Memorandum
Department of Public Works

TO: Michael O. Geisel, P.E.
City Administrator

FROM: James A. Eckrich, P.E.
Public Works Dir. / City Engineer

DATE: June 1, 2023

RE: Concrete Pavement Report

As you know, for some time we have been working on an analysis of our concrete pavement in an attempt to quantify whether our financial planning and pavement management strategy are appropriate to maintain our significant concrete infrastructure. The result of this effort is the attached Concrete Management Report (Report).

The Report, which was substantially completed by Civil Engineer Anjana Kittu and Assistant City Engineer Zachary Wolff, does an excellent job of detailing our pavement infrastructure, the current condition of our pavement, and future condition of our pavement. While the document is very technical where necessary (such as the pavement deterioration curve of y = -0.002x^3 + 0.0109x^2 – 0.2525x +10) it also effectively explains our concrete infrastructure planning in understandable terminology.

I am not going to attempt to duplicate the significant data contained in the report within this memorandum. I highly encourage anyone receiving the Report to take the time to review it in detail. The big takeaway is that our concrete pavement infrastructure is aging (most pavement between 25 and 30 years old) and our overall pavement condition rating is decreasing (from 8.19 in 2013 to 7.82 in 2022). The Report shows that even at the planned capital funding of nearly $5 million annually the overall network rating will continue to decrease. Accordingly, it is imperative that funding designated for street replacement not be repurposed. Further, it is important that we work to fill the high vacancies in the Street Maintenance Division to ensure that we can maintain our pavement and avoid high replacement costs until pavement has truly reached its end-of-life.

Our overall pavement network is in good to very good condition and will remain that way with the planned funding levels. But it is important to acknowledge that good to very good pavement is a baseline expectation of our residents. Accordingly, sufficient

capital funding for streets must be approved annually and not be reallocated for other purposes to ensure we can effectively address our streets and maintain them into the future. Further, it may be appropriate, in the near future, to reconsider the City's intolerance for asphalt joint repair and patching on concrete streets so that we are not prematurely replacing concrete pavement before it has achieved its intended service life.

Action Recommended

This matter should be forwarded to the Planning and Public Works Committee of City Council, where it should be "received and filed." No City Council action is necessary at this time. Should PPW require additional information related to our street infrastructure it should direct City Staff to conduct further work / research accordingly.

Please forward to PPW for explanation, review, and further consideration.

2023-6-4

City of Chesterfield

Concrete Pavement Report

June 2023

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1. Introduction and Purpose

The City of Chesterfield's (City) pavement system includes approximately 184 miles of publicly maintained roadways. The purpose of this report is to provide an analysis of the City's concrete pavement system. The analysis will include the following sections: pavement inventory, inspections, and ratings (type, classification, age, condition, quantity); historical pavement condition and spending; pavement condition prediction; future budget scenarios and condition implications; and a summary. This report will be updated annually in advance of the City's annual budget process.

While some information on the City's asphalt pavement is included in this Report, the intent of this Report is to concentrate on our concrete pavement infrastructure. Complete information on the City's asphalt pavement system can be found in the Asphalt Pavement Maintenance and Inspection Manual.

2. Pavement Inventory, Inspections, and Ratings

The City's pavement data is maintained by the GIS Division of the IT Department in collaboration with the Public Works Department. Appendix A includes a table of pertinent concrete pavement data that will be updated annually. Most of the City's pavement system, approximately 92% or 170 miles, is concrete pavement. The remainder of the City's pavement system, approximately 8% or 14 miles, is asphalt pavement. There is one small brick paver street segment on Appalachian Trail. As stated above, this report will focus on concrete pavement.

