PAVEMENT MANAGEMENT REPORT

July 2015

Pavement Management Update

City of North St. Paul
Ramsey County, MN

WSB Project No. 1887-340

NORTH ST.PAUL
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Pavement Management Report

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I. Executive Summary

This report is intended to be used as part of the pavement management program in North St. Paul. This report includes analysis of the data after completion of the 2015 pavement inspections which included all of the road segments within the city. This report is not intended to be a final document on public policy or planning and is subject to change upon review by the City Council.

The City recognizes the continued degradation of the city roadways and the need for a plan on maintaining and reconstructing the roadways which includes the current policy of preventative maintenance (treating the good roads) in addition to reactive maintenance (rebuilding the bad roads). The components of the Pavement Management Program include:

1. Pavement Conditions Report
2. Pavement Management Policies
3. Pavement Management Plan

As the first step in the establishment of the Pavement Management Program, this Pavement Conditions Report was prepared. The significant findings of this report are as follows (see Definitions Section following for explanation of acronyms and terminology):

- There are currently 45.0 miles of paved City roadways
  - 42.94 miles of bituminous roadways
  - 2.07 miles of concrete roadways.
- There are 2.86 miles of paved alleys in the City.
- The current average Overall Condition Index (OCI) of the paved roads is 57.53.
- The current average OCI of the paved alleys is 30.2.
- There are 9.43 miles of collector roadways in the City with an average OCI of 66.29.
- There are 35.58 miles of local roadways in the City with an average OCI of 56.15.

- 14.60% of roadways are rated as “excellent” and require only minimal scheduled preventative maintenance.
- 13.60% of the roadways are in “good” category requiring continued preventative maintenance or preservation improvement.
- 55.94% of roadways are in a “fair” category requiring proactive preservation.
- 15.86% of roadways are in the “poor” category, requiring complete reconstruction.
- Based on the current adopted 2014-2020 Capital Improvement Plan, the City is currently reconstructing some of the roadways in this study.

This report shows that the continuation of the current level of maintenance will result in the continued lowering of the overall condition of the City’s roadways and will cost significantly more to restore over
the long term than if increased funding was provided for roadways to be maintained and reconstructed at a more optimum time. The next step in this process would be to evaluate whether pavement management policies need to be adjusted, and to continue to develop an understanding of the current roadways via pavement inspections and pavement forensics and continue to update a pavement management and Capital Improvement plan.

The current annual average budget for surface treatments, mill and overlays, and reconstructions is approximately $1,100,000. This report recommends the budget be increased to closer to a $1,400,000 annual budget for surface treatments, mill and overlays and reconstructions.
II. Definitions

**OCI: Overall Condition Index**

The OCI provides a numerical rating for the condition of road segments within the road network, where 0 is the worst possible condition and 100 is the best.

**AC: Asphalt Concrete**

Another name for bituminous. Commonly referred to as blacktop, asphalt or asphalt cement.

**PCC: Portland Cement Concrete**

Another name for concrete pavement.

**Pavement Forensics**

Pavement forensics identifies what exists under the visible layer of the pavement and can give a wealth of information including depths of the pavement layers, signs of bonding or unbonding and distresses that might not be visible from the road surface. Soil borings along the roadways can be used to identify aggregate depths and soil classifications can provide a better understanding of the roadway section to determine the appropriate pavement rehabilitation technique. Another option is pavement cores which provide information on the pavement thickness, condition of the base course and amount of Class 5 that is in place. The findings from a pavement forensic study have been proven to lead to cost savings and better solutions for a road fix.

**Pavement Life Cycle**

Pavements have a useful life beginning from the time they are constructed until they have deteriorated to the extent of being unusable.

**PREVENTATIVE MAINTENANCE SURFACING TECHNIQUES**

Preventative maintenance can be defined as a treatment to an existing road that will help preserve and protect the road, while also slowing down future deterioration. This type of maintenance will improve the condition of the system without increasing structural capacity. Preventive maintenance is best performed on newer pavements prior to the appearance of significant and/or severe distresses. Types of preventative maintenance include crack sealing, fog sealing and chip sealing.

The preventative maintenance surfacing techniques considered in this report are as follows:
BITUMINOUS

Crack Sealing

Crack sealing is a type of preventative maintenance used to prevent the intrusion of water and incompressible materials into cracks. When water enters cracks, it can soften the sub-base and base layers and lead to further cracking and the development of more severe alligator cracking and the formation of potholes. In climates where freeze/thaw cycles exist, the water that enters the system through cracks can lead to issues with frost heaving. Crack sealing should be completed as preventative maintenance early on in the life of a new pavement or overlay (year 2-4) and roughly every seven years or as determined to be necessary. This technique will not improve the structural capacity of the pavement but will benefit future structural deterioration that could be caused when water enters the system. It is recommended that crack sealing be done prior to either fog sealing or chip sealing.

