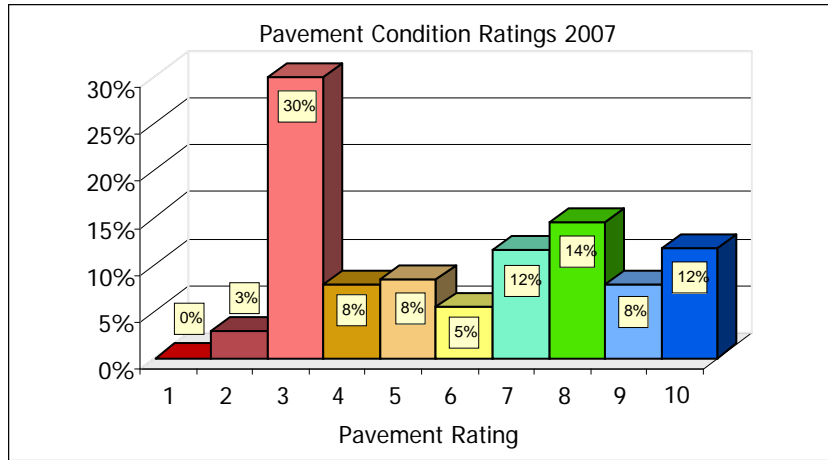
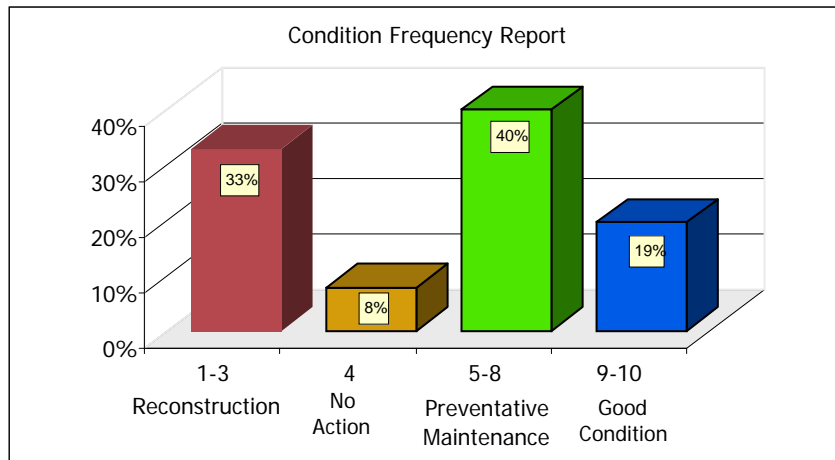


Background and Findings

The Village of Shorewood owns and maintains approximately 28 miles of roadway. Every odd year, in accordance with State Statute, the Shorewood Department of Public Works rates the Village roads according to the Wisconsin Department of Transportation PASER system. The graphic shown below is a summary of all Village maintained roads as rated in 2007, with corresponding updates for the roads reconstructed in 2008. This section also includes a Condition Frequency Map for a map corresponding to the graphic with a breakdown of roads by rating.



The graphic above indicates that one third of the Village roads are in need of reconstruction (rating 1-3). Additionally, more than one third (39%) of the Village roads are in need of preventative maintenance (rating 5-8). Only one fifth (20%) of the Village's roads are in a good enough condition that they do not require maintenance or reconstruction. This breakdown is graphically demonstrated below.



This section evaluates both the existing condition of the Village's roads and the performance of the Village's existing Street Replacement Program. A historical review of the Village's road ratings assesses the existing program and contrasts that with the improvements projected by implementing a Pavement Maintenance Program.

GENERAL

With an ever-changing climate and increasing amounts of traffic, paved roads are constantly subject to traffic wear. In order to control the deterioration of the roadway infrastructure, those roads that are in the worst shape must be identified so that immediate action can be taken. Further, those roads that are slightly deteriorated must also be identified so that preventative maintenance can be done to extend the service life of the pavement.

RATING YEAR

The ratings included in this report are as rated by the Department of Public Works Staff in 2007. Wisconsin State Statute 86.302(2) states that: "Every two years, municipalities and counties are required to submit pavement ratings to the Wisconsin Department of Transportation that represent the physical condition of roadways under their jurisdiction. Pavement rating information is due to WisDOT by December 15, odd year".

Pavement ratings were not completed again in 2008. However, the rating for the Morris Boulevard project, including adjacent roadways, was updated and included in this report.

WORK PLAN

The work plan outlines a systematic procedure used to evaluate the roads.

1. Rate all of the roads in the Village
2. Download Pavement Rating Spreadsheet
 - Download the information as provided by WisDOT.
 - Use the database to sort and analyze various aspects of the roadways
3. Recommend priority of street replacement
 - Review the existing program and amend as required based upon pavement ratings
4. Recommend methods of maintenance
 - Based upon the maintenance method associated with a particular road rating, evaluate which method is appropriate for each particular road
 - Compare the recommendations based solely upon the PASER system with those as identified by the Village of Shorewood DPW

PASER RATING SYSTEM

WisDOT requires biennial evaluation of all roads within the State. Most municipalities elect to review its roads in accordance to the Transportation Information Center's PASER Manuals. Manuals are available for asphalt, concrete and gravel roads, as well as several types of maintenance alternatives. This section includes an outline of the pavement ratings, descriptions and maintenance alternatives according to the PASER manual.

