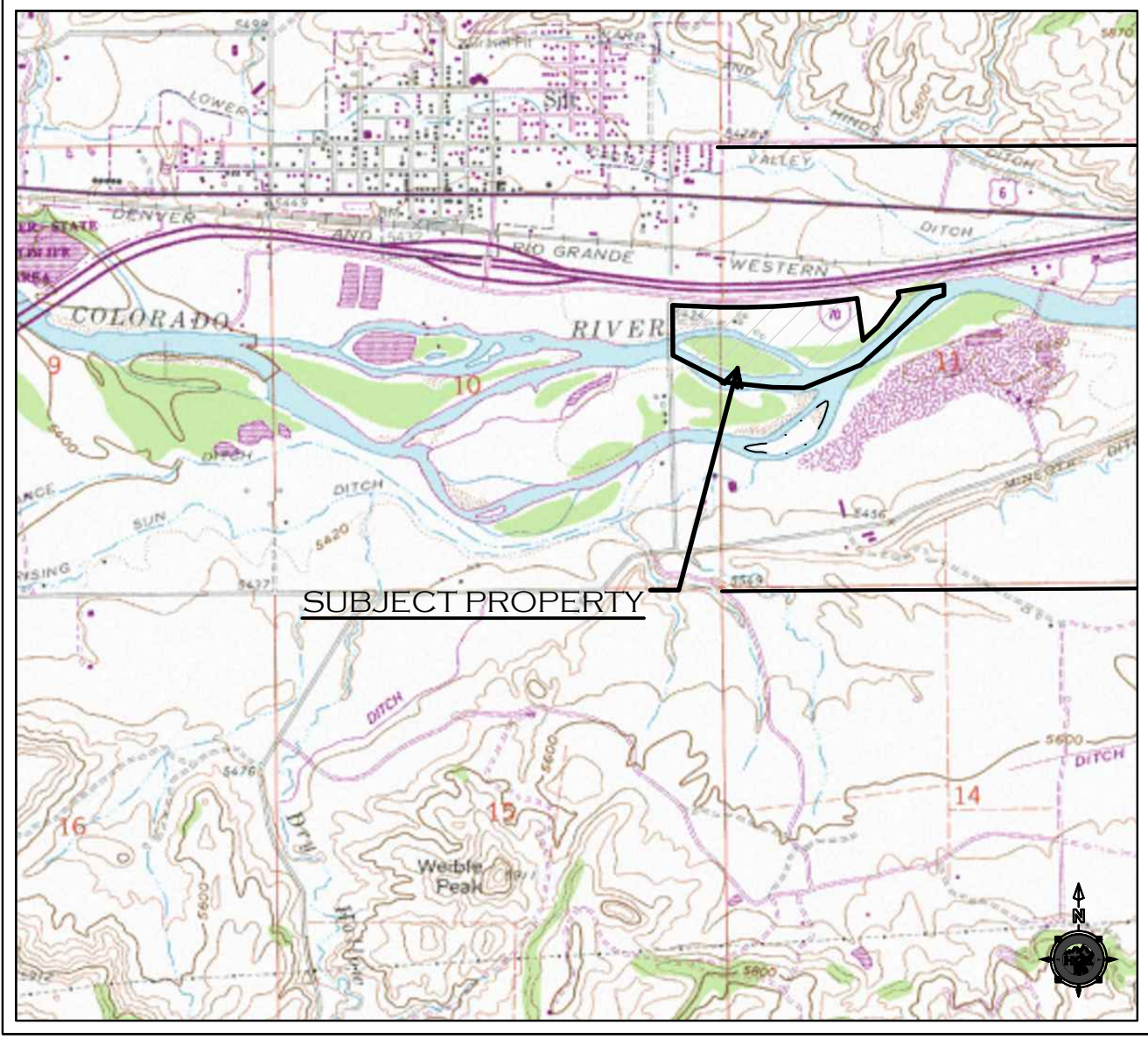
Exhibit A
The Rislende PUD Approved Preliminary Plat

PRELIMINARY PLAT
RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO

PLAT NOTES

1. BASIS OF BEARINGS FOR THIS SURVEY IS A BEARING OF N00°34'13"W BETWEEN A FOUND 3/4in REBAR WITH 3.25in ALUMINUM CAP LS NO. 36572 (40" WITNESS CORNER) NORTHWEST CORNER OF SECTION 11 AND A FOUND 3/4in REBAR WITH 3.25in BRASS CAP LS NO. 19698 (REF POINT) AT THE SOUTHWEST CORNER OF SECTION 10.
2. THIS PLAT IS BASED ON THE BLM EXEMPTION PLAT, RECEPTION NO. 741836 PREPARED BY HIGH COUNTRY ENGINEERING, INC., AND CORNERS FOUND IN PLACE.
3. THIS PROPERTY IS SUBJECT TO RESERVATIONS, RESTRICTIONS AND COVENANTS OF RECORD OR IN PLACE AND EXCEPTIONS TO TITLE SHOWN IN THE TITLE COMMITMENT PREPARED BY LAND TITLE GUARANTEE COMPANY DATED EFFECTIVE NOVEMBER 18, 2022 (ORDER NO. GW63017116-3).
4. DATE OF SURVEY BY HIGH COUNTRY ENGINEERING, INC. WAS SEPTEMBER 2022.
6. AS A CONDITION OF APPROVAL OF THIS PLAT BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, AND TO MEET THE REQUIREMENTS OF THE SILT MUNICIPAL CODE SECTION 16.04.280, AS AMENDED, NO CONSTRUCTION ON THE PUBLIC IMPROVEMENTS WITHIN THE SUBDIVISION AND NO CONVEYANCE OR TRANSFER OF TITLE OF ANY LOT, LOTS, TRACT OR TRACTS OF LAND WITHIN THE SUBDIVISION SHALL BE MADE UNTIL THE TOWN HAS GRANTED A CERTIFICATE OF COMPLIANCE CERTIFYING THAT THE OWNER HAS DEPOSITED AND THE TOWN HAS ACCEPTED MONETARY SECURITY EQUAL TO ONE HUNDRED AND TEN PERCENT (110%) OF THE ESTIMATED COSTS OF COMPLETION FOR THE PUBLIC IMPROVEMENTS WHICH CERTIFICATE OF COMPLIANCE HAS BEEN DULY RECORDED BY THE CLERK AND RECORDER OF GARFIELD COUNTY.
7. UNDERGROUND OR ABOVE GROUND UTILITY INFRASTRUCTURE SHALL BE MAINTAINED BY THE RESPECTIVE UTILITY OR RESPONSIBLE PARTY, DRAINAGE, TRAIL, AND ROAD FACILITIES LOCATED IN TOWN EASEMENTS SHALL BE MAINTAINED BY THE TOWN.
8. THIS PROPERTY IS SUBJECT TO, WITHOUT LIMITATION, THE MASTER DECLARATION OF COVENANTS, CONDITIONS AND RESTRICTIONS FOR RISLENDE P.U.D. AS RECORDED IN THE RECORDS OF THE GARFIELD COUNTY CLERK AND RECORDERS OFFICE AT RECEPTION NUMBER _____.
9. WETLANDS IN RISLENDE PUD WERE DELINEATED BY BIRCH ECOLOGY, LLC AND DAVID BUSCHER A CERTIFIED SOIL SCIENTIST ON MAY 16, 2022, WITH CONFIRMATION BY THE U.S. ARMY CORPS OF ENGINEERS NUMBER SPA-2022-00348 DATED DECEMBER 8, 2022.
10. NOXIOUS WEEDS. IT IS THE INDIVIDUAL LOT OWNER'S RESPONSIBILITY, ACCORDING TO THE COLORADO NOXIOUS WEED ACT AND THE TOWN OF SILT ORDINANCES, TO MANAGE ANY NOXIOUS WEEDS ON THE LOT OWNER'S PROPERTY.
12. ALL SIDEWALK, TRAIL AND PEDESTRIAN EASEMENTS ARE FOR NON-MOTORIZED USE BY THE PUBLIC, WITH THE EXCEPTION OF EMERGENCY USE AND/OR MAINTENANCE PURPOSES.



VICINITY MAP
SCALE: 1" = 2000'

LEGEND

- U = UTILITY EASEMENT
- D = DRAINAGE EASEMENT
- A = ACCESS EASEMENT
- R = ROAD MAINTENANCE EASEMENT
- P = PEDESTRIAN ACCESS EASEMENT
- T = TRAIL ACCESS EASEMENT
- SQ. FT. = SQUARE FEET

LAND USE SUMMARY

TRACT #	ACRES	ADDRESS	LAND USE
TRACT 1	3.7	0001 RIVER FRONTAGE ROAD	PUD-MFR (MULTI-FAMILY RESIDENTIAL)
TRACT 2	3.8	0002 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 3	2.2	0003 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 4	4.3	0004 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 5	2.0	0005 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 6	3.9	0001 RISLENDE LOOP	PUD-EVC (EVENTS CENTER)
TRACT 7	2.2	0002 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 8	15.8		PUD-ISL (ISLAND AREA)
TRACT 9	12.2		PUD-RIV (RIVER)
TRACT 10	0.2	RIPPLING WAY	
TRACT 11	0.7	RISLENDE LOOP	
TOTAL	51.1		

TITLE INSURANCE COMPANY OR ATTORNEYS CERTIFICATE

_____ DOES HEREBY CERTIFY THAT _____ HAS EXAMINED THE TITLE TO ALL LANDS HEREIN DEDICATED AND SHOWN UPON THIS PLAT AND TITLE TO SUCH LAND IS IN THE DEDICATOR FREE AND CLEAR OF ALL LIENS, TAXES AND ENCUMBRANCES, EXCEPT AS FOLLOWS:

Signature and Title _____ Date _____

SURVEYOR'S CERTIFICATE

I, _____ DO HEREBY CERTIFY THAT I AM A REGISTERED LAND SURVEYOR LICENSED UNDER THE LAWS OF THE STATE OF COLORADO, THAT THIS PLAT IS A TRUE, CORRECT AND COMPLETE PLAT OF THE (SUBDIVISION OR CONDOMINIUM PROJECT NAME) AS LAID OUT, PLATTED, DEDICATED AND SHOWN HEREON, THAT SUCH PLAT WAS MADE FROM AN ACCURATE SURVEY OF SAID PROPERTY BY ME OR UNDER MY SUPERVISION AND CORRECTLY SHOWS THE LOCATION AND DIMENSIONS OF THE LOTS, EASEMENTS AND STREETS OF SAID SUBDIVISION AS THE SAME ARE STAKED UPON THE GROUND IN COMPLIANCE WITH APPLICABLE REGULATIONS GOVERNING THE SUBDIVISION OF LAND.

BILL W.A. BAKER, COLORADO PROFESSIONAL LAND SURVEYOR #23875
CERTIFIED FEDERAL SURVEYOR #1699

UTILITY COMPANIES CERTIFICATE

BY THE SIGNING OF THIS PLAT, EACH UTILITY COMPANY AGREES AND ACKNOWLEDGES ANY AND ALL ACCESS AND UTILITY EASEMENTS DEDICATED TO THE TOWN AND EACH UTILITY COMPANY HEREBY WARRANTS THAT NO ABOVE GROUND VAULT, SPLICE BOX, TRANSFORMER, PEDESTAL OR OTHER ABOVE GROUND OR BELOW GROUND FACILITY WILL DIMINISH OR ALTER TOWN EASEMENTS.

CENTURYLINK

XCEL ENERGY

COMCAST CABLE

CLERK AND RECORDER'S CERTIFICATE

THIS PLAT WAS FILED FOR RECORD IN THE OFFICE OF THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO, AT _____ O'CLOCK _____ M., THIS _____ DAY OF _____, 20_____, IN BOOK _____, AT PAGE _____, RECEPTION NO. _____.

BOARD OF TRUSTEES CERTIFICATE

THIS PLAT APPROVED BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, COLORADO THIS _____ DAY OF _____, A.D. 20_____, FOR FILING WITH THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO AND FOR CONVEYANCE TO THE TOWN OF SILT FOR THE PUBLIC DEDICATIONS SHOWN HEREON, SUBJECT TO THE PROVISION THAT APPROVAL IN NO WAY OBLIGATES THE TOWN OF SILT FOR FINANCING OR CONSTRUCTION OF IMPROVEMENTS ON LANDS, STREETS OR EASEMENTS DEDICATED TO THE PUBLIC EXCEPT AS SPECIFICALLY AGREED TO BY THE BOARD OF TRUSTEES AND FURTHER THAT SAID APPROVAL SHALL IN NO WAY OBLIGATE THE TOWN OF SILT FOR MAINTENANCE OF STREETS AND UTILITIES DEDICATED TO THE PUBLIC UNTIL CONSTRUCTION OF IMPROVEMENTS THEREON HAVE BEEN COMPLETED TO THE SATISFACTION OF THE BOARD OF TRUSTEES, AND THE APPLICABLE WARRANTY PERIOD HAS ENDED.

TOWN OF SILT

BY: _____
MAYOR

WITNESS MY HAND AND SEAL OF THE TOWN OF SILT, COLORADO

ATTEST: _____
TOWN CLERK

CERTIFICATE OF DEDICATION AND OWNERSHIP

KNOW ALL MEN BY THESE PRESENTS THAT SILT 70 LLC, BEING SOLE OWNER IN FEE SIMPLE OF ALL THAT REAL PROPERTY DESCRIBED AS FOLLOWS: A TRACT OF LAND SITUATED IN THE EAST HALF OF SECTION 10 AND THE WEST HALF OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 89 WEST OF THE SIXTH PRINCIPAL MERIDIAN, COUNTY OF GARFIELD, STATE OF COLORADO, TO WIT:

A TRACT OF LAND SITUATED IN THE EAST HALF OF SECTION 10 AND THE WEST HALF OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 89 WEST OF THE SIXTH PRINCIPAL MERIDIAN, COUNTY OF GARFIELD, STATE OF COLORADO, TO WIT:

COMMENCING AT THE NORTHWEST CORNER OF THE SAID SECTION 11, MONUMENTED S 00°00'42" W, 40.00 FEET BY A FOUND 3/4IN. IRON PIN WITH 3.25IN. ALLOY CAP MARKED "WC" LS 36572; THENCE, ALONG THE WESTERLY BOUNDARY LINE OF THE NORTHWEST QUARTER OF THE SAID SECTION 11, WITH ALL BEARINGS CONTAINED HEREIN RELATIVE THERETO, S 00°34'13" E, A DISTANCE OF 1902.59 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE 60-FOOT-WIDE FRONTAGE ROAD ADJOINING INTERSTATE HIGHWAY 170, AS DELINEATED ON THAT COLORADO DEPARTMENT OF HIGHWAYS RIGHT-OF-WAY MAP OF THE FEDERAL AID PROJECT NO. 1-70-1(12)89SEC. 1 & 1-70-1(12)89 SEC. 2 (SHEET 14), DATED 24 APRIL, 1972, FROM WHENCE THE SOUTHWEST CORNER OF THE SAID SECTION 11 BEARS S 00°34'13" E, 3381.22 FEET DISTANT, THE SAID CORNER MONUMENTED BY A FOUND 2.5IN. IRON PIPE WITH 3IN. BRASS CAP MARKED GARFIELD COUNTY SURVEYOR (1972), THE SAID POINT OF INTERSECTION OF THE SAID WESTERLY BOUNDARY LINE OF THE SAID SECTION 11 AND THE SOUTHERLY RIGHT-OF-WAY OF THE SAID FRONTAGE ROAD IS REFERENCED 0.41 FEET NORTH AND 0.51 FEET WEST BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710, THE SAID POINT OF INTERSECTION BEING THE TRUE POINT OF BEGINNING;

THENCE, ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, 1650.44 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS N 88°16'44" E, 1648.58 FEET) TO THE NORTHWEST CORNER OF THAT TRACT OF LAND DESCRIBED IN THAT INSTRUMENT RECORDED UNDER RECEPTION NUMBER 871298 IN THE PUBLIC RECORDS OF THE SAID COUNTY, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE SAID SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD AND ALONG THE WESTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), S 07°56'11" E, A DISTANCE OF 504.89 FEET TO THE SOUTHWEST CORNER THEREOF, THE SAID CORNER MONUMENTED N 07°56'11" W, 20.00 FEET DISTANT BY A SET 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 47°27'23" E, A DISTANCE OF 246.25 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 36°34'25" E, A DISTANCE OF 415.01 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 08°48'32" W, A DISTANCE OF 76.53 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, N 81°10'10" E, A DISTANCE OF 550.81 FEET TO ITS INTERSECTION WITH THE EASTERLY BOUNDARY LINE OF THE NORTHEAST QUARTER OF THE SAID SECTION 11, FROM WHENCE THE NORTH QUARTER CORNER THEREOF BEARS N 00°02'50" E, 1647.82 FEET DISTANT, THE SAID QUARTER CORNER THEREOF BEING MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875, THE SAID POINT OF INTERSECTION BEING MONUMENTED N 00°02'50" E, 39.08 FEET DISTANT BY A FOUND 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID NORTHWEST QUARTER OF THE SAID SECTION 11, S 00°02'50" W, A DISTANCE OF 124.98 FEET TO THE CENTERLINE OF THE COLORADO RIVER FROM WHENCE THE SOUTH QUARTER CORNER OF THE SAID SECTION 11 BEARS S 00°02'50" W, 3504.03 FEET DISTANT, THE SAID QUARTER CORNER MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE CENTERLINE OF THE COLORADO RIVER THE FOLLOWING SEVEN (7) COURSES:

1. S 71°19'19" W, A DISTANCE OF 144.81 FEET;
2. S 46°55'17" W, A DISTANCE OF 664.55 FEET;
3. S 48°11'32" W, A DISTANCE OF 491.93 FEET;
4. S 67°52'01" W, A DISTANCE OF 731.09 FEET;
5. N 88°54'33" W, A DISTANCE OF 370.16 FEET;
6. N 83°50'18" W, A DISTANCE OF 563.90 FEET;
7. N 63°04'31" W, A DISTANCE OF 705.68 FEET TO A POINT ON THE SOUTHERLY EXTENSION OF THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, THE SAID POINT MONUMENTED N 00°04'28" W, 237.15 FEET DISTANT BY A SET 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, N 00°04'28" W, A DISTANCE OF 598.19 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 497.51 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 11634.21 FEET, (LONG CHORD BEARS S 87°24'24" E, 497.47 FEET) TO A POINT OF COMPOUND CURVATURE, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP (ILLEGIBLE);

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 54.45 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS S 88°51'03" E, 54.45 FEET) TO THE POINT OF BEGINNING.

THE SAID TRACT OF LAND IS COMPRISED OF 2,227,694 SQUARE FEET, (51.14 ACRES), MORE OR LESS.

HAVE BY THESE PRESENTS LAID OUT, PLATTED AND SUBDIVIDED THE SAME INTO TRACTS, AS SHOWN HEREON AND DESIGNATE THE SAME AS RISLENDE PLANNED UNIT DEVELOPMENT, IN THE TOWN OF SILT, COUNTY OF COLORADO, AND DO HEREBY GRANT TO THE TOWN OF SILT, COLORADO, FOR PUBLIC USE THE STREETS SHOWN HEREON INCLUDING LOOPS, DRIVES AND LANES, THE PUBLIC LANDS SHOWN HEREON FOR THEIR INDICATED PUBLIC USE, IF ANY, AND THE UTILITY AND DRAINAGE EASEMENTS SHOWN HEREON FOR UTILITY AND DRAINAGE PURPOSES ONLY; TRAIL AND PEDESTRIAN EASEMENTS SHOWN HEREON FOR PEDESTRIAN AND TRAIL PURPOSES; AND DO FURTHER STATE THAT THIS PUD SHALL BE SUBJECT TO THE PROTECTIVE COVENANTS FILED AND RECORDED FOR THIS PUD IN THE OFFICE OF THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO AS RECEPTION NO. _____.

EXECUTED THIS _____ DAY OF _____, A.D., 20_____.

OWNER SILT 70 LLC

STATE OF COLORADO)

COUNTY OF GARFIELD) §§

THE FOREGOING CERTIFICATE OF DEDICATION AND OWNERSHIP WAS ACKNOWLEDGED BEFORE ME THIS _____ DAY OF _____, A.D., 20_____, BY _____.

MY COMMISSION EXPIRES: _____

WITNESS MY HAND AND SEAL _____
NOTARY PUBLIC

NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.

S- 10-11
T- 6S
R- 92W
C- GARFIELD

REVISION	BY	DATE	NO.

DRAWN BY: DMC	CHECKED BY: BB
DATE: 01/30/2023	FILE: RISLENDEPUD

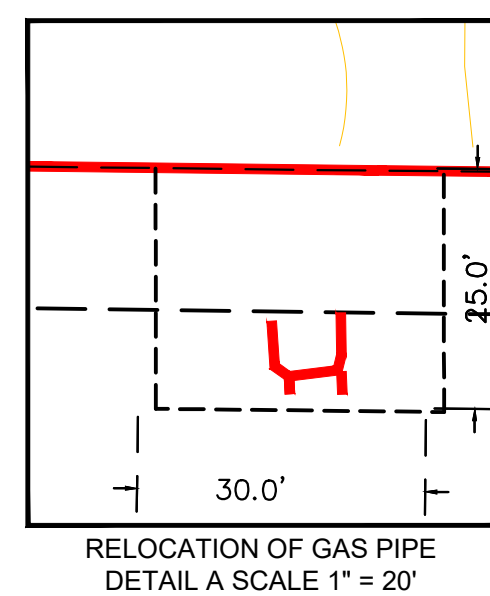
HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101,
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-8676 FAX (970) 945-2555
WWW.HCENG.COM



SILT 70 LLC,
RISLENDE PLANNED UNIT DEVELOPMENT
TOWN OF SILT,
GARFIELD COUNTY
COLORADO

PROJECT NO.
2211047

SHEET NUMBER
3

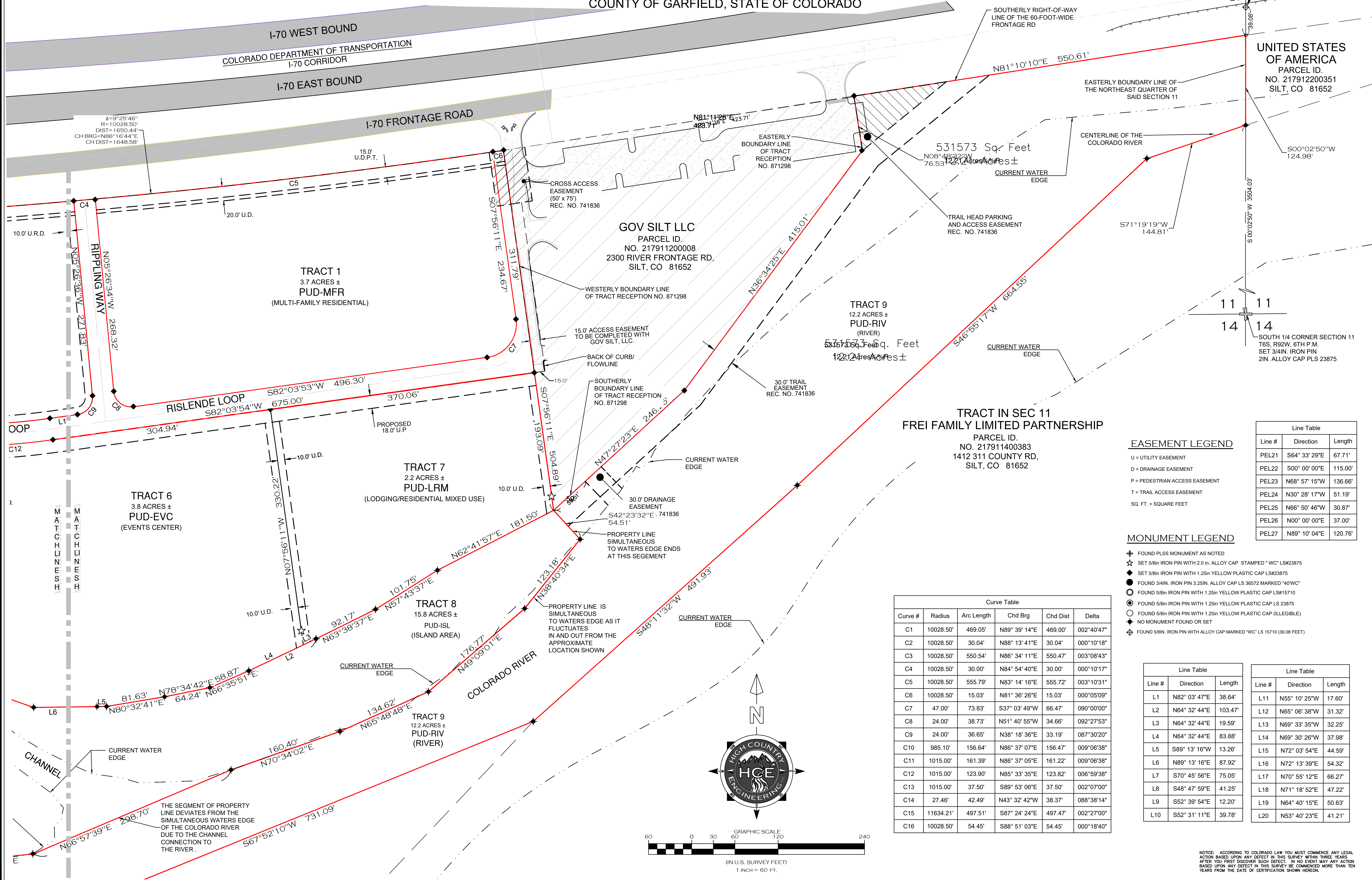


A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO



PRELIMINARY PLAT RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO



EASEMENT LEGEND

U = UTILITY EASEMENT
D = DRAINAGE EASEMENT
P = PEDESTRIAN ACCESS EASEMENT
T = TRAIL ACCESS EASEMENT
SQ. FT. = SQUARE FEET

MONUMENT LEGEND

✚ FOUND PLSS MONUMENT AS NOTED
★ SET 5/8in IRON PIN WITH 2.0 in. ALLOY CAP STAMPED "WC" LS#23875
◆ SET 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP LS#23875
● FOUND 3/4in. IRON PIN 3.25in. ALLOY CAP LS 38572 MARKED "40"WC"
○ FOUND 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP LS#15710
⊙ FOUND 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP LS 23875
○ FOUND 5/8in IRON PIN WITH 1.25in YELLOW PLASTIC CAP (ILLEGIBLE)
◆ NO MONUMENT FOUND OR SET
✚ FOUND 5/8in. IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710 (39.08 FEET)

Line Table		
Line #	Direction	Length
PEL21	S64° 33' 29"E	67.71'
PEL22	S00° 00' 00"E	115.00'
PEL23	N68° 57' 15"W	136.66'
PEL24	N30° 28' 17"W	51.19'
PEL25	N66° 50' 46"W	30.87'
PEL26	N00° 00' 00"E	37.00'
PEL27	N89° 10' 04"E	120.76'

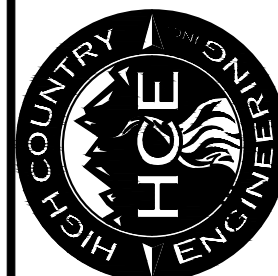
Curve Table					
Curve #	Radius	Arc Length	Chd Brg	Chd Dist	Delta
C1	10028.50'	469.05'	N89° 39' 14"E	469.00'	002°40'47"
C2	10028.50'	30.04'	N88° 13' 41"E	30.04'	000°10'18"
C3	10028.50'	550.54'	N86° 34' 11"E	550.47'	003°08'43"
C4	10028.50'	30.00'	N84° 54' 40"E	30.00'	000°10'17"
C5	10028.50'	555.79'	N83° 14' 16"E	555.72'	003°10'31"
C6	10028.50'	15.03'	N81° 36' 26"E	15.03'	000°05'09"
C7	47.00'	73.83'	S37° 03' 49"W	66.47'	090°00'00"
C8	24.00'	38.73'	N51° 40' 55"W	34.66'	092°27'53"
C9	24.00'	36.65'	N38° 18' 36"E	33.19'	087°30'20"
C10	985.10'	156.64'	N86° 37' 07"E	156.47'	009°06'38"
C11	1015.00'	161.39'	N86° 37' 05"E	161.22'	009°06'38"
C12	1015.00'	123.90'	N85° 33' 35"E	123.82'	006°59'38"
C13	1015.00'	37.50'	S89° 53' 06"E	37.50'	002°07'00"
C14	27.46'	42.49'	N43° 32' 42"W	38.37'	088°38'14"
C15	11634.21'	497.51'	S87° 24' 24"E	497.47'	002°27'00"
C16	10028.50'	54.45'	S88° 51' 03"E	54.45'	000°18'40"

Line Table		
Line #	Direction	Length
L1	N82° 03' 47"E	38.64'
L2	N64° 32' 44"E	103.47'
L3	N64° 32' 44"E	19.59'
L4	N64° 32' 44"E	83.88'
L5	S89° 13' 16"W	13.26'
L6	N89° 13' 16"E	87.92'
L7	S70° 45' 56"E	75.05'
L8	S48° 47' 59"E	41.25'
L9	S52° 39' 54"E	12.20'
L10	S52° 31' 11"E	39.78'

Line Table		
Line #	Direction	Length
L11	N55° 10' 25"W	17.60'
L12	N65° 06' 38"W	31.32'
L13	N69° 33' 35"W	32.25'
L14	N69° 30' 26"W	37.98'
L15	N72° 03' 54"E	44.59'
L16	N72° 13' 39"E	54.32'
L17	N70° 55' 12"E	66.27'
L18	N71° 18' 52"E	47.22'
L19	N64° 40' 15"E	50.63'
L20	N53° 40' 23"E	41.21'

NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.

HIGH COUNTRY ENGINEERING, INC.



SILT 70 LLC,
RISLENDE PLANNED UNIT DEVELOPMENT

TOWN OF SILT,
GARFIELD COUNTY
COLORADO

PROJECT NO.
2211047

SHEET NUMBER
5

BY: S-10-11

REVISION

DATE

NO.

DATE

FILE

DATE

FILE

DATE

FILE

DATE

FILE

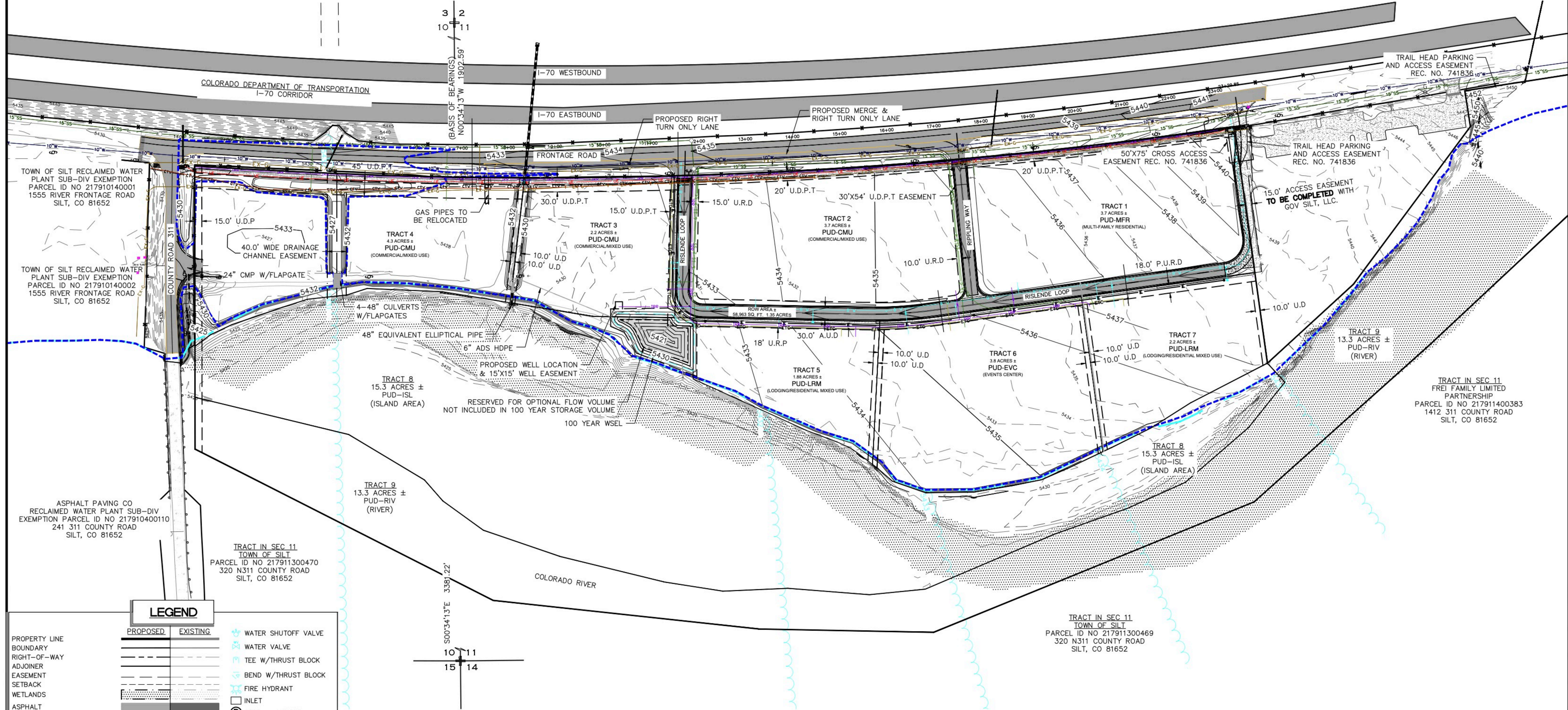
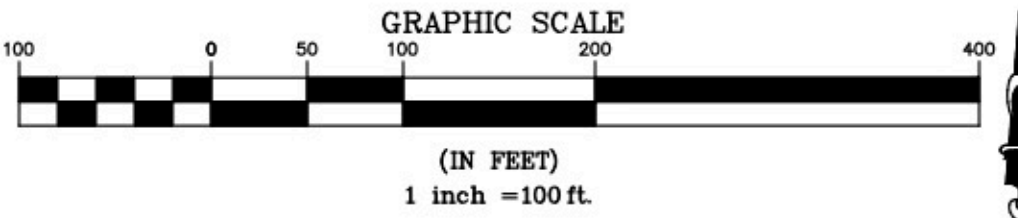
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OVERALL SITE MAP
Rislende Planned Unit Development
Situated in Section's 10 and 11, Township 6 South,
Range 92 West, of the 6TH Principal Meridian
Town of Silt, County of Garfield, State of Colorado.



LEGEND

PROPOSED	EXISTING
PROPERTY LINE	
BOUNDARY	
RIGHT-OF-WAY	
ADJOINER	
EASEMENT	
SETBACK	
WETLANDS	
ASPHALT	
GRAVEL	
CONCRETE	
WETLANDS	
RIPRAP	
CENTERLINE ROAD	
FEMA CROSS SECTIONS	
FLOODWAY	
FLOODPLAIN	
BASE FLOOD ELEVATION	
BASIN BOUNDARY	
PAVEMENT STRIPING	
PROPOSED WATER MAIN	
PROPOSED SEWER MAIN	
PROPOSED IRRIGATION	
UNDERGROUND ELECTRIC	
ELECTRIC, TELEPHONE, CABLE	
PROPOSED GAS	
STORM SEWER	
CONTOUR	
SPOT ELEVATION	
SLOPE OR GRADE	
SEDIMENT CONTROL FENCE	
FLOWLINE	
FENCE	

WATER SHUTOFF VALVE
WATER VALVE
TEE W/THRUST BLOCK
BEND W/THRUST BLOCK
FIRE HYDRANT
INLET
STORM MANHOLE
SANITARY MANHOLE
SANITARY CLEANOUT
OVERHEAD POWER POLE
STREET LIGHT
SEDIMENT CONTROL LOG
INLET PROTECTION
EROSION CONTROL BLANKET
VEHICLE TRACKING PAD

ABBREVIATIONS:
1. UDPT = UTILITY, DRAINAGE, PEDESTRIAN (SIDEWALK) & TRAIL (BIKE PATH)
2. AUD = ACCESS, UTILITY, & DRAINAGE
3. UD = UTILITY & DRAINAGE
4. URP = UTILITY, ROAD MAINTENANCE, & PEDESTRIAN (SIDEWALK)

BY: _____
REVISION: _____
DATE: _____
NO: _____
DRAWN BY: HCE
CHECKED BY: HCE
DATE: 01/2023
FILE: _____

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101,
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-8676 • FAX (970) 945-2555
WWW.HCENG.COM

SILT 70 LLC
RISLENDE PLANNED UNIT DEVELOPMENT
DIVIDE CREEK CENTER
SITE MAP
GARFIELD COUNTY, COLORADO

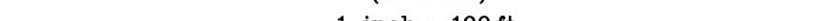
PROJECT NO.
2211047

6

Exhibit B
The Rislende PUD Amended Preliminary Plat

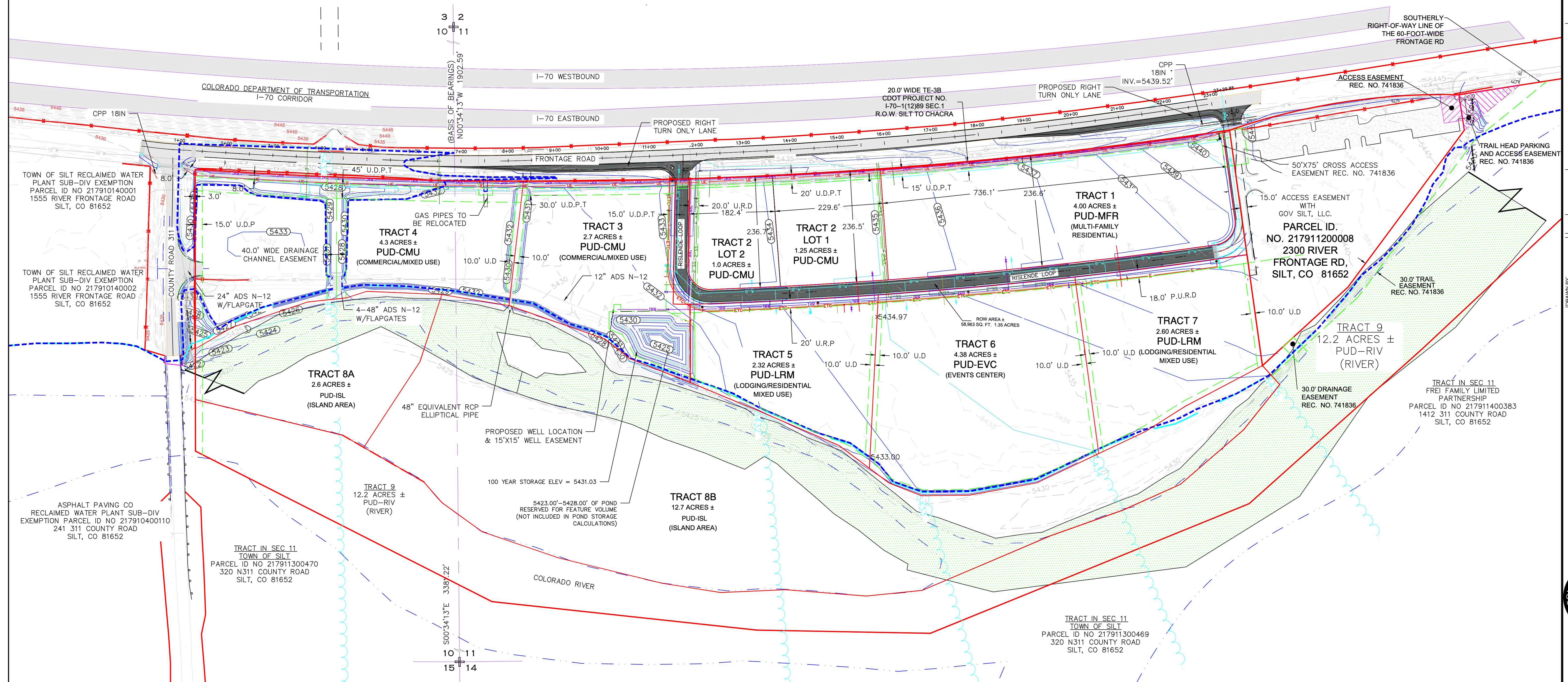
Rislende Planned Unit Development
Situated in Section's 10 and 11, Township 6 South,
Range 92 West, of the 6TH Principal Meridian
Town of Silt, County of Garfield, State of Colorado.

GRAPHIC SCALE




















(IN FEET)
1 inch = 100 ft.

PRELIMINARY
NOT FOR
CONSTRUCTION



SYMBOL LEGEND

	UTILITY POLE/POWER POLE
	SANITARY MANHOLE
	WATER VALVE
	FIRE HYDRANT
	WELL
	WATER MANHOLE
	FIBER OPTIC MARKER
	STREET SIGN
	CATV PEDESTAL
	UTILITY PEDESTAL
	CULVERT/FES/RIPRAP
	STREET SIGN
	SANITARY SEWER MANHOLE
	WATER VALVE
	FIRE HYDRANT
	WATER SHUTOFF
	WATER WFL

LINE LEGEND

BOUNDARY OR LOT LINE

ADJOINER LINE

MAJOR CONTOUR LINE

MINOR CONTOUR LINE

MAJOR CONTOUR LINE

MINOR CONTOUR LINE

PLSS LINE

ASPHALT

CONCRETE

EDGE OF WATER +/-
FLOODWAY LIMITS

GUARD RAIL

WIRE FENCE LINE

EASEMENT

8" SEWER LINE

8" WATER LINE

ELECTRIC / TELEPHONE/ CABLE LINE

IRRIGATION LINE

2" IRRIGATION SERVICE LINE

GAS LINE

FLOODPLAIN

WETLANDS

HCE 100 YR FLOODPLAIN

100 YR WATER SURFACE ELEV.

ABBREVIATIONS:

1. UDPT = UTILITY, DRAINAGE, PEDESTRIAN (SIDEWALK) & TRAIL (BIKE PATH)
2. AUD = ACCESS, UTILITY, & DRAINAGE
3. UD = UTILITY & DRAINAGE
4. URP = UTILITY, ROAD MAINTENANCE, & PEDESTRIAN (SIDEWALK)



COLORADO 811
CALL BEFORE
YOU DIG
 Utility Notification
 Center of Colorado

CHECKED BY:	HCE	NO.	DATE	REVISION	BY
DATE:	HCE				
FILE:	10/2023				

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101,
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-8676 • FAX (970) 945-2555
WWW.HCENG.COM



**RISLENDE
PLANNED UNIT DEVELOPMENT
OVERALL SITE PLAN
GARFIELD COUNTY, COLORADO**

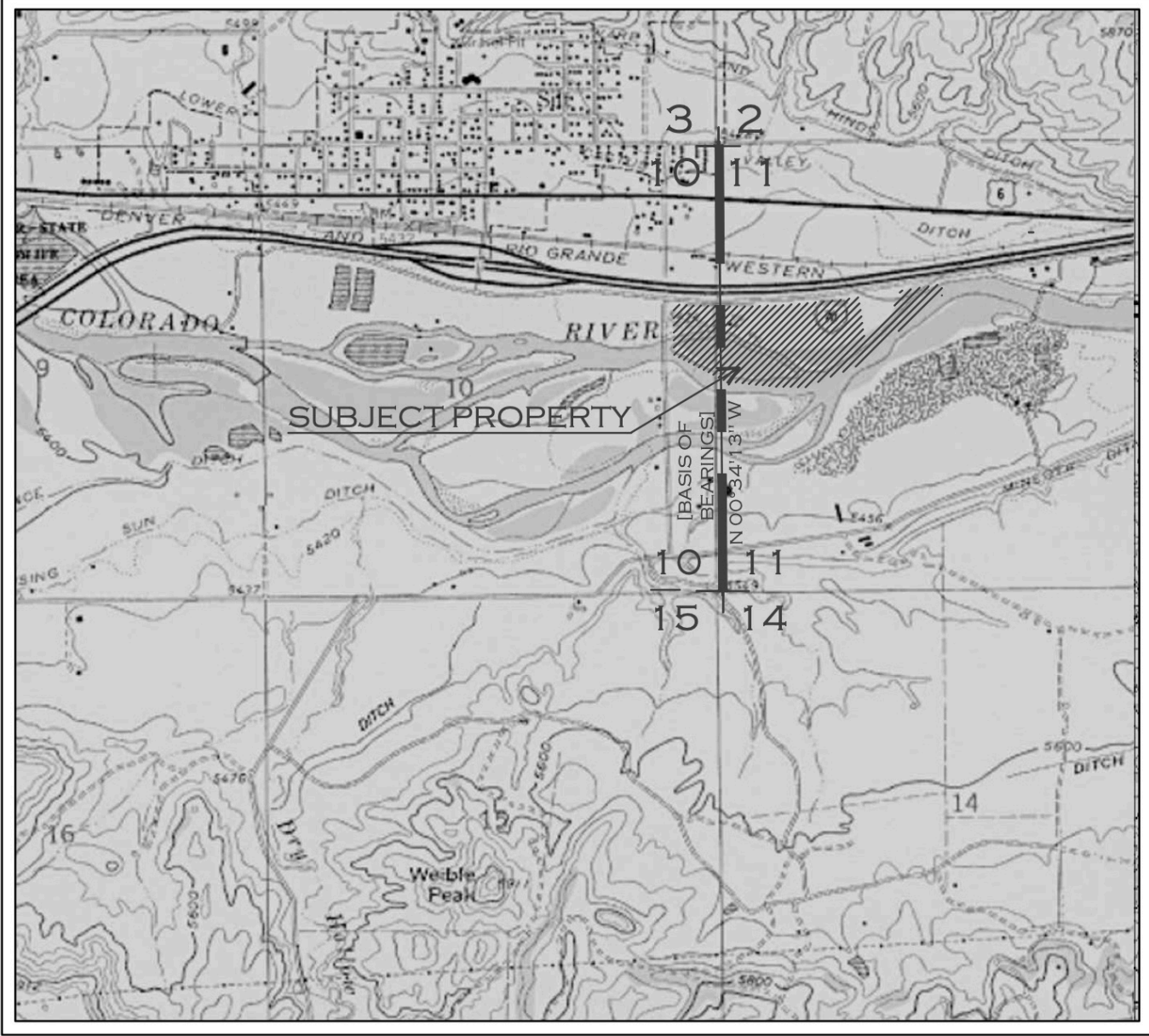
PROJECT NO.
2211047

PRELIMINARY PLAT
RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO

PLAT NOTES

- BASIS OF BEARINGS FOR THIS SURVEY IS A BEARING OF N00°34'13"W BETWEEN A FOUND 3/4in REBAR WITH 3.25in ALUMINUM CAP LS NO. 36572 (40' WITNESS CORNER) NORTHWEST CORNER OF SECTION 11 AND A FOUND 2.5IN. IRON PIPE 3IN. BRASS CAP GARCO (1972) SOUTHWEST CORNER OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 89 WEST OF THE 6TH. PRINCIPAL MERIDIAN.
- THIS PLAT IS BASED ON THE BLM EXEMPTION PLAT, RECEPTION NO. 741836 PREPARED BY HIGH COUNTRY ENGINEERING, INC., AND CORNERS FOUND IN PLACE.
- THIS PROPERTY IS SUBJECT TO RESERVATIONS, RESTRICTIONS AND COVENANTS OF RECORD OR IN PLACE AND EXCEPTIONS TO TITLE SHOWN IN THE TITLE COMMITMENT PREPARED BY LAND TITLE GUARANTEE COMPANY DATED FEBRUARY 06, 2023 (ORDER NO. GW63017116-3).
- DATE OF SURVEY BY HIGH COUNTRY ENGINEERING, INC. WAS SEPTEMBER 2022.
- AS A CONDITION OF APPROVAL OF THIS PLAT BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, AND TO MEET THE REQUIREMENTS OF THE SILT MUNICIPAL CODE SECTION 16.04.280, AS AMENDED, NO CONSTRUCTION ON THE PUBLIC IMPROVEMENTS WITHIN THE SUBDIVISION AND NO CONVEYANCE OR TRANSFER OF TITLE OF ANY LOT, LOTS, TRACT OR TRACTS OF LAND WITHIN THE SUBDIVISION SHALL BE MADE UNTIL THE TOWN HAS GRANTED A CERTIFICATE OF COMPLIANCE. CERTIFYING THAT THE OWNER HAS DEPOSITED AND THE TOWN HAS ACCEPTED MONETARY SECURITY EQUAL TO ONE HUNDRED AND TEN PERCENT (110%) OF THE ESTIMATED COSTS OF COMPLETION FOR THE PUBLIC IMPROVEMENTS WHICH CERTIFICATE OF COMPLIANCE HAS BEEN DULY RECORDED BY THE CLERK AND RECORDER OF GARFIELD COUNTY.
- UNDERGROUND OR ABOVE GROUND UTILITY INFRASTRUCTURE SHALL BE MAINTAINED BY THE RESPECTIVE UTILITY OR RESPONSIBLE PARTY. DRAINAGE, TRAIL, AND ROAD FACILITIES LOCATED IN TOWN EASEMENTS SHALL BE MAINTAINED BY THE TOWN.
- THIS PROPERTY IS SUBJECT TO, WITHOUT LIMITATION, THE MASTER DECLARATION OF COVENANTS, CONDITIONS AND RESTRICTIONS FOR RISLENDE P.U.D. AS RECORDED IN THE RECORDS OF THE GARFIELD COUNTY CLERK AND RECORDERS OFFICE AT RECEPTION NUMBER _____.
- WETLANDS IN RISLENDE PUD WERE DELINEATED BY BIRCH ECOLOGY, LLC AND DAVID BUSCHER A CERTIFIED SOIL SCIENTIST ON MAY 16, 2022, WITH CONFIRMATION BY THE U.S. ARMY CORPS OF ENGINEERS NUMBER SPA-2022-00348 DATED DECEMBER 8, 2022.
- NOXIOUS WEEDS. IT IS THE INDIVIDUAL LOT OWNER'S RESPONSIBILITY, ACCORDING TO THE COLORADO NOXIOUS WEED ACT AND THE TOWN OF SILT ORDINANCES, TO MANAGE ANY NOXIOUS WEEDS ON THE LOT OWNER'S PROPERTY.
- ALL SIDEWALK, TRAIL AND PEDESTRIAN EASEMENTS ARE FOR NON-MOTORIZED USE BY THE PUBLIC, WITH THE EXCEPTION OF EMERGENCY USE AND/OR MAINTENANCE PURPOSES.
- STORMWATER MITIGATION AND POLLUTANT TREATMENT SYSTEMS SHALL BE DESIGNED FOR EACH INDIVIDUAL TRACT AT THE TIME OF SITE PLAN AND/OR BUILDING PERMIT APPLICATION. TREATMENT SHALL COMPLY WITH MILE HIGH FLOOD DISTRICT (AKA URBAN DRAINAGE FLOOD CONTROL DISTRICT) STANDARDS, LATEST EDITION.
- NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.



VICINITY MAP
SCALE: 1" = 2000'

LEGEND

U = UTILITY EASEMENT
D = DRAINAGE EASEMENT
R = ROAD MAINTENANCE EASEMENT
P = PEDESTRIAN ACCESS EASEMENT
A = ACCESS EASEMENT
T = TRAIL ACCESS EASEMENT
SQ. FT. = SQUARE FEET

LAND USE SUMMARY

TRACT #	ACRES	ADDRESS	LAND USE
TRACT 1	4.0	0000 RIVER FRONTAGE ROAD	PUD-MFR (MULTI-FAMILY RESIDENTIAL)
TRACT 2 LOT 1	1.2	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 2 LOT 2	1.0	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 3	2.7	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 4	4.3	0000 RIVER FRONTAGE ROAD	PUD-CMU (COMMERCIAL/MIXED USE)
TRACT 5	2.3	0000 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 6	4.4	0000 RISLENDE LOOP	PUD-EVC (EVENTS CENTER)
TRACT 7	2.6	0000 RISLENDE LOOP	PUD-LRM (LODGING/RESIDENTIAL MIXED USE)
TRACT 8A	2.6		PUD-ISL (ISLAND AREA)
TRACT 8B	12.7		PUD-ISL (ISLAND AREA)
TRACT 9	12.2		PUD-RIV (RIVER)
TRACT 10	1.1		RISLENDE LOOP
TOTAL	51.1		

TITLE INSURANCE COMPANY OR ATTORNEY'S CERTIFICATE

_____, DOES HEREBY CERTIFY THAT _____ HAS EXAMINED THE TITLE TO ALL LANDS HEREIN DEDICATED AND SHOWN UPON THIS PLAT AND TITLE TO SUCH LAND IS IN THE DEDICATOR FREE AND CLEAR OF ALL LIENS, TAXES AND ENCUMBRANCES, EXCEPT AS FOLLOWS:

Signature and Title _____ Date _____

SURVEYOR'S CERTIFICATE

I, _____, DO HEREBY CERTIFY THAT I AM A REGISTERED LAND SURVEYOR LICENSED UNDER THE LAWS OF THE STATE OF COLORADO, THAT THIS PLAT IS A TRUE, CORRECT AND COMPLETE PLAT OF THE (RISLENDE PLANNED UNIT DEVELOPMENT AS Laid OUT, PLATTED, DEDICATED AND SHOWN HEREON, THAT SUCH PLAT WAS MADE FROM AN ACCURATE SURVEY OF SAID PROPERTY BY ME OR UNDER MY SUPERVISION AND CORRECTLY SHOWS THE LOCATION AND DIMENSIONS OF THE LOTS, EASEMENTS AND STREETS OF SAID SUBDIVISION AS THE SAME ARE STAKED UPON THE GROUND IN COMPLIANCE WITH APPLICABLE REGULATIONS GOVERNING THE SUBDIVISION OF LAND.

BILL W.A. BAKER, COLORADO PROFESSIONAL LAND SURVEYOR #23875
CERTIFIED FEDERAL SURVEYOR #1699

UTILITY COMPANIES CERTIFICATE

BY THE SIGNING OF THIS PLAT, EACH UTILITY COMPANY AGREES AND ACKNOWLEDGES ANY AND ALL ACCESS AND UTILITY EASEMENTS DEDICATED TO THE TOWN AND EACH UTILITY COMPANY HEREBY WARRANTS THAT NO ABOVE GROUND VAULT, SPLICE BOX, TRANSFORMER, PEDESTAL OR OTHER ABOVE GROUND OR BELOW GROUND FACILITY WILL DIMINISH OR ALTER TOWN EASEMENTS.

CENTURYLINK

XCEL ENERGY

COMCAST CABLE

CLERK AND RECORDER'S CERTIFICATE

THIS PLAT WAS FILED FOR RECORD IN THE OFFICE OF THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO, AT _____ O'CLOCK _____ M., THIS _____ DAY OF _____, 20_____, IN BOOK _____, AT PAGE _____, RECEPTION NO. _____.

BOARD OF TRUSTEES CERTIFICATE

THIS PLAT APPROVED BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, COLORADO THIS _____ DAY OF _____, A.D. 20_____, FOR FILING WITH THE CLERK AND RECORDER OF GARFIELD COUNTY, COLORADO AND FOR CONVEYANCE TO THE TOWN OF SILT FOR THE PUBLIC DEDICATIONS SHOWN HEREON: SUBJECT TO THE PROVISION THAT APPROVAL IN NO WAY OBLIGATES THE TOWN OF SILT FOR FINANCING OR CONSTRUCTION OF IMPROVEMENTS ON LANDS, STREETS OR EASEMENTS DEDICATED TO THE PUBLIC EXCEPT AS SPECIFICALLY AGREED TO BY THE BOARD OF TRUSTEES AND FURTHER THAT SAID APPROVAL SHALL IN NO WAY OBLIGATE THE TOWN OF SILT FOR MAINTENANCE OF STREETS AND UTILITIES DEDICATED TO THE PUBLIC UNTIL CONSTRUCTION OF IMPROVEMENTS THEREON HAVE BEEN COMPLETED TO THE SATISFACTION OF THE BOARD OF TRUSTEES, AND THE APPLICABLE WARRANTY PERIOD HAS ENDED.

TOWN OF SILT

BY: _____
MAYOR

WITNESS MY HAND AND SEAL OF THE TOWN OF SILT, COLORADO

ATTEST: _____
TOWN CLERK

CERTIFICATE OF DEDICATION AND OWNERSHIP

KNOW ALL MEN BY THESE PRESENTS THAT SILT 70 LLC, BEING SOLE OWNER IN FEE SIMPLE OF ALL THAT REAL PROPERTY DESCRIBED AS FOLLOWS: A TRACT OF LAND SITUATED IN THE EAST HALF OF SECTION 10 AND THE WEST HALF OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST OF THE SIXTH PRINCIPAL MERIDIAN, COUNTY OF GARFIELD, STATE OF COLORADO, TO WIT;

COMMENCING AT THE NORTHWEST CORNER OF THE SAID SECTION 11, MONUMENTED S 00°00'42" W, 40.00 FEET BY A FOUND 3/4IN. IRON PIN WITH 3.25IN. ALLOY CAP MARKED "WC" LS 36572; THENCE, ALONG THE WESTERLY BOUNDARY LINE OF THE NORTHWEST QUARTER OF THE SAID SECTION 11, WITH ALL BEARINGS CONTAINED HEREIN RELATIVE THERETO, S 00°34'13" E, A DISTANCE OF 1902.59 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE 60-FOOT-WIDE FRONTAGE ROAD ADJOINING INTERSTATE HIGHWAY 170, AS DELINEATED ON THAT COLORADO DEPARTMENT OF HIGHWAYS RIGHT-OF-WAY MAP OF THE FEDERAL AID PROJECT NO. I-70-1(12)89SEC. 1 & I-70-1(12)89 SEC 2 (SHEET 14), DATED 24 APRIL, 1972, FROM WHENCE THE SOUTHWEST CORNER OF THE SAID SECTION 11 BEARS S 00°34'13" E, 3381.22 FEET DISTANT, THE SAID CORNER MONUMENTED BY A FOUND 2.5IN. IRON PIPE WITH 3IN. BRASS CAP MARKED GARFIELD COUNTY SURVEYOR (1972), THE SAID POINT OF INTERSECTION OF THE SAID WESTERLY BOUNDARY LINE OF THE SAID SECTION 11 AND THE SOUTHERLY RIGHT-OF-WAY OF THE SAID FRONTAGE ROAD IS REFERENCED 0.41 FEET NORTH AND 0.51 FEET WEST BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710, THE SAID POINT OF INTERSECTION BEING THE TRUE POINT OF BEGINNING;

THENCE, ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, 1650.44 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS N 86°16'44" E, 1648.58 FEET) TO THE NORTHWEST CORNER OF THAT TRACT OF LAND DESCRIBED IN THAT INSTRUMENT RECORDED UNDER RECEPTION NUMBER 871298 IN THE PUBLIC RECORDS OF THE SAID COUNTY, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE SAID SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD AND ALONG THE WESTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), S 07°56'11" E, A DISTANCE OF 504.89 FEET TO THE SOUTHWEST CORNER THEREOF, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 47°27'23" E, A DISTANCE OF 246.25 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHEASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 38°34'25" E, A DISTANCE OF 415.01 FEET, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID TRACT OF LAND (RECEPTION NUMBER 871298), N 08°48'32" W, A DISTANCE OF 76.53 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, THE SAID CORNER MONUMENTED BY A SET 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE SAID FRONTAGE ROAD, N 81°10'10" E, A DISTANCE OF 550.61 FEET TO ITS INTERSECTION WITH THE EASTERLY BOUNDARY LINE OF THE NORTHEAST QUARTER OF THE SAID SECTION 11, FROM WHENCE THE NORTH QUARTER CORNER THEREOF BEARS N 00°02'50" E, 1647.82 FEET DISTANT, THE SAID QUARTER CORNER THEREOF BEING MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875, THE SAID POINT OF INTERSECTION BEING MONUMENTED N 00°02'50" E, 39.08 FEET DISTANT BY A FOUND 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY BOUNDARY LINE OF THE SAID NORTHWEST QUARTER OF THE SAID SECTION 11, S 00°02'50" W, A DISTANCE OF 124.98 FEET TO THE CENTERLINE OF THE COLORADO RIVER FROM WHENCE THE SOUTH QUARTER CORNER OF THE SAID SECTION 11 BEARS S 00°02'50" W, 3504.03 FEET DISTANT, THE SAID QUARTER CORNER MONUMENTED BY A SET 3/4IN. IRON PIN WITH 2.5IN. ALLOY CAP MARKED PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE CENTERLINE OF THE COLORADO RIVER THE FOLLOWING SEVEN (7) COURSES:

- S 71°19'19" W, A DISTANCE OF 144.81 FEET;
- S 46°55'17" W, A DISTANCE OF 664.55 FEET;
- S 48°11'32" W, A DISTANCE OF 491.93 FEET;
- S 67°52'10" W, A DISTANCE OF 731.09 FEET;
- N 88°54'33" W, A DISTANCE OF 370.16 FEET;
- N 83°50'18" W, A DISTANCE OF 563.90 FEET;
- N 63°04'31" W, A DISTANCE OF 705.68 FEET TO A POINT ON THE SOUTHERLY EXTENSION OF THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, THE SAID POINT MONUMENTED N 00°04'28" W, 237.15 FEET DISTANT BY A SET 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" PLS 23875;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE EASTERLY RIGHT-OF-WAY LINE OF GARFIELD COUNTY ROAD NUMBER 311, N 00°04'28" W, A DISTANCE OF 598.19 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP MARKED LS 15710;

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 497.51 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 11634.21 FEET, (LONG CHORD BEARS S 87°24'24" E, 497.47 FEET) TO A POINT OF COMPOUND CURVATURE, THE SAID POINT MONUMENTED BY A FOUND 5/8IN. IRON PIN WITH YELLOW PLASTIC CAP (ILLEGIBLE);

THENCE, DEPARTING FROM THE AFORESAID COURSE AND ALONG THE SOUTHERLY RIGHT-OF-WAY LINE OF THE AFORESAID SAID FRONTAGE ROAD, 54.45 FEET ALONG THE ARC OF A CIRCULAR CURVE, TURNING TO THE LEFT, WHOSE RADIUS IS 10028.50 FEET, (LONG CHORD BEARS S 88°51'03" E, 54.45 FEET) TO THE POINT OF BEGINNING.

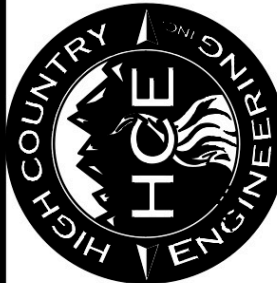
THE SAID TRACT OF LAND IS COMPRISED OF 2,227,694 SQUARE FEET, (51.14 ACRES), MORE OR LESS

S- 10-11
BY
REVISION
T- 6S
R- 92W
C- GARFIELD

NO. DATE

DRAWN BY: DMC
CHECKED BY: BB
DATE: 10/31/2023
FILE: RISLENDEPUD

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-6676 • FAX (970) 945-2555
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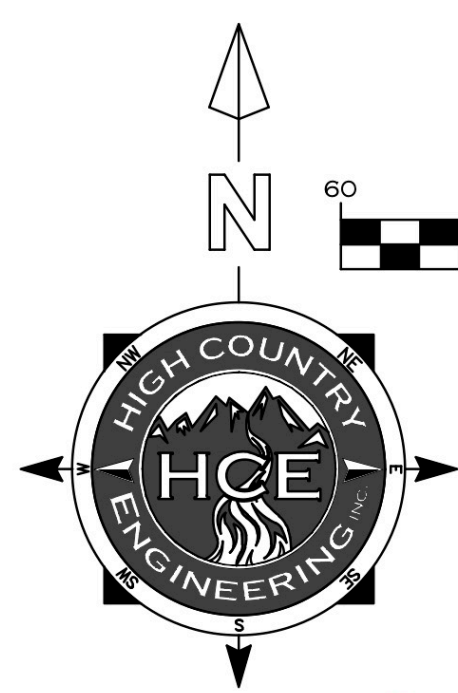


SILT 70 LLC.
RISLENDE
PLANNED UNIT DEVELOPMENT
GARFIELD COUNTY, COLORADO.