Pothole Patching

The remedy for repairing a pothole is generally referred to as “patching”. Patching can be described as the filling of a hole or a depression in a road surface by an appropriate asphalt mixture. The goal of patching is to return the pavement to a working condition that will not deteriorate the vehicles that ride on the road. There are different methods to perform pothole patching. Different procedures are used to fill potholes. The best practice was found to consist of the following steps:

1. Remove water and debris from the pothole.
2. Pour the hot or cold asphalt mixture and compact it in lifts with maximum thickness of two inches using the truck tires or vibratory roller/plate (preferred) until a 0.15 to 0.25 inch crown is formed. This allows passing traffic to further compact the patch and create a tighter seal, which corresponds to a higher density.
Chip Seal

Chip sealing is a type of preventative maintenance where an asphalt emulsion and rock chips are applied to the roadway to protect the roadway surface from environmental aging, moisture damage and oxidation. This places a protective coating over the pavement that can slow the destructive effects of the environment. Chip sealing is typically completed one year after crack sealing. Typically a good chip seal placed on a newer road can last 8 to 14 years. This assumes the chip seal is protected during placement to allow the proper time to cure. Other factors that affect chip seal performance include the type of binder that is used, the condition of the underlying road and external factors such as plow damage. It is the responsibility of the owner to insure that these external factors don’t contribute to premature failure of a chip seal. It is important to note that chip sealing can still be effective if constructed properly and if placed on a road that is a good candidate for a chip seal. Field surveys will assist in determining what roads are candidates for a chip seal.

Pros:

1. The Minnesota Chip Seal Handbook identifies that the primary benefit to chip seal an asphalt pavement is to protect the pavement from the deteriorating effects of sun and water. When an asphalt pavement is exposed to sun, wind and water, the asphalt hardens or oxidizes. This causes the pavement to become more brittle. As a result, the pavement will crack because it is unable to bend and flex when exposed to traffic and temperature changes. A chip seal combats this situation by providing a waterproof membrane, which not only slows down the oxidation process, but also helps the pavement to shed water, preventing it from entering the base material.

2. A secondary benefit of chip sealing is an increase in the surface friction it provides. This is accomplished by the additional texture the cover aggregate adds to the pavement. With time, traffic begins to wear the fine material from an asphalt pavement surface. This results in a condition referred to as raveling. When enough of the fine material is worn off the pavement surface, traffic is driving mostly on the course aggregate. As these aggregate particles begin to become smooth and polished, the roadway may become slippery, making it difficult to stop quickly. A chip seal increases the pavement texture and increases the surface friction properties.

3. Another benefit to chip sealing is that traffic can be placed on the road once the chips are placed so there is no delay in waiting for a chemical break or a cure time. With a fog seal, traffic cannot be placed on the road until the fog seal material has cured. Typically, this cure
time can take 15 to 45 minutes depending on weather conditions such as cloudiness, air temperature, humidity and wind conditions.

4. Provides a skid resistant surface and seals the surface.

Cons:

1. There have been issues related to chip seal stripping causing concern for doing more chip seals.

2. Should not be used on roads with large numbers of potholes or roads where rutting is an issue.

3. Bumpy road surface is not always ideal in recreational areas for rollerbladers.

4. Putting a chip seal on top of an essentially new road can lead to residents getting upset since there is money being spent on a newer road.

5. Residents don’t always like the trap rocks, they can track into resident’s homes and make a mess.

**Double Chip Seal**

A double chip seals involves placing two layers of a chip seal on top of each other. The pros and cons of a double chip seal are essentially the same as with a chip seal, however there is additional structural support due to the two chip seals. It will take longer for the cracks to reflect through.

**Fog Seal**

Fog sealing is another type of preventative maintenance in which only the asphalt emulsion is applied to the roadway to protect the roadway surface from environmental aging, moisture damage and oxidation. This preventative maintenance technique will not add any strength to the pavement. Fog sealing is typically completed one year after crack sealing. Typically a fog seal will last 3 to 5 years. It is important to note that while the color of a fog seal may fade as early as a year after its application, a fog seal remains effective for as many as 2 to 4 years. The industry is currently doing research on developing new applications including faster curing times of fog seals. Communities typically complete fog seals on cul-de-sacs. Some communities are also evaluating completing fog seals on low volume roads or completing a test section.

**Pros:** The Minnesota Chip seal Handbook identifies several benefits resulting from a fog seal application as follows:
1. The traveling public thinks it is driving on a new hot mix asphalt surface rather than a chip seal.

2. The emulsion is diluted, which yields a very low viscosity that allows most, if not all, of the additional asphalt binder to fill the chip voids increasing embedment by up to 15-percent with no bleeding.

3. The fog seal re-seals any chips that may have partially broken loose during sweeping operations.

4. Darkening the pavement surface with a light application of asphalt emulsion allows the pavement surface temperature to rise. The subsequent softening of the binder allows the chips to orient to their least dimension more quickly. This factor is very important in Minnesota where late season chip seal projects are more susceptible to failure due to colder weather conditions.

5. Fog sealing can provide a designer with a chance to give the appearance of a re-application of a chip seal application. If after traffic has driven on the surface, it appears that embedment is low, an engineer can add additional binder to the chip seal by increasing the fog seal amount. In some cases, the amount of fog seal emulsion applied increased to over 0.20 gallon per square yard.

6. When a fog seal is applied, a reduced amount of paint is necessary to make pavement markings visible on the surface.

Cons:

1. There is a loss of friction associated with a fog seal due to the oil sitting on the surface of a roadway.

2. The fog seal has to cure before traffic can be put on the fog seal.
3. The color of a fog seal may fade after a relatively short time however the fog seal is still effective as shown by the following chart.