ASPHALT

Rating	Description	Type of Road	Maintenance Alternatives
10 & 9	Newly constructed or recently overlaid roads are in excellent condition and require no maintenance.	<ul style="list-style-type: none"> ▪ New Construction ▪ Recent Overlay 	None required
8	This category includes roads which have been recently sealcoated or overlaid with new road mix. It also includes recently constructed or overlaid roads which may show longitudinal or transverse cracks. All cracks are tight or sealed.	<ul style="list-style-type: none"> ▪ Recently Sealcoated ▪ New Road Mix ▪ Widely Spaced, Sealed Cracks ▪ Occasional, Sealed Cracks ▪ Single, Transverse Crack Less than ¼ inch wide 	Little or no maintenance required
7	Roads show first signs of aging, and they may have very slight raveling. Any longitudinal cracks are along paving joint. Transverse cracks may be approximately 10 feet apart. All cracks are ¼ inch or less with little or no crack erosion. Few, if any patches, all in very good condition.	<ul style="list-style-type: none"> ▪ Transverse and longitudinal cracks. Cracks are tight and sealed ▪ Transverse cracks About 10 feet apart and well sealed ▪ Longitudinal cracks Open crack at construction joint and tight transverse cracks 	Routine crack filling required
6	Roads are in sound structural condition but show definite signs of aging. Sealcoating could extend their useful life. There may be slight raveling. Transverse cracks can be frequent. Cracks may be sealed or open ¼ - ½ inch. First signs of block cracking. May have slight or moderate bleeding or polishing and patches are in good condition.	<ul style="list-style-type: none"> ▪ Slight surface raveling Cracks are tight, closely spaced ▪ Frequent transverse cracking Well-sealed ▪ Block cracking First sign of block cracking ▪ Moderate flushing 	Consider preservative treatment

Rating	Description	Type of Road	Maintenance Alternatives
5	Roads are still in good structural condition but clearly need sealcoating or overlay. They may have moderate to severe surface raveling with significant loss of aggregate. First signs of longitudinal cracks near edge. First signs or raveling along cracks. Block cracking up to 50% of surface. Extensive to severe flushing or polishing. Any patches or edge wedges are in good condition.	<ul style="list-style-type: none"> ▪ Block cracking ▪ Moderate raveling. Raveling is extensive with block cracking. Slight crack raveling ▪ Severe flushing ▪ Wedges and patches Extensive but in good condition ▪ Aging pavement, sound structural condition No surface distortion 	Preservative treatment required
4	Roads show first signs of needing strengthening by overlay or recycling. They have very severe surface raveling which should no longer be sealed. Many longitudinal and transverse cracks are raveling slightly. Over 50% of the surface may have block cracking. Patches are in fair condition. They may have rutting less than ½ inch deep or slight distortion.	<ul style="list-style-type: none"> ▪ Severe raveling Extreme loss of aggregate ▪ Transverse cracks Open with slight crack raveling ▪ Longitudinal and block cracking Load related distress–strengthening needed ▪ Extensive block cracking Over 50% of surface, tight cracks ▪ Patch and slight rutting 	Structural improvement required
3	Roads must be strengthened soon. Will require a thick overlay or recycling and very likely will require pavement patching and repair beforehand. Cracking will likely be extensive and show raveling and erosion. Surface may have severe block cracking and show first signs of alligator cracking. Patches are in fair to poor condition. There is moderate directional rutting (1 – 2 inches) and occasional potholes	<ul style="list-style-type: none"> ▪ Many, raveled cracks Wide and raveled cracks indicated need for recycling asphalt surface ▪ Severe block cracking Open cracks with some deterioration ▪ Alligator cracking near edge. Needs repair and drainage improvement prior to rehabilitation ▪ Patches and distortion Patches are in poor condition with road settled around patch 	Structural improvement required

Rating	Description	Type of Road	Maintenance Alternatives
2	Roads are very severely deteriorated and need reconstruction. These roads have more than 25% alligator cracking, severe distortion, potholes or extensive patches in poor condition.	<ul style="list-style-type: none"> ▪ Extensive alligator cracking ▪ Patches and rutting Patches are in poor condition and there is rutting in wheel paths ▪ Severe edge distortion Water trapped at pavement edge softening subgrade 	Reconstruction required
1	Roads have failed, showing severe distress and extensive loss of surface integrity.	<ul style="list-style-type: none"> ▪ Potholes ▪ Extensive loss of surface ▪ Failed Pavement surface mostly lost 	Reconstruction required

CONCRETE

Rating	Description	Type of Road	Maintenance Alternatives
10 & 9	Some traffic wear. Slight map cracking or pop-outs.	<ul style="list-style-type: none"> ▪ New Construction ▪ Traffic wear in wheel path. ▪ Slight map cracking or pop-outs. 	No maintenance required.
8	More surface wear, or slight defects showing in lanes. Pop-outs, slight surface scaling, partial loss of joint sealant, or isolated meander crack. Isolated manhole distress.	<ul style="list-style-type: none"> ▪ Pop-outs, map cracking, or minor surface defects. ▪ Slight surface scaling. ▪ Partial loss of joint sealant. ▪ Isolated meander cracks, tight or well sealed. ▪ Isolated cracks at manholes, tight or well sealed. 	Little or no maintenance required.

