Cornell Local Roads Program

Town of Farmington

2014

Report by Joshua Ren, Summer Intern

Cornell University 2015

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Road Inventory

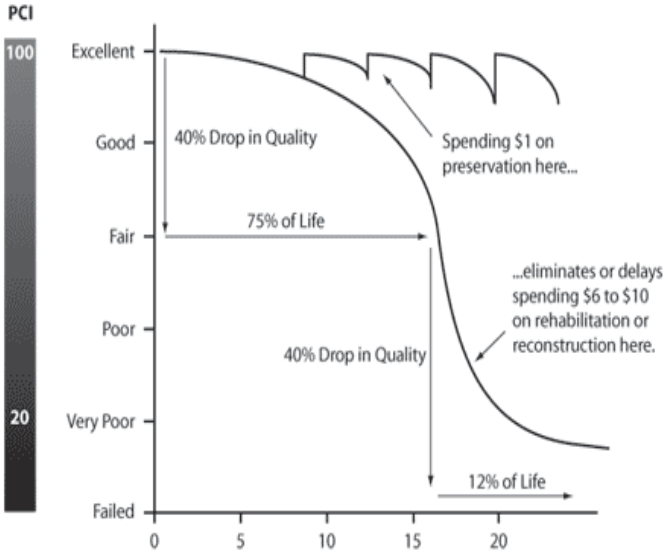
Chip Sealing Calculation

Maintenance Bond Record

Executive Summary

The goals of this Local Roads program were to identify the condition of Farmington's roads and systematically decide the repairs that each road needs. A realistic 5 year budget can then be developed.

The main benefit to identifying distresses in roads is to save on repair costs over time. Although, a road may appear to be in good condition, if it is neglected for several years, it will deteriorate quickly and its repair cost will multiply. Spending more money on the maintenance of roads is an investment that will lower the cost of large capital projects in the future.



The strategy employed in creating this 5 year plan was prioritizing preventive measures and deferring repair of roads already in poor condition until there is enough money to spare for a large rehabilitation project.

For the first two years, priority is given to good roads that show some cracking. These roads need to be when their condition has not deteriorated to the point of needing more expensive repairs.

This 2014 survey evaluated Farmington's roads to have an average PCI of 85, meaning they are in good condition, but are starting to show signs of distress. These roads will need continued funding every year to keep them at their current standard.

$331,000 will cover basic maintenance and repairs and prevent the rapid deterioration of roads. In other words, it will be enough to repair distresses at the rate they are formed on the "good" roads, but not enough to treat the roads in poorer condition.

Annual average maintenance...

14 miles of chip sealing at @ $18,200 per mile = $255,000

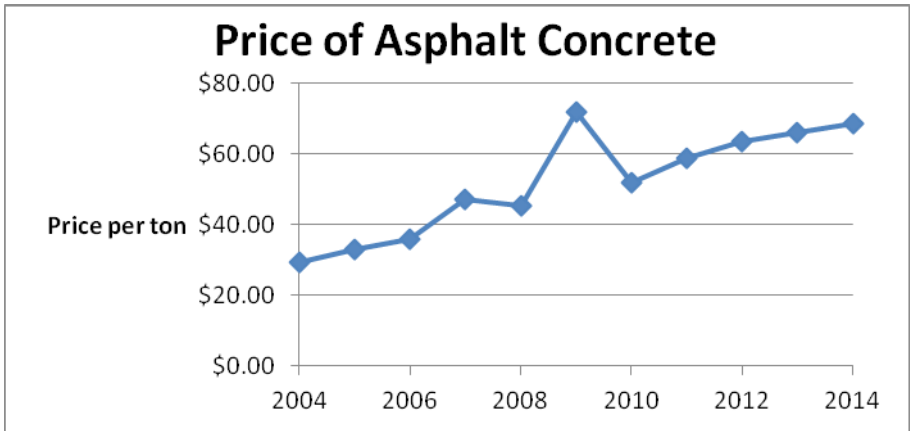
2000 gallons of crack sealing @ $13 per gallon = $26,000

120,000 square ft of slurry sealing @ $0.41 per square ft = $50,000

Continued maintenance of a good road will extend its lifespan, but not indefinitely. A portion of the budget must also be appropriated toward larger capital repair projects to rehabilitate failing roads. An additional $350,000 is needed to keep pace with the number of annual capital repairs, bringing the desired total road repair budget to $681,000. These capital repairs include mill and fills, overlays, recycling, and reconstructions.

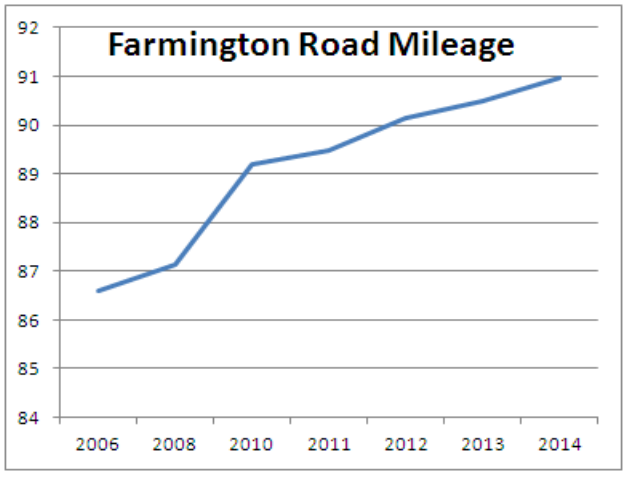
Rising Costs

A major concern that the Highway Department faces is the rising cost of repairs.