![Graph showing permeability over time for different chip seal locations.](image)

4. The fog seal re-seals any chips that may have partially broken loose during sweeping operations.

**Fog Seal over Chip Seal**

**Pros:**

1. In instances where there is rock loss, a fog seal on top of a chip seal will hold the rocks in place.

2. There isn’t as much friction loss as there is with just a fog seal since the underlying trap rock adds the friction to the surface.

**Cons:**

1. The fog seal has to cure before traffic can be put on the fog seal.
**Microsurfacing/Slurry Seal**

Microsurfacing is a mix of crushed aggregate, mineral filler, and latex-modified, emulsified asphalt. It is applied by a truck equipped with a squeegee or spreader box. Microsurfacing can be applied in multiple layers. It is effective at sealing low-severity cracks, including fatigue cracks, longitudinal cracking and transverse cracking. It also addresses raveling, friction loss, moisture infiltration, bleeding and roughness. Microsurfacing is often chosen to inhibit raveling and oxidation, as well as improving surface friction and filling minor irregularities and rutting in a roadway. A microsurfacing treatment can be expected to extend a roadway's life by 3-6 years, depending on the number of layers applied.

Because of the similar ingredients used in microsurfacing as in slurry seals, microsurfacing is sometimes referred to as a “polymer-modified slurry seal”. The difference, however, is slurry seals cure through a thermal process while microsurfacing uses a chemically controlled curing process. Since the use of a polymer-modified binder results in more stability, microsurfacing can be placed in multistone thicknesses, unlike slurry seals. Due to this thickness, more powerful mixers are needed than those required for slurry seals. In order to provide a uniform flow of the mixture into the spreader box, a twin-shafted paddle or spiral auger is needed. Microsurfacing should not be applied if either the pavement or air temperature is below 50°F (10°C) or if there is a possibility of the treatment freezing within 24 hours of placement. Microsurfacing is generally classified as a preventative maintenance treatment as opposed to a corrective maintenance treatment. Due to this classification by agencies involved in road repair and maintenance, microsurfacing is most often used as a surface treatment to correct rutting, improve surface friction, and extend pavement life by sealing any cracks in the pavement surface.

**CONCRETE PAVEMENT**

**Full-Depth Repairs**

This corrective technique repairs cracked slabs and joint deterioration by removing at least a portion of the existing slab and replacing it with new concrete. This maintains the structural integrity of the existing slab and pavement. Full-depth repair is also appropriate for shattered slabs, corner breaks and some low-severity durability problems. It involves marking the distressed concrete, saw cutting around the perimeter, removing the old concrete, providing load transfer and placing new concrete.
If deemed appropriate, standard full-depth concrete repair techniques, referred to as Type C3D repairs in MnDOT’s concrete pavement rehabilitation guidelines can be used. The repair material can be colored with pigment to match the existing slabs. The ingress of water and deicing chemicals are the primary driver of deterioration in concrete pavement joints. Once the joints have been resealed, it is very important to maintain that seal through inspection and a routine resealing program.

**Partial-Depth Repairs**

This corrective technique repairs correct surface distress and joint/crack deterioration in the upper third of a concrete slab. When the deterioration is greater in depth or reaches embedded steel, a full-depth repair must be used instead. It involves removing the deteriorated concrete, cleaning the patch area, placing new concrete and reforming the joint system. Partial-depth repairs may be effective if it is determined that the joint distress is present only in the upper third of the depth of the slab.

**Spot Slab Replacement**

In some cases smaller areas have surface issues that require replacement of portions of concrete. Recently 800 square feet of colored concrete was replaced in Burnsville. The old concrete was saw cut and jackhammered out and new concrete was poured and joints placed. This work was done at an estimated cost of $8.63 per square foot.

**Joint and Crack Resealing**

This preventative technique minimizes the infiltration of surface water and incompressible material into the joint system. Minimizing water infiltration reduces subgrade softening; and slows pumping and erosion of subgrade or subbase fines. Minimizing incompressible materials reduces the potential for spalling and blow-ups.
**Diamond Grinding**

This preventative technique improves a pavement ride by creating a smooth, uniform profile by removing faulting, slab warping, and patching.

**Dowel-Bar Retrofit**

This corrective and preventative technique increases the load transfer efficiency at transverse cracks and joints by linking the slabs together so that the load is distributed evenly across the joint. Improving the load transfer increases the pavement’s structural capacity and reduces the potential for faulting.

**REHABILITATION TECHNIQUES**

The rehabilitation options considered in this report along with the respective typical sections are as follows:

**Mill and Overlay**

A 2” mill and overlay in which 2 inches of the existing bituminous would be milled off and replaced with 2” of new asphalt. This option is estimated to last 10 – 15 years with proper maintenance. The high severity distresses present will eventually reflect through a mill and overlay. This option should be considered as a short term solution. Additional testing should be performed prior to a 2” mill and overlay being completed to ensure there is enough pavement structure in place to do this activity.