PROJECT NO.
2211047

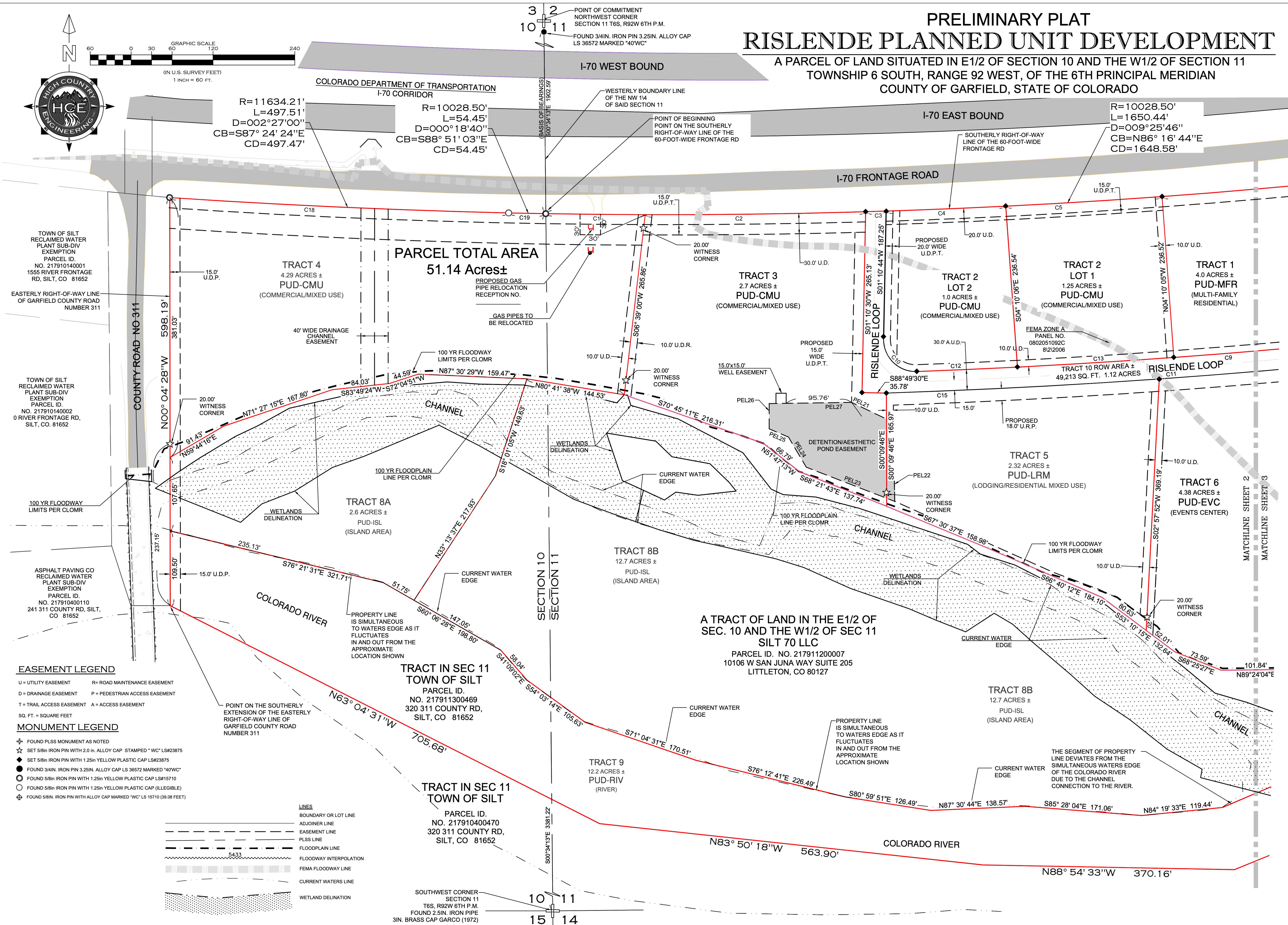
SHEET NUMBER
1

NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF CERTIFICATION SHOWN HEREON.



PRELIMINARY PLAT RISLENDE PLANNED UNIT DEVELOPMENT

A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO



EASEMENT LEGEND

U = UTILITY EASEMENT R = ROAD MAINTENANCE EASEMENT
D = DRAINAGE EASEMENT P = PEDESTRIAN ACCESS EASEMENT
T = TRAIL ACCESS EASEMENT A = ACCESS EASEMENT
SQ. FT. = SQUARE FEET

MONUMENT LEGEND

FOUND PLSS MONUMENT AS NOTED
SET 5/8" IRON PIN WITH 2.0" IN. ALLOY CAP STAMPED "WC" LS#23875
SET 5/8" IRON PIN WITH 1.25" IN. YELLOW PLASTIC CAP LS#23875
FOUND 3/4" IRON PIN 3.25" IN. ALLOY CAP LS 36572 MARKED "40WC"
FOUND 5/8" IRON PIN WITH 1.25" IN. YELLOW PLASTIC CAP LS#15710
FOUND 5/8" IRON PIN WITH 1.25" IN. YELLOW PLASTIC CAP (ILLEGIBLE)
FOUND 5/8" IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710 (39.08 FEET)

LINES

BOUNDARY OR LOT LINE
ADJOINER LINE
EASEMENT LINE
PLSS LINE
FLOODPLAIN LINE
FLOODWAY INTERPOLATION
FEMA FLOODWAY LINE
CURRENT WATERS LINE
WETLAND DELINEATION

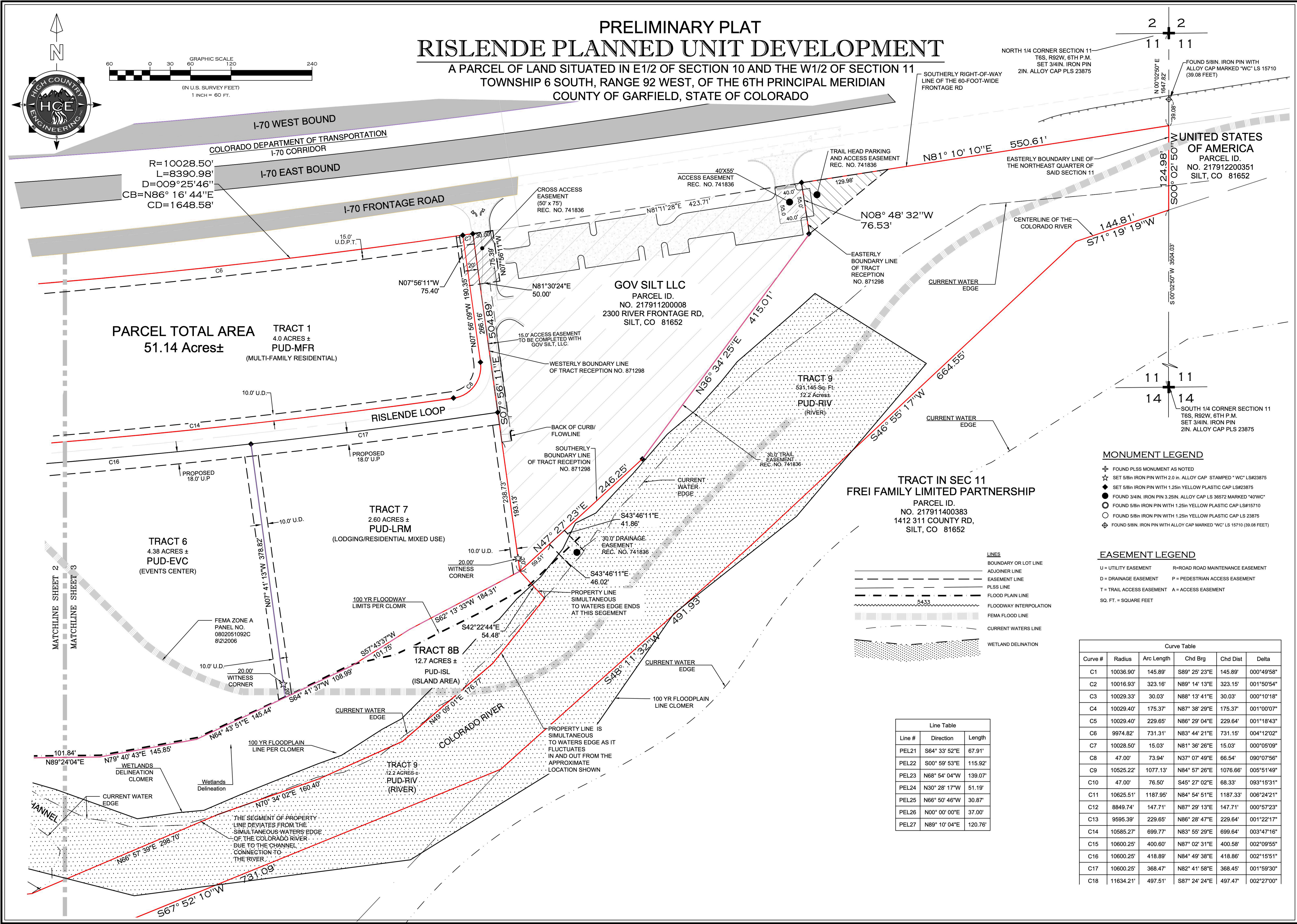
BY	NO.	DATE	REVISION	S- 10-11
BY	NO.	DATE	REVISION	T- 6S
BY	NO.	DATE	REVISION	R- 92W
BY	NO.	DATE	REVISION	C- GARFIELD
DRAWN BY	DMC	CHECKED BY	BB	FILE
DATE	10/31/2023	DATE	10/31/2023	FILE
PROJECT NO.	2211047	SHEET NUMBER	2	

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-6676 • FAX (970) 945-2555
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SILT 70 LLC.
RISLENDE
PLANNED UNIT DEVELOPMENT
GARFIELD COUNTY, COLORADO

PROJECT NO.
2211047

SHEET NUMBER
2



PRELIMINARY PLAT
RISLENDE PLANNED UNIT DEVELOPMENT
A PARCEL OF LAND SITUATED IN E1/2 OF SECTION 10 AND THE W1/2 OF SECTION 11
TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN
COUNTY OF GARFIELD, STATE OF COLORADO

NORTH 1/4 CORNER SECTION 11
T6S, R92W, 6TH P.M.
SET 3/4IN. IRON PIN
2IN. ALLOY CAP PLS 23875

FOUND 5/8IN. IRON PIN WITH
ALLOY CAP MARKED "WC" LS 15710
(39.08 FEET)

UNITED STATES
OF AMERICA
PARCEL ID.
NO. 217912200351
SILT, CO 81652

GOV SILT LLC
PARCEL ID.
NO. 217911200008
2300 RIVER FRONTAGE RD,
SILT, CO 81652

TRACT IN SEC 11
FREI FAMILY LIMITED PARTNERSHIP
PARCEL ID.
NO. 217911400383
1412 311 COUNTY RD,
SILT, CO 81652

- MONUMENT LEGEND**
- ✦ FOUND PLSS MONUMENT AS NOTED
 - ★ SET 5/8IN IRON PIN WITH 2.0 IN. ALLOY CAP STAMPED "WC" LS#23875
 - ☆ SET 5/8IN IRON PIN WITH 1.25IN YELLOW PLASTIC CAP LS#23875
 - FOUND 3/4IN. IRON PIN 3.25IN. ALLOY CAP LS 36572 MARKED "40WC"
 - FOUND 5/8IN IRON PIN WITH 1.25IN YELLOW PLASTIC CAP LS#15710
 - FOUND 5/8IN IRON PIN WITH 1.25IN YELLOW PLASTIC CAP LS 23875
 - ⊕ FOUND 5/8IN. IRON PIN WITH ALLOY CAP MARKED "WC" LS 15710 (39.08 FEET)

- EASEMENT LEGEND**
- U = UTILITY EASEMENT
 - D = DRAINAGE EASEMENT
 - T = TRAIL ACCESS EASEMENT
 - R = ROAD ROAD MAINTENANCE EASEMENT
 - P = PEDESTRIAN ACCESS EASEMENT
 - A = ACCESS EASEMENT
- SQ. FT. = SQUARE FEET

Curve Table					
Curve #	Radius	Arc Length	Chd Brg	Chd Dist	Delta
C1	10036.90'	145.89'	S89° 25' 23"E	145.89'	000°49'58"
C2	10016.93'	323.16'	N89° 14' 13"E	323.15'	001°50'54"
C3	10029.33'	30.03'	N88° 13' 41"E	30.03'	000°10'18"
C4	10029.40'	175.37'	N87° 38' 29"E	175.37'	001°00'07"
C5	10029.40'	229.65'	N86° 29' 04"E	229.64'	001°18'43"
C6	9974.82'	731.31'	N83° 44' 21"E	731.15'	004°12'02"
C7	10028.50'	15.03'	N81° 36' 26"E	15.03'	000°05'09"
C8	47.00'	73.94'	N37° 07' 49"E	66.54'	090°07'56"
C9	10525.22'	1077.13'	N84° 57' 26"E	1076.66'	005°51'49"
C10	47.00'	76.50'	S45° 27' 02"E	68.33'	093°15'31"
C11	10625.51'	1187.95'	N84° 54' 51"E	1187.33'	006°24'21"
C12	8849.74'	147.71'	N87° 29' 13"E	147.71'	000°57'23"
C13	9595.39'	229.65'	N86° 28' 47"E	229.64'	001°22'17"
C14	10585.27'	699.77'	N83° 55' 29"E	699.64'	003°47'16"
C15	10600.25'	400.60'	N87° 02' 31"E	400.58'	002°09'55"
C16	10600.25'	418.89'	N84° 49' 38"E	418.86'	002°15'51"
C17	10600.25'	368.47'	N82° 41' 58"E	368.45'	001°59'30"
C18	11634.21'	497.51'	S87° 24' 24"E	497.47'	002°27'00"

Line Table		
Line #	Direction	Length
PEL21	S64° 33' 52"E	67.91'
PEL22	S00° 59' 53"E	115.92'
PEL23	N68° 54' 04"W	139.07'
PEL24	N30° 28' 17"W	51.19'
PEL25	N66° 50' 46"W	30.87'
PEL26	N00° 00' 00"E	37.00'
PEL27	N89° 10' 04"E	120.76'

DRAWN BY: DMC
CHECKED BY: BB
DATE: 10/31/2023
FILE: A:\221\047 - Divide Creek Center, SILT-Land Coordinates System\Survey\CAD Data\DWG\Rislende PUD.dwg

BY: S- 10-11
T- 6S
R- 92W
C- GARFIELD

NO: DATE: REVISION:

HIGH COUNTRY ENGINEERING, INC.
1517 BLAKE AVENUE, STE 101,
GLENWOOD SPRINGS, CO 81601
PHONE (970) 945-8676 • FAX (970) 945-2555
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SILT 70 LLC.
RISLENDE
PLANNED UNIT DEVELOPMENT
GARFIELD COUNTY, COLORADO.

PROJECT NO.
2211047
SHEET NUMBER
3

Exhibit C
Town of Silt Ordinance No. 13 Series of 2022

**TOWN OF SILT
ORDINANCE NO. 13
SERIES OF 2022**

AN ORDINANCE OF THE TOWN OF SILT, COLORADO, AMENDING ZONING ORDINANCE NO. 9, SERIES OF 2013, AND ESTABLISHING PLANNED UNIT DEVELOPMENT ZONING FOR ANNEXED LAND FORMERLY KNOWN AS DIVIDE CREEK CENTER AND NOW COMMONLY KNOWN AS RISLENDE PLANNED UNIT DEVELOPMENT

WHEREAS, the Local Government Land Use Control Enabling Act of 1974, Section 29-20-101, et seq., C.R.S.; Article 23 of Title 31, C.R.S., and other applicable laws grant broad authority to the Town of Silt, Colorado ("Town") to plan for and regulate the development and use of land on the basis of the impact thereof on the community and surrounding areas; and

WHEREAS, the Town approved Ordinance No. 8, Series of 2007, on July 9, 2007, annexing the Dixon Annexation #1 parcel into the Town; and

WHEREAS, the Town approved Ordinance No. 21, Series of 2007, on July 9, 2007, annexing the Dixon Annexation #2 parcel into the Town; and

WHEREAS, the Town approved Ordinance No. 18, Series of 2007, on July 9, 2007, approving B-2 Highway Business District zoning for the property; and

WHEREAS, the Town approved a subdivision exemption for a portion of the Dixon Annexation property pursuant to Town of Silt Resolution 51-2007 to be used as a government office building and Owner has sold the same to a third-party, which parcel is not affected by this Ordinance; and

WHEREAS, Rislende Planned Unit Development constitutes the Dixon Annexation property, less the property subdivided for a government building, which property is described as Exhibit A and which property is the subject of this Ordinance (referred to as the "Property"); and

WHEREAS, the Town received an application from Applicant on or about August 15, 2013, requesting to amend the Dixon Annexation B-2 Highway Business District zoning; and

WHEREAS, on or about August 15, 2013, Applicant has also submitted a request to amend the Annexation and Development Agreement for the Dixon Annexation, which Agreement was entered into on July 9, 2007, by and between the Estate of Roger McFarland Dixon and the Town of Silt; and

WHEREAS, the Town approved Ordinance No. 9, 2013, on October 14, 2013 approving PUD Zoning for the Divide Creek Center; and

WHEREAS, the Town approved Resolution No.18, Series of 2013 on October 14, 2013 approving an Amended and Restated Annexation and Development Agreement for the Divide Creek Center; and,

WHEREAS, on or about March 4, 2022 August Group LLC applied for a PUD Rezoning and a Sketch Plan for the property now known as the Rislende Planned Unit Development; and

WHEREAS, the Town of Silt Planning and Zoning Commission considered the PUD Rezoning application for the property at duly noticed public meetings on May 3 and May 17, 2022 and reviewed various staff memoranda, and recommended to the Board approval of the Application; and

WHEREAS, the Town of Silt Board of Trustees held duly noticed public hearings on June 27, July 11 and July 25, 2022 where they reviewed various staff reports memoranda related documents; and

WHEREAS, at its August 8, 2022 meeting, the Board determined that the proposed PUD zoning for the Property is consistent and in conformity with the existing pattern of zoning within the Town, with the Town's annexation plan, with the Town's Comprehensive Plan, as amended, and that the proposed zoning will allow the Property to be developed in an efficient and economical manner, as required by the Planned Unit Development Act of 1972 set forth in C.R.S. §24-67-101, et seq.

NOW, THEREFORE, BE IT ORDAINED BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, COLORADO, THAT:

Section 1. Findings of Fact. The Board incorporates the following recitals as findings and determinations, and conclusively makes all of the Findings of Fact, Determinations, and Conclusions contained herein.

Section 2. PUD Approval/Conflicting Provisions of Code. The Property shall be considered, and is hereby zoned, as a Planned Unit Development, and the Zone Districts created by this Ordinance shall be governed in conformity with the regulations and conditions stated herein. The provisions of the ordinances of the town that conflict with the provisions of this ordinance shall not apply to the property except as otherwise noted herein.

Section 3. Zoning Ordinance Applies. Except as he hereinabove provided, all provisions of the zoning, subdivision, and other ordinances of the Town of Silt, Colorado shall be applicable to the property.

Section 4. Planned Unit Development Zoning. The subject property shall be considered, and is hereby zoned, as a planned unit development and the zone districts created by this ordinance shall be governed in conformity with the regulations contained in this ordinance. The PUD regulations are attached as Exhibit B and shall be known as the PUD guide for the Rislende the Property.



Reception#: 980003
10/05/2022 09:42:11 AM Jean Alberico
3 of 16 Rec Fee:\$88.00 Doc Fee:0.00 GARFIELD COUNTY CO

INTRODUCED, READ AND APPROVED on second reading, a public hearing, the 12th day of September, 2022.

TOWN OF SILT


Mayor Keith B. Richel

ATTEST:


Town Clerk Sheila M. McIntyre, CMC



TRACT OF LAND SITUATED IN THE E1/2 OF SECTION 10 AND W1/2 OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST OF THE 6TH P.M., COUNTY OF GARFIELD, STATE OF COLORADO, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHWEST CORNER OF SAID SECTION 11, THENCE S. 00°35'02" E. ALONG THE WESTERLY BOUNDARY OF SAID SECTION 11 A DISTANCE OF 1,901.80 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY BOUNDARY OF INTERSTATE 70, THE POINT OF BEGINNING;

THENCE ALONG SAID SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF 10,028.50 FEET AND A CENTRAL ANGLE OF 09° 25'58", A DISTANCE OF 1,651.00 FEET, (CHORD BEARS N. 86° 18'16" E. A DISTANCE OF 1,649.14 FEET); THENCE LEAVING SAID RIGHT-OF-WAY S. 07°56'11" E. A DISTANCE OF 504.51 FEET; THENCE N. 47°27'23" E. A DISTANCE OF 246.25 FEET; THENCE N. 36°34'25" E. A DISTANCE OF 415.01 FEET; THENCE N. 08°48'32" W. A DISTANCE OF 75.97 FEET TO A POINT ON SAID RIGHT-OF-WAY; THENCE N. 81°11'28" E. ALONG SAID RIGHT-OF-WAY A DISTANCE OF 550.00 FEET TO A POINT ON THE NORTH-SOUTH CENTERLINE OF SAID SECTION 11 (WHENCE A REBAR AND CAP L.S. #15710 BEARS N. 00°02'16" E. A DISTANCE OF 39.95 FEET); THENCE LEAVING SAID RIGHT-OF-WAY S. 00°02'16" W. ALONG SAID NORTH-SOUTH CENTERLINE A DISTANCE OF 124.28 FEET TO A POINT IN THE CENTERLINE OF THE COLORADO RIVER; THENCE LEAVING SAID NORTH-SOUTH CENTERLINE S. 71°19'19" W. ALONG THE CENTERLINE OF THE COLORADO RIVER A DISTANCE OF 144.32 FEET; THENCE CONTINUING ALONG THE CENTERLINE OF THE COLORADO RIVER S. 46°55'17" W. A DISTANCE OF 664.55 FEET; THENCE CONTINUING ALONG SAID CENTERLINE S. 48°11'32" W. A DISTANCE OF 491.93 FEET; THENCE CONTINUING ALONG SAID CENTERLINE S. 67°52'10" W. A DISTANCE OF 731.09 FEET; THENCE CONTINUING ALONG SAID CENTERLINE N. 88°54'33" W. A DISTANCE OF 370.16 FEET; THENCE CONTINUING ALONG SAID CENTERLINE N. 83°50'18" W. A DISTANCE OF 563.90 FEET; THENCE CONTINUING ALONG SAID CENTERLINE N. 63°04'31" W. A DISTANCE OF 705.68 FEET TO A POINT ON THE EASTERLY RIGHT-OF-WAY OF COUNTY ROAD NO. 311; THENCE LEAVING SAID CENTERLINE N. 00°04'18" W. ALONG SAID EASTERLY RIGHT-OF-WAY A DISTANCE OF 598.18 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY OF INTERSTATE 70, A REBAR AND CAP L.S. #15710 IN PLACE; THENCE LEAVING SAID EASTERLY RIGHT-OF-WAY ALONG SAID SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF 11,634.21 FEET AND A CENTRAL ANGLE OF 02°27'03" A DISTANCE OF 497.66 FEET (CHORD BEARS S. 87°26'49" E. A DISTANCE OF 497.63 FEET) TO A REBAR AND ILLEGIBLE CAP IN PLACE; THENCE CONTINUING ALONG SAID SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF 10,028.50 FEET AND A CENTRAL ANGLE OF 00°18'24", A DISTANCE OF 53.70 FEET (CHORD BEARS S. 88°49'32" E. A DISTANCE OF 53.70 FEET) TO THE POINT OF BEGINNING.

EXHIBIT A LEGAL DESCRIPTION

A TRACT OF LAND SITUATED IN THE EV/2 OF SECTION 10 AND W1/2 OF SECTION 11. TOWNSHIP & SOUTH, RANGE 9Z WEST OF THE 6TH P. M., COUNTY OF GARFIELD, STATE OF COLORADO, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHWEST CORNER OF SAD SECTION 11. THENCE S. 00 DEGREES 35'02" E. ALONG THE WESTERLY BOUNDARY OF SAID SECTION 11 A DISTANCE OF 1,901.80 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY BOUNDARY OF INTERSTATE 70. THE POINT OF BEGINNING:

THENCE ALONG SAD SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF 10,028.50 FEET AND A CENTRAL ANGLE OF 09 DEGREES 25'58", A DISTANCE OF 1,651.00 FEET, (CHORD BEARS N. 86 DEGREES 18'16" E. A DISTANCE OF 1,649.14 FEET); THENCE LEAVING SAD RIGHT-OF-WAY S. 07 DEGREES 56'11" E. A DISTANCE OF 504.51 FEET; THENCE N. 47 DEGREES 27'23" E. A DISTANCE OF 246.25 FEET; THENCE N. 36 DEGREES 34'25" E. A DISTANCE OF 415.01 FEET; THENCE N. 08 DEGREES 48'32" W. A DISTANCE OF 75.97 FEET TO A POINT ON SAD RIGHT-OF-WAY: THENCE N. 81 DEGREES 11'28" E. ALONG SAD RIGHT-OF-WAY A DISTANCE OF 550.00 FEET TO A POINT ON THE NORTH-SOUTH CENTERLINE OF SAD SECTION 11 (WHENCE A REBAR AND CAP L.S. #15710 BEARS N. 00 DEGREES 02' 16" E. A DISTANCE OF 39.95 FEET); THENCE LEAVING SAID RIGHT-OF-WAY S. 00 DEGREES 02'16" W. ALONG SAID NORTH-SOUTH CENTERLINE A DISTANCE OF 124.28 FEET TO A POINT IN THE CENTERLINE OF THE COLORADO RIVER: THENCE LEAVING SAID NORTH-SOUTH CENTERLINE S. 71 DEGREES 19'19" E. ALONG THE CENTERLINE OF THE COLORADO RIVER A DISTANCE OF 144.32 FEET THENCE CONTINUING ALONG THE CENTERLINE OF THE COLORADO RIVER S. 46 DEGREES 55'17" W. A DISTANCE OF 664.55 FEET; THENCE CONTINUING ALONG SAD CENTERLINE S. 48 DEGREES 11'32" W. A DISTANCE OF 491.93 FEET; THENCE CONTINUING ALONG SAD CENTERLINE S. 67 DEGREES 52'10" W. A DISTANCE OF 731.09 FEET; THENCE CONTINUING ALONG SAD CENTERLINE N. 8 DEGREES 54'33" W. A DISTANCE OF 370.16 FEET; THENCE CONTINUING ALONG SAD CENTERLINE N. 83 DEGREES 50'18" W. A DISTANCE OF 563.90 FEET; THENCE CONTINUING ALONG SAID CENTERLINE N. 63 DEGREES 04'31" W. A DISTANCE OF 705.68 FEET TO A POINT ON THE EASTERLY RIGHT-OF-WAY OF COUNTY ROAD NO: 311; THENCE LEAVING SAD CENTERLINE N. 10 DEGREES 04' 18" W. ALONG SAID EASTERLY RIGHT-OF-WAY A DISTANCE OF 598.18 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY OF INTERSTATE 70, A REBAR AND CAP L.S. #15710 IN PLACE: THENCE LEAVING SAD EASTERLY RIGHT-OF-WAY ALONG SAID SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF

11,634.21 FEET AND A CENTRAL ANGLE OF 02 DEGREES 27'03" A DISTANCE OF 197.66 FEET (CHORD BEARS S. 87 DEGREES 26'49" E. A DISTANCE OF 497.63 FEET) TO A REBAR AND ILLEGIBLE CAP IN PLACE; THENCE CONTINUING ALONG SAD SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF 10,028.50 FEET AND A CENTRAL ANGLE OF 00 DEGREES 18'24", A DISTANCE OF 53.70 FEET (CHORD BEARS S. 85 DEGREES 19'32" E. A DISTANCE OF 53.70 FEET) TO THE POINT OF BEGINNING.



Reception#: 980003
10/05/2022 09:42:11 AM Jean Alberico
5 of 16 Rec Fee:\$88.00 Doc Fee:0.00 GARFIELD COUNTY CO

EXHIBIT B

PUD GUIDE

PUD GUIDE RISLENDE PLANNED UNIT DEVELOPMENT

SECTION 1. PLANNED UNIT DEVELOPMENT ZONE TEXT.

A. PUD OBJECTIVES:

The objectives of the proposed Planned Unit Development are as follows:

1. Develop a high quality, attractive, and economically viable commercial/residential mixed-use center that
 - a. Is complementary to the Town of Silt and the region
 - b. Provides necessary goods and services to the Town of Silt and outlying areas while at the same time provides financial benefits to the Town and employment opportunities for the local population
 - c. Is harmonious with the natural landscape and enhances the scenic qualities of the property
 - d. Provides innovative design that encourages cluster development, creates open space opportunities, protects sensitive areas of the property and respects wildlife habitat and riparian areas
 - e. Is in general conformance with the Comprehensive Plan and conforms to the goals and policies of the Town of Silt
 - f. Provides opportunities for both passive and active parkland activities for residents and visitors
2. Create a residential component to the development that provides housing opportunities for residents of the Town of Silt in close proximity to commercial and recreational land uses
3. Ensure that high quality design standards are planned and implemented throughout the development

B. USE AREAS AND ZONES

The following Use Areas and Zones shall be applied to Rislende:

1. Use Area 1

PUD-CMU (Commercial/Residential Mixed Use). The CMU zone is intended to provide a balance of residences and commercial spaces to support a work-live environment.

PUD-LRM (Lodging/Residential Mixed Use). The LRM zone is intended to provide supporting lodging and accessory buildings for the events center and also allow flexibility for potential single-family riverfront residences.

PUD-EVC (Events Center). The Events Center zone is intended to provide flexible indoor and outdoor spaces for a wide array of events, such as weddings, corporate events, private celebrations, and business conferences.

PUD-ISL (Island Area). The Island Area zone is intended to provide for outdoor leisure uses related to Risende's commercial operations and events.

PUD-RIV (River). The River zone encompasses the portion of the Colorado River within the parcel's boundaries.

2. Use Area 2

PUD-MFR (Multi-Family Residential). The MFR zone is intended to provide for multi-family residences.

C. ZONE REGULATIONS – USE AREA 1

Commercial / Residential Mixed Use (PUD-CMU):

1. Permitted Residential Uses

- a. Multi-family units including but not limited to apartments, rowhouses, townhouses, and condominiums, but excluding mobile homes
 - i. Including those with three or four units per building or upon one lot
 - ii. Including those with five or more units per building or upon one lot
- b. Loft residences (residential units above commercial space)

2. Permitted Commercial Uses

- a. Banks or financial institutions, including title companies, investment companies, or credit unions
- b. Bakeries
- c. Breweries and bottling facilities
- d. Clothing establishments, excluding those establishments requiring outside storage, such as thrift stores
- e. Coffee roasting facilities
- f. Convenience stores, excluding gasoline pumps, but may include a food establishment
- g. Flex Spaces, defined as a building with some combination of office, retail, and light manufacturing/assembly/R&D. (Example: a high-tech carbon sequestration company with spaces to develop, assemble, store, and sell.) Such flex spaces shall contain a minimum of 30% office and/or retail/showroom space
- h. Furniture restoration and/or refinishing facilities, including upholstery
- i. Grocery stores
- j. Health care facilities, including wellness, physical therapy, nutrition and general medical clinics, health clubs, and fitness centers
- k. Liquor stores, taverns, or bars whereby the majority of business is derived from the sale of alcohol
- l. Plant nurseries whose sales are minimum fifty (50) percent retail

- m. Personal service establishments including, but not limited to, barber shops, beauty shops, tanning salons, etc.
- n. Recreational establishments (indoor) including, but not limited to bowling allies and swimming pools
- o. Restaurants, delicatessens, fast food establishments or any establishment providing prepared food, including serving of alcoholic beverages as a secondary sale
- p. Retail establishments where transactions take place on premises, but not requiring open storage

3. Permitted Office Uses

- a. Governmental or non-profit administrative offices, fire stations, police stations, and post offices
- b. Offices for the conduct of professional businesses (e.g., accountant, attorney), including flexible office (co-working) space, and not including home occupations
- c. Scientific (research, testing, or experimental) laboratories

4. Permitted Lodging Uses

- a. Hotels, motels, and lodges, but excluding extended stay facilities

5. Permitted Public/Institutional Uses

- a. Automobile parking lots and structures (public or private), as an accessory use to a business and/or building located on same lot or an adjacent lot and further limited to passenger cars and light trucks and excluding wrecked, inoperable, unlicensed or unsightly vehicles
- b. Child care facilities for ten or more children, when state licensed
- c. Community centers
- d. Theaters, clubs, museums, libraries or other indoor congregational facilities
- e. Parks (public or private), playgrounds and related facilities (e.g., gazebos, picnic facilities and/or restroom facilities)

6. Permitted Agricultural Uses

- a. Agricultural activity and sale of vegetative products grown on premises
- b. Growing and harvesting of pasture grass and hay is permitted as a temporary use while the PUD property is in transition from Agriculture to PUD. Once a portion of the PUD property is developed, agricultural use will be discontinued on that portion of the PUD property. At such time as there exists fewer than two acres of undeveloped property, agricultural use will be discontinued on all of the PUD property without obtaining written consent of the Town.
- c. Plant materials and nursery facilities which may include fenced and screened outdoor storage that does not exceed 2,500 square feet total in the PUD

7. Permitted Accessory Uses

- a. Accessory (customary) buildings and structures, including non-commercial workshops and greenhouses
- b. Beekeeping

8. Land Use Guidelines

- a. Units may be completely residential or completely non-residential, per the permitted uses listed above
- b. Within the PUD, non-residential density shall be limited to 50% of gross square footage (as one example: a 10,000 sf commercial unit must balance with at least 10,000 sf of residential)

Lodging / Residential Mixed-Use (PUD-LRM):

1. Permitted Residential Uses

- a. Single-family dwelling units, but excluding mobile homes ("single-family dwelling unit" means a detached dwelling unit arranged, designed, and intended for occupancy of one (1) family upon one (1) lot, or a unit within a duplex structure)
- b. The single-family residential density shall not be more than 4 units per acre

2. Permitted Public/Institutional Uses

- a. Amphitheaters, gazebos, picnic shelters, public restrooms
- b. Automobile parking lots and structures (public or private), as an accessory use to a business and/or building located on same lot or an adjacent lot and further limited to passenger cars and light trucks and excluding wrecked, inoperable, unlicensed or unsightly vehicles

3. Permitted Lodging Uses

- a. Hotels, motels, and lodges, but excluding extended stay facilities

4. Permitted Accessory Uses

- a. Additional dwelling units, when proposed as secondary to an approved single family residential unit
- b. Accessory (customary) buildings and structures, including non-commercial workshops and greenhouses
- c. Beekeeping

Events Center (PUD-EVC):

1. Permitted Events Uses

- a. Events facilities

2. Public/Institutional Uses

- a. Amphitheaters, gazebos, picnic shelters, public restrooms
- b. Automobile parking lots and structures (public or private), as an accessory use to a business and/or building located on same lot or an adjacent lot and further limited to passenger cars and light trucks and excluding wrecked, inoperable, unlicensed or unsightly vehicles



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3. Permitted Accessory Uses

- a. Accessory (customary) buildings and structures, including non-commercial workshops and greenhouses, but excluding those structures used for residential dwelling purposes

4. Permitted Lodging Uses

- a. Lodges, but excluding extended stay facilities

Island Area (PUD-ISL):

1. The Island Area zone is intended to provide for outdoor leisure and uses related to Rislende's commercial operations and events.
2. The Island Area zone may be improved with open lawn/natural grass areas and general clean-up, but will be otherwise maintained in a natural state. Above-ground non-permanent facilities (such as gazebos, picnic tables, food trucks, portable restrooms, decking, tents, and awnings) or utilities are permitted.
3. The Island Area zone will also support occasional private events such as dinners, celebrations, and performing arts events such as plays or music concerts.
4. The Island Area zone will remain private, with no regular public access, although events facilities and island spaces may be opened to the public for special events and occasions.

River (PUD-RIV):

1. The River zone encompasses the portion of the Colorado River within the parcel's boundaries.
2. Allowed uses within the River zone include fishing and river recreation

D. ZONE REGULATIONS – USE AREA 2

Multi-Family Residential (PUD-MFR):

1. Permitted Residential Uses

- a. Multi-family units including but not limited to apartments, rowhouses, townhouses, condominiums, but excluding mobile homes
 - i. Including those with three or four units per building or upon one lot
 - ii. Including those with five or more units per building or upon one lot
 - iii. Not more than 72 units total within the Use Area
 - iv. The multifamily density shall be not less than twelve (12) units per acre and not more than 20 units per acre.

2. Permitted Commercial Uses

- a. Accessory (customary) buildings and structures, including non-commercial workshops, bicycle storage and repair, mail delivery, and greenhouses
- b. Automobile parking lots and structures (public or private), as an accessory use to a business and/or building located on same lot or an adjacent lot and further limited to passenger cars and light trucks and excluding wrecked, inoperable, unlicensed or unsightly vehicles

3. Permitted Lodging Uses

- a. Hotels, motels, and lodges, including extended stay facilities

E. FORBIDDEN USES - ALL USE AREAS

All Marijuana land uses including cultivation, sales, processing, and clubs as defined in the Colorado Revised Statutes or the Silt Municipal Code are prohibited.

Section 2. General Development and Dimensional Standards.

The general development standards for Rislende PUD shall be as set forth below. If not otherwise specified in this document, a development standard shall rely upon Silt's Municipal Code for definition.



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A. PUD ZONE STANDARDS

SUMMARY OF DIMENSIONAL STANDARDS				
Item	MFR	LRM	CMU	EVC
Lot Standards				
Lot area, min.	Per Plat	8,500 SF	12,500 ³	Per Plat
Maximum Density Residential	20 units/ac.	4 units/ac.	16 units/ac.	
Maximum Density Lodging		Per Site Plan Review		
Maximum Lot Coverage	70 %	60%	70%	70% ⁴
Maximum density - Commercial			20,000 sf/ac.	20,000 sf/ac.
Setbacks, Minimum ⁵				
Front	20 ft.	20 ft.	20 ft.	20 ft.
Side	5 ft.	0 ft.	10 ft.	0 ft.
Rear	20 ft.	0 ft. ¹	10 ft.	10 ft.
Building Standards				
Height, Maximum, Principal bldg..	35 ft.	25 ft. ²	40 ft.	40 ft.
Minimum distance between structures	10 ft.	Per site plan Review	10 ft.	10 ft.
Minimum Unit Size (residential)	450 SF	800 sf	450 SF	
Minimum unit size (Lodging)		400 sf		
Maximum Building Size			30,000 SF	30,000 SF ⁴
Notes:				
1. Rear yard setback is 0 feet for both primary and/or accessory structure 2. Height may be 35 feet if there is upper-level residential or entire building is lodging facility 3. does not govern subdivision of the building and to convey able units upon subdivision/condominium approval. Such a lot may be smaller 4. Or as modified through Site Plan Review 5. Generally, multi-family residential, commercial building and event center buildings are measured from perimeter of overall parcel, not from between structures.				



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B. MINIMUM SETBACKS

1. From Frontage Road – building setback of 30 feet, parking setback of 15 feet, or as modified by site plan approval
2. From County Road 311 – building setback of 20 feet, parking setback of 10 feet, or as modified by site plan approval

C. OPEN SPACE / PARKLAND

1. The Rislende PUD Zone shall provide open space and/or parkland in an amount of at least twenty-five percent (25%) of the total project acreage to serve the project's residents and/or occupants.

D. LANDSCAPING

1. Minimum landscaped area as a percentage of total disturbed lot area shall be 18%, or as modified by site plan approval

SECTION 3. PARKING STANDARDS

A. Dimensional Standards

1. Dimensional standards for individual parking spaces shall be as provided in Title 17 of the Silt Municipal Code.

B. Off-Street Parking Requirements

Uses	Required Parking
<u>Residential</u>	
Studio Unit	1.0/unit
1 bedroom unit	1.0/unit
2 bedroom unit	2.0/unit
3 bedroom or more	2.0/unit
<u>Lodging</u>	
Lodge/motel/hotel	1.0/rental unit
<u>Events</u>	
Event facility	1.0/200 SF - GFA



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Commercial/Public

Commercial	1.0/200 SF – GFA
Office	1.0/400 SF – GFA
Public/Institutional	1.0/400 SF – GFA

Other

miscellaneous/not defined	Per Town Code
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SECTION 4. SITE PLAN REVIEW PROCESS

A. Intent.

All new construction for commercial and multifamily development will go through the Site Plan Review Process defined by Chapter 17.42 of the Silt Municipal Code, as amended. For this PUD, the Site Plan Review Process will be identical to that defined in the Silt, Colorado Municipal Code with the exception that there shall be an additional public hearing in front of the Board of Trustees as the final decision-making body. This process is noted below.

B. Process.

1. Pre-application conference with Town Staff
2. Submittal of Site Plan Review application per requirements outlined in the Silt, Colorado Municipal Code, as amended
3. Public hearing in front of the Planning Commission
4. Public hearing in front of the Board of Trustees

C. Uses Subject to Site Plan Review Process

Permitted uses requiring a site plan review - All new construction for commercial and multifamily (defined as three or more units within one building or upon one lot) permitted uses as described in this PUD require a site plan review per Application and Review requirements in the Silt, Colorado Municipal Code.

D. Items that can be modified as part of the Site Plan Review Process



Lot Coverage or maximum building size in the PUD – EVC (Events Center)
Zone District

E. Effect on PUD if Site Plan Review Process in Silt, Colorado Municipal Code changes

Various Design criteria for multifamily residential and commercial structures as contained in Chapter 17.42 of the Silt, Colorado Municipal Code, as amended shall apply to the Rislende PUD unless they specifically conflict with standards contained in this PUD guide. If the town eliminates these Site Plan Review Process from its zoning and land use code, the site plan review process in effect at the time of the elimination shall govern any required site plan reviews in the future.

Section 5. Definitions

Lot Coverage - The portion of a lot that is covered or occupied by buildings and structures. Lot coverage does not include areas such as driveways, parking, or walkways; nor does it include cantilever construction so long as the cantilever construction is at least 8 feet above the ground.

Section 6. Environmental Standards.

As part of the Rislende PUD approval process, the applicant/developer has conducted a wetlands delineation, Colorado River floodplain evaluation, and wildlife inventory and obtained all permits and approvals required by the Town of Silt, the U.S. Army Corps of Engineers, FEMA, and other governmental authorities.

All development in Rislende shall be conducted with awareness of the surrounding environment and with attention to Best Management Practices, sustainability, and conservation of water and other natural and manmade resources.

Section 7. Zone District Maps.

By the adoption of this Ordinance, the Town has brought the Property under the Town's zoning ordinance and, by the adoption of this Ordinance, has authorized the amendment of the Town's zone district maps to include the Property. The Town's zone district maps are currently on file at the Silt Town Hall, in accordance with the Colorado Revised Statutes.

Section 8. Conflict with Provisions of Title 16 And 17 of The Silt, Colorado Municipal Code

The provisions of this approved PUD shall govern the development of the Rislende of property. If there are any conflicts with the provisions of Title 16 and 17 of the

Municipal Code the PUD standards shall supersede. If the PUD does not address certain items in Title 16 and 17 of the municipal code, provisions of the Municipal Code shall apply.

Exhibit D
Town of Silt Resolution No. 16 Series of 2022

**TOWN OF SILT
RESOLUTION NO. 16
SERIES OF 2022**

A RESOLUTION OF THE TOWN OF SILT, COLORADO APPROVING THE SECOND AMENDED AND RESTATED ANNEXATION AND DEVELOPMENT AGREEMENT FOR THE DIXON ANNEXATION (FORMERLY KNOWN AS DIVIDE CREEK CENTER) AND NOW KNOWN AS RISLENDE, WITHIN THE TOWN OF SILT, GARFIELD COUNTY, STATE OF COLORADO

WHEREAS, The Board of Trustees ("Board") previously adopted Resolution 18 Series 2013 approving an Amended and Restated Annexation and Development Agreement for Land Formally Known as the Dixon Annexations 1 & 2, which was recorded in the public records of Garfield County at Reception No. 842785 ("ARADA"); and

WHEREAS, the owner of the property comprising the Dixon Annexations 1 & 2 (the "Property") has applied to the Town to amend the PUD zoning for the Property; and

WHEREAS, amendment of the PUD requires that various provisions in the ARADA be amended; and

WHEREAS, the Town and the owner of the Property desire to enter into a Second Amended and Restated Annexation and Development Agreement for the Dixon Annexation (Formerly Known as Divide Creek Center) and Now Known as Rislende ("Second ARADA").

NOW, THEREFORE BE IT RESOLVED BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, COLORADO, THAT:

1. The Second Amended and Restated Annexation and Development Agreement for the Dixon Annexation (Formerly Known as Divide Creek Center) and Now Known as Rislende, a copy of which is attached hereto as **Exhibit A** and incorporated herein by reference, is approved; and
2. The Mayor and Town Clerk are authorized to sign the Second ARADA on behalf of the Town and directs the Town Clerk to record such Amendment upon full execution.
3. The Second ARADA shall control matters involving the annexation and development of the Property and shall supersede the original ARADA.

4. In the event that the Board of Trustees does not approve on second reading the amendment to the PUD zoning for the Property, the Second ARADA shall be null and void.

INTRODUCED, READ AND APPROVED at a regular meeting of the Board of Trustees of the Town of Silt, Colorado held on the 22nd day of August, 2022.

ATTEST:


Town Clerk Sheila M. McIntyre, CMC

TOWN OF SILT

Mayor Keith B. Richel



SECOND AMENDED AND RESTATED ANNEXATION AND DEVELOPMENT AGREEMENT FOR THE DIXON ANNEXATION (FORMERLY KNOWN AS DIVIDE CREEK CENTER) AND NOW KNOWN AS RISLENDE

THIS SECOND AMENDED AND RESTATED ANNEXATION AND DEVELOPMENT AGREEMENT ("Agreement") is made and entered into this 12 day of SEPTEMBER 2022, by and between the TOWN OF SILT, COLORADO, a Colorado municipal corporation (hereinafter the "Town"), and SILT 70 LLC, a Colorado limited liability company (formerly known as Stillwater Commercial LLC, a Colorado limited liability company) (hereinafter "Owner");

WITNESSETH

WHEREAS, on or about October 14, 2013, the Town Board of Trustees ("Board") approved Town of Silt Ordinance No. 9, Series of 2013 Ordinance was recorded in the Public Records of Garfield County on November 4, 2013 as Reception No. 842784 approving PUD Zoning and the Amended and Restated Annexation and Development Agreement for Divide Creek Center for approximately 51 acres of land located east of Road 311 and between the Colorado River and Interstate 70 hereinafter known as the "Property"; and

WHEREAS, on or about February 22, 2022, the Owner submitted an application to the Town to change the zoning on the Property from Planned Unit Development to Amended Planned Unit Development; and

WHEREAS, ON OR ABOUT February 22, 2022, the Owner submitted an application to the Town to amend and restate the Amended and Restated Annexation and Development Agreement; and

WHEREAS, the Town and Owner desire to enter into this Agreement to set forth their agreements in writing concerning the terms and conditions of annexation of the Property to the Town,

NOW, THEREFORE, for and in consideration of the mutual promises and covenants contained herein, and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Town and Owner agree as follows:

SECOND AMENDED AND RESTATED ANNEXATION AGREEMENT

ARTICLE 1.

ANNEXATION OF THE PROPERTY

ARTICLE 1.1 Purpose. The purpose of this Agreement is to fully amend and restate the terms and conditions of the ADA, as amended, and to set forth the terms and conditions for the annexation of the Property to the Town and use of the Property in the Town. Except as expressly provided for herein to the contrary, all conditions herein are in addition to any and all requirements concerning annexation and development contained in the Municipal Code of the Town of Silt (hereinafter "Town Code"), the Town of Silt Subdivision Regulations, the Municipal Annexation Act of 1965, as amended at C.R.S. 831-12-101 et seq., and other applicable laws.

ARTICLE 1.2. Project Name. The name of the project to be developed on the Property (previously known as the Dixon Annexation and as Divide Creek Center) is RISLENDE. The Property may be described herein as the RISLENDE PUD. Current and future applications, requests, and approvals for development and

construction on the Property shall refer to RISLENDE.

ARTICLE 1.3 Annexation Affirmed. The parties affirm the effect of Town of Silt Ordinance Nos. 8 and 21, Series 2007 that annexed the Property to the Town of Silt.

ARTICLE 1.4 De-Annexation. The provisions of this Agreement, as well as acceptable Town zoning of the Property, are material considerations of Owner's agreement to annex the Property to the Town. Therefore, in the event that (a) the Town fails to perform under the terms of this Agreement; (b) Owner is unable to obtain, either before or after annexation proceedings are complete, zoning approval which Owner, in its sole discretion, finds acceptable; or (c) Owner determines, in Owner's sole discretion, that any Impact Fees contemplated under this Agreement or as part of the submission of a site specific land use application with the Town make the development of the Property financially infeasible, Owner and the Town stipulate and agree, pursuant to C.R.S. §31-12-501, that it shall be in the best interest of the Town that the Property be de-annexed from the Town. In such event, the Town agrees to enact an ordinance effecting, and to take all other steps necessary to effect, the de-annexation. The Town further acknowledges and agrees that de-annexation is not prohibited by the Town Code and ordinances, and that the Town will not amend its ordinances to preclude a de-annexation permitted hereunder. If the Property is de-annexed, all land dedicated or otherwise conveyed to the Town prior to de-annexation shall remain within the Town limits and shall remain Town property, unless the Town shall re-convey such property to Owner by written instrument. Conversely, if the Property does not develop as contemplated in this Agreement, or subsequent agreements between the Town and the Owner, its heirs, successors or assigns, and the Town finds that de-annexation is in the Town's best interest, then the Owner shall not object to the Town's processing of a de-annexation ordinance for the property, provided that the Property has not developed with the utilization of water and wastewater services.

ARTICLE 2. CONDITIONS OF DEVELOPMENT

ARTICLE 2.1

Fees.

A. Deferral of Fees. Except as provided otherwise in the Agreement, the assessment of all annexation and development impact fees, including but not limited to Cost Recovery Fees, Construction Impact Fees, and Park and Recreation Impact Fees, (specifically excluding any and all annexation and zoning application fees incurred by the Town as a result of the review of the applications) shall be deferred until such time as Owner obtains approval from the Town for development of the Property in a manner or intensity different from the existing uses of the Property described in this Agreement. For purposes of this Section, development for each lot, tract, parcel, or phase shall be deemed to occur upon issuance by the Town of a building permit on that lot, tract, parcel, or phase. The timing of payment and amount of any such fees shall be determined by that version of the Municipal Code of the Town of Silt, Town of Silt Subdivision Regulations, and other applicable laws in effect at the time of building permit issuance for such lot, tract, parcel, or phase.

B. Construction Impact Fee. Notwithstanding the above provisions of Paragraph 2.1. A, the Construction Impact Fee applicable to the Property shall be payable as follows. First, the Construction Impact Fee shall be based on approximately 21 acres of platted building sites pursuant to final plats thereof. The amount of the Construction Impact Fee per acre shall be determined by the Code and shall be paid at time of issuance of building permit(s).

C. Treated Water and Wastewater System Improvement Fees. Owner shall pay all applicable treated water and wastewater system improvement fees based on the required amount of EQRs for development of the Property at the time of issuance of building permits, per the Code. Except as set forth below, with the permission of the Board, which permission may be granted in the Board's sole discretion, Owner may use potable water for irrigation purposes in such manner consistent with the Municipal Code.

D. Non-Potable Water Irrigation.

- i. Prior to issuance of the first certificate of occupancy in Rislende (excluding the existing governmental office parcel east of the Property), Owner agrees to construct a non-potable irrigation water system in accordance with plans reviewed and approved by the Town of Silt as part of the initial final plat, minor subdivision, or Site Plan review for Rislende. Said non-potable water irrigation system may be completed in phases adequate to serve applicable phased development within the Property.
- ii. Said non-potable irrigation water system shall use as its legal and physical source of supply Silt Well No. 2 as proposed by the Town of Silt in its Application for Adjudication of Water Rights, Change of Water Right, Plan for Augmentation, and for Confirmation of Rights of Appropriative Exchange, Case Number 07CW219, or such alternate legal source of supply, available at the physical location of Silt Well No.2, as the Town may designate from time to time.
- iii. At Owner's option, prior to the issuance of a certificate of occupancy for Tract 1 as indicated on the Rislende PUD plan, Owner shall construct a raw water irrigation system and well for Tract 1 using a new well to be adjudicated by the Town at this location. Pursuant to Article 2.2(H), below, the Town will obtain a water court decree for a well decreed to divert from Tract 1 and include the well in the Town's plan for augmentation, with the costs of obtaining such decree reimbursed by Owner.
- iv. Owner shall be solely responsible for the operation, maintenance, repair, and replacement of the physical infrastructure for the non-potable water system or systems, including the well and pump associated with Silt Well No. 2, which well and pump shall be located and constructed in the central portion of the Rislende project (i.e., near the common corner of Tracts 2, 5 and 6) and any well and pump associated with the irrigation system for Tract 1.
- v. The well or wells shall include a meter capable of measuring the number of gallons pumped from the well. Owner shall provide the Town with monthly meter readings from the well (during the season that the well is in use) on an annual basis, or as otherwise requested by the Town. Owner may assign such operation, maintenance, repair and replacement obligations to a property owners association created to provide services to the Property. In the event Owner fails to maintain a meter and make regular readings, the Town may install and maintain meters, read the meters, or have readings done by a contractor, and Owner shall pay for the Town's costs.
- vi. Owner shall not be required to pay any Town of Silt raw water irrigation impact fee or raw water irrigation capacity development fee. Owner, and Owner's assignees, shall not be required to pay to the Town any fee or assessment for the use of the legal water right and plan for augmentation associated with Silt Well No.2, as decreed in Case No. 07CW219 or a replacement legal water supply as may be designated by the Town.

E. Cost Recovery. Owner may be required to pay to third parties certain cost recovery to connect to existing water and sewer infrastructure. Because the exact number of EQRs of service to the Property will not be known until Site Plan or subdivision review for the various lots, tracts, parcels, and phases in the Rislende PUD, cost recovery for water and sewer connections shall not be due until issuance by the Town of a building permit.

F. Other Fees. Except as expressly provided for herein to the contrary, all conditions herein are in addition

to any and all requirements and fees concerning annexation, development and off-site impacts (including, but not limited to, traffic impacts) contained in the Municipal Code of the Town of Silt (hereinafter "Town Code"), the Town of Silt Subdivision Regulations, the Municipal Annexation Act of 1965, as amended at C.R.S. §31-12-101 et seq., and other applicable laws. The Town may adopt, without limitation, future impact fees, surcharges, special permit fees, special taxes or assessments, development fees, and/or tap fees, so long as such fees and taxes are exacted uniformly and non-discriminately on the Property as exacted throughout the Town. Notwithstanding the foregoing, nothing herein affects or shall affect the Town's ability to exact impact fees for different facilities from certain residents or as to certain geographical areas.

G. Real Estate Taxes. Until such time as the Town approves a site-specific plan for development of the Property, the Town will not object to the Property maintaining its agricultural use designation for purposes of real estate tax appraisal and assessment.

ARTICLE 2.2

Dedication Requirements.

A. Parkland Dedications. Owner acknowledges the Property is subject to Section 16.12.030 of the Code regarding Parkland Dedication for Planned Unit Developments. Owner's Parkland Dedication requirement shall be calculated based upon a maximum buildout of 72 units of multi-family (180 residents), 16 units of single family (56 residents), and 72 units of commercial/residential mixed use (180 residents), which amounts to a requirement of 2.91 acres of total parkland dedication. Under the Town Code, a minimum of 80% of this dedication requirement (2.3 acres) must be for active recreation purposes, including but not limited to ball fields, tennis courts, picnic sites, gazebos, boating areas, skateboard parks, basketball courts, playgrounds, and the like. Up to 20 percent (0.6 acres) shall be for passive recreation, such as open space, environmentally sensitive areas, or floodplain. To satisfy the requirements of the Town Code and this Agreement with regard to parkland dedication, Owner shall comply with the following:

1. Active Parkland Dedication. In partial satisfaction of the active parkland dedication requirement of 2.3 acres, Owner shall dedicate a 15' public, nonexclusive easement for a regional hard-surface trail along the route depicted in Exhibit A to the Town at the time of recordation of the first final plat, minor subdivision, or Site Plan for the Property, whichever occurs first. The public trail on this easement shall be installed by Owner, pursuant to Section 2.2(G.1) below. This public trail easement shall satisfy 1.4 acres of Owner's active parkland dedication requirement. Owner shall dedicate 0.9 additional acres of active parkland as identified through the design review process for commercial and multifamily structures ("Site Plan") or the subdivision of residential lots, tracts, or parcels. Owner may satisfy up to 50% of this obligation (0.45 acres) through cash-in-lieu payments to the Town, calculated pursuant to Code Sections 16.04.530 through 16.04.550, due at the time of Site Plan review or final subdivision plat for residential lots, tracts, or parcels. Each Site Plan containing residential development that is reviewed and approved by the Town pursuant to this agreement shall contain some amount of dedicated active parkland that counts towards the satisfaction of the 0.9-acre active parkland requirement and no individual Site Plan shall be permitted to satisfy the active parkland requirement only through a cash-in-lieu payment.

2. Passive Parkland Dedication. In full satisfaction of Owner's passive parkland dedication requirement of 0.6 acres, Owner shall convey to the Town Tract 9 generally depicted on Exhibit A as the "River Parcel" (amounting to approximately 12.3 acres of land under the Colorado River) at the time of recordation of the first final plat, minor subdivision, or Site Plan for the Property, whichever occurs first. Nothing herein shall be interpreted as a public dedication of any other portion of the Property, including the shoreline or bed of the river under Tracts 3-7, which shall

remain privately owned.

3. Future Island Disposition. If a zone change is ever requested for the 3.9-acre parcel zoned PUD-EVC, indicated as Tract 6 on the PUD plan, then the Town may require a portion or all of the 15.1-acre island area zoned PUD-ISL, indicated as Tract 8 on the PUD plan, to be conveyed and dedicated to the Town as a condition of rezoning.

4. Active Parkland Standards for Residential Uses. Prior to the Town's approval of any Site Plan or subdivision for any lot, tract, or parcel that includes residential uses, Owner shall include plans for active parkland in the Site Plan or subdivision plat to meet the needs of residents, including children. Park equipment shall be paid for installed by Owner as part of Site Plan or subdivision plat approval, as directed by a subdivision or development improvements agreement, and shall include equipment such as a playground, jungle gym, swings, or other active recreational equipment.

B. Water Rights Dedication. The Town acknowledges that a predecessor of Owner has conveyed to the Town the four (4) shares in the Grand River Ditch Company that historically irrigated the Property. Prior to the dedication, a successor of Owner prepared and submitted to the Town a report by Zancanella & Associates dated June 20, 2007, and which describes historical consumptive use associated with irrigation using the four (4) Grand River Ditch shares, lagged return flows, the requirement to obtain a contract for a non-irrigation season water supply, the number of EQRs of municipal water service that can be provided to Owner based upon the dedication of the four (4) Grand River Ditch shares, and a contract for a non-irrigation season water supply. The Town has reviewed the Zancanella report and agrees that it represents an accurate discussion as to the historic consumptive use associated with the four (4) shares in the Grand River Ditch Company.

The Town agrees that Owner shall not be required to initiate and prosecute a water court case to quantify the historic consumptive use associated with Owner's four (4) shares or to change the point of diversion for the water right(s) associated with Owner's four (4) shares.

Town agrees to lease up to three (3) Grand River Ditch shares back to Owner to allow for the continued irrigation of the Property pending development of the Property. The number of shares subject to the lease shall be reevaluated with each final plat, minor subdivision, or Site Plan approved by the Town for the development of the Property. The Town shall continue to lease a proportional number of shares in the Grand River Ditch Company to Owner to allow for the continued irrigation of the Property so long as at least five (5) or more acres of land are potentially irrigable as pasture. In the event that the Property is de-annexed for any reason prior to the recordation of the first final plat, minor subdivision or Site Plan for the property, Town agrees to assign the four (4) shares back to Owner.

Owner shall be entitled to a credit against the Town's Water Rights Dedication requirement for 4.6 acres of raw water irrigation on the Property, together with 213 domestic EQRs. As part of the application for each building permit issued for the Property, Owner shall calculate the number of domestic EQRs to be served in the building(s). The Town shall review and approve Owner's calculation as being consistent with the Code. The Town shall then deduct the number of domestic EQRs from the credit described herein. For any domestic EQRs required for development of the Property in excess of 213 domestic EQRs, Owner, or the applicable site-specific property owner, shall pay the water rights dedication in-lieu fee as provided in the Code. Owner shall have the exclusive right to allocate the domestic EQR credits provided herein amongst the various lots, tracts, in Rislende. It is hereby acknowledged that Owner shall allocate up to 72 domestic EQRs to Use Area 2 (Tract 1) intended for development of multifamily housing. Owner shall allocate up to 0.75 acres of raw water irrigation credit to Tract 1 for the development of multifamily housing.

According to the Zancanella report, the seasonal stream depletion distribution for domestic and irrigation water uses at Rislende will be different than the historical irrigation stream depletion resulting in the need for a reservoir storage contract to replace winter depletions and loss of historical return flows. Resource Engineering determined, in a report dated 2/26/2009 that based upon the estimated irrigation of 4.6 acres and an estimated domestic EQR use of 213 EQRs, Owner is required to dedicate to the Town a reservoir contract in the amount of 14.5-acre feet (including transit losses). Owner and the Town agree that Owner shall pay to the Town an in-lieu fee to compensate the Town for use of a portion of the Reudi Reservoir contract that the Town has obtained. The parties agree that the in-lieu fee for the reservoir contract shall be \$30,010.10, which fee shall increase by 3% per year and be due at recordation of the first final plat, minor subdivision or Site Plan for Rislende.

Upon compliance with the following, Owner shall be deemed to have complied with the Town's Water Rights Dedication Ordinance for all raw water irrigation for the Property, together with 213 domestic EQRs from the Silt Municipal Water System or the non-potable water irrigation system described herein: (a) dedication of the four (4) Grand River Ditch Company shares, (b) payment of the Reudi Reservoir contract in lieu fee described herein and (c) payment of treated water system improvement fees at such time and as provided for in the Code. Use of the EQRs provided for herein shall be consistent with the use restrictions contained in the Silt Municipal Code.

Other Obligations.

C. Flood Study. A predecessor of Owner has commissioned and paid for the preparation of a flood study for the Property. On August 31, 2009, FEMA issued its CLOMR for the Property, a copy of which has been provided to the Town.

D. Drainage Improvements. The Parties acknowledge that they previously agreed to undertake and pay for a portion of certain drainage improvements described in a letter agreement between the Town of Silt and Valley Farms, Inc. (dated August 7, 2001). The Parties subsequently entered into a Drainage Improvement Agreement dated September 25, 2006, and recorded November 17, 2006 at Reception Number 711358 in the records of Garfield County, Colorado, which agreement is incorporated herein by reference as it affects the Property.

The Parties agree that as part of any Site Plan review for the development of Tract 4 as identified in the PUD plan, Owner shall include a plan to construct storm water piping and/or swales to convey offsite drainage through the Property to the Colorado River (the "Tract 4 Drainage Plan"). Upon completion of the work specified in the Tract 4 Drainage Plan, Owner shall have fulfilled its obligations in full under the above referenced September 25, 2006 Drainage Improvement Agreement.

E. Processing and Other Town Fees. All reasonable fees and costs hereto incurred by the Town, including but not limited to reasonable planning, engineering, surveying, and legal services rendered in connection with the review, preparation, negotiation, resolution, and finalization of any annexation, zoning, and PUD or subdivision review of the Property by the Town, including recording fees, costs of legal publication, and any and all other out-of-pocket costs incurred by the Town shall be paid by the Owner. Interest shall be imposed at a rate of 1.5% per month on all balances not paid within thirty (30) days of the date of the statement. In addition to any and all remedies available to the Town and in the event the Town is forced to pursue collection of any amounts due and unpaid under this provision or under this Agreement, the Town shall be entitled to collect reasonable attorney's fees and costs incurred in said collection efforts in addition to the amount due and unpaid, if the Town succeeds in such collection.

Further, any fees that may be required by this Agreement and the Town Code to be paid by Owner shall continue to be an obligation of Owner, or subsequent lot, tract, or parcel owners, even if the Code provisions are declared to be invalid. Payment of such fees pursuant to this Agreement is agreed to by and between the parties as a condition of annexation and, as such, Owner agrees that all such fees, whether in effect in the Town by ordinance or not (if repealed or not in effect, the last fee in effect shall apply and be paid), shall be imposed on them and as a condition of any development review. Owner further agrees not to contest the validity of such fees or any ordinance imposing such fees as they pertain to the Property. This obligation to pay such fees shall be a covenant running with the land and shall bind Owner and any party succeeding to any interest of Owner in and to any part of the Property which has not been granted final plat approval, and to any future lot, tract, or parcel owners.