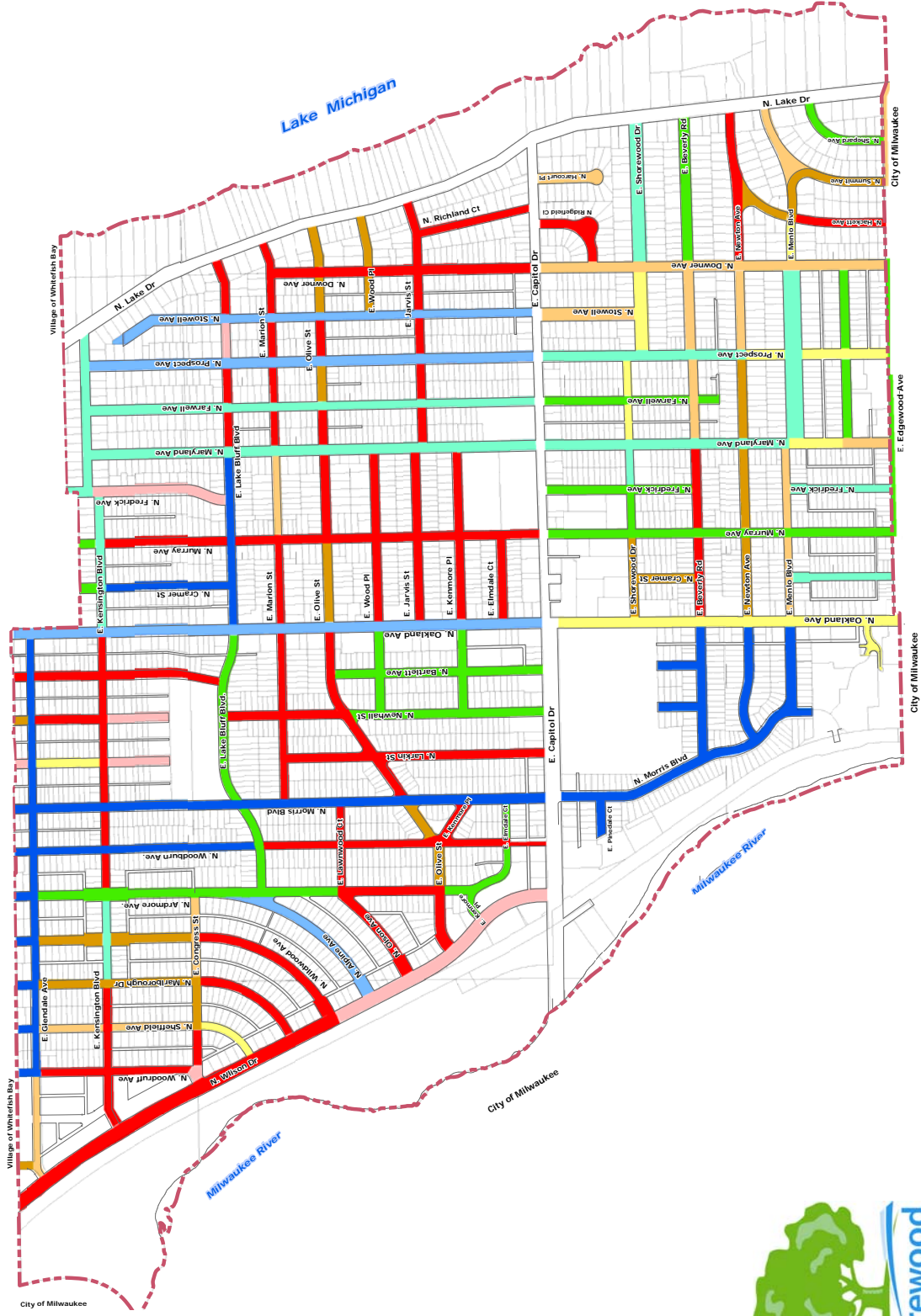
Rating	Description	Type of Road	Maintenance Alternatives
7	First signs of transverse cracking, patching or repair; more extensive pop-outs or scaling; some manhole displacement, isolated heave or settlement.	<ul style="list-style-type: none"> ▪ More extensive surface scaling. ▪ Some open joints. ▪ Isolated transverse or longitudinal cracks, tight or well sealed. ▪ Some manhole displacement and cracking. ▪ First utility patch, in good condition. ▪ First noticeable settlement or heave area. 	Seal open joints and other routine maintenance.
6	First signs of corner cracking or shallow reinforcement. More frequent transverse cracks. Open (1/4") joints and cracks. Moderate scaling.	<ul style="list-style-type: none"> ▪ Moderate scaling in several locations. ▪ A few isolated surface spalls. ▪ Shallow reinforcement causing cracks. ▪ Several corner cracks, tight or well sealed. ▪ Open (1/4" wide) longitudinal or transverse joints and more frequent transverse cracks (some open 1/4"). 	Needs general joint and crack sealing. Scaled areas could be overlaid.
5	First signs of joint or crack spalling, or faulting. Multiple cracking at corners with broken pieces. Patching in fair condition.	<ul style="list-style-type: none"> ▪ Moderate to severe polishing or scaling over 25% of the surface. ▪ High reinforcing steel causing surface spalling. ▪ Some joints and cracks have begun spalling. ▪ First signs of joint or crack faulting (1/4"). ▪ Multiple corner cracks with broken pieces. ▪ Moderate settlement or frost heave areas. ▪ Patching showing distress. 	Grind to repair surface defects. Some partial depth patching or joint repairs needed.

