

SECTION 02224

PIPE BORING AND JACKING

1.00 GENERAL

Work to be performed under this Section shall include all labor, materials, equipment and miscellaneous items necessary to perform all excavation, installation of casing and carrier pipe, backfilling and site restoration shown on the Drawings and specified herein.

All work within the rights-of-way of the Railroad Union Pacific Transportation Co, Colorado Department of Transportation, county governments or municipal governments shall be done in compliance with requirements issued by those agencies. All such requirements shall take precedence over these specifications. It shall be the Contractor's responsibility to secure all required excavation permits and pay all costs thereof.

1.02 Related Work Specified Elsewhere.

Section 02221 - Trenching, Backfilling and Compaction
Section 02222 - Embedment and Base Course Aggregate
Section 02555 - Water Transmission and Distribution Lines
Section 02672 - Pipe Casing and Spacers

1.03 Protection of Work. All pipe, fittings and equipment shall be carefully handled, stored and protected in such a manner as to prevent damage to materials. At no time shall such materials be dropped or dumped into trench.

Precaution shall be taken to prevent foreign matter from entering the pipe and fittings prior to and during installation. Place no debris, tools, clothing or other materials in the pipe during installation.

At such time as pipe installation is suspended, either temporarily or overnight, the open end of the pipe shall be sealed with a water-tight plug to prevent entrance of trench water, debris or foreign matter.

Under no circumstances shall trench water be allowed to enter the pipe line. When water is present in the trench, the seal shall remain in place until such time as the trench is pumped dry. Whenever trench water becomes evident, adequate measures shall be taken to prevent pipe flotation.

During work in right-of-way of state highways, warning signs shall be placed in accordance with *"The Manual of Uniform Traffic Control Devices"*.

1.04 Submittals.

A. Materials. Submit statement on casing pipe, spacing system, and end seals to be used.

B. Jacking and Boring Equipment. Submit statement on procedure and specializing

equipment to be used. Include information on jacking bands, jacking heads, bearing shims, jacking pit bracing, etc.

2.00 MATERIALS

2.01 Casing Pipe.

- A. Butt welded steel pipe with beveled ends.
- B. ASTM A-245 commercial grade or ASTM A-283, minimum wall thickness of 0.375".

2.02 Carrier Pipe.

- A. Use same material as referenced in Sections 02555 or 02560.

2.03 Equipment.

- A. Unless otherwise specified, the methods and equipment used in jacking casing or conduit shall be optional with the Contractor, provided that the proposed method is approved by the Engineer. Such approval, however, shall in no way relieve the Contractor of the responsibility for making a satisfactory installation meeting the criteria set forth herein.
- B. Only workers experienced in jacking operations shall be used.

2.04 Spacing System.

- A. Model CCS stainless steel casing spacer, Cascade Waterworks manufacturing Company, or equal.
- B. Spacer shall be bolt-on style minimum 14-gauge, T-304 stainless steel. They shall be lined with ribbed PVC extrusion. Bearing surfaces (runners) shall be made from UHMW polymer, mechanically fastened to spacer.

2.05 Casing End Seals.

Style CCES casing end seals, Cascade Waterworks MFG, Co. or equal.

3.00 METHODS AND PROCEDURES

3.01 Installation and Procedures.

- A. Access Pits. Contractor shall excavate access pits on each end of the installation sufficient to provide working access during installation and to allow field check of completed installation.
- B. Jacking/Boring. Steel casing pipe shall be of minimum size as shown on the Drawings. Contractor shall supply casing pipe size necessary to allow installation to the line and grade shown on the Drawings and shall provide end fitting as required to prevent wobble or alignment variation.

The joints of sections of casing to be jacked shall be welded with a continuous circumferential weld. It shall be the Contractor's responsibility to provide stress transfer across the joints which is capable of resisting the jacking forces involved. Welds shall be 90° to the longitudinal axis of the casing pipe.

The driving ends of the casing shall be properly protected against spalling and other damage, and intermediate joints shall be similarly protected by the installation of sufficient bearing shims to properly distribute the jacking stresses. Any section of casing showing signs of failure shall be removed and replaced with a new section of casing, or with a cast-in-place section, which is adequate to carry the loads imposed upon it.

Excavation shall not be made in excess of the outer dimensions of the casing being jacked unless approved by the Engineer. Every effort shall be made to avoid any loss of earth outside the jacking head. Excavated material shall be removed from the casing as excavation progresses, and no accumulation of such material within the casing will be permitted.

Upon completion of the jacking operations, all voids around the outside face of the casing shall be filled by grouting.

Grouting equipment and material shall be on the job site before jacking operations and drilling of grout holes are completed in order that grouting around the jacked casing may be started immediately after the jacking operations have finished.

Should appreciable loss of ground occur during the jacking operation, the voids shall be backpacked promptly to the extent practicable with soil cement consisting of a slightly moistened mixture of one part cement to five parts granular material. Where the soil is not suitable for this purpose, the Contractor shall import suitable material at his expense. The soil cement shall be thoroughly mixed and rammed into place as soon as possible after the loss of ground.

3.02 Installation of Carrier Pipe.

- A. Spacer. Install according to manufacturer's recommendations.
- B. Bulkhead. Provide a rubber seal clamp on both carrier pipe and casing pipe or a water-tight seal at each end of casing pipe.

4.00 QUALITY CONTROL - FIELD

- 4.01 Inspection and Testing. Any section of casing showing signs of failure shall be removed and replaced. Casing shall be at the line and grade established in the field by the Engineer. Casing and carrier pipe shall be checked for grade and line prior to backfill.

5.00 MEASUREMENT AND BASIS OF PAYMENT

Items under this section shall be paid at the unit price given on the bid schedule and shall be full compensation for work complete in place.

End of Section

SECTION 02255

DUST SUPPRESSION

1.00 GENERAL

1.01 Scope. Work under this Section shall include furnishing all materials, labor, equipment and miscellaneous items necessary to provide dust control over the entire project site.

1.02 Related Work Specified Elsewhere.

Section 02200 – Excavation and Embankment
Section 02201 – Excavation and Backfill for Structures
Section 02222 – Embedment and Base Course Aggregate

1.03 Submittals.

A. Chemical Products. Descriptive literature defining chemical constituents.

2.00 MATERIALS

2.01 Magnesium Chloride.

<u>Constituents</u>	<u>Percentage by Weight</u>
Magnesium Chloride	Approximately 28%-36%
Sulphate	2.5%
Potassium, sodium, calcium	Less than 1%
Nitrate	-0-

3.00 METHODS AND PROCEDURES

3.01 Dust Control. Dust control to be considered an integral part of the Work. Control shall be provided from the start of construction until the Work is complete. Fugitive dust as a result of construction shall be controlled at all times.

3.02 Watering. For road construction, the Contractor shall have a water truck on site at all times for dust control. Wetting shall be done at the direction of the Engineer as required until the final wearing surface is completed.

For utility construction, dust control may be accomplished by water truck or spray system from an on-site water system if approved. Contractor shall be prepared to provide dust control until the final acceptance of project.

The Contractor shall provide a water meter for metering any water taken from the municipal water system whether from fire hydrants or private taps. Watering shall be considered incidental to the related work and will not be paid for separately.

3.03 Chemical Control. Where required by the Engineer, dust control shall be provided by the use of magnesium chloride chemical spray to the road surface.

After the surface has been prepared, the road shall be pre-wet to a very damp condition. The product shall be applied using a watering truck with spray applicator, providing an even distribution across the surface. Application rate shall be 1/3 - 1/2 gallon per square yard. The surface shall be re-sprayed until complete coverage is attained. If Contractor is ordered to use magnesium chloride, Contractor shall be paid as per unit price in Bid Schedule, or in the absence of unit price, shall be negotiated with engineer and Owner before any application. No payment will be made prior to negotiating a price.

4.00 MEASUREMENT AND PAYMENT

This item will not be measured and paid for separately except as stated herein. Project dust suppression shall be the responsibility of the Contractor and included in the project.

End of Section

SECTION 02270

Erosion & Sediment Controls

1.00 General

1.01 SUMMARY

- A. Scope. This work consists of constructing, installing, maintaining, and removing when required, erosion control measures during the life of the Contract to prevent or minimize erosion, sedimentation, and pollution of any state waters, including wetlands. This work includes constructing a stabilized construction entrance, as shown on the plans.

1.02 QUALITY ASSURANCE

- A. The Contractor shall prepare and obtain a Storm Water Management Permit from the Colorado Department of Public Health and the Environment (CDPHE), including the payment of any fees associated with the permit.
- B. Submittals. Storm Water Management Plan (SWMP) and Best Management Practices (BMP) shall be submitted to the Engineer for approval prior to submission to the CDPHE.

1.03 MATERIALS

- A. Erosion Bales. Material for erosion bales shall consist of Certified Weed Free hay or straw. The hay or straw shall be 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., C.R.S.
1. Each certified weed free erosion bale shall be identified by one of the following:
 - a. One of the ties binding the bales shall consist of blue and orange twine;
 - b. One of the ties binding the bale shall consist of specially produced shiny galvanized wire; or
 - c. The bale shall have a regional Forage Certification Program tag indicating the Regional Forage Certification Program Number.
 2. Erosion bales 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.
 3. The Contractor shall not unload certified weed free erosion bales or

remove their identifying twine, wire or tags until the Engineer has inspected and accepted them. The Contractor shall provide a certificate of compliance showing the transit certificate number or a copy of the transit certificate as supplied from the forage producer. 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, Weed Free Forage Program, 700 Kipling Street, Suite 4000, Lakewood, CO 80215, (303) 239-4177.

4. Bales shall be approximately 5 cubic feet of material and weigh not less than 35 pounds.
- B. Silt Fence. Silt fence posts shall be metal or wood with a minimum length of 42 inches. Metal posts shall be “studded tee” or “U” type with minimum weight of 1.33 pounds per linear foot. Wood posts shall have a minimum diameter or cross section dimension of 2 inches. Silt fence geotextile shall conform to subsection 712.08(b). Geotextile shall be attached to posts with three or more staples per post.
- C. Temporary Berms. Temporary berms shall be constructed of compacted soil.
- D. Erosion Logs. Erosion logs shall be curled aspen wood excelsior with a consistent width of fibers evenly distributed throughout the log. The casing shall be seamless, photodegradable tube netting and shall have minimum dimensions of 12 inch diameter, 7-10 feet long, 2.5 pounds/foot with stake dimensions of 1.5 x 1.5 x 24 inches.
- E. Stabilized Construction Entrance. Unless otherwise directed by the Engineer, aggregate for the construction entrance shall be coarse material that meets the following gradation requirements:
 1. 100% Passing the 75 mm (3 inch) sieve
 2. 95-100% Passing the 50 mm (2 inch) sieve
 3. 0-15% Passing the 19.0 mm (3/4 inch) sieve

1.04 METHODS AND PROCEDURES

- A. Erosion Control Supervisor. The Contractor shall assign to the project an employee to serve in the capacity of the Erosion Control Supervisor (ECS). The ECS shall be a person other than the Superintendent, unless otherwise approved by the Engineer. The ECS shall be experienced in all aspects of construction. The ECS’s responsibilities shall be as follows:
 1. Ensure compliance with all water quality permits or certifications in effect during the construction work.
 2. Directly supervise the installation, construction, and maintenance of all erosion control measures specified on the Plans and coordinate the construction of erosion control measures with all other construction operations.

3. Direct the implementation of suitable temporary erosion and sediment control features as necessary to correct unforeseen conditions or emergency situations. Direct the dismantling of those features when their purpose has been fulfilled unless the Engineer directs that the features be left in place.
 4. Inspect, with the Engineer or designated representative, all erosion control features implemented for the project. The inspections shall take place at least once every 14 calendar days and after each storm event that causes surface runoff. A report shall be submitted to the Engineer after every inspection and shall become part of the project records. The inspections shall be made during the progress of the work, during work suspensions, and until final acceptance of the work. During project suspensions, inspections shall take place at least once every 30 calendar days, or as directed.
 5. Attend the Preconstruction Conference and all project scheduling meetings.
 6. Upon the Engineer's request, implement necessary actions to reduce anticipated or presently existing water quality or erosion problems resulting from construction activities. The criteria by which the Engineer initiates this action may be based on water quality data derived from monitoring operations or by any anticipated conditions (e.g., predicted storms) which the Engineer believes could lead to unsuitable water quality situations.
 7. Make available, upon the Engineer's request, all labor, material, and equipment judged appropriate by the Engineer to install and maintain suitable erosion and sediment control features.
- B. Construction of Erosion Control Measures. Erosion control measures shall be constructed in accordance with the following:
1. Erosion Bales. The bales shall be placed embedded into the soil and shall be anchored securely to the ground with wood stakes. Stakes shall have a minimum diameter or cross section dimension of 2 inches. Re-bars shall not be used. Gaps between bales shall be filled with Certified Weed Free mulch to obtain tight joints.
 2. Silt Fence. Silt fence shall be installed in locations specified on the Plans prior to any grubbing or grading activity. Sediment shall be removed from behind the silt fence when it accumulates to one half the exposed geotextile height and shall be disposed.
 3. Temporary Berms. Berms shall be constructed to the dimensions shown on the Plans, graded to drain to a designated outlet, and compacted with a minimum of two passes of a rubber tire vehicles, preferably a grader wheel.
 4. Temporary Diversion. Unless otherwise specified on the Plans or

directed, the diversion's ridge and channel shall be stabilized within 14 calendar days of its installation. The diversion shall be installed prior to any up slope land disturbance.

5. Outlet Protection. Geotextile used shall be protected from cutting or tearing. Overlaps between two pieces of geotextile shall be 1 foot minimum.
6. Storm Drain Inlet Protection. Storm drain inlet protection measures shall be constructed in locations and with materials and techniques specified in the plans. Construction shall be in a manner that will facilitate maintenance, and minimize interference with construction activities. At excavated drop inlet sediment traps, sediment shall be removed when it has accumulated to one-half the design depth of the trap and shall be disposed.
7. Erosion Logs. The Contractor shall maintain the erosion logs during construction to prevent sediment from passing over or under the logs or from sediment accumulation greater than two thirds of the original exposed height of each erosion log. Stakes shall be embedded to a minimum depth of 12 inches. At the discretion of the Engineer, a shallower depth may be permitted if rock is encountered.
8. Concrete Washout Structure Design. The concrete washout structure shall be designed to meet or exceed the dimensions shown on the plans. At least ten days prior to start of paving operations, the Contractor shall submit in writing a method statement outlining the design, site location and installation of a concrete structure that will contain washout from concrete placement operations. Work on this structure shall not begin until written acceptance is provided by the Engineer. The structure shall meet the following requirements:
 - a. Structure shall contain all washout water;
 - b. Storm water shall not carry wastes from washout and disposal locations. The site shall be located a minimum of 50 horizontal feet from state waters and shall meet all requirements for containment and disposal;
 - c. The site shall be signed as "Concrete Washout";
 - d. Each concrete truck driver and pump operator shall be aware of site locations;
 - e. The site shall be accessible to appropriate vehicles;
 - f. The bottom of excavation shall be a minimum of five feet vertical above groundwater or, alternatively, excavation must be lined with an impermeable synthetic liner that is designed to control seepage to a maximum rate of 10⁻⁶ centimeters per second.
 - g. Freeboard capacity shall be included into structure design to

reasonably ensure the structure will not overtop during or because of a precipitation event;

- h. The Contractor shall prevent tracking of washout material onto the roadway surface;
 - i. Solvents, flocculants, and acid shall not be added to wash water;
 - j. The structure shall be fenced with orange plastic construction fencing or equivalent fencing material to provide a barrier to construction equipment and to aid in identification of the concrete washout area;
 - k. The concrete washout structure shall be completed and ready for use prior to concrete placement operations;
 - l. Waste material from concrete washout operations shall be removed and disposed when it has accumulated to two-thirds of the wet storage capacity of the structure.
9. Stabilized construction entrance. Stabilized construction entrances shall be constructed to the minimum dimensions shown on the plans, unless otherwise directed by the Engineer. Construction of approved stabilized construction entrances shall be completed before any excavation or work is started between such entrances, as shown on the plans. The Contractor shall maintain the stabilized construction entrance during the entire time that it is in use in the project. The stabilized construction entrance shall be removed at the completion of this project unless otherwise directed by the Engineer.