With a mill and overlay, a milling machine will remove the surface of the pavement and a layer of hot mix asphalt will be placed on top. This should only be done on pavement surfaces that are in good condition, as cracked or structurally unsound pavements below can cause the asphalt overlay to fail (the overlay will reflect all of the cracks from the surface below). However, this can be a good short term solution if you want to temporarily improve the aesthetics of your road.
**Reclamation**

Full Depth Reclamation (FDR) is a rehabilitation technique in which the full depth existing bituminous and a predetermined portion of the underlying materials (subgrade) is ground up and blended to provide a stronger, homogeneous material. This option is estimated to last 30 – 40 years with proper maintenance. A reclamation will disrupt existing crack patterns in the bituminous and subgrade so there is no concern of reflective cracking.

The quality of the existing materials will determining the strength of the reclaimed material, which in some cases, may not be sufficient to support new traffic loads and volumes. If the existing road materials will not provide adequate strength after a full depth reclamation, virgin aggregate, recycled aggregate, reclaimed asphalt pavement, or crushed concrete may be added. A stabilized reclamation includes the addition of portland cement, fly ash, lime, emulsion, or foamed asphalt and can increase the strength of the new reclaimed material. Pavements composed of poor subgrades are only candidates for a reclamation when additional work is performed to correct drainage and subgrade issues.

**Reconstruction**

Reconstruction is the replacement of the entire existing pavement structure by the placement of the equivalent or increased pavement structure. This option is estimated to last 40 – 50 years with proper maintenance. A full reconstruction will disrupt existing crack patterns in the bituminous and subgrade so there is no concern of reflective cracking.

Reconstruction usually requires the complete removal and replacement of the existing pavement structure. Reconstruction may utilize either new or recycled materials incorporated into the materials used for the reconstruction of the complete pavement section. Reconstruction is appropriate when a pavement has structurally failed and can no longer support the traffic demand. Reconstruction increases the structural capacity of the pavement to a level that is required for long term performance.
II. INTRODUCTION

What is a Pavement Management Program?

A pavement management program is a systematic method of inspecting and rating the pavement condition for a network of roads. The system performs cost effective analysis of various maintenance and rehabilitation strategies, which assists decision makers in making the best decision on the use of available resources. The pavement management ideology, if implemented, can drastically improve the life cycle costs, performance and life of roads. The objective of a pavement management program is to maintain a high level network, measure the effectiveness of alternatives, and optimize cost effectiveness and timing of maintenance and construction activity. These objectives are usually met by implementing a system to regularly collect data and verify the condition of a system of roads. This data is typically managed within a computer database or pavement management program which can manage, sort and store the collected data. From this computer database, a variety of reports can be run to evaluate the types of repairs or preservation techniques that could be implemented in a cost effective manner. As part of the data analysis, models can be run allowing an agency to see the effect implemented budgets have on the overall network OCI. Models can also be run to determine the budget that would be required to maintain the OCI at a specific value. This information is crucial to decision makers in all aspects of pavement management planning.

The Pavement Management Program is comprised of three components:

1) The assessment of the current pavement conditions of the City’s roadways and recommended maintenance and reconstruction actions.
2) Policies which will guide the timing and type of maintenance actions and reconstruction activities and the financing of activities, and
3) A general schedule for the maintenance and reconstruction of the streets, and strategies for the financing of these activities.

Why establish a Pavement Management Program?

The City of North St. Paul is continuing to make improvements to their Pavement Management Program to preserve the City’s asset of roadways, provide for the safe and efficient travel of its citizens, retain property values, keep the City attractive and desirable, and minimize costs to the property owners and taxpayers for the City.

The Pavement Management Program will provide a guide for the City to make strategic decisions related to roadway maintenance and reconstruction activities to maximize the useful life of pavement and to minimize maintenance costs by performing proper actions at the optimum time. The program will also provide for financing strategies to make the most efficient use of available resources.

What is Pavement Forensics?

Pavement forensics identifies what exists under the visible layer of the pavement and can give a wealth of information including depths of the pavement layers, signs of bonding or unbonding and distresses
that might not be visible from the road surface. Soil borings along the roadways can be used to identify
aggregate depths and soil classifications can provide a better understanding of the roadway section to
determine the appropriate pavement rehabilitation technique. Another option is pavement cores which
provide information on the pavement thickness, condition of the base course and amount of Class 5 that
is in place. The findings from a pavement forensic study have been proven to lead to cost savings and
better solutions for a road fix.
III. PAVEMENT CONDITION REPORT

PAVEMENT LIFE CYCLE

Pavements have a useful life beginning from the time they are constructed until they have deteriorated to the extent of being unusable. Figure 1 shows the typical life expectancy of pavement based on data from the Army Corps of Engineers. While the actual useable life of roadways can vary somewhat due to different factors, as indicated by this graph pavement begins to deteriorate shortly after construction at a fairly constant rate and then deteriorates more rapidly as the pavement ages and its condition declines.

Figure 2 shows the effect performing certain types of maintenance can have on a pavement lifecycle. Doing the right fix at the right time can extend the life of a pavement by more than 40 years.

ROADWAY PAVEMENT CONDITION EVALUATION

WSB & Associates completed pavement inspections on the roads in North St. Paul in 2015. This was done to establish the segments condition based upon what defects each segment contained. This information was entered into Cartegraph and the database was updated and the estimated conditions of the pavement were re-evaluated to determine the network OCI.