F. Colorado Department of Transportation Access Permit. As required by CDOT, Owner agrees to apply for and obtain CDOT access permits as applicable for phased development of the Property. It is anticipated that said access permits, and accompanying notice to proceed documents, will specify those traffic mitigation improvements necessary to serve planned development of the Property. The Town hereby consents to be the applicant for CDOT access permit(s) for the Property, provided, however, that Owner shall be responsible to provide all application documents, including maps, cost estimates and traffic studies, and pay all fees and costs associated with obtaining such permits. Owner's intent is to request two access permits from CDOT, which access points are anticipated to occur along the south side of River Frontage Road (1) between Tracts 2 and 3, and (2) between Tracts 1 and 2 as depicted on the Rislende Sketch Plan. If access (differing from what exists today) is ever required for Tract 4, such access would be on the easterly side of County Road 311 to align with the Holiday Inn access to the west.

G. Riparian Revegetation and Trails Improvement

1. Trails. In satisfaction of its obligation to provide public trail planning and construction under this Agreement and the Town Code, Owner shall construct the public trail system in the locations depicted on Exhibit A, including crosswalks, signage, lighting, and similar trail improvements as identified in an engineered trail plan to be submitted and approved as part of the preliminary plat application process. ("Public Trails"). In the event that the Property is developed without subdivision, a non-motorized public trail plan for development of the Public Trails shall be submitted for review and approval by the Town as part of a Site Plan review process prior to issuance of building permits. In either event, the Public Trails shall be specifically designed to connect to the following proposed trails: 1) proposed public trail on the east side of Road 311 which may be developed south over the Colorado River by other parties; 2) north of the property along River Frontage Road to connect through the Interstate-70 underpass, portions of which may be developed by other parties; (3) a loop through the property between Tracts 2 and 3, along the south side of Tracts 1 and 2, and along the east side of Tract 1. All internal streets, trails, pathways, and sidewalks shall remain private except for the Public Trails specifically identified on Exhibit B.

2. Offsite Connector Contribution. Owner shall pay Town an offsite trail connector improvement contribution fee in the amount of \$20,000. This contribution fee shall offset the cost of infrastructure installed by Town or other parties to connect the Public Trails installed by Owner with the existing trail behind the hotel located on the west side of County Road 311. This fee shall be due at the time of Phase I trail construction described below, and in any event no later than the issuance of the first certificate of occupancy for the Property.

3. Phasing of Trails. Owner shall construct each trail in accordance with approved plans at its sole cost and expense in Phases and according to the standards and phasing increments attached as Exhibit C. Phase I shall be the trail along the south side of the frontage road and north of the property running

from the eastern edge of Tract 2 to the western edge of Tract 4 and then running south along the western edge of the property to the Colorado River, to include the connector to the I-70 pedestrian underpass tunnel and the pedestrian crossings over the frontage road and County Road 311. Phase I shall be constructed in accordance with the engineered plans by Owner at Owner's cost prior to the issuance of a certificate of occupancy for any development on Tracts 2, 3, 4, 5, or 6. Phase II shall be the trail south of the frontage road and north of the Property running from the eastern edge of Tract 2 past the BLM parcel and the Colorado River to the eastern boundary of the Property, including the river access trail on the parcel to be dedicated and conveyed to the Town. Phase II shall be constructed by Owner at Owner's cost prior to the issuance of a certificate of occupancy for any development on Tracts 1 or 7. Notwithstanding the deadlines in this section, Phase I and Phase II Public Trails shall be constructed by Owner at Owner's cost no later than five years after the date of execution of this Agreement. As part of the preliminary plan, minor subdivision, or Site Plan submittal for the Property, whichever occurs first, Owner shall submit engineering documents and cost estimates for the trail improvements, and the responsibilities therefore shall be addressed in a Subdivision and Development Improvement Agreement ("SIA"). Completion of the Public Trails discussed herein and approved as part of the review of applicable preliminary plan(s), minor subdivision(s) or Site Plan(s), shall constitute Owner's full compliance with trail planning and construction under this Agreement and the Town Code. The Public Trails in Phase I and Phase II shall be dedicated to the Town upon completion and acceptance thereof by the Town. Internal trails shall be owned and maintained by Owner or any property owner's association established for the Property.

4. Access to River. Owner agrees to provide two access points to the Colorado River, as depicted on Exhibit A, one on the western boundary of the Property (included in Phase I of the Public Trails), and one at the eastern edge of the property, east of the BLM parcel (included in Phase II of the Public Trails).

5. Easements. Owner shall dedicate easements to the Town for public access as follows:

a. Two easements for the river access trails, one for the western access trail (included in Phase I of the Public Trails), and one for the eastern access trail (included in Phase II of the Public Trails).

b. A 15-foot-wide easement for the Public Trails along the northern and western boundary of the Property.

c. An easement of approximately 25 feet by 25 feet at the southwestern corner of the property adjacent to the base of the current bridge over the Colorado River to facilitate a future pedestrian underpass or overpass.

6. Riparian Revegetation. As part of the subdivision process, Owner shall submit a riparian revegetation plan prepared by a wildlife biologist with specific expertise in this area. The Town may allow for a phased implementation of the riparian zone/transition zone revegetation plan as Owner obtains final plat, minor subdivision or Site Plan approval for development on the Property. The SIA shall detail the revegetation requirements and timeline for installation applicable to that portion of the Property.

H. Existing Well, New Well, and Septic. Owner has discontinued domestic use of the existing well and all use of the existing septic system and any associated leach field on the Property. Further, if and when Tract 4 is developed, Owner shall dispose of the septic tank and leach field in accordance with any applicable State or local laws at the time that the portion of the Property where the septic system and leach field are located are developed for a new use or new intensity of use. If and when the Property, other than Tract 1, is developed, Owner shall cap the existing well in accordance with state regulations and drill a new well on the property for the diversion of Silt Well No. 2 for raw water irrigation in accordance with the terms of Article

2.1(D), above. Within 120 days of approval of this Agreement, if directed by Owner, the Town shall apply for a water court decree for a new well on Tract 1 and shall include the well in the Town's plan for augmentation, to facilitate the raw water irrigation system for Tract 1, in accordance with the terms of Article 2.1(D), above.

I. Utility Easement. A successor of Owner has granted an easement contiguous with the common boundary of the Property and the Interstate 70 Frontage Road, ten (10) feet in width, for the limited purpose of placing public utilities approved by the Town. The Town, in its reasonable discretion, may require additional easement(s) upon further platting.

J. Wetlands Delineation. Owner acknowledges that a wetlands delineation report(s) is required for the entire annexed parcel(s) formerly known as Divide Creek Center (now known as Rislende) and subject to this Agreement. As part of any application for subdivision exemption, preliminary plan, or Site Plan review, Owner shall submit to the Town a report prepared by a qualified wetlands consultant, delineating jurisdictional and non-jurisdictional wetlands, if any, on that portion of the Property that is the subject of the application. Further, Owner shall submit to the U.S. Army Corps of Engineers ("Corps") such report(s) and apply for any applicable permits required by the Corps. If a wetlands delineation report was submitted and accepted by the Town as part of an application for subdivision exemption or preliminary plan, for final plat, minor subdivision or Site Plan for all or a portion of the Property, such a report shall be considered for subdivision or Site Plan review if for the same portion of the Property. It is acknowledged that a predecessor of Owner engaged Western Ecological Resources, Inc. of Boulder, Colorado to conduct wetlands delineation studies and reports and to file wetlands permit application to the U.S. Army Corps of Engineers. It is further acknowledged that the U.S. Army Corps of Engineers issued Nationwide General permit number (NWP) 39 dated January 15, 2009 authorizing proposed activity in approximately 0.233 acres of wetlands on the Property.

K. Undergrounding of Utilities. As part of any application for subdivision exemption, preliminary plan or Site Plan review, Owner shall provide plans for the undergrounding of all utilities except for: (1) the existing overhead electric distribution line that serves Coal Ridge High School; and (2) electric transformers and utility pedestals and connecting facilities that are customarily placed above ground in appropriate utility easements.

ARTICLE 2.3. Site Plan Review and Application Requirements

A. Site Plan Review. Prior to the issuance of any building permit on all Rislende parcels, tracts, or lots, all new construction for commercial and/or multifamily uses (defined as three or more units within one building or upon one lot) as described in the Rislende PUD shall require Site Plan review by the Planning Commission and Site Plan approval by the Board of Trustees, regardless of whether the Town Code would otherwise require Site Plan review for such use in any applicable zone district. For each Site Plan required, Owner shall submit a Site Plan that complies with the requirements of Silt Municipal Code Sec. 17.42.055.

ARTICLE 3. DEVELOPMENT OF THE PROPERTY

ARTICLE 3.1 Existing Use of the Property. Owner discloses the following existing uses of the Property, as further described herein, including, but not limited to:

A. Irrigated agricultural lands, including surface irrigation of hay and crop grasses and livestock grazing.

Prior to development, Owner may request, and the Town may consider a storage-type use to support agricultural uses on the Property; provided, however, that Owner proves to the reasonable satisfaction of Town that any such structure is not detrimental to health, life and safety.

B. Town agrees that the uses of the Property described in Section 3.1(A) above are considered allowed uses of the Property even if such uses may be non-conforming under the Town code. Such non-conforming uses may remain as long as such uses are not expanded or replaced with other uses not approved by the Town.

C. Owner agrees that Owner's expanded use or change in the nature or character of the use of the Property, different from the uses described in Section 3.1(A) above, will be subject to all applicable and then existing rules and regulations of the Town. The parties agree that Owner may develop (expand or change the nature or character of use) a portion of the Property independent of developing the entire Property. If Owner develops only a portion of the Property, the uses described in Section 3.1 (A) above may continue, unabated, on the remaining portion(s) of the Property. All future expansion of or use of the Property not described in Section 3.1 (A) above shall be subject to Town regulations, and no approvals of such expansion or use are implied in this Agreement.

D. Prior to such connection to the Town's systems, Owner shall file all necessary applications and pay all required fees (unless otherwise stated in this Agreement) for such connection to Town services and facilities as provided in this Agreement.

E. As part of a final approval for a change in use of the Property, Owner shall be required to connect the Property to the Town's water and sewer systems. Prior to such connection to the Town's system, Owner shall file all necessary applications and pay all required fees (unless otherwise stated in this Agreement) for such connection to Town services and facilities.

F. Owner shall be subject to cost recovery provisions benefiting the RE-2 School District or any other entity for any water or sewer improvements already constructed by the School District that benefit the Property.

ARTICLE 3.2 Zoning and Comprehensive Plan.

A. Simultaneous with approval of this Agreement, Owner is submitting for Town approval PUD zoning for the Property, which PUD zoning modifies currently approved Planned Unit Development zoning.

B. For purposes of complying with the Colorado River Corridor District provisions in the Town's Comprehensive Plan, the Town agrees that the maximum setback shall be as described in the PUD.

ARTICLE 3.3 Issuance of Building Permits.

Prior to the issuance of any building permit for a structure that only contains residential units, Owner shall undertake to subdivide the land that will be used exclusively for residential units from the remainder of the Property. Said subdivision shall be consistent with location of residential-only structures described in the PUD zoning for the Property.

ARTICLE 3.4 Subdivision Improvement Agreements. The Town and Owner agree that phased Subdivision Improvement Agreements or Development Agreements shall be executed at the time of approval of each applicable final plat, minor subdivision or Site Plan for Rislende.

ARTICLE 3.5 Landscaping. Owner agrees to maintain the Property in a neat and orderly manner. Owner

shall regularly remove trash from the Property, conduct appropriate weed maintenance activities, and mow grass or brush areas at least once per year. Upon site-specific development, Owner shall submit a landscaping plan in conformance with the Code for the Town's review and approval.

ARTICLE 3.6 Vested Rights.

A. The Town shall not initiate any zoning or land use action which would alter, impair, prevent, diminish, or impose a moratorium on development, or otherwise unreasonably interfere with any of Owner's rights set forth in this Agreement.

B. Notwithstanding the foregoing, the establishment of vested property rights under this Agreement shall not prevent the Town from enacting and enforcing (i) fees of general applicability as contemplated by Section 2.1, above, and/or (ii) regulations of general applicability (including, but not limited to, building, fire, plumbing, electrical and mechanical codes, including the preliminary plat and final plat subdivision requirements under the Town Code and other Town rules and regulations), except where the approved plans for development of the Property or state or federal regulations provide otherwise, as all of such regulations exist on the date of this Agreement or may be enacted or amended after the date of this Agreement.

C. The term of the vested rights granted under Article 3.6 of this Agreement shall be ten (10) years from recordation date of this Agreement,

ARTICLE 3.7 State and Federal Law.

This Agreement shall not preclude the application to the Property or the proposed project of changes in laws, regulations, plans or policies, to the extent that such changes are specifically mandated and required by changes in state or federal laws or regulations ("Changes in the Law"). In the event Changes in the Law prevent or preclude compliance with one or more provisions of this Agreement, such provisions of the Agreement shall be modified or suspended, or performance thereof delayed, as may be necessary to comply with Changes in the Law, and the Town and Owner shall take such action as may be required pursuant to this Agreement. Not in limitation of the foregoing, nothing in this Agreement shall preclude the Town from imposing on Owner any fee specifically mandated and required by state or federal laws and regulations. Notwithstanding the foregoing, all required county, state and federal permits shall be obtained prior to development.

ARTICLE 3.8 Project Phasing. Rislende is a phased project with three or more filings contemplated. The public improvements for Rislende shall be constructed in accordance with an applicable phase SIA.

Owner shall have five (5) years from the date of approval of this Agreement by the Town to fulfill the requirements described above and record a final plat, minor subdivision, or Site Plan for one or more lots, tracts, or parcels in Rislende.

ARTICLE 4. REPRESENTATION AND COOPERATION

ARTICLE 4.1 Owner Representations. All written representations of Owner set forth in its annexation petition, annexation plat, zoning application, and related documents shall, if accepted by the Town, be considered incorporated into this Agreement as if set forth in full herein. Notwithstanding their incorporation by reference, the Town makes no representation about the accuracy of such documents.

ARTICLE 4.2 Cooperation in the Event of Legal Challenge. If any legal or equitable action or other proceeding is commenced by a third party challenging the validity of any provision of this Agreement, Owner and the Town agree to cooperate in defending such action or proceeding, and in connection with any such action or proceeding, the Town shall bear its own expenses and Owner shall bear Owner's expenses. Unless the Town and Owner otherwise agree, each party shall select its own legal counsel to represent it in connection with any such action or proceeding. Nothing in this Article 4,2 shall be deemed as extending or waiving the applicable statute of limitations.

ARTICLE 5. DEFAULT & REMEDIES

ARTICLE 5.1 Breach by Owner. In the event of any default or breach by Owner of any term, condition, covenant or obligation under this Agreement, the Town may take such action as it deems necessary to protect the public health, safety, and welfare, to protect lot, parcel, or tract buyers and builders, and to protect the citizens of the Town from hardship.

A. Remedies. The Town's remedies for a default or breach by Owner include:

1. The refusal to issue to Owner any building permit or certificate of occupancy; provided, however, that this remedy shall not be available to the Town until after the affidavit described in Subparagraph (2) below has been recorded;
2. The recording with the Garfield County Clerk and Recorder of an affidavit, approved in writing by the Town Attorney and signed by the Town Administrator or his designee, stating that Owner has breached the terms and conditions of this Agreement (hereinafter, an "Affidavit of Breach"). At the next scheduled Board meeting, the Board shall either approve the filing of said Affidavit of Breach or direct the Town Administrator to file an affidavit stating that the breach, or default, has been cured (hereinafter, an "Affidavit of Cure"). Upon the recording of an Affidavit of Breach, no further lots, tracts, or parcels may be sold within the Property until an Affidavit of Cure is approved by the Board, and executed and recorded by the Town Administrator;
3. A demand that the security given for the completion of the public improvements be paid or Honored;
4. The refusal to consider further development plans within the Property; and/or
5. Any other remedy available at law.

B. Notice to Owner. Unless necessary to protect immediate health, safety and welfare of the Town or Town residents, the Town shall provide Owner thirty (30) days written notice of its intent to take any action under this Section 5.1 during which thirty-day period Owner may cure the breach described in said notice and prevent further action by the Town. Furthermore, unless an affidavit as described in this Section has been recorded with the Garfield County Clerk and Recorder, any person dealing with Owner shall be entitled to assume that no default by Owner has occurred hereunder unless a notice of breach has been served upon Owner as described above, in which event Owner shall be expressly responsible for informing any such third party of the claimed default by the Town.

C. Owner Responsibility for Costs. Owner shall be responsible for all attorney's fees and other professional fees, including but not limited to consultant fees, administrative fees and charges, and out-of-pocket costs the Town incurs directly or indirectly as a result of any breach of this Agreement by Owner.

ARTICLE 5.2 Breach by Town.

A. Events Constituting Breach by Town. Agreement shall be defined as:

1. Any zoning or land use action by the Town which would alter, impair, prevent, diminish, impose a moratorium on development or vested rights, or unreasonably delay the development or use of the Property as described in this Agreement prior to annexation or any future approved site specific development plan, and specifically excluding any non-discriminatory regulatory actions, inaction, or circumstances beyond the reasonable control of the Town; or
2. The Town's failure to fulfill or perform any material obligation of the Town contained in this Agreement.
3. The Town taking any action to abate or terminate any of the current uses described in this Agreement.

B. Owner's Remedies. If any default by the Town under this Agreement is not cured as described herein, Owner shall have the right to pursue the defaulting party's remedies allowable by Colorado law, subject to the limitations herein. Owner shall have the right to enforce the Town's obligations under this Agreement by an action for any available equitable remedy, including, without limitation, specific performance or mandatory or prohibitory injunction. Each remedy provided for in this Agreement is cumulative and is in addition to every other remedy provided for in this Agreement. Town shall be responsible for all attorney fees other professional fees, including but not limited to consultant fees, administrative fees and charges, and out-of-pocket costs the Owner incurs directly or indirectly as a result of any breach of this Agreement by Town.

ARTICLE 6. GENERAL PROVISIONS

ARTICLE 6.1 Incorporation of Recitals. The Recitals contained in this Agreement, and the introductory paragraph preceding the Recitals, are hereby incorporated into this Agreement as if fully set forth herein.

ARTICLE 6.2 Findings. The Town hereby finds and determines that execution of this Agreement furthers public health, safety and general welfare, and that the provisions of this Agreement are consistent with the Comprehensive Plan.

ARTICLE 6.3 Provisions Exclusive. The Town and Owner acknowledge and agree that this Agreement contains all basic requirements of Owner concerning the provision of water and sewer service to the property, raw water irrigation, open space, and park land dedication, trails, utilities, infrastructure, water rights dedications and other matters expressly addressed under this Agreement. Additional specifications and regulations shall be imposed upon Owner during the zoning and subdivision process with regard to these enumerated items.

ARTICLE 6.4 Other Necessary Acts. Each party shall execute and deliver to the other all such further instruments and documents as may be reasonably necessary to carry out the provisions and intent of this Agreement.

ARTICLE 6.5 Other Miscellaneous Terms. The singular shall include the plural; the masculine gender shall include the feminine; "shall" is mandatory; "may" is permissive. If there is more than one signer of this Agreement, the signer obligations are joint and several.

ARTICLE 6.6 Covenants Running With the Land. This Agreement shall be binding upon and inure to the

benefit of the parties hereto and their respective heirs, successors and assigns. Further, the terms and conditions of this Agreement shall constitute a covenant running with the land.

ARTICLE 6.7 No Agency, Joint Venture or Partnership. It is specifically understood and agreed to by and between the parties hereto that: (i) the subject development is a private development; (ii) the Town has no interest or responsibilities for, or duty to, third parties concerning any improvements until such time, and only until such time, that Town accepts the same pursuant to the provisions of this Agreement or subsequent SIA; and (iii) the Town and Owner hereby renounce the existence of any form of agency relationship, joint venture or partnership between Town and Owner and agree that nothing contained herein or in any document executed in connection herewith shall be construed as creating any such relationship between Town and Owner.

ARTICLE 6.8 Notices. All notices required under this Agreement shall be in writing and shall be hand-delivered or sent by facsimile transmission or registered or certified mail, return receipt requested, postage prepaid, to the addresses of the parties herein set forth. All notices by hand delivery shall be effective upon receipt. All facsimile transmissions shall be effective upon transmission receipt, provided that such transmissions received after 5 p.m. on any business day or at any time on a holiday or weekend shall be deemed received on the following business day. All notices by mail, if sent to the proper address as set forth below, shall be considered effective upon the date stamped on the return receipt. Either party, by notice so given, may change the address or phone number to which future notices shall be sent.

ARTICLE 6.10 Force Majeure. Performance by either party of its obligations hereunder (other than for payment of money or other financial obligations) shall be excused during any period of "Permitted Delay": as hereinafter defined. For purposes hereof, Permitted Delay shall mean delay beyond the reasonable control of the party claiming the delay including, but not limited to (i) acts of God, including but not limited to earthquakes, floods, fire, weather conditions that are abnormal for the period of time and could not have been reasonably anticipated, and other natural calamities; (ii) civil commotion, (iii) riots, (iv) strikes, picketing or other labor disputes, (v) shortages of materials or supplies, (vi) damage to work in progress by reason of fire, floods or other casualties, (vii) failure, delay or inability of the other party to act, provided, however, that Town's failure to take a discretionary action shall not be a Permitted Delay for Owner; (viii) vandalism, or (ix) delay caused by restrictions imposed or mandated by government entities other than the Town.

ARTICLE 6.11 Expenses. In connection with the Town's review and approval of this Agreement, Owner shall pay the amount of any expenses incurred by the Town upon thirty (30) days written notice by the Town specifying said expenses. In addition, Owner shall pay all reasonable costs incurred by the Town for fees and expenses of outside consultants in connection with the implementation of this Agreement, including, but not limited to, document and planning reviews, advice and assistance to the Board or administration or any agency of the Town, election matters and other issues after approval of this Agreement by the Board. Outside consultants shall include but not necessarily be limited to Town staff, attorneys, engineers and planners. Owner shall also timely pay to the Town all appropriate standard processing, application and permit fees of general applicability charged by the Town pursuant to the Town Code in connection with Owner's development of the Property, including, without limitation, the Town's standard processing or other fees for preliminary plat and final plat approvals, building permits and the like. In addition to the foregoing, Owner agrees to reimburse the Town for any expense incurred in connection with an election or ballot issue concerning the Property.

ARTICLE 6.12 Waiver of Defects. By executing this Agreement, Owner waives all objections it may have concerning defects, if any, in the formalities whereby it is executed, or concerning the power of the Town



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to impose conditions on Owner as set forth herein, and concerning the procedure, substance, and form of the ordinances or resolutions adopting this Agreement.

ARTICLE 6.13 Final Agreement. This Agreement supersedes and controls all prior written and oral agreements and representations of the parties and is the total integrated agreement between the Town and Owner.

ARTICLE 6.14 Captions. The captions in this Agreement are inserted only for convenience and in no way define, limit or prescribe the scope or intent of this Agreement or any part thereof.

ARTICLE 6.15 Invalid Provisions. If any provision of this Agreement shall be determined to be void by any court of competent jurisdiction, then such determination shall not affect any other provision hereof, all of which other provisions shall remain in full force and effect. It is the intention of the parties hereto that, if any provision of this Agreement is capable of two constructions, one of which would render the provision void, and the other of which would render the provision valid, then the provision shall have the meaning which renders it valid.

ARTICLE 6.16 Governing Law. The laws of the State of Colorado shall govern the validity, performance, and enforcement of this Agreement. Should either party institute legal suit or action for enforcement of any obligation contained herein, it is agreed that the venue of such suit or action shall be in Garfield County, Colorado.

ARTICLE 6.17 Attorneys' Fees; Survival. Should this Agreement become the subject of litigation between the Town and Owner, the prevailing party shall be entitled to attorneys' fees and costs of suit actually incurred, including expert witness fees. All rights concerning remedies and/or attorney's fees shall survive any termination of this Agreement.

ARTICLE 6.18 Authority. Each person signing this Agreement represents and warrants that he, she, or they is/are fully authorized to enter into and execute this Agreement, and to bind the party represented to the terms and conditions hereof.

ARTICLE 6.19 Counterparts. This Agreement may be executed in counterparts, each of which shall be deemed an original, and all of which, when taken together, shall be deemed one and the same instrument.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the day and year first above written,



TOWN OF SILT, COLORADO

By: Keith B. Richard

Mayor

ATTEST

By: Christa M. M. Ortega

Town Clerk

STATE COLORADO)
) ss
COUNTY OF GARFIELD)

The foregoing instrument was subscribed, sworn to and acknowledged before me this 28th
day of September, 2022 by Keith B. Richel, as Mayor and
Sheila M. McIntyre, as Town Clerk for the Town of Silt, Colorado.

Witness my hand and official seal

My commission expires:

9/18/2024

NOTARY PUBLIC

Amie Tucker

APPROVED AS TO FORM:



By: _____
Michael J. Sawyer, Esq.

SILT 70 LLC

By: _____
Dennis Carruth, Manager

STATE OF COLORADO)
) ss
COUNTY OF EAGLE)

The foregoing instrument was subscribed, sworn to and acknowledged before me this ____
day of _____, 2022 by _____, as Manager of Silt 70 LLC, a
Colorado limited liability company.

Witness my hand and official seal

STATE COLORADO)
) ss
COUNTY OF GARFIELD)

The foregoing instrument was subscribed, sworn to and acknowledged before me this 28th
day of September, 2022 by Keith B. Richel, as Mayor and
Sheila M. McIntyre, as Town Clerk for the Town of Silt, Colorado.

Witness my hand and official seal

My commission expires:

9/18/2024

NOTARY PUBLIC

Amie Tucker

APPROVED AS TO FORM:

By: Michael J. Sawyer, Esq.



SILT 70 LLC

By: Dennis Carruth, Manager

STATE OF COLORADO)
) ss
COUNTY OF EAGLE)

The foregoing instrument was subscribed, sworn to and acknowledged before me this ____
day of _____, 2022 by _____, as Manager of Silt 70 LLC, a
Colorado limited liability company.

Witness my hand and official seal

STATE COLORADO)
) ss
COUNTY OF GARFIELD)

The foregoing instrument was subscribed, sworn to and acknowledged before me this ____ day of _____, 2022 by _____, as Mayor and _____, as Town Clerk for the Town of Silt, Colorado.

Witness my hand and official seal

My commission expires:

NOTARY PUBLIC

APPROVED AS TO FORM:

By: _____
Michael J. Sawyer, Esq.

SILT 70 LLC

By: 
Dennis Carruth, Manager

STATE OF COLORADO)
COUNTY OF ^{PR}EAGLE Pitkin) ss

The foregoing instrument was subscribed, sworn to and acknowledged before me this 19th day of September, 2022 by Dennis Carruth, as Manager of Silt 70 LLC, a Colorado limited liability company.

Witness my hand and official seal

→

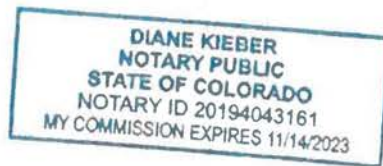
DIANE KIEBER
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20194043161
MY COMMISSION EXPIRES 11/14/2023

My commission expires:

11/14/23

NOTARY PUBLIC

Diane Kieber

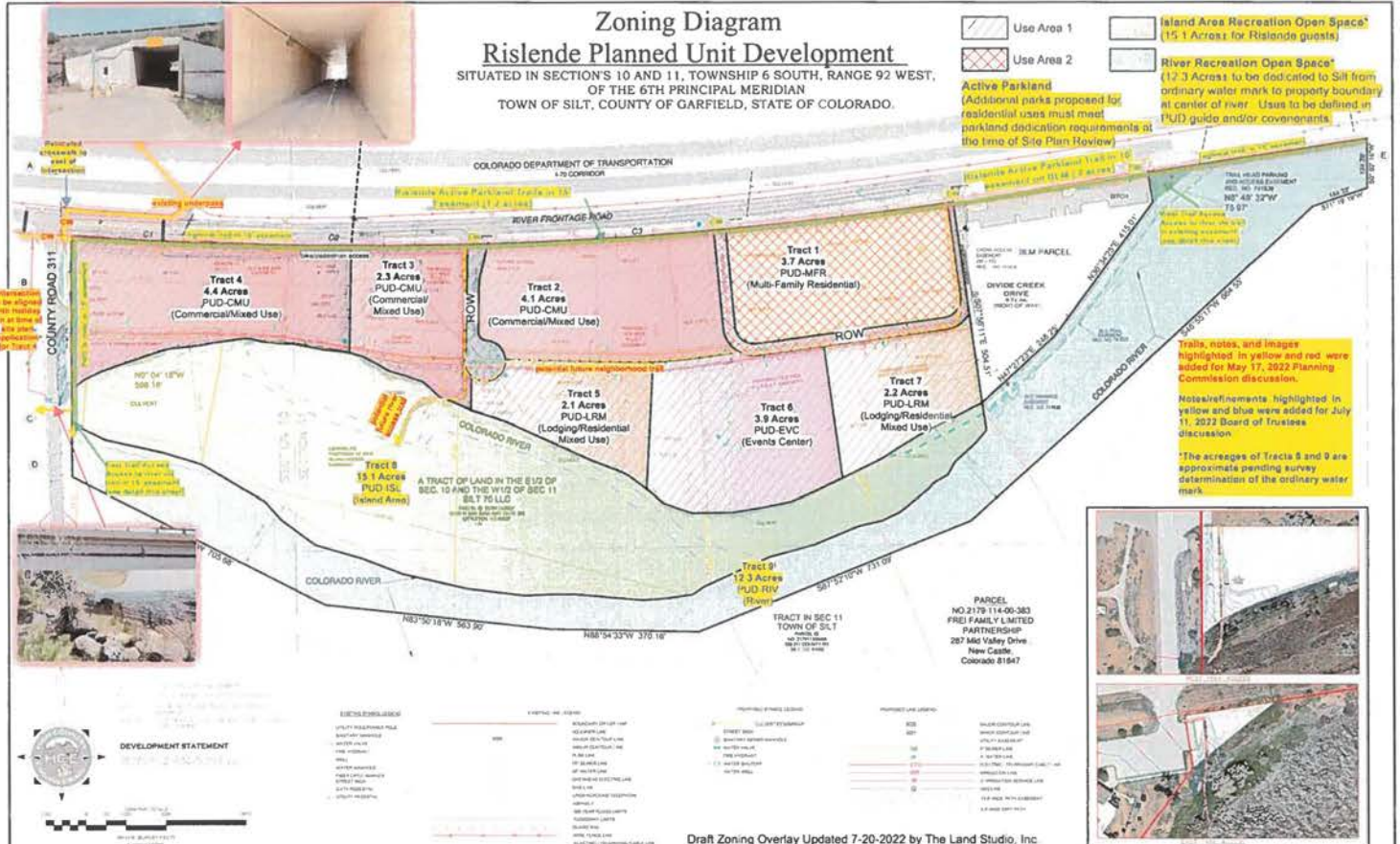


Zoning Diagram

Rislende Planned Unit Development

SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST,
OF THE 6TH PRINCIPAL MERIDIAN
TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

- Use Area 1
- Use Area 2
- Active Parkland (Additional parks proposed for residential uses must meet parkland dedication requirements at the time of Site Plan Review)
- Island Area Recreation Open Space* (15.1 Acres for Rislende guests)
- River Recreation Open Space* (12.3 Acres to be dedicated to Silt from ordinary water mark to property boundary at center of river. Uses to be defined in PUD guide and/or covenants)



Tracts, notes, and images highlighted in yellow and red were added for May 17, 2022 Planning Commission discussion.

Notes/refinements highlighted in yellow and blue were added for July 11, 2022 Board of Trustees discussion.

*The acreages of Tracts 8 and 9 are approximate pending survey determination of the ordinary water mark.

Draft Zoning Overlay Updated 7-20-2022 by The Land Studio, Inc.

HIGH COUNTRY ENGINEERING, INC.
1817 BLAKE AVENUE, STE 101
GLADSTONE, IDAHO 83840
PHONE (208) 945-8870 FAX (208) 945-8885
WWW.HCENG.COM

STILLWATER COMMERCIAL, LLC
RISLENDE PLANNED UNIT DEVELOPMENT
SKETCH PLAN
DEVELOPMENT MAP
TOWN OF SILT
GARFIELD COUNTY, COLORADO

NO. 2179 114-00-383
FRED FAMILY LIMITED
PARTNERSHIP
287 Mid Valley Drive
New Castle,
Colorado 81647

PROJECT
2211047
1 OF 1

Reception#: 980004

10/05/2022 09:42:11 AM Jean Alberico

23 of 24 Rec Fee:\$128.00 Doc Fee:0.00 GARFIELD COUNTY CO

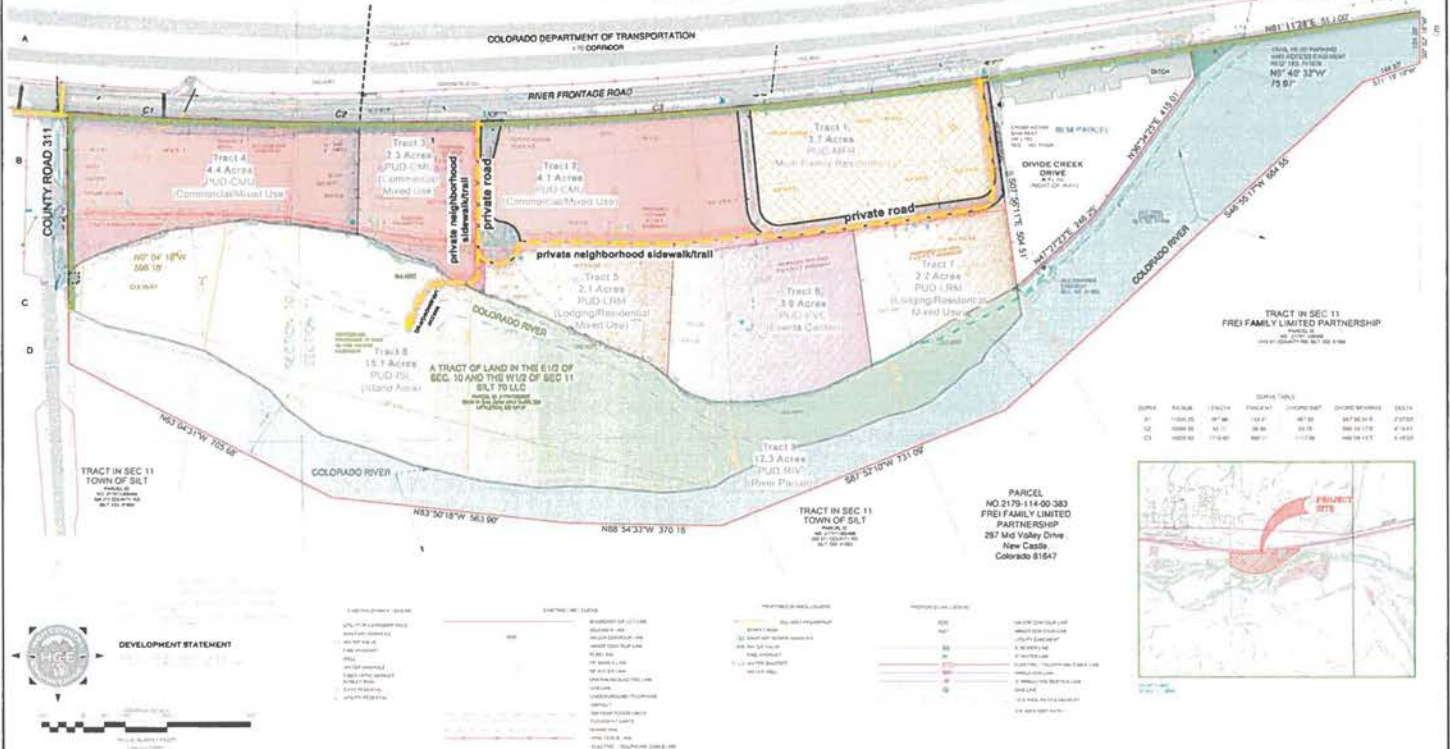
Exhibit B - Private Infrastructure Rislenle Planned Unit Development

SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST,
OF THE 6TH PRINCIPAL MERIDIAN
TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

Exhibit Prepared August 18, 2022

Use Area 1
Use Area 2

Island Area Recreation Open Space
(15.1 Acres for Rislenle guests)
River Recreation Open Space
(12.3 Acres to be dedicated to Silt from
ordinary water mark to property boundary
at center of river. Use to be defined in
PUD guide and/or covenants)



LINE	BEARING	DISTANCE	LINE	BEARING	DISTANCE
1	N 87° 04' 18" W	388.19	51	N 87° 04' 18" W	388.19
2	N 87° 04' 18" W	388.19	52	N 87° 04' 18" W	388.19
3	N 87° 04' 18" W	388.19	53	N 87° 04' 18" W	388.19
4	N 87° 04' 18" W	388.19	54	N 87° 04' 18" W	388.19
5	N 87° 04' 18" W	388.19	55	N 87° 04' 18" W	388.19
6	N 87° 04' 18" W	388.19	56	N 87° 04' 18" W	388.19
7	N 87° 04' 18" W	388.19	57	N 87° 04' 18" W	388.19
8	N 87° 04' 18" W	388.19	58	N 87° 04' 18" W	388.19
9	N 87° 04' 18" W	388.19	59	N 87° 04' 18" W	388.19
10	N 87° 04' 18" W	388.19	60	N 87° 04' 18" W	388.19



DEVELOPMENT STATEMENT

1. THE PROJECT IS A PLANNED UNIT DEVELOPMENT (PUD) FOR THE RISLENLE PLANNED UNIT DEVELOPMENT, SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

2. THE PROJECT IS A PLANNED UNIT DEVELOPMENT (PUD) FOR THE RISLENLE PLANNED UNIT DEVELOPMENT, SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

3. THE PROJECT IS A PLANNED UNIT DEVELOPMENT (PUD) FOR THE RISLENLE PLANNED UNIT DEVELOPMENT, SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

4. THE PROJECT IS A PLANNED UNIT DEVELOPMENT (PUD) FOR THE RISLENLE PLANNED UNIT DEVELOPMENT, SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

5. THE PROJECT IS A PLANNED UNIT DEVELOPMENT (PUD) FOR THE RISLENLE PLANNED UNIT DEVELOPMENT, SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

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7. THE PROJECT IS A PLANNED UNIT DEVELOPMENT (PUD) FOR THE RISLENLE PLANNED UNIT DEVELOPMENT, SITUATED IN SECTION 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST, OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.

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HIGH COUNTRY ENGINEERING, INC.
1817 BLAKE AVENUE, STE 101
GLENNWOOD SPRING, CO 81611
PHONE (970) 833-8879 FAX (970) 845-2585
WWW.HCENG.COM

STILLWATER COMMERCIAL, LLC
RISLENLE PLANNED UNIT DEVELOPMENT
SKETCH PLAN
DEVELOPMENT MAP
TOWN OF SILT
GARFIELD COUNTY, COLORADO

DATE: 01.14.22
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PROJECT
2211047
1 OF 1



Reception#: 980004

10/05/2022 09:42:11 AM Jean Alberico

24 of 24 Rec Fee:\$128.00 Doc Fee:0.00 GARFIELD COUNTY CO

Exhibit C - Trail Phasing Rislenle Planned Unit Development

SITUATED IN SECTION'S 10 AND 11, TOWNSHIP 6 SOUTH, RANGE 92 WEST,
OF THE 6TH PRINCIPAL MERIDIAN
TOWN OF SILT, COUNTY OF GARFIELD, STATE OF COLORADO.
Exhibit Prepared August 26, 2022

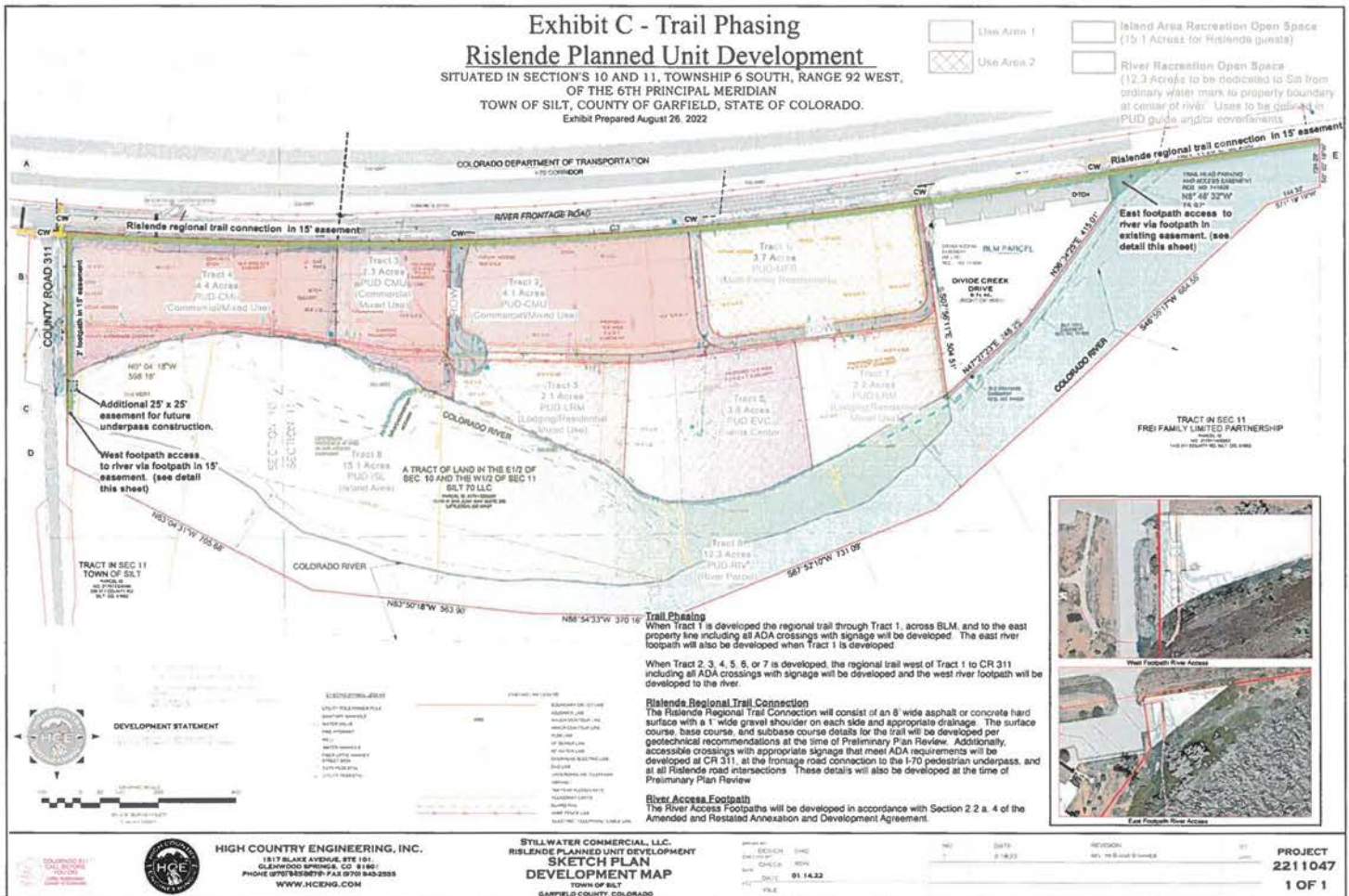


Exhibit E
Town of Silt Resolution No. 16 Series of 2023

**TOWN OF SILT
RESOLUTION NO. 16
SERIES OF 2023**

A RESOLUTION OF THE TOWN OF SILT, COLORADO, APPROVING THE MAJOR SUBDIVISION PRELIMINARY PLAN FOR PROPERTY FORMERLY KNOWN AS DIVIDE CREEK CENTER AND NOW COMMONLY KNOWN AS RISLENDE PLANNED UNIT DEVELOPMENT

WHEREAS, the Town approved Ordinance No. 8, Series of 2007, on July 9, 2007, annexing the Dixon Annexation #1 parcel into the Town; and

WHEREAS, the Town approved Ordinance No. 21, Series of 2007, on July 9, 2007, annexing the Dixon Annexation #2 parcel into the Town; and

WHEREAS, the Town approved Ordinance No. 18, Series of 2007, on July 9, 2007, approving B-2 Highway Business District zoning for the property; and

WHEREAS, the Town approved a subdivision exemption for a portion of the Dixon Annexation property pursuant to Town of Silt Resolution No. 51, Series of 2007 to be used as a government office building and Owner has sold the same to a third-party, which parcel is not affected by this Resolution; and

WHEREAS, Rislende Planned Unit Development constitutes the Dixon Annexation property, less the property subdivided for a government building, which property is described as Exhibit A and which property is the subject of this Resolution (referred to as the "Property"); and

WHEREAS, the Town received an application from applicant on or about August 15, 2013, requesting to amend the Dixon Annexation B-2 Highway Business District zoning; and

WHEREAS, on or about August 15, 2013, applicant has also submitted a request to amend the Annexation and Development Agreement for the Dixon Annexation, which Agreement was entered into on July 9, 2007, by and between the Estate of Roger McFarland Dixon and the Town of Silt; and

WHEREAS, the Town approved Ordinance No. 9, 2013, on October 14, 2013 approving PUD Zoning for the Divide Creek Center; and

WHEREAS, the Town approved Resolution No.18, Series of 2013 on October 14, 2013 approving an Amended and Restated Annexation and Development Agreement for the Divide Creek Center; and

WHEREAS, the Town approved the PUD zoning for the Rislende the Planned Unit Development by adoption of Ordinance No. 13, Series of 2022 on September 12, 2022; and



Reception#: 988250
08/02/2023 09:27:36 AM Jacklyn K. Harmon
2 of 4 Rec Fee:\$28.00 Doc Fee:0.00 GARFIELD COUNTY CO

WHEREAS, the Town of Silt approved the Second Amended and Restated Annexation and Development Agreement for the Dixon Annexation now known as the Rislende Planned Unit Development by adoption of Resolution No. 16, Series of 2022 on September 22, 2022; and

WHEREAS, on or about February 8, 2022 August Group, LLC applied for a Major Subdivision Preliminary Plan for the Rislende the Planned Unit development; and

WHEREAS, the Town of Silt Planning and Zoning Commission considered the Major Subdivision Preliminary Plan for the property at a duly noticed public hearing on April 4, 2023 and reviewed various staff memoranda, and recommended to the Board approval of the Major Subdivision Preliminary Plan application; and

WHEREAS, the Town of Silt Board of Trustees held a duly noticed public hearing on May 22, 2023 where they reviewed various staff reports memoranda related documents; and

WHEREAS, at its May 22, 2023 meeting, the Board determined that the Major Subdivision Preliminary Plan for the Rislende the Planned Unit Development should be approved with conditions.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF TRUSTEES OF THE TOWN OF SILT, COLORADO, THAT the Major Subdivision Preliminary Plan for the Rislende the Planned Unit development should be approved with the following conditions:

1. Any representations in writing or made at public hearings in front of the Planning Commission or the Board of Trustees are considered conditions of approval.
2. That the applicant update all information as directed by the Town Engineer, were in good faith with the town engineer to resolve these issues and have these updates prepared for the submittal of the Final Plat.
3. That no development will occur until there is an approved Site Plan Review for each individual tract.
4. That a plat note or other approval condition be added to require individuals storm water management and pollution treatment for each individual tract upon development/site plan review.
5. That the applicant may provide a sidewalk 6-foot in width as indicated on the Loop Road right-of-way (AKA Rislende Loop and Rippling Way). 10-foot-wide sidewalks will be considered at time of each Site Plan Review for each parcel and decisions made at that time.
6. On street parking will not be allowed on the Rislende the Loop/Rippling Way Loop Road right-of-way.



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08/02/2023 09:27:36 AM Jacklyn K. Harmon
3 of 4 Rec Fee: \$28.00 Doc Fee: 0.00 GARFIELD COUNTY CO

Introduced, read and approved on first reading on the 22nd day of May, 2023.

Town of Silt

Mayor Keith B. Richel

Attest:

Town Clerk Sheila M. McIntyre, CMC



EXHIBIT A LEGAL DESCRIPTION

A TRACT OF LAND SITUATED IN THE EV/2 OF SECTION 10 AND W1/2 OF SECTION 11. TOWNSHIP & SOUTH, RANGE 9Z WEST OF THE 6TH P. M., COUNTY OF GARFIELD, STATE OF COLORADO, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHWEST CORNER OF SAD SECTION 11. THENCE S. 00 DEGREES 35'02" E. ALONG THE WESTERLY BOUNDARY OF SAID SECTION 11 A DISTANCE OF 1.901.80 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY BOUNDARY OF INTERSTATE 70. THE POINT OF BEGINNING:

THENCE ALONG SAD SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF 10.028.50 FEET AND A CENTRAL ANGLE OF 09 DEGREES 25'58", A DISTANCE OF 1,651.00 FEET, (CHORD BEARS N. 86 DEGREES 18'16" E. A DISTANCE OF 1,649.14 FEET); THENCE LEAVING SAD RIGHT-OF-WAY S. 07 DEGREES 56'11" E. A DISTANCE OF 504.51 FEET; THENCE N. 47 DEGREES 27'23" E. A DISTANCE OF 246.25 FEET; THENCE N. 36 DEGREES 34'25" E. A DISTANCE OF 415.01 FEET; THENCE N. 08 DEGREES 48'32" W. A DISTANCE OF 75.97 FEET TO A POINT ON SAD RIGHT-OF-WAY: THENCE N. 81 DEGREES 11'28" 2. ALONG SAD RIGHT-OF-WAY A DISTANCE OF 550.00 FEET TO A POINT ON THE NORTH-SOUTH CENTERLINE OF SAD SECTION 11 (WHENCE A REBAR AND CAP L.S. #15710 BEARS N. DO DEGREPS 02' 16" E. A DISTANCE OF 39.95 FEET); THENCE LEAVING SAID RIGHT-OF-WAYS.00 DEGREES 02'16" W. ALONG SAID NORTH-SOUTH CENTERLINE A DISTANCE OF 124.28 FEET TO A POINT IN THE CENTERLINE OF THE COLORADO RIVER: THENCE LEAVING SAID NORTH-SOUTH CENTERLINE S. 71 DEGREES 19'19" TY. ALONG THE CENTERLINE OF THE COLORADO RIVER A DISTANCE OF 144.32 FEET THENCE CONTINUING ALONG THE CENTERLINE OF THE COLORADO RIVER S. 46 DEGREES 55'17" W. A DISTANCE OF 664.55 FEET; THENCE CONTINUING ALONG SAD CENTERLINE S. 48 DEGREES 11'32" W. A DISTANCE OF 491.93 FEET; THENCE CONTINUING ALONG SAD CENTERLINE S. 67 DEGREES 52'10" W. A DISTANCE OF 731.09 FEET; THENCE CONTINUING ALONG SAD CENTERLINE N. 8 DEGREES 54'33" W. A DISTANCE OF 370.16 FEET; THENCE CONTINUING ALONG SAD CENTERLINE N. 83 DEGREES 50'18" W. A DISTANCE OF 563.9D FEET; THENCE CONTINUING ALONG SAID CENTERLINE N. G3 DEGREES 04'31" W. A DISTANCE OF 705.68 FEET TO A POINT ON THE EASTERLY RIGHT-OF-WAY OF COUNTY ROAD NO: 311; THENCE LEAVING SAD CENTERLINE N. 10 DEGREES 04 '18" W. ALONG SAID LASTLERY RIGHT-OF-WAY A DISTANCE OF 598: 18 FEET TO A POINT ON THE SOUTHERLY RIGHT-OF-WAY OF INTERSTATE 70, A REBAR AND CAP L.S. \$15710 IN PLACE: THENCE LEAVING SAD EASTERLY RIGHT-OF-WAY ALONG SAID SOUTHERLY RIGHT-OF-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF

11.634.21 FEET AND A CENTRAL ANGLE OF 0Z DEGREES 27'03" A DISTANCE OF 197.66 FEET (CHORD PEARS S. 87 DEGREES 26'49" E. A DISTANCE OF 497.63. FEE] TO A REBAR AND ILLEGIBLE CAP IN PLACE; THENCE CONTINUING ALONG SAD SOUTHERLY RIGHT-OE-WAY ALONG THE ARC OF A CURVE TO THE LEFT HAVING A RADIUS OF 10,028,50 FEET AND A CENTRAL ANGLE OF 00 DEGREES 18"24", A DISTANCE OF 53.70 FEET (CHORD BEARS S. 85 DEGREES 19'32" E A DISTANCE OF 53.70 FEET) TO THE POINT OF BEGINNING.

Exhibit F
Risende PUD Traffic Impact Study

Rislende PUD

Traffic Impact Study

Town of Silt, Colorado



Date: October 18, 2023

Submitted To:

Mitchell Weimer
August Group LLC
121 Polo Road
Glenwood Springs, CO 81601

Submitted By:

Fox Tuttle Transportation Group, LLC
1580 Logan St, 6th Floor
Denver, CO 80203
FT# 22025

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APPENDIX

Level of Service Definitions

Existing Traffic Data

Intersection Capacity Worksheets

RISLENDE PUD TRAFFIC IMPACT STUDY

1.0 Introduction

The Fox Tuttle Transportation Group has prepared this traffic impact study for the development of the Rislende Planning Unit Development (PUD) in the Town of Silt, Colorado. The project proposes to develop a vacant site with mixed-use commercial and residential uses. The property is located on the north side of River Frontage Road just east of Divide Creek Road (County Road 311). Access to the project is proposed along River Frontage Road and CR 311. The property will be developed over time with the assumed full build out and occupancy by the Year 2035 planning horizon. **Figure 1** provides a vicinity map for the proposed project.

The purpose of this study is to assist in identifying potential traffic impacts within the study area as a result of developing this project. The traffic study addresses existing, project buildout (Year 2035), and long-term (Year 2045) peak hour intersection conditions in the study area with and without the project-generated traffic. The information contained in this study is anticipated to be used by the Town of Silt in identifying any intersection or roadway deficiencies and potential improvements for the build-out condition and long-term future scenarios. This study focused on the weekday AM and PM peak hours which represent the periods of highest trip generation for the proposed use and adjacent street traffic.

The following supporting documents were reviewed and incorporated into this analysis as appropriate:

- *US Highway 6 and River Frontage Road Access Control Plan*. PBS&J. January 2010.
- *I-70 Exit 97 Silt Interchange Study*. Stolfus Associates. May 2016.

2.0 Project Description

The Rislende PUD project plans proposes to develop a vacant site with mixed-use commercial and residential uses located on the north side of River Frontage Road just east of Divide Creek Road CR 311. The proposed land use plan includes development on 8 tracts, with commercial, single-family residential and multi-family residential uses, including two tracts used for passive outdoor use and a special event area, to support the other tracts/developed uses. Access is proposed, as follows:

- Full-movement access along River Frontage Road approx. 1,050' east of CR 311 (side-street stop-controlled)
- Full-movement access along River Frontage Road approx. 2,245' east of of CR 311 (this access currently exists for the BLM office and will be shared with this use) (side-street stop-controlled)
- Full-movement access along CR 311, approximately 250' south of River Frontage Road (this access is proposed to align with the existing hotel access on the west side of CR 311, to become a four-leg, side-street stop-controlled intersection)

Per discussions with the applicant, it is projected that full buildout of the project may occur over the next 10-15 years. For the purposes of this study, the Year 2035 was assumed as the buildout planning horizon for the project. The planning zoning map and proposed access points are shown on **Figure 2**.

3.0 Study Considerations

3.1 Data Collection

Intersection turning movement volumes were collected in April 2022 at six (6) existing intersections during the weekday AM and PM peak hours. Daily traffic volumes with vehicular classifications were also collected on CR 311 and River Frontage Road adjacent to the project site. The existing traffic volumes, intersection geometry, and traffic control are illustrated on **Figure 3**. Count data sheets are provided in the **Appendix**.

Historic traffic volumes and future projections on the study roadways were gathered from Colorado Department of Transportation's (CDOT) Transportation Data Management System (TDMS) and CDOT's Online Transportation Information System (OTIS).

3.2 Evaluation Methodology

The traffic operations analysis addressed the signalized and unsignalized intersection operations using the procedures and methodologies set forth by the *Highway Capacity Manual (HCM)*¹. Stop-controlled and signalized intersections were evaluated using Synchro software (v11) and roundabouts were evaluated using SIDRA (v9) software.

3.3 Level of Service Capacity Analysis

A Level of Service analysis was conducted to determine the existing and future performance of the study area intersections and accesses to determine the most appropriate intersection traffic controls and auxiliary lanes for future conditions.

To measure and describe the operational status of the study intersections, transportation engineers and planners commonly use a grading system referred to as “Level of Service” (LOS) that is defined by the *HCM*. LOS characterizes the operational conditions of an intersection’s traffic flow, ranging from LOS A (indicating very good, free flow operations) and LOS F (indicating congested and sometimes oversaturated conditions). These grades represent the perspective of drivers and are an indication of the comfort and convenience associated with traveling through the intersections. The intersection LOS is represented as a delay in seconds per vehicle for the intersection as a whole and for each turning movement.

Typically, LOS A through D is considered to be acceptable for the overall intersection operations. Individual movements may be allowed to fall to LOS E/F depending on the circumstances, such as a low-volume, side-street approach to an arterial or a protected-only, and/or a protected, signalized left-turn movement. Criteria contained in the *HCM* was applied for these analyses in order to determine peak hour LOS for each scenario. A more detailed discussion of LOS methodology is contained in the **Appendix** for reference.

¹ *Highway Capacity Manual*, Highway Research Board Special Report 209, Transportation Research Board, National Research Council, 6th Edition (2016).

4.0 Existing Conditions

4.1 Roadways

The study area boundaries are based on the amount of traffic to be generated by the project and potential impact to the existing roadway network. The primary public roadways that serve the project site are discussed in the following text and illustrated on **Figure 1**.

I-70 is a four-lane interstate roadway that provides east-west access through the region. This highway has a posted speed limit of 75 miles per hour (mph) and serves approximately 28,400 (CDOT TDMS 2022 data) in the project vicinity.

9th Street is a two-lane, north-south roadway classified as “I-70E” and a Expressway or Major Bypass (category EX) between US 6 and River Frontage Road per the CDOT US 6/River Frontage Road Access Control Plan. 9th Street serves as the main access route Town of Silt and I-70. The posted speed limit is 15 mph at the I-70 ramp intersections. The I-70 eastbound and westbound ramp terminals are unsignalized, with side-street stop controls.

River Frontage Road is a two-lane, east-west roadway serving primarily commercial uses, that parallels I-70 on the south side of the highway that extends from approximately 1.25 miles west of the site to approximately 5 miles east of the site. The posted speed limit is 45 mph within the project area. The intersection of River Frontage Road with 9th Street is controlled with stop signs on the River Frontage Road approaches.

Divide Creek Road (CR 311, 16th Street) is a two-lane roadway that serves existing commercial, agricultural and rural-residential land uses south of the project area. The posted speed limit is 35 mph within the project area. The intersection of CR 311 with River Frontage Road is controlled with a stop sign on the CR 311 (northbound) approach.

4.2 Pedestrian and Bicycle

Within the study area, there is currently only a sidewalk on the south side of River Frontage Road adjacent to the hotel site west of the project (west of CR 311) and then continuing on the north side of River Frontage Road just east of CR 311. This sidewalk connects to a pedestrian underpass just north of the project side that extends under I-70, providing pedestrian access to the Town of Silt roadway grid at 16th Street/US 6. There are no dedicated bicycle lanes or bikeable shoulders within the immediate project vicinity.

4.3 Existing Intersection Capacity Analysis

The existing volumes, lane configuration, and traffic control are illustrated on **Figure 3**. The details of LOS for each movement are provided in **Table 1** and the 95th percentile queues are provided on the Synchro worksheets in the **Appendix**). **All of the study intersections currently operate overall at LOS D or better in both peak hours, with the following exception:**

- **#2 – I-70 Eastbound Ramps at 9th Street:** This side-street stop-controlled intersection currently operates overall at LOS F overall in the AM peak hour, with the eastbound left-turn movement operating at LOS F. These delays are due to the heavy southbound-to-westbound I-70 pattern with residents of Silt heading east up the valley in the morning.

Recommendations: To mitigate existing delays, signalized or roundabout traffic control should be implemented. Per the I-70 Exit 97 Silt Interchange Study, both types of traffic controls have been considered for future implementation. For the purposes of this study, it has been analyzed that signalization may occur in the near-term future with implementation of roundabout improvements (to include both ramp terminals and the River Frontage Road intersection along 9th Street). These improvements are analyzed in the Year 2035 and Year 2045 traffic scenarios.

Note that while not formalized with signing or striping, there exists enough width on the I-70 westbound off-ramp at 9th Street for approximately 2 vehicle lengths of storage for westbound-to-southbound left-turn vehicles to stack, allowing westbound right-turn traffic (the predominant pattern for people returning from up valley in the evening peak hour) to proceed around these stacked left-turn vehicles. This was represented in the operational (Synchro) modeling for existing conditions. In the future, we understand that additional width may be provided to formalize separate westbound I-70 off ramp left-turn and right-turn lanes, similar to what was recently constructed for the eastbound off-ramp.

5.0 Future Conditions

5.1 Annual Growth Factor and Future Volume Methodology

In order to forecast the future peak hour traffic volumes, the 20-year factors along study roadways provided by CDOT's traffic database was utilized. Per the CDOT OTIS data, a 1% annual growth rate was applied within the study area for future-year background traffic scenarios.

The Year 2035 background volumes are summarized on **Figure 4** and the Year 2045 background volumes are summarized on **Figure 5**.

5.2 Year 2035 Background Intersection Capacity Analysis

The study area intersections were evaluated to determine baseline operations for the Year 2035 background scenario and to identify any capacity constraints associated with background traffic growth in the project buildout year. The background volumes, lane configuration, and traffic control are illustrated on **Figure 4**.

The Level of Service criteria discussed previously was applied to the study area intersections to determine the impacts with the short-term background volumes. This analysis assumes the existing signal timing was still in place.

The details of LOS for each movement are provided in **Table 1** and the 95th percentile queues are provided on the Synchro worksheets in the **Appendix**). Signalization of both the eastbound and westbound ramp terminals on 9th Street was assumed to be in place for this background traffic scenario, consistent with the I-70 Exit 97 Silt Interchange Study and to meet Year 2035 background traffic demands.

All of the study intersections are projected to operate acceptably overall in both peak hours for the Year 2035 background scenario. As noted above, this assumes that the I-70 ramp terminals have been signalized (or roundabouts constructed) to meet future background traffic growth.

5.3 Year 2045 Background Intersection Capacity Analysis

The study area intersections were evaluated to determine baseline operations for the Year 2045 background scenario and to identify any capacity constraints associated with background traffic in the long-term scenario. The long-term background volumes, lane configuration, and traffic control are illustrated on **Figure 5**.

The Level of Service criteria discussed previously was applied to the study area intersections to determine the impacts with the long-term background volumes. Consistent with the I-70 Exit 97 Silt Interchange Study, it is assumed that two roundabouts will be constructed by the Year 2045 scenario to meet long-term background traffic demands. The north roundabout would service the 9th Street/I-70 westbound ramps and the south roundabout would service the 9th Street/I-70 eastbound ramps as well as the 9th Street/River Frontage Road intersection movements. Lane geometry was assumed to be consistent with the concept plans included with the I-70 Exit 97 Silt Interchange Study (hybrid single-lane/multi-lane roundabout).

The results of the LOS calculations for each intersection and movement are provided in **Table 1** and the 95th percentile queues are provided on the SIDRA worksheets in the **Appendix**).

All of the study intersections are projected to operate acceptably overall in both peak hours for the Year 2045 background scenario. As noted above, this assumes that the I-70 ramp terminals have been converted to roundabouts to meet future background traffic growth.

6.0 Future Conditions with the Rislende PUD Project

The Rislende PUD project plans proposes to develop a vacant site with mixed-use commercial and residential uses on 8 tracts. Commercial, single-family residential and multi-family residential uses are proposed, with two tracts used for passive outdoor use and a special event area, to support the other tracts/developed uses.

6.1 Trip Generation

A trip generation estimate was performed to determine the traffic characteristics of the proposed density and land uses of the development. The trip rates contained in the Institute of Transportation Engineers (ITE) *Trip Generation Manual*² were applied to the projected maximum density and land use for each tract to estimate the site-generated trips. For mixed-use tracts, the potential square footage was calculated by applying an 0.20 floor area ratio (FAR) to the tract acreage and assuming 50/50 split between retail/commercial and residential to calculate gross floor areas and dwelling units.