C. Failure to Perform Erosion Control.

- 1. The Contractor will be subject to liquidated damages for incidents of failure to perform erosion control as required by the Contract. Incidents to which these liquidated damages may be applied include the following:
 - a. Failure to submit an initial schedule or failure to submit a monthly schedule update;
 - b. Failure of the Erosion Control Supervisor to perform the inspections required.
 - c. Failure of the Erosion Control Supervisor to implement necessary actions requested by the Engineer;
 - d. Failure to design and implement erosion and sediment control measures for unforeseen conditions;
 - e. Failure to construct or implement erosion control or spill containment measures, or failure to construct or implement them in accordance with the Contractor's approved schedule;
 - f. Failure to limit the exposed surface areas of erodible earth to 34 or

fewer acres;

- g. Failure to temporarily stabilize areas where work is temporarily halted within seven days;
- h. Failure to perform maintenance of an erosion control feature within 48 hours after notice from the Engineer to perform maintenance;
- i. Failure to remove and dispose of sediment from erosion control features; &
- j. Failure to install and properly utilize a concrete washout structure for containing washout from concrete placement operations.

- 2. The Engineer will notify the Contractor in writing of each incident of failure to perform erosion control, items (1) through (10) above. The Contractor will be allowed seven calendar days from the date of notification to correct the failure. The Contractor will be charged liquidated damages in the amount of \$500 for each calendar day after the seventh day that one or more of the incidents of failure, items (a) through (i) above, remains uncorrected. This deduction will not be considered a penalty, but will be considered liquidated damages based on estimated additional construction engineering costs. The liquidated damages will accumulate, for each cumulative day that one or more of the incidents remains uncorrected. The number of days to which liquidated damages are assessed will be cumulative for the duration of the project; that is: the damages for a particular day will be added to the total number of days for which liquidated damages are accumulated on the project. The liquidated damages will be deducted from any monies due the Contractor.

1.05 MEASUREMENT AND PAYMENT

- A. Where items are specifically included on the bid schedule, they will be paid for by the unit given. All other items in this section that are essential to the project but for which there are no specific pay items, will not be measured and paid for separately, but shall be included in the project.

END OF SECTION

SECTION 02271

RIPRAP

1.00 GENERAL

1.01 Description.

- A. Work shall consist of furnishing and placing of riprap according to the location shown on the Drawings.
- B. Work shall conform to the relevant provisions of Section 506 "Riprap" of the Standard Specifications for Road and Bridge Construction, State Department of Highways, Division of Highways, State of Colorado, 1981 Edition, except as modified.

2.00 PRODUCTS

2.01 Riprap.

- A. Riprap shall consist of hard, dense rough fractured rock as nearly cubical as possible. Thin slab, flaking rock and sandstone shall not be used. The rock shall have a minimum specific gravity of 2.25. Removed concrete may not be substituted for rock. Round river rock shall not be used as riprap unless approved by Engineer.
- B. The average diameter of rock shall be as shown on Drawings.

3.00 CONSTRUCTION METHODS

3.01 Slope Preparation. Areas on which the riprap is to be placed will be trimmed and dressed to conform to cross sections shown on the Drawings within an allowable tolerance of plus or minus two inches (2") from the theoretical slope lines and grades. Where such areas are below the allowable minus tolerance limit, they shall be brought to grade by filling with material similar to the adjacent material and well compacted with no additional compensation to be allowed to the Contractor for any extra materials thus required.

3.02 Filter Cloth. Provide Mirafi 140-N filter fabric under rip rap, or equal.

3.03 Bedding Blanket. To be six inches (6") thick placed on top of prepared slope and under riprap where called for on Drawings.

<u>Sieve Measure</u>	<u>% By Weight Passing Square Mesh Sieves</u>
3"	100
3/4"	20 - 90
#4	0 - 20
#200	0 - 3

3.04 Riprap Placement. Stone for riprap will be placed on the prepared slope in such a manner as to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids, and will be constructed within tolerances specified herein and to the slopes, lines and grades shown on the Drawings or as otherwise approved by Engineer in the field.

A tolerance of plus or minus three inches (3") from the slope lines and grades shown on the Drawings shall be allowed in the finished surface of the riprap. Placement of stones at the outlet of drainage structures shall allow positive flow in the direction intended with no stone placed to constrict or reduce flows. (also see Section 506.03).

Riprap will be placed to its full course of thickness in one operation. The placing shall progress upwards on the slopes. The riprap will be carefully placed on the prepared slope in such a manner that adjacent stones are in close contact and, in general, have their greatest dimensions across or perpendicular to the slope. Through stones will be well distributed throughout the mass.

As used herein, a "through stone" is defined as a stone whose dimension as normal to the surface being riprapped is not less than the full depth of riprap. The finished riprap will be free from objectionable pockets of small stone clusters of larger stones. Placing riprap in layers will not be permitted.

4.00 MEASUREMENT AND PAYMENT

Payment will be made at the unit price given on the bid schedule and shall be for work complete in place.

End of Section

SECTION 02520

STORM DRAINAGE UTILITIES

1.00 GENERAL

1.01 Scope. Work under this section includes furnishing, installing, cleaning and testing drainage pipe (including culverts) underdrains, trench drains, bands, collars, inlet section, outlet sections and all other items appurtenant to drainage pipe.

1.02 Related Work Specified Elsewhere.

Section 02200 - Excavation and Embankment
Section 02201 - Excavation and Backfill for Structures
Section 02221 - Trenching, Backfilling and Compaction
Section 02222 - Embedment and Base Course Aggregate
Section 02560 - Sanitary Sewer Lines

1.03 Reference Standards.

Colorado State Department of Transportation Standards
Specifications for Road and Bridge Construction Section 707 and M-Standards

1.04 Submittals. Product data including catalogue cut sheets and descriptive literature.

1.05 Protection of Work. All pipe and appurtenances shall be carefully handled, stored and protected in such a manner as to prevent damage to materials and protective coatings and linings. At no time shall such materials be dropped or dumped into trench.

Precaution shall be taken to prevent foreign matter from entering the pipe and appurtenances prior to and during installation. Place no debris, tools, clothing or other materials in the pipe during installation.

2.00 MATERIALS

This item covers the types of material that will be required for the construction and installation of drainage pipe. All materials used shall be new and the best quality available. All material used shall be in accordance with applicable standards of the American National Standards Institute (ANSI), the American Standards Association (ASA), the American Society of Testing and Materials (ASTM) and the American Association of State Highway Transportation Officials (AASHTO).

2.01 Corrugated Galvanized Steel Pipe and Pipe Arches.

A. Pipe and Bands.

1. Conform to AASHTO M-36, M-274, and M-196, as applicable.
2. Steel Pipe and connecting bands shall be Aluminized Corrugated Steel

Pipe, Type 2 (ALT2).

3. Sizes, lengths, and shapes as shown on Drawings.
4. Corrugations to be 2-2/3" x 1/2 or 3" x 1" unless shown otherwise.
5. Gauge to be minimum 16 gauge (0.064") for pipe smaller than 36" diameter and 14 gauge (0.079") for arch pipe and pipe 36" diameter and larger.
6. Bands to be "Hugger" type with forged steel bars secured to connecting bar with tension straps. The use of channel bands as described in 9.1 of AASHTO M-36 will not be allowed. Connecting bands shall be at least 10-1/2 inches wide.
7. Gasket use rubber O-ring, two for each joint.
8. Pipe seams shall be continuous weld type.

B. End Sections.

1. Conform to M-603-CA.

2.02 Smooth Interior Corrugated Polyethylene Pipe (CPP).

- A. Pipe. This specification applies to high density polyethylene corrugated pipe with an integrally formed smooth waterway. Pipe shall be Advanced Drainage Systems N-12 Watertight Pipe (ADS N-12 WT) or engineer approved equal.

Nominal Sizes: 4" to 36" diameter.

CPP to have a full circular cross-section, with an outer corrugated pipe wall and an essentially smooth inner wall (waterway). Corrugations for sizes listed may be either annular or spiral. Corrugation type must compliment the bands and fittings supplied with the pipe.

Sizes 42 and 48 inch (ADS N-12 WT HC) shall consist of an essentially smooth waterway braced circumferentially with circular ribs which are formed simultaneously with an essentially smooth outer wall.

All sizes shall conform to the AASHTO classification "Type D".

Pipe manufactured for this specification shall comply with the requirements for test methods, dimensions, and markings found in AASHTO Designations M252 and M294.

Pipe and fittings shall be made from virgin PE compounds which conform with the requirements of cell class 324420C as defined and described in ASTM D3350.

Minimum parallel plate stiffness values when tested in accordance with ASTM D2412 shall be as follows:

Diameter	Pipe Stiffness	Diameter	Pipe Stiffness
4"	50 psi	18"	40 psi
6"	50 psi	24"	34 psi
8"	50 psi	30"	28 psi
10"	50 psi	36"	22 psi
12"	50 psi	42"	19 psi
15"	42 psi	48"	17 psi

B. Fittings. The fittings shall not reduce or impair the overall integrity or function of the pipe. Fittings may be either molded or fabricated. Common corrugated fittings include inline joint fittings, such as couplers and reducers, and branch or complimentary assembly fittings such as tees, wyes, and end caps. These fittings may be installed by various methods, such as snap-on, screw-on, bell and spigot, and wrap-around. Couplings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Only fittings supplied or recommended by the pipe manufacturer shall be used. A neoprene or rubber gasket shall be supplied.

C. Curb Inlets, Inline Drains, Drain Basins and Manholes.

- a. Nyloplast-Advanced Drainage Systems, Inc.
- b. Nyloplast Snout or BMP, Inc. 'NP' Snout structures
- c. BMP, Inc. oil skirt OB-2116
- d. The cast iron grates
- e. Manholes: In conformance with Section 02560-Sanitary Sewer Lines;
- f. Water tight flexible elastomeric seals
- g. Capable of supporting H-20 wheel loading
- h. Grates shall be hinged to the frame using pins
- i. Installed per manufacturer's recommendations and guidelines.

D. Installation. Installation of the pipe specified above shall be in accordance with ASTM Recommended Practice D2321 as covered elsewhere in these specifications.

2.03 Reinforced Concrete Pipe (RCP).

A. This pipe shall conform to the requirements of AASHTO M-170 for the specified diameters and strength classes. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional. Reinforced concrete pipe

being jacked shall be Class V and shall be furnished with grouting nipples spaced not more than 8 feet apart. Joints for this pipe shall come equipped with steel rings and rubber gaskets conforming to ASTM C 361 and as described in Bureau of Reclamation Specifications for Type R-2 joints.

- B. Elliptical pipe conforming to AASHTO M-207 shall be furnished when required on the plans. Arch pipe conforming to AASHTO M-206 shall be furnished when required on the plans.
- C. Precast reinforced concrete end sections shall have at least one line of reinforcement conforming to the requirements of AASHTO M-170 equivalent to the square inches per linear foot for elliptical reinforcement in circular pipe, Class II, Wall B.
- D. Pipe shall be obtained from a manufacturer that is a current plant quality certified member of the American Concrete Pipe Association (ACPA), meeting all current ACPA requirements for this certification. A copy of the ACPA certification shall be submitted to the Engineer prior to deliver of the pipe.

3.00 METHODS AND PROCEDURES

3.01 Cleaning and Inspection. Clean all pipe and appurtenances thoroughly of all foreign material and inspect for cracks, flaws or other defects prior to installation. Mark all defective, damage or unsound materials with bright marking crayon or pain and remove from job site.

3.02 Pipe Installation. Pipe shall be laid in straight sections except as noted on the plans. Jointing of the pipe shall be made in accordance with the directions of the manufacturer of the pipe and the manufacturer of the coupling and shall have rubber gaskets or joint sealing compound as approved. All pipe to be install with minimum cover of 12 inches.

The pipe laying shall begin at the downstream end of the pipe line. The lower segment of the pipe shall be in contact with the prepared bedding throughout its full length. Bell or groove ends of concrete pipes and outside circumferential laps of metal or plastic pipes shall be placed facing upstream.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical shaped pipe and circular pipe with elliptical reinforcement shall have the top clearly marked with paint or with imprinted letters and with lifting eye holes in which laying pins can be used. Holes shall be finished smooth with grout or with plugs. Pipes shall be placed with the vertical axis within five degrees of a vertical plane through the longitudinal axis of the pipe.

3.03 Joining Pipe.

- A. Concrete Pipe. Conduit sections shall be joined in such manner that the ends are fully entered and the inner surfaces are reasonably flush and even. Rubber gaskets shall be used for concrete pipe joints.
- B. Metal Conduit. Corrugated metal pipe sections shall be placed and aligned to within $\frac{3}{4}$ inch of the adjacent section and shall be firmly joined with either one-piece or two-

piece coupling bands. Pipe with helical corrugations shall be joined with the corrugations matched across the joints and with all corrugations of the pipe completely engaged by the corrugations or dimples of the coupling band.

Where existing corrugated metal pipe culverts are to be extended, damaged ends shall be cut off or repaired in an approved manner. All ends of pipes requiring extensions shall be cleaned within the area necessary for proper installation of connecting bands.

Arch culverts shall be extended with pipe having a compatible arch shape. When special joint treatment is called for on the plans to prevent infiltration or exfiltration, the joints shall be made using a sealing compound conforming to manufacturer's recommendations for use with the connecting band.

C. Plastic Conduit. Couplings shall be as recommended by the conduit manufacturer. Rubber gaskets shall be used for plastic conduit pipe joints.

3.03 Pipe Embedment. Pipe shall be embedded according to applicable details on the Drawings.

3.04 Apron Endwalls. Apron endwalls (end sections) shall be constructed at the ends of all drainage pipe as shown on the plans. All entrance endwalls shall have toe plates. Excavation for endwalls shall be such that the endwall rests on undisturbed soil in its final position. Excavation for toe plates shall be such that the inside of the toe plate rests on undisturbed soil in its final position. Backfill shall be done as in Part 3.03 of this section.

3.05 Flared End Sections. Flared end sections shall be installed on all surface culverts with a minimum of 4'W x 6'L of 9" nominal angular rock riprap at all outlets less than 30" diameter and a minimum of 24" wider than the pipe diameter x 10'L of 12" nominal angular rock riprap at all outlets 30" diameter and larger. Riprap shall be extended down past the toe of all outlet slopes steeper than 6H:1V.

3.06 Construction Traffic. Pipe base subgrade shall be prepared prior to placement of pipe. Mulch and organic matter shall be removed and replaced with 3" maximum granular material with low silt or clay contents. Pipe shall be backfilled with granular material in 6" lifts or flowable concrete as specific on the details.

4.00 QUALITY CONTROL - FIELD

4.01 Inspection and Testing. Inspection and testing to be performed at direction of the Engineer. Contractor to cooperate fully with all testing procedures.

Any pipe section which has been damaged in any way which, in the opinion of the Engineer, may affect the structural integrity of the pipe or reduce the expected corrosion resistance of the pipe, shall be removed and replaced. At the option of the Engineer, recoating of minor dents and deformities with an approved fluid applied galvanized material may be allowed.

5.00 MEASUREMENT AND BASIS OF PAYMENT

Payment will be made at the unit price given on the bid schedule for each item of work and will be full compensation for that item complete in place.

End of Section

SECTION 02545

CHIP SEAL COAT SURFACING

1.00 GENERAL

1.01 Scope. Work under this section shall consist of all labor, materials, equipment, traffic control and safety devices required for chip sealing of the roads listed in the construction schedule and in conformance with the Drawings, Specifications, typical sections and Contract Documents.