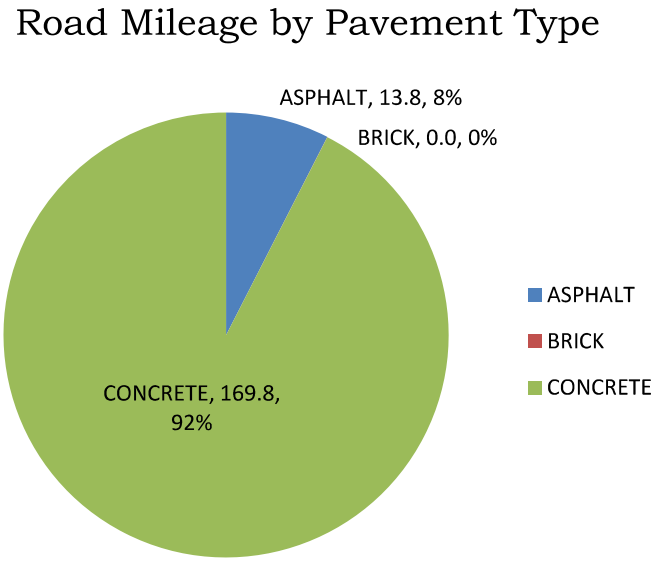


Figure 1

The City's roadways are classified into three categories: local, collector, and minor arterial. Local roads generally serve individual residences and include internal subdivision streets. Collector roads, as the name implies, collect traffic from local roads, provide connectivity into the arterial road system, and have fewer direct access points compared to local roads. Collector roads include Wildhorse Parkway, Greentrails Drive South, and Highcroft Drive. Minor arterial roads serve to efficiently move traffic through an area, typically with even fewer direct access points than collector roads. City maintained minor arterial roads are Edison Avenue, Ladue Road, Hog Hollow, and Schoettler Road. Figure 2 below shows the current street classification and total miles of City streets in each category. The City's current Street Classification Map is included as Appendix B.

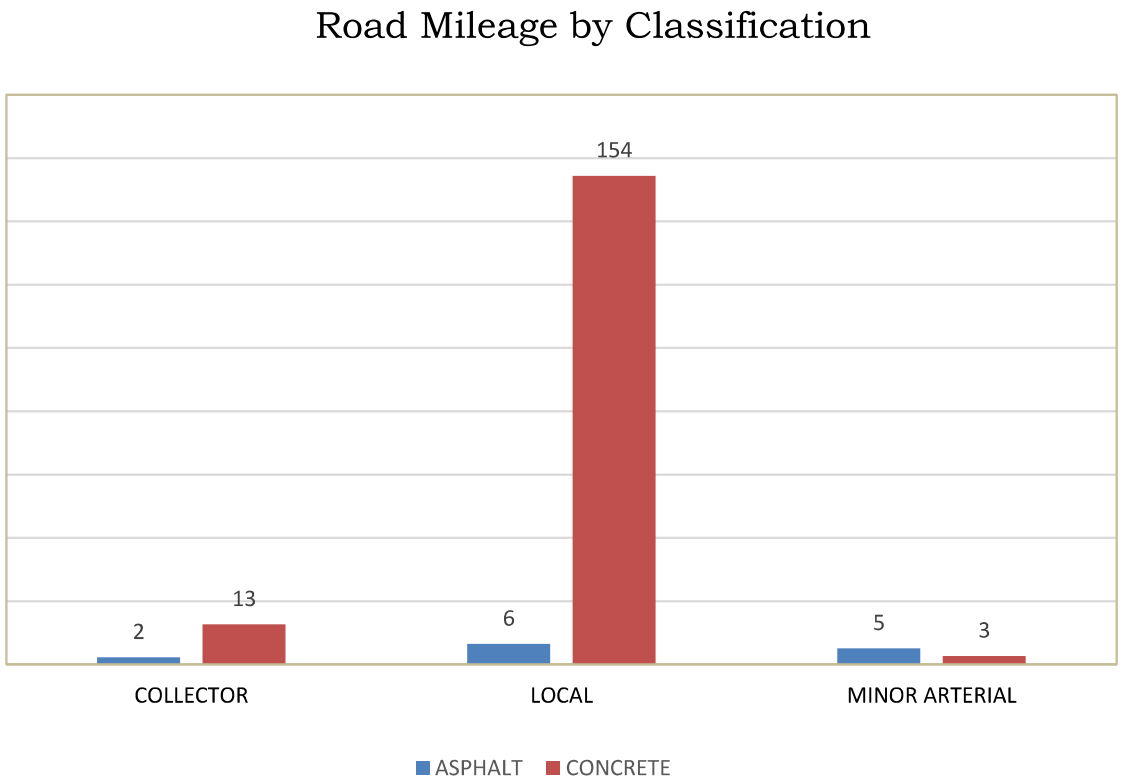


Figure 2

The City's concrete pavement system is inspected and rated on a rolling three-year cycle such that over any three-year period the entire City is inspected. Pavement inventory and ratings information are captured at the slab level; meaning that age and condition information are specific to every individual concrete slab. The City's pavement system includes just over 151,000 total unique slabs. Pavement condition ratings are conducted in accordance with the Pavement Surface Evaluation and Rating (PASER) Manual published by

University of Wisconsin-Madison Transportation Information Center (Appendix C). The PASER system is a visual evaluation of each slab by a City inspector who assesses surface defects, joints, pavement cracks, and pavement deformation to determine a condition rating from 10 (excellent) to 1 (failed). Figure 3 on the following page includes a summary of PASER ratings and the typical visual condition and/or defects that may be present in a concrete slab at each rating.