Table 2 provides the detailed trip generation estimates for the Rislende PUD project. The proposed project is expected to experience mostly new trips as discussed below:

Primary Trips. These trips are made specifically to visit the site and are considered “new” trips. Primary trips would not have been made if the proposed project did not exist. Therefore, this is the only trip type that increases the total number of trips made on a regional basis.

Pass-By. These trips already exist on the area roadways but will divert into the site to visit a commercial/retail use. An example would be someone who is traveling along CR 311 but would divert into the site to visit a coffee shop. Given the relatively low volume of trips on the adjacent roadways, a pass-by trip reduction was not applied to this project. Thus, the projected volume of primary trips can be considered conservatively high.

In addition, given the mixed-use land uses proposed, it is anticipated that there will be internal (non-auto or short-trip auto) trips that do not impact the external roadways. This would include someone who lives in the development walking to a coffee shop or restaurant type use, or someone visiting more than one

² *Trip Generation Manual, 11th Edition*, Institute of Transportation Engineers, 2021.

retail use in a single automobile trip. For the purposes of this traffic analysis, a 10% “MXD” reduction was applied to retail uses in this development. No reduction was applied to residential uses.

The project proposes Tract 6 to be used for special events such as weddings, corporate events, annual dinners, etc. Since these events are not anticipated to occur during typical weekday peak period (they would typically occur after the PM peak hour), these uses were not included in the trip generation estimates and peak hour intersection analyses. The weekday AM and PM peak hours for the proposed residential and commercial uses represents a higher volume traffic scenario for trip generation as well as higher volumes on the adjacent roadway and intersection network than would occur for off-peak hour events.

As shown on **Table 2**, the Rislende PUD project is estimated to generate approximately 3,472 daily weekday trips with 171 trips in the AM peak hour and 370 trips in the PM peak hour.

6.2 Trip Distribution and Assignment

The estimated trip volumes were distributed onto the study area street network based on existing traffic characteristics, land uses, and traffic patterns in the area, and existing and future roadway connectivity.

The assumed trip distribution and new site-generated trips for the study intersections and roadways are shown on **Figure 6**.

6.3 Year 2035 Background + Project Intersection Capacity Analysis

This section discusses impacts associated with the addition of the Rislende PUD development trips in the project buildout-year scenario. The site-generated volumes were added to the Year 2035 background volumes and are illustrated on **Figure 7**. This figure also illustrates the necessary traffic control and lane configurations for all of the study intersections and proposed accesses. The recommended I-70 ramp terminal improvements along 9th Street in the Year 2035 background scenario were assumed to be implemented.

The results of the LOS calculations for each intersection and movement are provided in **Table 1** and the 95th percentile queues are provided in the **Appendix**.

All of the study intersections are projected to operate acceptably overall in both peak hours for the Year 2035 total (with project) scenario. The following approaches are anticipated to operate at LOS E/F in at least one peak hour:

- **#3 – 9th Street at River Frontage Road:** If this intersection remains with side-street stop control for the Year 2035 total traffic scenario, the eastbound approach is anticipated to operate at LOS F in the PM peak hour with a 95th-percentile queue of 184' (roughly 7 vehicles). However, with the projected volumes this intersection would not meet the minimum volumes to meet MUTCD signal warrants. As an all-way stop, this intersection and all movements would operate acceptably (all movements LOS D or better).

Recommendations: Given the proximity of this intersection to the westbound ramp terminal, if the westbound ramp terminal is signalized in this scenario, an all-way stop control would result in southbound queues (95th-percentile of 4.4 vehicles) backing into the westbound ramp terminal intersection. This intersection could potentially be signalized to be synchronized with the westbound ramp terminal intersection, but the preferred scenario would be that the roundabout design per the I-70 Exit 97 Silt Interchange Study is implemented by this scenario (all movements operate at LOS A with a roundabout at this intersection). If the roundabouts are not yet implemented by this scenario but are still planned to occur, it is recommended to leave the side-street stop control with the roundabout serving as the ultimate configuration for this intersection.

6.4 Year 2045 Background + Project Intersection Capacity Analysis

The site-generated volumes for the Rislende PUD project were added to the Year 2045 background volumes and are illustrated on **Figure 8**. This figure also illustrates the necessary traffic control and lane configurations for all of the study intersections. The recommended improvements in the previous scenarios were assumed to be implemented, namely the roundabouts on 9th Street at I-70 and the River Frontage Road. The results of the LOS calculations for each intersection and movement are provided in **Table 1** and the 95th percentile queues are provided in the **Appendix**.

All of the study intersections are projected to operate acceptably overall in both peak hours for the Year 2035 total (with project) scenario. As noted, this assumes that the I-70 ramp terminals have been converted to roundabouts to meet future long-term traffic growth per the I-70 Exit 97 Silt Interchange Study.

6.5 Access and Auxiliary Lane Recommendations

The proposed access points include two (2) accesses (one existing shared with the existing BLM office) along River Frontage Road. This roadway is classified as a "F-A" "Frontage Road" roadway by CDOT per the US 6/River Frontage Road Access Control Plan (ACP) (Town of Silt, CDOT, Garfield County and PBS&J, January 2010). The ACP shows three existing access points along the River Frontage Road for the project

properties but shows only one access point on the Recommended Access Points (Figure 12 of that document), with a second access point that is the existing (future shared) access for the BLM office just east of the project site. Thus, the proposed site access plan is consistent with the recommendations of the ACP.

The need for auxiliary turn lanes at the site access points, to include the CR 311 access, was determined using CDOT State Highway Access Code criteria. Based on these criteria, the following auxiliary lanes are warranted based on volume, posted speed, and roadway classification:

- Access 1 & River Frontage Road: Construct an eastbound right-turn deceleration lane (435' total minimum length, inclusive of a 13.5:1 taper)
- Access 3 & River Frontage Road (shared, existing BLM access): Construct an eastbound right-turn deceleration lane (435' total minimum length, inclusive of a 13.5:1 taper)

Based on the roadway volumes and posted speeds at the site access locations, none of the access points are projected to meet the need for left-turn deceleration lanes or for right-turn acceleration lanes. At the CR 311 access point, minimum volumes are not met for any auxiliary lanes. While side-street width to accommodate separate right-turn and left-turn lane movements may be provided to improve side-street approach delays, the LOS analysis was performed not assuming separate side-street lanes and all LOS/delays are acceptable without separate outbound lanes.

7.0 Conclusions

The Rislende Planned Unit Development (PUD) project proposes to develop a currently vacant site with mixed-use commercial and residential uses. The property is located on the north side of River Frontage Road just east of Divide Creek Road (County Road 311). Access to the project is proposed at two (2) locations along River Frontage Road, one of which exists and will be shared with the existing BLM office, and one (1) new access along CR 311 south of River Frontage Road. The proposed site access plan is consistent with the recommendations of the US 6/River Frontage Road Access Control Plan.

The project is estimated to generate approximately 3,472 daily trips with 171 trips in the AM peak hour and 370 trips in the PM peak hour at full build-out of all land uses and tracts. **It was determined that the proposed roadway system can adequately accommodate the projected traffic volumes for buildout conditions with planned improvements.**

The following recommendations should be considered:

Background Conditions (Non-Project Related):

- **9th Street at I-70 Ramps:** Signalize the I-70 ramp terminal intersections or construct roundabouts, consistent with the I-70 Exit 97 Silt Interchange Study recommended designs. The eastbound ramp terminal eastbound left-turn is currently projected to operate at LOS F based on existing volumes in the AM peak hour. A roundabout at the I-70 eastbound ramps should incorporate the River Frontage Road & 9th Street intersection, as proposed in the conceptual designs.

Project Conditions:

- **River Frontage Road:** Construct eastbound right-turn deceleration lanes (435' total minimum length, inclusive of a 13.5:1 taper) at both proposed access points east of CR 311, one of which is the existing access that will be shared with the adjacent BLM office.

Since this study will serve the entire PUD and current land uses are projected based on density and assumed commercial/residential splits for mixed-use, traffic conformance memos may need to be prepared in the future with each individual site plan submittal as specific uses are proposed. This is anticipated to occur over a period of years as the site will develop in stages.

Tables and Figures:

Table 1 – Peak Hour Intersection LOS Summary

Table 2 – Trip Generation Summary

Figure 1 – Vicinity Map

Figure 2 – Site Plan

Figure 3 – Existing Traffic Volumes

Figure 4 – Year 2035 Background Traffic Volumes

Figure 5 – Year 2045 Background Traffic Volumes

Figure 6 – Site Generated Trips and Distribution

Figure 7 – Year 2035 Total Traffic Volumes with Project

Figure 8 – Year 2045 Total Traffic Volumes with Project

Table 1 - Peak Hour Intersection Level of Service Summary

Intersection and Lanes Groups	2022 Existing				2035 Background				2035 Bkgrd + Project				2045 Background				2045 Bkgrd + Project			
	AM Peak Delay LOS		PM Peak Delay LOS		AM Peak Delay LOS		PM Peak Delay LOS		AM Peak Delay LOS		PM Peak Delay LOS		AM Peak Delay LOS		PM Peak Delay LOS		AM Peak Delay LOS		PM Peak Delay LOS	
STOP SIGN CONTROL																				
9th St at I-70 Westbound Ramps	2	A	13	B																
Westbound Left+Through+Right	13	B	25	C	Analyzed as Signalized				Analyzed as Signalized				Analyzed as Roundabout				Analyzed as Roundabout			
Northbound Left+Through	10	A	8	A																
Southbound Through+Right	0	A	0	A																
9th St at I-70 Eastbound Ramps	89	F	7	A																
Eastbound Left	> 120	F	21	C	Analyzed as Signalized				Analyzed as Signalized				Analyzed as Roundabout				Analyzed as Roundabout			
Eastbound Through+Right	9	A	9	A																
Northbound Through+Right	0	A	0	A																
Southbound Left+Through	11	B	8	A																
9th St at River Frontage Rd	10	A	11	B	9	A	9	A	12	B	29	D								
Eastbound Left+Through	19	C	19	C	19	C	18	C	34	D	> 120	F	Analyzed as Roundabout				Analyzed as Roundabout			
Westbound Through+Right	10	A	10	A	9	A	10	A	10	A	12	B								
Southbound Left+Right	4	A	5	A	5	A	5	A	5	A	6	A								
Divide Creek Rd at River Frontage Rd	6	A	3	A	6	A	4	A	5	A	3	A	6	A	4	A	5	A	3	A
Eastbound Through+Right	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A
Westbound Left+Through	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A
Northbound Left+Right	11	B	10	A	10	A	10	A	12	B	13	B	11	B	10	A	13	B	15	B
Divide Creek Rd at Dry Hollow Rd	4	A	3	A	5	A	2	A	4	A	2	A	5	A	2	A	5	A	3	A
Eastbound Left+Right	11	B	10	A	10	A	10	A	11	B	10	A	11	B	10	A	11	B	10	A
Northwestbound Left+Through	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A
Southeastbound Through+Right	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A
Divide Creek Rd at Colorado River Rd	3	A	4	A	4	A	5	A	3	A	5	A	4	A	5	A	4	A	4	A
Eastbound Through+Right	1	A	0	A	2	A	0	A	3	A	3	A	2	A	4	A	2	A	4	A
Westbound Left+Through	6	A	6	A	7	A	7	A	3	A	7	A	8	A	6	A	5	A	7	A
Northbound Left+Right	3	A	2	A	5	A	3	A	3	A	3	A	4	A	3	A	4	A	3	A
Access at River Frontage Rd (New)									3	A	2	A					3	A	4	A
Westbound Left+Through									8	A	8	A					8	A	8	A
Northbound Left+Right									10	A	10	A					10	A	10	A
Access at River Frontage Rd (Shared BLM)									2	A	4	A					2	A	3	A
Westbound Left+Through									7	A	7	A					7	A	7	A
Northbound Left+Right									9	A	9	A					9	A	9	A
Access at Divide Creek Rd (New)									1	A	1	A					1	A	1	A
Eastbound Left+Through+Right									10	A	10	A					11	B	10	A
Westbound Left+Through+Right									10	A	10	A					10	A	10	A
Northbound Left+Through+Right									8	A	8	A					8	A	8	A
Southbound Left+Through+Right									8	A	8	A					8	A	8	A

Table 1 - Peak Hour Intersection Level of Service Summary

Intersection and Lanes Groups	2022 Existing				2035 Background				2035 Bkgrd + Project				2045 Background				2045 Bkgrd + Project			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
SIGNAL CONTROL																				
1. 9th St at I-70 Westbound Ramps					7	A	27	C	8	A	29	C								
Westbound Left+Through+Right	<i>Analyzed as Stop-Control</i>				25	C	37	D	36	D	35	C	<i>Analyzed as Roundabout</i>				<i>Analyzed as Roundabout</i>			
Northbound Left+Through					3	A	16	B	4	A	7	A								
Southbound Through+Right					7	A	16	B	5	A	4	A								
2. 9th St at I-70 Eastbound Ramps					23	C	12	B	32	C	14	B								
Eastbound Left	<i>Analyzed as Stop-Control</i>				21	C	16	B	33	C	16	B	<i>Analyzed as Roundabout</i>				<i>Analyzed as Roundabout</i>			
Eastbound Through+Right					21	C	14	B	34	C	15	B								
Northbound Through+Right					4	A	9	A	4	A	11	B								
Southbound Left+Through					30	C	12	B	43	D	16	B								
ROUNDABOUT																				
1. 9th St at I-70 Westbound Ramps																				
Westbound Left+Through+Right	<i>Analyzed as Stop-Control</i>				<i>Analyzed as Signalized</i>				<i>Analyzed as Signalized</i>				4	A	8	A	4	A	9	A
Westbound Right													1	A	2	A	0	A	2	A
Northbound Left+Through													5	A	6	A	5	A	6	A
Southbound Through+Right													7	A	5	A	8	A	6	A
2. 9th St / I-70 EB / River Frontage Rd																				
SE Bound Left+Through+Right	<i>Analyzed as Stop-Control</i>				<i>Analyzed as Signalized</i>				<i>Analyzed as Signalized</i>				15	C	7	A	18	C	9	A
NE Bound Left+Through+Right													12	B	6	A	13	B	8	A
NW Bound Left+Through													10	A	6	A	12	B	7	A
NW Bound Right													11	B	5	A	12	B	6	A
Southbound Left													9	A	4	A	10	A	4	A
Southbound Left+Right													4	A	4	A	4	A	5	A

Note: Delay represented in average seconds per vehicle.

Rislende PUD Traffic Impact Study

Table 2 - Trip Generation Estimate

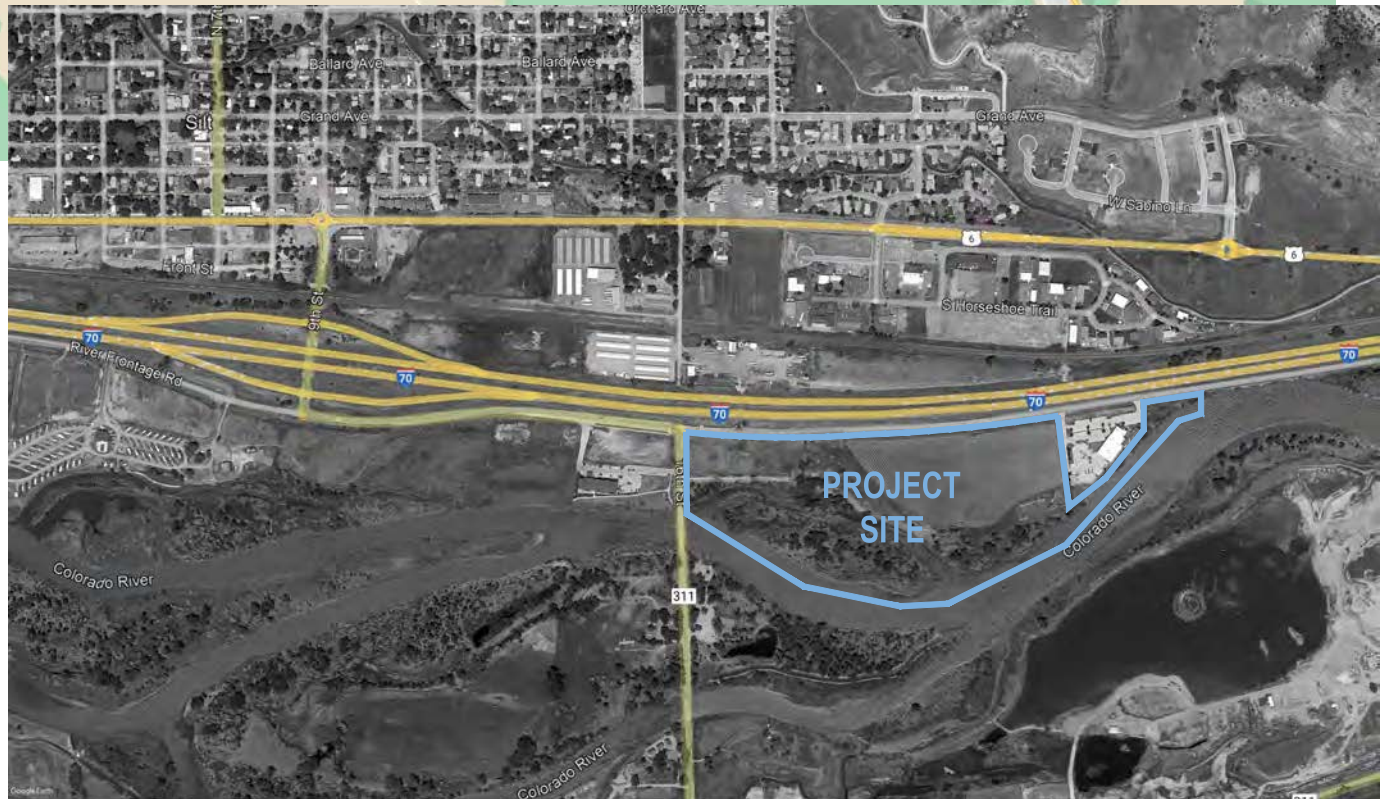
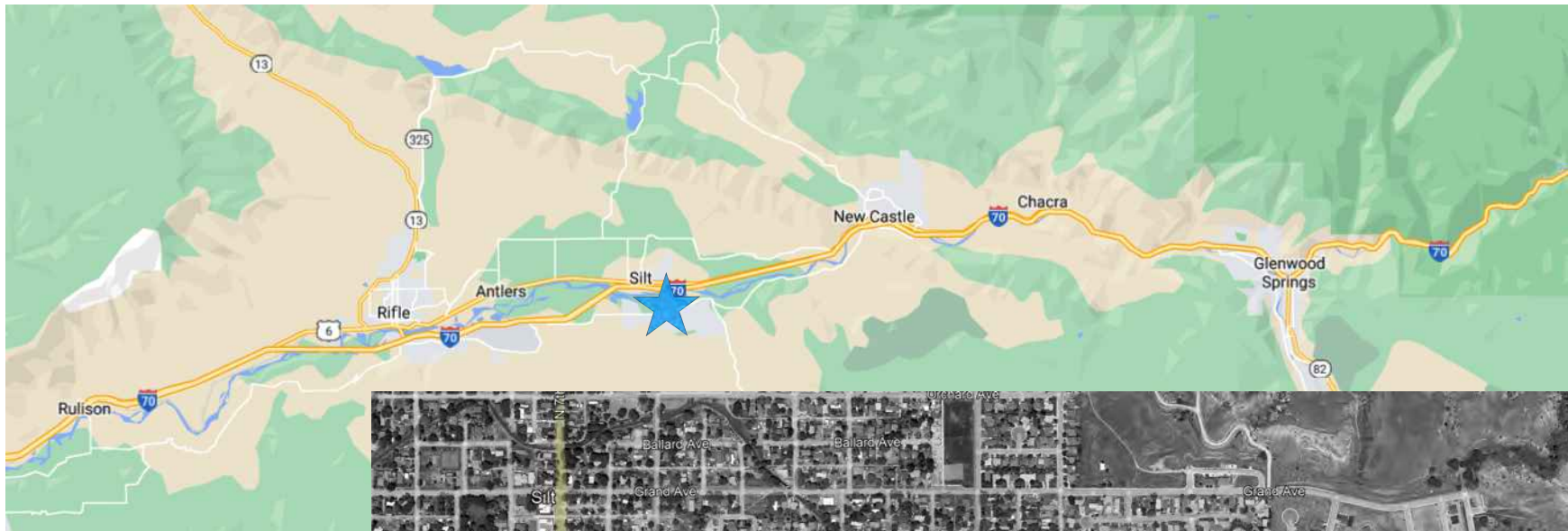
				MXD	Average Daily Trips			A.M. Peak Hour Trips				P.M. Peak Hour Trips				
Tract	Land Use	Size	Unit	Factor*	Rate	Total	In	Out	Rate	Total	In	Out	Rate	Total	In	Out
1	ITE 220-Multifamily Housing (Low-Rise)	72	DU	1.00	6.74	485	243	242	0.40	29	7	22	0.51	37	23	14
2	ITE 822-Strip Retail Plaza (<40k)	18	1,000 SF	0.90	54.45	882	441	441	2.36	38	23	15	6.59	107	53	54
	ITE 220-Multifamily Housing (Low-Rise)	30	DU	1.00	6.74	202	101	101	0.40	12	3	9	0.51	15	10	5
	Tract 2 Subtotal					1,084	542	542		50	26	24		122	63	59
3	ITE 822-Strip Retail Plaza (<40k)	10	1,000 SF	0.90	54.45	490	245	245	2.36	21	13	8	6.59	59	30	29
	ITE 220-Multifamily Housing (Low-Rise)	17	DU	1.00	6.74	115	57	58	0.40	7	2	5	0.51	9	5	4
	Tract 2 Subtotal					605	302	303		28	15	13		68	35	33
4	ITE 822-Strip Retail Plaza (<40k)	19	1,000 SF	0.90	54.45	931	466	465	2.36	40	24	16	6.59	113	56	57
	ITE 220-Multifamily Housing (Low-Rise)	32	DU	1.00	6.74	216	108	108	0.40	13	3	10	0.51	16	10	6
	Tract 2 Subtotal					1,147	574	573		53	27	26		129	66	63
5	ITE 210-Single-Family Detatched Housing	8	DU	1.00	9.43	75	38	37	0.70	6	3	3	0.92	7	4	3
6	Special Events Only ⁽¹⁾															
7	ITE 210-Single-Family Detatched Housing	8	DU	1.00	9.43	75	38	37	0.70	6	1	5	0.92	7	5	2
8	Ancilliary Use ⁽²⁾															
	Totals:					3,472	1,737	1,734		171	79	93		370	196	174

Source: ITE Trip Generation 11th Edition. 2021.

* MXD factor accounts for mixed-use and non-auto trips that occur between adjacent uses

⁽¹⁾ Tract 6 use projected to have a capacity of approx. 300 people (weddings, corporate events, annual dinners, etc.); not anticipated to occur during typical weekday and peak hour periods

⁽²⁾ Tract 8 use is proposed as open space/passive outdoor uses and not anticipated to generate separate trips from adjacent Tract 3 use



ACCESS #1

SIDE-STREET STOP CONTROLLED, FULL MOVEMENT

The diagram shows a plan view of a road intersection. A vertical road on the left has a 'RIGHT TURN LANE' labeled 'RD'. A horizontal road at the bottom is labeled '20.0' WIDE TE-3B'. Stationing points are marked along the horizontal road: 19+00, 14+00, 10+00, 06+00, and 02+00. A red line with square markers indicates a specific path or boundary. Project information is provided in the top right corner.

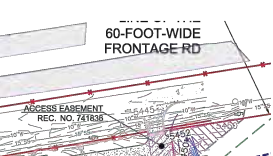
RD
RIGHT TURN LANE

20.0' WIDE TE-3B
CDDT PROJECT NO.
1-03-1128W REC. I
BLD.W: SILT TO CHAGRA

19+00 14+00 10+00 06+00 02+00

ACCESS #3

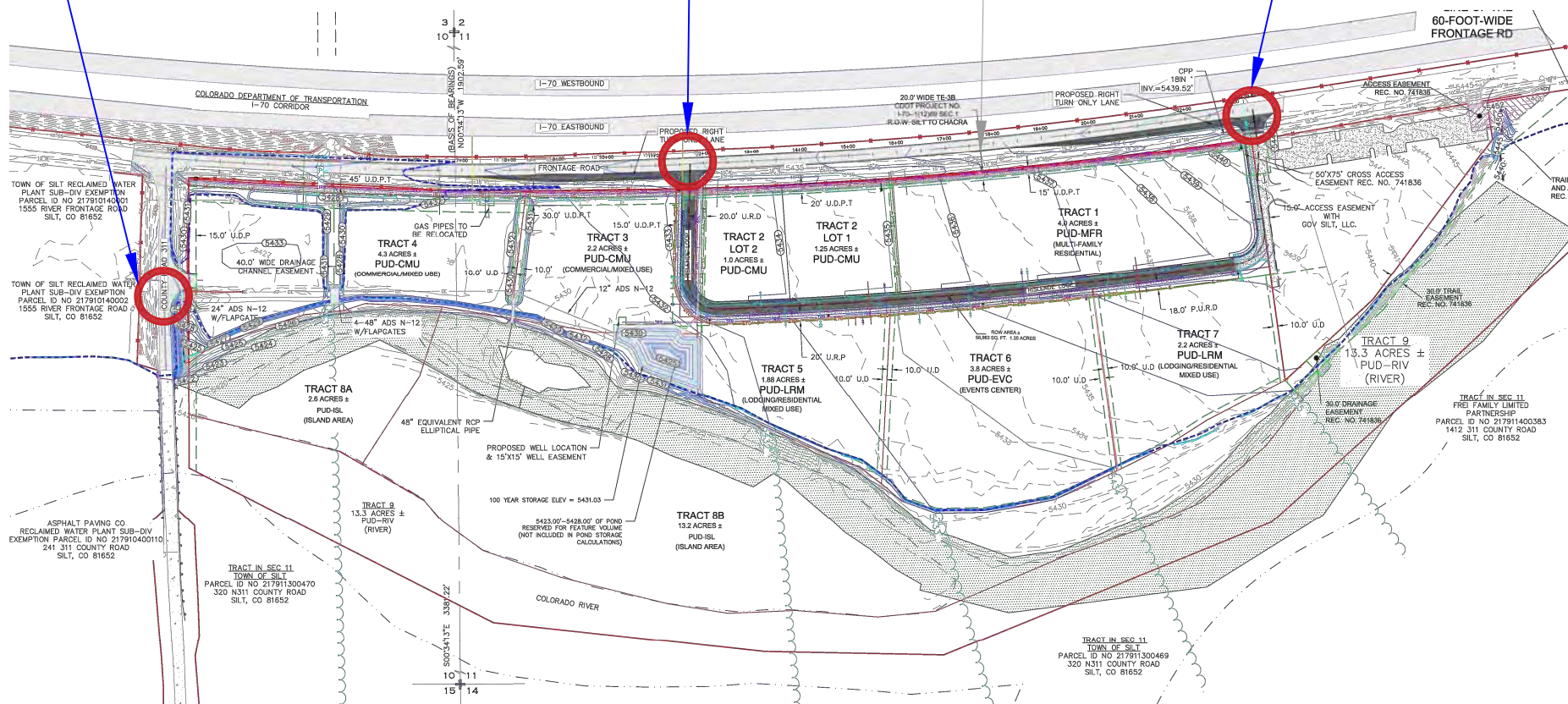
SIDE-STREET STOP CONTROLLED, FULL MOVEMENT (EXISTING)



60-FOOT-WIDE
FRONTAGE RD

ACCESS EASEMENT
REC. NO. 741838

NOTE: ACCESS #2 FROM PREVIOUS SITE PLAN HAS BEEN REMOVED



FOX TUTTLE
TRANSPORTATION GROUP

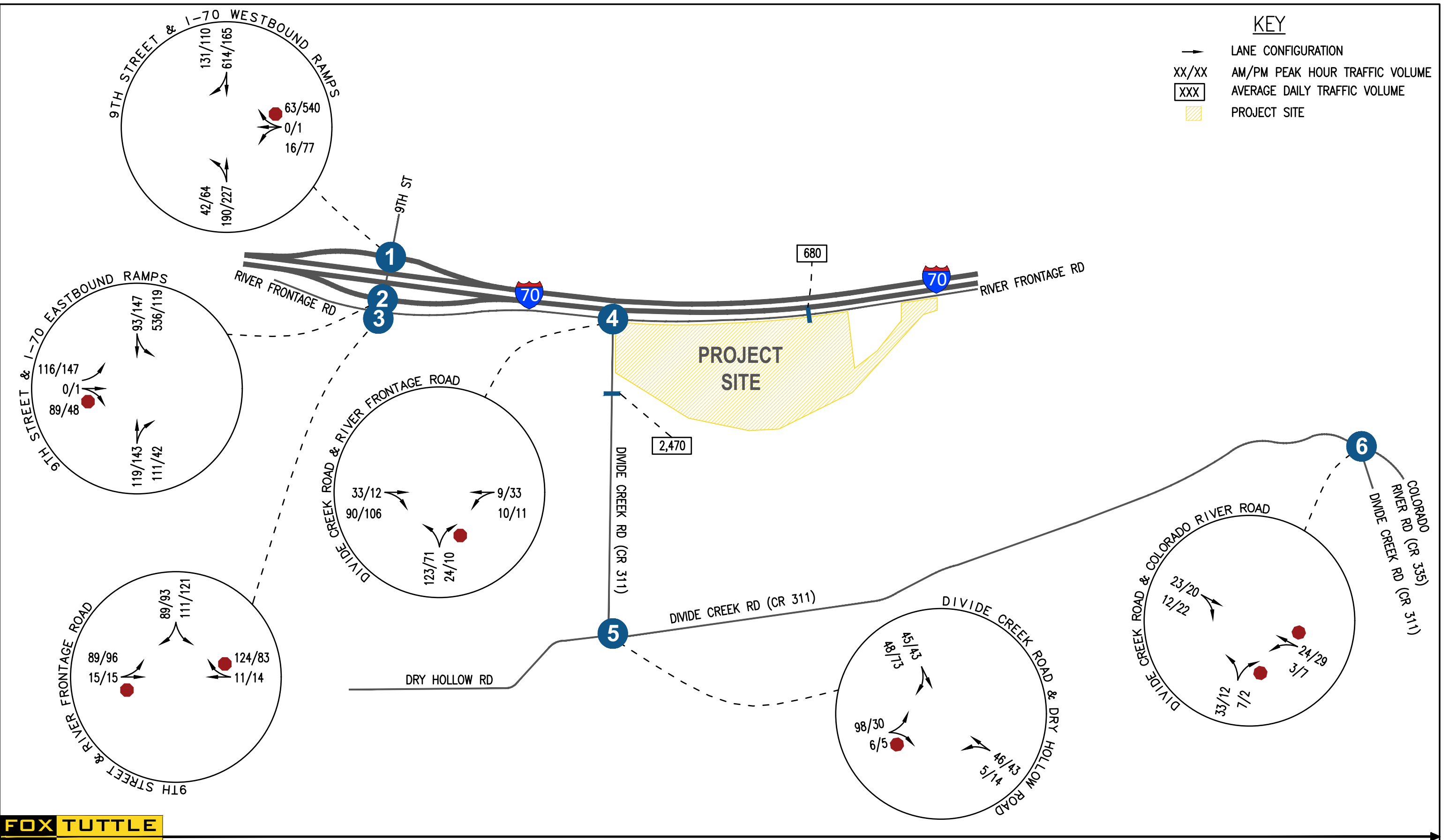
RISLENDE PUD TRAFFIC IMPACT STUDY - SILT, COLORADO

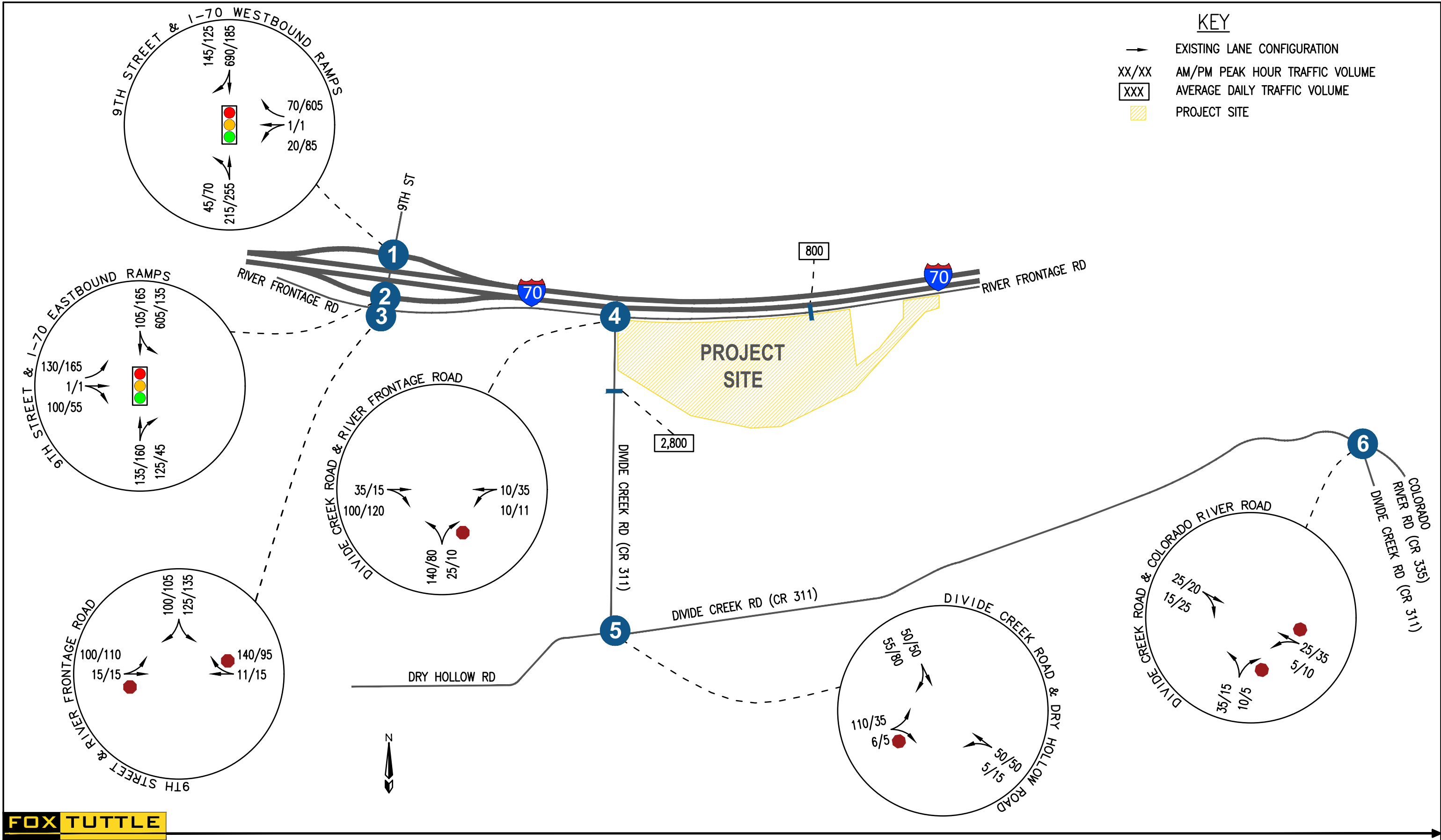
SITE PLAN AND ACCESS LOCATIONS

FT Project #	22025	Original Scale	NTS	Date	10/16/23	Drawn by	MAR	Figure #	2
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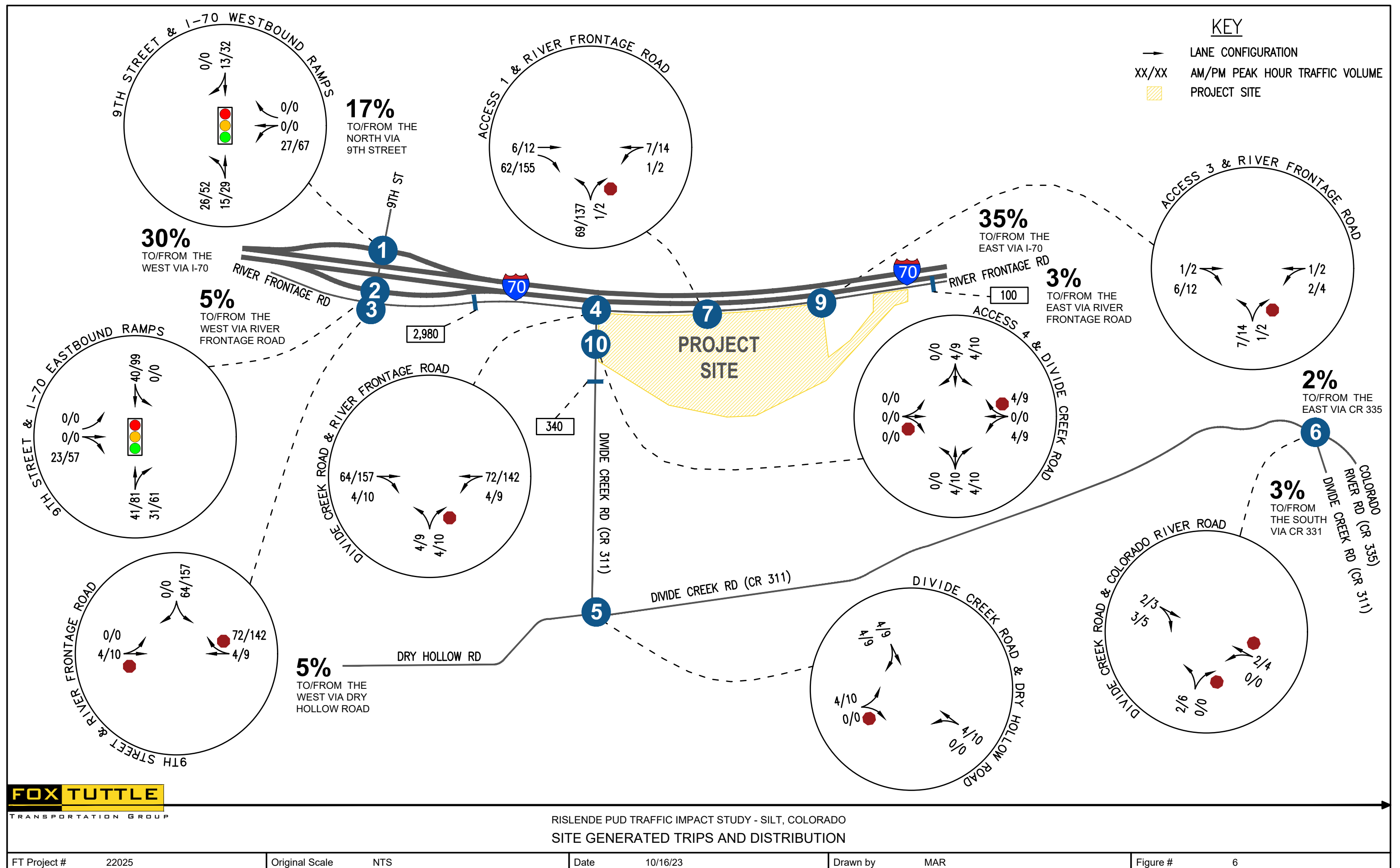
KEY

- LANE CONFIGURATION
- XX/XX AM/PM PEAK HOUR TRAFFIC VOLUME
- XXX AVERAGE DAILY TRAFFIC VOLUME
- PROJECT SITE



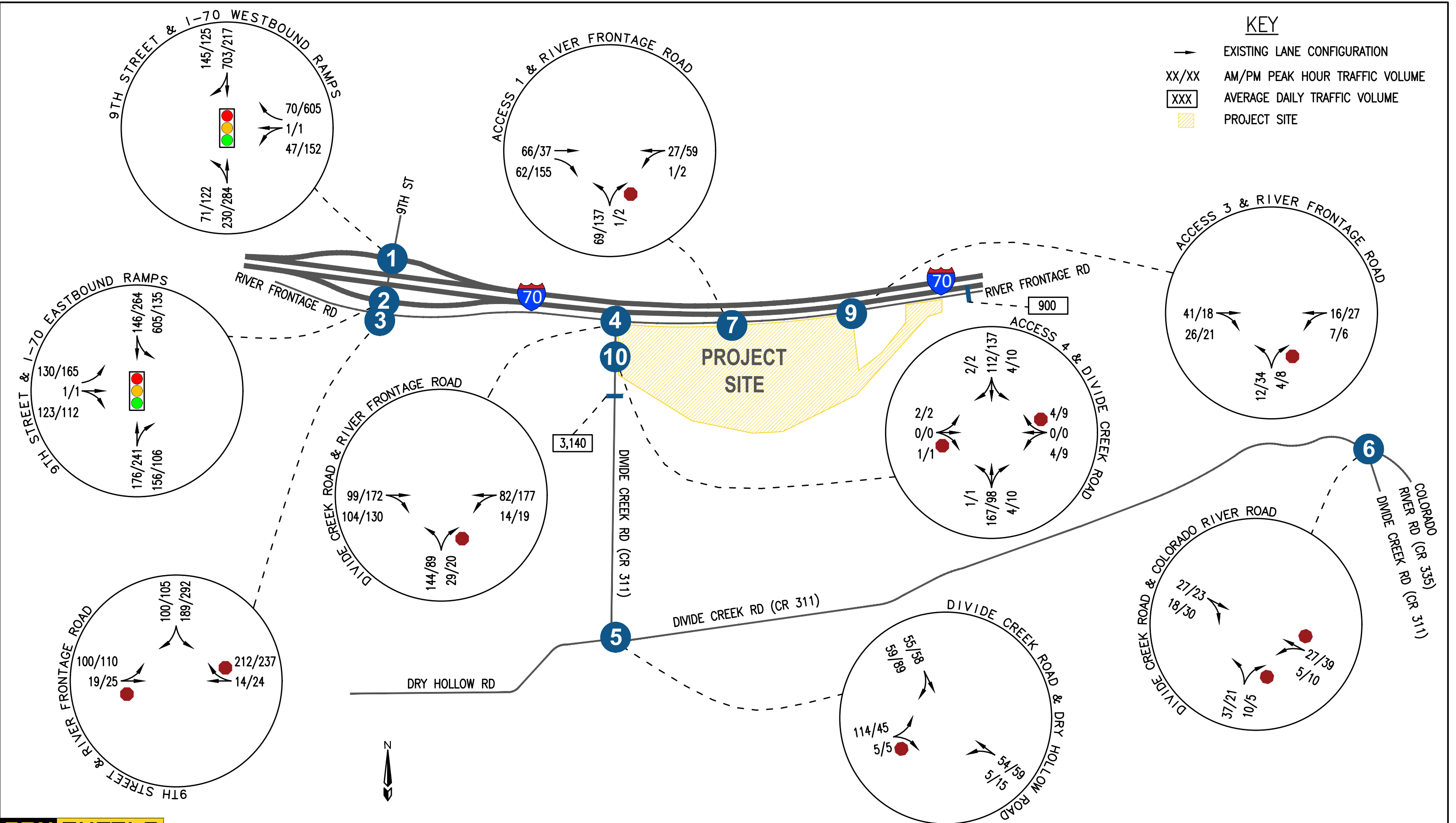






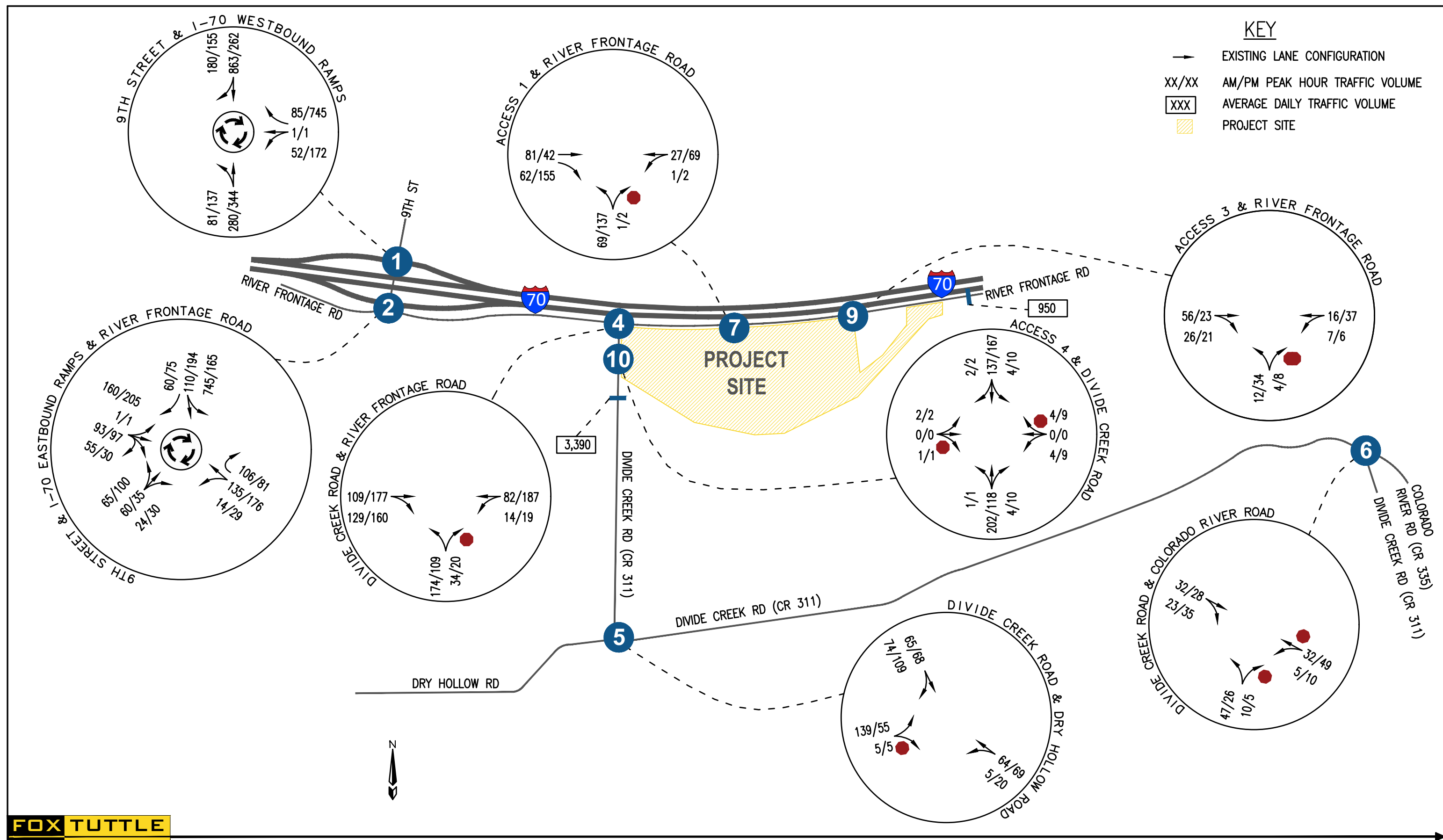
KEY

- EXISTING LANE CONFIGURATION
- XX/XX AM/PM PEAK HOUR TRAFFIC VOLUME
- XXX AVERAGE DAILY TRAFFIC VOLUME
- PROJECT SITE



KEY

- EXISTING LANE CONFIGURATION
- XX/XX AM/PM PEAK HOUR TRAFFIC VOLUME
- XXX AVERAGE DAILY TRAFFIC VOLUME
- PROJECT SITE



RISLENDE PUD TRAFFIC IMPACT STUDY - SILT, COLORADO YEAR 2045 TOTAL TRAFFIC VOLUMES WITH PROJECT

FT Project #	22025	Original Scale	NTS	Date	10/16/23	Drawn by	MAR	Figure #	8
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Appendix:

Level of Service Definitions

Existing Traffic Data

Intersection Capacity Worksheets



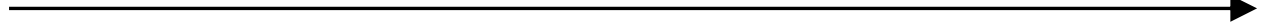
Level of Service Definitions

LEVEL OF SERVICE DEFINITIONS

In rating roadway and intersection operating conditions with existing or future traffic volumes, “Levels of Service” (LOS) A through F are used, with LOS A indicating very good operation and LOS F indicating poor operation. Levels of service at signalized and unsignalized intersections are closely associated with vehicle delays experienced in seconds per vehicle. More complete level of service definitions and delay data for signal and stop sign controlled intersections are contained in the following table for reference.

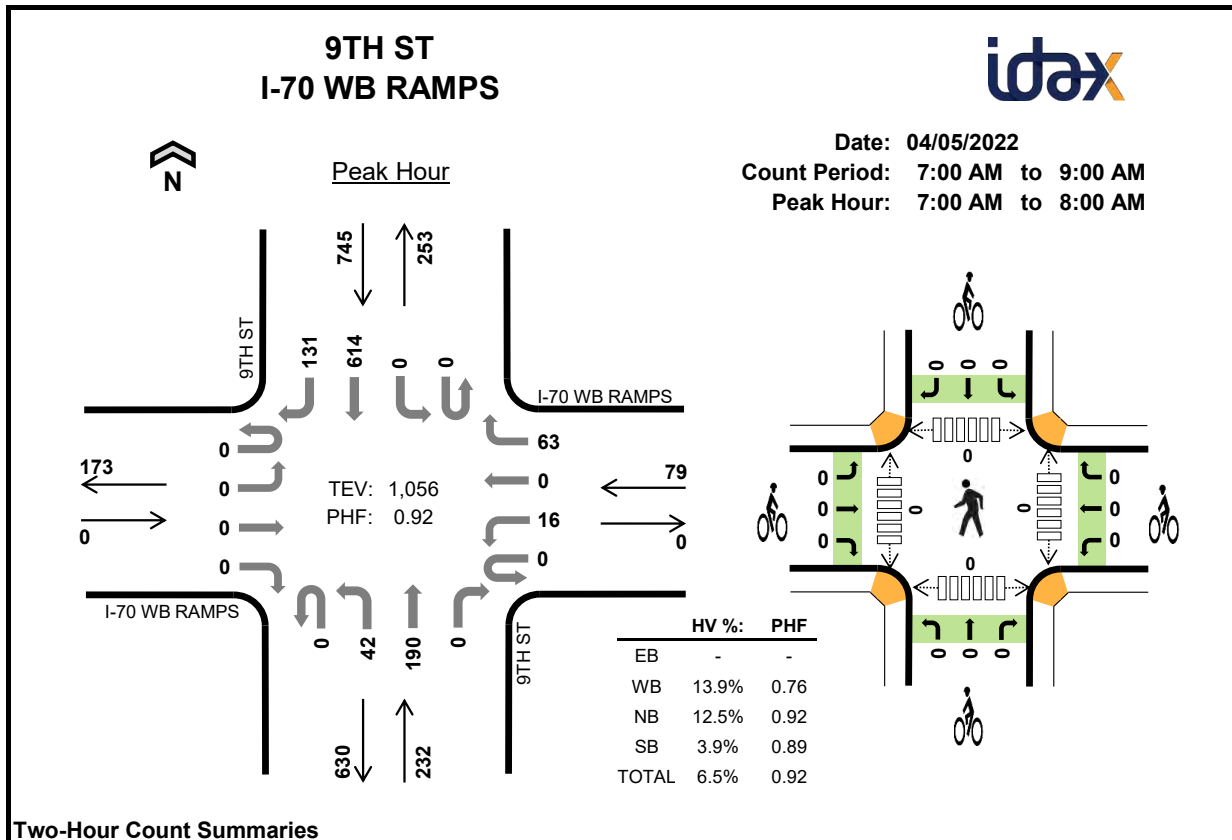
Level of Service Rating	Delay in seconds per vehicle (a)		Definition
	Signalized	Unsignalized	
A	0.0 to 10.0	0.0 to 10.0	Low vehicular traffic volumes; primarily free flow operations. Density is low and vehicles can freely maneuver within the traffic stream. Drivers are able to maintain their desired speeds with little or no delay.
B	10.1 to 20.0	10.1 to 15.0	Stable vehicular traffic volume flow with potential for some restriction of operating speeds due to traffic conditions. Vehicle maneuvering is only slightly restricted. The stopped delays are not bothersome and drivers are not subject to appreciable tension.
C	20.1 to 35.0	15.1 to 25.0	Stable traffic operations, however the ability for vehicles to maneuver is more restricted by the increase in traffic volumes. Relatively satisfactory operating speeds prevail, but adverse signal coordination or longer vehicle queues cause delays along the corridor.
D	35.1 to 55.0	25.1 to 35.0	Approaching unstable vehicular traffic flow where small increases in volume could cause substantial delays. Most drivers are restricted in ability to maneuver and selection of travel speeds due to congestion. Driver comfort and convenience are low, but tolerable.
E	55.1 to 80.0	35.1 to 50.0	Traffic operations characterized by significant approach delays and average travel speeds of one-half to one-third the free flow speed. Vehicular flow is unstable and there is potential for stoppages of brief duration. High signal density, extensive vehicle queuing, or corridor signal progression/timing are the typical causes of vehicle delays at signalized corridors.
F	> 80.0	> 50.0	Forced vehicular traffic flow and operations with high approach delays at critical intersections. Vehicle speeds are reduced substantially, and stoppages may occur for short or long periods of time because of downstream congestion.

(a) Delay ranges based on Highway Capacity Manual (6th Edition, 2016) criteria.



Existing Traffic Data





Two-Hour Count Summaries

Interval Start		I-70 WB RAMPS				I-70 WB RAMPS				9TH ST				9TH ST				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM		0	0	0	0	0	5	0	13	0	5	57	0	0	0	130	28	238	0
7:15 AM		0	0	0	0	0	4	0	17	0	14	40	0	0	0	162	29	266	0
7:30 AM		0	0	0	0	0	3	0	11	0	14	49	0	0	0	176	33	286	0
7:45 AM		0	0	0	0	0	4	0	22	0	9	44	0	0	0	146	41	266	1,056
8:00 AM		0	0	0	0	0	8	0	17	0	10	29	0	0	0	130	30	224	1,042
8:15 AM		0	0	0	0	0	6	1	19	0	9	25	0	0	0	87	38	185	961
8:30 AM		0	0	0	0	0	5	0	23	0	9	23	0	0	0	67	25	152	827
8:45 AM		0	0	0	0	0	7	0	17	0	12	32	0	0	0	68	28	164	725
Count Total		0	0	0	0	0	42	1	139	0	82	299	0	0	0	966	252	1,781	0
Peak Hour	All	0	0	0	0	0	16	0	63	0	42	190	0	0	0	614	131	1,056	0
	HV	0	0	0	0	0	3	0	8	0	14	15	0	0	0	20	9	69	0
	HV%	-	-	-	-	-	19%	-	13%	-	33%	8%	-	-	-	3%	7%	7%	0

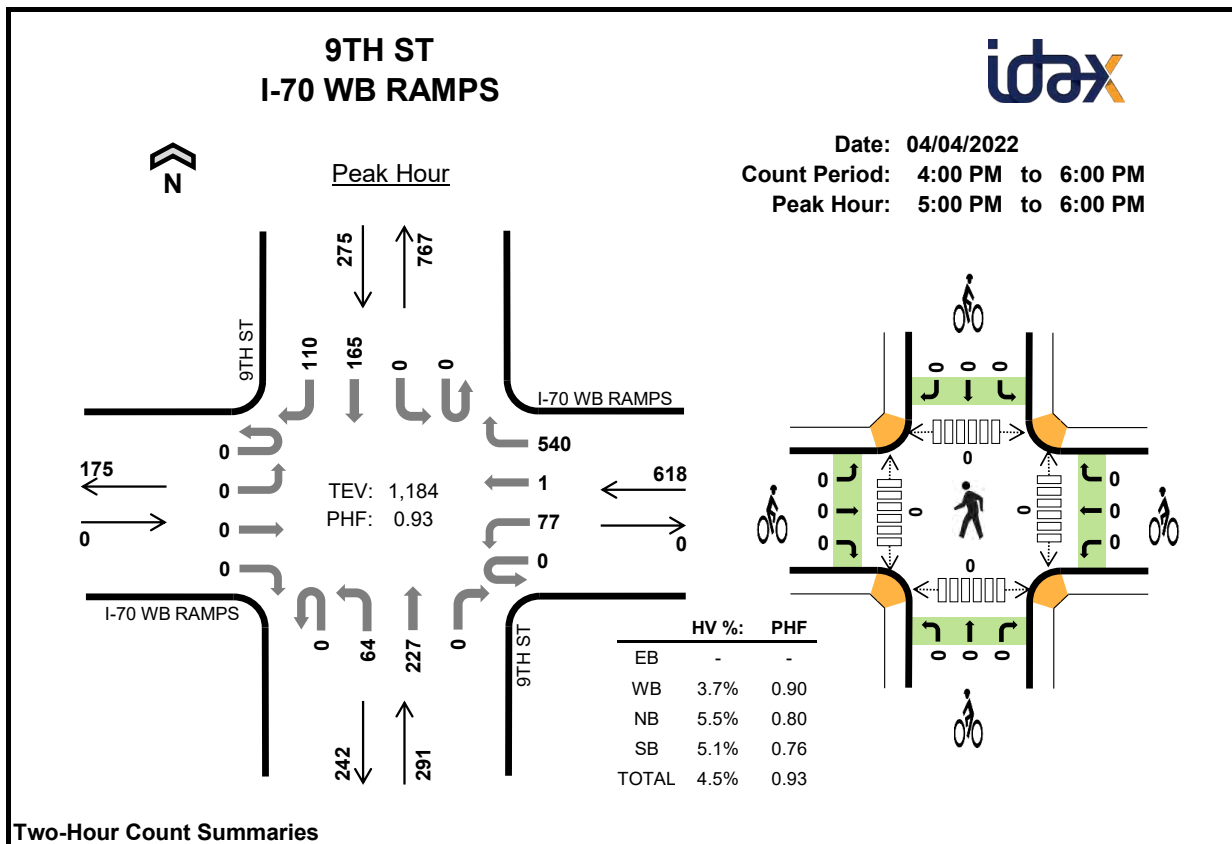
Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

[illegible]

Two-Hour Count Summaries - Heavy Vehicles																			
Interval Start	I-70 WB RAMPS				I-70 WB RAMPS				9TH ST				9TH ST				15-min Total	Rolling One Hour	
	Eastbound				Westbound				Northbound				Southbound						
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT			
7:00 AM	0	0	0	0	0	1	0	0	0	0	0	5	0	0	0	5	2	13	0
7:15 AM	0	0	0	0	0	1	0	4	0	0	6	2	0	0	0	3	2	18	0
7:30 AM	0	0	0	0	0	1	0	1	0	0	4	4	0	0	0	8	2	20	0
7:45 AM	0	0	0	0	0	0	0	3	0	0	4	4	0	0	0	4	3	18	69
8:00 AM	0	0	0	0	0	1	0	2	0	0	4	3	0	0	0	5	2	17	73
8:15 AM	0	0	0	0	0	2	1	1	0	0	4	5	0	0	0	4	4	21	76
8:30 AM	0	0	0	0	0	1	0	0	0	0	5	2	0	0	0	3	4	15	71
8:45 AM	0	0	0	0	0	5	0	0	0	0	4	5	0	0	0	4	4	22	75
Count Total	0	0	0	0	0	12	1	11	0	0	31	30	0	0	0	36	23	144	0
Peak Hour	0	0	0	0	0	3	0	8	0	0	14	15	0	0	0	20	9	69	0

Two-Hour Count Summaries - Bikes																		
Interval Start	I-70 WB RAMPS				I-70 WB RAMPS				9TH ST				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	LT	TH	RT		LT	TH	RT		LT	TH	RT		LT	TH	RT			
7:00 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
7:15 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
7:30 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
7:45 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:00 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:15 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:30 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:45 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
Count Total	0	0	0		0	0	0		0	0	0		0	0	0		0	0
Peak Hour	0	0	0		0	0	0		0	0	0		0	0	0		0	0

Note: U-Turn volumes for bikes are included in Left-Turn, if any.



Two-Hour Count Summaries

Interval Start		I-70 WB RAMPS				I-70 WB RAMPS				9TH ST				9TH ST				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM		0	0	0	0	0	11	1	84	0	18	49	0	0	0	47	22	232	0
4:15 PM		0	0	0	0	0	12	1	100	0	12	62	0	0	0	45	38	270	0
4:30 PM		0	0	0	0	0	15	2	103	0	4	49	0	0	0	54	31	258	0
4:45 PM		0	0	0	0	0	15	3	78	0	10	55	0	0	0	37	28	226	986
5:00 PM		0	0	0	0	0	22	0	116	0	18	73	0	0	0	50	40	319	1,073
5:15 PM		0	0	0	0	0	22	1	141	0	14	65	0	0	0	50	24	317	1,120
5:30 PM		0	0	0	0	0	18	0	154	0	17	48	0	0	0	38	20	295	1,157
5:45 PM		0	0	0	0	0	15	0	129	0	15	41	0	0	0	27	26	253	1,184
Count Total		0	0	0	0	0	130	8	905	0	108	442	0	0	0	348	229	2,170	0
Peak Hour	All	0	0	0	0	0	77	1	540	0	64	227	0	0	0	165	110	1,184	0
	HV	0	0	0	0	0	5	0	18	0	6	10	0	0	0	8	6	53	0
	HV%	-	-	-	-	-	6%	0%	3%	-	9%	4%	-	-	-	5%	5%	4%	0

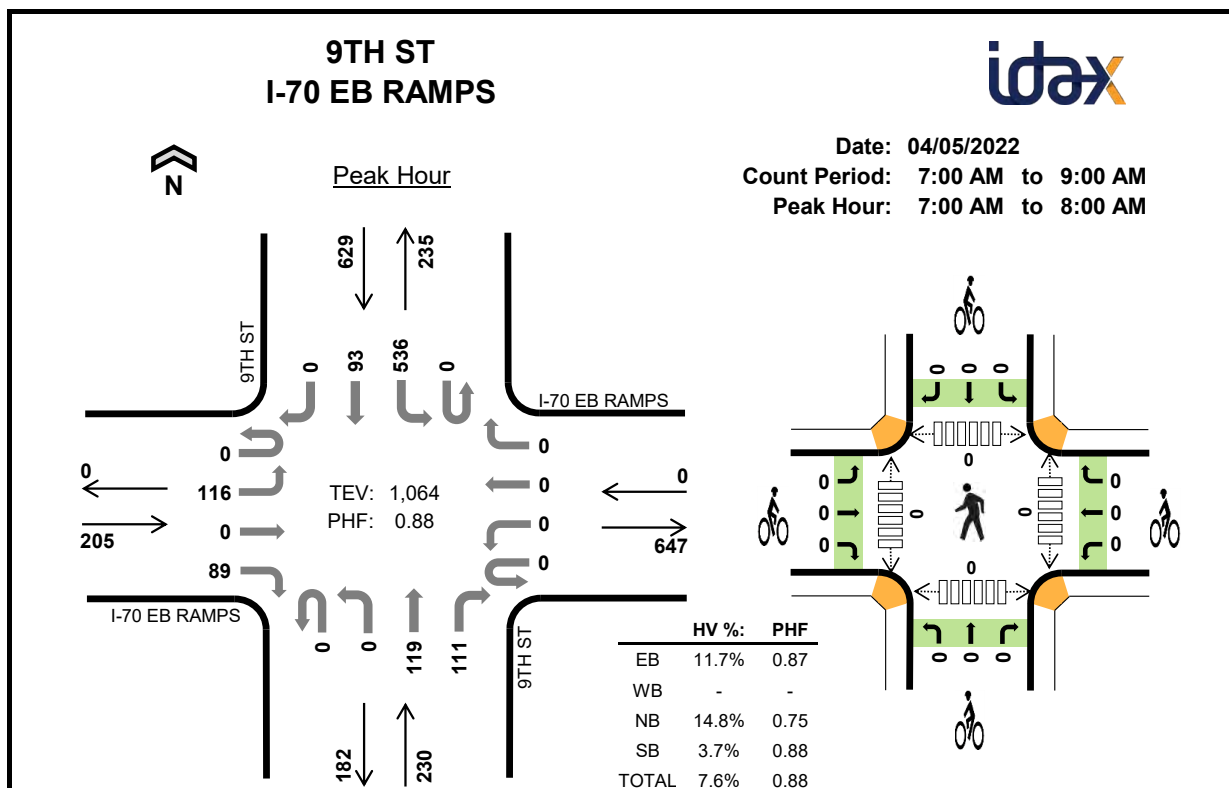
Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

[illegible]

Two-Hour Count Summaries - Heavy Vehicles																		
Interval Start	I-70 WB RAMPS				I-70 WB RAMPS				9TH ST				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	1	1	6	0	1	4	0	0	0	1	1	15	0
4:15 PM	0	0	0	0	0	0	0	6	0	3	1	0	0	0	1	3	14	0
4:30 PM	0	0	0	0	0	3	0	4	0	1	2	0	0	0	1	1	12	0
4:45 PM	0	0	0	0	0	1	2	2	0	0	1	0	0	0	5	1	12	53
5:00 PM	0	0	0	0	0	0	0	2	0	1	2	0	0	0	2	3	10	48
5:15 PM	0	0	0	0	0	4	0	8	0	2	2	0	0	0	1	3	20	54
5:30 PM	0	0	0	0	0	1	0	5	0	3	2	0	0	0	2	0	13	55
5:45 PM	0	0	0	0	0	0	0	3	0	0	4	0	0	0	3	0	10	53
Count Total	0	0	0	0	0	10	3	36	0	11	18	0	0	0	16	12	106	0
Peak Hour	0	0	0	0	0	5	0	18	0	6	10	0	0	0	8	6	53	0

Two-Hour Count Summaries - Bikes																		
Interval Start	I-70 WB RAMPS			I-70 WB RAMPS			9TH ST			9TH ST			15-min Total	Rolling One Hour				
	Eastbound			Westbound			Northbound			Southbound								
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT						
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0				

Note: U-Turn volumes for bikes are included in Left-Turn, if any.