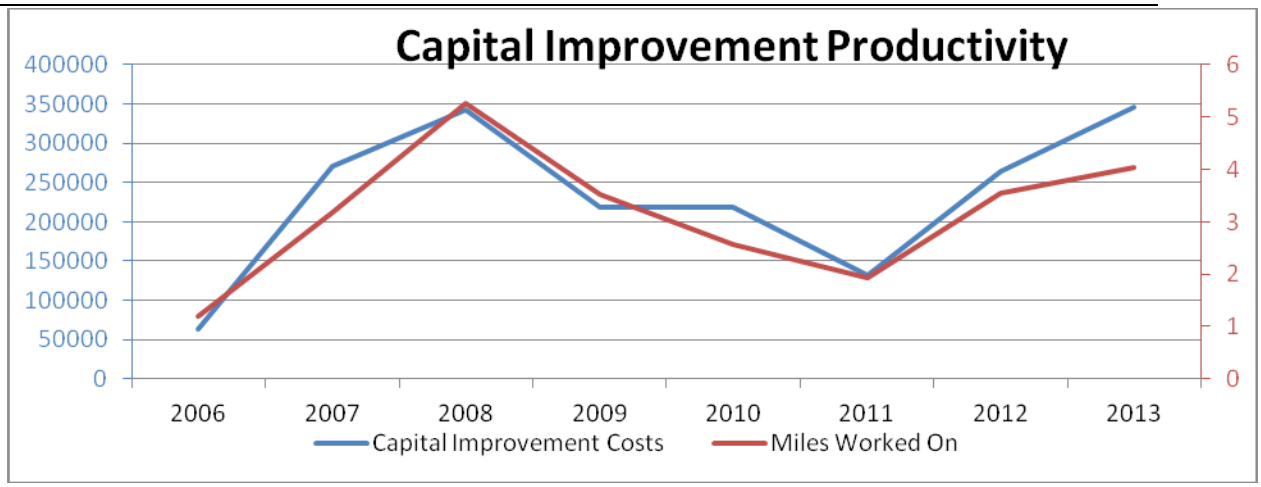


In the past 10 years, the price of hot mix asphalt has risen almost 300%, and it is likely to continue rising in price. Asphalt accounts for about 46% of the cost of a 2" overlay, a commonly done repair.

Another factor for rising costs is Farmington's increasing road mileage. Over the past 12 years, considerable construction has been done, adding over 5 miles of new subdivision roads. The new roads increase the total amount of area that needs to be maintained and drive up costs.



In 2014, the repair budget for the improvement of roads is about $600,000 (includes general repair budget, VLT and CHIPS money). This is an adequate amount of money to maintain roads at their current conditions, but it can be observed that costs are on the rise, and he budget needs to be increased to compensate. If the budget is increased further, forward progress can be made to increase the quality of Farmington's roads.

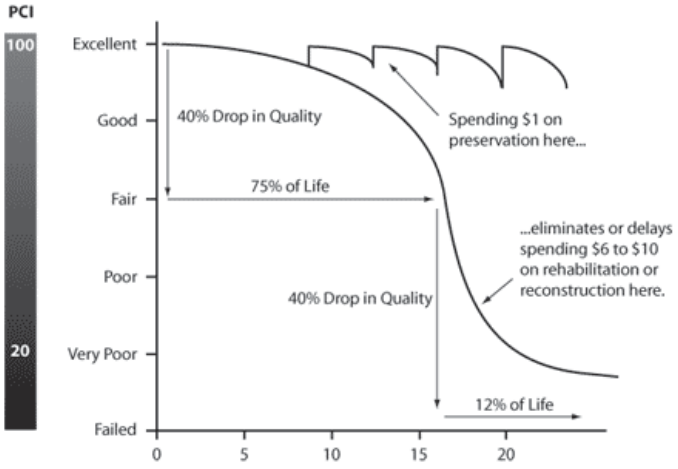

Capital Improvement Productivity
400000
350000
300000
250000
200000
150000
100000
50000
0
6
5
4
3
2
1
0
2006
2007
2008
2009
2010
2011
2012
2013
Capital Improvement Costs
Miles Worked On

Detailed Description

Intern Joshua Ren was hired for the summer of 2014 to work with the Highway Department of Farmington to:

- Conduct an up-to-date a survey of road conditions
- Calculate average cost per square foot for each treatment Farmington uses on its roads
- Assign repairs to roads and estimate cost for repair
- Form a 5 year plan, targeting high priority roads first

Joshua Ren was hired through the Cornell Local Roads Program. Through this program, he and Highway Superintendent Ed McLaughlin, who would later act as Joshua Ren's supervisor, participated a three day training period. The Local Roads interns were instructed on the goals of the program, pavement repairs, pavement distresses, and using the CAMP-RS Software. The goal of the program is to reduce road repair costs for the municipalities over time by using the strategy, "Keep your good roads good." This strategy involves prioritizing surface treatments on roads that have started to show distresses, rather than targeting roads that have already fallen into serious disrepair. The logic behind this is that it is much cheaper to maintain a good road than to reconstruct a poor road. The dollar spent per year of lifespan extension ratio is more favorable when the road is still in fair condition. With this strategy, a 5 year plan is to be created to help the municipality appropriate its limited funds most efficiently.