1.02 Related Work Specified Elsewhere.

Section 02200 - Excavation and Embankment

Section 02201 - Excavation and Backfill for Structures

Section 02222 - Embedment and Base Course Aggregate

2.00 MATERIALS

2.01 Bituminous Material.

- A. The Asphaltic Prime Coat shall be AEP or equivalent and shall be in accordance with Section 702 of the 1999 Colorado Department of Transportation "*Standard Specifications for Road and Bridge Construction, 1999*".
- B. The Asphaltic Binder shall be HEMS-2P and shall be in accordance with Section 702 of the 1999 Colorado Department of Transportation "*Standard Specifications for Road and Bridge Construction, 1999*".

2.02 Mineral Aggregate.

- A. Type IV. The 3/4" No. 6, aggregate coat shall meet the requirements of Section 703.5 of the 1999 Colorado Department of Transportation "*Standard Specifications for Road and Bridge Construction, 1999*", except that;
 - 1) The gradation shall be gradation No. 6 from the concrete aggregate gradation table found on Page 880 and additionally shall have less than 2% passing the No. 200 sieve;
 - 2) The aggregate shall be washed or tested in accordance with AASHTO T182 and be shown to have a retained bituminous film about 95% with or without the addition of anti-stripping additives, meeting the requirements of Section 712.10;
 - 3) The aggregate shall have a percentage of wear not greater than 35 when tested per AASHTO T96; and
 - 4) The aggregate shall be at least 50% of the gravel retained on the No. 4 sieve and shall have at least one fractured face instead of 90%.

- B. Type I. The 3/8" aggregate coat shall meet the requirements of Section 703.05 of the 1999 Colorado Department of Transportation "*Standard Specifications for Road and Bridge Construction*".
- 1) The aggregate shall be washed or tested in accordance with AASHTO T182 and be shown to have a retained bituminous film about 95% with or without the addition of anti-stripping additives, meeting the requirements of Section 712.10.
 - 2) The aggregate shall have a percentage of wear not greater than 35 when tested per AASHTO T96.

3.00 CONSTRUCTION REQUIREMENTS

- A. Chip and Seal Mat - Typical Section "B". This work shall consist of furnishing and applying bituminous materials and cover coat materials in both single coat application and a double coat application in accordance with these Specifications and in reasonably close conformity with the lines shown on the Drawings or established.
- B. An analysis of a representative sample of the aggregate proposed to be used, performed by an independent laboratory, shall be furnished to Schmueser Gordon Meyer. The analysis shall test abrasion, sieve analysis, unit weight, and material finer than No. 200 sieve.
- C. Per Colorado Department of Transportation "*Standard Specifications for Road and Bridge Construction, 1999*", Subsection 409.04 through 409.08, except as follows:

409.04 - Weather Limitations (substitute the following)

Bituminous material shall not be applied on a damp surface, when either the air or pavement surface temperature is below 60°F, or when weather conditions would prevent the proper construction for the seal coat.

409.07- Applying Bituminous Material (Add the following)

The bituminous coat for the 3/4" chips shall be applied at a rate of 0.50 to 0.60 gallons per square yard and 0.30 to 0.40 gallons per square yard for the 3/8" chips.

409.07- Application of Cover Coat Material (Delete the last paragraph; add the following:

After the first lane of a two-lane roads is chipped, the loose chips shall be swept back from the centerline for at least 6 inches, and the second lane bituminous and chip application shall overlap 6 inches onto the first lane application.

Where applicable, excess material shall be swept from the entire surface by means of rotary power brooms within 24 hours after application of cover coat material. Said excess material shall be collected in residential areas, and disposed of off-site by the Contractor.

Unless otherwise approved by the Engineer, the 3/4" aggregate shall be applied at a rate of 40 to 50 pounds per square yard and the 3/8" aggregate shall be applied at a rate of 20 to 30 pounds per square yard.

Where multiple layers of chips are to be placed, a period of seven (7) days of temperatures above 60°F shall be allowed between the first chip seal and the second chip seal for curing, unless otherwise approved by the Engineer.

4.00 SAMPLES

Sampling of asphalt materials shall be in accordance with the latest revision of AASHTO Designation T40 (ASTM Designation D140). Sampling of mineral aggregate shall be in accordance with the latest revision of AASHTO Designation T2 (ASTM Designation D75).

5.00 METHODS OF TESTING

Asphalt materials shall be tested using the appropriate methods of test of the American Association of State Highway and Transportation Officials (AASHTO). If an AASHTO method of test is not available, the approximated American Society for Testing and Materials (ASTM) method shall be used.

Mineral aggregate shall be tested as designated in the detailed requirements of those specifications, by one or more of the following AASHTO methods of test. If an AASHTO method is not available, the approximate ASTM method shall be used.

6.00 CHARACTERISTIC

	Method of Testing	
	MSHTO	ASTM
Abrasion of Coarse Aggregate Los Angeles Machine	T96	
C131 Sieve Analysis, Fine and Coarse Aggregates	T27	C136
Unit Weight of Aggregate	T19	C19
Amount of Material Fine than No. 200 Sieve in Aggregate	T11	C117

7.00 METHOD OF MEASUREMENT.

Chip seal coat will be measured by the mile along the centerline of finished chip seal coated surface roadway or by square yardage of total surfaced roadway (centerline length by average width).

8.00 BASIS OF PAYMENT

The accepted quantities of chip seal coat will be paid for at the contract price per mile or square yard.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
(Size) Chip Seal (Bituminous Material) (Road Name) (General Location - Optional) (Nominal Roadway Width)	Square Yard

Bituminous material, prime coat, and sampling & testing will not be paid for under separate items, but will be considered incidental to this Work.

9.00 FOG SEAL

The Fog Seal shall be a 50-50 dilution of bituminous materials HFMS-2P and water. This solution shall be applied at a rate of 0.08 to 0.15 gallons per square yard.

A light dusting of sand may be applied to the Fog Seal to accommodate traffic as soon as possible, if needed.

10.00 CONSTRUCTION ZONE TRAFFIC CONTROL

Construction Zone Traffic Control per the construct Zone Traffic Control per Colorado Department of Transportation "*Standard Specifications for Road and Bridge Construction, 1999*, Subsection 630.01 through 630.14, inclusive, except as follows:

630.07 - General

Traffic shall be kept off freshly placed chips until rolling is complete. When it is necessary to route traffic over the new treatment, speed shall be restricted to twenty (20 mph, or less, for twenty-four (24) hours after application.

630.13 - Methods of Measurement

Construction Zone Traffic Control will be measured on a lump sum basis. 630.14 -

Basis of Payment

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Construction Zone Traffic Control	Lump Sum

The Contractor shall be required to submit a Traffic Control Plan at a Preconstruction Conference, the time and place which will be decided after the presentation of the Notice of Award. **STRICT IMPLEMENTATION OF THE CONTRACTOR'S TRAFFIC CONTROL PLAN TO SLOW TRAFFIC ON THE FRESHLY-CHIPPED ROAD SURFACES IS A PRIORITY.**

11.00 HIGHWAY PAINTING AND STRIPING

This Work shall consist of the furnishing and applying pavement markings, and furnishing, installing, and removing temporary pavement marking in accordance with the Colorado Department of Transportation "*Standard Specifications for Road and Bridge Construction, 1999*", Section 627 Pavement Marking, the Manual of Uniform Traffic Control devices for Streets and Highways (MUTCD), the Colorado supplement thereto, and in conformity to the lines, dimensions, patterns, locations and details shown on the plans or established, except as follows:

627.10 - Method of Measurement

Highway Painting and Striping will be measured on a lump sum basis.

627.11 - Basis of Payment

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Highway Painting and Striping	Lump Sum

END OF SECTION

SECTION 02555
WATER TRANSMISSION AND DISTRIBUTION LINES

1.00 GENERAL

1.01 Scope. Work under this Section shall include furnishing all materials, labor, equipment and miscellaneous items necessary to install, disinfect, and test all raw water and potable water transmission and distribution pipelines and appurtenances as specified herein and shown on the Drawings.

1.02 Related Work Specified Elsewhere.

Section 02221 - Trenching, Backfilling and Compaction Section
02222 - Embedment and Base Course Aggregate Section
02612 - Hot Bituminous Pavement

1.03 Submittals. Product data including catalog sheets and descriptive literature shall be submitted for all materials and equipment specified. Submittal shall include certificates of compliance as stated in section 01300 subsection of these Specifications.

1.04 Protection of Work. All pipe fittings, valves and equipment shall be carefully handled, stored and protected in such a manner as to prevent damage to materials and protective coatings and linings.

Pipe stored or stockpiled on site shall have the ends sealed to prevent animals and foreign matter from contaminating the pipe.

At no time shall such materials be dropped or dumped into trench.

Precaution shall be taken to prevent foreign matter from entering the pipe, fittings and valves prior to and during installation. Place no debris, tools, clothing or other materials in the pipe during installation.

At such time as pipe installation is suspended, either temporarily or overnight, the open end of the pipe shall be sealed with a watertight plug to prevent entrance of trench water, debris or foreign matter.

Under no circumstances shall trench water be allowed to enter the pipeline. When water is present in the trench, the seal shall remain in place until such time as the trench is pumped dry. Whenever trench water becomes evident, adequate measures shall be taken to prevent pipe floatation.

If, in the opinion of the Engineer, the Contractor is incapable of keeping the pipe free of foreign matter during installation, the Engineer shall require the Contractor to cover the pipe ends with close woven bags until the start of the joining operation.

2.00 MATERIALS

This item covers the types of materials that will be required for the construction and installation of water lines. All materials used shall be new, of the best quality available, and conform with applicable standards as indicated herein. [NOTE: Local jurisdiction

specifications (i.e., municipality, district, etc.), will govern when two or more alternatives are given in these specifications, or where there is a discrepancy between these specifications and local jurisdiction specifications.

2.01 Polyvinyl Chloride (PVC) Pipe and Fittings.

A. PVC Pipe.

1. Materials: ASTM D1784, Type 1, Grade 1, PVC 1120, 2000 psi design stress.
2. Reference Standard: AWWA C900, latest edition, 4" - 12".
3. Class: 200 (DR-14), 4" - 12".
4. Reference Standard: AWWA C905, latest edition, 14" - 30".
5. Class: 235 (DR-18), 14" - 30".
6. Markings: Manufacturer's name, nominal size, class pressure rating, PVC 1120, NSF logo, identification code.
7. Size: Shall conform to outside diameter of DIP.

B. Fittings.

1. Type: All fittings shall be mechanical joint except where specifically shown or detailed otherwise.
2. Reference Standard: ANSI/AWWA C110/A.21.10 or C153/A.21.53, latest edition.
3. Pressure Rating: 250 psi for C110; 350 psi for C153
4. Gasket Reference Standard: AWWA C111, latest edition.
5. Cor-Blue or stainless steel bolts and nuts.

C. Joints

1. Push-on rubber gasket.
2. Gasket Reference Standard: AWWA C111, latest edition.

2.02 Fire Hydrants.

A. Dry Barrel Type.

1. Reference Standard - AWWA C502, latest edition.
2. Outlet Size – (1) 4-1/2 inch, (2) 2-1/2 inch.

3. Hydrant Size - 5 1/4 inch.
4. Inlet Size - 6 inch.
5. Operation— 1-1/2 inch pentagonal national standard operating nut, open counter clockwise.
6. Special Features - outlet hydrant shall open when turned to the left (counter clockwise).
7. Depth of Bury - As shown on Drawings.
8. Additional Requirements - Furnish hydrant complete with pipe and tee, 6 inch (6") restrained mechanical joint gate valve and thrust blocks. Hydrant shall be restrain-to the hydrant tee by 3/4 inch threaded rods protected from corrosion by the use of an approved bituminous coating, or approved equal.
9. Traffic Model with break-away bolts and coupling.
10. Cor-Blue or stainless steel bolts and nuts.
11. Manufacturers Reference: Mueller Centurion.
12. Acceptable manufacturers: Mueller and Kennedy.

2.03 Valves.

A. Gate Valves.

1. Resilient Wedge.
 - a. Size as shown on Drawings.
 - b. Reference Standard - AWWA C509, latest edition.
 - c. Style - Iron body, bronze stem resilient seat gate valves, lubrication free, unobstructed through port to minimize head loss, entire body encapsulated inside and out with epoxy coating, Cor-Blue or stainless steel bolts and nuts.
 - d. Pressure Rating - 200 psi.
 - e. Wrench Nut: 2 inch square.
 - f. Acceptable manufacturers – Mueller and Kennedy.

B. Combination Air Release Valve.

1. Size: 1" Orifice, or as recommended by manufacturer for correct application.
2. Inlet: 1" Pipe Thread.
3. Materials.

Body - Cast Iron
Float - Stainless Steel
Seat: Buna-N
Lever Frame: Delsrin
4. Pressure Rating: 200 psi
5. Manufacturer's Reference: APCO
6. Performance - Permits efficient filling or draining of long pipelines, for protection against vacuum, and will continuously vent pockets of air as they accumulate in pipeline.

C. Pressure Reducing Valves.

All pressure reducing valves shall be Golden-Anderson cushioned, single globe, pilot pattern, hydraulically operated with flanged ends (Figure 4500) or equal. The valve body shall be of cast iron ASTM-126 with flanges conforming to the latest ANSI standards. The valve body shall be extra heavy construction throughout. The valve interior trim shall be bronze B-62 as well as the main valve operation. The valve seals shall be easily renewable while no diaphragm shall be permitted within the main valve body. All controls and piping shall be non-corrosive construction.

2.04 Valve Boxes.

A. Screw Type - Three Piece.

1. Material: Cast Iron
2. Size: 5 1/4 inch diameter
3. Type: Three piece adjustable screw type
4. Cover: Deep socket type with the word "water" cast in the top
5. Base: #160 type with 20.5" bottom opening
6. Acceptable manufacturer is Tyler Union

2.05 Water Service & Tap Components.

A. Corporation Stops

1. Material: brass or bronze
2. Size: As shown on Drawings
3. Reference Standard - AWWA C800, latest edition.
4. Thread inlet - Tapered (CC) Type
5. Thread outlet - Copper Service Thread for compression connection
compression connection if local jurisdiction permits (revise as necessary
when Pure-Core HDPE pipe is used).
6. Manufacturer's Reference - Mueller H 15000, Ford F600, Mueller 25008
for compression.

B. Copper Service Pipe

1. Reference Standard - AWWA 75-CR Type K
2. Size - As shown on Drawings.

C. HDPE Service Pipe

1. Reference Standard: ASTM D 2239, AWWA C901
2. Size: As shown on Drawings.

D. Curb Box.

1. Material: Cast iron box, arch base pattern, telescoping, complete with lid
and red brass screw.
2. Size: 1/2 inch thru 2 inch.
3. Acceptable manufacturer: Mueller.

E. Curb Stop.

1. Material - Cast brass or bronze body, resilient O-ring, standard tee-head operator. Teflon coated ball valve.
2. Size: As shown on Drawings.
3. Inlet: Copper service, thread or compression connection or compression connection if local jurisdiction permits.
4. Outlet: Copper service thread for compression connection if local jurisdiction permits.
5. Manufacturer's Reference: Mueller B-25204; Mueller B-25209 for compression.

C. Service Clamps.

1. Materials: Bronze service clamp, O-ring gasket, stainless steel double strap, two section or three section clamp, (CC) threads, Cor-Blue or stainless steel nuts and bolts.
2. Manufacturer's Reference: Mueller BR2S Series, or engineered approved equal.

2.07 Concrete for Thrust Blocks and Encasing of Pipe. Concrete for thrust blocks and for encasing the water pipe line shall have a 28-day compressive strength of not less than 3000 psi.

2.08 Tracer Wire. No. 14 or larger, insulated, solid copper. All splices to be watertight, underground type.

2.09 Detectable Metallic Underground Tape. Shall be blue in color and marked *""Caution - Buried Waterlines below"*. Follow manufacturer's recommendations for installation procedures.