Two-Hour Count Summaries

Interval Start		I-70 EB RAMPs				I-70 EB RAMPs				9TH ST				9TH ST				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM		0	37	0	17	0	0	0	0	0	0	27	28	0	118	19	0	246	0
7:15 AM		0	22	0	24	0	0	0	0	0	0	30	24	0	148	19	0	267	0
7:30 AM		0	24	0	22	0	0	0	0	0	0	39	38	0	150	28	0	301	0
7:45 AM		0	33	0	26	0	0	0	0	0	0	23	21	0	120	27	0	250	1,064
8:00 AM		0	18	1	21	0	0	0	0	0	0	19	20	0	106	34	0	219	1,037
8:15 AM		0	15	0	16	0	0	0	0	0	0	21	14	0	68	23	0	157	927
8:30 AM		0	16	1	11	0	0	0	0	0	0	14	15	0	58	15	0	130	756
8:45 AM		0	23	0	18	0	0	0	0	0	0	22	7	0	53	21	0	144	650
Count Total		0	188	2	155	0	0	0	0	0	0	195	167	0	821	186	0	1,714	0
Peak Hour	All	0	116	0	89	0	0	0	0	0	0	119	111	0	536	93	0	1,064	0
	HV	0	10	0	14	0	0	0	0	0	0	20	14	0	18	5	0	81	0
	HV%	-	9%	-	16%	-	-	-	-	-	-	17%	13%	-	3%	5%	-	8%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

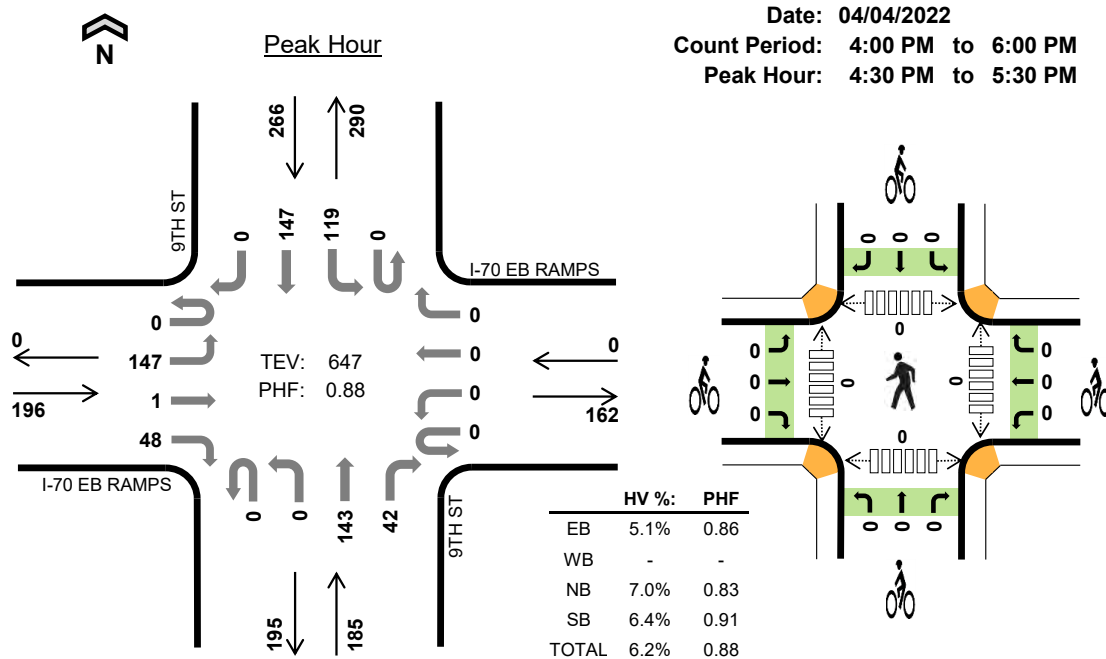
Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
7:00 AM	4	0	10	6	20	0	0	0	0	0	0	0	0	0	0
7:15 AM	6	0	10	4	20	0	0	0	0	0	0	0	0	0	0
7:30 AM	6	0	8	10	24	0	0	0	0	0	0	0	0	0	0
7:45 AM	8	0	6	3	17	0	0	0	0	0	0	0	0	0	0
8:00 AM	8	0	6	7	21	0	0	0	0	0	0	0	0	0	0
8:15 AM	9	0	9	6	24	0	0	0	0	0	0	0	0	0	0
8:30 AM	6	0	8	4	18	0	0	0	0	0	0	0	0	0	0
8:45 AM	11	0	7	9	27	0	0	0	0	0	0	0	0	0	0
Count Total	58	0	64	49	171	0	0	0	0	0	0	0	0	0	0
Peak Hour	24	0	34	23	81	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles																		
Interval Start	I-70 EB RAMPS				I-70 EB RAMPS				9TH ST				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	1	0	3	0	0	0	0	0	0	4	6	0	4	2	0	20	0
7:15 AM	0	1	0	5	0	0	0	0	0	0	6	4	0	3	1	0	20	0
7:30 AM	0	4	0	2	0	0	0	0	0	0	5	3	0	8	2	0	24	0
7:45 AM	0	4	0	4	0	0	0	0	0	0	5	1	0	3	0	0	17	81
8:00 AM	0	3	0	5	0	0	0	0	0	0	3	3	0	3	4	0	21	82
8:15 AM	0	4	0	5	0	0	0	0	0	0	6	3	0	1	5	0	24	86
8:30 AM	0	3	0	3	0	0	0	0	0	0	3	5	0	2	2	0	18	80
8:45 AM	0	5	0	6	0	0	0	0	0	0	5	2	0	2	7	0	27	90
Count Total	0	25	0	33	0	0	0	0	0	0	37	27	0	26	23	0	171	0
Peak Hour	0	10	0	14	0	0	0	0	0	0	20	14	0	18	5	0	81	0

Two-Hour Count Summaries - Bikes																	
Interval Start	I-70 EB RAMPS			I-70 EB RAMPS			9TH ST			9TH ST			15-min Total	Rolling One Hour			
	Eastbound			Westbound			Northbound			Southbound							
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT					
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0			

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

9TH ST I-70 EB RAMP



Two-Hour Count Summaries

Interval Start		I-70 EB RAMPs				I-70 EB RAMPs				9TH ST				9TH ST				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
	4:00 PM	0	31	0	8	0	0	0	0	0	0	34	9	0	26	30	0	138	0
	4:15 PM	0	30	0	17	0	0	0	0	0	0	42	11	0	23	33	0	156	0
	4:30 PM	0	27	0	9	0	0	0	0	0	0	28	13	0	40	30	0	147	0
	4:45 PM	0	35	1	16	0	0	0	0	0	0	29	6	0	20	34	0	141	582
	5:00 PM	0	49	0	8	0	0	0	0	0	0	44	9	0	30	43	0	183	627
	5:15 PM	0	36	0	15	0	0	0	0	0	0	42	14	0	29	40	0	176	647
	5:30 PM	0	29	0	20	0	0	0	0	0	0	35	2	0	15	40	0	141	641
	5:45 PM	0	28	0	8	0	0	0	0	0	0	29	5	0	14	29	0	113	613
Count Total		0	265	1	101	0	0	0	0	0	0	283	69	0	197	279	0	1,195	0
Peak Hour	All	0	147	1	48	0	0	0	0	0	0	143	42	0	119	147	0	647	0
	HV	0	4	0	6	0	0	0	0	0	0	7	6	0	2	15	0	40	0
	HV%	-	3%	0%	13%	-	-	-	-	-	-	5%	14%	-	2%	10%	-	6%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

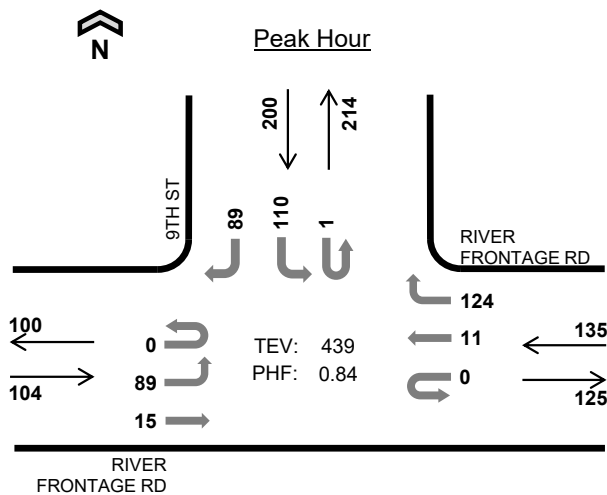
Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
4:00 PM	4	0	5	2	11	0	0	0	0	0	0	1	0	0	1
4:15 PM	4	0	7	1	12	0	0	0	0	0	0	1	0	0	1
4:30 PM	3	0	2	4	9	0	0	0	0	0	0	0	0	0	0
4:45 PM	2	0	2	7	11	0	0	0	0	0	0	0	0	0	0
5:00 PM	2	0	3	1	6	0	0	0	0	0	0	0	0	0	0
5:15 PM	3	0	6	5	14	0	0	0	0	0	0	0	0	0	0
5:30 PM	5	0	4	3	12	0	0	0	0	0	0	0	0	0	0
5:45 PM	2	0	4	3	9	0	0	0	0	0	0	0	0	0	0
Count Total	25	0	33	26	84	0	0	0	0	0	0	2	0	0	2
Peak Hour	10	0	13	17	40	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles																		
Interval Start	I-70 EB RAMPS				I-70 EB RAMPS				9TH ST				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	2	0	2	0	0	0	0	0	0	3	2	0	1	1	0	11	0
4:15 PM	0	0	0	4	0	0	0	0	0	0	4	3	0	1	0	0	12	0
4:30 PM	0	2	0	1	0	0	0	0	0	0	1	1	0	1	3	0	9	0
4:45 PM	0	0	0	2	0	0	0	0	0	0	1	1	0	0	7	0	11	43
5:00 PM	0	1	0	1	0	0	0	0	0	0	2	1	0	1	0	0	6	38
5:15 PM	0	1	0	2	0	0	0	0	0	0	3	3	0	0	5	0	14	40
5:30 PM	0	1	0	4	0	0	0	0	0	0	4	0	0	1	2	0	12	43
5:45 PM	0	1	0	1	0	0	0	0	0	0	3	1	0	0	3	0	9	41
Count Total	0	8	0	17	0	0	0	0	0	0	21	12	0	5	21	0	84	0
Peak Hour	0	4	0	6	0	0	0	0	0	0	7	6	0	2	15	0	40	0

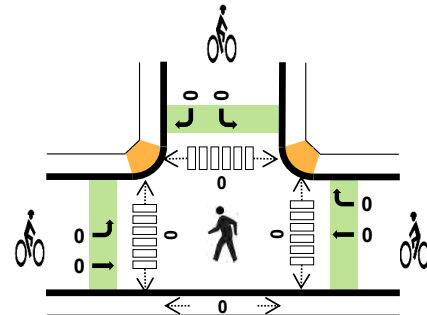
Two-Hour Count Summaries - Bikes																		
Interval Start	I-70 EB RAMPS			I-70 EB RAMPS			9TH ST			9TH ST			15-min Total	Rolling One Hour				
	Eastbound			Westbound			Northbound			Southbound								
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT						
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0				

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

9TH ST RIVER FRONTAGE RD



Date: 04/05/2022
Count Period: 7:00 AM to 9:00 AM
Peak Hour: 7:15 AM to 8:15 AM



	HV %:	PHF
EB	14.4%	0.68
WB	11.9%	0.77
NB	-	-
SB	12.0%	0.93
TOTAL	12.5%	0.84

Two-Hour Count Summaries

Interval Start		RIVER FRONTAGE RD				RIVER FRONTAGE RD				n/a				9TH ST				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM		0	29	1	0	0	0	3	25	0	0	0	0	0	23	0	13	94	0
7:15 AM		0	24	2	0	0	0	6	30	0	0	0	0	0	17	0	27	106	0
7:30 AM		0	34	4	0	0	0	2	42	0	0	0	0	0	24	0	24	130	0
7:45 AM		0	14	2	0	0	0	2	30	0	0	0	0	1	35	0	18	102	432
8:00 AM		0	17	7	0	0	0	1	22	0	0	0	0	0	34	0	20	101	439
8:15 AM		0	15	2	0	0	0	2	20	0	0	0	0	0	24	0	17	80	413
8:30 AM		0	18	4	0	0	0	2	10	0	0	0	0	0	15	0	10	59	342
8:45 AM		0	16	2	0	0	0	3	14	0	0	0	0	0	20	0	20	75	315
Count Total		0	167	24	0	0	0	21	193	0	0	0	0	1	192	0	149	747	0
Peak Hour	All	0	89	15	0	0	0	11	124	0	0	0	0	1	110	0	89	439	0
	HV	0	14	1	0	0	0	0	16	0	0	0	0	0	12	0	12	55	0
	HV%	-	16%	7%	-	-	-	0%	13%	-	-	-	-	0%	11%	-	13%	13%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

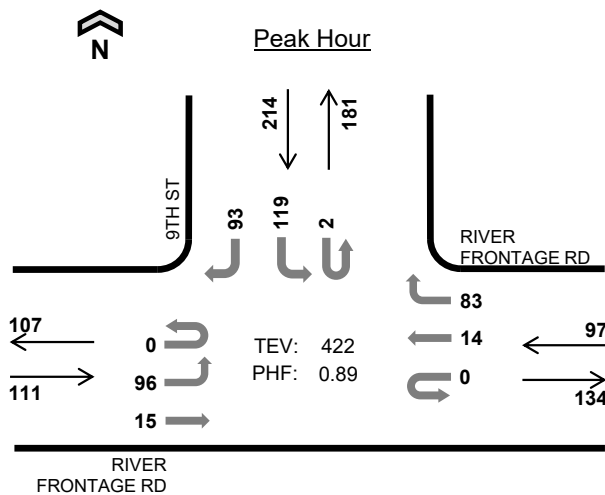
Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
7:00 AM	3	7	0	5	15	0	0	0	0	0	0	0	0	0	0
7:15 AM	4	6	0	6	16	0	0	0	0	0	0	0	0	0	0
7:30 AM	5	3	0	4	12	0	0	0	0	0	0	0	0	0	0
7:45 AM	3	3	0	6	12	0	0	0	0	0	0	0	0	0	0
8:00 AM	3	4	0	8	15	0	0	0	0	0	0	0	0	0	0
8:15 AM	5	7	0	9	21	0	0	0	0	0	0	0	0	0	0
8:30 AM	9	1	0	5	15	0	0	0	0	0	0	0	0	0	0
8:45 AM	2	5	0	13	20	0	0	0	0	0	0	0	0	0	0
Count Total	34	36	0	56	126	0	0	0	0	0	0	0	0	0	0
Peak Hr	15	16	0	24	55	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles																		
Interval Start	RIVER FRONTAGE RD				RIVER FRONTAGE RD				n/a				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	3	0	0	0	0	0	7	0	0	0	0	0	4	0	1	15	0
7:15 AM	0	3	1	0	0	0	0	6	0	0	0	0	0	3	0	3	16	0
7:30 AM	0	5	0	0	0	0	0	3	0	0	0	0	0	1	0	3	12	0
7:45 AM	0	3	0	0	0	0	0	3	0	0	0	0	0	4	0	2	12	55
8:00 AM	0	3	0	0	0	0	0	4	0	0	0	0	0	4	0	4	15	55
8:15 AM	0	5	0	0	0	0	2	5	0	0	0	0	0	2	0	7	21	60
8:30 AM	0	7	2	0	0	0	0	1	0	0	0	0	0	4	0	1	15	63
8:45 AM	0	2	0	0	0	0	0	5	0	0	0	0	0	8	0	5	20	71
Count Total	0	31	3	0	0	0	2	34	0	0	0	0	0	30	0	26	126	0
Peak Hour	0	14	1	0	0	0	0	16	0	0	0	0	0	12	0	12	55	0

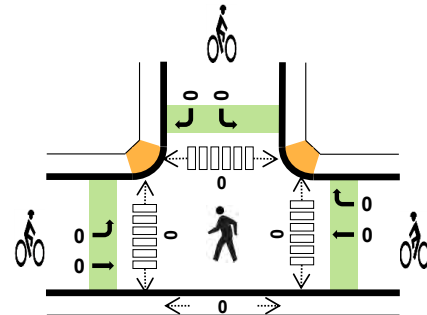
Two-Hour Count Summaries - Bikes																		
Interval Start	RIVER FRONTAGE RD				RIVER FRONTAGE RD				n/a				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	LT	TH	RT		LT	TH	RT		LT	TH	RT		LT	TH	RT			
7:00 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
7:15 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
7:30 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
7:45 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:00 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:15 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:30 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
8:45 AM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
Count Total	0	0	0		0	0	0		0	0	0		0	0	0		0	0
Peak Hour	0	0	0		0	0	0		0	0	0		0	0	0		0	0

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

9TH ST RIVER FRONTAGE RD



Date: 04/04/2022
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 4:45 PM to 5:45 PM



	HV %:	PHF
EB	12.6%	0.65
WB	7.2%	0.69
NB	-	-
SB	10.7%	0.92
TOTAL	10.4%	0.89

Two-Hour Count Summaries

Interval Start		RIVER FRONTAGE RD				RIVER FRONTAGE RD				n/a				9TH ST				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM		0	20	3	0	0	0	6	24	0	0	0	0	0	27	0	12	92	0
4:15 PM		0	22	4	0	0	0	3	29	0	0	0	0	0	25	0	25	108	0
4:30 PM		0	17	1	0	0	0	4	25	0	0	0	0	0	23	0	16	86	0
4:45 PM		0	19	6	0	0	0	2	15	0	0	0	0	0	30	0	20	92	378
5:00 PM		0	23	2	0	0	0	6	29	0	0	0	0	0	25	0	27	112	398
5:15 PM		0	37	6	0	0	0	3	19	0	0	0	0	1	29	0	24	119	409
5:30 PM		0	17	1	0	0	0	3	20	0	0	0	0	1	35	0	22	99	422
5:45 PM		0	20	1	0	0	0	0	15	0	0	0	0	0	17	0	20	73	403
Count Total		0	175	24	0	0	0	27	176	0	0	0	0	2	211	0	166	781	0
Peak Hour	All	0	96	15	0	0	0	14	83	0	0	0	0	2	119	0	93	422	0
	HV	0	12	2	0	0	0	3	4	0	0	0	0	0	10	0	13	44	0
	HV%	-	13%	13%	-	-	-	21%	5%	-	-	-	-	0%	8%	-	14%	10%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
4:00 PM	2	3	0	3	8	0	0	0	0	0	0	0	0	0	0
4:15 PM	4	4	0	4	12	0	0	0	0	0	0	0	0	0	0
4:30 PM	1	0	0	4	5	0	0	0	0	0	0	0	0	0	0
4:45 PM	3	1	0	9	13	0	0	0	0	0	0	0	0	0	0
5:00 PM	1	4	0	1	6	0	0	0	0	0	0	0	0	0	0
5:15 PM	8	0	0	7	15	0	0	0	0	0	0	0	0	0	0
5:30 PM	2	2	0	6	10	0	0	0	0	0	0	0	0	0	0
5:45 PM	4	0	0	4	8	0	0	0	0	0	0	0	0	0	0
Count Total	25	14	0	38	77	0	0	0	0	0	0	0	0	0	0
Peak Hr	14	7	0	23	44	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles																		
Interval Start	RIVER FRONTAGE RD				RIVER FRONTAGE RD				n/a				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	2	0	0	0	0	0	3	0	0	0	0	0	1	0	2	8	0
4:15 PM	0	4	0	0	0	0	0	4	0	0	0	0	0	1	0	3	12	0
4:30 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	2	5	0
4:45 PM	0	2	1	0	0	0	1	0	0	0	0	0	0	5	0	4	13	38
5:00 PM	0	1	0	0	0	0	2	2	0	0	0	0	0	0	0	1	6	36
5:15 PM	0	7	1	0	0	0	0	0	0	0	0	0	0	3	0	4	15	39
5:30 PM	0	2	0	0	0	0	0	2	0	0	0	0	0	2	0	4	10	44
5:45 PM	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	3	8	39
Count Total	0	23	2	0	0	0	3	11	0	0	0	0	0	15	0	23	77	0
Peak Hour	0	12	2	0	0	0	3	4	0	0	0	0	0	10	0	13	44	0

Two-Hour Count Summaries - Bikes																		
Interval Start	RIVER FRONTAGE RD				RIVER FRONTAGE RD				n/a				9TH ST				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	LT	TH	RT		LT	TH	RT		LT	TH	RT		LT	TH	RT			
4:00 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
4:15 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
4:30 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
4:45 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
5:00 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
5:15 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
5:30 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
5:45 PM	0	0	0		0	0	0		0	0	0		0	0	0		0	0
Count Total	0	0	0		0	0	0		0	0	0		0	0	0		0	0
Peak Hour	0	0	0		0	0	0		0	0	0		0	0	0		0	0

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

CR 311 RIVER FRONTAGE RD

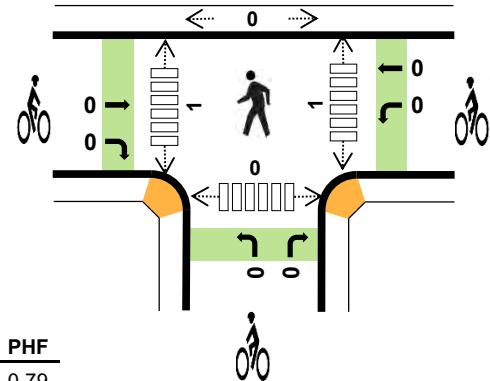
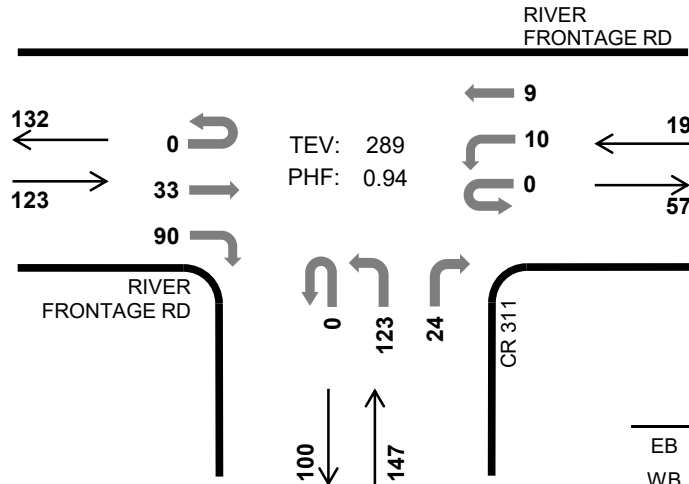


Peak Hour

Date: 04/05/2022

Count Period: 7:00 AM to 9:00 AM

Peak Hour: 7:15 AM to 8:15 AM



	HV %:	PHF
EB	8.9%	0.79
WB	5.3%	0.59
NB	12.2%	0.74
SB	-	-
TOTAL	10.4%	0.94

Two-Hour Count Summaries

Interval Start		RIVER FRONTAGE RD				RIVER FRONTAGE RD				CR 311				n/a				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM		0	0	12	11	0	0	2	0	0	26	0	2	0	0	0	0	53	0
7:15 AM		0	0	5	13	0	0	1	0	0	39	0	11	0	0	0	0	69	0
7:30 AM		0	0	11	21	0	1	3	0	0	36	0	5	0	0	0	0	77	0
7:45 AM		0	0	9	25	0	3	3	0	0	30	0	7	0	0	0	0	77	276
8:00 AM		0	0	8	31	0	6	2	0	0	18	0	1	0	0	0	0	66	289
8:15 AM		0	0	6	19	0	0	1	0	0	20	0	4	0	0	0	0	50	270
8:30 AM		0	0	4	16	0	0	1	0	0	12	0	2	0	0	0	0	35	228
8:45 AM		0	0	6	15	0	3	3	0	0	13	0	1	0	0	0	0	41	192
Count Total		0	0	61	151	0	13	16	0	0	194	0	33	0	0	0	0	468	0
Peak Hour	All	0	0	33	90	0	10	9	0	0	123	0	24	0	0	0	0	289	0
	HV	0	0	0	11	0	0	1	0	0	17	0	1	0	0	0	0	30	0
	HV%	-	-	0%	12%	-	0%	11%	-	-	14%	-	4%	-	-	-	-	10%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
7:00 AM	4	2	7	0	13	0	0	1	0	1	1	0	0	0	1
7:15 AM	3	0	7	0	10	0	0	0	0	0	0	0	0	0	0
7:30 AM	1	1	2	0	4	0	0	0	0	0	0	1	0	0	1
7:45 AM	3	0	4	0	7	0	0	0	0	0	0	0	0	0	0
8:00 AM	4	0	5	0	9	0	0	0	0	0	1	0	0	0	1
8:15 AM	3	0	6	0	9	0	0	0	0	0	0	0	0	0	0
8:30 AM	5	0	1	0	6	0	0	0	0	0	0	0	0	0	0
8:45 AM	8	0	5	0	13	0	0	0	0	0	0	0	0	0	0
Count Total	31	3	37	0	71	0	0	1	0	1	2	1	0	0	3
Peak Hr	11	1	18	0	30	0	0	0	0	0	1	1	0	0	2

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	RIVER FRONTAGE RD				RIVER FRONTAGE RD				CR 311				n/a				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	2	2	0	0	2	0	0	7	0	0	0	0	0	0	13	0
7:15 AM	0	0	0	3	0	0	0	0	0	7	0	0	0	0	0	0	10	0
7:30 AM	0	0	0	1	0	0	1	0	0	2	0	0	0	0	0	0	4	0
7:45 AM	0	0	0	3	0	0	0	0	0	3	0	1	0	0	0	0	7	34
8:00 AM	0	0	0	4	0	0	0	0	0	5	0	0	0	0	0	0	9	30
8:15 AM	0	0	0	3	0	0	0	0	0	6	0	0	0	0	0	0	9	29
8:30 AM	0	0	1	4	0	0	0	0	0	1	0	0	0	0	0	0	6	31
8:45 AM	0	0	0	8	0	0	0	0	0	5	0	0	0	0	0	0	13	37
Count Total	0	0	3	28	0	0	3	0	0	36	0	1	0	0	0	0	71	0
Peak Hour	0	0	0	11	0	0	1	0	0	17	0	1	0	0	0	0	30	0

Two-Hour Count Summaries - Bikes

Interval Start	RIVER FRONTAGE RD			RIVER FRONTAGE RD			CR 311			n/a			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	1	0	0	0	1	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

CR 311 RIVER FRONTAGE RD

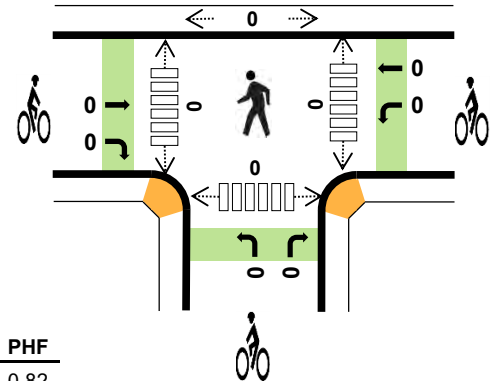
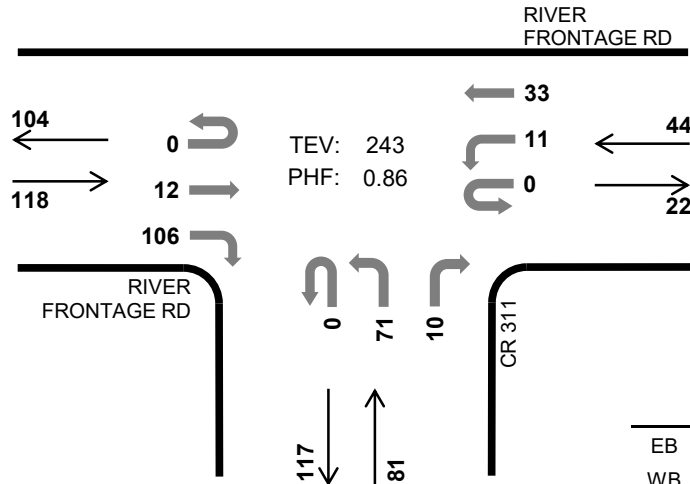


Peak Hour

Date: 04/04/2022

Count Period: 4:00 PM to 6:00 PM

Peak Hour: 4:00 PM to 5:00 PM



	HV %:	PHF
EB	8.5%	0.82
WB	9.1%	0.69
NB	8.6%	0.88
SB	-	-
TOTAL	8.6%	0.86

Two-Hour Count Summaries

Interval Start		RIVER FRONTAGE RD				RIVER FRONTAGE RD				CR 311				n/a				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM		0	0	3	29	0	6	10	0	0	17	0	6	0	0	0	0	71	0
4:15 PM		0	0	2	24	0	2	12	0	0	20	0	2	0	0	0	0	62	0
4:30 PM		0	0	3	21	0	2	8	0	0	20	0	2	0	0	0	0	56	0
4:45 PM		0	0	4	32	0	1	3	0	0	14	0	0	0	0	0	0	54	243
5:00 PM		0	0	0	25	0	1	9	0	0	26	0	1	0	0	0	0	62	234
5:15 PM		0	0	8	28	0	2	10	0	0	13	0	4	0	0	0	0	65	237
5:30 PM		0	0	5	26	0	4	6	0	0	16	0	3	0	0	0	0	60	241
5:45 PM		0	0	4	17	0	1	3	0	0	10	0	2	0	0	0	0	37	224
Count Total		0	0	29	202	0	19	61	0	0	136	0	20	0	0	0	0	467	0
Peak Hour	All	0	0	12	106	0	11	33	0	0	71	0	10	0	0	0	0	243	0
	HV	0	0	1	9	0	2	2	0	0	5	0	2	0	0	0	0	21	0
	HV%	-	-	8%	8%	-	18%	6%	-	-	7%	-	20%	-	-	-	-	9%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
4:00 PM	1	2	3	0	6	0	0	0	0	0	0	0	0	0	0
4:15 PM	2	1	2	0	5	0	0	0	0	0	0	0	0	0	0
4:30 PM	2	0	2	0	4	0	0	0	0	0	0	0	0	0	0
4:45 PM	5	1	0	0	6	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	2	2	0	4	0	0	0	0	0	0	0	0	0	0
5:15 PM	4	1	0	0	5	0	0	0	0	0	0	0	0	0	0
5:30 PM	2	0	1	0	3	0	1	0	0	1	0	0	0	0	0
5:45 PM	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Count Total	17	7	10	0	34	0	1	0	0	1	0	0	0	0	0
Peak Hr	10	4	7	0	21	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles

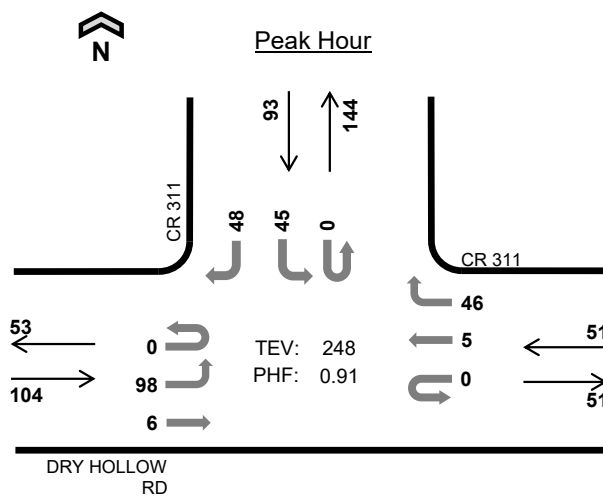
Interval Start	RIVER FRONTAGE RD				RIVER FRONTAGE RD				CR 311				n/a				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	1	0	1	1	0	0	2	0	1	0	0	0	0	6	0
4:15 PM	0	0	0	2	0	1	0	0	0	2	0	0	0	0	0	0	5	0
4:30 PM	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	4	0
4:45 PM	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	6	21
5:00 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	4	19
5:15 PM	0	0	0	4	0	0	1	0	0	0	0	0	0	0	0	0	5	19
5:30 PM	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	3	18
5:45 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	13
Count Total	0	0	1	16	0	2	5	0	0	8	0	2	0	0	0	0	34	0
Peak Hour	0	0	1	9	0	2	2	0	0	5	0	2	0	0	0	0	21	0

Two-Hour Count Summaries - Bikes

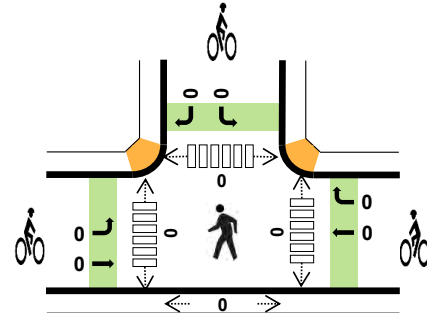
Interval Start	RIVER FRONTAGE RD			RIVER FRONTAGE RD			CR 311			n/a			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	1	0	0	0	0	0	0	0	1	1
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Count Total	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

CR 311 DRY HOLLOW RD



Date: 04/05/2022
Count Period: 7:00 AM to 9:00 AM
Peak Hour: 7:15 AM to 8:15 AM



	HV %:	PHF
EB	16.3%	0.76
WB	5.9%	0.71
NB	-	-
SB	14.0%	0.73
TOTAL	13.3%	0.91

Two-Hour Count Summaries

Interval Start		DRY HOLLOW RD				CR 311				n/a				CR 311				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM		0	34	0	0	0	0	3	15	0	0	0	0	0	7	0	8	67	0
7:30 AM		0	29	2	0	0	0	2	13	0	0	0	0	0	10	0	12	68	0
7:45 AM		0	20	2	0	0	0	0	11	0	0	0	0	0	16	0	8	57	192
8:00 AM		0	15	2	0	0	0	0	7	0	0	0	0	0	12	0	20	56	248
8:15 AM		0	15	1	0	0	0	2	9	0	0	0	0	0	7	0	16	50	231
8:30 AM		0	6	0	0	0	0	1	7	0	0	0	0	0	6	0	11	31	194
8:45 AM		0	8	0	0	0	0	0	4	0	0	0	0	0	5	0	14	31	168
Count Total		0	127	7	0	0	0	8	66	0	0	0	0	0	63	0	89	360	0
Peak Hour	All	0	98	6	0	0	0	5	46	0	0	0	0	0	45	0	48	248	0
	HV	0	15	2	0	0	0	0	3	0	0	0	0	0	0	0	13	33	0
	HV%	-	15%	33%	-	-	-	0%	7%	-	-	-	-	-	0%	-	27%	13%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

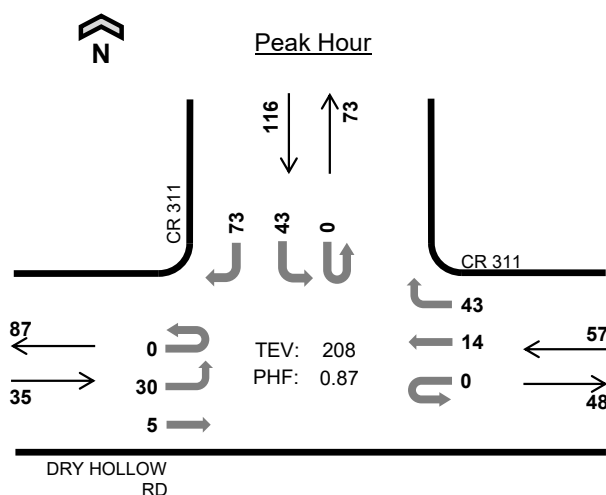
Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	5	2	0	3	10	0	0	0	0	0	0	0	0	0	0
7:30 AM	3	0	0	2	5	0	0	0	0	0	0	0	0	0	0
7:45 AM	4	0	0	3	7	0	0	0	0	0	0	0	0	0	0
8:00 AM	5	1	0	5	11	0	0	0	0	0	0	0	0	0	0
8:15 AM	5	1	0	3	9	0	0	0	0	0	0	0	0	0	0
8:30 AM	1	0	0	4	5	0	0	0	0	0	0	0	0	0	0
8:45 AM	5	0	0	8	13	0	0	0	0	0	0	0	0	0	0
Count Total	28	4	0	28	60	0	0	0	0	0	0	0	0	0	0
Peak Hr	17	3	0	13	33	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles																		
Interval Start	DRY HOLLOW RD				CR 311				n/a				CR 311				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7:15 AM	0	5	0	0	0	0	0	2	0	0	0	0	0	0	0	3	10	
7:30 AM	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	
7:45 AM	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	3	7	
8:00 AM	0	4	1	0	0	0	0	1	0	0	0	0	0	0	0	5	11	
8:15 AM	0	5	0	0	0	0	0	1	0	0	0	0	0	0	0	3	9	
8:30 AM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	
8:45 AM	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	7	13	
Count Total	0	26	2	0	0	0	0	4	0	0	0	0	0	1	0	27	60	
Peak Hour	0	15	2	0	0	0	0	3	0	0	0	0	0	0	0	13	33	

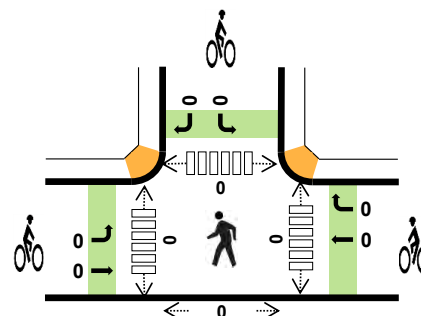
Two-Hour Count Summaries - Bikes																	
Interval Start	DRY HOLLOW RD			CR 311			n/a			CR 311			15-min Total	Rolling One Hour			
	Eastbound			Westbound			Northbound			Southbound							
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT					
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0			

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

CR 311 DRY HOLLOW RD



Date: 04/04/2022
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 4:45 PM to 5:45 PM



	HV %:	PHF
EB	2.9%	0.63
WB	3.5%	0.89
NB	-	-
SB	10.3%	0.85
TOTAL	7.2%	0.87

Two-Hour Count Summaries

Interval Start		DRY HOLLOW RD				CR 311				n/a				CR 311				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM		0	15	2	0	0	0	4	6	0	0	0	0	0	11	0	16	54	0
4:30 PM		0	9	1	0	0	0	3	12	0	0	0	0	0	9	0	14	48	0
4:45 PM		0	3	0	0	0	0	2	10	0	0	0	0	0	8	0	26	49	151
5:00 PM		0	11	1	0	0	0	1	15	0	0	0	0	0	8	0	14	50	201
5:15 PM		0	10	4	0	0	0	6	9	0	0	0	0	0	10	0	21	60	207
5:30 PM		0	6	0	0	0	0	5	9	0	0	0	0	0	17	0	12	49	208
5:45 PM		0	5	0	0	0	0	1	5	0	0	0	0	0	8	0	9	28	187
Count Total		0	59	8	0	0	0	22	66	0	0	0	0	0	71	0	112	338	0
Peak Hour	All	0	30	5	0	0	0	14	43	0	0	0	0	0	43	0	73	208	0
	HV	0	1	0	0	0	0	1	1	0	0	0	0	0	2	0	10	15	0
	HV%	-	3%	0%	-	-	-	7%	2%	-	-	-	-	-	5%	-	14%	7%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	2	0	4	6	0	0	0	0	0	0	0	0	0	0
4:30 PM	1	1	0	1	3	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	1	0	6	7	0	0	0	0	0	0	0	0	0	0
5:00 PM	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	4	4	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Count Total	2	5	0	18	25	0	0	0	0	0	0	0	0	0	0
Peak Hr	1	2	0	12	15	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles																		
Interval Start	DRY HOLLOW RD				CR 311				n/a				CR 311				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	3	6	0
4:30 PM	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3	0
4:45 PM	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	5	7	16
5:00 PM	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	18
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	14
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	4	15
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	9
Count Total	0	2	0	0	0	0	1	4	0	0	0	0	0	4	0	14	25	0
Peak Hour	0	1	0	0	0	0	1	1	0	0	0	0	0	2	0	10	15	0

Two-Hour Count Summaries - Bikes																		
Interval Start	DRY HOLLOW RD			CR 311			n/a			CR 311			15-min Total	Rolling One Hour				
	Eastbound			Westbound			Northbound			Southbound								
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT						
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0				

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

CR 335 CR 311

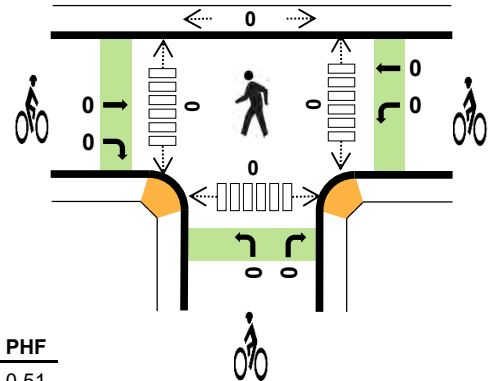
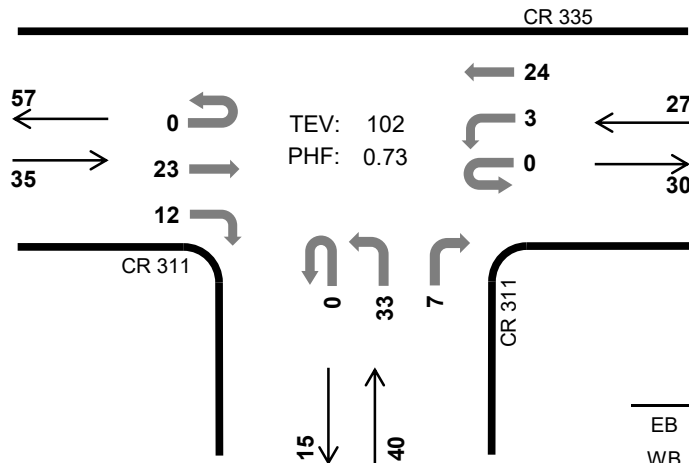


Peak Hour

Date: 04/05/2022

Count Period: 7:00 AM to 9:00 AM

Peak Hour: 7:00 AM to 8:00 AM



Two-Hour Count Summaries

Interval Start		CR 311				CR 335				CR 311				n/a				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM		0	0	3	2	0	0	6	0	0	4	0	1	0	0	0	0	16	0
7:15 AM		0	0	3	3	0	1	8	0	0	10	0	2	0	0	0	0	27	0
7:30 AM		0	0	4	3	0	0	4	0	0	11	0	2	0	0	0	0	24	0
7:45 AM		0	0	13	4	0	2	6	0	0	8	0	2	0	0	0	0	35	102
8:00 AM		0	0	7	6	0	0	0	0	0	2	0	1	0	0	0	0	16	102
8:15 AM		0	0	3	2	0	0	5	0	0	2	0	3	0	0	0	0	15	90
8:30 AM		0	0	4	4	0	0	3	0	0	8	0	1	0	0	0	0	20	86
8:45 AM		0	0	2	1	0	2	4	0	0	0	0	0	0	0	0	0	9	60
Count Total		0	0	39	25	0	5	36	0	0	45	0	12	0	0	0	0	162	0
Peak Hour	All	0	0	23	12	0	3	24	0	0	33	0	7	0	0	0	0	102	0
	HV	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0
	HV%	-	-	0%	0%	-	0%	4%	-	-	3%	-	0%	-	-	-	-	2%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
7:00 AM	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Count Total	0	2	1	0	3	0	0	0	0	0	0	0	0	0	0
Peak Hr	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	CR 311				CR 335				CR 311				n/a				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
Count Total	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	3	0
Peak Hour	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2	0

Two-Hour Count Summaries - Bikes

Interval Start	CR 311			CR 335			CR 311			n/a			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

CR 335 CR 311

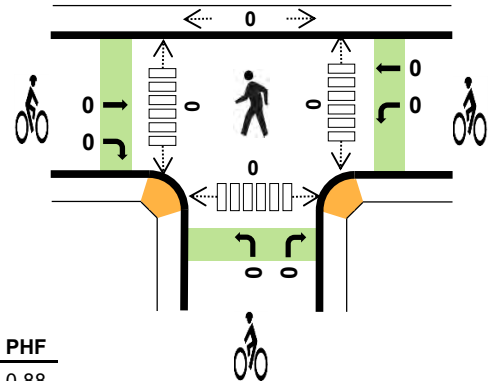
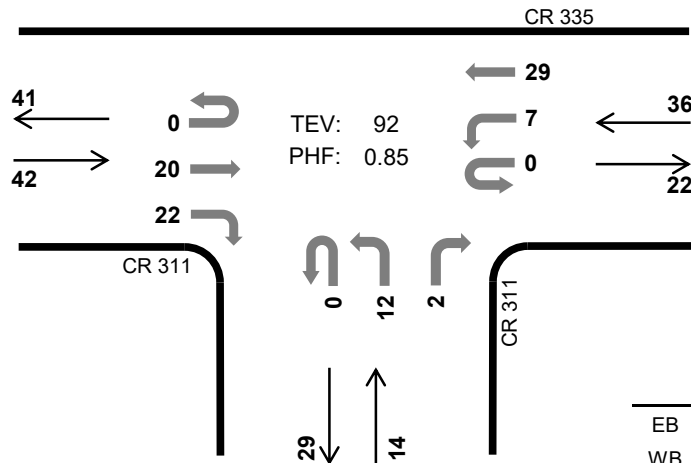


Peak Hour

Date: 04/04/2022

Count Period: 4:00 PM to 6:00 PM

Peak Hour: 4:00 PM to 5:00 PM



	HV %:	PHF
EB	0.0%	0.88
WB	2.8%	0.75
NB	14.3%	0.70
SB	-	-
TOTAL	3.3%	0.85

Two-Hour Count Summaries

Interval Start		CR 311				CR 335				CR 311				n/a				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM		0	0	7	4	0	3	9	0	0	4	0	0	0	0	0	0	27	0
4:15 PM		0	0	3	9	0	2	5	0	0	2	0	1	0	0	0	0	22	0
4:30 PM		0	0	6	5	0	1	9	0	0	4	0	1	0	0	0	0	26	0
4:45 PM		0	0	4	4	0	1	6	0	0	2	0	0	0	0	0	0	17	92
5:00 PM		0	0	1	5	0	0	8	0	0	3	0	0	0	0	0	0	17	82
5:15 PM		0	0	5	4	0	1	11	0	0	3	0	0	0	0	0	0	24	84
5:30 PM		0	0	5	11	0	2	4	0	0	5	0	1	0	0	0	0	28	86
5:45 PM		0	0	1	8	0	1	4	0	0	2	0	0	0	0	0	0	16	85
Count Total		0	0	32	50	0	11	56	0	0	25	0	3	0	0	0	0	177	0
Peak Hour	All	0	0	20	22	0	7	29	0	0	12	0	2	0	0	0	0	92	0
	HV	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	3	0
	HV%	-	-	0%	0%	-	14%	0%	-	-	17%	-	0%	-	-	-	-	3%	0

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	3	2	0	5	0	0	0	0	0	0	0	0	0	0
Peak Hr	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	CR 311				CR 335				CR 311				n/a				15-min Total	Rolling One Hour	
	Eastbound				Westbound				Northbound				Southbound						
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT			
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4:15 PM	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3
5:00 PM	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	5
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Count Total	0	0	0	0	0	1	2	0	0	2	0	0	0	0	0	0	0	5	0
Peak Hour	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	3	0

Two-Hour Count Summaries - Bikes

Interval Start	CR 311			CR 335			CR 311			n/a			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

Location: RIVER FRONTAGE RD E-O CR 311
 Date Range: 4/5/2022 - 4/11/2022
 Site Code: 01

Time	Tuesday			Wednesday			Thursday			Friday			Saturday			Sunday			Monday			Mid-Week Average		
	4/5/2022			4/6/2022			4/7/2022			4/8/2022			4/9/2022			4/10/2022			4/11/2022					
	EB	WB	Total	EB	WB	Total	EB	WB	Total	EB	WB	Total	EB	WB	Total	EB	WB	Total	EB	WB	Total	EB	WB	Total
12:00 AM	1	2	3	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
1:00 AM	1	0	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
2:00 AM	0	0	0	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1
3:00 AM	0	0	0	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
4:00 AM	0	0	0	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1
5:00 AM	12	1	13	12	1	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	1	13
6:00 AM	33	7	40	43	11	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	9	47
7:00 AM	60	13	73	76	12	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	68	13	81
8:00 AM	33	16	49	28	14	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	15	46
9:00 AM	20	17	37	10	14	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	16	31
10:00 AM	13	15	28	20	6	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	11	27
11:00 AM	14	13	27	15	19	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	16	31
12:00 PM	20	17	37	20	28	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	23	43
1:00 PM	15	22	37	24	20	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	21	41
2:00 PM	12	17	29	20	13	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	15	31
3:00 PM	29	36	65	19	29	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	33	57
4:00 PM	17	47	64	29	49	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	48	71
5:00 PM	26	37	63	19	52	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	45	67
6:00 PM	22	28	50	13	19	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	24	41
7:00 PM	9	14	23	17	20	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	17	30
8:00 PM	4	8	12	4	7	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	8	12
9:00 PM	4	0	4	3	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	4
10:00 PM	0	3	3	0	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	3	3
11:00 PM	1	1	2	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1
Total	346	314	660	377	320	697	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	362	317	679
Percent	52%	48%	-	54%	46%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	53%	47%	-

1. Mid-week average includes data between Tuesday and Thursday.





Location: CR 311 S-O RIVER FORNTAGE RD
 Date Range: 4/5/2022 - 4/11/2022
 Site Code: 02

Time	Tuesday			Wednesday			Thursday			Friday			Saturday			Sunday			Monday			Mid-Week Average		
	4/5/2022			4/6/2022			4/7/2022			4/8/2022			4/9/2022			4/10/2022			4/11/2022					
	NB	SB	Total	NB	SB	Total	NB	SB	Total	NB	SB	Total	NB	SB	Total	NB	SB	Total	NB	SB	Total	NB	SB	Total
12:00 AM	4	4	8	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	5
1:00 AM	1	1	2	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
2:00 AM	3	1	4	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	3
3:00 AM	5	0	5	7	1	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	1	7
4:00 AM	11	1	12	8	1	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	1	11
5:00 AM	34	16	50	29	16	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32	16	48
6:00 AM	63	32	95	61	26	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	62	29	91
7:00 AM	160	73	233	158	93	251	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	159	83	242
8:00 AM	70	93	163	85	82	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	88	165
9:00 AM	84	68	152	68	68	136	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	76	68	144
10:00 AM	68	65	133	73	58	131	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	71	62	132
11:00 AM	76	66	142	95	78	173	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	86	72	158
12:00 PM	89	84	173	68	69	137	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	79	77	155
1:00 PM	83	73	156	84	96	180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	84	85	168
2:00 PM	73	79	152	83	85	168	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	82	160
3:00 PM	86	73	159	103	98	201	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95	86	180
4:00 PM	72	117	189	93	115	208	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	83	116	199
5:00 PM	86	109	195	80	124	204	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	83	117	200
6:00 PM	61	96	157	68	99	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	98	162
7:00 PM	46	61	107	48	61	109	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	61	108
8:00 PM	24	35	59	16	37	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	36	56
9:00 PM	13	16	29	13	20	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	18	31
10:00 PM	5	15	20	7	12	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	14	20
11:00 PM	4	7	11	7	7	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	7	13
Total	1,221	1,185	2,406	1,257	1,248	2,505	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,239	1,217	2,456
Percent	51%	49%	-	50%	50%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50%	50%	-

1. Mid-week average includes data between Tuesday and Thursday.

Intersection Capacity Worksheets:
Existing

Intersection												
Int Delay, s/veh	1.5											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↩	↩		↩			↩	
Traffic Vol, veh/h	0	0	0	16	0	63	42	190	0	0	614	131
Future Vol, veh/h	0	0	0	16	0	63	42	190	0	0	614	131
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	40	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	76	76	76	92	92	92	89	89	89
Heavy Vehicles, %	2	2	2	14	14	14	13	13	13	4	4	4
Mvmt Flow	0	0	0	21	0	83	46	207	0	0	690	147
Major/Minor												
Minor1				Major1				Major2				
Conflicting Flow All	1063	1136	207	837	0	-	-	-	-	-	0	
Stage 1	299	299	-	-	-	-	-	-	-	-	-	
Stage 2	764	837	-	-	-	-	-	-	-	-	-	
Critical Hdwy	6.54	6.64	6.34	4.23	-	-	-	-	-	-	-	
Critical Hdwy Stg 1	5.54	5.64	-	-	-	-	-	-	-	-	-	
Critical Hdwy Stg 2	5.54	5.64	-	-	-	-	-	-	-	-	-	
Follow-up Hdwy	3.626	4.126	3.426	2.317	-	-	-	-	-	-	-	
Pot Cap-1 Maneuver	235	192	804	752	-	0	0	-	-	-	-	
Stage 1	726	645	-	-	-	0	0	-	-	-	-	
Stage 2	439	366	-	-	-	0	0	-	-	-	-	
Platoon blocked, %												
Mov Cap-1 Maneuver	219	0	804	752	-	-	-	-	-	-	-	
Mov Cap-2 Maneuver	219	0	-	-	-	-	-	-	-	-	-	
Stage 1	676	0	-	-	-	-	-	-	-	-	-	
Stage 2	439	0	-	-	-	-	-	-	-	-	-	
Approach												
WB				NB				SB				
HCM Control Delay, s	12.7			1.8				0				
HCM LOS	B											
Minor Lane/Major Mvmt												
NBL				NBTWBLn1WBLn2				SBT SBR				
Capacity (veh/h)	752	-	219	804	-	-	-	-	-	-	-	-
HCM Lane V/C Ratio	0.061	-	0.096	0.103	-	-	-	-	-	-	-	-
HCM Control Delay (s)	10.1	0	23.2	10	-	-	-	-	-	-	-	-
HCM Lane LOS	B	A	C	B	-	-	-	-	-	-	-	-
HCM 95th %tile Q(veh)	0.2	-	0.3	0.3	-	-	-	-	-	-	-	-

Intersection												
Int Delay, s/veh	89.4											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	116	0	89	0	0	0	0	119	111	536	93	0
Future Vol, veh/h	116	0	89	0	0	0	0	119	111	536	93	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	490	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	92	92	92	75	75	75	88	88	88
Heavy Vehicles, %	12	12	2	2	2	2	2	15	15	4	4	2
Mvmt Flow	133	0	102	0	0	0	0	159	148	609	106	0

Major/Minor	Minor2			Major1			Major2		
Conflicting Flow All	1557	1631	106	-	0	0	307	0	0
Stage 1	1324	1324	-	-	-	-	-	-	-
Stage 2	233	307	-	-	-	-	-	-	-
Critical Hdwy	6.52	6.62	6.22	-	-	-	4.14	-	-
Critical Hdwy Stg 1	5.52	5.62	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.52	5.62	-	-	-	-	-	-	-
Follow-up Hdwy	3.608	4.108	3.318	-	-	-	2.236	-	-
Pot Cap-1 Maneuver	~ 117	96	948	0	-	-	1242	-	0
Stage 1	237	215	-	0	-	-	-	-	0
Stage 2	783	643	-	0	-	-	-	-	0
Platoon blocked, %					-	-		-	
Mov Cap-1 Maneuver	~ 56	0	948	-	-	-	1242	-	-
Mov Cap-2 Maneuver	~ 56	0	-	-	-	-	-	-	-
Stage 1	237	0	-	-	-	-	-	-	-
Stage 2	375	0	-	-	-	-	-	-	-




Approach	EB	NB	SB
HCM Control Delay, s	449.2	0	9.1
HCM LOS	F		




Minor Lane/Major Mvmt	NBT	NBR	EBLn1	EBLn2	SBL	SBT
Capacity (veh/h)	-	-	56	948	1242	-
HCM Lane V/C Ratio	-	-	2.381	0.108	0.49	-
HCM Control Delay (s)	-	-	\$ 786.7	9.3	10.7	0
HCM Lane LOS	-	-	F	A	B	A
HCM 95th %tile Q(veh)	-	-	13.4	0.4	2.8	-

Notes			
~: Volume exceeds capacity	\$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↰	↰		↰	
Traffic Volume (veh/h)	89	15	11	124	111	89
Future Volume (Veh/h)	89	15	11	124	111	89
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.68	0.68	0.77	0.77	0.93	0.93
Hourly flow rate (vph)	131	22	14	161	119	96
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	454	286	334	0	0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	454	286	334	0	0	
tC, single (s)	7.2	6.6	6.6	6.3	4.2	
tC, 2 stage (s)						
tF (s)	3.6	4.1	4.1	3.4	2.3	
p0 queue free %	66	96	97	85	92	
cM capacity (veh/h)	388	558	527	1056	1560	
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	153	175	215			
Volume Left	131	0	119			
Volume Right	0	161	96			
cSH	406	978	1560			
Volume to Capacity	0.38	0.18	0.08			
Queue Length 95th (ft)	43	16	6			
Control Delay (s)	19.1	9.5	4.4			
Lane LOS	C	A	A			
Approach Delay (s)	19.1	9.5	4.4			
Approach LOS	C	A				
Intersection Summary						
Average Delay		10.2				
Intersection Capacity Utilization		35.6%		ICU Level of Service		A
Analysis Period (min)		15				

Intersection						
Int Delay, s/veh	5.8					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	33	90	10	9	123	24
Future Vol, veh/h	33	90	10	9	123	24
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	79	79	59	59	74	74
Heavy Vehicles, %	9	9	5	5	12	12
Mvmt Flow	42	114	17	15	166	32
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	156	0	149	100
Stage 1	-	-	-	-	99	-
Stage 2	-	-	-	-	50	-
Critical Hdwy	-	-	4.15	-	6.52	6.32
Critical Hdwy Stg 1	-	-	-	-	5.52	-
Critical Hdwy Stg 2	-	-	-	-	5.52	-
Follow-up Hdwy	-	-	2.245	-	3.608	3.408
Pot Cap-1 Maneuver	-	-	1406	-	820	929
Stage 1	-	-	-	-	900	-
Stage 2	-	-	-	-	947	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1406	-	809	928
Mov Cap-2 Maneuver	-	-	-	-	809	-
Stage 1	-	-	-	-	900	-
Stage 2	-	-	-	-	935	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		4		10.7	
HCM LOS					B	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	826	-	-	1406	-	
HCM Lane V/C Ratio	0.24	-	-	0.012	-	
HCM Control Delay (s)	10.7	-	-	7.6	0	
HCM Lane LOS	B	-	-	A	A	
HCM 95th %tile Q(veh)	0.9	-	-	0	-	

Intersection						
Int Delay, s/veh	4.4					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	98	6	5	46	45	48
Future Vol, veh/h	98	6	5	46	45	48
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	76	76	71	71	73	73
Heavy Vehicles, %	16	16	6	6	14	14
Mvmt Flow	129	8	7	65	62	66
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	174	95	128	0	-	0
Stage 1	95	-	-	-	-	-
Stage 2	79	-	-	-	-	-
Critical Hdwy	6.56	6.36	4.16	-	-	-
Critical Hdwy Stg 1	5.56	-	-	-	-	-
Critical Hdwy Stg 2	5.56	-	-	-	-	-
Follow-up Hdwy	3.644	3.444	2.254	-	-	-
Pot Cap-1 Maneuver	785	925	1434	-	-	-
Stage 1	895	-	-	-	-	-
Stage 2	910	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	781	925	1434	-	-	-
Mov Cap-2 Maneuver	781	-	-	-	-	-
Stage 1	891	-	-	-	-	-
Stage 2	910	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	10.5	0.7		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1434	-	788	-	-	
HCM Lane V/C Ratio	0.005	-	0.174	-	-	
HCM Control Delay (s)	7.5	0	10.5	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0	-	0.6	-	-	

6: CR 311 & CR 335 Performance by approach





Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.1	0.1
Total Del/Veh (s)	0.8	6.2	3.2	2.6

Intersection												
Int Delay, s/veh	12.7											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	0	0	77	1	540	64	227	0	0	165	110
Future Vol, veh/h	0	0	0	77	1	540	64	227	0	0	165	110
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	40	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	90	90	90	80	80	80	76	76	76
Heavy Vehicles, %	2	2	2	4	4	4	6	6	6	5	5	5
Mvmt Flow	0	0	0	86	1	600	80	284	0	0	217	145

Major/Minor	Minor1	Major1	Major2									
Conflicting Flow All	734	806	284	362	0	-	-	-	-	0		
Stage 1	444	444	-	-	-	-	-	-	-	-		
Stage 2	290	362	-	-	-	-	-	-	-	-		
Critical Hdwy	6.44	6.54	6.24	4.16	-	-	-	-	-	-		
Critical Hdwy Stg 1	5.44	5.54	-	-	-	-	-	-	-	-		
Critical Hdwy Stg 2	5.44	5.54	-	-	-	-	-	-	-	-		
Follow-up Hdwy	3.536	4.036	3.336	2.254	-	-	-	-	-	-		
Pot Cap-1 Maneuver	384	313	750	1175	-	0	0	-	-	-		
Stage 1	642	572	-	-	-	0	0	-	-	-		
Stage 2	755	622	-	-	-	0	0	-	-	-		
Platoon blocked, %					-			-		-		
Mov Cap-1 Maneuver	353	0	750	1175	-	-	-	-	-	-		
Mov Cap-2 Maneuver	353	0	-	-	-	-	-	-	-	-		
Stage 1	590	0	-	-	-	-	-	-	-	-		
Stage 2	755	0	-	-	-	-	-	-	-	-		

Approach	WB	NB	SB
HCM Control Delay, s	25.1	1.8	0
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBTWBLn1WBLn2	SBT	SBR
Capacity (veh/h)	1175	- 353 750	-	-
HCM Lane V/C Ratio	0.068	- 0.246 0.8	-	-
HCM Control Delay (s)	8.3	0 18.5 26.1	-	-
HCM Lane LOS	A	A C D	-	-
HCM 95th %tile Q(veh)	0.2	- 0.9 8.3	-	-

Intersection												
Int Delay, s/veh	6.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	147	1	48	0	0	0	0	143	42	119	147	0
Future Vol, veh/h	147	1	48	0	0	0	0	143	42	119	147	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	490	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	86	86	86	92	92	92	83	83	83	91	91	91
Heavy Vehicles, %	5	5	5	1	1	1	7	7	7	6	6	6
Mvmt Flow	171	1	56	0	0	0	0	172	51	131	162	0




Major/Minor	Minor2			Major1			Major2		
Conflicting Flow All	622	647	162	-	0	0	223	0	0
Stage 1	424	424	-	-	-	-	-	-	-
Stage 2	198	223	-	-	-	-	-	-	-
Critical Hdwy	6.45	6.55	6.25	-	-	-	4.16	-	-
Critical Hdwy Stg 1	5.45	5.55	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.45	5.55	-	-	-	-	-	-	-
Follow-up Hdwy	3.545	4.045	3.345	-	-	-	2.254	-	-
Pot Cap-1 Maneuver	446	386	875	0	-	-	1323	-	0
Stage 1	654	582	-	0	-	-	-	-	0
Stage 2	828	713	-	0	-	-	-	-	0
Platoon blocked, %					-	-		-	
Mov Cap-1 Maneuver	397	0	875	-	-	-	1323	-	-
Mov Cap-2 Maneuver	397	0	-	-	-	-	-	-	-
Stage 1	654	0	-	-	-	-	-	-	-
Stage 2	738	0	-	-	-	-	-	-	-