The program rates the roadways by using an Overall Condition Index (OCI) having a 1-100 scale with 100 being a perfect new roadway. It then uses the degradation curves to project how an OCI will drop so today’s OCI can be found. Cartegraph also gives budget-dependent maintenance protocols for a given time period.
FIGURE 1

PAVEMENT PERFORMANCE CURVE

Years in Service (Age)

PCI
Engineering staff has established the following OCI categories to describe the conditions of the roadways:

Excellent -- Overall Condition Index (OCI)  90.00 – 100.00
Good -- Overall Condition Index (OCI)  70.00 – 89.00
Fair -- Overall Condition Index (OCI)  35.00 – 69.00
Poor -- Overall Condition Index (OCI)  0.00 – 34.00

Photographs of representative road sections for each OCI category are included as Figure 3.

The types of improvements or maintenance strategies that would be expected or recommended for roadway segments within OCI categories are as follows. The following are guidelines only, and engineering judgement must be used to determine actual appropriate and feasible roadway maintenance and rehabilitation measures for any given roadway:

Excellent  OCI 90 – 100:  Minimal Maintenance, Timed Crack Seal/Surface Treatment
Good   OCI 70 – 89:  Crack Seal/Surface Treatment
Fair   OCI 35 – 69:  Mill and Overlay
Poor   OCI 0 – 34:  Reconstruction

EXISTING ROADWAY PAVEMENT CONDITIONS

Much of the roadway system at this time is in good or fair condition, but it is approaching a critical stage as an increasing percentage of the system falls within the Fair Category. Without proactive rehabilitation improvements, this major segment of the network is trending toward Poor Category. As illustrated in Table 1 which follows, the unit costs to address roadways in the Poor Category are significantly higher, increasing the overall cost to maintain or improve system integrity.

- Weighted average roadway OCI (2015) = 57.53
- Weighted average alley OCI (2015) = 30.20

A breakdown of the City’s roadway overall condition is:

<table>
<thead>
<tr>
<th>Overall Condition Index</th>
<th>Mileage</th>
<th>Percent of System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Category – 90.00 – 100.00</td>
<td>6.58 miles</td>
<td>14.60%</td>
</tr>
<tr>
<td>Good Category – 70.00 – 89.00</td>
<td>6.13 miles</td>
<td>13.60%</td>
</tr>
<tr>
<td>Fair Category – 35.00 – 69.00</td>
<td>25.22 miles</td>
<td>55.94%</td>
</tr>
<tr>
<td>Poor Category – 0.00 – 34.00</td>
<td>7.15 miles</td>
<td>15.86%</td>
</tr>
</tbody>
</table>
A breakdown of the City’s alleys overall condition is:

<table>
<thead>
<tr>
<th>Overall Condition Index</th>
<th>Mileage</th>
<th>Percent of System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Category – 90.00 – 100.00</td>
<td>0.00 miles</td>
<td>0.00%</td>
</tr>
<tr>
<td>Good Category – 70.00 – 89.00</td>
<td>0.105 miles</td>
<td>3.67%</td>
</tr>
<tr>
<td>Fair Category – 35.00 – 69.00</td>
<td>.833 miles</td>
<td>29.15%</td>
</tr>
<tr>
<td>Poor Category – 0.00 – 34.00</td>
<td>1.92 miles</td>
<td>67.18%</td>
</tr>
</tbody>
</table>

Appendix A is a map of all City roadways showing their OCI classification. The specific OCI rating for each roadway segment is contained in Appendix B.

### 2011 ROADWAY PAVEMENT CONDITIONS

As a comparison, the 2011 roadway pavement conditions are shown below.

- Weighted average roadway OCI (2011) = 66.57
- Weighted average alley OCI (2011) = 52.93

A breakdown of the City’s 2011 roadway overall condition is:

<table>
<thead>
<tr>
<th>Overall Condition Index</th>
<th>Mileage</th>
<th>Percent of System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Category – 90.00 – 100.00</td>
<td>4.55 miles</td>
<td>10.37%</td>
</tr>
<tr>
<td>Good Category – 70.00 – 89.00</td>
<td>16.79 miles</td>
<td>38.26%</td>
</tr>
<tr>
<td>Fair Category – 35.00 – 69.00</td>
<td>20.01 miles</td>
<td>45.60%</td>
</tr>
<tr>
<td>Poor Category – 0.00 – 34.00</td>
<td>2.53 miles</td>
<td>5.77%</td>
</tr>
</tbody>
</table>

A breakdown of the City’s alleys overall condition is:

<table>
<thead>
<tr>
<th>Overall Condition Index</th>
<th>Mileage</th>
<th>Percent of System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Category – 90.00 – 100.00</td>
<td>0.00 miles</td>
<td>0.00%</td>
</tr>
<tr>
<td>Good Category – 70.00 – 89.00</td>
<td>0.311 miles</td>
<td>10.86%</td>
</tr>
<tr>
<td>Fair Category – 35.00 – 69.00</td>
<td>2.15 miles</td>
<td>75.04%</td>
</tr>
<tr>
<td>Poor Category – 0.00 – 34.00</td>
<td>.404 miles</td>
<td>14.10%</td>
</tr>
</tbody>
</table>
NORTH ST. PAUL PAVEMENT RATING EXAMPLES