3.00 METHODS AND PROCEDURES

3.01 Cleaning and Inspection. Clean all pipe, fittings, valves and related material thoroughly of all foreign material and inspect for cracks, flaws or other defects prior to installation. Mark all defective, damaged or unsound materials with bright marking crayon or paint and remove from jobsite.

The Contractor shall take all necessary precautions to prevent any construction debris from entering the water lines during construction of water lines and appurtenances. If this debris should enter the distribution system, the Contractor shall furnish all labor and material necessary to clean the system. Under no circumstances will the Contractor flush the debris into an existing distribution system.

3.02 Verification. Verify dimensions and class of all existing and proposed pipe, valves, fittings and equipment prior to installation to ensure the piping system will fit together properly.

3.03 Pipe Embedment.

- A. Placing Embedment Material - Refer to Section 02221 for placement methods.
- B. Embedment Classes - Refer to Section 02222 for embedment materials as listed below.

Use Class 6 aggregate 4" below pipe and 12" above pipe for all pipe materials. Contractor shall compact trench bottom before placing bedding and shall compact bedding.

3.04 Pipe Installation.

- A. Methodology. Pipe shall be laid in straight section with bell ends facing the direction of laying unless otherwise directed by the Engineer. Where pipe is laid on a grade of ten percent (10%) or greater, the installation shall proceed uphill with the bell ends facing upgrade. The pipeline shall be installed so that a continuous positive or negative grade is maintained between high and low points to avoid air pockets. Jointing of the pipe shall be made in accordance with the directions of the manufacturer of the pipe and the manufacturer of the coupling.

The pipe shall be brought to correct line and grade, and secured in place with the specified bedding material as directed in Section 02221.

- B. Pipeline Depth. As indicated on Drawings, or as per local jurisdiction but always below frost level. Depth shall be based on depth below finished grade of a project and not existing grade. Contractor shall be responsible for keeping pipelines from freezing if fire line is temporarily installed above frost line before fill material is installed.
- C. Concrete Encasement. Install concrete encasement where indicated on the drawings or as required by other sections of this Specification. Concrete shall have a three thousand (3000) psi compressive strength. Reinforcing shall consist of four (4) evenly spaced longitudinal No. 4 rebar.
- D. Installation of Polyvinyl Chloride (PVC) Pipe.
 - 1. Pipe Handling. Pipe should be carefully lowered into the trench to avoid pipe falling into the trench.
 - 2. Pipe Laying. Pipe shall be laid in straight sections with bell ends facing the direction of laying. When pipe laying is not in progress, the open end of the pipe shall be closed by a water-tight plug.
 - 3. Jointing the Pipe. The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.
 - 4. Pipe Cutting. The cutting of pipe for fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe. Bevel the end of the pipe with a beveling tool after the pipe is cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.

- E. Metal Components: All metal components shall be wrapped with 10 mil polyethylene wrap. All damaged material coatings to be completely covered with a bitumastic coating prior to wrapping.
- F. Clay Cutoff Dams: Clay cutoff dams shall be constructed across the pipe embedment material at intervals of 100 lineal feet, or less, and within 20-feet all tees. Clay cutoff dams shall be 4 to 6 inches wide, extend 3 inches minimum into the adjacent native soils, and be comprised of on-site clays approved by the Engineer or a lean bentonite mixture recommended by the material supplier and approved by the Engineer.

3.05 Installation of Pipeline Appurtenances.

- A. General. Install all valves, meters, manholes, and other equipment appurtenant to pipeline at the locations indicated on the drawings or as otherwise designated by the Engineer to accommodate field conditions. Document "record" measurements prior to backfill referencing all appurtenant equipment to the nearest permanent surface improvement.
- B. Installation of Valves. Install valves in the pipeline in the same manner specified for laying and jointing the pipe and in accordance with details included in Drawings.
- C. Valve Boxes. Except where specified otherwise, install valve boxes on all buried valves. Install boxes such that no stress is transmitted to the valve. Set boxes plumb and directly over the valve with the top of the box placed flush with the finished grade. Backfill and thoroughly compact around each box. Provide extended stems on valves where required such that the operating nut is not lower than seven feet (7') below finished grade.
- D. Debris Caps. Install debris caps in valve boxes per plan details. All valve boxes shall have debris caps installed.
- E. Fire Hydrants. Install hydrants in accordance with the standard details on the drawings. All mechanical joints to be wrapped with a 10 mil polyethylene wrap prior to backfill. All tie rods and appurtenances to be completely covered with a bitumastic coating prior to backfill. Hydrant to be set plumb and true to grade. Contractor to bag or cover the fire hydrant that is not in operation.
- F. Reaction Anchor and Blocking. Concrete thrust blocks shall be provided, as shown in the details included with the Drawings for all tees, elbows, plugs, reducers, valves, fire hydrants and crosses if one or more sides of the cross is plugged. The bearing area of the block shall be at least equal to that stated on the drawings. The bearing surface shall be against undisturbed earth. The block shall be placed normal to the thrust as shown on the drawings. Concrete for thrust blocks shall have three thousand (3000) psi compressive strength. Anchor blocks are required under all valves unless the valve is directly attached to a tee and secured to the tee with a mechanical joint.

Contractor will be required to use either plywood forms or plastic to protect the nuts and bolts on the fittings when the concrete reaction block is placed.

Contractor to also use star clamps or wood blocking as a method of temporary restraint to secure fittings while concrete reaction blocks set up. {Note: Temporary restraint to be used for those cases where a tie-in is being made and the water needs to be turned back on as soon as possible}.

- G. Metal Components: All metal components shall be wrapped with 10 mil polyethylene wrap. All damaged material coatings shall be completely covered with a bitumastic coating prior to wrapping.

3.06 Connection to Existing Water Facilities. All main line connections between existing and proposed piping shall be made during non-business hours or at a time which is acceptable to the Owner. All scheduled shut-offs shall be planned and approved in advance to allow ample time for notifications. All persons affected by the shut-off shall be given a 24 hour notice in the local newspaper and/or local radio at the Contractor's expense. In addition, the Contractor shall personally warn those affected 1 hour before the water is shut off.

The tie-ins between existing and proposed mains shall be made so that both the proposed main and existing main are in service at the same time. Only after both mains are tested, approved and in service can the individual proposed service lines tie into the existing service line on the building side of the curb valve. The affected property shall be given a minimum of one (1) hour notice before the water is shut off. The new line must have passed the pressure testing and bacteriological test prior to connecting the services to the proposed water line.

Remove existing curb boxes and locate new curb boxes on property line unless otherwise instructed by Project Engineer. Contractor is to provide all necessary fittings needed to reconnect service line on property side of curb box. Contractor shall notify Project Engineer if existing service line is leaking prior to connection. Contractor shall be responsible for repair of existing service line if it leaking after connection is made. Contractor shall keep the connection to existing pipe exposed, and notify Project Inspector, and again approval from Project Inspector prior to backfilling over connection to existing service line.

Take all precautions to prevent contamination when making connections to existing potable water lines. No trench water, mud or other contaminating substances shall be permitted to enter the pipeline.

Swab the interior of all new pipe, fittings and valves installed in the existing pipeline with a 5 percent (50,000 ppm) chlorine solution prior to installation. After the connection is completed, flush the main to remove all contaminated water.

3.07 Protection of Water Supplies. Water lines shall be located a minimum of ten feet (10') horizontally from existing or proposed sewer mains. Wherever the sewer line crosses above or within eighteen inches (18") beneath the water mains, the sewer line shall be made impervious by the method listed below:

1. When Crossing Over Sanitary/Storm Sewer: Encase the sanitary sewer line with concrete, to a distance of two (2) feet each side of the outside edge of the water main.

2. When Crossing Under Sanitary/Storm Sewer: Any existing VCP sanitary sewer pipe must be replaced with PVC pipe and all joints on the sewer line within ten (10) feet of the water line shall be concrete encased, unless otherwise approved by the Project Engineer.
3. Paralleling Foreign Conduits. The Town reserves the right to require concrete encasement of pipe joints or the entire pipe of sanitary or storm sewer which are within ten (10) feet and/or less than two (2) feet below the flowline of a water line being installed.

In all cases, select granular backfill shall be used to prevent any settling of the higher pipe.

- 3.08 Service Connections. Customer service connections shall be installed in accordance with the details set forth on the Drawings. Terminate the service with a curb stop and box and mark with a stake except where shown otherwise on the Drawings.
- 3.09 Tracer Wire. Tracer wire is required on all water mains and HDPE water services. Tape the electrical tracing wire to the top of the pipe at 20-foot intervals to prevent dislocation of the wire during backfilling. Extend wire to ground surface at all valves, fire hydrants, curb stops, and other locations shown on drawings. The tracing wire shall be brought up on the outside of the valve box. When the wire is within 4" of the top of the lid, the wire shall be brought back inside the box and securely fastened. Provide sufficient slack in the wire outside of the box to compensate for any future adjustment to the valve box. Prior to final acceptance of the water line but not before final restoration and grading, a continuity test shall be made on all tracer wire. The contractor will be responsible for performing this test and shall do so in the presence of the Resident Project Representative.

4.00 FIELD QUALITY CONTROL

- 4.01 Hydrostatic Tests. Make pressure and leakage tests on all newly laid pipe. Furnish all necessary equipment and material, make all taps in the pipe as required, and conduct the tests. The tests shall be conducted between valved sections of the pipeline, or as approved by the Engineer. The Engineer and a representative of the Fire Department will monitor the tests.

Furnish the following equipment and material for the tests:

Amount	Description
2	Approved graduated containers
2	Pressure gauges
1	Hydraulic force pump approved by the Engineer
1	Additional 1/2 inch pressure tap for Engineer's test gauge
	Suitable hose and suction pipe as required

Conduct the tests after the trench has been partially backfilled with the joints left exposed for inspection, or when completely backfilled, as permitted by the Engineer. Where any section of pipe is provided with concrete reaction blocking, do not make the pressure test until at least 5 days have elapsed after the concrete thrust blocking is installed. If high-early cement is used for the concrete thrust blocking, the time may be cut to 2 days.

Conduct pressure test in the following manner, unless otherwise approved by the Engineer: after the trench has been backfilled or partially backfilled as hereinbefore specified, fill the pipe with water, expelling all air during the filling. The test pressure shall be 1.5 times normal working pressure at the point of lowest elevation of the test gauge, or 150 psi, whichever is greater.

A. Duration.

1. The duration of each pressure test shall be 2 hours, unless otherwise directed by the Engineer.

B. Procedure.

1. Slowly fill the pipe with water and allow to stand for 24 hours. Expel all air from the pipe. Allow and maintain the specified test pressure by continuous pumping if necessary for the entire test period. The test pressure shall be calculated for the point of lowest elevation, or as specified by the Engineer. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately.

2. Before the line is pressurized, the Engineer shall verify that all necessary main line valves are open or closed with regard to the section of line being tested. In addition, the Engineer shall verify that all hydrant valves are open.

C. Allowable Leakage.

1. The allowable leakage per test section shall be calculated from the formula contained in the subsection. Different sized water mains that might be contained within the same test section shall be calculated separately and their allowable leakage added together. This formula represents the allowable leakage regardless of the number of joints, couplings, fittings, valves, pressure reducing or pump station or any other appurtenances on the water main. The length of the pipe contained in these appurtenances shall not be counted as adding to the length of water main being tested:

$$V = \frac{LD\sqrt{P}}{148,000}$$

Where:

V = Allowable leakage in gallons per hour.

L = Length of water main in feet.

D = Nominal diameter in inches.

P = Average test pressure in psi**

**The average test pressure shall be calculated as the test pressure for the lowest elevation of the test section less on-half the elevation change to the highest point on the test section, or 150 psi, whichever is greater.

- D. The pressure testing of water service lines shall follow the same procedure as outlined in the section. In all cases, however, the corporation stop, service line and curb stop shall be visually inspected under full line pressure and any leaks fixed.

E. Correction of Excessive Leakage

Should any test of pipe laid disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

5.00 DISINFECTION OF POTABLE WATERLINES

- 5.01 General. Flush and disinfect potable waterlines in accordance with the procedure set forth in AWWA C651, latest edition, Disinfecting Water Mains.

Provide all temporary blow-offs, pumps, chlorination equipment, chlorine and all other necessary apparatus required.

- 5.02 Pipe Cleaning. If the pipe contains dirt or heavy encrusted matter that, in the opinion of the Engineer, will not be removed during the flushing operation, the Contractor shall clean and swab the interior of the pipe with a five percent (50,000 ppm) chlorine solution.

Preliminary Flushing. Flush pipeline to disinfection, except when the tablet method is used,

to remove all remaining foreign material. The flushing operation shall develop a minimum velocity of 2.5 ft./sec.

5.03 Chlorine Application. In general, chlorine shall be applied using the continuous feed method. However, on large diameter lines where this would not be practical, the slug method may be used. The tablet method may be used on short extensions (up to 2500 feet) of small diameter mains (12 inches and smaller).

A. Tablet Method: Five (5) gram calcium hypochlorite tablets, each containing 3.75 grams available chlorine, shall only be used when the line cannot be flushed prior to chlorination. The tablet method shall not be used when trench water or foreign materials have entered the water line during installation or the ambient temperature is below forty-one (41) degrees Fahrenheit. The tablets shall be secured to the crown of each pipe section, as it is installed in the trench, with "red" PERMATEX or other approved adhesive. Under normal conditions to obtain the 25 Mg/L residual chlorine concentration, after twenty-four (24) hour solution time, will require the use of the number of tablets called for under pipe diameter and opposite pipe joint length as listed below:

Pipe Joint Length	Tablets per Joint					
	6"	8"	10"	12"	14"	16"
13'	2	2	3	5	6	8
20'	3	4	5	7	11	14

B. Continuous Feed Method: This method shall be used when it is necessary to flush the line prior to chlorination or for rechlorination. Water from an existing distribution source shall be made to flow at a constant rate through the line to be disinfected. Chlorine is then pumped into the line from the water supply source at a rate which will result in a chlorine concentration of no less than 50 Mg/L, when tested at any or all accessible discharge locations. The amount of chlorine to be inserted per 100 feet of pipe, to produce 25 Mg/L residual concentration after a twenty-four (24) hour solution time, will normally be as show below:

Pipe Diameter	100% Chorine lbs/100ft	1% of Sol. gal/100ft
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

C. Slug Method. The slug method shall be used for 18" and larger transmission mains or where use of the tablet or continuous feed method are impractical. Chlorine in gaseous or super chlorinated liquid form shall be introduced at the water supply source, after the line has been filled. The chlorine slug shall be caused to traverse the entire length of the line, at a velocity, length and concentration, such that the entire interior surface of the pipe is exposed to the

equivalent of 300 Mg/L of chlorine for at least three (3) hours.

- D. **Cut and Repair Method.** When a water line breaks or is cut into and it is impossible or impractical to rechlorinate using the continuous feed or slug methods, the following procedure shall be used. All fittings, valves, couplings, and make up pipe sections shall be swabbed with a 5% sodium hypochlorite solution (Clorox) or a 35 Mg/L available chlorine solution made from calcium hypochlorite, just prior to being installed. (One 5g tablet as specified under the tablet method, dissolved in 10 liters of water is equal to 350 Mg/L).

- 5.04 **Final Flushing.** Flushing Super Chlorinated Water Lines: Prior to connecting super chlorinated lines to the Town system, the lines shall be flushed with potable water until the residual chlorine does not exceed 1.0 parts per million. Care in flushing must be taken to prevent erosion and/or killing desirable vegetation. The Contractor is responsible for providing any special materials or supplies to meet this requirement.