Rating	Description	Type of Road	Maintenance Alternatives
4	Severe surface distress requires asphalt overlay or extensive surface texturing. Multiple transverse cracks with spalling and broken pieces. Corner cracking with potholes or patches. Blowups.	<ul style="list-style-type: none"> ▪ Severe polishing, scaling, map cracking, or spalling over 50% of the area. ▪ Joints and cracks show moderate to severe spalling. ▪ Pumping and faulting of joints (1/2") with fair ride. ▪ Several slabs have multiple transverse or meander cracks with moderate spalling. ▪ Spalled area broken into several pieces. ▪ Corner cracks with missing pieces or patches. ▪ Pavement blowups. 	Needs some full depth repairs, grinding, and/or asphalt overlay to correct surface defects.
3	Most joints and cracks are open (1"), spalled, or patched. D-cracking is evident. Severe (1") faulting.	<ul style="list-style-type: none"> ▪ Most joints and cracks are open, with multiple parallel cracks, severe spalling, or faulting. ▪ D-cracking is evident. ▪ Severe faulting (1") giving poor ride. ▪ Extensive patching in fair to poor condition. ▪ Many transverse and meander cracks, open and severely spalled. 	Needs extensive full depth patching plus some full slab replacement.
2	Roads are very severely deteriorated and need reconstruction.	<ul style="list-style-type: none"> ▪ Extensive slab cracking, severely spalled and patched. ▪ Joints failed. ▪ Patching in very poor condition. ▪ Severe and extensive settlements or frost heaves. 	Recycle and/or rebuild pavement.
1	Roads have failed, showing severe distress and extensive loss of surface integrity.	<ul style="list-style-type: none"> ▪ Restricted speed. ▪ Extensive potholes. ▪ Almost total loss of pavement integrity. 	Total reconstruction.

CONDITION FREQUENCY MAP

The map found on the following page is a representation of each road in the Village and its corresponding rating. A detailed table of each road and its rating can be found in the appendix.

2007 Village of Shorewood Pavement Ratings



Legend	Pavement Rating
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10



HISTORICAL PERFORMANCE

RECENTLY CONSTRUCTED STREETS

The Village of Shorewood operates a street replacement program which reconstructs a portion of the Village's roads on a biennial basis. The program history dates back to 1993. The table below provides a summary of project length per project year based upon Village maintenance records.

Year	Project Length (Linear Feet)	Percent of total road length
1993	3380	2.3%
1994	2642	1.8%
1995	317	0.2%
1996	3433	2.3%
1997	4807	3.2%
1998	4383	2.9%
1999	5123	3.4%
2000	3908	2.6%
2001	368	0.2%
2002	11,353	7.6%
2003	3,433	2.3%
2005	5,705	3.8%
2006	7,445	5.0%
2007	457	0.3%
2008	9,475	6.4%

Prior to 2002, the Village of Shorewood reconstructed roads at an average rate of 2.4% per year. At that rate, it would take the Village 42 years to reconstruct all of the roads within its corporate limits. After 2002, the Village implemented a new version of its Street Replacement Program which projected to reconstruct all of the roads within the corporate limits by 2034.

While the reconstruction of all of the roads within the Village will eventually be required, completing only reconstruction projects every two years places a large strain on the road budget. This strain cannot be relieved without the implementation of intermediate maintenance. Upon completion of the existing Street Replacement Program in 2034, another program would be created in its place to begin reconstructing the roads all over again in 2036.

The table below shows the reconstruction projects from 1993 to date and also provides its current PASER rating. The table demonstrates how many of the “recently” reconstructed roads have begun to deteriorate, several to a rating of 6-7. Without a formal program, maintenance efforts are concentrated on those roads showing an immediate need for maintenance. While it is important to provide maintenance on an as needed basis, it is also important to provide maintenance prior to the appearance of significant deterioration. A good cracksealing program, for example, implemented within the first 3-5 years of reconstruction can significantly increase the amount of time until a more expensive maintenance strategy is required.

Road	Year Reconstructed	2007 Rating
North Morris Boulevard	2008	10
East Beverly Road (North Morris Boulevard to North Oakland Avenue)	2008	10
North Newton Avenue (North Morris Boulevard to North Oakland Avenue)	2008	10
East Menlo Boulevard (North Morris Boulevard to North Oakland Avenue)	2008	10
North Newhall Street (East Beverly Road to termini)	2008	10
North Bartlett Avenue (East Beverly Road to termini)	2008	10
East Pinedale Court	2008	10
East Glendale Avenue (North Woodruff Avenue to North Larkin Street)	2006	10
North Woodburn Avenue (East Lake Bluff Boulevard to corporate limits)	2006	10
East Lake Bluff Boulevard (North Oakland Avenue to North Maryland Avenue)	2006	10
North Cramer Street (East Lake Bluff Boulevard to East Kensington Boulevard)	2006	10
North Woodruff Avenue (East Glendale Avenue to termini)	2006	10
North Sheffield Avenue (East Glendale Avenue to termini)	2006	10
North Marlborough Drive (East Glendale Avenue to termini)	2006	10
North Ardmere Avenue (East Glendale Avenue to termini)	2006	10
North Morris Boulevard (East Glendale Avenue to termini)	2006	10
North Prospect Avenue (East Capitol Drive to East Kensington Boulevard)	2005	9
North Stowell Avenue (East Capitol Drive to East Lake Bluff Boulevard)	2005	9
North Murray Avenue (corporate limits to East Capitol Drive)	2003	8
North Frederick Avenue (East Beverly Road to East Shorewood Drive)	2003	8
North Ardmere Avenue (East Lawndale Court to East Glendale Avenue)	2002	8
North Alpine Avenue (North Wilson Avenue to North Ardmere Avenue)	2002	9
East Lake Bluff Boulevard (North Ardmere Avenue to North Oakland Avenue)	2002	8