OCI RATING = 3

19th Avenue
Cartograph ID: 83.0035

Detailed Distresses:

- AC Patching, Moderate Severity, 58.8%
- AC Fatigue (Alligator) Cracking, High Severity, 93.1%
- AC Linear Cracking, High Severity, 3.1%
OCI RATING = 19.73

18th Avenue
Cartograph ID: 82.001

Detailed Distresses:

- AC Fatigue (Alligator) Cracking, Moderate Severity, 15.3%
- AC Linear Cracking, Moderate Severity, 1.2%
- AC Linear Cracking, High Severity, 2.6%
- AC Patching, Moderate Severity, 32.9%
OCI RATING = 28.43

Indian Way
Cartograph ID: 30.001

Detailed Distresses:

- AC Patching, Moderate Severity, 30.6%
- AC Linear Cracking, Moderate Severity, 45.36%
- AC Linear Cracking, High Severity, .7%
OCI RATING = 39.26

Memory Lane
Cartegraph ID: 42.001

Detailed Distresses:

- AC Patching, Moderate Severity, 21.3%
- AC Fatigue (Alligator) Cracking, Low Severity, 17%
- AC Linear Cracking, Moderate Severity, .5%
- AC Linear Cracking, High Severity, .3%
OCI RATING = 55.86

7th Street
Cartgraph ID: 92.005

Detailed Distresses:

- AC Fatigue (Alligator) Cracking, Low Severity, 1.12%
- AC Fatigue (Alligator) Cracking, Moderate Severity, 2.81%
- AC Linear Cracking, High Severity, .6%
- AC Linear Cracking, Moderate Severity, 3.6%
- AC Patching, Moderate Severity, 1.12%
OCI RATING = 70.59

Spirit Hills Lane
Cartograph ID: 37.001

Detailed Distresses:

- AC Linear Cracking, Low Severity, 22.94%
- AC Linear Cracking, Moderate Severity, 2.1%
OCI RATING = 82.29

Charles Street N
Cartegraph ID: 143

Detailed Distresses:

- PCC Joint Seal Damage, Moderate Severity, 45%
- PCC Linear Cracking, Moderate Severity, 17.6%
- PCC Linear Cracking, Low Severity, 11.8%
OCI RATING = 96.4

Holloway Avenue
Cartegraph ID: 29.001

Detailed Distresses:

- AC Linear Cracking, Low Severity, 1.8%
ROADWAY PAVEMENT CONDITION PROJECTIONS

Using the computer analysis, the expected useful life of each block was projected. This was done taking into account past records of maintenance and reconstruction. It is important to note that the historical pavement management protocol in the City has been primarily reactive and has included minimal preventative maintenance prior to 2013.

This analysis showed:

1. In order to maintain the current system OCI level, the annual budget for maintenance and rehabilitation is estimated to be approximately $1,480,000 a year.
2. By “front loading” the budgeted amount over a 20 year period (meaning spending more annually in the first 5 years than in the following 15 years), moderately improving the overall network OCI over 20 years can be achieved at slightly lower annual average budgets of $1,275,000 (Proposed Budget #3) and $1,400,000 (Proposed Budget #1).
3. If a more significant investment is made to raise the overall OCI to a 70, the network may be maintained at that level for a lower average annual budget of $1,042,351, which will provide cost savings over an analysis budget period of 20 years or the overall lifecycle of the pavement.
4. If no further investments are made in roadway maintenance and pavement remediation, the average OCI rating for the entire City is projected to be in the Poor category in approximately 10-15 years (2026 to 2031 timeframe). As it does nothing to address deteriorating roadway conditions, this is not a feasible or recommended option.
5. Based on the current adopted 2014-2020 Capital Improvement Plan and pavement management project practices, the current annual budget is approximately $1,100,000.

To facilitate the analysis, a model that was run had a protocol which included performing:

- A 2 inch bituminous mill and overlay when the OCI was between 35 and 69
- A full bituminous reconstruction when the OCI is less than 35
- A chip seal on the bituminous roadways at age 3
- A chip seal on the bituminous roadways when the OCI is between 70 and 90
- A full concrete reconstruction when the OCI is less than 35
- A partial depth concrete pavement rehabilitation when the OCI is between a 36 and 50.

The model that was run used the following unit costs:

- AC Mill and Overlay = $1.65 per square foot
- AC Reconstruction = $7.96 per square foot
- AC Surface Treatment (Includes Crack Sealing) = $.20 per square foot
- PCC Reconstruction = $11.35 per square foot
- PCC Partial Depth Pavement Rehabilitation = $5.44 per square foot

These unit costs were based on recent project costs from clients we have worked with. The unit costs were adjusted for inflation and include a cost factor for contingencies and indirect costs.
EXTENDING PAVEMENT LIFE BY SPECIAL MAINTENANCE ACTIONS

North St. Paul has typically engaged in chip seals, patching or reconstructs to extend the life of a roadway. These maintenance actions are anticipated to last several years and be cost effective.