In accordance with the PASER rating system, pavement doesn't technically "fail" until it reaches a rating of 1. However, a concrete slab reaches the end of its useful service long before reaching a rating of 1. For the City' of Chesterfield's purposes, slabs with a PASER rating of around 6 have significant defects that warrant consideration for slab replacement. As you can see from Figure 3, a rating of six indicates slabs broken into multiple sections with asphalt patches. A slab in this condition will typically generate complaints from area residents.

While the City assesses each slab individually, it would be impractical and ineffective to manage a pavement network on a slab-by-slab basis. Instead, a group of slabs (typically a block) are incorporated into a segment, and those segment ratings are used to prioritize work. Generally, slabs within a segment deteriorate at a consistent rate. However, there are also instances where some slabs within a segment deteriorate quicker than others. In these cases, the City will generally attempt to maintain the deteriorated slabs and postpone their replacement until replacement of the entire segment is warranted. We will typically not perform "postage stamp" slab replacement, as this will frequently damage good slabs adjacent to the replacement slab and create an endless cycle of replacement. This means that you cannot solely rely on segment ratings when prioritizing work, as one segment with a rating of 7.5 may contain consistent slabs while another section of 7.5 may contain a group of slabs with ratings as high as 9 and as low as 5.

PASER Rating and Condition Table

Rating	Visual Condition
10	No cracks, asphalt patches or partial depth patches. No displacement, scaling or popouts. May have minor imperfections in the original pouring of the slab (e.g. rough edges from surface scrapes, rounded corners that show no sign of continuing wear.
9	The slab may have one minor hairline crack and no asphalt or partial depth patch. Minor imperfections are allowed such as minor scaling or few popouts. No raveling of the joints.
8	The slab may have one minor crack separating it into two pieces, but no displacement. May have partial depth patch in excellent condition, but no asphalt patches. Some minor scaling alllowed or few popouts.
7	Slab may have one crack separating it into two pieces. Joints may have asphalt patching, but not more than 2" wide. May have partial depth patches in good condition. No patches inside the slab.
6	Slab is broken into 3 sections. Asphalt patches at the joints not more than 2" wide. May have partial depth patching in good condition.
5	Slab is cracked into more than 3 sections. Asphalt patches at the joints are more than 3" wide. Partial depth patches are failing.
4	Slab has patches that cover 30% of its surface. Joints are unraveled 3" or more.
3	Slab has asphalt or partial depth patches that cover 30-50% of its surface. Joints unraveling more than 3" wide. Cracked and displaced slab in need or repair.
2	Slab has asphalt or partial depth patches that cover over 50% of its surface. Slab is undermined or displaced. Severe deterioration of the joints and surface. The slab may create unsafe driving conditions.
1	Failed

Figure 3

Figure 4 below depicts the City's pavement area by age. Pavement age data will be reviewed and updated annually. In an ideal situation, the City's pavement system would have a uniform age distribution across all age ranges which would allow for uniform replacement cycles and annual spending. However, due to a number of factors such a distribution is not realistic, and the City's actual pavement age information is shown below.