Road	Year Reconstructed	2007 Rating
North Newhall Street (East Capitol Drive to East Olive Street)	2002	8
North Bartlett Avenue (East Capitol Drive to East Olive Street)	2002	8
East Kenmore Place (North Newhall Street to North Oakland Avenue)	2002	8
East Beverly Road (North Downer Avenue to North Lake Drive)	2000	8
East Menlo Boulevard (North Maryland Avenue to North Downer Avenue)	2000	7
East Stratford Court (North Prospect Avenue to North Downer Avenue)	2000	8
North Shepard Avenue (corporate limits to North Lake Drive)	2000	8
North Cramer Street (corporate limits to East Menlo Boulevard)	1999	7
North Frederick Avenue (corporate limits to East Menlo Boulevard)	1999	7
North Maryland Avenue (Stratford Court/Menlo alley to East Capitol Drive)	1999	7
North Farwell Avenue (termini to East Capitol Drive)	1999	8
North Farwell Avenue (East Capitol Drive to East Kensington Boulevard)	1998	7
East Glendale Avenue (North Larkin Avenue to North Oakland Avenue)	1997	10
East Kensington Boulevard (North Oakland Avenue to North Lake Drive)	1997	7
North Stowell Avenue (East Lake Bluff Boulevard to termini)	1997	9
East Wood Place (North Stowell Avenue to North Downer Avenue and North Downer Avenue to North Lake Drive)	1997	4
North Oakland Avenue (East Capitol Drive to East Jarvis Street and East Wood place to East Kensington Boulevard)	1996	9
North Oakland Avenue (East Jarvis Street to East Wood Place)	1995	9
North Prospect Avenue (corporate limits to East Menlo Boulevard and East Menlo Boulevard to East Beverly Road)	1994	6
North Prospect Avenue (East Beverly Road to East Capitol Drive)	1994	7
North Maryland Avenue (East Capitol Drive to East Marion Street and East Marion Street to East Kensington Boulevard)	1993	7

A map of the Village's previous Street Replacement Programs (1993-2008) can be found on the following page.

Village of Shorewood Previous Street Replacement Programs (1993 - 2008)

Legend	Year Completed
	2008
	2007
	2006
	2005
	2003
	2002
	2001
	2000
	1999
	1998
	1997
	1996
	1995
	1994
	1993

(Prior to 1993 Slurry Seal Only)



Cyclical Maintenance

Portions of this information were presented to the Village in 2008 as a part of the Life Cycle Cost Analysis report contrasting the lifetime cost differences between asphalt and concrete.

This section introduces the theory of cyclical maintenance. With budget constraints, it is not feasible for the Village to simultaneously maintain all of its roads each year. Establishing a routine maintenance service associated with each pavement rating and then implementing that maintenance strategy on various roads based upon priority, average daily traffic or project location provides the long term planning required for a successful maintenance program.

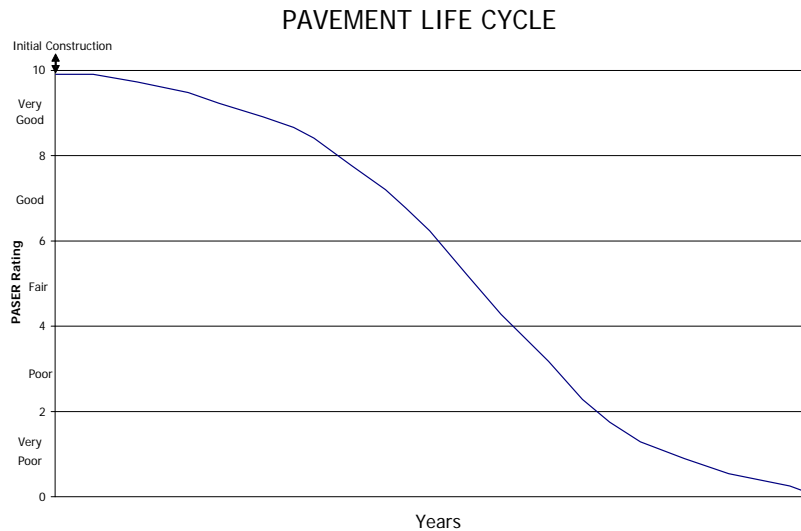
Proper maintenance management requires a valid evaluation of current conditions (Background and Findings), determination of the best method of maintenance (Maintenance Strategies) and selection of those projects that will fit within the budget (Pavement Maintenance Program).

PERPETUAL DETERIORATION

Roads are constantly subject to the effects of aging. Aging leads to pavement deterioration which can be caused by daily traffic, truck deliveries and weather conditions. In Wisconsin, roads are adversely affected by harsh freeze/thaw cycles. In the fall, tiny cracks within the pavement surface appear and by the next spring they have widened to 1-2" cracks.

The moment a reconstructed road is opened to traffic it begins to deteriorate. While a well-constructed road will not show signs of aging for several years, subsurface deterioration and surface deterioration not yet visible by the naked eye begin to affect the integrity of the newly constructed road. Due to constant and instantaneous decline, municipalities are continually juggling projects in an attempt to manage the rate of deterioration.

The rate of deterioration is directly related to time. The graph below depicts a typical deterioration cycle of a road with no maintenance.



Municipalities are constantly trying to stay ahead of pavement deterioration. With each of its roads deteriorating, roads are reconstructed or maintained in an effort to keep them from deteriorating to the point that they are no longer passable. Generally speaking, when a road becomes “bad enough” it is reconstructed. However, there are many maintenance strategies the Village can implement to extend the time between road reconstruction projects and even maintenance projects. This section proposes that the Village utilize cyclical maintenance to extend the life of its roads.

PROGRAM GOALS

The goal of cyclical maintenance is not to simultaneously upgrade all Village roadways to a “10” rating. Rather, the program focuses on arranging the maintenance schedule in a manner which creates a consistent budget over the life of the program. The most cost-effective program will have roads with various ratings, to avoid having weighted costs up-front. By increasing the amount of preventative maintenance each year in the program, the Village increases the service life of the roads and, in turn, decreases the overall cost of maintaining its roads.