In order to maximize the life cycle of the pavement at minimum maintenance cost, the proper maintenance actions need to be undertaken at the optimum time. An updated proposed schedule for these special maintenance activities is provided below in Table 2. This updated schedule includes performing maintenance activities based on the age of the pavement, not simply on the OCI value.

A map highlighting our recommendations for maintenance can be found in Appendix C. This is intended to be a guide and used to assist engineers in making decisions on road maintenance. Other factors such as scheduling of other projects, use of the road, expected life, cost, and public perception should also be considered. In general, chip seals should be used as a preventative maintenance activity and put on the road when the road is still in excellent to good condition. The map in Appendix C highlights roads which could be candidates for a surface treatment. Some roads were recommended to have no maintenance performed on them since they appeared to have had a recent or previous chip seal. Some roads are recommended to have no maintenance performed if they are in a stage where it will be more cost effective to let the OCI drop to the point at which a mill and overlay is appropriate. A typical concrete maintenance schedule would include doing a partial depth repair of the concrete at year 27-30 and then a full concrete reconstruction at year 50-60.
### TABLE 1

<table>
<thead>
<tr>
<th>Cumulative Pavement Age (Years)</th>
<th>Time Between Maintenance</th>
<th>Maintenance</th>
<th>Predicted OCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>New Construction</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>2 Years After New Construction</td>
<td>Initial Crack Seal</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>2 Years After Crack Seal</td>
<td>2nd Crack Seal</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Treatment</td>
<td>100</td>
</tr>
<tr>
<td>18-22</td>
<td>14-18 Years After Chip Seal</td>
<td>Mill and Overlay</td>
<td>59</td>
</tr>
<tr>
<td>20-24</td>
<td>2 Years After Overlay</td>
<td>Initial Crack Seal</td>
<td>78</td>
</tr>
<tr>
<td>22-26</td>
<td>2 Years After Chip Seal</td>
<td>2nd Crack Seal</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Treatment</td>
<td>97</td>
</tr>
<tr>
<td>36-44</td>
<td>14-18 Years After Chip Seal</td>
<td>Mill and Overlay</td>
<td>58</td>
</tr>
<tr>
<td>38-46</td>
<td>2 Years After Overlay</td>
<td>Initial Crack Seal</td>
<td>77</td>
</tr>
<tr>
<td>40-48</td>
<td>2 Years After Chip Seal</td>
<td>2nd Crack Seal</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Treatment</td>
<td>96</td>
</tr>
<tr>
<td>50-60</td>
<td>10-20 Years After Chip Seal</td>
<td>Reconstruction</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

**AVERAGE ANNUAL LIFECYCLE COST FOR ENTIRE NETWORK**

An exercise was done to see what the average annual life cycle cost would be per year assuming every segment in North St. Paul was constructed on the same day and underwent the same performance curve (i.e. all segments followed the same laid out 60 year plan for pavement maintenance). The results are shown in the following table. It can be seen that the estimated 60 year average annual cost would be close to $1,493,183. While this is higher than the current annual budget in place in North St. Paul, it helps demonstrate that an increase in the annual budget is needed to maintain the network of roads in North St. Paul. The City should establish the average OCI level at which the overall roadway network should be maintained.
## TABLE 2: Overall System Assumed Lifecycle Maintenance Annual Average Cost

<table>
<thead>
<tr>
<th>Maintenance Activity</th>
<th>Area (Square Feet)</th>
<th>Unit Cost (per square foot)</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 3 Bituminous Chip Seal</td>
<td>6,990,250</td>
<td>$0.20</td>
<td>$1,398,050.00</td>
</tr>
<tr>
<td>Year 18-20 Bituminous Mill and Overlay</td>
<td>6,990,250</td>
<td>$1.65</td>
<td>$11,533,912.50</td>
</tr>
<tr>
<td>Year 22-26 Bituminous Chip Seal</td>
<td>6,990,250</td>
<td>$0.20</td>
<td>$1,398,050.00</td>
</tr>
<tr>
<td>Year 36-44 Bituminous Mill and Overlay</td>
<td>6,990,250</td>
<td>$1.65</td>
<td>$11,533,912.50</td>
</tr>
<tr>
<td>Year 40-48 Bituminous Chip Seal</td>
<td>6,990,250</td>
<td>$0.20</td>
<td>$1,398,050.00</td>
</tr>
<tr>
<td>Year 60 Bituminous Reconstruct</td>
<td>6,990,250</td>
<td>$7.96</td>
<td>$55,642,390.00</td>
</tr>
<tr>
<td>Year 22-26 Concrete Partial Depth Repair</td>
<td>398,247</td>
<td>$5.44</td>
<td>$2,166,463.68</td>
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<tr>
<td>Year 60 Concrete Reconstruct</td>
<td>398,247</td>
<td>$11.35</td>
<td>$4,520,103.45</td>
</tr>
</tbody>
</table>

**Estimated 60 Year Average Cost (per year)**: $1,493,182.20

**MAINTENANCE COSTS INCREASE AS PAVEMENT GETS OLDER**

Maintenance costs increase considerably as the pavement gets older. This is why implementing a preventative maintenance strategy is both cost effective appropriate. Preventative maintenance actions such as crack seals, chip seals, fog seals, and microsurfacing are done at a much lower cost than preservation actions such as mill and overlays. The idea behind a preventative maintenance strategy is that you keep the good roads in good condition by applying the appropriate maintenance action at the right time at a lower cost. This is often a better strategy then waiting for the road to deteriorate before applying a fix at which point the fix needed may cost 9 to 10 times as much as a chip seal or a fog seal.
Figure 2 demonstrates that with preventative maintenance techniques you can extend the life of a pavement from 20 years to close to 60 years if the correct fix is done at the correct time. A good pavement management plan will budget for both preventative maintenance, to keep the good roads in good condition, and also for some roads to be reconstructed each year so that the worst roads start to be addressed.