Super chlorinated water in the line must be dechlorinated so that no more than 1.0 ppm chlorine residual is detected prior to release to streets or into storm sewers, ditches, streams, and/or their tributaries. Contractor's proposed method of dechlorination must be approved by the Town Public Works Director and be performed within the limits set forth in the NPDES permit, as issued by the Town by the Colorado Department of Health (or Garfield County). Sodium Thiosulfate Pentahydrate XTL can be used as a dechlorinator, available from Van Waters & Rogers, Inc. If the super chlorinated water is released to a dirt area that will not run to a receiving water, then the requirement to dechlorinate may be waived by the Town Public Works Director.

- 5.05 **Bacteriologic Tests.** After completion of the final flushing and prior to placing the pipeline in service, collect samples from the end of the line and test for bacteriologic quality to show the absence of coliform organisms. The number and frequency of samples shall conform to the requirements of the Public Health Authority having jurisdiction, but in no case shall the number be less than one for chlorinated supplies.

Collect samples in sterile bottles from a standard corporation stop furnished and installed by the Contractor in the main. Do not collect samples using a hose or fire hydrant.

- 5.06 **Repetition of Procedure.** If the original disinfection fails to produce satisfactory samples, repeat the disinfection procedure until satisfactory results are obtained.

6.00 MEASUREMENT AND BASIS OF PAYMENT

Payment will be made at the unit price given on the bid schedule for each item of work and will be full compensation for that item complete in place.

End of Section

SECTION 02560 SANITARY SEWERLINES (WASTEWATER COLLECTION MAINS)

1.00 GENERAL

1.01 Scope. Work under this section shall include furnishing all materials, labor and tools necessary to perform all installation, cleaning and testing of all sanitary sewer lines and appurtenances as specified herein and shown on the Drawings.

1.02 Related Work Specified Elsewhere.

Section 02221 - Trenching, Backfilling and Compaction
Section 02222 - Embedment and Base Course Aggregate

1.03 Submittals. Product data including catalog sheets and descriptive literature shall be submitted for all materials and equipment specified. Submittals shall state manufacturer's compliance with all published standards referenced herein.

1.04 Protection of Work. All pipe, fittings and equipment shall be carefully handled, stored and protected in such a manner as to prevent damage to materials. At no time shall such materials be dropped or dumped into trench.

Precaution shall be taken to prevent foreign matter from entering the pipe and fittings prior to and during installation. Place no debris, tools, clothing or other materials in the pipe during installation.

At such time as pipe installation is suspended, either temporarily or over night, the open end of the pipe shall be sealed with a watertight plug to prevent entrance of trench water, debris or foreign matter. A mechanical-type fitting shall be used for this seal. At no time shall duct tape or any other tape be used for this seal.

Under no circumstances shall trench water be allowed to enter the pipeline. When water is present in the trench, the seal shall remain in place until such time the trench is pumped dry. Whenever trench water becomes evident, adequate measures shall be taken to prevent pipe flotation. Contract shall bear all costs associated with keeping trench free of liquids.

If, in the opinion of the Engineer, the Contractor is incapable of keeping the pipe free of foreign matter during installation, the Engineer shall require the Contractor to cover the pipe ends with close woven bags until the start of the jointing operation.

2.00 MATERIALS

This item covers the types of materials that will be allowed for the construction and installation of sewer lines. All materials used shall be new, of the best quality available and conform to applicable standards as indicated herein.

2.01 Ductile Iron Pipe and Fittings. Not permitted.

2.02 Polyvinyl Chloride (PVC) Pipe and Fittings (Gravity Main).

A. PVC Pipe, through 15" diameter.

1. Material Reference Standard - ASTM 01784
2. Pipe Reference Standard - ASTM 03034
3. Class - SOR35
4. Markings - Manufacturer's name, nominal size, PVC classification, Type PSM, SOR-35, PVC gravity sewer pipe, ASTM 03034 and code number, green coloring dyed into PVC.

B. PVC Pipe, 18" to 27" diameter.

1. Material Reference Standard - ASTM 01784
2. Pipe Reference Standard - ASTM F679
3. Markings - Manufacturer's name, nominal size, PVC cell classification, PS 46 PVC Sewer Pipe and ASTM F679. Green coloring dyed into PVC.
4. Variance - PVC piping meeting the stiffness requirement of ASTM F679 but not meeting wall thickness requirement will be allowed under this specification. Manufacturers will be required to provide a list of at least five (5) similar projects with references in which pipe has been successfully used and laboratory testing data showing the pipe meets the structural requirements of ASTM F679.

C. Fittings

1. Type - PVC push-joint
2. Materials - ASTM 01784
3. Reference Standard - ASTM 03034 or ASTM F679

D. Joints

1. Type - push-on rubber gasket
2. Gasket reference standard - ASTM F477

E. Restraint-type Glands.

2.03 Force Main.

A. PVC Pipe.

1. Materials - ASTM 0 1784, Type 1, Grade 1, PVC 1120, 2000 psi design stress.
2. Reference Standard - AWWA C-900.
3. Class - 150 (OR-18).
4. Markings - Manufacturer's name, nominal size, class pressure rating,

PVC 1120, NSF logo, identification code.

5. Specialties - Electrical tracing wire, 14 gauge solid copper insulated wire.
6. Size - Shall conform to outside diameter of DIP.

B. Fittings.

1. Type - All fittings shall be restrained mechanical joint except where specifically shown or detailed otherwise.
2. Reference Standard - AWWA/ANSI C153/A21.53
3. Pressure Rating - 250 psi
4. Gasket Reference Standard - AWWA C-111

C. Testing

Force main to follow waterline leakage testing procedures.

2.04 Concrete for Thrust Blocks and Encasing of Pipe. Concrete for thrust blocks and for encasing the sewer pipeline shall have 28-day compressive strength of not less than 3000 psi.

2.05 Manholes.

A. Concrete Rings/Cones.

1. Type - Precast
2. Reference Standard - ASTM C478
3. Size - Four-foot or five-foot inside diameter

B. Manhole Bases.

1. Shall be precast or cast-in-place, depending upon local jurisdiction standards, with integrally cast-in water stops. Tee tops of base shall be at least 12 inches above top of pipe.
2. Reference Concrete Standard - ASTM C150 Type II modified or Type V.

C. Manhole Steps.

1. Material – Aluminum, ASTM C478
2. Size/Type – ½” round stock x 10” wide aluminum with slip-proof tread.
3. Mounting – Grouted in place on concrete ring with ASTM C150 Type II modified Portland Cement mortar and sand grout for watertight joint.

D. Joints.

1. Type – Rub'r Nek reformed gasket as manufactured by K.T. Snyder Co., Inc. , Houston, Texas or equal.
2. Cement Mortar Material Reference Standard – One part Portland Cement, Type II, modified with three parts of sand. Cement mortar to be used with concrete grade rings only.

E. Grade Adjustment Rings.

1. Type – Precast ASTM C150 Type II modified concrete.
2. Size – Not less than 6" wide x heights to allow for one-inch adjustments.

2.06 Sewer Service Line Materials.

A. Wyes – Required for all new sewer line construction.

1. Material – ASTM D3034 PVC
2. Strength – for use with SDR-35
3. Joint – Slip-on rubber gasket

B. Saddles (Required for tapping existing mains).

1. Material – ASTM D3034 PVC
2. Joint – Rubber seal to main with stainless steel compression bands. Slip-on service joint with rubber gasket.

3.00 METHODS AND PROCEDURES

3.01 Cleaning and Inspection. Clean all pipe, fittings and related materials thoroughly of all foreign material and inspect for cracks, flaws or other defects prior to installation. Mark all defective, damaged or unsound materials with bright marking crayon or paint and remove from job site.

The Contractor shall take all necessary precautions to prevent any construction debris from entering the sewer lines during construction. If this debris should enter the pipeline system, the Contractor shall furnish all labor and materials necessary to clean the system. Under no circumstances will the Contractor flush the debris into an existing sanitary sewer system.

3.02 Placement of Pipe.

Laser Beam. All sanitary sewer pipe must be installed with a laser. If bending of the beam due to air temperature variations becomes apparent with "in pipe" units, a fan shall be provided to circulate air in the pipe. Air velocity shall not be so excessive as to cause pulsating or vibrating of the beam. If, in the opinion of the Engineer, the beam cannot be accurately controlled, this method of setting line and grade shall be abandoned.

3.03 Pipe Embedment.

- A. Placing embedment material - Refer to Section 02221 for placement methods.
- B. Embedment Classes - Refer to Section 02221 and Construction Drawings for embedment materials for each class listed below:

Pipe shall be embedded according to applicable details on the Construction Drawings.

3.04 Pipe Installation.

- A. Installation of Ductile Iron Pipe Lines. Not allowed.
- B. Installation of Polyvinyl Chloride (PVC) Pipe.
 - 1. Pipe Handling. Pipe should be carefully lowered into the trench to avoid pipe falling into trench.
 - 2. Pipe Laying. Pipe shall be laid true to line and grade, in an uphill direction, with bell ends facing in the direction of laying. When pipe laying is not in progress, the open end of the pipe shall be closed by a watertight plug.
 - 3. Joining the Pipe. The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.
 - 4. Pipe Cutting. The cutting of pipe for manholes or for fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe. Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.
- C. Installation of Slipline Pipe. Not applicable.

3.05 Sewer Manhole Installation.

- A. General. Manholes shall be furnished and installed to depths and dimensions shown on the Construction Drawings and/or staked in the field. Manholes shall be constructed of precast concrete rings in accordance with details shown on the Construction Drawings.
- B. Connections to Manholes. Connection of manhole with pipe shall be made with flexible connector detail. See details on Construction Drawings. In addition, extra care shall be taken by grouting or other means of sealing to assure positive watertight manholes around the inlet or outlet pipes.
- C. Manhole Floor and Inverts. Manhole bases shall be constructed to conform to the details shown on the Drawings. The invert channels shall be smooth and semi-circular in shape, conforming to the inside of the incoming and outgoing sewer

pipelines. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. Where large differences in invert elevations exist, sloped flow channels shall be formed so the wastewater does not undergo a vertical drop. The invert channels may be formed directly in the concrete of the manhole base. The floor of the manhole outside the channel shall be smooth and shall slope toward the channels.

- D. Finish Grade and Adjustment. To bring the manhole cover to the correct elevation, the top section of each manhole shall be constructed of pre-cast concrete grade adjustment rings. These rings shall be not less than six inches (6") wide and furnished in heights to allow for two-inch (2") adjustments. Grade adjustment with rings shall be eight inches (8") maximum and two inches (2") minimum. All rings shall be grouted in place.

Finish Grade and Adjustment HDPE Alternate. High-density polyethylene grade rings may also be used to bring manhole cover to correct elevation. Grade rings shall be molded from HDPE as defined in ASTM Specification D1248-84. Available thicknesses are 1.25", 1.50", 2.00" 4.00" and a sloped thickness .75" x 1.50". When this alternate is used, pavement slope should be matched using one or more sloped rings. Manufacturer's reference - Ludtech, Inc.

- E. Manhole Stubs. All pipe stubs required from manholes are shown on the Drawings. Stubs shall extend approximately 24" from the outside face of the manhole and shall be capped or plugged with manufactured fittings to form a watertight installation.

3.06 Connection to Existing Sewer Facilities. Connections to existing sewer facilities where live flows exist shall be made only after prior consultation with and receipt of written permission from the Engineer. No bypass of sewage to the surface will be allowed in the completion of this connection. Connections shall be made as shown on the Drawings. All connections between pipes of different materials shall be made with approved manufactured connectors. All taps must be watertight and root tight.

3.07 Protection of Water Supplies. Sewer lines shall be located a minimum of ten feet (10') horizontally from existing or proposed water mains. Where the sewer line crosses above the waterline, or is less than eighteen inches (18") vertically below the invert of the water line, or is less than 10 feet (10') horizontally from the water main, the sewer line shall be made impervious by either of the methods listed below:

- A. The sewer pipe shall be reinforced with a concrete encasement. The encasement shall be at least six inches (6") thick on all sides of the sewer pipe and extend ten feet (10') on either side of the water main. Use three No. 4 rebar the length of the encasement.
- B. Install one piece of C-900 PVC pipe centered over the waterline.
- C. Install a grout collar over the two sewer joints on either side of the water crossing. The grout collar shall be around the entire perimeter of the joint.

If clearance is less than twelve (12) inches vertically, the space between the water and sewer mains shall be filled by 3000 psi concrete.

In all cases, bedding material shall be used to prevent any settling of the higher pipe.

3.08 Service Connections. Customer service connections shall be installed in accordance with the details set forth on the construction Drawings. After the service connection is installed, the end shall be plugged watertight with a manufactured plug and marked with a stake except as shown otherwise on the Drawings.

4.00 FIELDQUALITYCONTROL

4.01 Alignment and Grade. Sewer pipelines will be checked by the Engineer to determine whether any displacement of the pipe has occurred after the trench has been backfilled. The test will be as follows:

A light will be flashed between manholes, or if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, earth or other debris in the pipe, or any other kind of defect, the defects determined by the Engineer shall be remedied by the Contractor at his own expense. Test will be repeated after completion of backfilling and any poor alignment, displaced pipe, or other defects determined by the Engineer, shall be corrected.

4.02 Leakage Test. Sewer lines shall be tested using a low-pressure air test only; water tests will not be allowed. Only after the sanitary sewers, including appurtenances and sanitary laterals have been installed, backfilled and cleaned, shall the Contractor proceed with an air test on the installed facilities.

Low Pressure Air Test Procedure. The section of sewer line to be tested should be flushed and cleaned prior to conducting the low-pressure air test. This serves to clean out any debris, wet the pipe, and produce more consistent results. Isolate the section of sewerline to be tested by means of inflatable stoppers or other suitable test plugs. One of the plugs should have an inlet tap, or other provision for connecting a hose to a portable air control source.

If the test section is below the groundwater level, determine the height of the ground water above the spring line of the pipe at each end of the test section and compute the average. For every foot of groundwater above the pipe spring line, increase the gauge test pressure by 0.43 pounds per square inch. Connect the air hose to the inlet tap and a portable air control source. The air equipment should consist of necessary valves and pressure gates to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. Also, the testing apparatus should be equipped with a pressure relief device to avoid the possibility of loading the test section with the full capacity of the compressor.

Add air slowly to the test section until the pressure inside the pipe is raised to 5.0 psig greater than the average backpressure of any groundwater that may be over the pipe. After a pressure of 5.0 psig is obtained, regulate the air supply so that the pressure is maintained between 4.5 and 5.0 psig (above the average ground water back pressure) for a period of two minutes. This allows the air temperature to stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until temperature equilibrium is obtained.

Determine the rate of air loss by the time/pressure drop method. After the two- minute air stabilization period, the air supply is disconnected and the test pressure allowed to decrease to 4.5 psig. The time required for the test pressure to drop from 4.5 psig to 4.0

psig is determined by means of a stopwatch and this time interval is then compared to the required time in the attached table to determine if the rate of air loss is within the allowable time limit. If the time is equal to or greater than the times indicated in the tables, the pipeline shall be deemed acceptable.

MINIMUM DURATION FOR AIR TEST PRESSURE DROP

Pipe Size		Time
<u>Inches.</u>	mm.	Minutes
4	100	2.5
6	150	4
8	200	5
10	225	6.5
12	305	7.5
15	380	9.5

Upon completion of the test, open the bleeder valve to allow air to escape. Plugs should not be removed until all air pressure in the test section has been released. During this time, no one should be allowed in the trench or manhole while the pipe is being decompressed. Air test shall also include service lines and appurtenances.

4.03 Manhole Inspection. During the construction of the manholes, the Contractor shall, in accordance with good practice, ensure that no earth, sand, rocks or other foreign material exists on the joint surfaces during assembly of the section. The Engineer shall check each manhole to determine whether the manhole fulfills the requirements of the Drawings and Specifications.

A. Visual Examination. The Engineer shall visually check each manhole, both exterior and interior, for flaws, cracks, holes, or other inadequacies, which might affect the operation or watertight integrity of the manhole. Should any inadequacies be found, the Contractor, at his own expense, shall make any repairs deemed necessary by the Engineer.