First, a thorough survey of the road conditions in Farmington was conducted. This involved driving along all of Farmington's roads and inspecting for distresses. The distresses looked for are: drainage, roughness, longitudinal cracking, alligator cracking, edge cracking, potholes, rutting, and bleeding. (see **Sample Condition Survey** for full descriptions) The severity and extent of each are recorded used to calculate the pavement condition index (PCI) of each road, which serves as a general indicator of how much repair the road needs. PCI ranges from 0 to 94, a road in perfect condition being a 94. Based on the severity, extent, and type of distresses a road has, a repair category for the road is selected. (see **Decision Trees** for more detail about how repair categories are picked) The repair

categories are as listed in ascending order of expenses: Defer Maintenance, Crack Repairs, Patching, Surface Treatment, Overlay, Drainage Work, Rehab, and Reconstruction.

CAMP-RS Software

The CAMP-RS Software is a computer program that is to be used as a tool to help better address road repairs in a municipality. It was developed by the Cornell Local Roads Program for municipalities to integrate into their maintenance programs. CAMP-RS was used to develop the 5 year budgeting plan found in this report.

After completing the road survey, the data was inputted into CAMP-RS and saved into its database. The software then calculates the PCI of each road which it will use later to determine each road's priority value.

The software abides by the stratagem of "keep your good roads good" and uses a formula to calculate a priority value for each road. This value is based on the volume of traffic, the suggested repair category, and PCI. Roads with drainage issues often will be prioritized first, as this often leads to a rapid deterioration of the road. Crack repairs are also highly prioritized because it is a very cheap repair that will extend the life of the road. Surface treatments and overlays have moderate priority so that several of them will be done a year. Rehabilitations and reconstructions have low priority because they are expensive and that money should be directed toward maintenance of good roads.

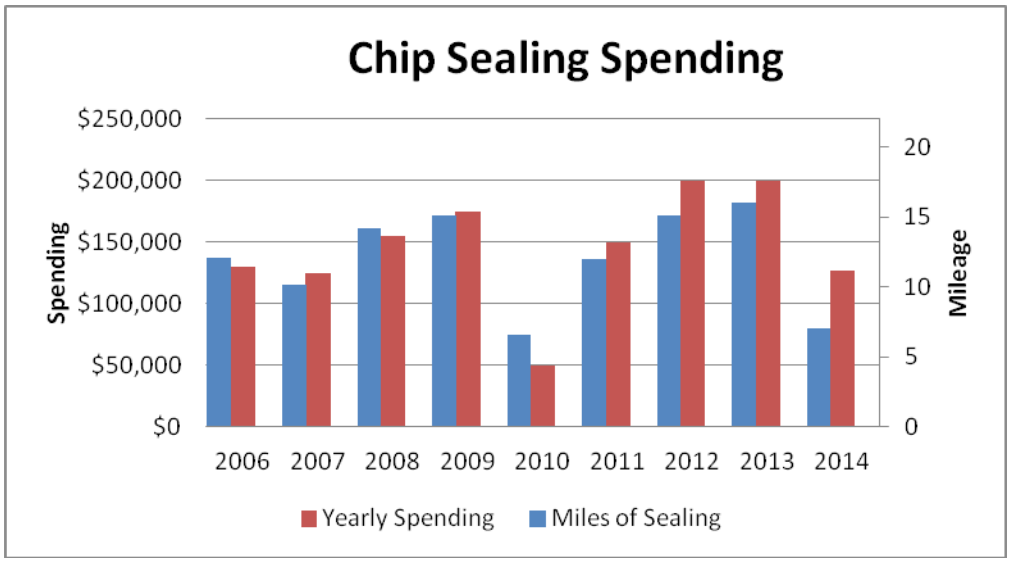
Next, the user must input values for the price per square foot of each repair. Since costs for labor and materials vary by municipality and by year, the price for each repair that Farmington uses needed to be calculated (for exact numbers for each repair see **Repair Alternatives)**. Farmington uses contractors for crack sealing, cape sealing, and central plant recycling. Estimated costs per square foot could be taken from past invoices for these repairs. Farmington does its own chip sealing, overlays, mill and fills, and edge repaving. More in depth calculations had to be done to figure out cost per square footage for these (an example of this calculation is included in the **Appendix**).

Given parameters for road width and length and cost per square footage of repair, the cost to repair each road section was calculated by CAMP-RS.

Overview of Repairs

Farmington uses a number of repairs for its roads. For surface treatments, chip seals are used on town roads and cape seals are used on subdivision roads because it provides a smoother surface. For overlays, 1.5" overlays, 2" overlays, and 2" mill and fills are used. For roads that have edges that are falling apart, an edge repaving is done, often followed by a surface treatment the next year. (see **Repair Alternatives** for detailed descriptions)

Using Section 284 documents from 2006-2014, the average yearly spending on crack filling and surface treatments is $200,000. However, this number has been increasing over time, and is estimated to be $326000 in 2014.



5 Year Budget

The CAMP-RS can create a rough draft budget when a yearly budget is inputted. $650,000 was inputted as the yearly budget. This number was based on the yearly spending on highway repairs from previous years. The software fit in as many high priority roads as the yearly budget will allow, creating the first draft of the budget (see **Appendix**).

Highway Superintendent Ed McLaughlin was shown the draft, whereupon he made revisions. A significant amount of the 2014 repair budget was diverted toward the Mertensia Road Culvert Project which created setbacks for Superintendent McLaughlin's repair plan. Because of this, the yearly spending was reduced down to $450,000. This provides ample leeway to account for a variety of factors: budget

being reduced, losing VLT money, deterioration of roads that appear during the five year period, additional unexpected expenses. This reduction in yearly spending resulted from reducing of some overlays and mill and fills to less expensive repairs and deferring maintenance on several expensive projects. The $650,000 figure was contingent upon the General Repair budget increasing from 2014 and onwards, and therefore, it would overestimate the amount of roads that could be repaired in a year if the budget does not increase.