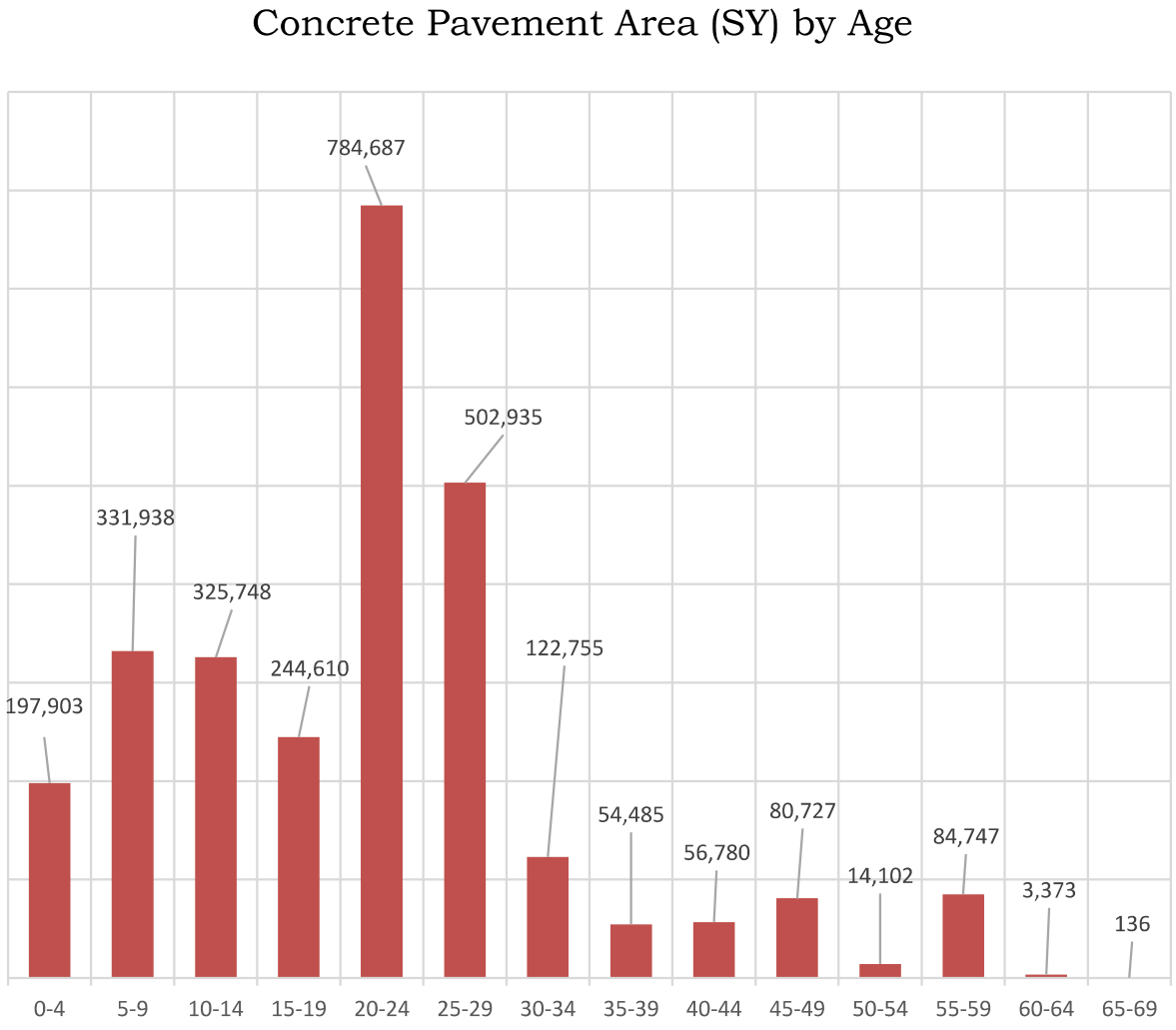


Figure 4

Figure 5 on the following page shows the City's PASER ratings by pavement area. The City's total concrete pavement area is about 2.8 million square yards. Most of the City's pavement (~2.0 million square yards or about 70%) is rated an 8. A single concrete slab is approximately 15 to 20 square yards.