**EFFECT OF ANNUAL BUDGET ON AVERAGE CONDITION OF SYSTEM**

**Proposed Budget #1:**
- Annual budget = $2,000,000 annually for the first 5 years on reconstructions. Plan years 6-20 have annual budgets of $500,000 for mill and overlays and partial depth concrete repairs, $400,000 for reconstructions and $100,000 for surface treatments.

**Proposed Budget #2:**
- Annual budget = $1,000,000 annually for the first 5 years on reconstructions. Plan years 6-20 have annual budgets of $250,000 for mill and overlays and partial depth concrete repairs, $400,000 for reconstructions and $100,000 for surface treatments.

**Proposed Budget #3:**
- Annual budget = $2,000,000 annually for the first 5 years on reconstructions. Plan years 6-20 have annual budgets of $500,000 for mill and overlays and partial depth concrete repairs, $100,000 for reconstructions and $200,000 for surface treatments.

**Proposed Budget #4:**
- Annual budget = $0 annually. This is a “Do Nothing” scenario and shows how the OCI will drop if no maintenance or rehabilitation is done.
### FIGURE 5

**Effect of Budget on OCI Level**

<table>
<thead>
<tr>
<th>Plan Year</th>
<th>Proposed Budget #1</th>
<th>Proposed Budget #2</th>
<th>Proposed Budget #3</th>
<th>Proposed Budget #4</th>
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<tbody>
<tr>
<td>1</td>
<td>59.41</td>
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<td>2</td>
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<tr>
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<td>60.67</td>
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<tr>
<td>4</td>
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<td>64.17</td>
<td>53.6</td>
<td>62.79</td>
<td>40.54</td>
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<td>9</td>
<td>65.06</td>
<td>53.3</td>
<td>63.09</td>
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<td>66.03</td>
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<td>70.32</td>
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<tr>
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<td>73.5</td>
<td>55.24</td>
<td>66.73</td>
<td>19.41</td>
</tr>
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</table>
HIGHER NETWORK OCI LEVELS COST LESS TO MAINTAIN

Figure 4 shows the budget required to maintain various OCI levels including the current average OCI of a 57.53. Figure 5 shows the effect certain budgets have on the OCI values. The graph and table illustrate that at an average network OCI of 70, the annual budgeted cost difference between maintaining an OCI of 65 compared to an average OCI of 70 is approximately $450,000, or $9,000,000 in savings over 20 years. It is important to note that:

1. The large one time budgeted expense in Plan Year 1 is for illustrative purposes only, and is intended to set the network overall OCI at the level at which it is to be maintained. A one-time expenditure of over $8,000,000 may not be financially feasible, however it illustrates the potential ongoing savings realized when maintaining a network at a higher OCI level, and the impact of “front loading” a pavement management plan budget.

2. These scenarios include doing both reconstructions and mill and overlays.

![Graph](image-url)

**Budget Required to Maintain OCI Level**

- **Maintain 57.53**
- **Maintain 65**
- **Maintain 70**
The current annual average budget for surface treatments, mill and overlays, and reconstructions is approximately $1,100,000. This report recommends the budget be increased to closer to a $1,400,000 annual budget for surface treatments, mill and overlays and reconstructions. Figure 4 shows that to maintain an OCI of 57.53 the average annual budget required would be $1,480,646 (includes all types of maintenance).
IV. PAVEMENT MANAGEMENT RECOMMENDATIONS

Using the computer analysis, many alternatives were run to determine the optimum actions to extend the pavement life at the lowest overall cost. It was found that the key to achieving that goal is doing the right maintenance action at the right time. This will require City initiated actions rather than waiting for complaints or petitions.

It is recommended that the City continue and enhance its maintenance and reconstruction program in order to continue to tackle the deteriorating network of roads. It is recognized that the desire to maintain a high overall condition must be balanced with the City’s financial capabilities to fund the maintenance and reconstruction program. Now that the City has begun to catch up on some larger reconstruction projects, it will be important to follow through with a preventative maintenance program to extend the life of the new roadways.

It is being recommended that it be the City’s intent to maintain the current roadway Overall Condition Index rating of 65 or 70 as the long term average condition rating of its roadway system. In order to maintain this rating, it has been determined that the present level of maintenance and reconstruction activities, and therefore funding must be increased.

This level of increased special maintenance and reconstruction funding will contribute towards improving the road network in the City over the next 20 years in comparison to continuing the past maintenance and reconstruction funding or providing no funding.

This report represents the initial presentation of data and analysis to the City Council for their use in the continuation of the development of an overall Pavement Management Program. It should not be construed to be a final public policy or plan and is subject to change pending further Council review and direction.