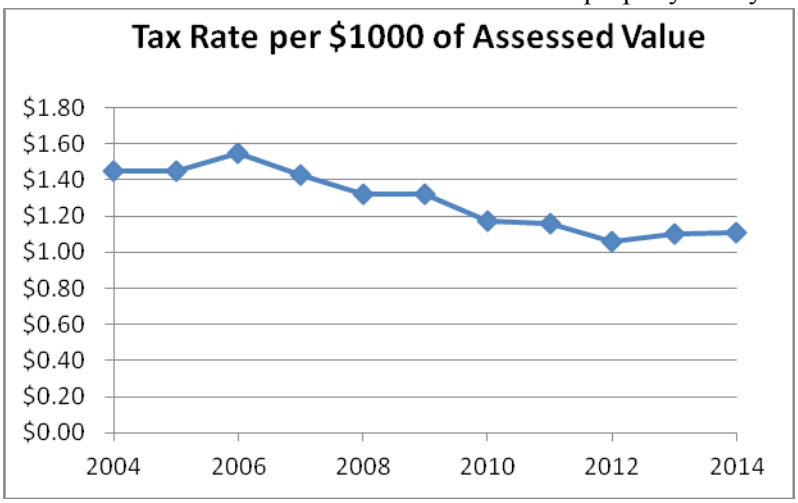
Proposal

Ed McLaughlin worked with intern Joshua Ren to create a suggested plan for a rate of increase for the General Road Repair budget. The plan is to increase the General Road Repair budget an amount equal to the maintenance bonds accrued that year. Maintenance bonds are a sum of money put aside by the contracting company that constructs a new road. The bond amount is equal to 10% of the cost to build. This bond is used to pay for the possible maintenance of the road if it shows distress and expires after two years. Since the responsibility of funding a newly built or rebuilt road shifts to the Highway Department after two years, the General Road repairs fund should be increased by the maintenance bond amount every year in preparation for when the bond expires.

On average over the past 12 years, $27,000 is accrued in maintenance bonds per year. From 2010 to 2014, the property tax levied through the Town of Farmington has increased by 4.3% per year, roughly equal to $24,000 per year. However, the tax rate per $1000 of assessed property value has gone down from $1.17 to $1.11 in the same time frame. This means that housing in Farmington has been being bought at a very high enough to offset the decrease in taxation per capita.

In the long run, the roads are bound to suffer from an increase in traffic from all of the new housing if taxation rates continue at the current downwards rate.

The maximum allowable increase in property tax by the New York tax cap is 2% yearly, which roughly equates to a $12000 increase. Taking into account the rate of properties being sold, if the tax rate is increased by 2%, the maintenance bond amount can be matched every year, and there would be excess money to compensate for the rising cost of repairs.