B. Leakage Test. All manholes shall be tested for leakage and all tests shall be witnessed by the Engineer. The leakage test shall be conducted prior to backfilling around the manhole and shall be carried out in the following manner:

1. Stub-outs, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn.
2. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications for which performance information has been provided by the manufacturer and approved by the Engineer.
3. A measured vacuum of 10" of mercury shall be established in the manhole. The time for the vacuum to drop to 9" of mercury shall be recorded.
4. Acceptance standards for leakage shall be established from the elapsed

time for a negative pressure change from 10" to 9" of mercury. The maximum allowable leakage rate for a 4' diameter manhole shall be in accordance with the following:

MANHOLE DEPTH	MINIMUM ELAPSED TIME FOR A PRESSURE CHANGE OF 1 INCH Hg
10 ft. or less	60 seconds
> 10 ft. but < 15 ft.	75 seconds
> 15 ft. but < 25 ft.	90 seconds

For manholes 5' in diameter, add an additional 15 seconds and for manholes 6' in diameter, add an additional 30 seconds to the time requirements for 4-foot diameter manholes.

5. If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly.
6. If a manhole joint mastic is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

4.04 Deflection Test for Non-Rigid Pipe. The maximum allowable pipe deflection for a completely backfilled, non-rigid sewer pipe shall not exceed five percent (5%) of the nominal internal pipe diameter. Deflections in non-rigid pipe shall be checked by measurement or by pulling a mandrel with the minimum allowable diameter through the pipe. The minimum allowable diameter shall be equal to the minimum interior diameter of the pipe, as specified in the applicable portions of the ASTM Standard Specifications or the pipe manufacturer's recommendations, minus five percent of the minimal interior diameter of the pipe. Those sections of non-rigid pipe with deflections greater than the maximum allowable five percent shall not be acceptable and the Contractor will remove and replace these sections at his own expense.

Deflection tests will be run if in the opinion of the Engineer testing is warranted. The program for testing shall be mutually determined by the Engineer and the Contractor. The Contractor shall furnish all labor, tools and equipment necessary to make the tests and to perform any work incidental thereto.

4.05 Pressure Testing of Force Main. Make pressure and leakage tests on all newly laid pipe. Furnish all necessary equipment and material, make all taps in the pipe as required, and conduct the tests. The tests shall be conducted between valved sections of the pipeline, or as approved by the Engineer. The Engineer will monitor the tests.

Furnish the following equipment and material for the tests:

Amount	Description
2	Approved graduated containers
2	Pressure gauges
1	Hydraulic force pump approved by the Engineer
1	Additional 1/2-inch pressure tap for Engineer's test gauge
	Suitable hose and suction pipe as required

Conduct the tests after the trench has been partially backfilled with the joints left exposed for inspection, or when completely backfilled, as permitted by the Engineer. Where any section of pipe is provided with concrete reaction blocking, do not make the pressure test until at least 5 days have elapsed after the concrete thrust blocking is installed. If high-early cement is used for the concrete thrust blocking, the time may be cut to 2 days.

Conduct pressure test in the following manner, unless otherwise approved by the Engineer: after the trench has been backfilled or partially backfilled as herein before specified, fill the pipe with water, expelling all air during the filling. The test pressure shall be 1.5 times normal working pressure at the point of lowest elevation of the test gauge.

A. Duration. The duration of each pressure test shall be 2 hours, unless otherwise directed by the Engineer.

B. Procedure.

1. Slowly fill the pipe with water and allow to stand for 24 hours. Expel all air from the pipe. Allow and maintain the specified test pressure by continuous pumping if necessary for the entire test period. The test pressure shall be calculated for the point of lowest elevation, or as specified by the Engineer. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately.
2. Before the line is pressurized, the Engineer shall verify that all necessary main line valves are open or closed with regard to the section of line being tested. In addition, the Engineer shall verify that all hydrant valves are open.

C. Leakage.

Leakage shall be defined as the quantity of water necessary to hold the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{0.0001 \cdot NDVP \cdot P}{7400}$$

In the above formula:

L= Allowable leakage, in gallons per hour

N= Number of joints in the length of pipe tested

D= Nominal diameter of pipe, in inches

P= Average test pressure during the leakage test, in pounds per square inch gauge.

D. Pressure Testing. The pressure testing of water service lines shall follow the same procedure as outlined in the section. In all cases, however, the corporation stop, service line and curb stop shall be visually inspected under full test pressure and any leaks fixed.

E. Correction of Excessive Leakage.

Should any test of pipe laid disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

4.06 Televising Main. All sewer connection lines eight inches (8") or larger shall be televised. The tape shall have a running footage meter showing the exact footage from the entry manhole. Tapes shall be provided with a log showing the location of all defects and service lines.

5.00 MEASUREMENT OF PAYMENT

See Bid Schedule

End of Section

SECTION 02612

HOT MIX ASPHALT

1.00 GENERAL

1.01 Scope. Work to be performed under this section shall include all labor, equipment, materials and miscellaneous items necessary to furnish and install one or more courses of hot mix asphalts (HMA) constructed on a prepared surface in accordance with the Specifications or as shown on the Drawings. The finished product shall be in close conformity with the lines, grades, thickness, and typical cross sections shown on the Drawings or as established in the field.

1.02 Related Work Specified Elsewhere.

Section 02222 - Embedment and Base Course Aggregate

1.03 Reference Standards. All work is to be performed in accordance with the "Colorado Department of Transportation - Standard Specifications for Road and Bridge Construction", latest edition. The reference Specifications are not reproduced in their entirety.

1.04 Submittals.

A. Mix Design. Provide complete mix design by independent testing laboratory, including certifications of all material compliance. The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of asphalt material to be added to the aggregate, and a single temperature for the mixture at the discharge point of the plant.

a. Submitted mix design shall be sealed by a Professional Engineer in the State of Colorado.

B. Prime Coat. Certification of material.

C. Tack Coat. Certification of material.

1.05 Coordination. It shall be the responsibility of the Contractor under this section to coordinate this work with all other trades involved in the project. No paving work shall be started until the work of others has progressed to a point that a definable area can be paved; patching, blending, butting, etc. of work under this section will not be allowed except as required as part of the normal paving operation.

2.00 MATERIALS

2.01 Composition of Mixture. Reference Section 403.02 (further reference 401.02 through 401.06) Section 702, Section 703, and Section 704, with revisions and additions as follows:

A. Use Grading SX (Ref. Section 703.04); aggregate gradation per Table 703-4.

B. Superpave performance graded binder shall be PG 58-28.

- C. The Contractor shall prepare a quality control plan outlining the steps to be taken to minimize segregation of HMA. This plan shall be submitted to the Engineer prior to beginning the paving operations. When the Engineer determines that segregation is unacceptable, the paving shall stop and the cause of segregation corrected before paving operations will be allowed to resume.
- D. The Hot Mix Asphalt shall not contain reclaimed material.
- E. Contractor to provide to the Engineer a job mix composition meeting this section. Submittal shall include testing results sufficient to show compliance. Testing shall be under the certification of an independent testing laboratory acceptable to the Engineer. The mix design shall have been completed within the preceding 12 months.
- D. Contractor may use an anti-stripping additive from the current CDOT approved list of additives.

2.02 Prime Coat. Reference Section 702.02.

Prime coat shall be MC-70 (ASTM 02026)

2.03 Tack Coat. Reference Section 702.03.

Tack Coat to be SS-1h (ASTM D977) or CSS-1h (AASHTO M208).

2.04 Pavement Marking. Reference Section 708.05

- A. No glass beads required on Town right-of-way.
- B. Glass bead required in CDOT right-of-way.

3.00 METHODS AND PROCEDURES

3.01 General Requirements.

- A. Reference Section 403.03 (further reference 401.07 through 401.20) and Section 407.04 through 407.08.
- A. Maximum compacted pavement depth per pass to be 3-inch.
- B. Prime not required unless indicated on Drawings. Prepared base course or subgrade surfaces receiving pavement courses shall be primed at Contractor's expense if the surface has deteriorated, due to traffic, weather or time lapse between surface preparation and placement of bituminous materials, such that in the opinion of the Engineer, use of prime coat is required.
- C. Tack coat required between lifts, on all abutting old pavement surfaces and for overlays on existing pavements unless waived by Engineer. Application rate shall be 0.05 to 0.10 gallons per square yard diluted.
 - a. Dilution shall be one part tack emulsion to one part water.

- b. All cut asphalt surfaces that are to butt new pavement sections shall be tacked with a liberal application of tack coat prior to paving.

3.02 Compaction.

- A. The plant mix bituminous pavement shall be compacted by rolling. The number, weight and type of rollers furnished shall be that which is sufficient to obtain the required density while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continuous until the required density is obtained. When the mixture surface temperature falls below 185 degrees F, no further compaction effort will be permitted unless approved.
- B. All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted during surface course final rolling and will not be permitted on any rolling on bridge decks covered with waterproofing membrane.
- C. Pavement shall be compacted to a density of 92 percent to 96 percent of the maximum theoretical density, determined according to AASHTO T209. Field density determinations will be made in accordance with Colorado Procedure 44 or 81.
- D. Along forms, curbs, headers, walls and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers.
- E. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with fresh hot mixture, and compacted to conform with the surrounding area.

3.03 Surface Tolerances.

- A. Section 401.20. The variations between any two contacts with the surface shall not exceed 3/16-inch in 10 feet. Irregularities exceeding the specified tolerance shall be corrected at the Contractor's expense. No skin patching will be allowed.
- B. Pavements abutting concrete structures (i.e. curbs, cross pans, pavement, crosswalks, driveways, etc.) shall be installed at a final compacted paved grade 1/4-inch to 1/2-inch above the adjacent concrete surface.
- C. All manholes, valve boxes, vaults, etc., shall be 1/4-inch to 1/2-inch below the final compacted paved grade. The finish grade of pavement shall be 1/4-inch above the rim elevation with a 2-foot transition provided.

- 3.04 Thickness Tolerance. The total compacted thickness of all layers shall be within 1/4-inch of the required compacted thickness specified on the Drawings. In no case shall the minimum thickness be less than 4-inches in a Town right-of-way or as required by CDOT in a CDOT right-of-way.

3.05 Pavement Marking. Reference Section 627.06. Centerline marking shall be double yellow line, 4-inch wide each stripe. Parking stall marking shall be single white line, 4-inch wide stripe. Crosswalk marking shall be white panels, 12-inch wide by 8-feet long with 12-inch clear spacing the width of the roadway. Cross-hatching to be white, 8-inch wide, spaced at maximum 4-foot intervals. Symbols, letters and arrows to conform to *Standard Alphabets for Highway Signs and Pavement Marking*, adopted by the Federal Highway Administration.

4.00 FIELDQUALITYCONTROL

4.01 Inspection and Testing.

- A. Contractor is solely responsible for Quality Control. They must take whatever means they deem necessary to assure the quality of the product.
- B. All testing reports shall be submitted to the Engineer.
- C. Owner may provide additional Quality Assurance testing. Contractor to cooperate fully with all persons engaged in testing.

4.02 Density Testing and Control.

- A. See Section 3.01, Compaction, above.
- B. Field Testing. Testing for density during compaction operations to be done using nuclear density methods.
- C. Frequency of Testing. Minimum of one (1) test every 10,000 square-feet or as directed by Engineer. Testing to be paid for by Contractor.
- D. Retesting. In the event of failure to meet compaction criteria, Contractor shall re-compact and/or replace defective work at direction of Engineer. All retesting is to be performed by testing firm approved by the Engineer and paid by the Contractor.

5.00 MEASUREMENT AND BASIS OF PAYMENT

Where items are specifically included on the bid schedule, they will be paid for by the unit given. All other items in this section that are essential to the project but for which there are no specific pay items, will not be measured and paid for separately but shall be included in the project.

End of Section

SECTION 02626

CONCRETE CURB AND GUTTER, SIDEWALK, CURBWALK AND DRIVEWAY

1.00 GENERAL

1.01 Scope. This Work shall include furnishing all materials, labor, equipment and miscellaneous items necessary for the construction of concrete curb, gutter, sidewalk, sidewalk ramps, driveway or any combination thereof, all in accordance with these Specifications and in close conformity with the lines, grades, and typical sections as shown on the Construction Drawings or established in the field. Sidewalks and sidewalk ramps shall meet Federal ADA Accessibility Guidelines.

1.02 Related Work Specified Elsewhere.

Section 02222 - Embedment and Base Course Aggregate

1.03 Reference Standards.

Federal Standards for Accessible Design - Rules and Regulations
Americans with Disabilities Act - Accessibility Guidelines

2.00 MATERIALS

The materials shall conform to the requirements specified in the following:

Section 02222 - Embedment and Base Course Aggregate

2.01 Joint Filler. Pre-molded, preformed conforming to AASHTO M213 to the full depth of the section.

2.02 Structural Concrete. 28-day compressive strength of 4,000 psi. See Section 03300 for complete Specification.

2.03 Fibermesh. Fibermesh additive at the rate of 1.5 pounds/cubic yard shall be used with all concrete. Use shall be in accordance with manufacturer's recommendations.

3.00 METHODS AND PROCEDURES

3.01 Excavation. Excavation shall be made to the required depth and width to permit the installation and bracing of the forms. The foundations shall be shaped and compacted to a firm even surface conforming to the section shown on the Construction Drawings. Material determined to be unsuitable or non-compact by the Engineer will be removed and replaced.

3.02 Forms. Forms shall be wood or metal and shall extend for the full depth of the concrete. All forms shall be straight, free from warp and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in alignment both horizontally and vertically until removal. Satisfactory slip forms may be used when approved.

Use of curbing machine will be permitted providing line and grade tolerances can be met.

Steel plates that can be shaped to the desired radius shall be used on all short radii. Open joints shall be formed with a steel separator plate conforming to the section being installed.

Oil and clean all forms prior to placement of concrete.

3.03 Mixing and Placing. The foundations shall be thoroughly moistened immediately prior to the placing of the concrete. Compaction of the concrete shall have thorough consolidation achieved by tamping, spading, vibrating or other acceptable methods. Forms shall be left in place until the concrete has set sufficiently to prevent deformation due to removal. Upon removal of the forms, the curb face shall be immediately finished to a uniform surface. In the case of matching existing concrete finishes, an approved method shall be used.

3.04 Finishing. The surface shall be floated with a wood or magnesium float and given a broom finish. No plastering of the surface will be permitted. All outside edges of slabs and joints shall be rounded to a .5 inch radius. Broom marks to be perpendicular to traffic or pedestrian flow for installation of sidewalk or concrete flatwork. Broom marks to be parallel to traffic flow for installation of curb and gutter.

3.05 Joints. Expansion joints shall be made using .5" pre-molded expansion joint. Construction joints, using .5" pre-molded joint filler, shall be placed at the end of a day's run or during a day's work if there is more than a 30 minute delay in concrete delivery.

Construction joints shall be formed around all appurtenances such as manholes, utility poles, adjacent structures, etc., extending into or abutting the Work. Pre-molded expansion joint filler .25" thick shall be installed in these joints. Expansion joint filler shall be installed between concrete sidewalks and any fixed structure.

Dummy joints (contraction joints) shall be made by a forming tool to a depth of ¼ of the section with a width of 1/8" to 1/4". Open joints shall be made with a separator plate, 1/8" to 1/4" in width. Dummy joints in lieu of open joints will be permitted with use of curbing machine.

Joint spacing shall be located as follows:

- A. Expansion joints: Every 90' on center; at end of corner radius; at driveway sections; as shown on Construction Drawings.
- B. Construction joints: As required during construction; at appurtenances and structures through or abutting Work.
- C. Dummy or open joints: Every 10' on center for curb and gutter and curbside; equal to width of sidewalk for sidewalk; as shown on Construction Drawings.

3.06 Curing. Immediately upon completion of the finishing, concrete shall be moistened and kept moist for a minimum of 72 hours. In lieu of wetting, use of a membrane curing compound, at the direction of the Engineer, will be permitted.