Approach	EB	NB	SB
HCM Control Delay, s	18	0	3.6
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	EBLn1	EBLn2	SBL	SBT
Capacity (veh/h)	-	-	397	875	1323	-
HCM Lane V/C Ratio	-	-	0.431	0.065	0.099	-
HCM Control Delay (s)	-	-	20.8	9.4	8	0
HCM Lane LOS	-	-	C	A	A	A
HCM 95th %tile Q(veh)	-	-	2.1	0.2	0.3	-



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↰	↰		↰	
Traffic Volume (veh/h)	96	15	14	83	121	93
Future Volume (Veh/h)	96	15	14	83	121	93
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.65	0.65	0.69	0.69	0.92	0.92
Hourly flow rate (vph)	148	23	20	120	132	101
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	444	314	365	0	0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	444	314	365	0	0	
tC, single (s)	7.2	6.6	6.6	6.3	4.2	
tC, 2 stage (s)						
tF (s)	3.6	4.1	4.1	3.4	2.3	
p0 queue free %	64	96	96	89	92	
cM capacity (veh/h)	407	534	509	1070	1566	
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	171	140	233			
Volume Left	148	0	132			
Volume Right	0	120	101			
cSH	421	925	1566			
Volume to Capacity	0.41	0.15	0.08			
Queue Length 95th (ft)	48	13	7			
Control Delay (s)	19.3	9.6	4.5			
Lane LOS	C	A	A			
Approach Delay (s)	19.3	9.6	4.5			
Approach LOS	C	A				
Intersection Summary						
Average Delay			10.5			
Intersection Capacity Utilization			31.8%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection						
Int Delay, s/veh	3.4					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	12	106	11	33	71	10
Future Vol, veh/h	12	106	11	33	71	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	82	82	69	69	88	88
Heavy Vehicles, %	9	9	9	9	9	9
Mvmt Flow	15	129	16	48	81	11
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	144	0	160	80
Stage 1	-	-	-	-	80	-
Stage 2	-	-	-	-	80	-
Critical Hdwy	-	-	4.19	-	6.49	6.29
Critical Hdwy Stg 1	-	-	-	-	5.49	-
Critical Hdwy Stg 2	-	-	-	-	5.49	-
Follow-up Hdwy	-	-	2.281	-	3.581	3.381
Pot Cap-1 Maneuver	-	-	1397	-	815	961
Stage 1	-	-	-	-	926	-
Stage 2	-	-	-	-	926	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1397	-	805	961
Mov Cap-2 Maneuver	-	-	-	-	805	-
Stage 1	-	-	-	-	926	-
Stage 2	-	-	-	-	915	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		1.9		9.9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	821	-	-	1397	-	
HCM Lane V/C Ratio	0.112	-	-	0.011	-	
HCM Control Delay (s)	9.9	-	-	7.6	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.4	-	-	0	-	

Intersection						
Int Delay, s/veh	2.6					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	30	5	14	43	43	73
Future Vol, veh/h	30	5	14	43	43	73
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	63	63	89	89	85	85
Heavy Vehicles, %	3	3	4	4	10	10
Mvmt Flow	48	8	16	48	51	86
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	174	94	137	0	-	0
Stage 1	94	-	-	-	-	-
Stage 2	80	-	-	-	-	-
Critical Hdwy	6.43	6.23	4.14	-	-	-
Critical Hdwy Stg 1	5.43	-	-	-	-	-
Critical Hdwy Stg 2	5.43	-	-	-	-	-
Follow-up Hdwy	3.527	3.327	2.236	-	-	-
Pot Cap-1 Maneuver	814	960	1435	-	-	-
Stage 1	927	-	-	-	-	-
Stage 2	941	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	805	960	1435	-	-	-
Mov Cap-2 Maneuver	805	-	-	-	-	-
Stage 1	917	-	-	-	-	-
Stage 2	941	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	9.7	1.9		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1435	-	824	-	-	
HCM Lane V/C Ratio	0.011	-	0.067	-	-	
HCM Control Delay (s)	7.5	0	9.7	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.2	-	-	

Intersection Capacity Worksheets: 2035 Background



Lane Group	WBT	WBR	NBL	NBT	SBT
Lane Configurations	↔	↔		↔	↔
Traffic Volume (vph)	1	70	45	215	690
Future Volume (vph)	1	70	45	215	690
Turn Type	NA	Perm	Perm	NA	NA
Protected Phases	8			2	6
Permitted Phases		8	2		
Detector Phase	8	8	2	2	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5		4.5	4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	C-Max	C-Max	C-Max
Act Effect Green (s)	6.5	6.5		35.3	35.3
Actuated g/C Ratio	0.14	0.14		0.78	0.78
v/c Ratio	0.10	0.28		0.26	0.65
Control Delay	17.0	8.3		2.7	8.9
Queue Delay	0.0	0.0		0.0	0.0
Total Delay	17.0	8.3		2.7	8.9
LOS	B	A		A	A
Approach Delay	10.3			2.7	8.9
Approach LOS	B			A	A

Intersection Summary

Cycle Length: 45

Actuated Cycle Length: 45

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green

Natural Cycle: 65

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.65

Intersection Signal Delay: 7.6

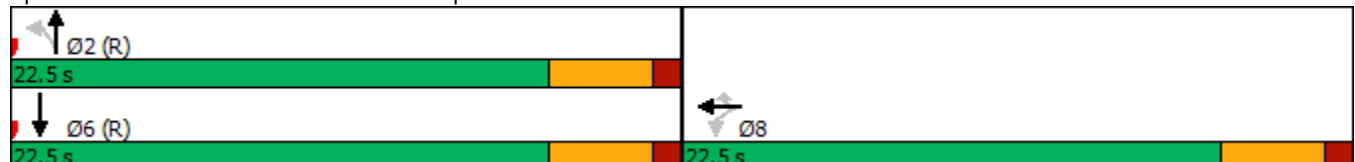
Intersection LOS: A

Intersection Capacity Utilization 61.5%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 1: 9th St & I-70 WB ramp






Lane Group	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	23	76	283	908
v/c Ratio	0.10	0.28	0.26	0.65
Control Delay	17.0	8.3	2.7	8.9
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	17.0	8.3	2.7	8.9
Queue Length 50th (ft)	5	0	10	111
Queue Length 95th (ft)	19	25	21	#380
Internal Link Dist (ft)	977		244	1334
Turn Bay Length (ft)		40		
Base Capacity (vph)	636	612	1082	1407
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.04	0.12	0.26	0.65










Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

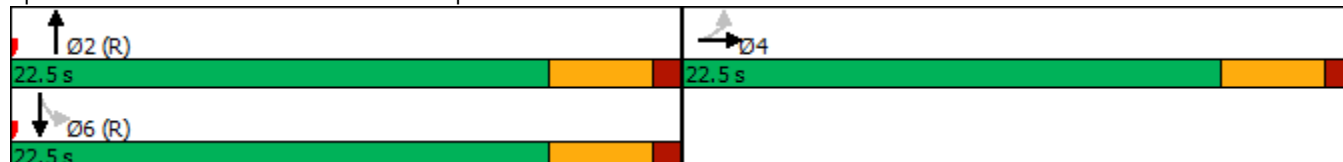
HCM 6th Signalized Intersection Summary
06/26/2022





1: 9th St & I-70 WB ramp
2035 Background - AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↶	↷		↶			↷	
Traffic Volume (veh/h)	0	0	0	20	1	70	45	215	0	0	690	145
Future Volume (veh/h)	0	0	0	20	1	70	45	215	0	0	690	145
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1693	1693	1693	1707	1707	0	0	1841	1841
Adj Flow Rate, veh/h				22	1	76	49	234	0	0	750	158
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				14	14	14	13	13	0	0	4	4
Cap, veh/h				122	6	113	188	797	0	0	1063	224
Arrive On Green				0.08	0.08	0.08	0.72	0.72	0.00	0.00	0.72	0.72
Sat Flow, veh/h				1545	70	1434	131	1105	0	0	1474	311
Grp Volume(v), veh/h				23	0	76	283	0	0	0	0	908
Grp Sat Flow(s),veh/h/ln				1615	0	1434	1235	0	0	0	0	1785
Q Serve(g_s), s				0.6	0.0	2.3	1.1	0.0	0.0	0.0	0.0	13.0
Cycle Q Clear(g_c), s				0.6	0.0	2.3	14.1	0.0	0.0	0.0	0.0	13.0
Prop In Lane				0.96		1.00	0.17		0.00	0.00		0.17
Lane Grp Cap(c), veh/h				127	0	113	985	0	0	0	0	1287
V/C Ratio(X)				0.18	0.00	0.67	0.29	0.00	0.00	0.00	0.00	0.71
Avail Cap(c_a), veh/h				646	0	574	985	0	0	0	0	1287
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00
Uniform Delay (d), s/veh				19.4	0.0	20.2	2.3	0.0	0.0	0.0	0.0	3.6
Incr Delay (d2), s/veh				0.7	0.0	6.7	0.7	0.0	0.0	0.0	0.0	3.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.2	0.0	0.9	0.3	0.0	0.0	0.0	0.0	1.9
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				20.0	0.0	26.9	3.0	0.0	0.0	0.0	0.0	6.8
LnGrp LOS				C	A	C	A	A	A	A	A	A
Approach Vol, veh/h					99			283			908	
Approach Delay, s/veh					25.3			3.0			6.8	
Approach LOS					C			A			A	
Timer - Assigned Phs		2				6		8				
Phs Duration (G+Y+Rc), s		37.0				37.0		8.0				
Change Period (Y+Rc), s		4.5				4.5		4.5				
Max Green Setting (Gmax), s		18.0				18.0		18.0				
Max Q Clear Time (g_c+I1), s		16.1				15.0		4.3				
Green Ext Time (p_c), s		0.3				1.8		0.2				
Intersection Summary												
HCM 6th Ctrl Delay				7.4								
HCM 6th LOS				A								

					
Lane Group	EBL	EBT	NBT	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	130	1	135	605	105
Future Volume (vph)	130	1	135	605	105
Turn Type	Perm	NA	NA	Perm	NA
Protected Phases		4	2		6
Permitted Phases	4			6	
Detector Phase	4	4	2	6	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	C-Max	C-Max	C-Max
Act Effct Green (s)	9.4	9.4	29.5		29.5
Actuated g/C Ratio	0.21	0.21	0.66		0.66
v/c Ratio	0.42	0.26	0.27		1.11
Control Delay	18.3	5.3	4.0		83.4
Queue Delay	0.0	0.0	0.0		0.0
Total Delay	18.3	5.3	4.0		83.4
LOS	B	A	A		F
Approach Delay		12.6	4.0		83.4
Approach LOS		B	A		F
Intersection Summary					
Cycle Length: 45					
Actuated Cycle Length: 45					
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green					
Natural Cycle: 100					
Control Type: Actuated-Coordinated					
Maximum v/c Ratio: 1.11					
Intersection Signal Delay: 52.6			Intersection LOS: D		
Intersection Capacity Utilization 72.2%			ICU Level of Service C		
Analysis Period (min) 15					

















Splits and Phases: 2: 9th St & I-70 EB Ramps



				
Lane Group	EBL	EBT	NBT	SBT
Lane Group Flow (vph)	141	110	283	772
v/c Ratio	0.42	0.26	0.27	1.11
Control Delay	18.3	5.3	4.0	83.4
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	18.3	5.3	4.0	83.4
Queue Length 50th (ft)	32	0	15	~262
Queue Length 95th (ft)	61	25	54	#455
Internal Link Dist (ft)		1729	155	190
Turn Bay Length (ft)	490			
Base Capacity (vph)	644	699	1056	695
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.22	0.16	0.27	1.11
Intersection Summary				
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.				
# 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.				

HCM 6th Signalized Intersection Summary
06/26/2022

2: 9th St & I-70 EB Ramps
2035 Background - AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	130	1	100	0	0	0	0	135	125	605	105	0
Future Volume (veh/h)	130	1	100	0	0	0	0	135	125	605	105	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1722	1722	1870				0	1678	1678	1841	1841	0
Adj Flow Rate, veh/h	141	1	109				0	147	136	658	114	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	12	12	2				0	15	15	4	4	0
Cap, veh/h	225	2	198				0	532	492	723	100	0
Arrive On Green	0.14	0.14	0.14				0.00	0.66	0.66	0.66	0.66	0.00
Sat Flow, veh/h	1640	13	1448				0	802	742	868	150	0
Grp Volume(v), veh/h	141	0	110				0	0	283	772	0	0
Grp Sat Flow(s),veh/h/ln	1640	0	1461				0	0	1544	1018	0	0
Q Serve(g_s), s	3.7	0.0	3.2				0.0	0.0	3.4	26.4	0.0	0.0
Cycle Q Clear(g_c), s	3.7	0.0	3.2				0.0	0.0	3.4	29.8	0.0	0.0
Prop In Lane	1.00		0.99				0.00		0.48	0.85		0.00
Lane Grp Cap(c), veh/h	225	0	200				0	0	1024	823	0	0
V/C Ratio(X)	0.63	0.00	0.55				0.00	0.00	0.28	0.94	0.00	0.00
Avail Cap(c_a), veh/h	656	0	585				0	0	1024	823	0	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.00	1.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	18.3	0.0	18.1				0.0	0.0	3.1	10.9	0.0	0.0
Incr Delay (d2), s/veh	2.9	0.0	2.3				0.0	0.0	0.7	19.5	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	0.0	1.0				0.0	0.0	0.6	9.3	0.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	21.2	0.0	20.5				0.0	0.0	3.8	30.4	0.0	0.0
LnGrp LOS	C	A	C				A	A	A	C	A	A
Approach Vol, veh/h	251						283			772		
Approach Delay, s/veh	20.9						3.8			30.4		
Approach LOS	C						A			C		
Timer - Assigned Phs	2			4			6					
Phs Duration (G+Y+Rc), s	34.3			10.7			34.3					
Change Period (Y+Rc), s	4.5			4.5			4.5					
Max Green Setting (Gmax), s	18.0			18.0			18.0					
Max Q Clear Time (g_c+I1), s	5.4			5.7			31.8					
Green Ext Time (p_c), s	1.3			0.8			0.0					
Intersection Summary												
HCM 6th Ctrl Delay	22.8											
HCM 6th LOS	C											




HCM Unsignalized Intersection Capacity Analysis




06/26/2022

3: River Frontage Rd & 9th St
2035 Background - AM Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↩	↩		↩	
Traffic Volume (veh/h)	100	15	11	140	125	100
Future Volume (Veh/h)	100	15	11	140	125	100
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.93	0.93
Hourly flow rate (vph)	109	16	12	152	134	108
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh						
Upstream signal (ft)					235	
pX, platoon unblocked						
vC, conflicting volume	480	322	376	0	0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	480	322	376	0	0	
tC, single (s)	7.2	6.6	6.6	6.3	4.2	
tC, 2 stage (s)						
tF (s)	3.6	4.1	4.1	3.4	2.3	
p0 queue free %	71	97	98	86	91	
cM capacity (veh/h)	374	527	493	1056	1560	
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	125	164	242			
Volume Left	109	0	134			
Volume Right	0	152	108			
cSH	389	975	1560			
Volume to Capacity	0.32	0.17	0.09			
Queue Length 95th (ft)	34	15	7			
Control Delay (s)	18.6	9.4	4.5			
Lane LOS	C	A	A			
Approach Delay (s)	18.6	9.4	4.5			
Approach LOS	C	A				
Intersection Summary						
Average Delay			9.3			
Intersection Capacity Utilization			38.6%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection						
Int Delay, s/veh	5.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	35	100	10	10	140	25
Future Vol, veh/h	35	100	10	10	140	25
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	5	5	12	12
Mvmt Flow	38	109	11	11	152	27
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	147	0	127	94
Stage 1	-	-	-	-	93	-
Stage 2	-	-	-	-	34	-
Critical Hdwy	-	-	4.15	-	6.52	6.32
Critical Hdwy Stg 1	-	-	-	-	5.52	-
Critical Hdwy Stg 2	-	-	-	-	5.52	-
Follow-up Hdwy	-	-	2.245	-	3.608	3.408
Pot Cap-1 Maneuver	-	-	1417	-	844	936
Stage 1	-	-	-	-	906	-
Stage 2	-	-	-	-	963	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1417	-	836	935
Mov Cap-2 Maneuver	-	-	-	-	836	-
Stage 1	-	-	-	-	906	-
Stage 2	-	-	-	-	954	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		3.8		10.4	
HCM LOS	B					
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	850	-	-	1417	-	
HCM Lane V/C Ratio	0.211	-	-	0.008	-	
HCM Control Delay (s)	10.4	-	-	7.6	0	
HCM Lane LOS	B	-	-	A	A	
HCM 95th %tile Q(veh)	0.8	-	-	0	-	

Intersection						
Int Delay, s/veh	4.5					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	110	5	5	50	50	55
Future Vol, veh/h	110	5	5	50	50	55
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	85	85	85	85
Heavy Vehicles, %	16	16	6	6	14	14
Mvmt Flow	129	6	6	59	59	65
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	163	92	124	0	-	0
Stage 1	92	-	-	-	-	-
Stage 2	71	-	-	-	-	-
Critical Hdwy	6.56	6.36	4.16	-	-	-
Critical Hdwy Stg 1	5.56	-	-	-	-	-
Critical Hdwy Stg 2	5.56	-	-	-	-	-
Follow-up Hdwy	3.644	3.444	2.254	-	-	-
Pot Cap-1 Maneuver	796	928	1438	-	-	-
Stage 1	898	-	-	-	-	-
Stage 2	918	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	793	928	1438	-	-	-
Mov Cap-2 Maneuver	793	-	-	-	-	-
Stage 1	894	-	-	-	-	-
Stage 2	918	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	10.4	0.7		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1438	-	798	-	-	
HCM Lane V/C Ratio	0.004	-	0.17	-	-	
HCM Control Delay (s)	7.5	0	10.4	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0	-	0.6	-	-	

6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach

Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.2	0.1
Total Del/Veh (s)	1.8	6.6	4.7	3.7

	←	↖	↗	↑	↓
Lane Group	WBT	WBR	NBL	NBT	SBT
Lane Configurations	↖	↗		↖	↗
Traffic Volume (vph)	1	605	70	255	185
Future Volume (vph)	1	605	70	255	185
Turn Type	NA	Perm	Perm	NA	NA
Protected Phases	8			2	6
Permitted Phases		8	2		
Detector Phase	8	8	2	2	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	31.0	31.0	29.0	29.0	29.0
Total Split (%)	51.7%	51.7%	48.3%	48.3%	48.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5		4.5	4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	Max	Max
Act Effect Green (s)	26.5	26.5		24.5	24.5
Actuated g/C Ratio	0.44	0.44		0.41	0.41
v/c Ratio	0.12	0.70		0.56	0.46
Control Delay	10.5	8.8		13.5	12.5
Queue Delay	0.0	0.0		0.0	0.0
Total Delay	10.5	8.8		13.5	12.5
LOS	B	A		B	B
Approach Delay	9.0			13.5	12.5
Approach LOS	A			B	B

Intersection Summary

Cycle Length: 60

Actuated Cycle Length: 60

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green

Natural Cycle: 50

Control Type: Pretimed

Maximum v/c Ratio: 0.70

Intersection Signal Delay: 10.9

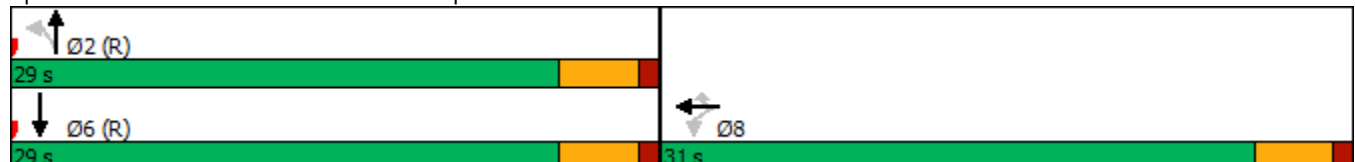
Intersection LOS: B

Intersection Capacity Utilization 62.3%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 1: 9th St & I-70 WB ramp






























Lane Group	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	93	658	353	337
v/c Ratio	0.12	0.70	0.56	0.46
Control Delay	10.5	8.8	13.5	12.5
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	10.5	8.8	13.5	12.5
Queue Length 50th (ft)	19	44	93	65
Queue Length 95th (ft)	42	149	152	126
Internal Link Dist (ft)	977		244	1334
Turn Bay Length (ft)		40		
Base Capacity (vph)	768	940	630	739
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.12	0.70	0.56	0.46
Intersection Summary				

HCM 6th Signalized Intersection Summary
06/26/2022

1: 9th St & I-70 WB ramp
2035 Background - PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	85	1	605	70	255	0	0	185	125
Future Volume (veh/h)	0	0	0	85	1	605	70	255	0	0	185	125
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1841	1841	1841	1811	1811	0	0	1826	1826
Adj Flow Rate, veh/h				92	1	658	76	277	0	0	201	136
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				4	4	4	6	6	0	0	5	5
Cap, veh/h				766	8	689	160	527	0	0	415	281
Arrive On Green				0.44	0.44	0.44	0.41	0.41	0.00	0.00	0.41	0.41
Sat Flow, veh/h				1735	19	1560	214	1291	0	0	1015	687
Grp Volume(v), veh/h				93	0	658	353	0	0	0	0	337
Grp Sat Flow(s),veh/h/ln				1754	0	1560	1505	0	0	0	0	1702
Q Serve(g_s), s				1.9	0.0	24.4	2.6	0.0	0.0	0.0	0.0	8.8
Cycle Q Clear(g_c), s				1.9	0.0	24.4	11.4	0.0	0.0	0.0	0.0	8.8
Prop In Lane				0.99		1.00	0.22		0.00	0.00		0.40
Lane Grp Cap(c), veh/h				775	0	689	687	0	0	0	0	695
V/C Ratio(X)				0.12	0.00	0.96	0.51	0.00	0.00	0.00	0.00	0.48
Avail Cap(c_a), veh/h				775	0	689	687	0	0	0	0	695
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00
Uniform Delay (d), s/veh				9.9	0.0	16.2	13.4	0.0	0.0	0.0	0.0	13.1
Incr Delay (d2), s/veh				0.3	0.0	24.9	2.7	0.0	0.0	0.0	0.0	2.4
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.7	0.0	11.8	3.6	0.0	0.0	0.0	0.0	3.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				10.2	0.0	41.1	16.1	0.0	0.0	0.0	0.0	15.5
LnGrp LOS				B	A	D	B	A	A	A	A	B
Approach Vol, veh/h					751			353			337	
Approach Delay, s/veh					37.2			16.1			15.5	
Approach LOS					D			B			B	
Timer - Assigned Phs		2				6		8				
Phs Duration (G+Y+Rc), s		29.0				29.0		31.0				
Change Period (Y+Rc), s		4.5				4.5		4.5				
Max Green Setting (Gmax), s		24.5				24.5		26.5				
Max Q Clear Time (g_c+I1), s		13.4				10.8		26.4				
Green Ext Time (p_c), s		1.7				1.7		0.0				
Intersection Summary												
HCM 6th Ctrl Delay				27.0								
HCM 6th LOS				C								

					
Lane Group	EBL	EBT	NBT	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	165	1	160	135	165
Future Volume (vph)	165	1	160	135	165
Turn Type	Perm	NA	NA	Perm	NA
Protected Phases		4	2		6
Permitted Phases	4			6	
Detector Phase	4	4	2	6	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	25.0	25.0	35.0	35.0	35.0
Total Split (%)	41.7%	41.7%	58.3%	58.3%	58.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	Max	Max
Act Effect Green (s)	20.5	20.5	30.5		30.5
Actuated g/C Ratio	0.34	0.34	0.51		0.51
v/c Ratio	0.30	0.11	0.25		0.47
Control Delay	16.3	5.1	7.9		10.1
Queue Delay	0.0	0.0	0.0		0.0
Total Delay	16.3	5.1	7.9		10.1
LOS	B	A	A		B
Approach Delay		13.5	7.9		10.1
Approach LOS		B	A		B

Intersection Summary

Cycle Length: 60

Actuated Cycle Length: 60

Offset: 4 (7%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 45

Control Type: Pretimed

Maximum v/c Ratio: 0.47

Intersection Signal Delay: 10.5

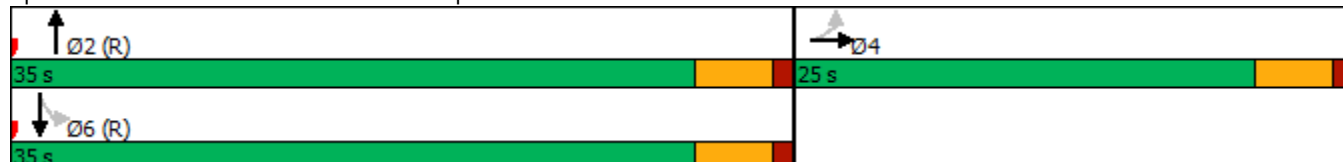
Intersection LOS: B





Intersection Capacity Utilization 47.7%

ICU Level of Service A

Analysis Period (min) 15

















Splits and Phases: 2: 9th St & I-70 EB Ramps



				
Lane Group	EBL	EBT	NBT	SBT
Lane Group Flow (vph)	179	61	223	326
v/c Ratio	0.30	0.11	0.25	0.47
Control Delay	16.3	5.1	7.9	10.1
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	16.3	5.1	7.9	10.1
Queue Length 50th (ft)	46	0	35	54
Queue Length 95th (ft)	90	21	69	84
Internal Link Dist (ft)		1729	155	190
Turn Bay Length (ft)	490			
Base Capacity (vph)	587	566	892	699
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.30	0.11	0.25	0.47
Intersection Summary				




HCM 6th Signalized Intersection Summary
06/26/2022




2: 9th St & I-70 EB Ramps
2035 Background - PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	165	1	55	0	0	0	0	160	45	135	165	0
Future Volume (veh/h)	165	1	55	0	0	0	0	160	45	135	165	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1826	1826	1826				0	1796	1796	1811	1811	0
Adj Flow Rate, veh/h	179	1	60				0	174	49	147	179	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	5	5	5				0	7	7	6	6	0
Cap, veh/h	594	9	521				0	685	193	365	412	0
Arrive On Green	0.34	0.34	0.34				0.00	0.51	0.51	0.51	0.51	0.00
Sat Flow, veh/h	1739	25	1526				0	1348	380	548	811	0
Grp Volume(v), veh/h	179	0	61				0	0	223	326	0	0
Grp Sat Flow(s),veh/h/ln	1739	0	1551				0	0	1728	1359	0	0
Q Serve(g_s), s	4.5	0.0	1.6				0.0	0.0	4.4	6.1	0.0	0.0
Cycle Q Clear(g_c), s	4.5	0.0	1.6				0.0	0.0	4.4	10.4	0.0	0.0
Prop In Lane	1.00		0.98				0.00		0.22	0.45		0.00
Lane Grp Cap(c), veh/h	594	0	530				0	0	878	778	0	0
V/C Ratio(X)	0.30	0.00	0.12				0.00	0.00	0.25	0.42	0.00	0.00
Avail Cap(c_a), veh/h	594	0	530				0	0	878	778	0	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.00	1.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	14.5	0.0	13.5				0.0	0.0	8.3	9.9	0.0	0.0
Incr Delay (d2), s/veh	1.3	0.0	0.4				0.0	0.0	0.7	1.7	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	0.0	0.6				0.0	0.0	1.5	2.7	0.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	15.8	0.0	14.0				0.0	0.0	9.0	11.5	0.0	0.0
LnGrp LOS	B	A	B				A	A	A	B	A	A
Approach Vol, veh/h	240						223			326		
Approach Delay, s/veh	15.3						9.0			11.5		
Approach LOS	B						A			B		
Timer - Assigned Phs	2			4			6					
Phs Duration (G+Y+Rc), s	35.0			25.0			35.0					
Change Period (Y+Rc), s	4.5			4.5			4.5					
Max Green Setting (Gmax), s	30.5			20.5			30.5					
Max Q Clear Time (g_c+I1), s	6.4			6.5			12.4					
Green Ext Time (p_c), s	1.3			0.7			2.0					
Intersection Summary												
HCM 6th Ctrl Delay	12.0											
HCM 6th LOS	B											



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↰	↰		↰	
Traffic Volume (veh/h)	110	15	15	95	135	105
Future Volume (Veh/h)	110	15	15	95	135	105
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	120	16	16	103	147	114
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh						
Upstream signal (ft)					235	
pX, platoon unblocked						
vC, conflicting volume	462	351	408	0	0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	462	351	408	0	0	
tC, single (s)	7.2	6.6	6.6	6.3	4.2	
tC, 2 stage (s)						
tF (s)	3.6	4.1	4.1	3.4	2.3	
p0 queue free %	70	97	97	90	91	
cM capacity (veh/h)	402	504	476	1070	1566	
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	136	119	261			
Volume Left	120	0	147			
Volume Right	0	103	114			
cSH	412	916	1566			
Volume to Capacity	0.33	0.13	0.09			
Queue Length 95th (ft)	35	11	8			
Control Delay (s)	18.0	9.5	4.6			
Lane LOS	C	A	A			
Approach Delay (s)	18.0	9.5	4.6			
Approach LOS	C	A				
Intersection Summary						
Average Delay			9.2			
Intersection Capacity Utilization			34.1%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection						
Int Delay, s/veh	3.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	15	120	11	35	80	10
Future Vol, veh/h	15	120	11	35	80	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	9	9	9	9
Mvmt Flow	16	130	12	38	87	11
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	146	0	143	81
Stage 1	-	-	-	-	81	-
Stage 2	-	-	-	-	62	-
Critical Hdwy	-	-	4.19	-	6.49	6.29
Critical Hdwy Stg 1	-	-	-	-	5.49	-
Critical Hdwy Stg 2	-	-	-	-	5.49	-
Follow-up Hdwy	-	-	2.281	-	3.581	3.381
Pot Cap-1 Maneuver	-	-	1394	-	833	960
Stage 1	-	-	-	-	925	-
Stage 2	-	-	-	-	943	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1394	-	826	960
Mov Cap-2 Maneuver	-	-	-	-	826	-
Stage 1	-	-	-	-	925	-
Stage 2	-	-	-	-	935	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		1.8		9.9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	839	-	-	1394	-	
HCM Lane V/C Ratio	0.117	-	-	0.009	-	
HCM Control Delay (s)	9.9	-	-	7.6	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.4	-	-	0	-	

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	35	5	15	50	50	80
Future Vol, veh/h	35	5	15	50	50	80
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	89	89	85	85
Heavy Vehicles, %	3	3	4	4	10	10
Mvmt Flow	41	6	17	56	59	94
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	196	106	153	0	-	0
Stage 1	106	-	-	-	-	-
Stage 2	90	-	-	-	-	-
Critical Hdwy	6.43	6.23	4.14	-	-	-
Critical Hdwy Stg 1	5.43	-	-	-	-	-
Critical Hdwy Stg 2	5.43	-	-	-	-	-
Follow-up Hdwy	3.527	3.327	2.236	-	-	-
Pot Cap-1 Maneuver	790	946	1415	-	-	-
Stage 1	916	-	-	-	-	-
Stage 2	931	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	781	946	1415	-	-	-
Mov Cap-2 Maneuver	781	-	-	-	-	-
Stage 1	905	-	-	-	-	-
Stage 2	931	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	9.8	1.7		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1415	-	798	-	-	
HCM Lane V/C Ratio	0.012	-	0.059	-	-	
HCM Control Delay (s)	7.6	0	9.8	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.2	-	-	










6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach

Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.1	0.1
Total Del/Veh (s)	0.0	6.7	2.7	4.7

Intersection Capacity Worksheets: 2045 Background




HCM Unsignalized Intersection Capacity Analysis
06/26/2022

4: CR 311 & River Frontage Rd
2045 Background AM Peak Hour

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	45	125	10	10	170	30
Future Volume (Veh/h)	45	125	10	10	170	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	49	136	11	11	185	33
Pedestrians	1			1		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	3.5			3.5		
Percent Blockage	0			0		
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			185		151	118
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		151	118
tC, single (s)			4.1		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.2		3.6	3.4
p0 queue free %			99		77	96
cM capacity (veh/h)			1372		811	907
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	185	22	218			
Volume Left	0	11	185			
Volume Right	136	0	33			
cSH	1700	1372	824			
Volume to Capacity	0.11	0.01	0.26			
Queue Length 95th (ft)	0	1	27			
Control Delay (s)	0.0	3.9	10.9			
Lane LOS		A	B			
Approach Delay (s)	0.0	3.9	10.9			
Approach LOS			B			
Intersection Summary						
Average Delay			5.8			
Intersection Capacity Utilization			28.1%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection

Int Delay, s/veh 5.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	45	125	10	10	170	30
Future Vol, veh/h	45	125	10	10	170	30
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	5	5	12	12
Mvmt Flow	49	136	11	11	185	33










Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	185
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.15
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.245
Pot Cap-1 Maneuver	-	-	1372
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1372
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-




Approach	EB	WB	NB
HCM Control Delay, s	0	3.8	10.9
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	824	-	-	1372	-
HCM Lane V/C Ratio	0.264	-	-	0.008	-
HCM Control Delay (s)	10.9	-	-	7.6	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	1.1	-	-	0	-

HCM Unsignalized Intersection Capacity Analysis
06/26/2022




5: CR 311 & Dry Hollow Rd
2045 Background AM Peak Hour




						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	135	5	5	60	60	70
Future Volume (Veh/h)	135	5	5	60	60	70
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	159	6	6	71	71	82
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	195	112	153			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	195	112	153			
tC, single (s)	6.6	6.4	4.2			
tC, 2 stage (s)						
tF (s)	3.6	3.4	2.3			
p0 queue free %	79	99	100			
cM capacity (veh/h)	760	904	1403			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	165	77	153			
Volume Left	159	6	0			
Volume Right	6	0	82			
cSH	764	1403	1700			
Volume to Capacity	0.22	0.00	0.09			
Queue Length 95th (ft)	20	0	0			
Control Delay (s)	11.0	0.6	0.0			
Lane LOS	B	A				
Approach Delay (s)	11.0	0.6	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay		4.7				
Intersection Capacity Utilization		21.9%		ICU Level of Service		A
Analysis Period (min)		15				

Intersection						
Int Delay, s/veh	4.7					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	135	5	5	60	60	70
Future Vol, veh/h	135	5	5	60	60	70
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	85	85	85	85
Heavy Vehicles, %	16	16	6	6	14	14
Mvmt Flow	159	6	6	71	71	82
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	195	112	153	0	-	0
Stage 1	112	-	-	-	-	-
Stage 2	83	-	-	-	-	-
Critical Hdwy	6.56	6.36	4.16	-	-	-
Critical Hdwy Stg 1	5.56	-	-	-	-	-
Critical Hdwy Stg 2	5.56	-	-	-	-	-
Follow-up Hdwy	3.644	3.444	2.254	-	-	-
Pot Cap-1 Maneuver	763	904	1403	-	-	-
Stage 1	879	-	-	-	-	-
Stage 2	906	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	760	904	1403	-	-	-
Mov Cap-2 Maneuver	760	-	-	-	-	-
Stage 1	875	-	-	-	-	-
Stage 2	906	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	11	0.6		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1403	-	764	-	-	
HCM Lane V/C Ratio	0.004	-	0.216	-	-	
HCM Control Delay (s)	7.6	0	11	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0	-	0.8	-	-	

6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach

Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.1	0.1
Total Del/Veh (s)	0.1	7.6	3.5	3.7

Intersection						
Int Delay, s/veh	3.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	20	150	11	45	100	10
Future Vol, veh/h	20	150	11	45	100	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	9	9	9	9
Mvmt Flow	22	163	12	49	109	11
Major/Minor	Major1	Major2	Minor1			
Conflicting Flow All	0	0	185	0	177	104
Stage 1	-	-	-	-	104	-
Stage 2	-	-	-	-	73	-
Critical Hdwy	-	-	4.19	-	6.49	6.29
Critical Hdwy Stg 1	-	-	-	-	5.49	-
Critical Hdwy Stg 2	-	-	-	-	5.49	-
Follow-up Hdwy	-	-	2.281	-	3.581	3.381
Pot Cap-1 Maneuver	-	-	1349	-	797	932
Stage 1	-	-	-	-	903	-
Stage 2	-	-	-	-	932	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1349	-	790	932
Mov Cap-2 Maneuver	-	-	-	-	790	-
Stage 1	-	-	-	-	903	-
Stage 2	-	-	-	-	924	-
Approach	EB	WB		NB		
HCM Control Delay, s	0	1.5		10.3		
HCM LOS	B					
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	801	-	-	1349	-	
HCM Lane V/C Ratio	0.149	-	-	0.009	-	
HCM Control Delay (s)	10.3	-	-	7.7	0	
HCM Lane LOS	B	-	-	A	A	
HCM 95th %tile Q(veh)	0.5	-	-	0	-	

Intersection						
Int Delay, s/veh	2.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	45	5	20	60	60	100
Future Vol, veh/h	45	5	20	60	60	100
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	89	89	85	85
Heavy Vehicles, %	3	3	4	4	10	10
Mvmt Flow	53	6	22	67	71	118
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	241	130	189	0	-	0
Stage 1	130	-	-	-	-	-
Stage 2	111	-	-	-	-	-
Critical Hdwy	6.43	6.23	4.14	-	-	-
Critical Hdwy Stg 1	5.43	-	-	-	-	-
Critical Hdwy Stg 2	5.43	-	-	-	-	-
Follow-up Hdwy	3.527	3.327	2.236	-	-	-
Pot Cap-1 Maneuver	745	917	1373	-	-	-
Stage 1	894	-	-	-	-	-
Stage 2	911	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	732	917	1373	-	-	-
Mov Cap-2 Maneuver	732	-	-	-	-	-
Stage 1	879	-	-	-	-	-
Stage 2	911	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	10.2	1.9		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1373	-	747	-	-	
HCM Lane V/C Ratio	0.016	-	0.079	-	-	
HCM Control Delay (s)	7.7	0	10.2	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0.1	-	0.3	-	-	

6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach

Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.1	0.1
Total Del/Veh (s)	3.8	6.4	2.8	4.5

***Intersection Capacity Worksheets:
2035 Background
+ Project***

Timings
06/26/2022

1: 9th St & I-70 WB ramp
2035 Total AM Peak Hour



Lane Group	WBT	WBR	NBL	NBT	SBT
Lane Configurations	↔	↔		↔	↔
Traffic Volume (vph)	1	70	71	230	703
Future Volume (vph)	1	70	71	230	703
Turn Type	NA	Perm	Perm	NA	NA
Protected Phases	8			2	6
Permitted Phases		8	2		
Detector Phase	8	8	2	2	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	22.5	22.5	47.5	47.5	47.5
Total Split (%)	32.1%	32.1%	67.9%	67.9%	67.9%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5		4.5	4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	C-Max	C-Max	C-Max
Act Effect Green (s)	7.8	7.8		56.1	56.1
Actuated g/C Ratio	0.11	0.11		0.80	0.80
v/c Ratio	0.30	0.34		0.34	0.64
Control Delay	32.2	12.0		2.8	6.8
Queue Delay	0.0	0.0		0.0	0.0
Total Delay	32.2	12.0		2.8	6.8
LOS	C	B		A	A
Approach Delay	20.2			2.8	6.8
Approach LOS	C			A	A

Intersection Summary

Cycle Length: 70

Actuated Cycle Length: 70

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green

Natural Cycle: 65

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.64

Intersection Signal Delay: 7.1

Intersection LOS: A

Intersection Capacity Utilization 77.3%

ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 1: 9th St & I-70 WB ramp






























Lane Group	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	52	76	327	922
v/c Ratio	0.30	0.34	0.34	0.64
Control Delay	32.2	12.0	2.8	6.8
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	32.2	12.0	2.8	6.8
Queue Length 50th (ft)	21	0	17	135
Queue Length 95th (ft)	50	34	34	294
Internal Link Dist (ft)	977		244	1334
Turn Bay Length (ft)		40		
Base Capacity (vph)	408	420	975	1436
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.13	0.18	0.34	0.64
Intersection Summary				

HCM 6th Signalized Intersection Summary
06/26/2022





1: 9th St & I-70 WB ramp
2035 Total AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	47	1	70	71	230	0	0	703	145
Future Volume (veh/h)	0	0	0	47	1	70	71	230	0	0	703	145
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1693	1693	1693	1707	1707	0	0	1841	1841
Adj Flow Rate, veh/h				51	1	76	77	250	0	0	764	158
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				14	14	14	13	13	0	0	4	4
Cap, veh/h				123	2	112	218	660	0	0	1174	243
Arrive On Green				0.08	0.08	0.08	0.79	0.79	0.00	0.00	0.79	0.79
Sat Flow, veh/h				1582	31	1434	195	832	0	0	1480	306
Grp Volume(v), veh/h				52	0	76	327	0	0	0	0	922
Grp Sat Flow(s),veh/h/ln				1613	0	1434	1027	0	0	0	0	1786
Q Serve(g_s), s				2.1	0.0	3.6	3.6	0.0	0.0	0.0	0.0	15.4
Cycle Q Clear(g_c), s				2.1	0.0	3.6	19.0	0.0	0.0	0.0	0.0	15.4
Prop In Lane				0.98		1.00	0.24		0.00	0.00		0.17
Lane Grp Cap(c), veh/h				126	0	112	878	0	0	0	0	1417
V/C Ratio(X)				0.41	0.00	0.68	0.37	0.00	0.00	0.00	0.00	0.65
Avail Cap(c_a), veh/h				415	0	369	878	0	0	0	0	1417
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00
Uniform Delay (d), s/veh				30.8	0.0	31.4	2.6	0.0	0.0	0.0	0.0	3.1
Incr Delay (d2), s/veh				2.2	0.0	7.1	1.2	0.0	0.0	0.0	0.0	2.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.9	0.0	1.4	0.7	0.0	0.0	0.0	0.0	2.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				32.9	0.0	38.5	3.9	0.0	0.0	0.0	0.0	5.4
LnGrp LOS				C	A	D	A	A	A	A	A	A
Approach Vol, veh/h					128			327			922	
Approach Delay, s/veh					36.2			3.9			5.4	
Approach LOS					D			A			A	
Timer - Assigned Phs		2				6		8				
Phs Duration (G+Y+Rc), s		60.0				60.0		10.0				
Change Period (Y+Rc), s		4.5				4.5		4.5				
Max Green Setting (Gmax), s		43.0				43.0		18.0				
Max Q Clear Time (g_c+I1), s		21.0				17.4		5.6				
Green Ext Time (p_c), s		2.5				8.0		0.3				
Intersection Summary												
HCM 6th Ctrl Delay				7.9								
HCM 6th LOS				A								

					
Lane Group	EBL	EBT	NBT	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	130	1	176	605	146
Future Volume (vph)	130	1	176	605	146
Turn Type	Perm	NA	NA	Perm	NA
Protected Phases		4	2		6
Permitted Phases	4			6	
Detector Phase	4	4	2	6	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	22.5	22.5	47.5	47.5	47.5
Total Split (%)	32.1%	32.1%	67.9%	67.9%	67.9%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	C-Max	C-Max	C-Max
Act Effct Green (s)	11.4	11.4	49.6		49.6
Actuated g/C Ratio	0.16	0.16	0.71		0.71
v/c Ratio	0.54	0.37	0.32		1.16
Control Delay	33.8	8.0	3.8		97.4
Queue Delay	0.0	0.0	0.0		0.0
Total Delay	33.8	8.0	3.8		97.4
LOS	C	A	A		F
Approach Delay		21.2	3.8		97.4
Approach LOS		C	A		F
Intersection Summary					
Cycle Length: 70					
Actuated Cycle Length: 70					
Offset: 8 (11%), Referenced to phase 2:NBT and 6:SBTL, Start of Green					
Natural Cycle: 150					
Control Type: Actuated-Coordinated					
Maximum v/c Ratio: 1.16					
Intersection Signal Delay: 59.7			Intersection LOS: E		
Intersection Capacity Utilization 78.9%			ICU Level of Service D		
Analysis Period (min) 15					

















Splits and Phases: 2: 9th St & I-70 EB Ramps



				
Lane Group	EBL	EBT	NBT	SBT
Lane Group Flow (vph)	141	135	361	817
v/c Ratio	0.54	0.37	0.32	1.16
Control Delay	33.8	8.0	3.8	97.4
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	33.8	8.0	3.8	97.4
Queue Length 50th (ft)	56	0	29	~431
Queue Length 95th (ft)	100	40	74	#670
Internal Link Dist (ft)		1729	155	190
Turn Bay Length (ft)	490			
Base Capacity (vph)	414	506	1130	707
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.34	0.27	0.32	1.16
Intersection Summary				
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.				
# 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.				

HCM 6th Signalized Intersection Summary
06/26/2022











2: 9th St & I-70 EB Ramps
2035 Background AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	130	1	123	0	0	0	0	176	156	605	146	0
Future Volume (veh/h)	130	1	123	0	0	0	0	176	156	605	146	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1722	1722	1870				0	1678	1678	1841	1841	0
Adj Flow Rate, veh/h	141	1	134				0	191	170	658	159	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	12	12	2				0	15	15	4	4	0
Cap, veh/h	211	1	186				0	608	541	683	143	0
Arrive On Green	0.13	0.13	0.13				0.00	0.74	0.74	0.74	0.74	0.00
Sat Flow, veh/h	1640	11	1450				0	818	728	794	192	0
Grp Volume(v), veh/h	141	0	135				0	0	361	817	0	0
Grp Sat Flow(s),veh/h/ln	1640	0	1461				0	0	1547	986	0	0
Q Serve(g_s), s	5.7	0.0	6.2				0.0	0.0	5.5	46.5	0.0	0.0
Cycle Q Clear(g_c), s	5.7	0.0	6.2				0.0	0.0	5.5	52.0	0.0	0.0
Prop In Lane	1.00		0.99				0.00		0.47	0.81		0.00
Lane Grp Cap(c), veh/h	211	0	188				0	0	1149	825	0	0
V/C Ratio(X)	0.67	0.00	0.72				0.00	0.00	0.31	0.99	0.00	0.00
Avail Cap(c_a), veh/h	422	0	376				0	0	1149	825	0	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.00	1.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	29.1	0.0	29.3				0.0	0.0	3.0	14.1	0.0	0.0
Incr Delay (d2), s/veh	3.7	0.0	5.1				0.0	0.0	0.7	29.0	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.3	0.0	2.3				0.0	0.0	1.1	17.4	0.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.7	0.0	34.4				0.0	0.0	3.7	43.1	0.0	0.0
LnGrp LOS	C	A	C				A	A	A	D	A	A
Approach Vol, veh/h	276						361			817		
Approach Delay, s/veh	33.6						3.7			43.1		
Approach LOS	C						A			D		
Timer - Assigned Phs	2			4			6					
Phs Duration (G+Y+Rc), s	56.5			13.5			56.5					
Change Period (Y+Rc), s	4.5			4.5			4.5					
Max Green Setting (Gmax), s	43.0			18.0			43.0					
Max Q Clear Time (g_c+I1), s	7.5			8.2			54.0					
Green Ext Time (p_c), s	2.5			0.8			0.0					
Intersection Summary												
HCM 6th Ctrl Delay	31.5											
HCM 6th LOS	C											

HCM Unsignalized Intersection Capacity Analysis




06/26/2022

3: River Frontage Rd & 9th St
2035 Total AM Peak Hour

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	100	19	14	212	189	100
Future Volume (Veh/h)	100	19	14	212	189	100
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.93	0.93
Hourly flow rate (vph)	109	21	15	230	203	108
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh						
Upstream signal (ft)					235	
pX, platoon unblocked						
vC, conflicting volume	698	460	514	0	0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	698	460	514	0	0	
tC, single (s)	7.2	6.6	6.6	6.3	4.2	
tC, 2 stage (s)						
tF (s)	3.6	4.1	4.1	3.4	2.3	
p0 queue free %	53	95	96	78	87	
cM capacity (veh/h)	233	418	392	1056	1560	
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	130	245	311			
Volume Left	109	0	203			
Volume Right	0	230	108			
cSH	250	957	1560			
Volume to Capacity	0.52	0.26	0.13			
Queue Length 95th (ft)	68	26	11			
Control Delay (s)	33.9	10.1	5.4			
Lane LOS	D	B	A			
Approach Delay (s)	33.9	10.1	5.4			
Approach LOS	D	B				
Intersection Summary						
Average Delay		12.4				
Intersection Capacity Utilization		47.0%		ICU Level of Service		A
Analysis Period (min)		15				

Intersection




Int Delay, s/veh 4.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	99	104	14	82	144	29
Future Vol, veh/h	99	104	14	82	144	29
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	5	5	12	12
Mvmt Flow	108	113	15	89	157	32

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	221
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	4.15	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	2.245	-
Pot Cap-1 Maneuver	-	1331	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	1331	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.1	12
HCM LOS			B




Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	700	-	-	1331	-
HCM Lane V/C Ratio	0.269	-	-	0.011	-
HCM Control Delay (s)	12	-	-	7.7	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	1.1	-	-	0	-





Intersection						
Int Delay, s/veh	4.4					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	114	5	5	54	55	59
Future Vol, veh/h	114	5	5	54	55	59
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	85	85	85	85
Heavy Vehicles, %	16	16	6	6	14	14
Mvmt Flow	134	6	6	64	65	69
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	176	100	134	0	-	0
Stage 1	100	-	-	-	-	-
Stage 2	76	-	-	-	-	-
Critical Hdwy	6.56	6.36	4.16	-	-	-
Critical Hdwy Stg 1	5.56	-	-	-	-	-
Critical Hdwy Stg 2	5.56	-	-	-	-	-
Follow-up Hdwy	3.644	3.444	2.254	-	-	-
Pot Cap-1 Maneuver	783	919	1426	-	-	-
Stage 1	890	-	-	-	-	-
Stage 2	913	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	780	919	1426	-	-	-
Mov Cap-2 Maneuver	780	-	-	-	-	-
Stage 1	886	-	-	-	-	-
Stage 2	913	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	10.6	0.6		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1426	-	785	-	-	
HCM Lane V/C Ratio	0.004	-	0.178	-	-	
HCM Control Delay (s)	7.5	0	10.6	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0	-	0.6	-	-	

6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach

Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.1	0.0
Total Del/Veh (s)	3.0	3.4	2.9	3.1

Intersection						
Int Delay, s/veh	2.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖	↘	
Traffic Vol, veh/h	66	62	1	27	69	1
Future Vol, veh/h	66	62	1	27	69	1
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	275	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	72	67	1	29	75	1
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	139	0	103	72
Stage 1	-	-	-	-	72	-
Stage 2	-	-	-	-	31	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1445	-	895	990
Stage 1	-	-	-	-	951	-
Stage 2	-	-	-	-	992	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1445	-	894	990
Mov Cap-2 Maneuver	-	-	-	-	894	-
Stage 1	-	-	-	-	951	-
Stage 2	-	-	-	-	991	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0.3		9.4	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	895	-	-	1445	-	
HCM Lane V/C Ratio	0.085	-	-	0.001	-	
HCM Control Delay (s)	9.4	-	-	7.5	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.3	-	-	0	-	

Intersection						
Int Delay, s/veh	1.8					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	41	26	7	16	12	4
Future Vol, veh/h	41	26	7	16	12	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	45	28	8	17	13	4
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	73	0	92	59
Stage 1	-	-	-	-	59	-
Stage 2	-	-	-	-	33	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1527	-	908	1007
Stage 1	-	-	-	-	964	-
Stage 2	-	-	-	-	989	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1527	-	903	1007
Mov Cap-2 Maneuver	-	-	-	-	903	-
Stage 1	-	-	-	-	964	-
Stage 2	-	-	-	-	984	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		2.2		9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	927	-	-	1527	-	
HCM Lane V/C Ratio	0.019	-	-	0.005	-	
HCM Control Delay (s)	9	-	-	7.4	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.1	-	-	0	-	

Intersection												
Int Delay, s/veh	0.5											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	2	0	1	4	0	4	1	167	4	4	112	2
Future Vol, veh/h	2	0	1	4	0	4	1	167	4	4	112	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	2	0	1	4	0	4	1	182	4	4	122	2
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	319	319	123	318	318	184	124	0	0	186	0	0
Stage 1	131	131	-	186	186	-	-	-	-	-	-	-
Stage 2	188	188	-	132	132	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	634	598	928	635	598	858	1463	-	-	1388	-	-
Stage 1	873	788	-	816	746	-	-	-	-	-	-	-
Stage 2	814	745	-	871	787	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	629	596	928	632	596	858	1463	-	-	1388	-	-
Mov Cap-2 Maneuver	629	596	-	632	596	-	-	-	-	-	-	-
Stage 1	872	786	-	815	745	-	-	-	-	-	-	-
Stage 2	809	744	-	867	785	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	10.1		10		0		0.3					
HCM LOS	B		B									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBL	SBT	SBR					
Capacity (veh/h)	1463	-	-	705	728	1388	-	-				
HCM Lane V/C Ratio	0.001	-	-	0.005	0.012	0.003	-	-				
HCM Control Delay (s)	7.5	0	-	10.1	10	7.6	0	-				
HCM Lane LOS	A	A	-	B	B	A	A	-				
HCM 95th %tile Q(veh)	0	-	-	0	0	0	-	-				

	←	↖	↗	↑	↓
Lane Group	WBT	WBR	NBL	NBT	SBT
Lane Configurations	↖	↗		↖	↗
Traffic Volume (vph)	1	605	122	284	217
Future Volume (vph)	1	605	122	284	217
Turn Type	NA	Perm	Perm	NA	NA
Protected Phases	8			2	6
Permitted Phases		8	2		
Detector Phase	8	8	2	2	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	31.0	31.0	29.0	29.0	29.0
Total Split (%)	51.7%	51.7%	48.3%	48.3%	48.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.5	4.5		4.5	4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	Max	Max
Act Effect Green (s)	26.5	26.5		24.5	24.5
Actuated g/C Ratio	0.44	0.44		0.41	0.41
v/c Ratio	0.22	0.72		0.89	0.50
Control Delay	11.3	10.2		38.2	13.9
Queue Delay	0.0	0.0		0.0	0.0
Total Delay	11.3	10.2		38.2	13.9
LOS	B	B		D	B
Approach Delay	10.4			38.2	13.9
Approach LOS	B			D	B

Intersection Summary

Cycle Length: 60

Actuated Cycle Length: 60

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green

Natural Cycle: 55

Control Type: Pretimed

Maximum v/c Ratio: 0.89

Intersection Signal Delay: 18.7

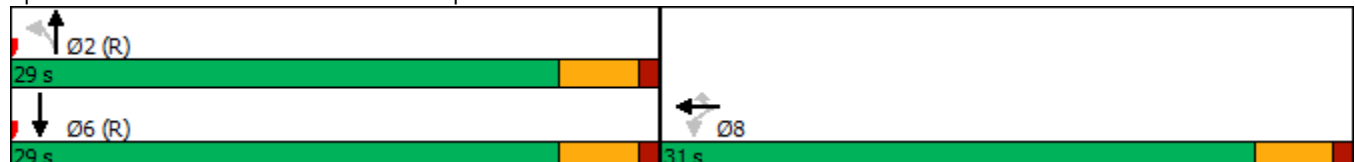
Intersection LOS: B

Intersection Capacity Utilization 66.7%

ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 1: 9th St & I-70 WB ramp





















Lane Group	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	166	658	442	372
v/c Ratio	0.22	0.72	0.89	0.50
Control Delay	11.3	10.2	38.2	13.9
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	11.3	10.2	38.2	13.9
Queue Length 50th (ft)	35	56	118	79
Queue Length 95th (ft)	68	173	#296	147
Internal Link Dist (ft)	977		244	1334
Turn Bay Length (ft)		40		
Base Capacity (vph)	768	915	494	737
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.22	0.72	0.89	0.50










Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

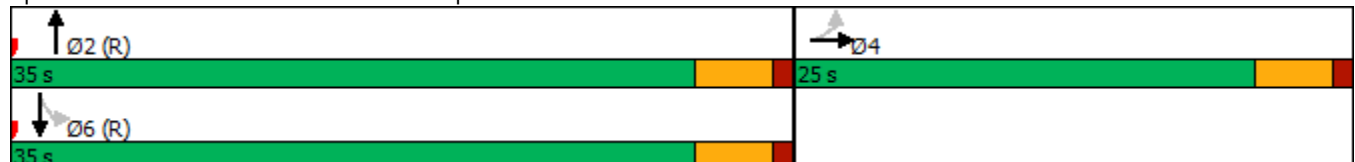
HCM 6th Signalized Intersection Summary
06/26/2022





1: 9th St & I-70 WB ramp
2035 Total PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	152	1	605	122	284	0	0	217	125
Future Volume (veh/h)	0	0	0	152	1	605	122	284	0	0	217	125
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1841	1841	1841	1811	1811	0	0	1826	1826
Adj Flow Rate, veh/h				165	1	658	133	309	0	0	236	136
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				4	4	4	6	6	0	0	5	5
Cap, veh/h				770	5	689	184	365	0	0	444	256
Arrive On Green				0.44	0.44	0.44	0.41	0.41	0.00	0.00	0.41	0.41
Sat Flow, veh/h				1743	11	1560	259	893	0	0	1087	626
Grp Volume(v), veh/h				166	0	658	442	0	0	0	0	372
Grp Sat Flow(s),veh/h/ln				1754	0	1560	1153	0	0	0	0	1713
Q Serve(g_s), s				3.5	0.0	24.4	12.9	0.0	0.0	0.0	0.0	9.8
Cycle Q Clear(g_c), s				3.5	0.0	24.4	22.8	0.0	0.0	0.0	0.0	9.8
Prop In Lane				0.99		1.00	0.30		0.00	0.00		0.37
Lane Grp Cap(c), veh/h				774	0	689	549	0	0	0	0	700
V/C Ratio(X)				0.21	0.00	0.96	0.81	0.00	0.00	0.00	0.00	0.53
Avail Cap(c_a), veh/h				774	0	689	549	0	0	0	0	700
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00
Uniform Delay (d), s/veh				10.3	0.0	16.2	18.2	0.0	0.0	0.0	0.0	13.4
Incr Delay (d2), s/veh				0.6	0.0	24.9	11.9	0.0	0.0	0.0	0.0	2.9
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				1.3	0.0	11.8	7.1	0.0	0.0	0.0	0.0	3.9
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				11.0	0.0	41.1	30.1	0.0	0.0	0.0	0.0	16.3
LnGrp LOS				B	A	D	C	A	A	A	A	B
Approach Vol, veh/h					824			442			372	
Approach Delay, s/veh					35.0			30.1			16.3	
Approach LOS					C			C			B	
Timer - Assigned Phs	2			6			8					
Phs Duration (G+Y+Rc), s	29.0			29.0			31.0					
Change Period (Y+Rc), s	4.5			4.5			4.5					
Max Green Setting (Gmax), s	24.5			24.5			26.5					
Max Q Clear Time (g_c+I1), s	24.8			11.8			26.4					
Green Ext Time (p_c), s	0.0			1.9			0.0					
Intersection Summary												
HCM 6th Ctrl Delay	29.4											
HCM 6th LOS	C											

					
Lane Group	EBL	EBT	NBT	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	165	1	241	135	264
Future Volume (vph)	165	1	241	135	264
Turn Type	Perm	NA	NA	Perm	NA
Protected Phases		4	2		6
Permitted Phases	4			6	
Detector Phase	4	4	2	6	6
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	22.5	22.5	22.5	22.5	22.5
Total Split (s)	25.0	25.0	35.0	35.0	35.0
Total Split (%)	41.7%	41.7%	58.3%	58.3%	58.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0
Total Lost Time (s)	4.5	4.5	4.5		4.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	Max	Max
Act Effct Green (s)	20.5	20.5	30.5		30.5
Actuated g/C Ratio	0.34	0.34	0.51		0.51
v/c Ratio	0.30	0.20	0.42		0.65
Control Delay	16.3	4.3	9.6		15.5
Queue Delay	0.0	0.0	0.0		0.0
Total Delay	16.3	4.3	9.6		15.5
LOS	B	A	A		B
Approach Delay		11.4	9.6		15.5
Approach LOS		B	A		B
Intersection Summary					
Cycle Length: 60					
Actuated Cycle Length: 60					
Offset: 4 (7%), Referenced to phase 2:NBT and 6:SBTL, Start of Green					
Natural Cycle: 55					
Control Type: Pretimed					
Maximum v/c Ratio: 0.65					
Intersection Signal Delay: 12.4			Intersection LOS: B		
Intersection Capacity Utilization 60.9%			ICU Level of Service B		
Analysis Period (min) 15					

















Splits and Phases: 2: 9th St & I-70 EB Ramps



				
Lane Group	EBL	EBT	NBT	SBT
Lane Group Flow (vph)	179	123	377	434
v/c Ratio	0.30	0.20	0.42	0.65
Control Delay	16.3	4.3	9.6	15.5
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	16.3	4.3	9.6	15.5
Queue Length 50th (ft)	46	0	65	88
Queue Length 95th (ft)	90	29	121	129
Internal Link Dist (ft)		1729	155	190
Turn Bay Length (ft)	490			
Base Capacity (vph)	587	606	892	667
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.30	0.20	0.42	0.65
Intersection Summary				

HCM 6th Signalized Intersection Summary
06/26/2022

2: 9th St & I-70 EB Ramps
2035 Total PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	165	1	112	0	0	0	0	241	106	135	264	0
Future Volume (veh/h)	165	1	112	0	0	0	0	241	106	135	264	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1826	1826	1826				0	1796	1796	1811	1811	0
Adj Flow Rate, veh/h	179	1	122				0	262	115	147	287	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	5	5	5				0	7	7	6	6	0
Cap, veh/h	594	4	525				0	602	264	255	459	0
Arrive On Green	0.34	0.34	0.34				0.00	0.51	0.51	0.51	0.51	0.00
Sat Flow, veh/h	1739	13	1537				0	1183	519	344	904	0
Grp Volume(v), veh/h	179	0	123				0	0	377	434	0	0
Grp Sat Flow(s),veh/h/ln	1739	0	1549				0	0	1703	1248	0	0
Q Serve(g_s), s	4.5	0.0	3.4				0.0	0.0	8.4	9.7	0.0	0.0
Cycle Q Clear(g_c), s	4.5	0.0	3.4				0.0	0.0	8.4	18.1	0.0	0.0
Prop In Lane	1.00		0.99				0.00		0.31	0.34		0.00
Lane Grp Cap(c), veh/h	594	0	529				0	0	866	715	0	0
V/C Ratio(X)	0.30	0.00	0.23				0.00	0.00	0.44	0.61	0.00	0.00
Avail Cap(c_a), veh/h	594	0	529				0	0	866	715	0	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.00	1.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	14.5	0.0	14.1				0.0	0.0	9.3	12.0	0.0	0.0
Incr Delay (d2), s/veh	1.3	0.0	1.0				0.0	0.0	1.6	3.8	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	0.0	1.2				0.0	0.0	2.9	4.7	0.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	15.8	0.0	15.1				0.0	0.0	10.9	15.8	0.0	0.0
LnGrp LOS	B	A	B				A	A	B	B	A	A
Approach Vol, veh/h	302						377			434		
Approach Delay, s/veh	15.5						10.9			15.8		
Approach LOS	B						B			B		
Timer - Assigned Phs	2			4			6					
Phs Duration (G+Y+Rc), s	35.0			25.0			35.0					
Change Period (Y+Rc), s	4.5			4.5			4.5					
Max Green Setting (Gmax), s	30.5			20.5			30.5					
Max Q Clear Time (g_c+I1), s	10.4			6.5			20.1					
Green Ext Time (p_c), s	2.3			1.0			2.2					
Intersection Summary												
HCM 6th Ctrl Delay	14.1											
HCM 6th LOS	B											