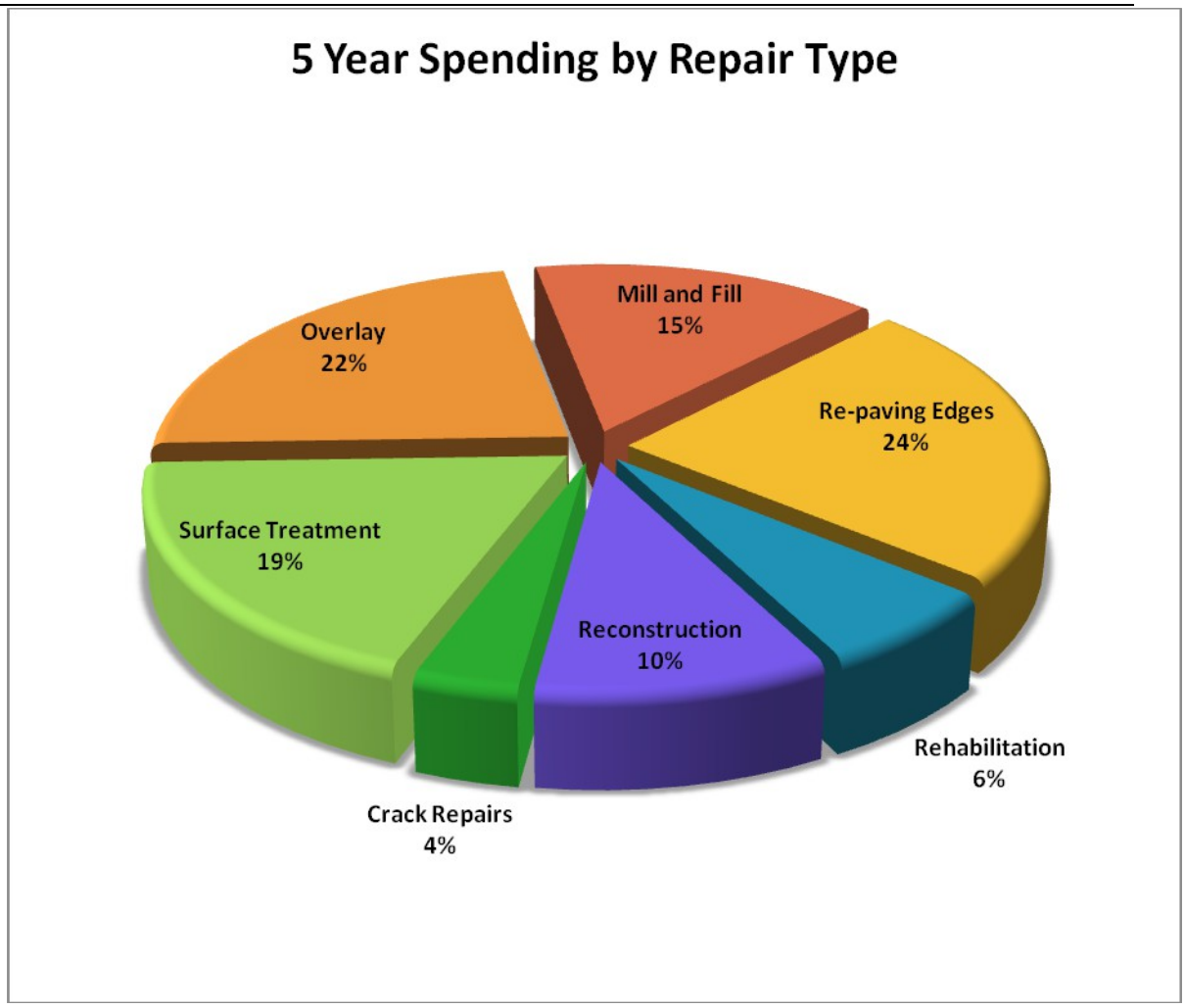


Currently, the Highway Department spends about $600,000 yearly on road repairs and has $300,000 in General Road Repairs budget. This is made possible because the Highway Fund receives additional funds from VLT and CHIPS money.

If this plan is implemented and the General Roads Repair is increased by 36000 a year, in 10 years, the fund will increase to $660,000, enough to minimize the need for VLT and CHIPS money.

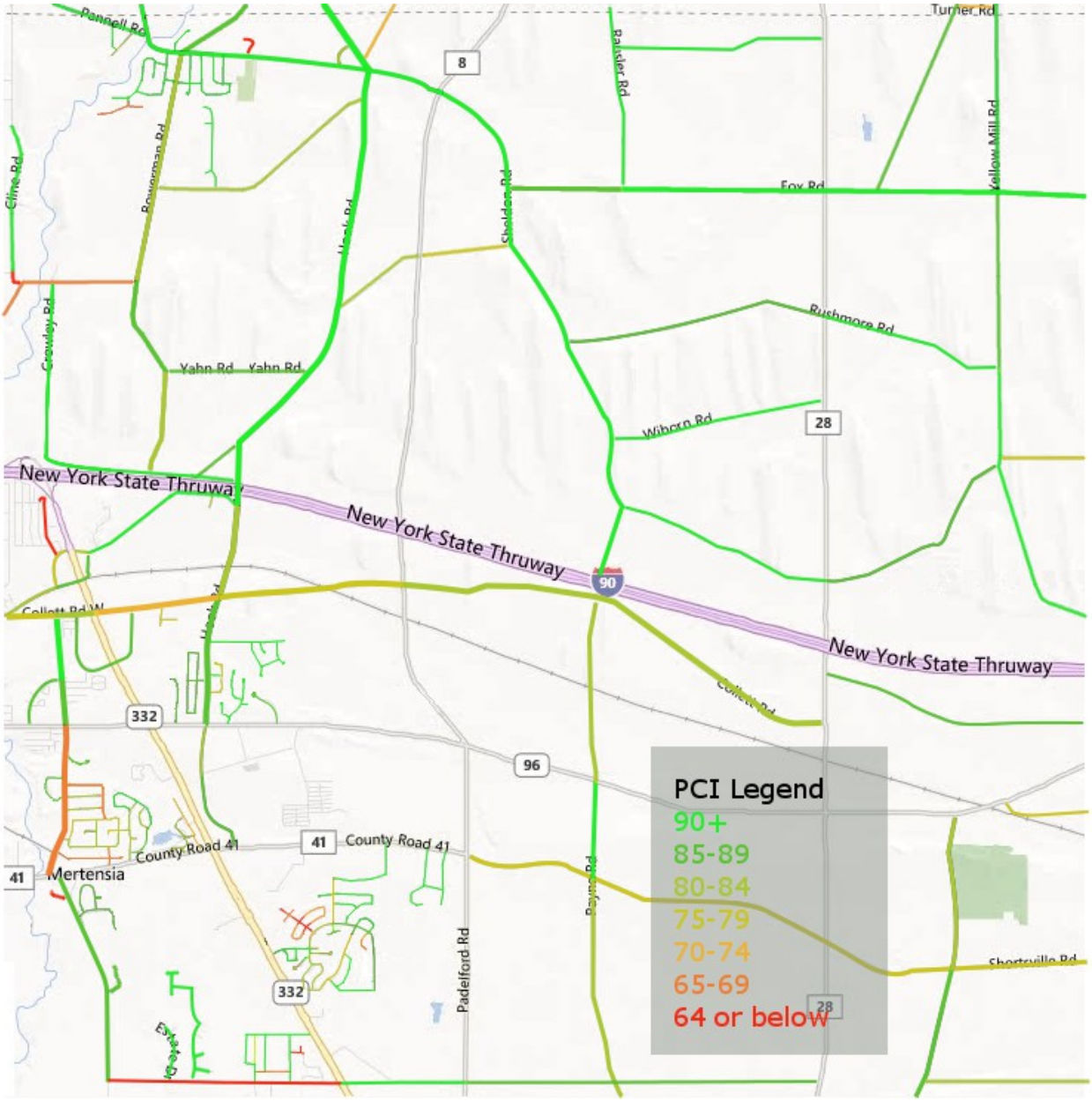
Conclusion

The summer of 2014 was the first time that the Highway Department took on an intern through the Cornell Local Road's Program. Superintendent Ed McLaughlin has considered the benefits of the CAMP-RS program and is willing to continue its usage in the future. A through survey of the road conditions has also proven to be very useful in the development of an effective five year plan of road maintenance, and so it will likely continue to be done periodically. The five year plan will provide guidance on maintaining and preserving roads with a limited budget, but roads will not see significant overall improvement in quality unless funds are increased.