3.07 Backfilling. After the concrete has set sufficiently, the areas behind the curb shall be backfilled to the required elevations and shall be thoroughly compacted in accordance with Section 02200 - Earthwork.

4.00 FIELDQUALITY CONTROL

- 4.01 Tolerances. All vertical surfaces shall not vary more than $\frac{1}{4}$ " in 10' in the horizontal direction. Surface deviation shall not exceed $\frac{1}{4}$ " when measured with a 16' straight edge.
- 4.02 Concrete Strength. The Geo-technical Engineer may take field samples for purposes of testing concrete strength. All substandard strength concrete shall be removed and replaced at Contractor's expense.

5.00 MEASUREMENT AND PAYMENT

- A. Handicap ramps, curb cuts and chase drains will be paid for by the unit given. Aggregate Base Course and geotextile fabric used under walks and driveway ramps will be included in the unit price bid for each item.
- B. Concrete Curb and Gutter, with or without attached walks, will be measured by the linear foot along the gutter flowline at the finished grade elevation. Aggregate Base Course and geotextile fabric under curb and gutter will be included in the unit price for concrete curb and gutter. No additional payment will be made for curb cuts required at driveways.
- C. Detached Concrete Sidewalks will be measured by the square yard of finish surface. Aggregate Base Course and geotextile fabric under curb and gutter will be included in the unit price for concrete curb and gutter. No additional payment will be made for curb cuts required at driveways.
- D. Curb Return Aprons and Concrete Cross Pans will be measured by the square yard of finished surface. Aggregate Base Course and geotextile fabric used under aprons and concrete cross pans will be included in the unit price bid for curb return aprons and concrete cross pans.
- E. Payment. The accepted quantities will be paid for at the contract unit price for each of the pay items listed above that appear on the Bid Schedule. No other payment will be made for incidental items necessary for a complete installation.
- F. Where items are specifically included on the bid schedule, they will be paid for by the unit given. All other items in this section that are essential to the project but for which there are no specific pay items, will not be measured and paid for separately but shall be included in the project.

End of Section

SECTION 02700

FINISHED GRADING AND RESTORATION

1.00 GENERAL

- 1.01 Scope. This Work shall consist of finish grading, restoration of grounds and clean-up. This shall be a continuous process from project start-up to final acceptance of the Work.
- 1.02 Related Work Specified Elsewhere. This section pertains to all other sections of these Specifications.

2.00 MATERIALS AND METHODS

- 2.01 General Clean-Up. Clean-up shall include the regrading, resurfacing, rebuilding and replacing of all surfaces on which construction took place, and rebuilding or replacing any areas disturbed by the construction. The streets or roads where disturbed shall be resurfaced by the Contractor, including both gravel and oil roads, and shall be replaced in as good or better condition than that at the start of construction. The Engineer shall be the sole judge as to whether streets, roads or property have been restored to a condition as good or better than at the start of construction.

The Contractor shall, at all times, keep property on which Work is in progress free from accumulation of waste material or rubbish caused by employees or caused by the Work, and he shall carry on a constant program to maintain Work area, structure sites, right-of-ways and the surface of streets and roads in a condition satisfactory to the appropriate authority, grantor of the right-of-way, and the Engineer.

Preliminary clean-up shall commence as soon as the construction site is occupied by the Contractor (including his employees, supplies, materials or equipment) and shall be a continuous process, if necessary, in order that the site of the Work shall have an appearance and/or utility equal to or better than the start of the Work.

Upon completion of the Work, the Contractor shall remove all remaining rubbish, tools, equipment, scaffolds and surplus materials from the job and leave the Work area clean and free of debris.

3.00 RESTORATION

- 3.01 General. All driveways, retaining walls, concrete flatwork, drainage ditches, trees, shrubs, and other miscellaneous items shall be returned to as good or better than pre-construction conditions if they are impacted by Work.
- 3.02 Landscaping. Not applicable.
- 3.03 Irrigation Ditches. Because of the large amount of lateral irrigation ditches, special care shall be taken to ensure the ditches are restored to pre-construction conditions.

4.00 MEASUREMENT AND BASIS FOR PAYMENT

Clean-up and restoration shall not be measured and paid for as a separate bid item but shall be considered a part of the project.

End Section

SECTION 02720
METAL GUARDRAIL

1.00 GENERAL

- 1.01 Scope. Work under this section shall consist of furnishing all materials, labor, equipment and miscellaneous items necessary to furnish and install metal guardrail as shown on the Drawings.
- 1.02 Reference Standards. All Work and materials shall be in compliance with applicable standards of the Colorado Department of Transportation.

2.00 MATERIALS

- 2.01 General. All materials shall conform to M-606-2, Guardrail for Local Roads and Type 3 Bridge Rail, Department of Transportation Bridge Standards.
- 2.02 "W" Beam Rail. The types of guardrail are designated as follows:

Type 3 Guardrail "W" Beam

The rail elements shall be corrugated sheet steel beams conforming to the requirements of AASHTO M 180 of the designated class and type. The beams and metal offset devices shall be galvanized.

- 2.03 Guardrail Posts. Railing posts shall be of wood.

Wood posts shall be fabricated from an approved or specified timber species and shall be of the quality, diameter or section, and length as specified or as shown on the Drawings. When treated posts are specified, they shall be fabricated or framed before treatment. Timber preservatives shall conform to the requirements of AASHTO M 133. Preservative treatment shall conform to the requirements for "Preservative Treatments for Timber" of the AASHTO Standard Specifications for Highway Bridges.

- 2.04 Guardrail Hardware. Splices and end connections shall be of the type and design specified or shown on the Drawings, and shall be of such strength as to develop the full design strength of the rail elements.

End anchor rods and accessories shall be as specified or as shown on the Drawings and shall be of such size and strength as to develop the full design strength of the rail elements.

Bolts, nuts and washers shall be galvanized in accordance with AASHTO M 232, Class 6, or AASHTO M 298, Class 50, Type 1. All other fittings shall be galvanized in accordance with AASHTO M 111. Bolts, Nuts and washers for corrosion resistant guardrail shall be of corrosion resistant material and conform to or exceed the requirements of ASTM A 307.

- 2.05 Structural Steel. Steel shall be of the self-rusting type or "Corten".

- 2.06 Painting System. Not Applicable.

3.00 METHODS AND PROCEDURES

3.01 Post and Rail Elements.

- A. Posts shall be set firm and aligned with a tolerance of $\pm 1/4$ " from plumb, grades and lines as staked. All fittings and metal plates shall be placed securely in position to conform to designated dimensions and requirements.

Posts shall be set as required in Drawings by one of the following methods:

1. Driven in place.
2. Set in dug holes.
3. Set in concrete base.
4. Posts on bridges shall be as shown on Drawings.

Driving of posts shall be accomplished with approved methods and equipment that will leave the posts in their final position free from any distortion, burring or any other damage.

Excavated post holes shall have a firm bottom and be backfilled with acceptable material placed in layers and thoroughly compacted.

When required, posts shall be spliced with breakaway plates as shown on the Drawings.

Dissimilar metal-to-metal or aluminum-to-concrete posts or rail installations shall have contact surfaces separated by an approved protective coating.

Wood posts cut in the field shall have the cut surfaces protected with two coats of hot creosote or a 5% pentachlorophenol-in-oil solution. When the cut surface is above ground, the treating solution to be used shall be the same type as was used in the original treatment.

- B. Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts in the finished rail shall be drawn tight. Bolts shall be of sufficient length to extend beyond the nuts. Rail shall be shop bent for installations on horizontal curves having a radius of 150 feet or less.

3.02 Painting. Not applicable.

4.00 FIELD QUALITY CONTROL

- 4.01 Inspection and Testing. Inspection and testing to be performed at the direction of the Engineer. Contractor to cooperate fully with all persons engaged in testing.

5.00 MEASUREMENTS AND BASIS OF PAYMENT

See Bid Schedule

End of Section

SECTION 02751

RAW WATER IRRIGATION DISTRIBUTION AND UNDERGROUND SPRINKLER SYSTEM

1.00 GENERAL

1.01 Definitions. For purposes of this specification, all references to "Town" shall mean the Town of Silt or authorized representative.

1.02 Scope. Work in this section generally includes provisions for the installation of an underground sprinkler system, including the following:

- A. Trenching, stockpiling excavation materials, refilling and compacting trenches.
- B. Complete irrigation system including, but not limited to: piping, valves, fittings, heads, controllers and wiring, and final adjustments to insure complete coverage.
- C. Water connections.
- D. Replacement of unsatisfactory materials.
- E. Clean-up, inspections, and approval.
- F. Tests.

1.03 Related Sections.

Examine all sections related to project work.

1.04 References.

- A. Perform work in accordance with requirements of conditions of the contract as well as provisions of all applicable laws, codes, ordinances, rules, and regulations.
- B. Conform to requirements of reference information listed below, except where more stringent requirements are shown or specified in Contract Documents or as required by the Town:
 - 1. Town of Silt Public Works Manual, latest version
 - 2. American Society for Testing and Materials (ASTM) – Specifications and Test Methods specifically referenced in this section.
 - 3. Underwriters Laboratories (UL) – UL Wire and Cables: National Electric Code.
 - 4. International Plumbing Code (published by the International Code Council).

1.05 Quality Assurance.

- A. Installer Qualifications. Installer shall have had considerable experience and demonstrate ability in the installation of irrigation system(s) of specific type(s) in a neat, orderly, and responsible manner in accordance with recognized standards and workmanship.

B. Special Requirements:

1. Tolerances. Specified depths of mains and laterals and pitch of pipes are minimums. Settlement of trenches is cause for removal of finish grade treatment, refilling, compaction, and repair of finish grade treatment.
2. Coordination with other Contractors. Protect, maintain, and coordinate work with other trades working in same areas.
3. Damage to other Improvements. Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, or planting completed under other sections during work associated with installation of irrigation system. The contractor shall be responsible for damage caused by leaks in the piping systems being installed or having been installed, during warranty/guaranty period, by him/her. He/she shall repair at his/her own expense all damage so caused in a manner satisfactory to the Project Engineer and the Town. Any repair/replacement work under this section shall be completed at no additional cost to the Town.

1.06 Submittals. Prepare and make submittals in accordance with conditions of the contract or as stated herein.

A. Record Drawings (As-Builts):

1. At onset of irrigation installation secure, at a minimum, one set of drawings of the approved design from Engineer solely for the purpose of tracking as-built installation of the irrigation system. Any working drawings needed shall be secured in addition. At the end of every day, revise prints for work accomplished that day in red ink. As-built sepias shall be brought up-to-date at the close of the working day every Friday by a qualified draftsman. A print of the record plan(s) shall be available at the project site. Indicate zoning changes on weekly as-built drawings. Indicate non-pressure piping changes on as-builts. Upon completion of project, submit for review, prior to final acceptance, final set of as-built mylar sepias. Dimensions, from two permanent points of reference (building corners, sidewalk, road intersections or permanent structures), shall be included for the location of following items:
 - a. Connections to water source;
 - b. Routing of sprinkler pressure lines (dimension maximum 100-feet along routing);
 - c. Sprinkler control valves;
 - d. Quick coupling valves;
 - e. Drain valves;
 - f. Drip line blow-out stubs;
 - g. Control wire routing if not with pressure mainline;
 - h. Gate valves;

- i. Other related equipment as directed.
 - 2. Engineer will not certify any pay request submitted by the Contractor if the as-built drawings are not current.
 - B. Operation instructions. Submit three (3) written operating instructions, including winterization procedures and start-up, with cut sheets of products, and coordinate controller/watering operation instruction with maintenance personnel.
 - 1. Controller charts:
 - a. Do not prepare charts until record (as-built) drawings have been reviewed by Engineer;
 - b. Provide one controller chart for each automatic controller installed;
 - 1) Chart may be reproduction of record drawing, if scale permits fitting of controller door. If photo reduction prints are required, keep reduction to maximum size possible to retain full legibility.
 - 2) Chart shall be blueline print of actual "as-built" system, showing area covered by that controller.
 - c. Identify area of coverage of each remote control valve, using distinctly different pastel color drawing over entire area of coverage.
 - d. Following review of charts by Engineer, they shall be hermetically sealed between two layers of 20 mm thick plastic sheet.
 - e. Charts shall be completed and reviewed prior to final review of irrigation system.
 - C. Certificates of Compliance. Shall be submitted for all materials (pipe, valves, valve boxes, fittings, etc.) used in the construction of the irrigation system. Each certificate shall include project name/location, material description, manufacturer's name, identifying number of material actually delivered, and a statement that the product meets the applicable specifications.
- 1.07 Delivery, Storage, and Handling. Deliver, unload, store, and handle materials, packaging, bundling, products in dry, weatherproof condition in a manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism. Deliver in original, unopened packaging or 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 job site damage.

Handling of PVC Pipe. Exercise care in handling, loading and storing of PVC pipe. 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 if installed, shall be replaced with new piping.

1.08 Job Site Conditions.

- A. Protection of Property. Preserve and protect all trees, plants, monuments, structures, and paved areas from damage due to work of this section. In the event damage does occur, all damage to inanimate items shall be completely repaired and replaced to satisfaction of the Town, and all injury to living plants shall be repaired or plants replaced by Contractor. All costs of such repairs shall be paid by Contractor.
- B. Existing Trees:
 - 1. All trenching or other work under limb spread of any and all evergreens or low branching deciduous material shall be done by hand or by other methods so as to prevent damage to limbs or branches.
 - 2. Where it is necessary to excavate adjacent to existing trees, use all possible care to avoid injury to tree and tree roots. Excavation in areas where 2-inch and larger roots occur shall be done by hand. Roots 2 inches or larger in diameter, except directly in the path of pipe or conduit, shall be tunneled under and shall be heavily wrapped with burlap to prevent scarring or excessive drying. Where a trenching machine is operated close to trees having roots smaller than 2 inches in diameter, wall of trench adjacent to tree shall be hand-trimmed, making clean cuts through roots. Trenches adjacent to trees shall be closed within 24 hours, and when this is not possible, side of trench adjacent to tree shall be kept shaded with moistened burlap or canvas.
- C. Protection and Repair of Underground Lines. Request utility companies to stake location of all underground utilities. Take whatever precautions are necessary to protect underground lines and appurtenances from damage. If damage does occur, all damage shall be repaired by Utility Owner. All costs of such repairs shall be paid by Contractor, unless other arrangements have been made.
- D. Replacement of Paving and Curbs. Where trenches and lines crossing existing roadways, paths, curbing, etc., damage to these shall be kept to a minimum and shall be restored to original or better condition.

1.09 Warranty/Guaranty. Manufacturer shall warrant materials against defects for a period of one year from date of Substantial Completion. Installer(s) shall guaranty workmanship for similar period. The warranty/guaranty shall be for 100% of the installed price.

- A. Settling of backfilled trenches which may occur during guaranty period shall be repaired at no expense to Owner, including complete restoration of damaged property.
- B. Expenses due to vandalism before substantial completion shall be borne by Contractor.

1.10 Maintenance.

- A. Furnish the following maintenance items to Owner prior to final acceptance:
 - 1. Two (2) sets of special tools required for removing, disassembling, and adjusting each type of sprinkler head and valve supplied on this project.

2. Two (2) 6-foot valve keys for operation of gate valves or stop and waste valves (if applicable);
 3. Two (2) keys for each automatic controller.
 4. Four (4) quick coupler keys and two (2) matching hose swivels for each type of quick coupling valve installed;
 5. Two (2) aluminum drain valve keys of sufficient length for operation of drain valves.
 6. Five (5) sprinkler heads of each type used.
- B. Winterization. Contractor shall winterize complete system at conclusion of sprinkling season (in which system received final acceptance and is within warranty period) within 3 days notification by the Engineer. System shall be voided of water using compressed air or similar method reviewed by the Town. Reopen, operate, and adjust system malfunctions accordingly during the spring of following season, within three (3) days notification by Engineer.