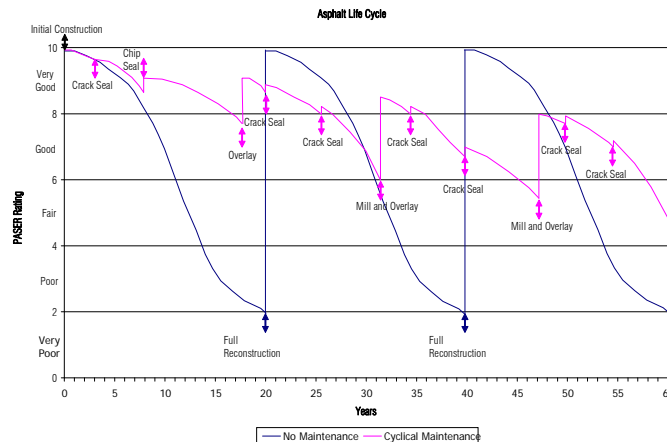
Another program goal is to extend the design life of a road. With routine maintenance, the Village can slow the rate of deterioration, thereby increasing the life of the road. A product of a longer design life is an increase in the time between reconstruction projects. Increasing the life of the road also increases the amount of time between reconstruction projects and reduces the budget expenditures on reconstruction projects. Maintenance projects are less costly than reconstruction, which also allows the Village to reduce its overall road budget.

ASPHALT

LIFE CYCLE

When an asphalt road is initially constructed, a typical road would be designed for 20 years (with proper drainage). Therefore a road left unmaintained over its lifetime would require reconstruction again in 20 years. This applies to the design life only, while the actual road surface may deteriorate at varying levels based upon traffic loading, drainage and initial construction.

With the implementation of cyclical maintenance, the design life of the road can be extended significantly. For an asphalt road, maintenance generally includes cleaning, grouting and sealing cracks as needed at 3-5 year intervals, and paving an overlay or completing a mill and overlay every 10-15 years. The performance of this routine maintenance may extend the design life of a road from 20 to 60 years.



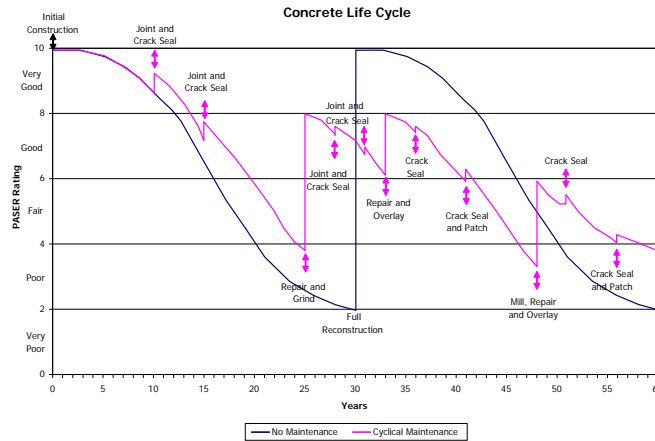
The graph represents both maintenance strategies: reconstruction only and cyclical maintenance. In a 60-year road lifetime, an asphalt road would require the initial construction, as well as two reconstructions. Cyclical maintenance reduces the annual cost of the road over the 60-year lifespan by 44%. Please refer to the Life Cycle Cost Analysis for exact calculations.

CONCRETE

LIFE CYCLE

When a concrete road is initially constructed, a typical road would be designed for 30 years (with proper drainage). Therefore a road left unmaintained over its lifetime would require reconstruction again in 30 years. This applies to the design life only, while the actual road surface may deteriorate at varying levels based upon traffic loading, drainage and initial construction.

With the implementation of cyclical maintenance, the design life of the road can be extended significantly. For a concrete road, maintenance generally includes patch repair as required, joint and crack sealing every 5-7 years, and repair and grind or repair and overlay every 10-12 years. The performance of this routine maintenance may extend the design life of a road from 30 to 60 years.



The graph represents both maintenance strategies: reconstruction only and cyclical maintenance. In a 60-year road lifetime, a concrete road would require the initial construction, as well as one reconstruction. Cyclical maintenance reduces the annual cost of the road over the 60-year lifespan by 34%. Please refer to the Life Cycle Cost Analysis for exact calculations.

TIMELINE

EFFECTIVE PROGRAM

A maintenance program must be in place for several years before there is an accurate measure of its effectiveness. Prior to the implementation of the program, roads are steadily deteriorating without maintenance. In the first year that maintenance is performed, the rate of deterioration on that particular road is slowed, but the remaining roads in the Village continue to deteriorate at the same rate.

After several years of program implementation, the number of reconstructed or maintained roads in the Village will outnumber the roads in the Village with no maintenance. At that time, there can be a true measure of the program's effectiveness. Analysis will show that roads rated 4-10

(maintenance only) will remain in that range longer before slipping into the 1-3 range (reconstruction).

Maintenance Strategies

The Village of Shorewood's existing Street Replacement Program is based upon biennial reconstruction of Village Roads. In order to plan the priority of the projects, Bonestroo generated a map of all of the Village owned roads within the Village and indicated which year the roads would be scheduled for reconstruction (see Street Replacement Program). The map represented a course of action for the Village to reconstruct roads over a 10-year period.

Without an effective maintenance program to accompany the Street Replacement Program, the Village will constantly be reconstructing its roads, with no relief from reconstruction projects or for budget constraints.

This section of the report defines types of pavement distress and failure and provides options for preventative maintenance.

GENERAL

The construction industry provides several alternatives for municipalities to use as maintenance strategies in addition to reconstruction. Typically maintenance strategies are selected based upon the type and rate of deterioration of a road. The strategy should take into account the type of pavement, the current road condition, or rating, the intended life of the maintenance and the traffic conditions.