Repair Type	Predicted Spending over 5 Years
Crack Repairs	$63,050
Surface Treatment	$327,020
Overlay	$394,100
Mill and Fill	$268,000
Re-paving Edges	$412,400
Rehabilitation	$112,000
Reconstruction	$174,600

Distress Map



CAMP-RS Asphalt Pavement Condition Survey

Street: _____	Distance: _____	Name: _____
Section #: _____	Start : _____	Date: _____
Start: _____	End : _____	Weather: _____
End: _____	Length: _____	Temp (F°/C°): _____

LONGITUDINAL/ TRANSVERSE CRACKING

NO Defects

SEVERITY	EXTENT Low	Med	High
Low	1	2	3
Med	4	5	6
High	7	8	9

ALLIGATOR CRACKING

NO Defects

SEVERITY	EXTENT Low	Med	High
Low	1	2	3
Med	4	5	6
High	7	8	9

EDGE CRACKING

NO Defects

SEVERITY	EXTENT Low	Med	High
Low	1	2	3
Med	4	5	6
High	7	8	9

PATCHING / POTHOLES

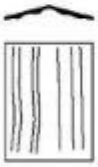
NO Defects

Do not include good patches

EXTENT

1	Low
2	Medium
3	High

RUTTING



NO Defects

SEVERITY	EXTENT Low	Med	High
Low	1	2	3
Med	4	5	6
High	7	8	9

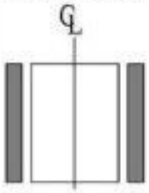
BLEEDING

CONDITION

SEVERITY

1	Good
4	Fair
7	Poor

DRAINAGE



CONDITION

SEVERITY

1	Good
4	Fair
7	Poor

ROUGHNESS

Check road for presence of the following:

- uneven surface
- rage
- humps
- frost heaves

CONDITION

SEVERITY

1	Good
4	Fair
7	Poor

Description of Distresses

Longitudinal/Transverse Cracking

Severity:

Low- Cracks are very thin, or they have been crack sealed already but starting to reform.

Medium- Cracks are 15 ft or longer and smaller cracks are forming off of main branches.

High- Cracks are wider than 1 cm and stretch across width of road or many cracks have formed off of a main crack, appearing almost like alligator cracking.

Extent:

Low- Cracks exist on less than 10% of road.

Medium- Cracks exist on roughly 10% to 40% of the road.

High- Cracks exist on more than 40% of the road.

Alligator Cracking

Severity:

Low- Cracks are thin; area of cracking is level with road.

Medium- Well defined cracking, with up to ⅛” in width. Pieces of pavement may be loose but have not broken away. Area of cracking may be depressed.

High- Cracks are wider than ⅛” and pieces have been broken away. Area of cracking is considerably warped and depressed.

Extent:

Low- One small patch every quarter mile.

Medium- A patches spanning a meter or more in diameter and take up 10% to 30% of road.

High- Cracks span more than 30% of the road.

Potholes/Patching

Extent:

Low- Fewer than or approximately equal to one pothole per half mile.

Medium- Two to three potholes per half mile.

High- Three or more potholes per half mile.

Edge Cracking

Severity:

Low- Cracks are very thin, or they have been crack sealed already but starting to reform.

Medium- Well defined cracking, with up to ⅛” in width. Pieces of pavement may be loose but have not broken away.

High- Cracks are wider than ⅛” and pieces have been broken away.

Extent:

Low- Cracks exist on less than 10% of the section length.

Medium- Cracks exist on roughly 10% to 40% of the section length.

High- Cracks exist on more than 40% of the section length.

Drainage

Condition:

Good- No water accumulation on surface, road has good crown.

Fair- Road crown is in good condition, but pools of water form either in the shoulder or the road. There might be collected sediment on the road, evidence of suboptimal drainage.

Poor- There are large standing pools of water on pavement surface.

Roughness

Condition:

Good- Road surface is even and smooth.

Fair- Road has noticeable unevenness.

Poor- Road is bumpy to the point of being unsafe at the posted speed limit.

Rutting

Severity:

Low- Depth of rut is less than ½”

Medium- Depth of rut is between ½” and 1” deep

High- Ruts are greater than 1” deep and are holding water

Extent:

Low- Less than 10% of the road is covered by rutting.

Medium- Between 10% and 30% of the road is covered by rutting.

High- More than 30% of the road is covered by rutting.

Bleeding

Condition:

Good- No bleeding or only very isolated spots of bleeding are seen.

Fair- Bleeding covers 5% to 30% of road surface.

Poor- Bleeding covers more than 30% of road surface.

Overview of Repairs

Farmington's roads generally have been built on good foundations so distresses stemming from a poor base are uncommon. Crack filling, surface treatments, and overlays can be used to treat the vast majority of the roads.

Crack filling is the cheapest repair available. It involves injecting sealant into the cracks in the road to prevent water from seeping through and weakening the foundation. Ideally, this would be used for newer or recently surface treated roads to keep it in good shape. However, it has also been used on roads that have fallen into more disrepair. This is done because there is not enough money in the budget for an overlay or mill and fill, and crack filling will keep the road watertight and buy some time.