1.11 Water Source.

- A. Water Supply and Point of Connection. Water supply shall be extended as shown from water supply lines. Where the system source shall be non-potable water, **NO CROSS-CONNECTION SHALL BE MADE TO EXISTING OR FUTURE TOWN POTABLE WATER SUPPLIES**. Irrigation systems, if approved with source designated as Town's potable water system, shall be metered for quantity consumed.
- B. Systems of Non-Potable Water Sources. All fixtures terminating above ground shall be clearly labeled as "Not For Human Consumption" or similar warning.

2.00 MATERIALS

2.01 General Piping:

- A. Mainline and Lateral Pipe: Class 200 PVC manufactured from virgin polyvinyl chloride (PVC) compound in accordance with ASTM D 1784 and D 2466, cell classification 12454-B, Type 1, Grade 1. Pipe sizes three inches and smaller shall be of the solvent weld type.
- B. Sleeving: Class 200 PVC

2.02 Brass Pipe and Fittings:

- A. Brass pipe. 85% red brass, ANSI Schedule 40 screwed pipe.
- B. Fittings. Medium brass, screwed 125 pound class.

2.03 Plastic Pipe and Fittings:

- A. Fittings shall be standard weight Schedule 40 injection molded PVC conforming to ASTM D 1784 and D 2466, cell classification 12454-B. Threaded nipples shall be Schedule 40 PVC with molded threads conforming to ASTM D 2464. Threaded

fittings shall conform to ASTM D 2564. The pipe shall have an integral bell end.

B. Identification Markings:

Identify all pipe with following indelible markings:

1. Manufacturer's name;
2. Nominal pipe size;
3. Schedule of class;
4. Pressure rating;
5. NSF (National Sanitation Foundation) seal of approval;
6. Date of extrusion.

2.04 Quick Coupling Valves. Brass two-piece body designed for working pressure of 150 PSI; operable with quick coupler. Equip quick coupler with purple thermoplastic, locking rubber cover with molded-in warnings of "DO NOT DRINK" in English and Spanish. The valve shall be opened and closed by a brass key of the same manufacturer.

2.05 Valve Boxes:

- A. Gate Valves, Manual Drains, and Wire Splice Box. Carson Brooks #910-10 box or as approved.
- B. ¾ inch through 2 inch Control Valves. Carson #1419-12 box or as approved.

2.06 Electrical Control Wiring:

A. Low Voltage:

1. Electrical Control Wire. AWG UFUL approved No. 14 direct burial copper wire.
2. Electrical Common Wire. AWG UFUL approved No. 12 direct burial copper wire.
3. Wire Colors.
 - a. Control Wires – Red;
 - b. Common Wires – White;
 - c. All Spare Wires – Blue.

Control wire connections and splices shall be made with 3m DBM direct bury splice Rain Bird pentite connectors, or similar UL listed dry splice method.

- B. High Voltage. Type required by local codes and ordinances, of proper size to accommodate needs of equipment serviced.

- 2.07 Automatic Controller. The enclosure shall be of a vandal- and weather-resistant nature manufactured entirely of 304 grad stainless steel. Size and type as needed to meet the requirements of the system. The enclosure shall have louvers in the upper and lower body to allow for cross-ventilation.
- 2.08 Electric Control Valves. Automatic control valves shall be self-flushing and suitable for pressures ranging from 20 to 200 PSI. Each automatic control valve shall have a PVC ball valve upstream to be used to isolate the valve for maintenance purposes. Size and type shown on drawings having manual flow adjustment and manual bleed nut.
- 2.09 Sprinkler Heads:
- A. Pop-up Spray (PUSp): Fixed pattern with screw-type flow adjustment;
 - B. Flush Surface (FLSrf): Fixed patter with screw-type flow adjustment;
 - C. Shrubbery (Shrub): Fixed pattern with screw-type flow adjustment.
- 2.10 Backflow Preventer. Brass construction anti-syphon device to meet local code.
- 2.11 Manual Drain Valves. Shall be threaded bronze gate valves with resilient-seated gate and non-rising stem. Manual drain valves shall be located at all low points of the mainline whether shown on the drawings or not. A three cubic foot sump filled with washed aggregate shall be provided below the outlet of the manual drain. All drain valve locations shall be staked by the Contractor and approved by the Engineer prior to backfill and final acceptance.

3.00 METHODS AND PROCEDURES

- 3.01 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.
- 3.02 Static Pressure Verification. Contractor shall field verify the static pressure at the project site, prior to commencing work or ordering irrigation materials, and submit findings, in writing, to Consultant. If Contractor fails to verify static water pressure 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, and plant replacement costs.
- 3.03 Inspection. Examine areas and conditions under which work of this section is to be performed. Do not proceed with work until satisfactory conditions have been corrected.

Grading operations, with the exception of final grading, shall be completed and approved by Engineer before staking or installation of any irrigation system begins.

3.04 Preparation.

- A. Install sleeving under asphalt paving and concrete walks, prior to concrete placement and paving operations, to accommodate piping and wiring. Compact

backfill around sleeves to 95% Modified Proctor Density within 2% of optimum moisture content in accordance with STM D 1557. Pipe sleeves shall extend four (4) feet beyond the edge of pavement, curbs, and sidewalks, and shall be marked with stakes located at the ends of the sleeve. The ends of the pipe shall be protected in a manner not to allow intrusion of materials detrimental to intended use.

B. Trenching. Trench excavation shall follow, as much as possible, layout shown on drawing. Dig trenches straight and support pipe continuously on bottom of trench. Trench bottom shall be clean and smooth with all rock and organic debris removed.

1. Clearances:

- a. Piping three (3) inches and larger. Make trenches of sufficient width (fourteen (14) inches minimum) to properly assemble and position pipe in trench. Minimum clearance of piping three (3) inches or larger shall be five (5) inches horizontally on both sides of the trench.
- b. Piping smaller than three (3) inches. Trenches shall have a minimum width of seven (7) inches.
- c. Line clearance. Provide not less than six (6) inches of clearance between each line, and not less than twelve (12) inches of clearance between lines of other trades.

2. Pipe and Wire Depth (Minimums):

- a. Mainline – twenty-four (24) inches;
- b. Lateral lines – eighteen (18) inches;
- c. Pipe under roadways – minimum cover of eighteen (18) inches between the top of the pipe and the bottom of the aggregate base of the pavement.
- d. Drip lines – four (4) inches; twelve (12) inches in turf areas;
- e. PVC Sleeving – To meet requirements of type of piping contained and location placed;
- f. PVC Electrical Conduit – twelve (12) inches from top of pipe;
- g. Non-pressure piping (pop-up) – twelve (12) inches from top of pipe;
- h. Control wiring – side of pressure main.

3. Boring will be permitted only where pipe must pass under obstruction(s) which cannot be removed. In backfilling bore, final density of backfill shall match that of surrounding soil. It is acceptable to use sleeves of suitable diameter installed first by jacking or boring, and pipe laid through sleeves. Observe same precautions as though pipe were installed in open trench.

3.05 Installation. Locate other equipment as near as possible to locations designated. Deviations shall be reviewed by Engineer prior to installation.

A. PVC Piping. Snake pipe in trench as much as possible to allow for expansion and contraction. Do not install pipe when air temperature is below forty (40) degrees Fahrenheit. 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 day, close pipe ends with tight plug or cap. Perform work in accordance with good practices prevailing in piping trades.

B. Solvent Weld PVC Pipe. Lay pipe and make all plastic to plastic joints in accordance with manufacturer's recommendations.

C. Control Wiring.

1. Low Voltage Wiring.

- a. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to main pipe lines with such wires to be consistently located below and to one side of pipe, or in separate trenches;
- b. Bundle all 24-volt wires at ten (10) foot intervals and lay with pressure supply line pipe to one side of the trench.
- c. Provide an expansion loop at every pressure pipe angle fitting, every electric control valve location (in valve box), and every five hundred (500) feet. Form expansion loop by wrapping wire at least eight (8) times around a $\frac{3}{4}$ " pipe and withdrawing pipe;
- d. Make all splices and E.C.V. connections using dry splice connectors;
- e. Install all control wire splices not occurring at control valve in a separate splice valve box;
- f. Install one control wire for each control valve;
- g. Run two spare #14 AWG UFUL control wires and one common wire from controller pedestal to the end of each and every leg of mainline. Label spare wires at controller and wire stub box.

2. High Voltage Wiring for Automatic Controller:

- a. Provide 120-volt power connection to automatic controller;
- b. All electric work shall conform to local codes, ordinances, and authorities having jurisdiction. All high voltage electrical work shall be performed by licensed electrician.

D. Automatic Controller:

1. Install controller in accordance with manufacturer's instructions as detailed and where shown on drawings;

2. Connect remote control valves to controller in numerical sequence as shown on drawings;
 3. Final location of controller shall be approved by Engineer prior to installation;
 4. Each controller shall be a dedicated separate ground wire and grounding rod as detailed;
 5. All above ground conduit shall be rigid galvanized with appropriate fittings. All below ground conduit shall be Schedule 40 PVC.
- E. Electric Control Valves. Install cross-handle three (3) inches below finished grade where shown on drawings as detailed. When grouped together, allow at least twelve (12) inches between valve box sides. Install each remote control valve in a separate valve box. Install individual valve box flush with grade.
- F. Quick Coupling Valves. At control valve cluster locations.
- G. Drain Valves. Install manual drain valves at all low points in pressure supply line as detailed. Provide one three (3) cubic foot gravel drainage sump for each drain valve installed.
- H. Valve Boxes:
1. Install one valve box for each type of valve installed as detailed. Install gravel sump after compaction of all trenches. Place final portion of gravel inside valve box after valve box is backfilled and compacted;
 2. Locate valve no closer than twelve (12) inches from and parallel to all walk edges, buildings, and walls. Install valve boxes side by side in multiple-valve installations.
- I. Gate Valves. Install where shown on drawings as detailed.
- J. Sprinkler Heads. Install sprinkler heads where designated on drawings or where staked. Set to finish grade. Spacing of heads shall not exceed the maximum indicated on drawing unless re-staked as directed by Engineer. In no case shall the spacing exceed maximum recommended by manufacturer. Install heads on double swing-joint risers of Schedule 40 PVC pipe. Angled nipple relative to non-pressure line shall be no more than forty-five (45) degrees or less than ten (10) degrees. 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. Engineer may request nozzle changes or adjustments without additional cost.
- K. Backflow Preventer. Install as detailed.
- L. Backfilling. Do not begin backfilling operations until required system tests have been completed. Backfill shall not be done in freezing weather except with review by Engineer. Leave trenches slightly mounded to allow for settlement after backfilling is completed. Trenches shall be finish graded prior to walk-through of system by Engineer.

1. Materials. Excavated material is generally considered satisfactory for backfill purposes. Backfill material shall be free of rubbish, vegetable matter, frozen materials, and stones larger than one (1) inch maximum diameter. Do not mix subsoil with topsoil. Material not suitable for backfill shall be hauled away. Contractor shall be responsible for providing suitable backfill if excavated material is unacceptable or not sufficient to meet backfill, compaction, and final grade requirements.
2. Do not leave trenches open for a period of more than forty-eight (48) hours. Open excavations shall be protected in accordance with OSHA regulations.
3. Compact backfill to 90% maximum density, determined in accordance with ASTM D155-7 utilizing the following methods:
 - a. Mechanical tamping;
 - b. Puddling or ponding. Puddling or ponding and/or jetting is prohibited within 20'-0" of building or foundation walls and under roadways.

M. Piping Under Pavement:

1. Install in accordance with the procedure contained herein with a minimum cover of eighteen (18) inches between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete or concrete pavement;
2. Piping located under areas where asphalt or concrete pavement will be installed shall be bedded with sand (a layer of six (6) inches below the pipe and six (6) inches above the pipe);
3. Compact backfill material in six (6) inch lifts at 95% maximum density determined in accordance with ASTM D155-7 using manual or mechanical tamping devices;
4. Set in place, cap, and pressure test all piping under pavement, in presence of Owner, prior to backfilling and pavement operations;
5. Piping under existing walks or concrete pavement shall be done by jacking, boring, or hydraulic driving, but where cutting or breaking of walks and/or concrete is necessary, it shall be done and replaced at Contractor's cost. Obtain permission from the Town to cut or break walks and/or concrete.

- N. Water Supply and Point of Connection. Water supply shall be extended as shown from water supply lines. Where the system source shall be non-potable water, **NO CONNECTION SHALL BE MADE TO EXISTING OR FUTURE TOWN POTABLE WATER SUPPLIES**. Irrigation systems, if approved with the source designated as the Town's potable water system, shall be metered for quantity consumed.

Systems of non-potable water sources. All fixtures terminating above ground shall be clearly labeled as "Not For Human Consumption", or similar warning.

4.00 FIELD QUALITY CONTROL

4.01 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. Install cap risers after flushing.

4.02 Testing. Conduct tests in presence of Engineer. Arrange for presence of Engineer forty-eight (48) hours in advance of testing. Supply force pump and all other test equipment.

A. The contractor shall subject the mainline pipe to a hydrostatic pressure equal to 40 PSI over the designated static pressure or 120 PSI, whichever is greater, for a period of two (2) hours. This test shall be done with mainline components installed and shall be witnessed by the Engineer.

B. Pipes shall be backfilled to prevent them from moving under pressure, and couplings and fittings shall be exposed during testing.

C. When leakage is detected by visual inspection, the Contractor shall replace defective pipe, fittings, joints, valves, or appurtenances, and shall repeat the test until the pipe passes test. A maximum pressure loss of two (2) PSI will be allowed for acceptance.

D. Operational Test. The Contractor shall activate each remote control valve in sequence from controller. The Engineer will visually observe operation, water application, and leakage. The Contractor shall replace all defective remote control valves, solenoids, wiring, or appurtenances to correct operational deficiencies. The Contractor shall replace, adjust, or move water emission devices to correct operational or coverage deficiencies. The Contractor shall replace defective pipe, fittings, joints, valves, sprinklers, or appurtenances to correct leakage problems. Cement or caulking to seal leaks is prohibited. The Contractor shall repeat test(s) until each lateral passes all tests. Repeat tests, replacement of components, and correction of deficiencies shall be at no additional cost to Owner.

E. Before final acceptance, pressure supply line shall remain under pressure for a minimum period of forty-eight (48) hours.

4.03 Walk-Through for Substantial Completion.

A. Arrange for Engineer/Town presence forty-eight (48) hours in advance of walk-through.

B. Entire system shall be completely installed and operational prior to scheduling of walk-through.

C. Operate each zone in its entirety for Engineer at time of walk-through and additionally, open all valve boxes if directed.

D. Generate a list of items to be corrected prior to final completion.

E. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.

4.04 Walk-Through for Final Completion.

- A. Arrange for Engineer's presence forty-eight (48) hours in advance of walk-through.
- B. Provide Engineer with all accessories, charts, record drawings, and equipment as required before final completion walk-through is scheduled.
- C. Operate each zone, in its entirety for Engineer at time of walk-through to insure correction of all incomplete items.
- D. Items deemed not acceptable by Engineer shall be reworked to complete satisfaction of Engineer.

5.00 ADJUSTING

5.01 Upon completion of installation, "fine-tune" entire system by regulating valves, adjusting patterns and break-up arms, 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 +/- 7%.

- A. If it is determined that irrigation adjustments will provide proper coverage, and improved water distribution as determined by Engineer, Contractor shall make such adjustments prior to final acceptance, as directed, at no additional cost. Adjustments may also include changes in nozzle sizes, degrees of arc, and control valve throttling.
- B. All sprinkler heads shall be set perpendicular to finish grade unless otherwise designated.
- C. Areas which do not conform to designated operation requirements due to unauthorized changes or poor installation practices shall be immediately corrected at no additional cost.

6.00 CLEANING

Maintain continuous cleaning operation throughout duration of work. Dispose of, off-site at no additional cost to owner, all trash and debris generated by installation of irrigation system.

End of Section