PROGRAM

Although the program designates a maintenance strategy based upon the pavement type and rating, at the time of maintenance each road should be reevaluated to verify the prescribed maintenance is appropriate.

LIFE OF MAINTENANCE

The life span of an individual maintenance strategy is intended to slow the rate of deterioration. The applied maintenance should prolong the life of the road until it is time to apply the next maintenance strategy. There is no single strategy, including reconstruction, which will prevent deterioration or that will not require maintenance. By utilizing cyclical maintenance, a municipality can predict the deterioration of a roadway and apply maintenance strategies according to a prescribed schedule. The result is a road that increases its road rating or maintains its existing rating for a longer period of time.

MAINTENANCE ALTERNATIVES

The following are possible maintenance and repair alternatives along with costs associated with the improvement. Please note that all cost estimates have been obtained via the WisDOT – Average Unit Price List and will vary depending upon project size and location. Each project should be individually evaluated before determining the maintenance budget.

ASPHALT

CRACK SEALING

- **Description** – First step: clean and rout (as needed) cracks. Second Step: fill with sealing compound. There should be no water in the crack at the time of sealing. Process will close

the cracks and prevent water from entering aggregate base. The process also prevents damage from freeze-thaw cycles. Generally used to repair cracks up to 3 inches in depth.

- **Cost** – Estimated at \$0.60 per linear foot of joint/crack sealed, but the amount of material required will fluctuate based upon the width and depth of the cracks.

CHIP SEAL

- **Description** – Chip sealing is a form of emulsified asphalt surface treatment. An emulsion (mix of asphalt and water) is sprayed onto the pavement surface. A layer of gravel is spread over the surface and compacted.
- **Cost** – Estimated at \$40.00 per cubic yard of application depending on the quantity applied. Unit prices can vary significantly for small amounts.

SCRATCH COAT

- **Description** – Less invasive than milling or pulverizing, a metal or stiff rubber strike off is used to “scratch” the top of the asphalt to create an even surface. An emulsion or overlay is paved on top.
- **Cost** – Estimated at \$5 per square yard depending on the amount of material required to build the surface.

MILLING

- **Description** – Process by which the pavement surface is scraped off. The milled pavement may be used as the aggregate in the overlay, or removed. Milling must be accompanied by a chipseal or overlay, depending upon the depth milled and surface condition.
- **Cost** – Estimated at \$8.00 per square yard including a 2-inch overlay of asphalt depending on the quantity of milling required.

PULVERIZING

- **Description** – Pulverizing is a process by which the surface is broken down and ground into additional base material. The end result is an increased base depth to which an additional layer of pavement can be applied.
- **Cost** – Estimated at \$7.50 per square yard including a 2-inch overlay of asphalt depending on the quantity of pulverizing required.

ASPHALT OVERLAY

- **Description** – Process by which an additional layer of asphalt is added to the road surface. Depth of overlay required depends upon the existing condition of the road surface.
- **Cost** – Estimated at \$6.50 per square yard for a 2-inch overlay.

HAND PATCHING

- **Description** – Localized repair. The existing pavement may be sawcut and removed, milled or pulverized. The void is filled by hand with asphalt and compacted in place.
- **Cost** – Estimated at \$4.00 per square yard based on a thickness of 2 inches.

RECONSTRUCTION

- **Description** – Complete removal of the existing pavement surface and aggregate base, if required. Paving of new road surface in accordance with the approved cross section. If required, drainage improvements and utility replacement/repair should be completed prior to reconstruction.
- **Cost** – Varies dependent upon the scope of reconstruction including pavement and base removal, curb and gutter replacement or repair, sidewalk and any alignment adjustments required. An individual cost estimate should be prepared for each project.

CONCRETE

JOINT AND CRACK SEAL

- **Description** – First step: clean and rout (as needed) cracks. Second Step: fill with sealing compound. There should be no water in the crack at the time of sealing. Process will close the cracks and prevent water from entering aggregate base. The process also prevents damage from freeze-thaw cycles. Generally used to repair cracks up to 3 inches in depth.
- **Cost** – Estimated at \$0.60 per linear foot of joint/crack sealed, but the amount of material required will fluctuate based upon the width and depth of the cracks.

CRACK/JOINT REPAIR

PARTIAL DEPTH

- **Description** – First step: remove damaged concrete, typically by milling. Step two: apply bonding grout and place new concrete to the same grade and alignment. Step three: reestablish joints, either by tooling or sawing, or placing compression materials as required.
- **Cost** – Estimated at \$9.50 per linear foot of joint and \$14.75 per linear foot of crack repair, but the depth of removal and replacement of concrete will cause the price to vary significantly.

FULL DEPTH

- **Description** – First step: saw cut and remove full depth of concrete slab to the base course, to include damaged concrete and sufficient buffer. Step two: apply bonding grout and place and cure new concrete to the same grade and alignment. Step three: reestablish joints, either by tooling or sawing, or placing compression materials as required.
- **Cost** – Estimated at \$200 per square yard of repair, but the existing cross section will cause the price to vary significantly.

REPAIR AND OVERLAY

- **Description** – Localized repair of concrete (partial depth or full depth), method similar to that of the crack/joint repair. Once completed, a bonding agent would be applied to the surface and the road overlaid with asphalt.
- **Cost** – Repair costs as outlined above. Asphalt overlay estimated at \$6.50 per square yard for a 2-inch overlay.

GRIND, REPAIR AND OVERLAY

- **Description** – First step: localized repair of concrete (partial depth or full depth), method similar to that of the crack/joint repair. Second step: diamond grinding of concrete surface to remove the top several inches of concrete. Third step: application of a bonding agent and paving of an asphalt overlay.
- **Cost** – Repair costs as outlined above. Grinding estimated at \$3.50 per square yard. Asphalt overlay estimated at \$6.50 per square yard for a 2-inch overlay.