Road Lifespan Extension: 2-3 years

Cost per Square foot: $.0176

Chip sealing is the cheapest surface treatment available. It is done by spraying a layer of tack coat on the road to seal all of the cracks. Then, a thin layer of gravel is spread on the tack coat to form the new road surface. Due to its affordability, it is the first choice for surface treatments on large town roads. The main disadvantage is that it creates a surface that is significantly rougher than asphalt. This makes it a less than ideal repair to use for subdivision roads.

Road Lifespan Extension: 3-4 years

Cost per Square foot: $.125

Cape Sealing is the second type of surface treatment used in Farmington. Cape sealing involves putting a chip seal on a road first. Then, a slurry seal is applied on top of the chip seal. The advantage of this method is that the road ends up with a smooth-textured and resilient surface, making it the preferable surface treatment to use on subdivision roads.

Road Lifespan Extension: 3-4 years

Cost per Square foot: $.41

Overlays are an expensive repair used to treat serious distresses in roads. Low to medium severity cracking can usually be fixed with crack filling or a surface treatment. However, if a road's cracking is severe and extensive an overlay might be required. Also, if a road develops, roughness, potholes, or rutting, a thick 2" overlay will be required to fill in the depressions in the road and re-level it, since a surface treatment will not be enough to fix those distresses. A thinner 1.5" overlay would be used on a road with extensive cracking, but a relatively even surface.

Road Lifespan Extension: 6-7 years

1.5" Cost per Square foot: $.61

2" Cost per Square foot: $.81

Mill and Fills are used to treat serious distresses in roads. 2" of the top surface is milled out and replaced with new asphalt. Although this is an expensive repair and overlays are a cheaper alternative, it is necessary to use on roads with gutters. Whereas an overlay will increase the height of the road, mill and fills will keep the road at level with the gutter.

Road Lifespan Extension: 6-7 years

Cost per Square foot: $.95

Central Plant Recycling/Cold-in-Place Recycling is a rehabilitation treatment used for roads that have fallen into disrepair. First, 3" of the road is first milled out. Central plant recycling involves transporting the resulting aggregate to a central plant. There, oil emulsion is added to create asphalt concrete. This mixture is sent back to the road where it is placed down as a new road surface. For cold-in-place recycling, the aggregate is mixed with the oil emulsion at location instead of being brought to a plant. Otherwise, he process is the same. Both types of recycling will require a surface treatment or overlay done on the road soon after to protect and strengthen the road.