Concrete Pavement Area (SY) by PASER Rating

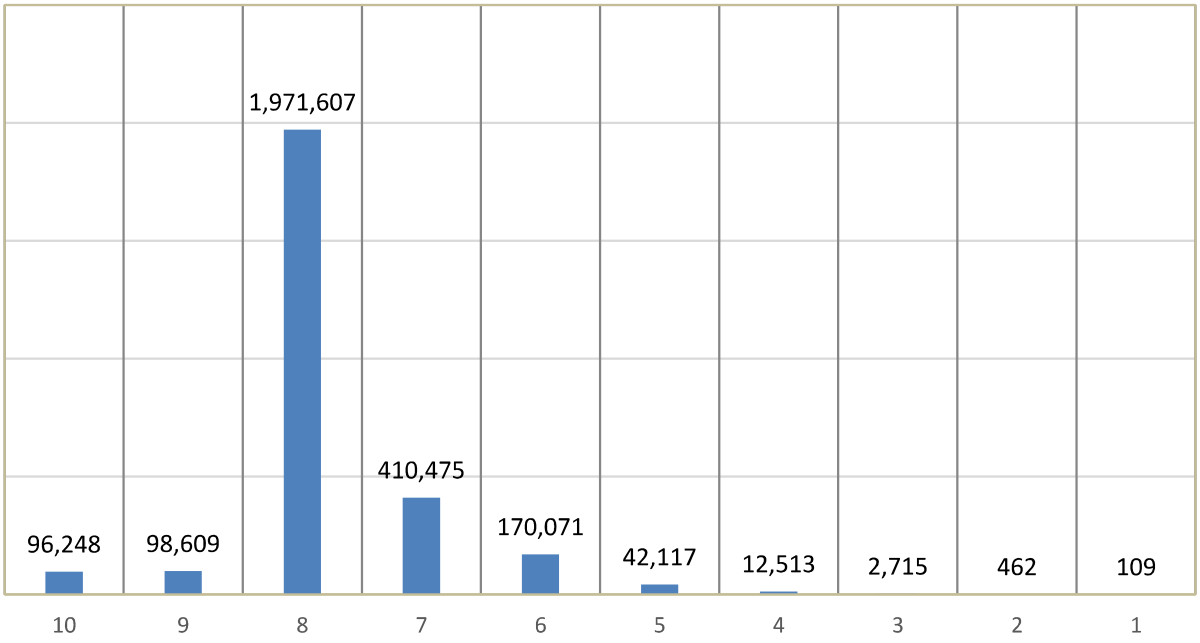


Figure 5

3. Historical Pavement Condition and Spending

Figure 6 on the following page shows the City's historic spending on capital pavement repairs and replacement, data points of the actual composite pavement ratings for each year, and a trendline of the ratings. You will note that spending varies year to year, in part due to grant funding and other city priorities, including sidewalk, trails, and facilities. City staff work to leverage available funding for reconstruction of collector and arterial roadways and adjust pavement repair spending accordingly. Recent grant projects include Ladue Road (2014), Appalachian Trail (2015), Greentrails Drive South (2016), and the Schoettler Road bridge (2017). Note that spending on these types of grant projects (both the grant amount and the City match) are not included in Figure 6, specifically because these projects frequently include improvements other than pavement.

Despite the City's significant efforts to maintain and replace its pavement, the condition trendline has a clear downward trajectory indicating a gradual decrease in the City's pavement condition at historic spending levels. Specifically, the City's overall pavement condition has deteriorated 0.37 points from 8.19 in 2013 to 7.82 in 2022. Given the age distribution shown in Figure 4 this downward trend will continue, and worsen, unless replacement funding is significantly increased.

It is worth noting that a drop of 0.37 points is not inconsequential. You can see from the PASER Table in Figure 3 that there is a discernible difference between a rating of an 8 and a rating of a 7. Specifically, a rating of a 7 indicates the possibility of asphalt patching, which has been problematic to many of our residents.