HCM Unsignalized Intersection Capacity Analysis




06/26/2022

3: River Frontage Rd & 9th St
2035 Total PM Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↰	↰		↰	
Traffic Volume (veh/h)	110	25	24	237	292	105
Future Volume (Veh/h)	110	25	24	237	292	105
Sign Control		Stop	Stop		Free	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	120	27	26	258	317	114
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh						
Upstream signal (ft)					235	
pX, platoon unblocked						
vC, conflicting volume	962	691	748	0	0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	962	691	748	0	0	
tC, single (s)	7.2	6.6	6.6	6.3	4.2	
tC, 2 stage (s)						
tF (s)	3.6	4.1	4.1	3.4	2.3	
p0 queue free %	10	90	90	76	80	
cM capacity (veh/h)	134	283	267	1070	1566	
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	147	284	431			
Volume Left	120	0	317			
Volume Right	0	258	114			
cSH	148	839	1566			
Volume to Capacity	0.99	0.34	0.20			
Queue Length 95th (ft)	184	38	19			
Control Delay (s)	131.9	11.5	6.2			
Lane LOS	F	B	A			
Approach Delay (s)	131.9	11.5	6.2			
Approach LOS	F	B				
Intersection Summary						
Average Delay		29.4				
Intersection Capacity Utilization		55.9%		ICU Level of Service		B
Analysis Period (min)		15				




Intersection						
Int Delay, s/veh	2.7					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	172	130	19	177	89	20
Future Vol, veh/h	172	130	19	177	89	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	9	9	9	9
Mvmt Flow	187	141	21	192	97	22
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	328	0	492	258
Stage 1	-	-	-	-	258	-
Stage 2	-	-	-	-	234	-
Critical Hdwy	-	-	4.19	-	6.49	6.29
Critical Hdwy Stg 1	-	-	-	-	5.49	-
Critical Hdwy Stg 2	-	-	-	-	5.49	-
Follow-up Hdwy	-	-	2.281	-	3.581	3.381
Pot Cap-1 Maneuver	-	-	1193	-	524	764
Stage 1	-	-	-	-	769	-
Stage 2	-	-	-	-	789	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1193	-	514	764
Mov Cap-2 Maneuver	-	-	-	-	514	-
Stage 1	-	-	-	-	769	-
Stage 2	-	-	-	-	773	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0.8		13.4	
HCM LOS					B	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	547	-	-	1193	-	
HCM Lane V/C Ratio	0.217	-	-	0.017	-	
HCM Control Delay (s)	13.4	-	-	8.1	0	
HCM Lane LOS	B	-	-	A	A	
HCM 95th %tile Q(veh)	0.8	-	-	0.1	-	





Intersection						
Int Delay, s/veh	2.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	45	5	15	59	58	89
Future Vol, veh/h	45	5	15	59	58	89
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	89	89	85	85
Heavy Vehicles, %	3	3	4	4	10	10
Mvmt Flow	53	6	17	66	68	105
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	221	121	173	0	-	0
Stage 1	121	-	-	-	-	-
Stage 2	100	-	-	-	-	-
Critical Hdwy	6.43	6.23	4.14	-	-	-
Critical Hdwy Stg 1	5.43	-	-	-	-	-
Critical Hdwy Stg 2	5.43	-	-	-	-	-
Follow-up Hdwy	3.527	3.327	2.236	-	-	-
Pot Cap-1 Maneuver	765	928	1392	-	-	-
Stage 1	902	-	-	-	-	-
Stage 2	921	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	755	928	1392	-	-	-
Mov Cap-2 Maneuver	755	-	-	-	-	-
Stage 1	890	-	-	-	-	-
Stage 2	921	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	10.1	1.5		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1392	-	769	-	-	
HCM Lane V/C Ratio	0.012	-	0.076	-	-	
HCM Control Delay (s)	7.6	0	10.1	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0	-	0.2	-	-	

6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach

Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.3	0.1	0.1
Total Del/Veh (s)	3.4	6.8	3.2	4.6

Intersection						
Int Delay, s/veh	1.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖	↘	
Traffic Vol, veh/h	37	155	2	137	59	2
Future Vol, veh/h	37	155	2	137	59	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	275	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	40	168	2	149	64	2
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	208	0	193	40
Stage 1	-	-	-	-	40	-
Stage 2	-	-	-	-	153	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1363	-	796	1031
Stage 1	-	-	-	-	982	-
Stage 2	-	-	-	-	875	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1363	-	794	1031
Mov Cap-2 Maneuver	-	-	-	-	794	-
Stage 1	-	-	-	-	982	-
Stage 2	-	-	-	-	873	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0.1		9.9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	800	-	-	1363	-	
HCM Lane V/C Ratio	0.083	-	-	0.002	-	
HCM Control Delay (s)	9.9	-	-	7.6	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.3	-	-	0	-	

Intersection						
Int Delay, s/veh	3.7					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	18	21	6	27	34	8
Future Vol, veh/h	18	21	6	27	34	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	20	23	7	29	37	9
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	43	0	75	32
Stage 1	-	-	-	-	32	-
Stage 2	-	-	-	-	43	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1566	-	928	1042
Stage 1	-	-	-	-	991	-
Stage 2	-	-	-	-	979	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1566	-	923	1042
Mov Cap-2 Maneuver	-	-	-	-	923	-
Stage 1	-	-	-	-	991	-
Stage 2	-	-	-	-	974	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		1.3		9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	944	-	-	1566	-	
HCM Lane V/C Ratio	0.048	-	-	0.004	-	
HCM Control Delay (s)	9	-	-	7.3	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.2	-	-	0	-	

Intersection												
Int Delay, s/veh	1											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	2	0	1	9	0	9	1	98	10	10	137	2
Future Vol, veh/h	2	0	1	9	0	9	1	98	10	10	137	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	2	0	1	10	0	10	1	107	11	11	149	2
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	292	292	150	288	288	113	151	0	0	118	0	0
Stage 1	172	172	-	115	115	-	-	-	-	-	-	-
Stage 2	120	120	-	173	173	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	660	619	896	664	622	940	1430	-	-	1470	-	-
Stage 1	830	756	-	890	800	-	-	-	-	-	-	-
Stage 2	884	796	-	829	756	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	649	613	896	659	616	940	1430	-	-	1470	-	-
Mov Cap-2 Maneuver	649	613	-	659	616	-	-	-	-	-	-	-
Stage 1	829	750	-	889	799	-	-	-	-	-	-	-
Stage 2	874	795	-	821	750	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	10.1		9.8		0.1		0.5					
HCM LOS	B		A									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR				
Capacity (veh/h)	1430	-	-	715	775	1470	-	-				
HCM Lane V/C Ratio	0.001	-	-	0.005	0.025	0.007	-	-				
HCM Control Delay (s)	7.5	0	-	10.1	9.8	7.5	0	-				
HCM Lane LOS	A	A	-	B	A	A	A	-				
HCM 95th %tile Q(veh)	0	-	-	0	0.1	0	-	-				

APPROACH AND EXIT FLOWS

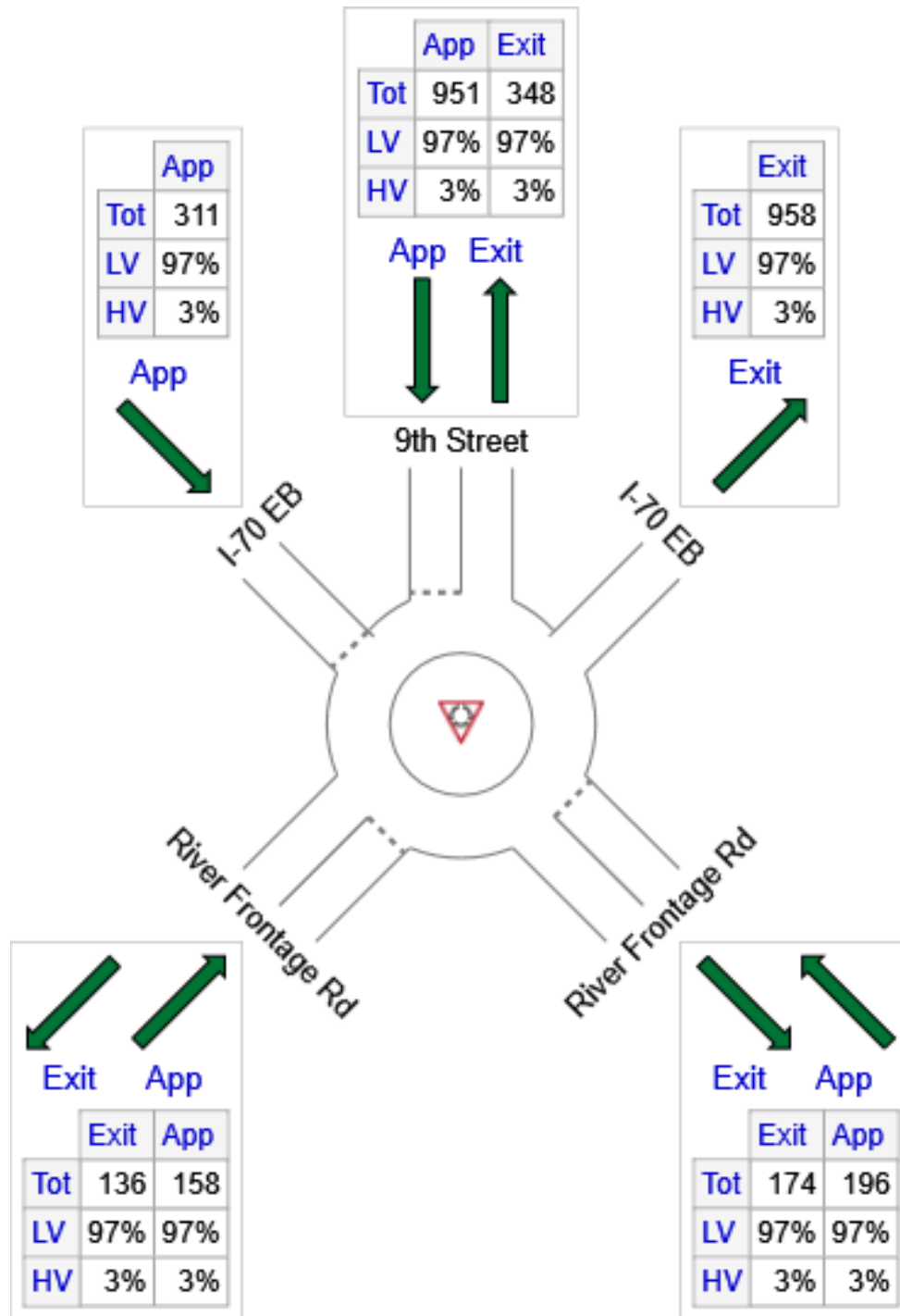
Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 Site: 2 [I-70 EB 2045 AM (Site Folder: Background)]

I-70 EB Ramp Roundabout

Site Category: (None)

Roundabout



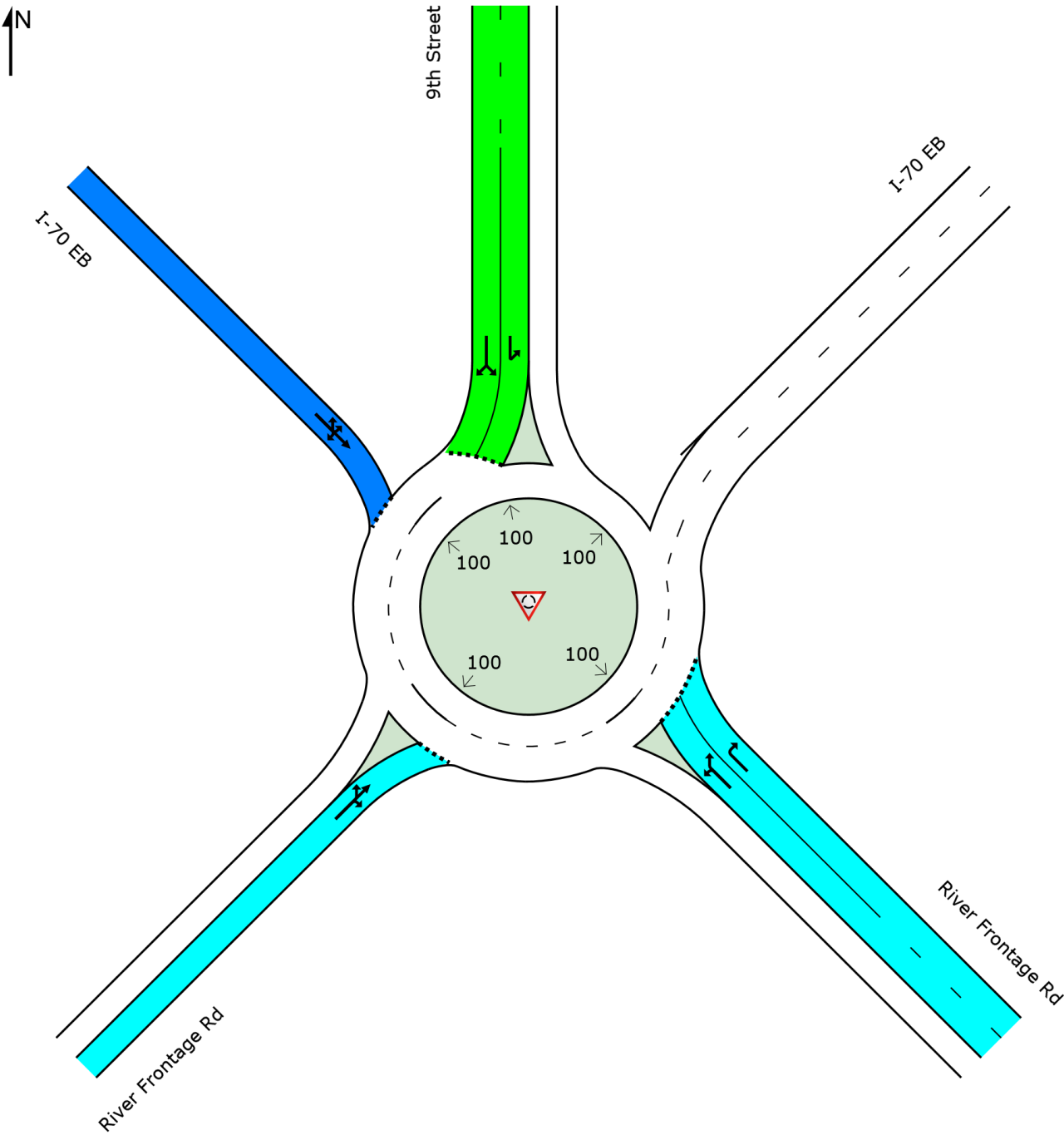
LEVEL OF SERVICE

Lane Level of Service

 **Site: 2 [I-70 EB 2045 AM (Site Folder: Background)]**

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

	Approaches				Intersection
	Southeast	North	Northwest	Southwest	
LOS	B	A	C	B	B



DELAY (CONTROL)

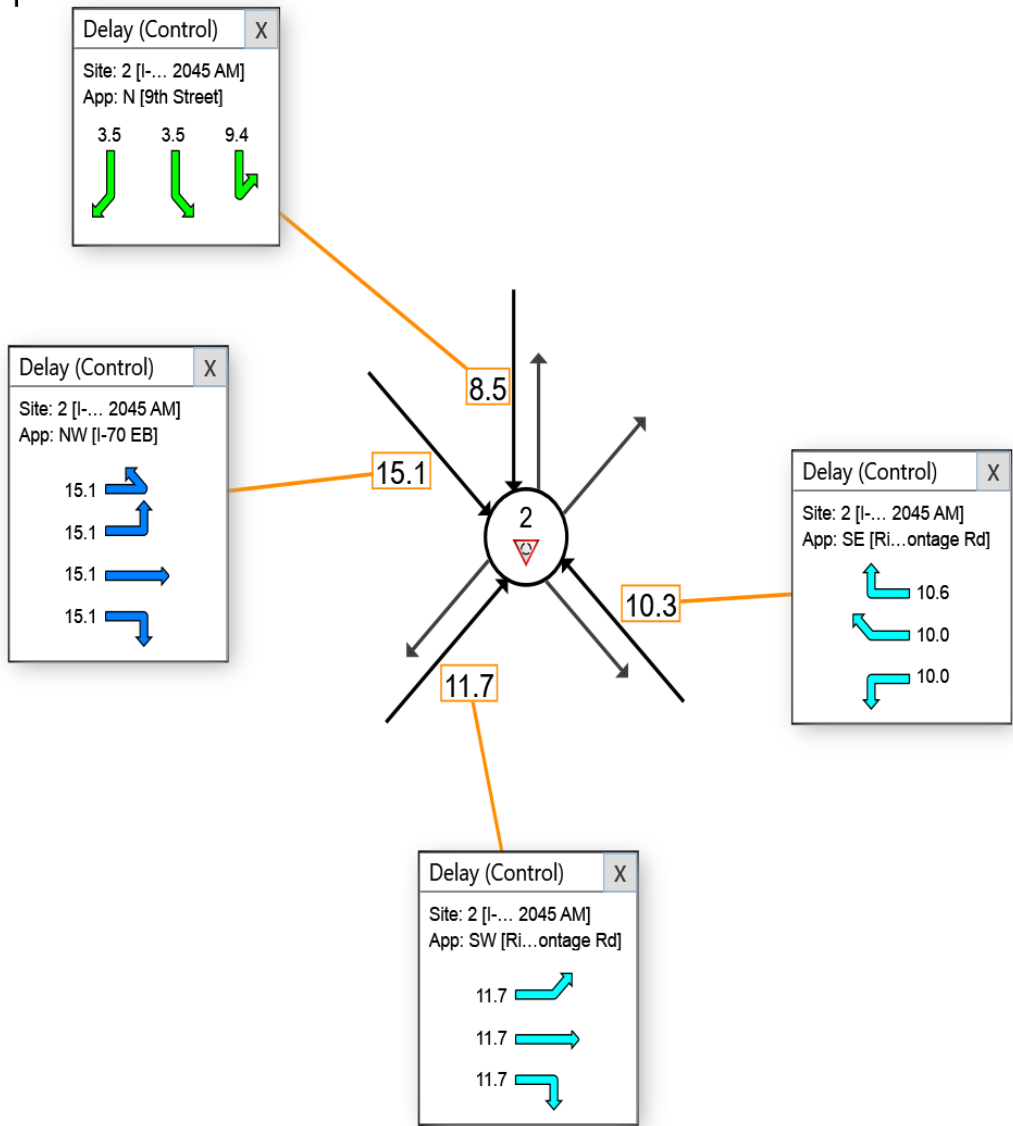
Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 2 [I-70 EB 2045 AM (Site Folder: Background)]

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



QUEUE DISTANCE (PERCENTILE)

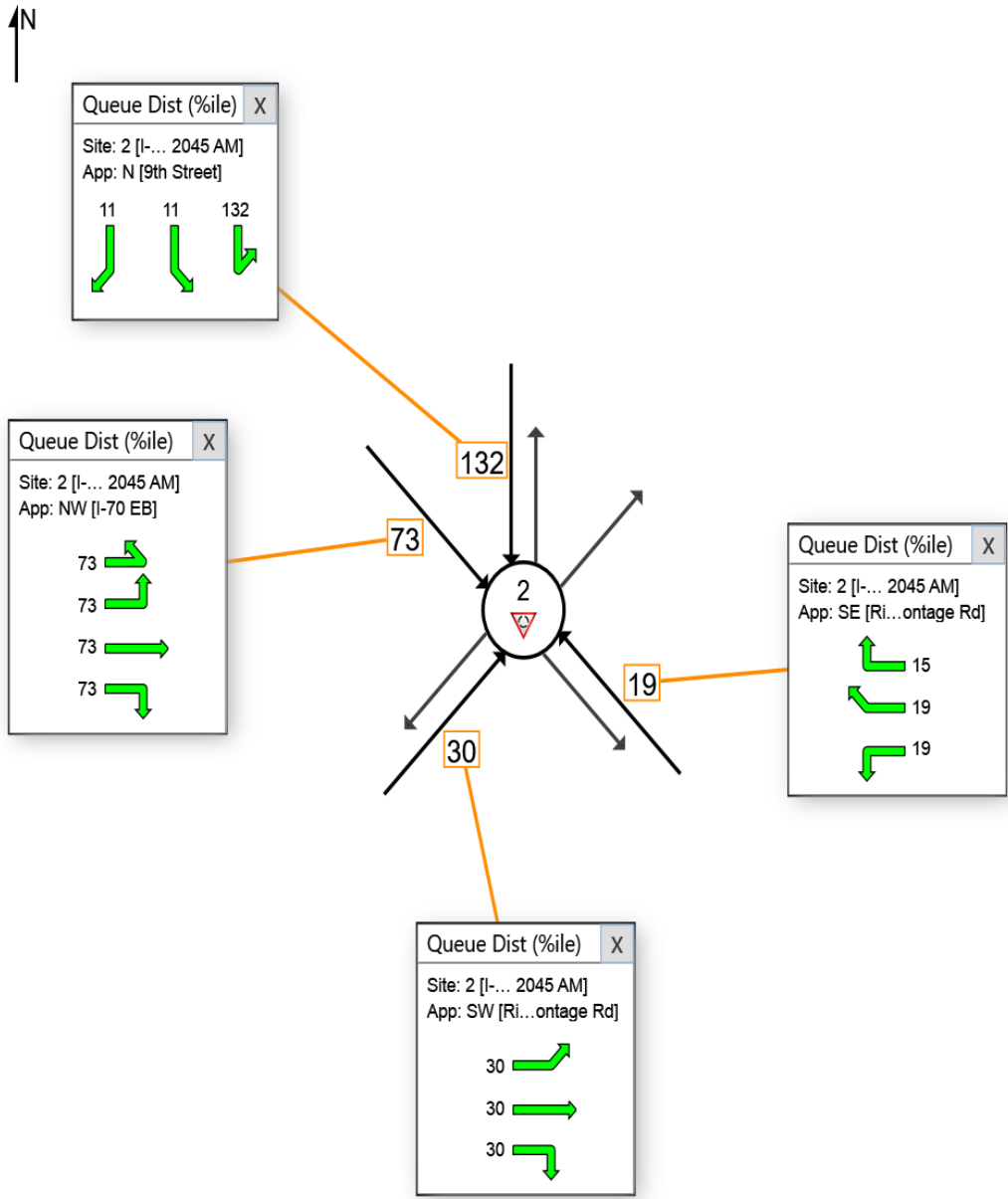
Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

Site: 2 [I-70 EB 2045 AM (Site Folder: Background)]

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones. Click and drag popup boxes to move to preferred positions.

Close All Popups



APPROACH AND EXIT FLOWS

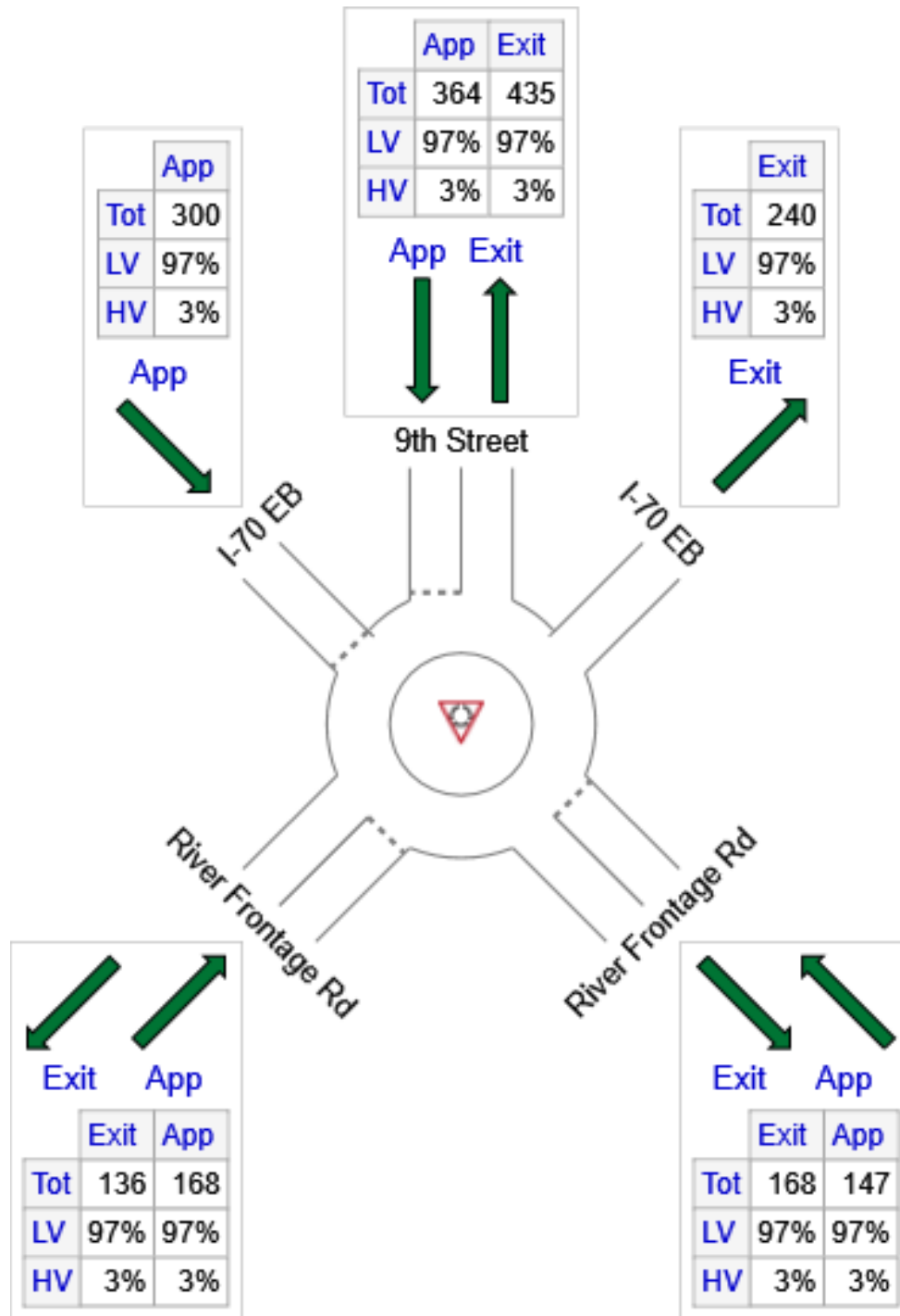
Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 Site: 2 [I-70 EB 2045 PM (Site Folder: Background)]

I-70 EB Ramp Roundabout

Site Category: (None)

Roundabout



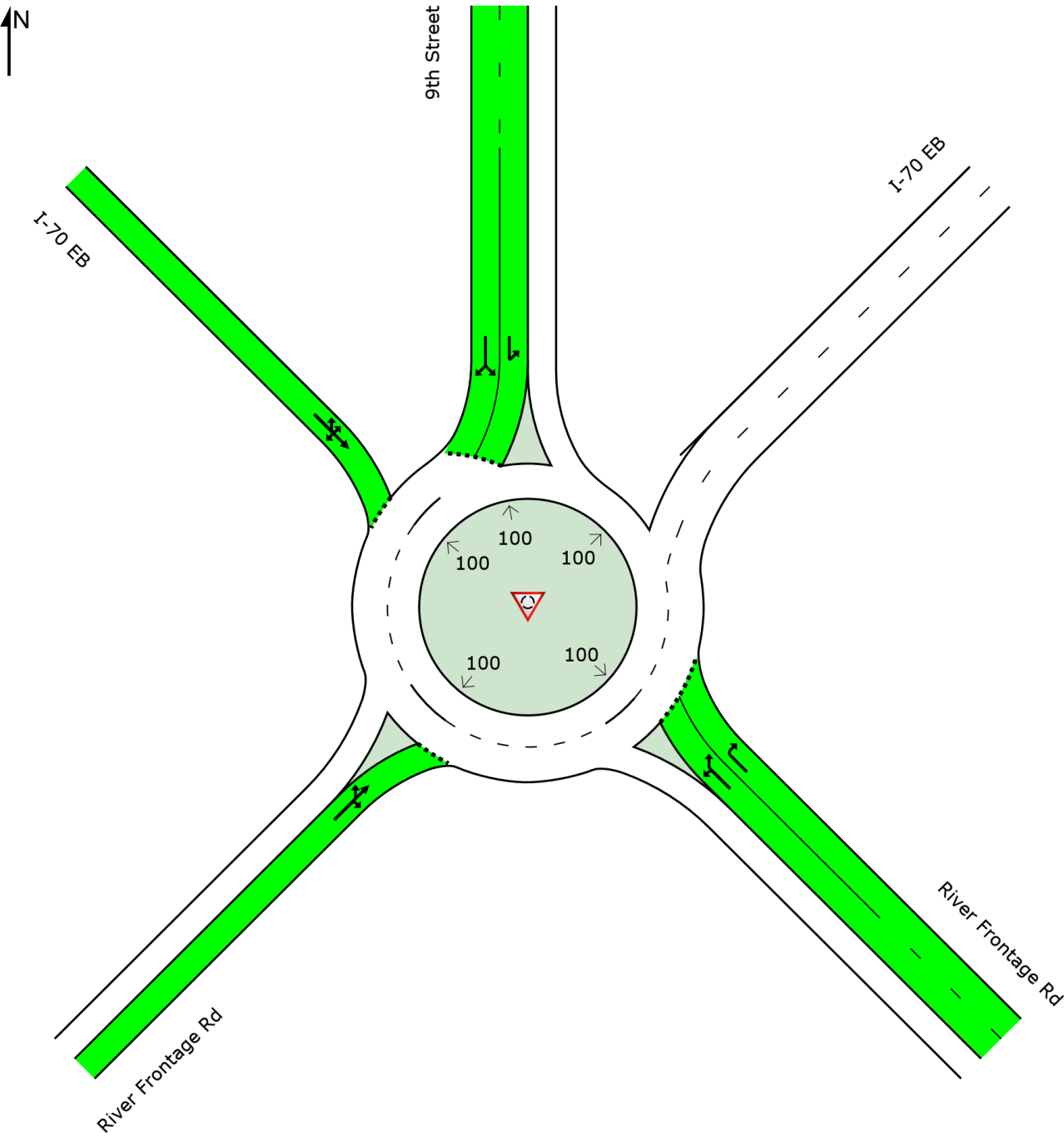
LEVEL OF SERVICE

Lane Level of Service

 **Site: 2 [I-70 EB 2045 PM (Site Folder: Background)]**

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

	Approaches				Intersection
	Southeast	North	Northwest	Southwest	
LOS	A	A	A	A	A



DELAY (CONTROL)

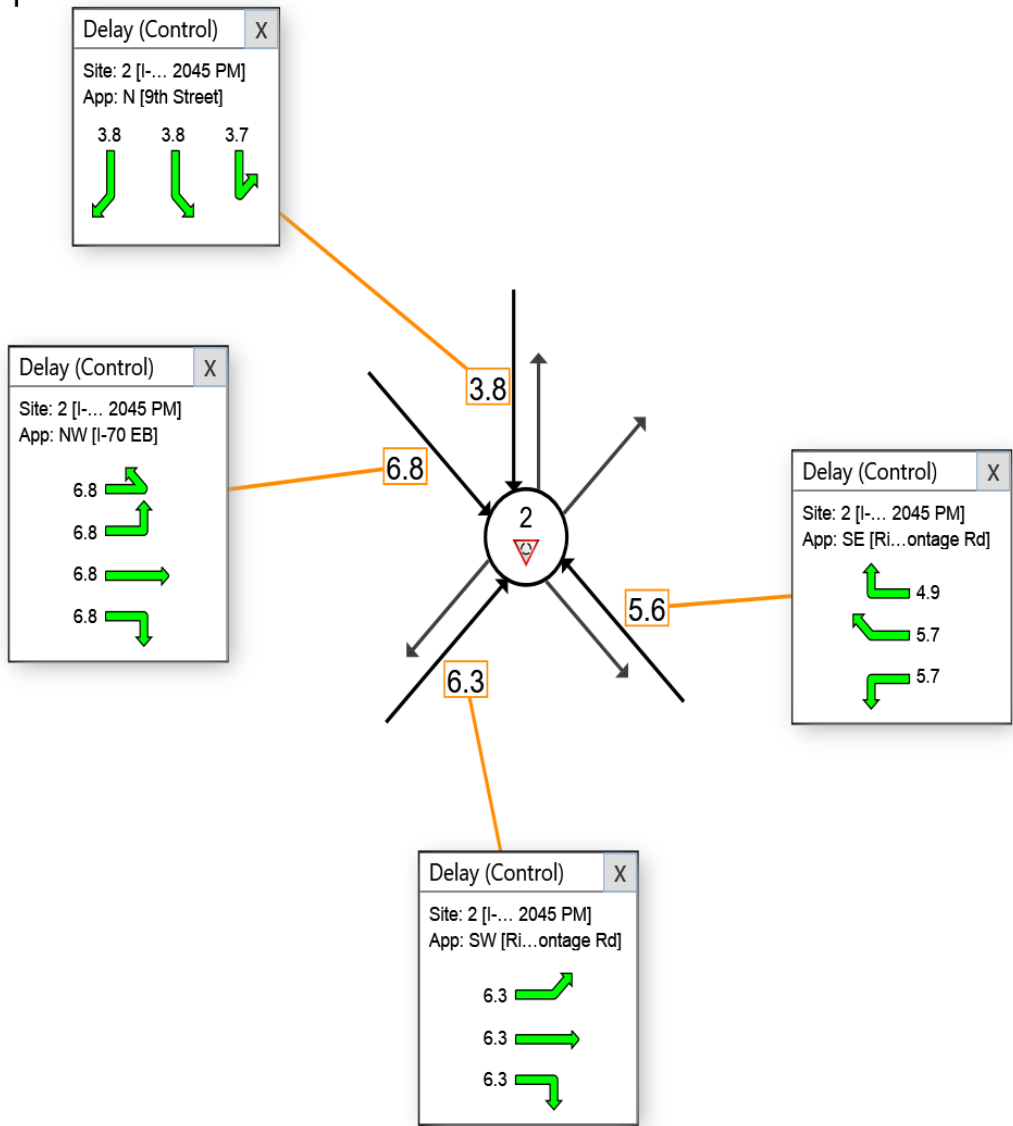
Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 2 [I-70 EB 2045 PM (Site Folder: Background)]

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



QUEUE DISTANCE (PERCENTILE)

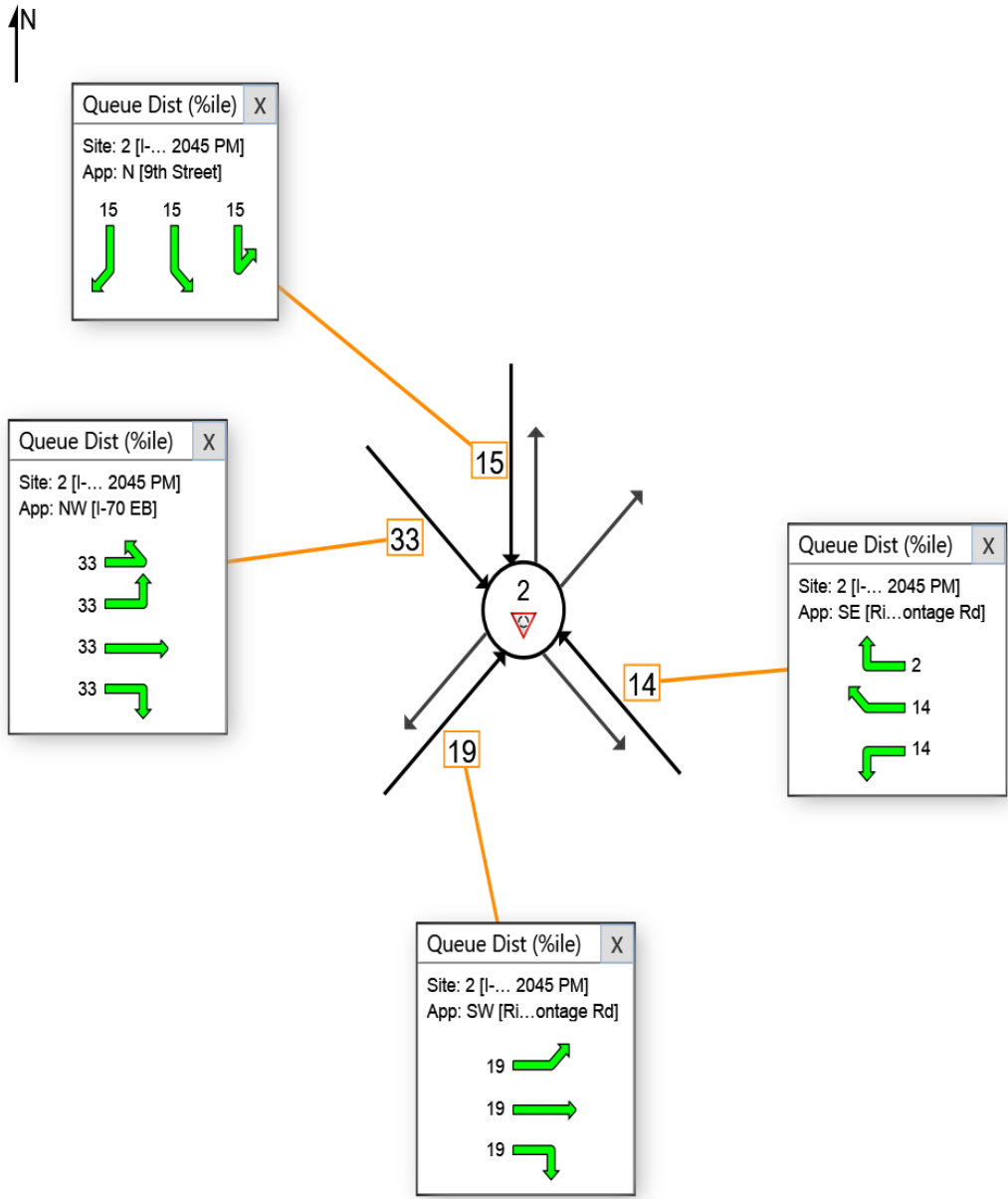
Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

 **Site: 2 [I-70 EB 2045 PM (Site Folder: Background)]**

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups

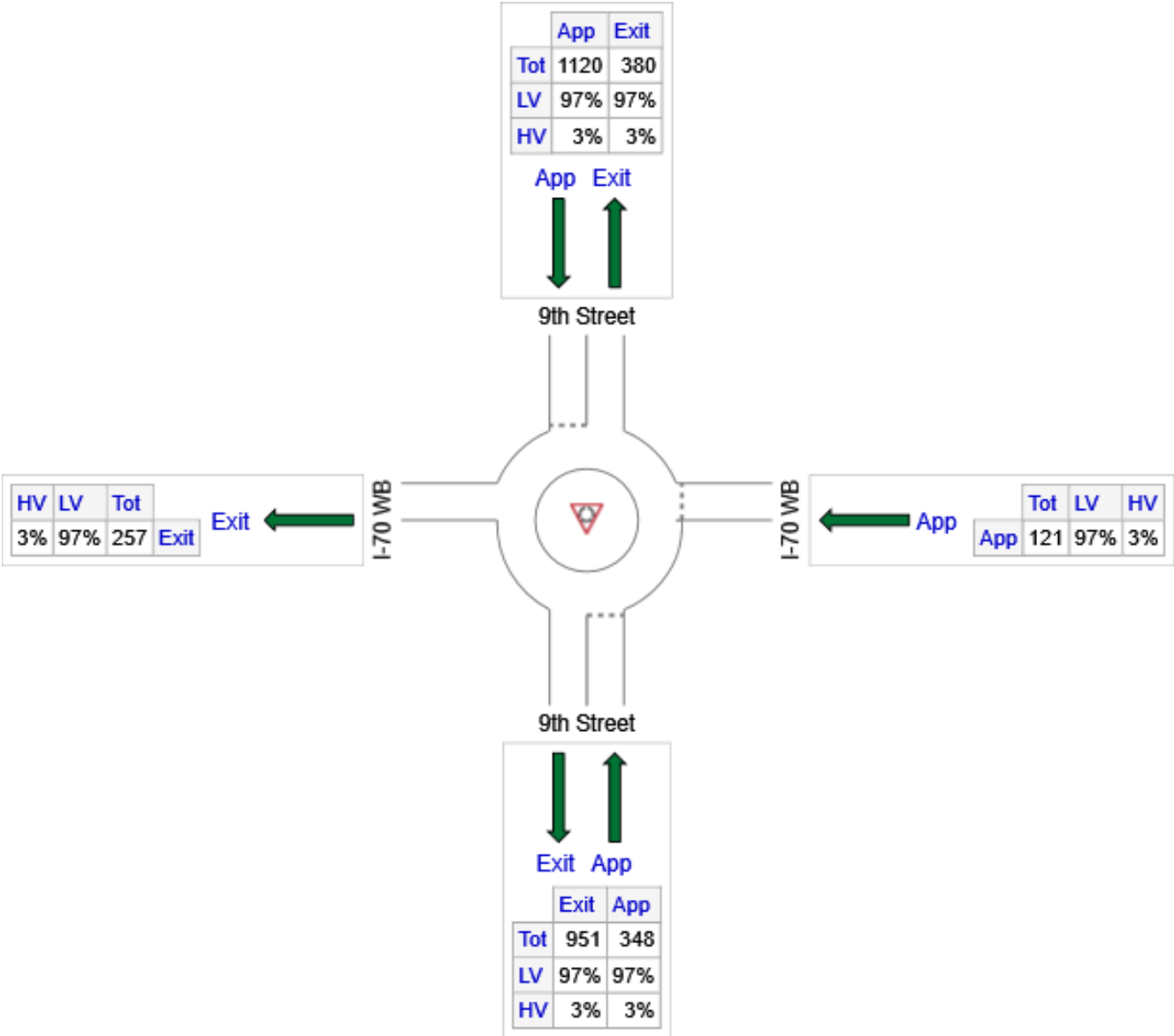


APPROACH AND EXIT FLOWS

Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 Site: 1 [I-70 WB 2045 AM (Site Folder: Background)]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout



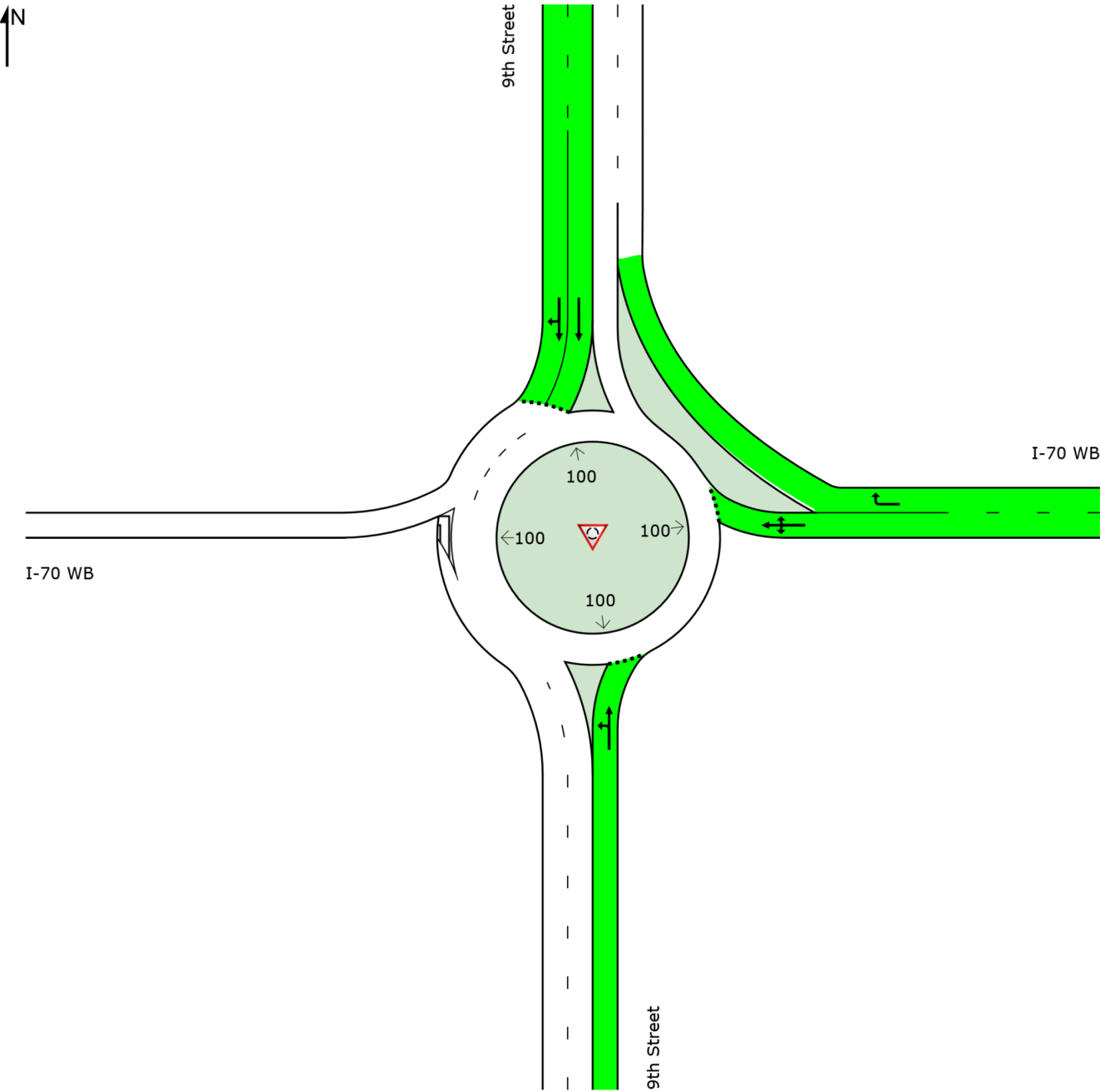
LEVEL OF SERVICE

Lane Level of Service

 Site: 1 [I-70 WB 2045 AM (Site Folder: Background)]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

	Approaches			Intersection
	South	East	North	
LOS	A	A	A	A



DELAY (CONTROL)

Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 1 [I-70 WB 2045 AM (Site Folder: Background)]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



Delay (Control) X

Site: 1 [I-... 2045 AM]
App: N [9th Street]

7.3

7.3

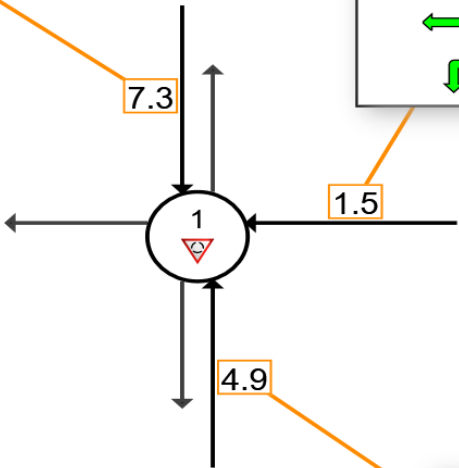
Delay (Control) X

Site: 1 [I-... 2045 AM]
App: E [I-70 WB]

0.8

4.0

4.0



Delay (Control) X

Site: 1 [I-... 2045 AM]
App: S [9th Street]

4.9

4.9

QUEUE DISTANCE (PERCENTILE)

Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

 Site: 1 [I-70 WB 2045 AM (Site Folder: Background)]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



Queue Dist (%ile) X

Site: 1 [I-... 2045 AM]
App: N [9th Street]

69

69

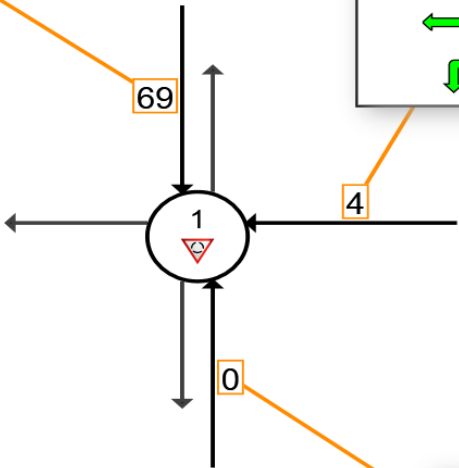
Queue Dist (%ile) X

Site: 1 [I-... 2045 AM]
App: E [I-70 WB]

4

4

4



Queue Dist (%ile) X

Site: 1 [I-... 2045 AM]
App: S [9th Street]

0

0

APPROACH AND EXIT FLOWS

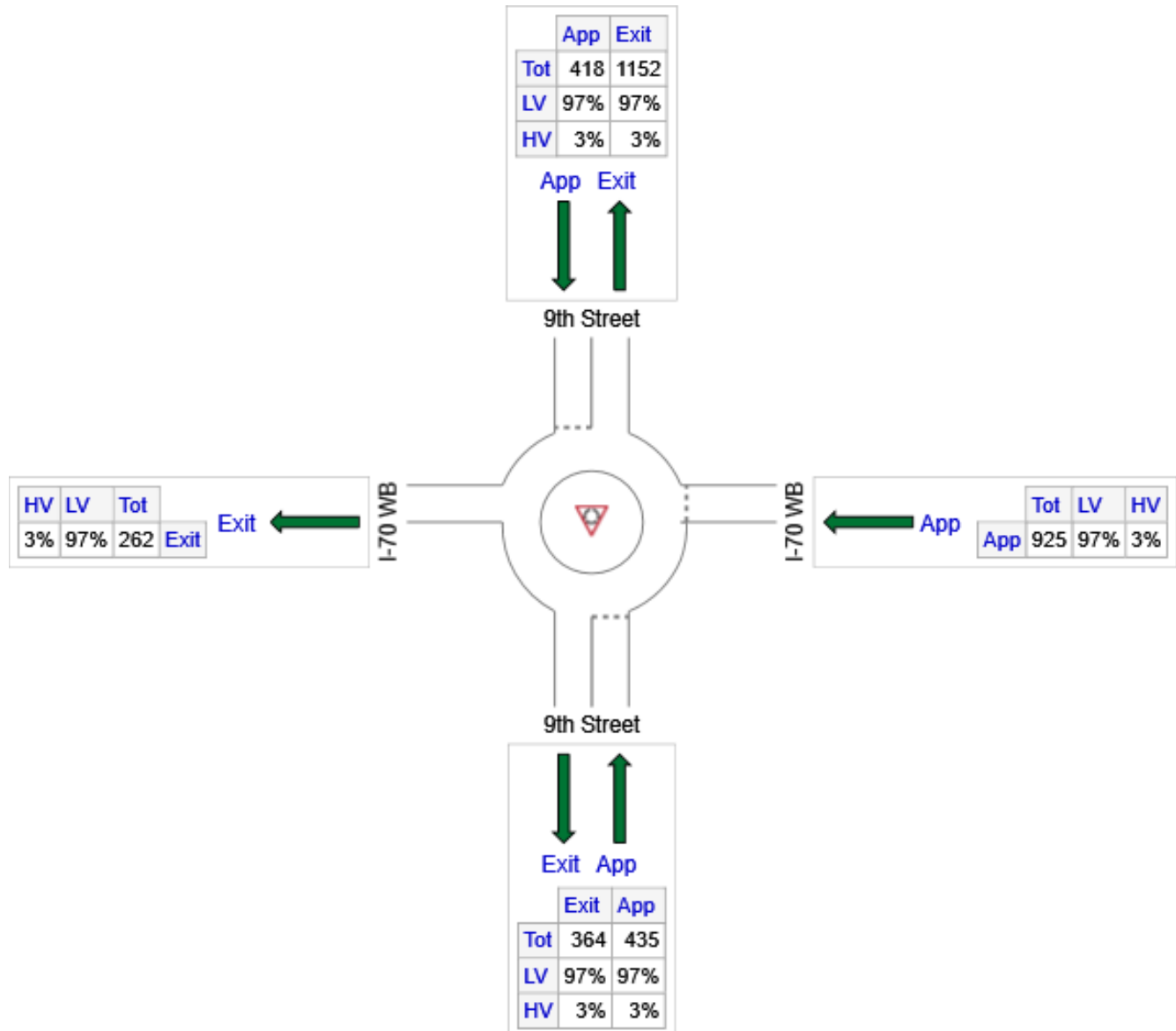
Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 Site: 1 [I-70 WB 2045 PM (Site Folder: Background)]

I-70 WB Ramp Roundabout

Site Category: (None)

Roundabout



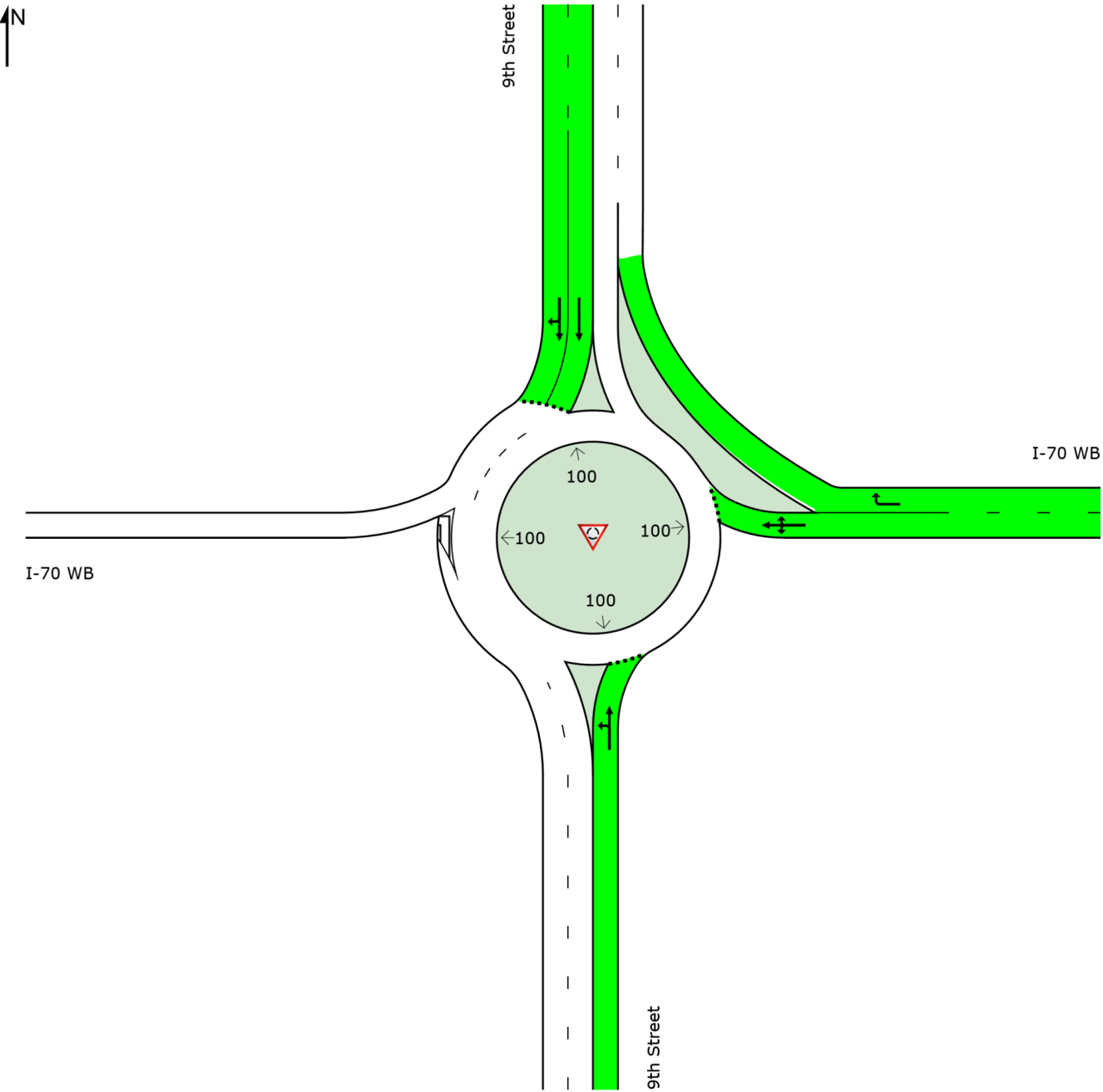
LEVEL OF SERVICE

Lane Level of Service

 Site: 1 [I-70 WB 2045 PM (Site Folder: Background)]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

	Approaches			Intersection
	South	East	North	
LOS	A	A	A	A



DELAY (CONTROL)

Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 1 [I-70 WB 2045 PM (Site Folder: Background)]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



Delay (Control) X

Site: 1 [I-... 2045 PM]
App: N [9th Street]

4.8

4.8

Delay (Control) X

Site: 1 [I-... 2045 PM]
App: E [I-70 WB]

2.1

8.0

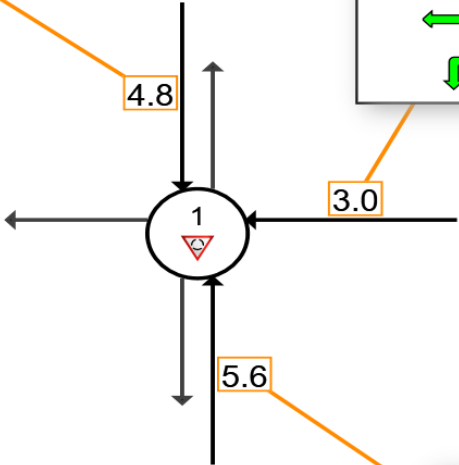
8.0

Delay (Control) X

Site: 1 [I-... 2045 PM]
App: S [9th Street]

5.6

5.6



QUEUE DISTANCE (PERCENTILE)

Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

 Site: 1 [I-70 WB 2045 PM (Site Folder: Background)]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



Queue Dist (%ile) X

Site: 1 [I-... 2045 PM]
App: N [9th Street]

20

20

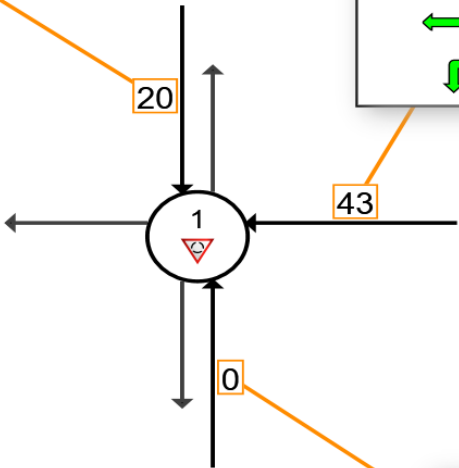
Queue Dist (%ile) X

Site: 1 [I-... 2045 PM]
App: E [I-70 WB]

43

43

43






Queue Dist (%ile) X




Site: 1 [I-... 2045 PM]
App: S [9th Street]

0

0

***Intersection Capacity Worksheets:
2045 Background
+ Project***




Intersection						
Int Delay, s/veh	5.1					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	109	129	14	82	174	34
Future Vol, veh/h	109	129	14	82	174	34
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	5	5	12	12
Mvmt Flow	118	140	15	89	189	37
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	258	0	308	189
Stage 1	-	-	-	-	188	-
Stage 2	-	-	-	-	120	-
Critical Hdwy	-	-	4.15	-	6.52	6.32
Critical Hdwy Stg 1	-	-	-	-	5.52	-
Critical Hdwy Stg 2	-	-	-	-	5.52	-
Follow-up Hdwy	-	-	2.245	-	3.608	3.408
Pot Cap-1 Maneuver	-	-	1289	-	664	828
Stage 1	-	-	-	-	821	-
Stage 2	-	-	-	-	881	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1289	-	655	827
Mov Cap-2 Maneuver	-	-	-	-	655	-
Stage 1	-	-	-	-	821	-
Stage 2	-	-	-	-	870	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		1.1		12.9	
HCM LOS					B	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	678	-	-	1289	-	
HCM Lane V/C Ratio	0.333	-	-	0.012	-	
HCM Control Delay (s)	12.9	-	-	7.8	0	
HCM Lane LOS	B	-	-	A	A	
HCM 95th %tile Q(veh)	1.5	-	-	0	-	

Intersection						
Int Delay, s/veh	4.7					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	139	5	5	64	65	74
Future Vol, veh/h	139	5	5	64	65	74
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	85	85	85	85
Heavy Vehicles, %	16	16	6	6	14	14
Mvmt Flow	164	6	6	75	76	87
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	207	120	163	0	-	0
Stage 1	120	-	-	-	-	-
Stage 2	87	-	-	-	-	-
Critical Hdwy	6.56	6.36	4.16	-	-	-
Critical Hdwy Stg 1	5.56	-	-	-	-	-
Critical Hdwy Stg 2	5.56	-	-	-	-	-
Follow-up Hdwy	3.644	3.444	2.254	-	-	-
Pot Cap-1 Maneuver	751	895	1392	-	-	-
Stage 1	872	-	-	-	-	-
Stage 2	902	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	748	895	1392	-	-	-
Mov Cap-2 Maneuver	748	-	-	-	-	-
Stage 1	869	-	-	-	-	-
Stage 2	902	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	11.2	0.6		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1392	-	752	-	-	
HCM Lane V/C Ratio	0.004	-	0.225	-	-	
HCM Control Delay (s)	7.6	0	11.2	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0	-	0.9	-	-	




6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach




Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.1	0.1
Total Del/Veh (s)	2.4	5.3	4.4	3.8

Intersection						
Int Delay, s/veh	2.8					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖	↘	
Traffic Vol, veh/h	81	62	1	27	69	1
Future Vol, veh/h	81	62	1	27	69	1
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	275	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	88	67	1	29	75	1
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	155	0	119	88
Stage 1	-	-	-	-	88	-
Stage 2	-	-	-	-	31	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1425	-	877	970
Stage 1	-	-	-	-	935	-
Stage 2	-	-	-	-	992	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1425	-	876	970
Mov Cap-2 Maneuver	-	-	-	-	876	-
Stage 1	-	-	-	-	935	-
Stage 2	-	-	-	-	991	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0.3		9.5	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	877	-	-	1425	-	
HCM Lane V/C Ratio	0.087	-	-	0.001	-	
HCM Control Delay (s)	9.5	-	-	7.5	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.3	-	-	0	-	

Intersection						
Int Delay, s/veh	1.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	56	26	7	16	12	4
Future Vol, veh/h	56	26	7	16	12	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	61	28	8	17	13	4
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	89	0	108	75
Stage 1	-	-	-	-	75	-
Stage 2	-	-	-	-	33	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1506	-	889	986
Stage 1	-	-	-	-	948	-
Stage 2	-	-	-	-	989	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1506	-	885	986
Mov Cap-2 Maneuver	-	-	-	-	885	-
Stage 1	-	-	-	-	948	-
Stage 2	-	-	-	-	984	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		2.3		9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	908	-	-	1506	-	
HCM Lane V/C Ratio	0.019	-	-	0.005	-	
HCM Control Delay (s)	9	-	-	7.4	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.1	-	-	0	-	

Intersection												
Int Delay, s/veh	0.4											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	2	0	1	4	0	4	1	202	4	4	137	2
Future Vol, veh/h	2	0	1	4	0	4	1	202	4	4	137	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	2	0	1	4	0	4	1	220	4	4	149	2
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	384	384	150	383	383	222	151	0	0	224	0	0
Stage 1	158	158	-	224	224	-	-	-	-	-	-	-
Stage 2	226	226	-	159	159	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	574	550	896	575	550	818	1430	-	-	1345	-	-
Stage 1	844	767	-	779	718	-	-	-	-	-	-	-
Stage 2	777	717	-	843	766	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	569	548	896	573	548	818	1430	-	-	1345	-	-
Mov Cap-2 Maneuver	569	548	-	573	548	-	-	-	-	-	-	-
Stage 1	843	765	-	778	717	-	-	-	-	-	-	-
Stage 2	772	716	-	839	764	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	10.6		10.4		0		0.2					
HCM LOS	B		B									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBL	SBT	SBR					
Capacity (veh/h)	1430	-	-	648	674	1345	-	-				
HCM Lane V/C Ratio	0.001	-	-	0.005	0.013	0.003	-	-				
HCM Control Delay (s)	7.5	0	-	10.6	10.4	7.7	0	-				
HCM Lane LOS	A	A	-	B	B	A	A	-				
HCM 95th %tile Q(veh)	0	-	-	0	0	0	-	-				




Intersection						
Int Delay, s/veh	3					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	177	160	19	187	109	20
Future Vol, veh/h	177	160	19	187	109	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	9	9	9	9	9	9
Mvmt Flow	192	174	21	203	118	22
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	366	0	524	279
Stage 1	-	-	-	-	279	-
Stage 2	-	-	-	-	245	-
Critical Hdwy	-	-	4.19	-	6.49	6.29
Critical Hdwy Stg 1	-	-	-	-	5.49	-
Critical Hdwy Stg 2	-	-	-	-	5.49	-
Follow-up Hdwy	-	-	2.281	-	3.581	3.381
Pot Cap-1 Maneuver	-	-	1155	-	502	743
Stage 1	-	-	-	-	752	-
Stage 2	-	-	-	-	780	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1155	-	492	743
Mov Cap-2 Maneuver	-	-	-	-	492	-
Stage 1	-	-	-	-	752	-
Stage 2	-	-	-	-	764	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0.8		14.5	
HCM LOS					B	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	519	-	-	1155	-	
HCM Lane V/C Ratio	0.27	-	-	0.018	-	
HCM Control Delay (s)	14.5	-	-	8.2	0	
HCM Lane LOS	B	-	-	A	A	
HCM 95th %tile Q(veh)	1.1	-	-	0.1	-	