Road Lifespan Extension: 7-8 years

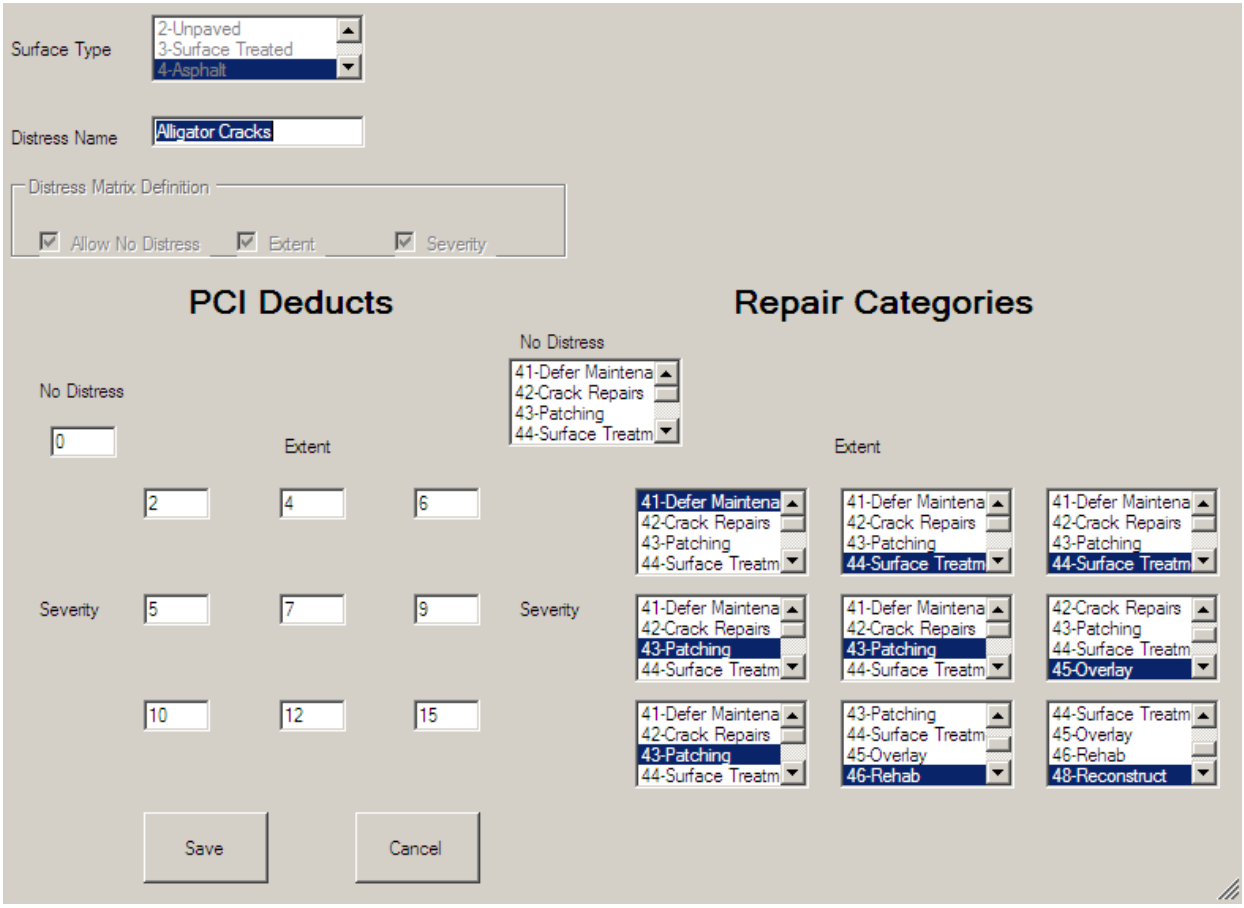
Cost per Square foot: $.70

Reconstruction is the most expensive repair possible and involves digging up the road and its base entirely and rebuilding it with all new stone. It is done infrequently and used as a last resort for roads that have fallen into severe disrepair and compromised the integrity of the base. Reconstruction projects will vary in price due to a variety of factors and will require engineers to properly assess and plan out.

Road Lifespan Extension: ~10 years

Cost per Square foot: ~$6.00

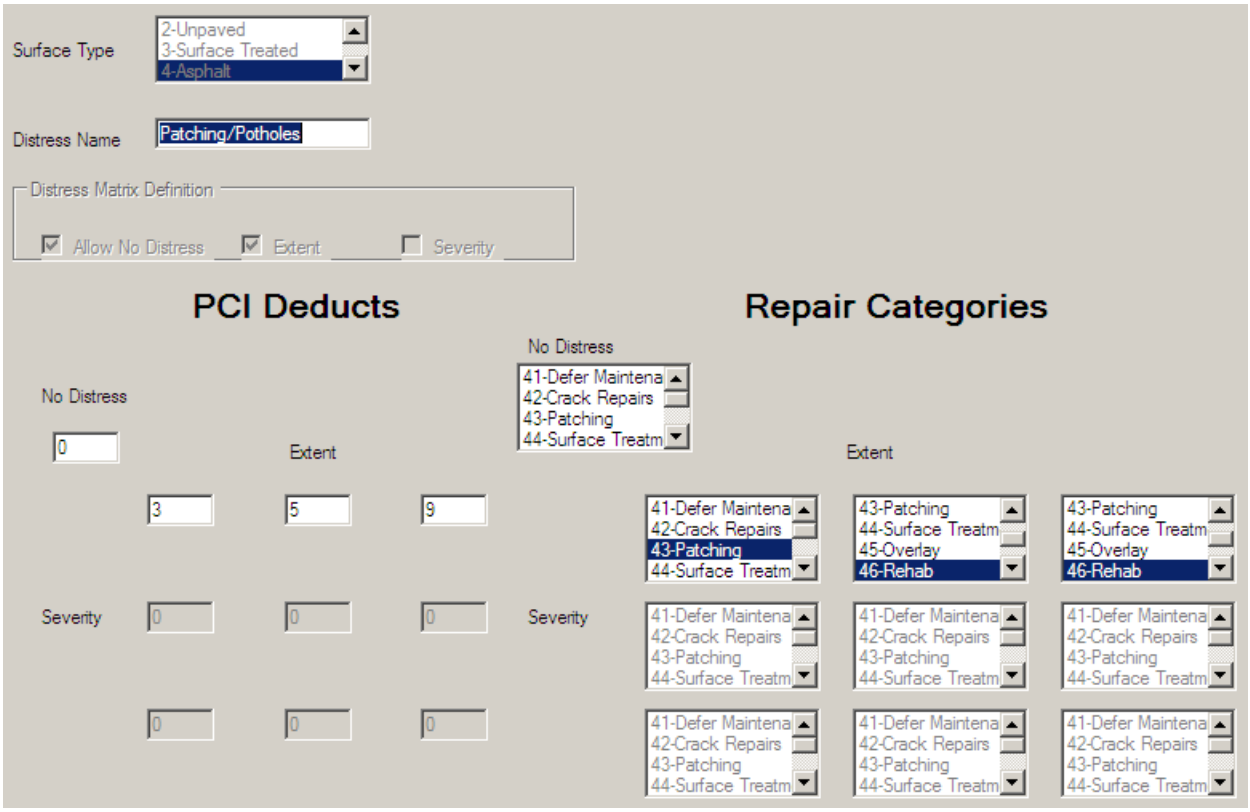
Decision Trees Explained



The CAMP-RS Software uses a decision tree to decide the recommended repair category and PCI deduction for each possible distress. On the 3 x 3 matrices, extent is on the horizontal axis and severity on the vertical. A low extent, low severity distress corresponds to the top left entry, a high extent, high severity distress corresponds to the bottom right entry and so on. The PCI deductions are commutative among all of the distresses observed for a road. The road is assigned the repair category with the highest repair category index number, listed next to the name of the repair category.

> **Example:** A road has moderate severity, high extent alligator cracking and low extent, low severity longitudinal cracking. The alligator cracking results in a PCI deduction of 9 and the longitudinal cracking results in 2. This gives a total PCI of 94-2-9 = 83. For repair categories, the longitudinal cracking will select 42-Crack Repairs and the alligator cracking will select 45-Overlay. Since Overlay has the higher index, it will be recommended for the road.

The Decision Tree shown on the previous page is for Alligator cracking. Each distress does not necessarily have the same Decision tree. The tree for Patching/Potholes shown below has a 1x3 matrix and only takes extent into account. It is difficult to judge the severity of certain distresses, so they are judged only on extent.



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