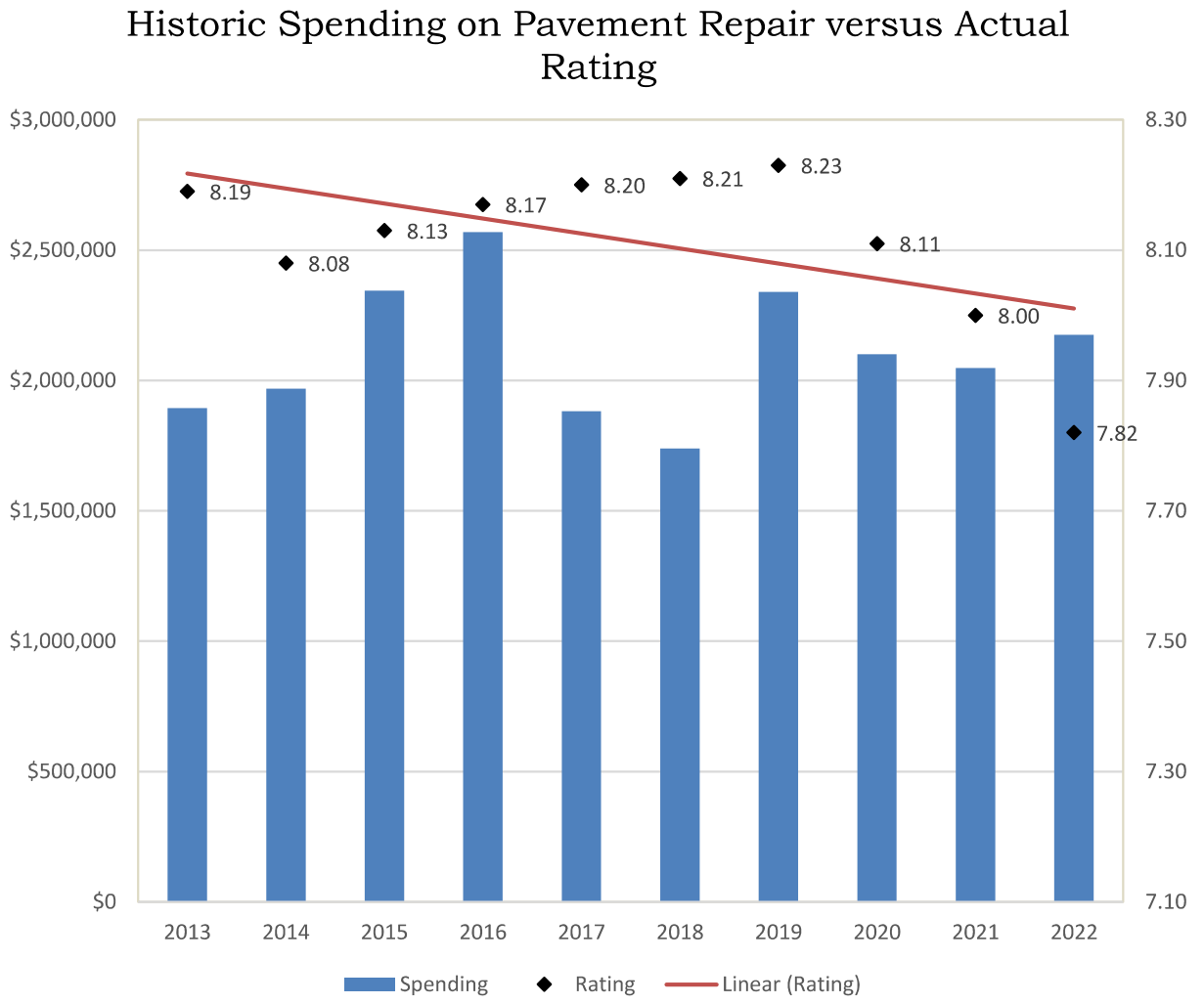


Figure 6

4. Pavement Condition Prediction

City Engineering Staff analyzed historic pavement age and condition ratings to create a condition versus age curve specific to the City's concrete pavement. Additional data will be added annually to continually refine the condition versus age curve. The City's pavement condition data is based on a pavement sample size of streets with known age and condition ratings.

Figure 7 below shows the theoretical pavement deterioration curve for the City's pavement. New pavement is rated a 10 and according to the current prediction curve it would normally deteriorate to a PASER rating of around 6 by year 35. As stated previously, a rating of 6 generally corresponds to the condition that residents find unacceptable. The equation in the top right portion of the chart is a polynomial regression reflecting the relationship between City's pavement ratings (y) and pavement ages (x).