Intersection						
Int Delay, s/veh	2.5					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	55	5	20	69	58	109
Future Vol, veh/h	55	5	20	69	58	109
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	89	89	85	85
Heavy Vehicles, %	3	3	4	4	10	10
Mvmt Flow	65	6	22	78	68	128
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	254	132	196	0	-	0
Stage 1	132	-	-	-	-	-
Stage 2	122	-	-	-	-	-
Critical Hdwy	6.43	6.23	4.14	-	-	-
Critical Hdwy Stg 1	5.43	-	-	-	-	-
Critical Hdwy Stg 2	5.43	-	-	-	-	-
Follow-up Hdwy	3.527	3.327	2.236	-	-	-
Pot Cap-1 Maneuver	732	915	1365	-	-	-
Stage 1	892	-	-	-	-	-
Stage 2	901	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	720	915	1365	-	-	-
Mov Cap-2 Maneuver	720	-	-	-	-	-
Stage 1	877	-	-	-	-	-
Stage 2	901	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	10.4	1.7		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1365	-	733	-	-	
HCM Lane V/C Ratio	0.016	-	0.096	-	-	
HCM Control Delay (s)	7.7	0	10.4	-	-	
HCM Lane LOS	A	A	B	-	-	
HCM 95th %tile Q(veh)	0.1	-	0.3	-	-	

6: CR 311 Divide Creek Rd & CR 311/CR 335 Colorado River Rd Performance by approach




Approach	EB	WB	NB	All
Denied Del/Veh (s)	0.0	0.1	0.1	0.1
Total Del/Veh (s)	3.5	7.2	3.2	4.3

Intersection						
Int Delay, s/veh	3.5					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖	↘	
Traffic Vol, veh/h	42	155	2	69	137	2
Future Vol, veh/h	42	155	2	69	137	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	275	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	46	168	2	75	149	2
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	214	0	125	46
Stage 1	-	-	-	-	46	-
Stage 2	-	-	-	-	79	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1356	-	870	1023
Stage 1	-	-	-	-	976	-
Stage 2	-	-	-	-	944	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1356	-	868	1023
Mov Cap-2 Maneuver	-	-	-	-	868	-
Stage 1	-	-	-	-	976	-
Stage 2	-	-	-	-	942	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0.2		10	
HCM LOS					B	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	870	-	-	1356	-	
HCM Lane V/C Ratio	0.174	-	-	0.002	-	
HCM Control Delay (s)	10	-	-	7.7	0	
HCM Lane LOS	B	-	-	A	A	
HCM 95th %tile Q(veh)	0.6	-	-	0	-	

Intersection						
Int Delay, s/veh	3.3					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	23	21	6	37	34	8
Future Vol, veh/h	23	21	6	37	34	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	25	23	7	40	37	9
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	48	0	91	37
Stage 1	-	-	-	-	37	-
Stage 2	-	-	-	-	54	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1559	-	909	1035
Stage 1	-	-	-	-	985	-
Stage 2	-	-	-	-	969	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1559	-	904	1035
Mov Cap-2 Maneuver	-	-	-	-	904	-
Stage 1	-	-	-	-	985	-
Stage 2	-	-	-	-	964	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		1		9.1	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	926	-	-	1559	-	
HCM Lane V/C Ratio	0.049	-	-	0.004	-	
HCM Control Delay (s)	9.1	-	-	7.3	0	
HCM Lane LOS	A	-	-	A	A	
HCM 95th %tile Q(veh)	0.2	-	-	0	-	

Intersection												
Int Delay, s/veh	0.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	2	0	1	9	0	9	1	118	10	10	167	2
Future Vol, veh/h	2	0	1	9	0	9	1	118	10	10	167	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	2	0	1	10	0	10	1	128	11	11	182	2
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	346	346	183	342	342	134	184	0	0	139	0	0
Stage 1	205	205	-	136	136	-	-	-	-	-	-	-
Stage 2	141	141	-	206	206	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	608	577	859	612	580	915	1391	-	-	1445	-	-
Stage 1	797	732	-	867	784	-	-	-	-	-	-	-
Stage 2	862	780	-	796	731	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	598	572	859	607	575	915	1391	-	-	1445	-	-
Mov Cap-2 Maneuver	598	572	-	607	575	-	-	-	-	-	-	-
Stage 1	796	726	-	866	783	-	-	-	-	-	-	-
Stage 2	852	779	-	789	725	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	10.4		10.1		0.1		0.4					
HCM LOS	B		B									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR				
Capacity (veh/h)	1391	-	-	665	730	1445	-	-				
HCM Lane V/C Ratio	0.001	-	-	0.005	0.027	0.008	-	-				
HCM Control Delay (s)	7.6	0	-	10.4	10.1	7.5	0	-				
HCM Lane LOS	A	A	-	B	B	A	A	-				
HCM 95th %tile Q(veh)	0	-	-	0	0.1	0	-	-				

Intersection	
Intersection Delay, s/veh	13.8
Intersection LOS	B

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	110	25	24	237	292	105
Future Vol, veh/h	110	25	24	237	292	105
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	13	13	7	7	11	11
Mvmt Flow	120	27	26	258	317	114
Number of Lanes	0	1	1	0	1	0

Approach	EB	WB	SB
Opposing Approach	WB	EB	
Opposing Lanes	1	1	0
Conflicting Approach Left	SB		WB
Conflicting Lanes Left	1	0	1
Conflicting Approach Right		SB	EB
Conflicting Lanes Right	0	1	1
HCM Control Delay	10.8	11.1	16.6
HCM LOS	B	B	C

Lane	EBLn1	WBLn1	SBLn1
Vol Left, %	81%	0%	74%
Vol Thru, %	19%	9%	0%
Vol Right, %	0%	91%	26%
Sign Control	Stop	Stop	Stop
Traffic Vol by Lane	135	261	397
LT Vol	110	0	292
Through Vol	25	24	0
RT Vol	0	237	105
Lane Flow Rate	147	284	432
Geometry Grp	1	1	1
Degree of Util (X)	0.241	0.391	0.626
Departure Headway (Hd)	5.916	4.967	5.221
Convergence, Y/N	Yes	Yes	Yes
Cap	606	729	690
Service Time	3.955	2.967	3.247
HCM Lane V/C Ratio	0.243	0.39	0.626
HCM Control Delay	10.8	11.1	16.6
HCM Lane LOS	B	B	C
HCM 95th-tile Q	0.9	1.9	4.4

APPROACH AND EXIT FLOWS

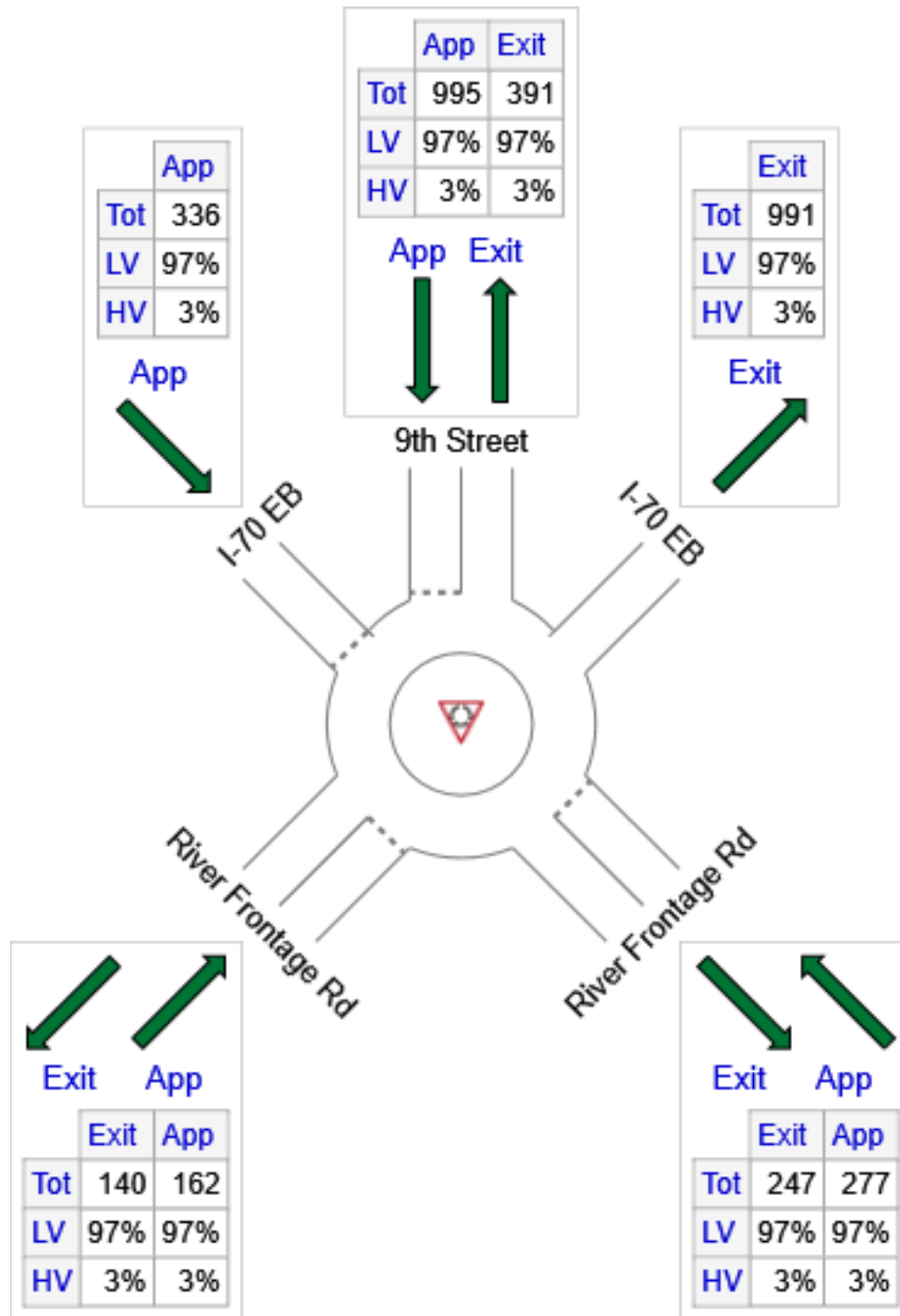
Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 Site: 2 [I-70 EB 2045 AM (Site Folder: with Project (Total))]

I-70 EB Ramp Roundabout

Site Category: (None)

Roundabout



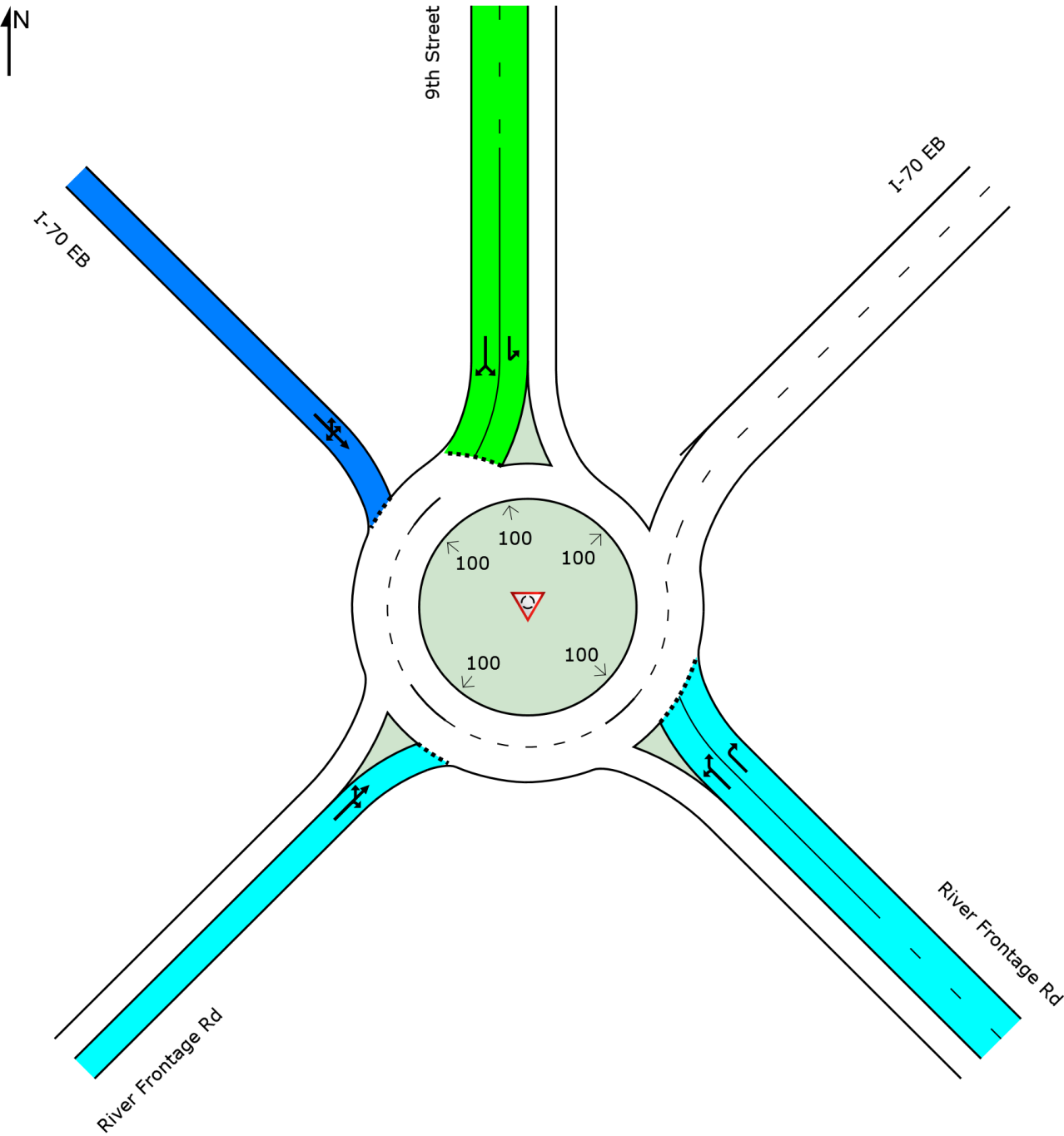
LEVEL OF SERVICE

Lane Level of Service

 **Site: 2 [I-70 EB 2045 AM (Site Folder: with Project (Total))]**

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

	Approaches				Intersection
	Southeast	North	Northwest	Southwest	
LOS	B	A	C	B	B



DELAY (CONTROL)

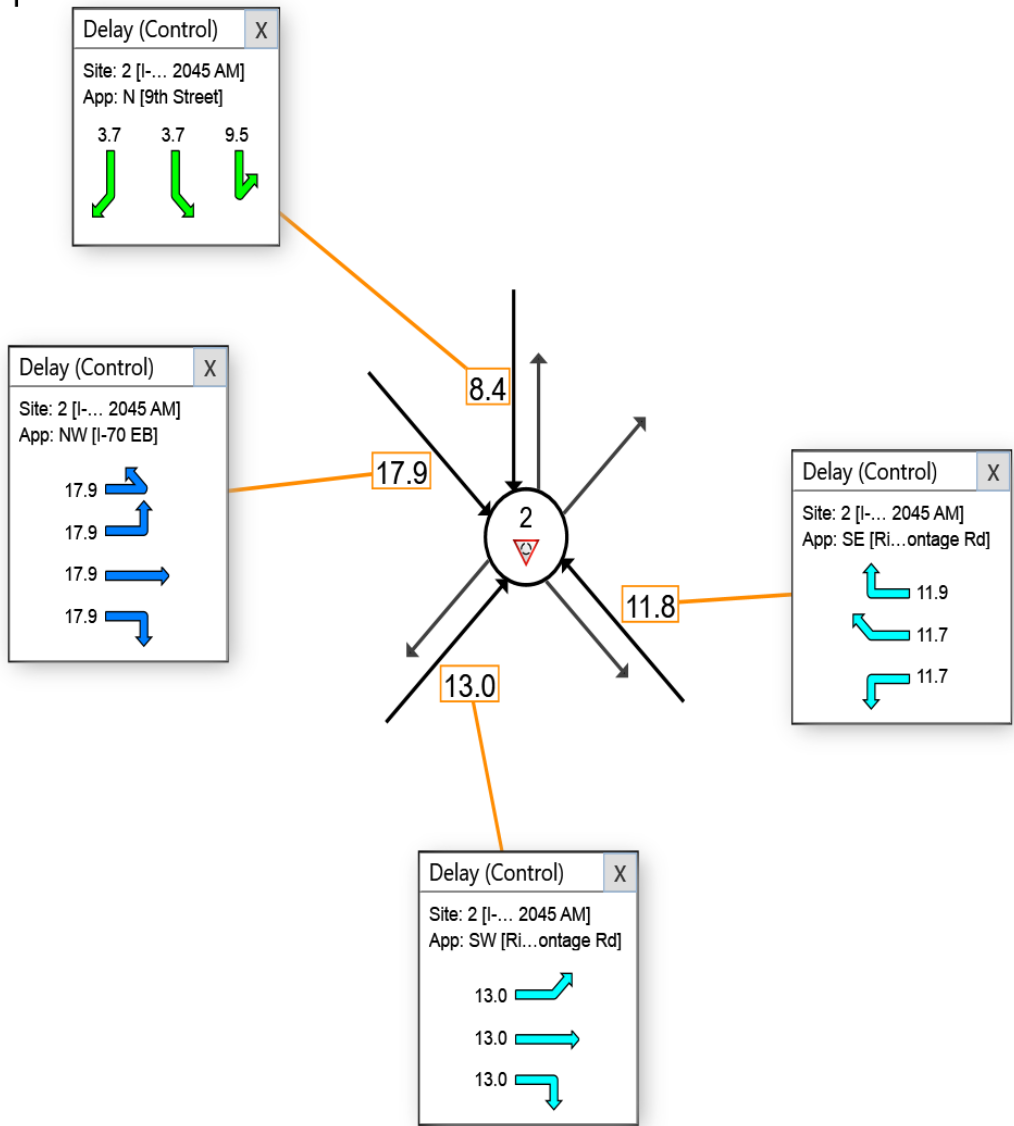
Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 2 [I-70 EB 2045 AM (Site Folder: with Project (Total))]

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



QUEUE DISTANCE (PERCENTILE)

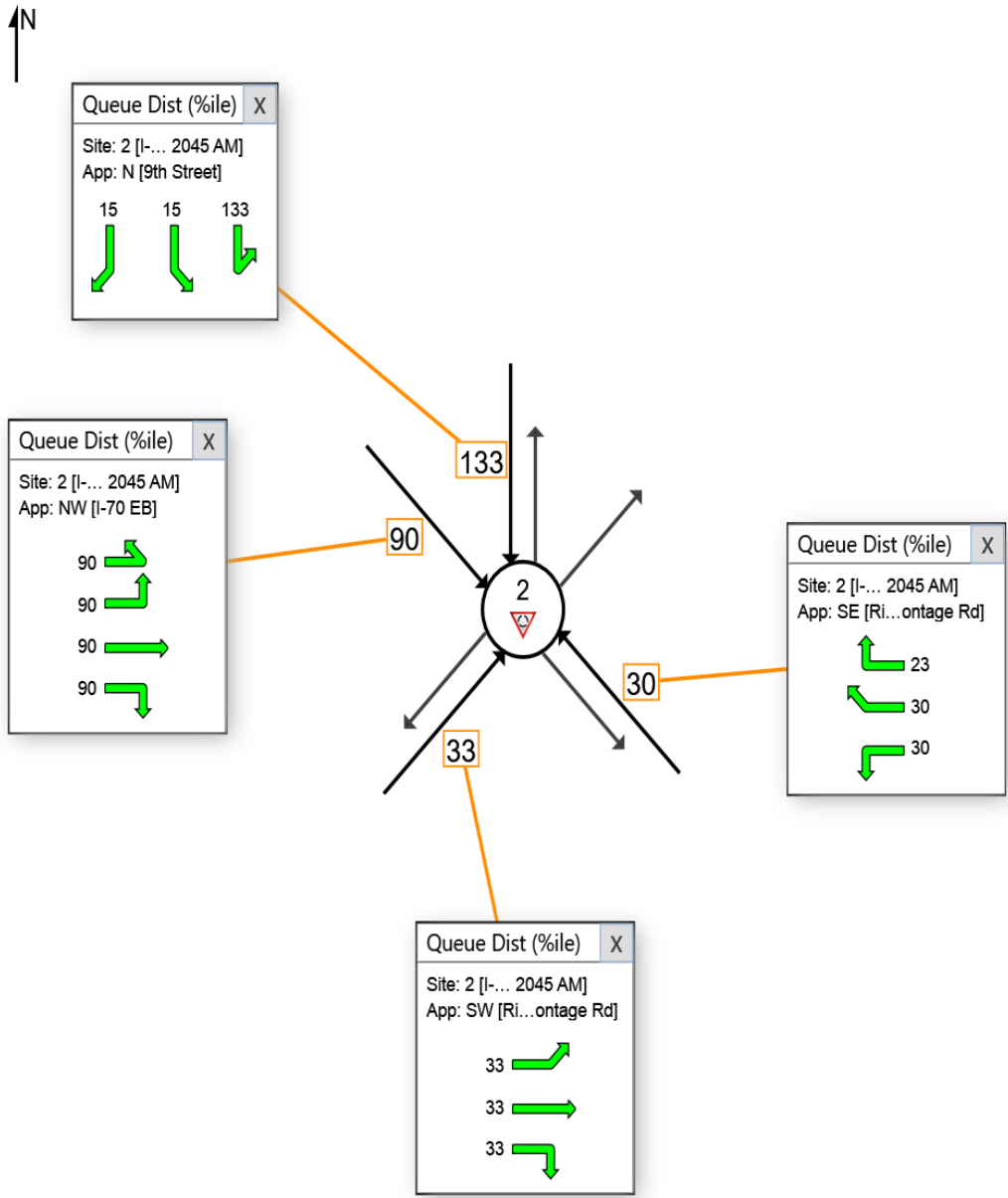
Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

 Site: 2 [I-70 EB 2045 AM (Site Folder: with Project (Total))]

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



APPROACH AND EXIT FLOWS

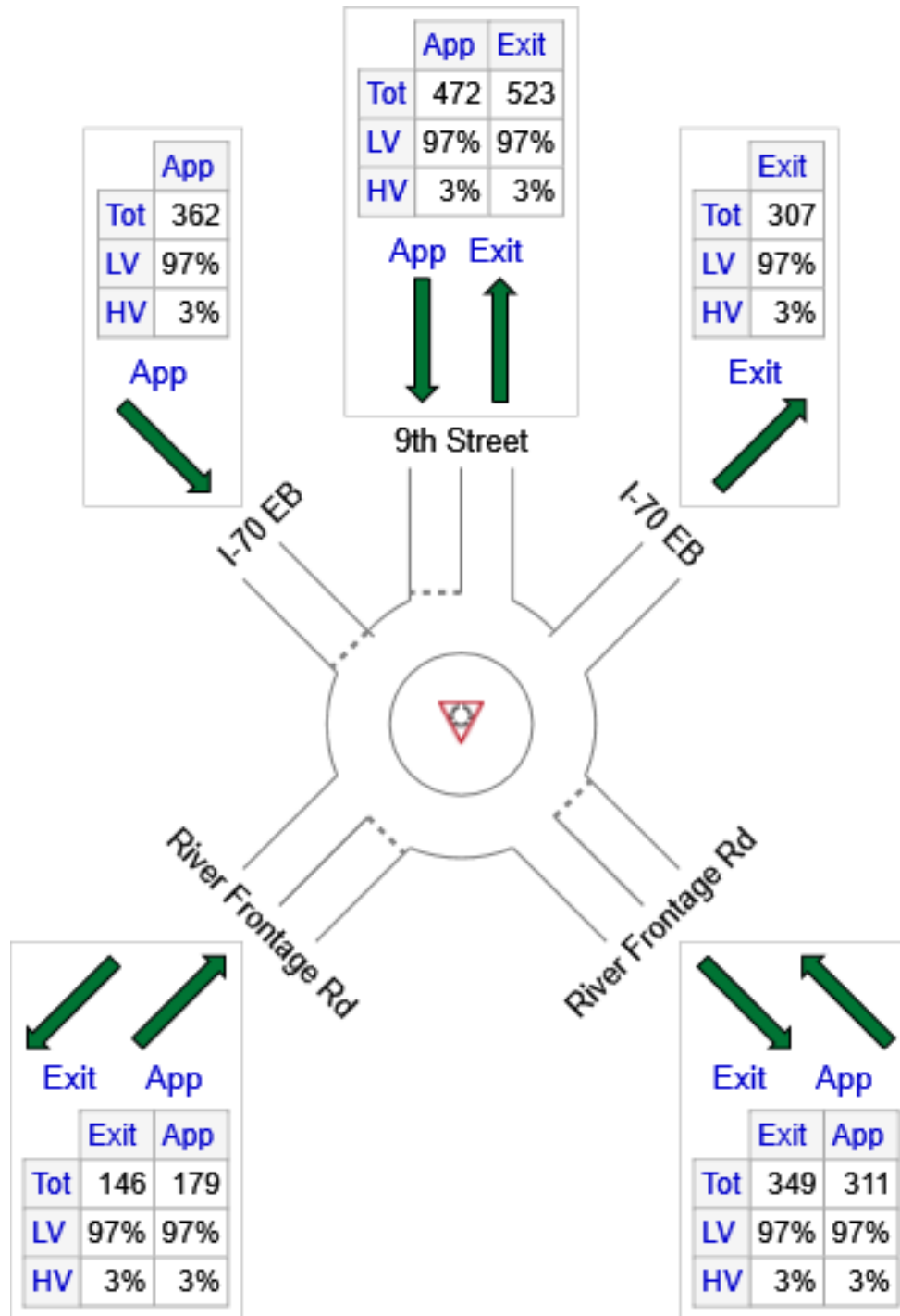
Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 Site: 2 [I-70 EB 2045 PM (Site Folder: with Project (Total))]

I-70 EB Ramp Roundabout

Site Category: (None)

Roundabout



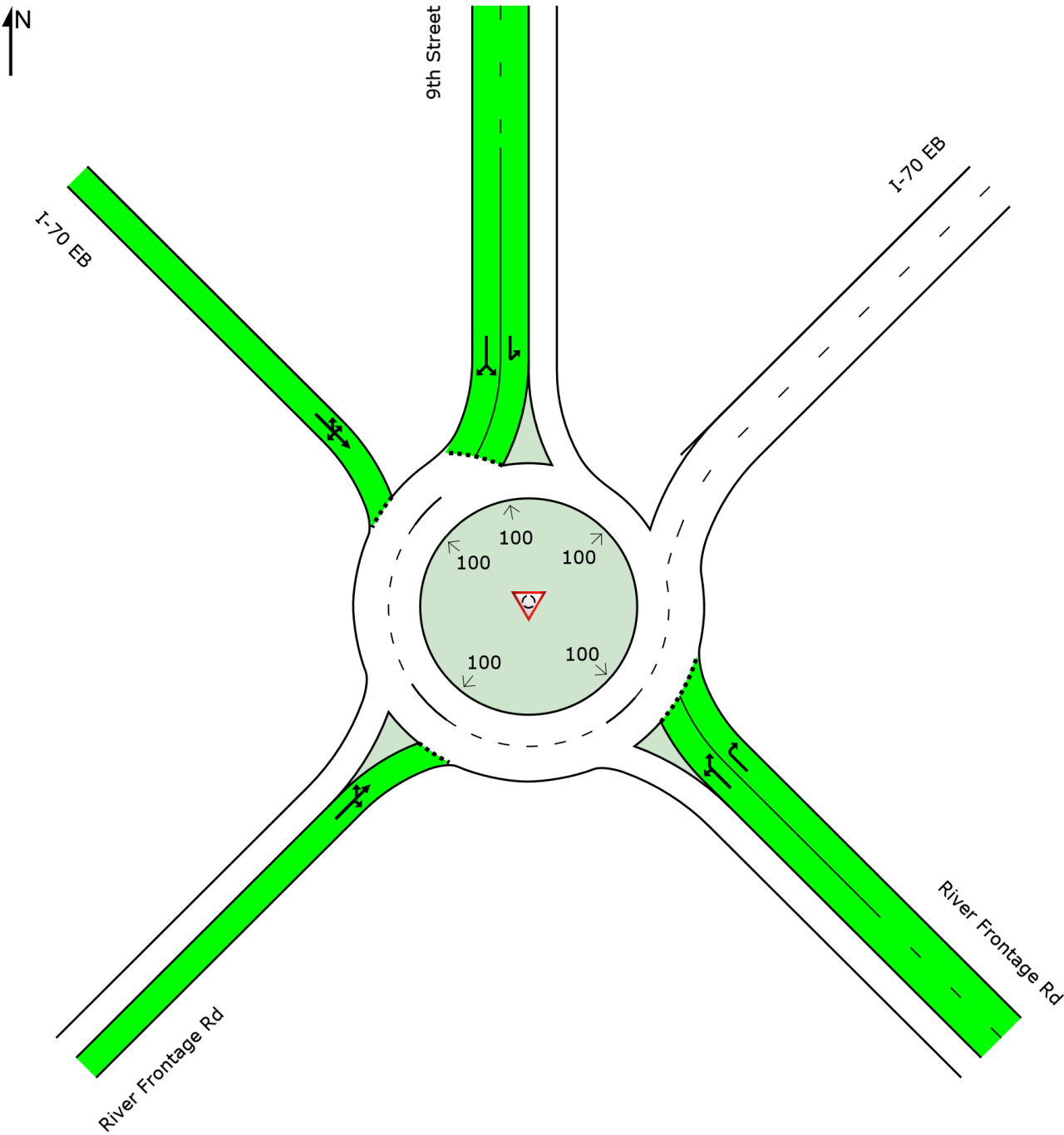
LEVEL OF SERVICE

Lane Level of Service

 **Site: 2 [I-70 EB 2045 PM (Site Folder: with Project (Total))]**

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

	Approaches				Intersection
	Southeast	North	Northwest	Southwest	
LOS	A	A	A	A	A



DELAY (CONTROL)

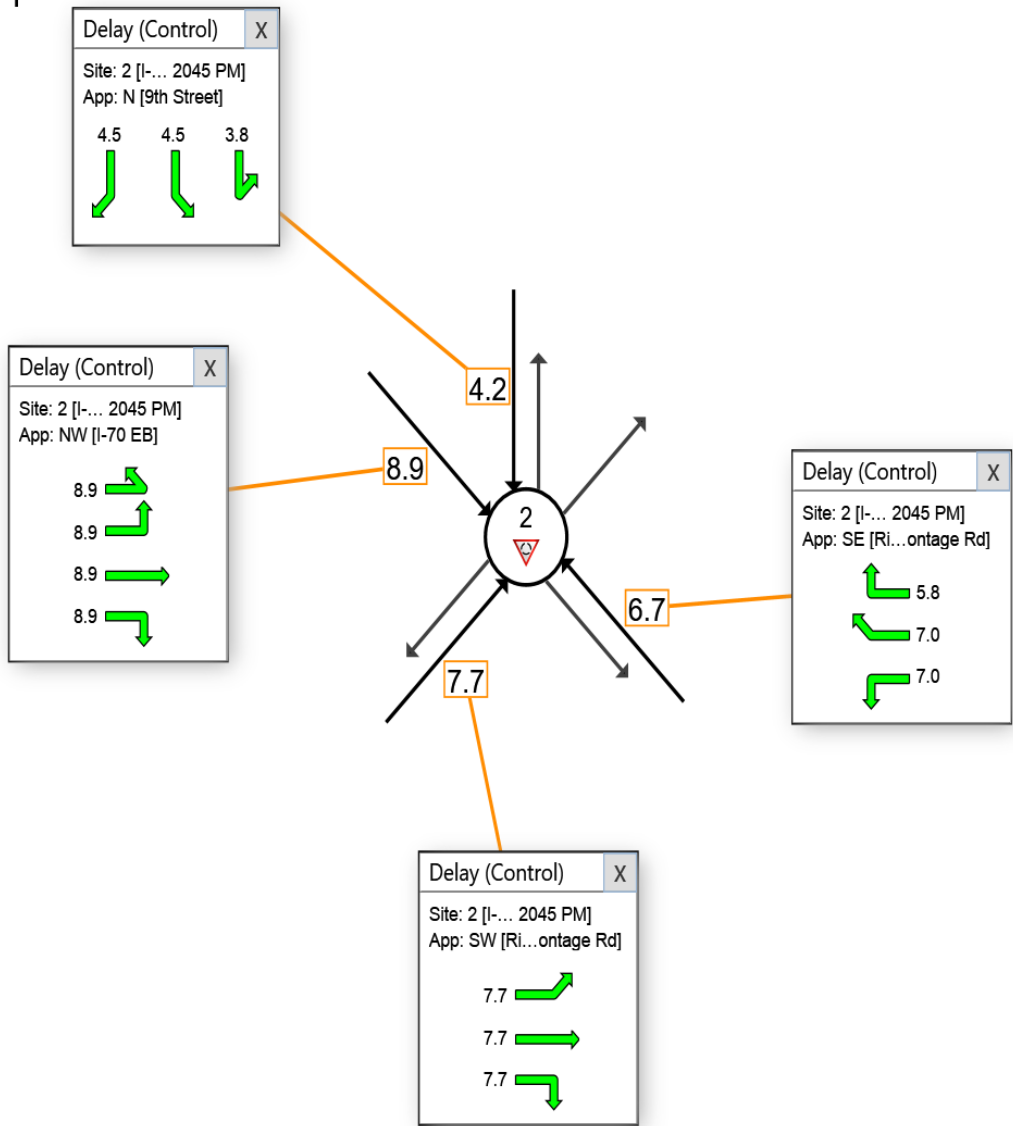
Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 2 [I-70 EB 2045 PM (Site Folder: with Project (Total))]

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups

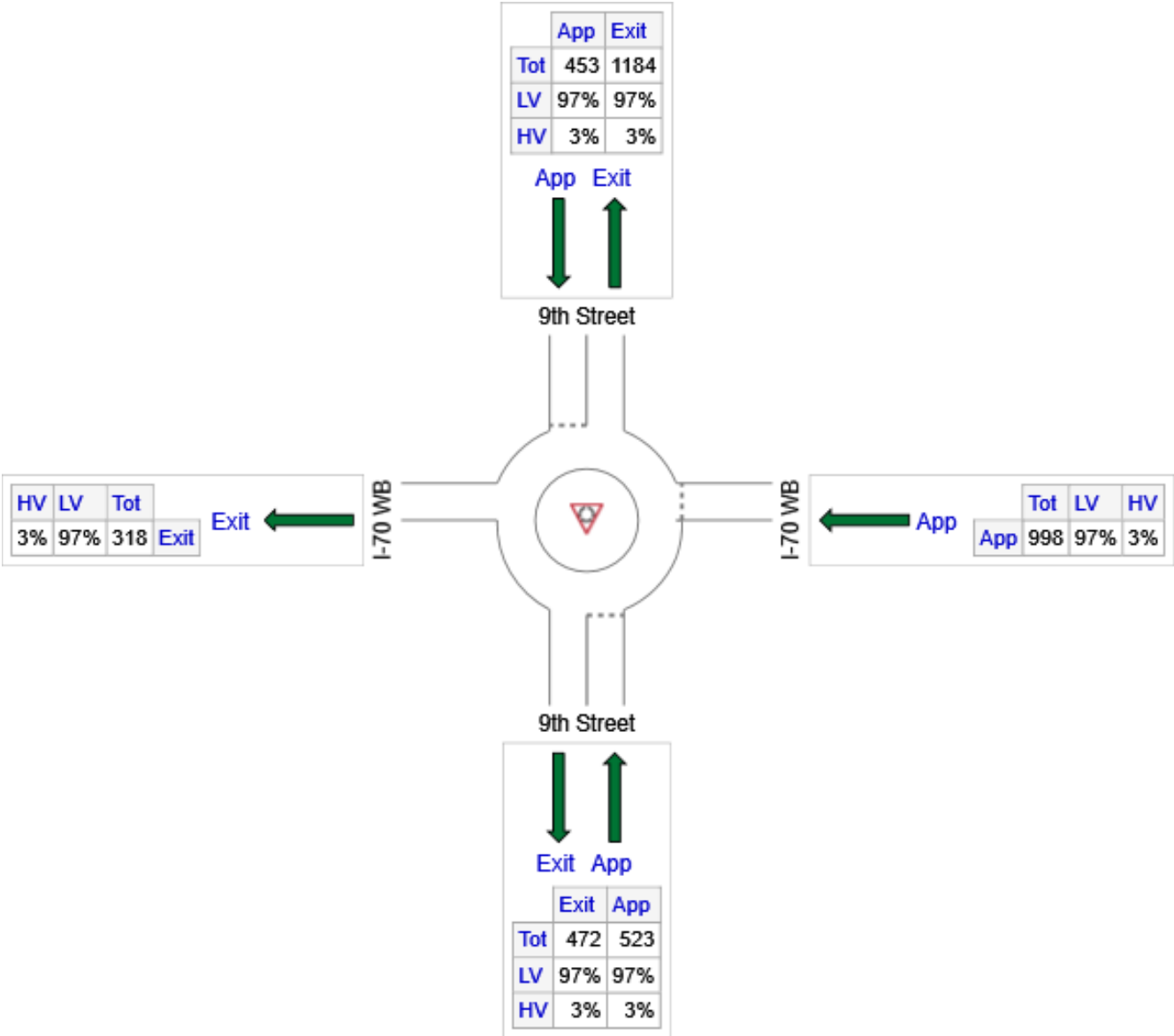


APPROACH AND EXIT FLOWS

Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 **Site: 1 [I-70 WB 2045 PM (Site Folder: with Project (Total))]**

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout



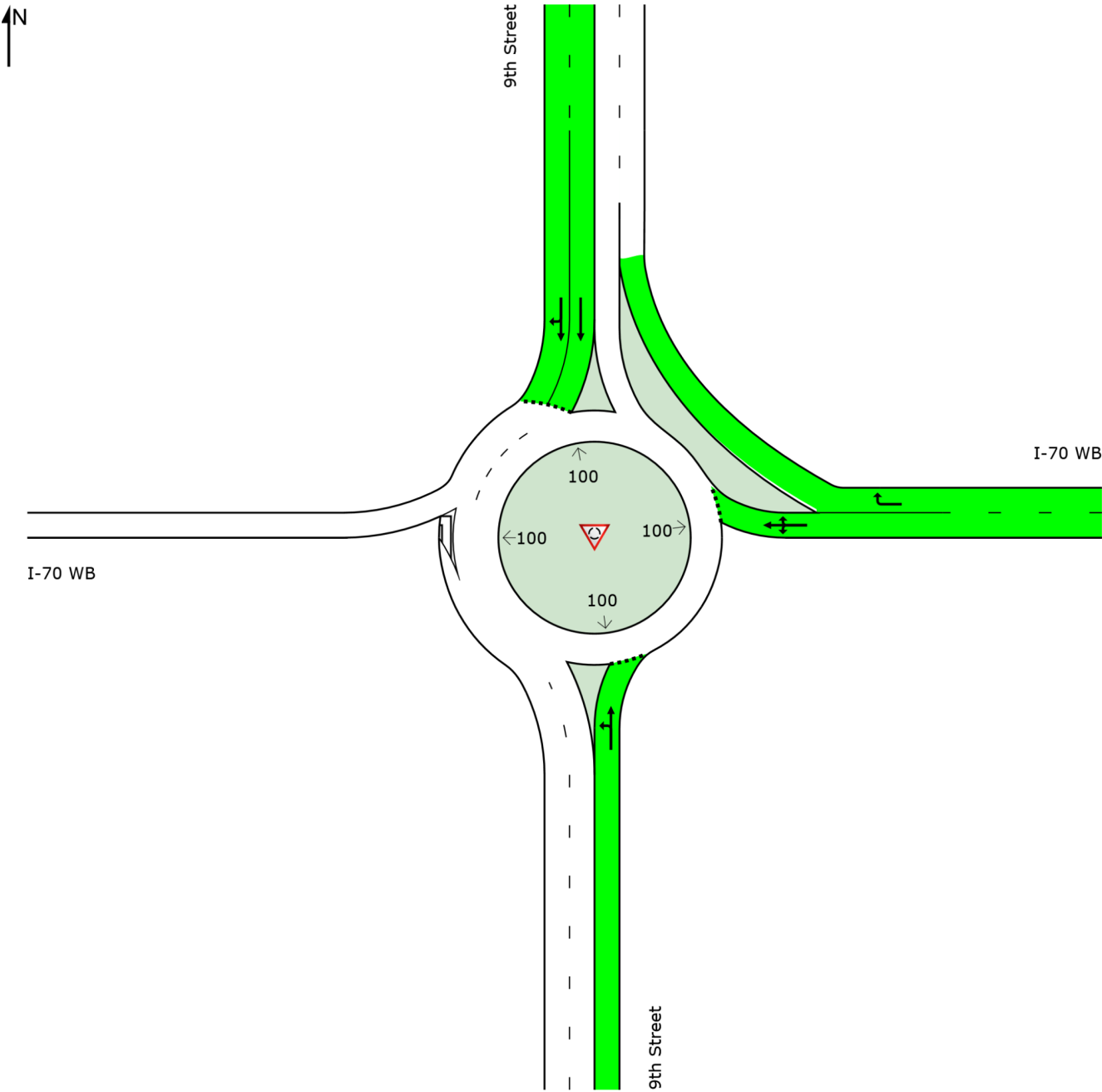
LEVEL OF SERVICE

Lane Level of Service

 **Site: 1 [I-70 WB 2045 PM (Site Folder: with Project (Total))]**

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

	Approaches			Intersection
	South	East	North	
LOS	A	A	A	A



DELAY (CONTROL)

Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 1 [I-70 WB 2045 PM (Site Folder: with Project (Total))]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups





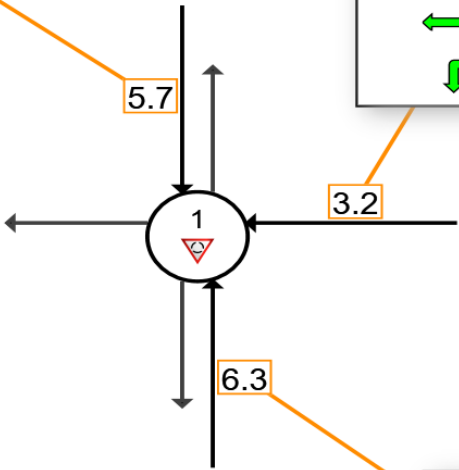
Delay (Control) X

Site: 1 [I-... 2045 PM]
App: N [9th Street]

5.7

5.7








Delay (Control) X

Site: 1 [I-... 2045 PM]
App: E [I-70 WB]

1.7

9.1

9.1





Delay (Control) X

Site: 1 [I-... 2045 PM]
App: S [9th Street]

6.3

6.3



QUEUE DISTANCE (PERCENTILE)

Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

 Site: 1 [I-70 WB 2045 PM (Site Folder: with Project (Total))]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



Queue Dist (%ile) X

Site: 1 [I-... 2045 PM]
App: N [9th Street]

25

25

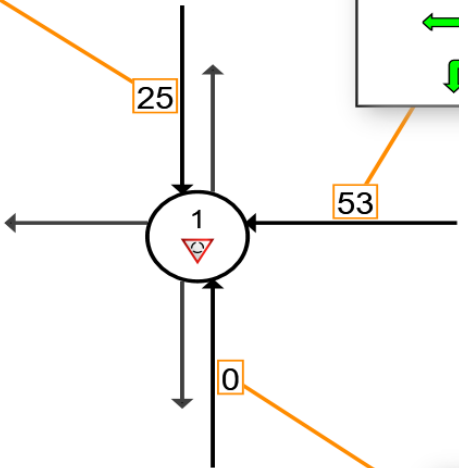
Queue Dist (%ile) X

Site: 1 [I-... 2045 PM]
App: E [I-70 WB]

53

53

53



Queue Dist (%ile) X

Site: 1 [I-... 2045 PM]
App: S [9th Street]

0

0

QUEUE DISTANCE (PERCENTILE)

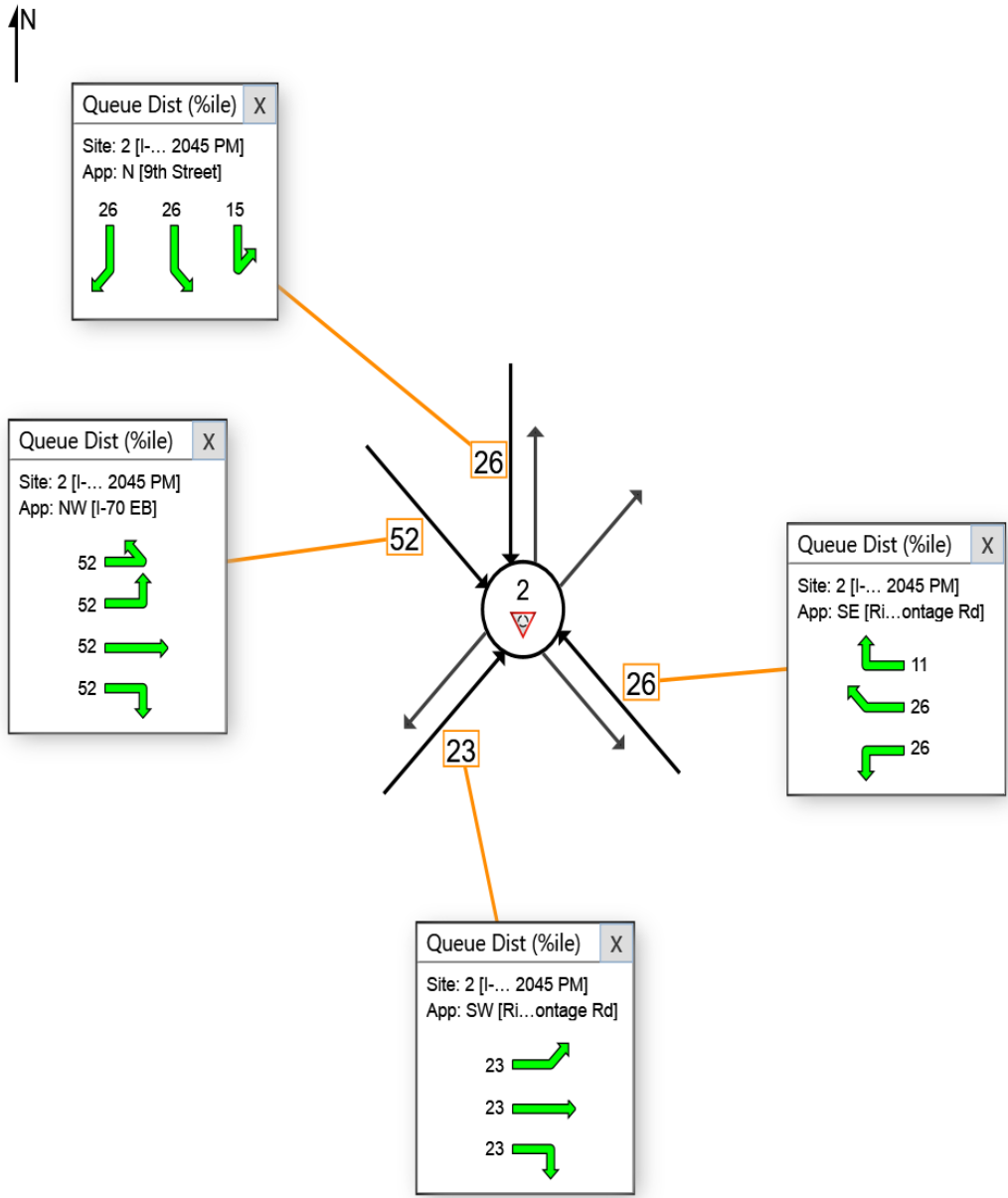
Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

 Site: 2 [I-70 EB 2045 PM (Site Folder: with Project (Total))]

I-70 EB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups



APPROACH AND EXIT FLOWS

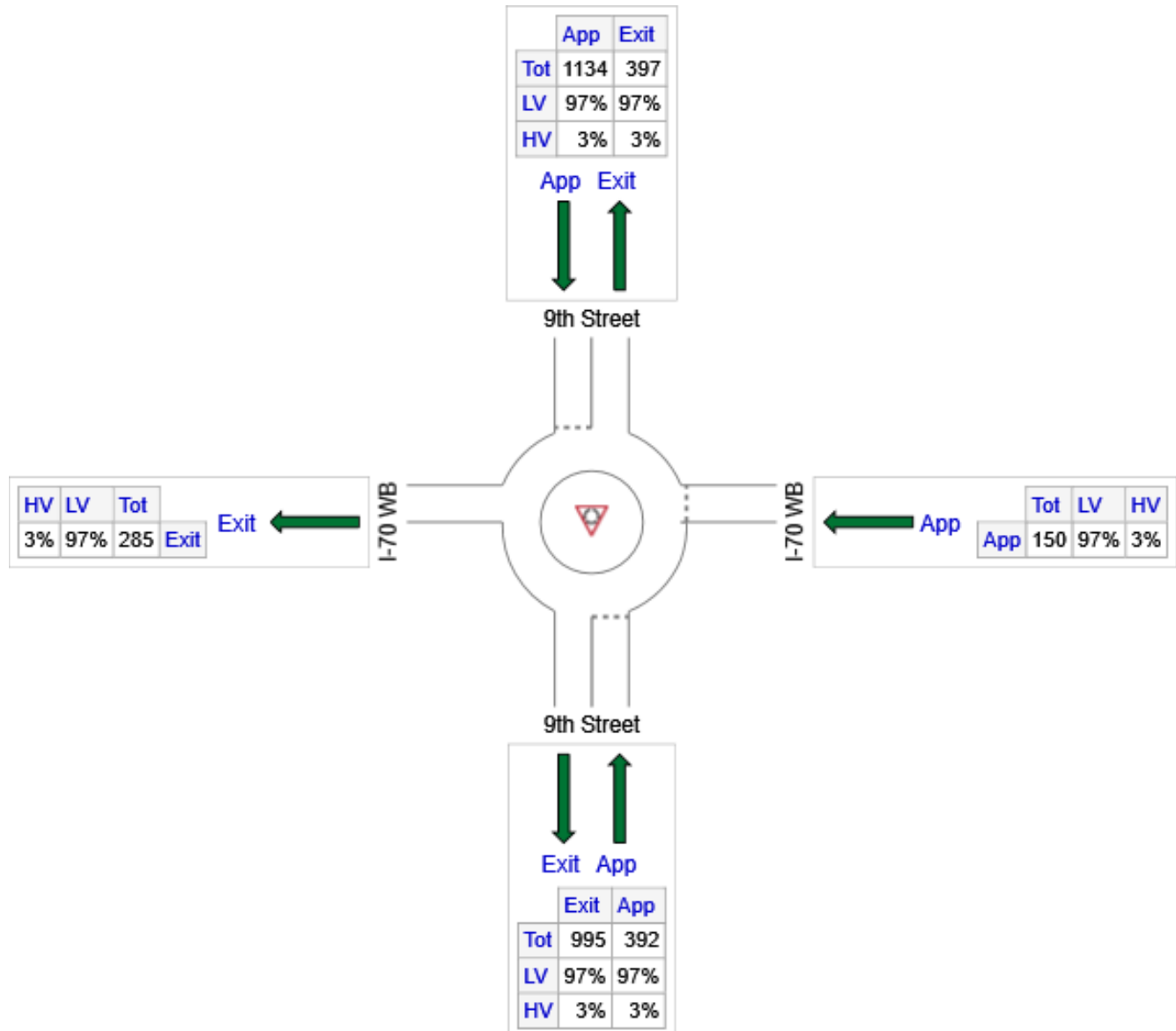
Total Values for All Movement Classes Based on Site Demand Flow Rates
(veh/h)

 Site: 1 [I-70 WB 2045 AM (Site Folder: with Project (Total))]

I-70 WB Ramp Roundabout

Site Category: (None)

Roundabout



Lane Level of Service

I-70 WB Ramp Roundabout

Site Category: (None)

Roundabout

The diagram illustrates a roundabout intersection. The central area is a green circle with a white border. Four roads enter and exit the roundabout: 9th Street from the top, 9th Street from the bottom, I-70 WB from the left, and I-70 WB from the right. The roundabout has four entry points, each marked with a white arrow pointing towards the center and the number '100'. A red triangular yield sign is located in the center. The roads are shown with lane markings and traffic flow arrows. A north arrow is in the top left corner.

DELAY (CONTROL)

Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 1 [I-70 WB 2045 AM (Site Folder: with Project (Total))]

I-70 WB Ramp Roundabout
Site Category: (None)
Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups





Delay (Control) X

Site: 1 [I-... 2045 AM]
App: N [9th Street]

8.0

8.0






Delay (Control) X

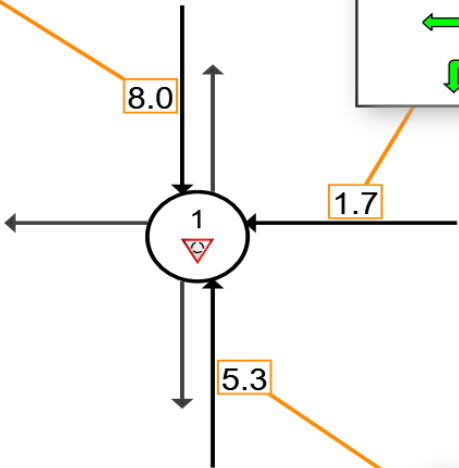
Site: 1 [I-... 2045 AM]
App: E [I-70 WB]

0.0

4.3

4.3







Delay (Control) X

Site: 1 [I-... 2045 AM]
App: S [9th Street]

5.3

5.3



QUEUE DISTANCE (PERCENTILE)

Largest 95% Back of Queue Distance for any lane used by the vehicle movement (feet)

 Site: 1 [I-70 WB 2045 AM (Site Folder: with Project (Total))]

I-70 WB Ramp Roundabout

Site Category: (None)

Roundabout

Use the button below to open or close all popup boxes. Click value labels to open selected ones.
Click and drag popup boxes to move to preferred positions.

Close All Popups

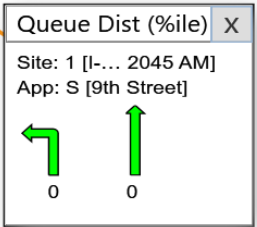
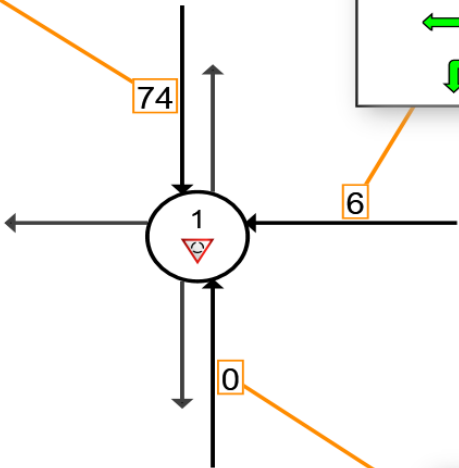
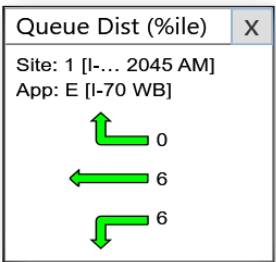
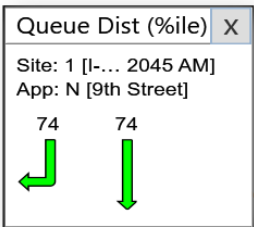


Exhibit G
High Country Engineering Roadway Analysis Letter



October 24, 2023

Mark Chain
Mark Chain Consulting LLC
Town of Silt

Re: Rislende PUD Preliminary Plan Revision– Town of Silt, Garfield County, Colorado
HCE Project No. 2211047.01

Dear Mark:

The proposed modification to the road system of the Rislende project does not have any significant impact to the approved project. The approved project had three access points with a potential connection loop of all three access points. The connection is now proposed between two of the three access points and one access is eliminated. The looped internal road was also moved northerly to work with the proposed development entities. Utilities essentially follow the same path as the approved submittal. Drainage will also follow the same paths as the approved submittal but will flow in curb lines instead of a swale. Traffic is reduced to two access points and was reviewed by the traffic engineer to see what modifications may be required by the proposed two access points instead of the three approved access points.

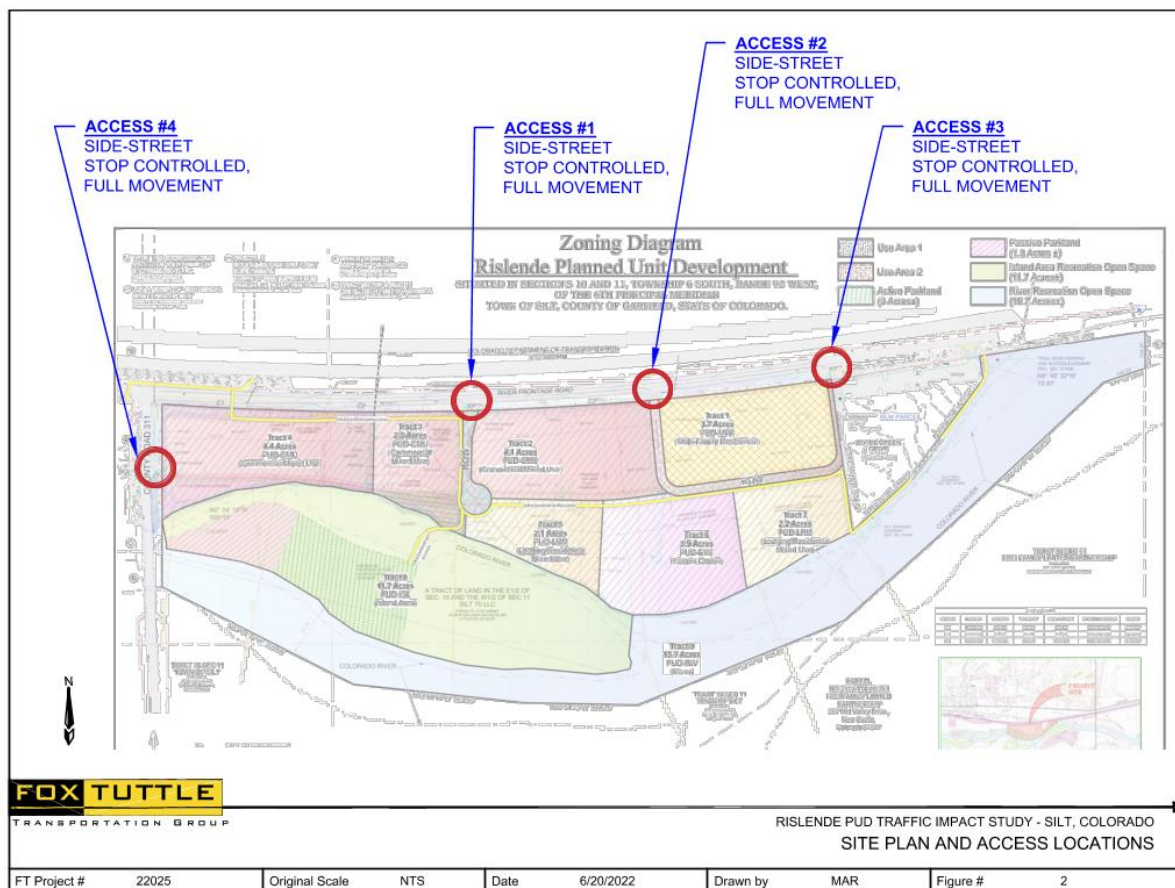
Below are the bullet points of the current approval vs. the proposed modification.

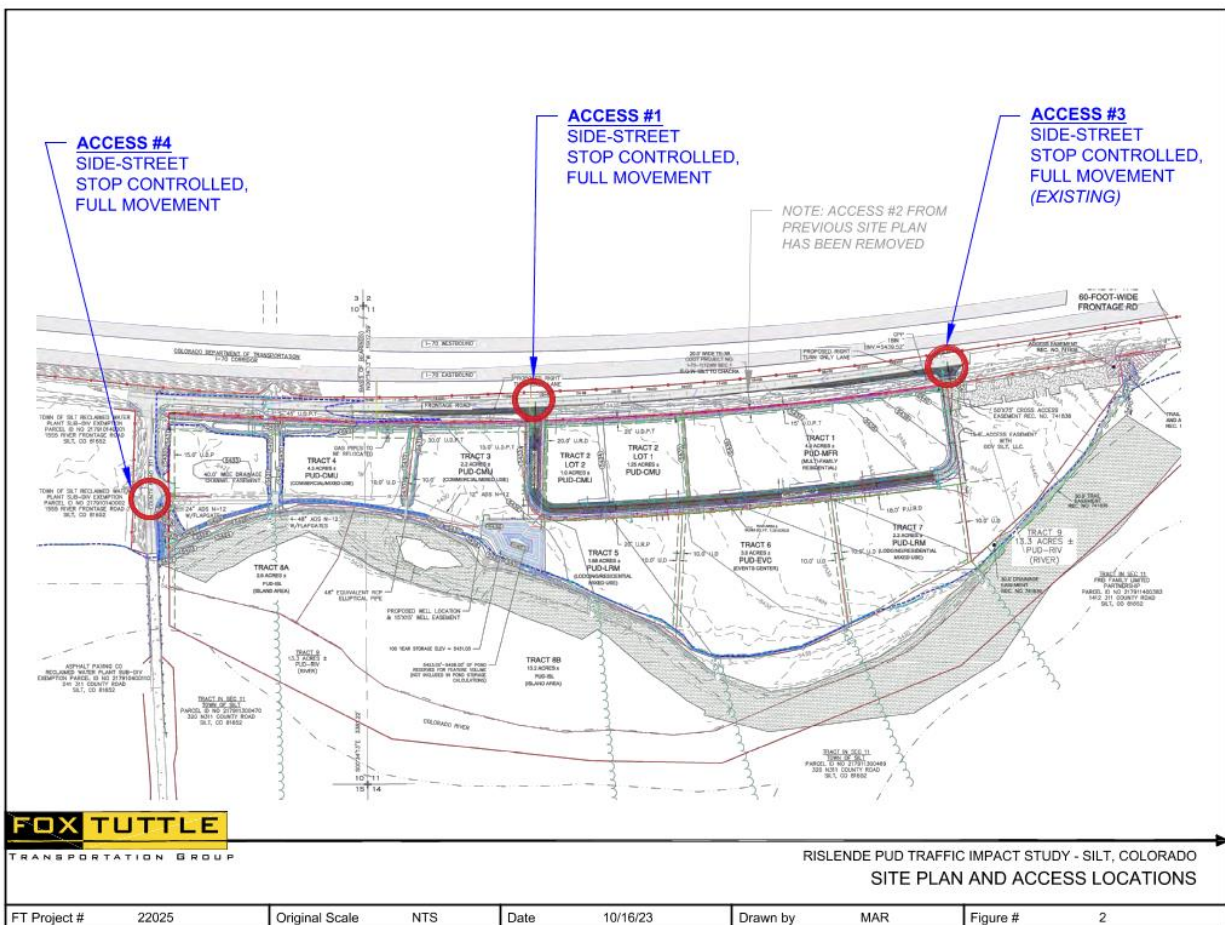
Traffic

- The project, as approved, was estimated to generate approximately 3,425 daily trips with 166 trips in the AM peak hour and 363 trips in the PM peak hour at full build-out of all land uses and tracts.
- The revision, as proposed, is essentially the same estimate to generate approximately 3,472 daily trips with 171 trips in the AM peak hour and 370 trips in the PM peak hour at full build-out of all land uses and tracts.
- For the project, as approved, it was recommended by Fox Tuttle Transportation Group that at River Frontage Road: Construct eastbound right-turn deceleration lane (435' total minimum length, inclusive of a 13.5:1 taper) at all three proposed access points.
- For the revision proposed, it is recommended by Fox Tuttle Transportation Group that at River Frontage Road: Construct eastbound right-turn deceleration lane (435' total minimum length, inclusive of a 13.5:1 taper) at the first and second access points east of CR 311.

- For both options it was determined that the proposed roadway system can adequately accommodate the projected traffic volumes for buildout conditions with planned improvements. The CR 311 access was not impacted.

Exhibits of the previous layout and the proposed layout are shown below with recommendations from the Traffic Engineer.





If you have any questions, please contact me to discuss.

Sincerely,

HIGH COUNTRY ENGINEERING, INC.

Roger Neal, P.E.
Project Manager

RDN/blc