RECONSTRUCTION

- **Description** – Complete removal of the existing pavement surface and aggregate base, if required. Paving of new road surface in accordance with the approved cross section. If required, drainage improvements and utility replacement/repair should be completed prior to reconstruction.
- **Cost** – Varies dependent upon the scope of reconstruction including pavement and base removal, curb and gutter replacement or repair, sidewalk and any alignment adjustments required. An individual cost estimate should be prepared for each project.

All prices vary depending on the classification of road. Namely, the maintenance and reconstruction of major arterials is generally more costly than the maintenance and reconstruction of local neighborhood roads.

ASPHALT ON CONCRETE

The maintenance for roads consisting of asphalt on concrete is dependent upon the road's original construction. If the road was originally constructed with a concrete base and asphalt surface, the road is typically maintained as if it was an asphalt road, with localized concrete base repair when required. If the road was originally constructed as a concrete road and an asphalt overlay has since been applied as a form of maintenance, the road is typically approaching a reconstruction. However, continued maintenance including crack sealing, patching and mill, repair and overlay will continue to prolong the life of the road.

MILL, REPAIR AND OVERLAY

- **Description** – Generally completed on a concrete road that had previously been maintained via a grind, repair and overlay. The asphalt surface is milled off and removed, localized concrete repair completed as necessary, with a reapplication of an asphalt overlay.
- **Cost** – Repair costs as outlined above. Mill and overlay estimated at \$8.00 per square yard for a 2-inch overlay of asphalt depending on the quantity of milling required.

All prices vary depending on the classification of road. Namely, the maintenance and reconstruction of major arterials is generally more costly than the maintenance and reconstruction of local neighborhood roads.

MAINTENANCE SCHEDULE

ASPHALT

In conjunction with PASER ratings, the following table was created to manage the type of maintenance required on Village Roads:

ROAD RATING	TYPICAL MAINTENANCE
1	Reconstruction
2	Reconstruction
3	Reconstruction
4	No Maintenance
5	Mill/Pulverize and Overlay
6	Mill/Pulverize and Overlay
7	Chip Seal
8	Chip Seal
9	Crack seal within 3-5 years of reconstruction
10	No maintenance required

As outlined in the maintenance section of this report, roads rated at a 9 or 10 are in good condition and not in need of maintenance. However, roads should be crack sealed within the first three to five years after reconstruction. Roads rated 9 that are deteriorating at a slow rate may be recommended for a crack seal.

Roads rated at a 7 or 8 are beginning to show signs of wear and could benefit from localized patching and an overall sealcoat or chipseal. Roads rated at a 5 or 6 may show signs of some localized cracking and the life of the road would be prolonged with an overlay, or scratchcoat and overlay in cases of heavier cracking. Roads rated at a 4 show signs of structural damage and are beyond benefit of an overlay. However, roads rated at a 4 have not yet deteriorated to the point that they require complete reconstruction. These roads are best left to decline until such time that reconstruction is warranted. Roads rated at a 1-3 have already depreciated to the point that a complete reconstruction is required.

CONCRETE

In conjunction with PASER ratings, the following table was created to manage the type of maintenance required on Village Roads:

ROAD RATING	TYPICAL MAINTENANCE
1	Reconstruction
2	Reconstruction
3	Grind, repair and overlay or mill, repair and overlay
4	Crack Seal and Patch
5	Repair and Overlay
6	Repair and Overlay
7	Joint and Crack Seal
8	Joint and Crack Seal
9	Joint and Crack Seal within 3-5 years of Reconstruction
10	No maintenance required

Please note that the recommended maintenance is also dependent upon the age of the road. In the case of roads rated 3-4, the grind, repair and overlay or mill, repair and overlay will depend upon whether the road was previously overlaid. The cyclical maintenance graph and individual pavement evaluation will be utilized to determine the proper method of maintenance.

As outlined in the maintenance section of this report, roads rated at a 9 or 10 are in good condition and not in need of maintenance. However, roads should be joint and cracksealed within the first three to five years after reconstruction. Roads rated 9 that are deteriorating at a slow rate may be recommended for a crack seal.

Roads rated at a 5 or 6 are beginning to show signs of wear and could benefit from localized repair and overlay. Roads rated at a 4 benefit from crack seal and patching. Depending upon the type and rate of deterioration, the life of roads rated 3 may be prolonged by a repair and grind or repair, grind and overlay. Roads rated at a 1-2 have already depreciated to the point that a complete reconstruction is required.

ASPHALT ON CONCRETE

In conjunction with PASER ratings, the following table was created to manage the type of maintenance required on Village Roads:

ROAD RATING	TYPICAL MAINTENANCE
1	Reconstruction
2	Reconstruction
3	Reconstruction
4	Mill, Repair and Overlay
5	Crack Seal and Patch
6	Repair and Overlay
7	Crack Seal
8	Crack Seal
9	No maintenance required
10	No maintenance required

Asphalt on concrete construction typically follows the maintenance strategy of a concrete road, as the asphalt overlay itself is a form of maintenance. For roads constructed or reconstructed as asphalt on concrete, the table above prescribes a method of maintenance. As with asphalt and concrete roads, asphalt on concrete roads rated 9 or 10 are in good condition and do not require maintenance. Roads rated 6 or 7 benefit from crack sealing. Roads rated 6 should have the concrete base repaired and an asphalt overlay installed. Roads rated 5 may require asphalt crack sealing and localized patching. As the road deteriorates to a rating of 4, the road will benefit from a mill, repair and overlay. Roads deteriorating to a 1-3 should be reconstructed.