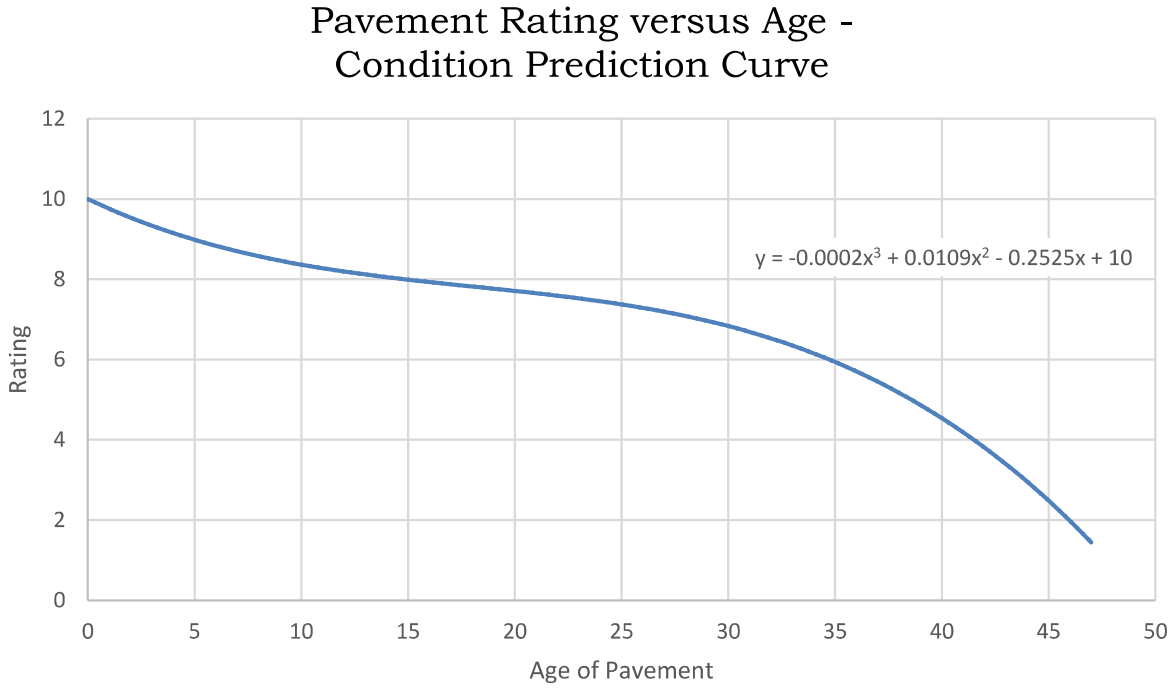


Figure 7

Conventional engineering practice holds that concrete pavement has an intended 30-year pavement design life. A pavement's design life ends when it is no longer suitable for carrying traffic at a reasonable level of service. Every agency, municipality, and owner determine their reasonable level of service. Based on the City's pavement data, it appears the City can reasonably expect slightly more than 30 years of life from some of its pavement. It is important to note that the City does not ignore pavement and allow it to deteriorate without any maintenance. Therefore, the City's pavement ratings data inherently include all the City's regular pavement maintenance activities including crack-sealing, partial depth repairs, asphalt joint repair, slab repair, and asphalt patches. These maintenance activities are strategically programmed with the goal of prolonging pavement life and minimizing deterioration to the greatest extent practical. The City's pavement rating versus age data and associated theoretical condition curve indicate the City's effort to prolong pavement life has been

effective. That is one of several reasons why the current staffing shortage in the Street Maintenance Division is so concerning. Our inability to complete necessary maintenance activities since 2020 is going to have a long-term impact on our pavement system.

The serviceability of pavement should not be confused with resident or consumer satisfaction. Serviceability is typically an assessment of the pavement's performance at carrying the intended traffic loads at an acceptable condition. Consumer satisfaction is typically an assessment of the pavement's aesthetic appearance. Replacing pavement based primarily on aesthetics, and not its performance, represents an inefficient use of limited capital funds. For example, if a ten-year-old street begins to experience joint deterioration, that joint deterioration can often be addressed with concrete joint partial depth repair (PDR) – which residents will typically accept. However, there are times that the deterioration is more severe, including pavement compromised by Alkali Silica Reaction (ASR) or Alkali Carbonate Reaction (ACR). In these cases, PDR will be ineffective, and the proper treatment is to construct asphalt joint repairs, to prolong serviceability. Unfortunately, many residents find the asphalt repairs aesthetically unacceptable resulting in low consumer satisfaction for the street. We work to balance both serviceability and consumer satisfaction when determining street replacement candidates. However, in some cases, due to City practice regarding asphalt on concrete pavement, the pavement is scheduled for replacement prematurely, prior to reaching the end of its service life. This has a negative impact on the City's overall pavement network as limited funds are spent to address aesthetic concerns on a street that has not reached the end of its service life.

5. Future Budget Scenarios and Condition Implications

The condition prediction curve was utilized in combination with additional pavement data and financial information, such as the anticipated replacement cost per square yard for removal and replacement of concrete pavement, anticipated annual inflation, and composite pavement rating and age of the City's concrete pavement system to develop a pavement budget and system condition prediction spreadsheet (Appendix D). The spreadsheet is a simplified representation of how the City's overall pavement system is expected to age and deteriorate under a specific funding scenario. It allows for a repeatable annual analysis to evaluate anticipated impacts of the City's predicted spending on the future overall pavement system condition. Using the pavement prediction spreadsheet, Engineering staff ran two future budget scenarios, detailed on the following pages, to show how funding can impact the overall pavement system condition. Both scenarios utilized an initial cost per square yard for removal and replacement of pavement of $80 per square yard and an assumed annual construction inflation rate of three percent (3%).

Scenario 1, shown in Figure 8, assumes a constant $4.0 million capital street reconstruction budget for the next five years. If the budget is held at a constant $4.0 million, we can expect to see a decline in pavement condition by an estimated 0.16 points over the next five years from a current composite pavement condition rating of 7.82 in 2023 to an estimated 7.66 in 2028. As detailed above, the negative trendline demonstrates that our pavement infrastructure is deteriorating. Due to the age grouping of our slabs (most 20-24 years old) the trend will worsen if action is not taken to increase funding. Additionally, the charts below only consider our existing slab network. Obviously, the addition of other slabs, through subdivision development or annexation, would require additional funding.

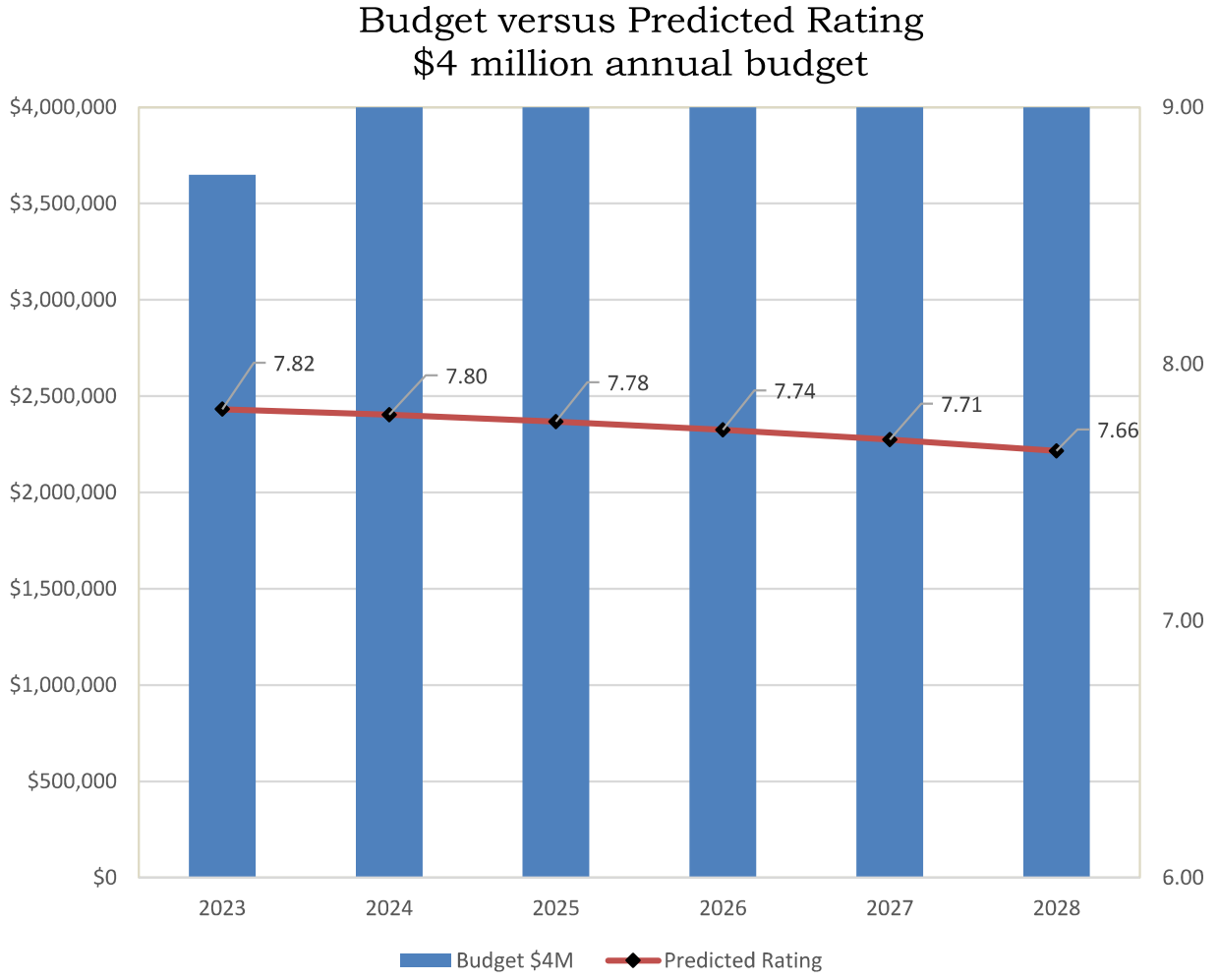


Figure 8

Scenario 2, shown in Figure 9, assumes we desire to maintain the current composite pavement condition rating and reflects the necessary budget amount to do so. In order to keep the pavement condition constant, we would need to increase the annual capital street reconstruction budget from $3.7 million in 2023 to an estimated $9.8 million in 2028. While such an increase is likely impractical, it demonstrates that any available funding within the Capital Projects Fund should be dedicated to streets to minimize the degradation of our pavement system.

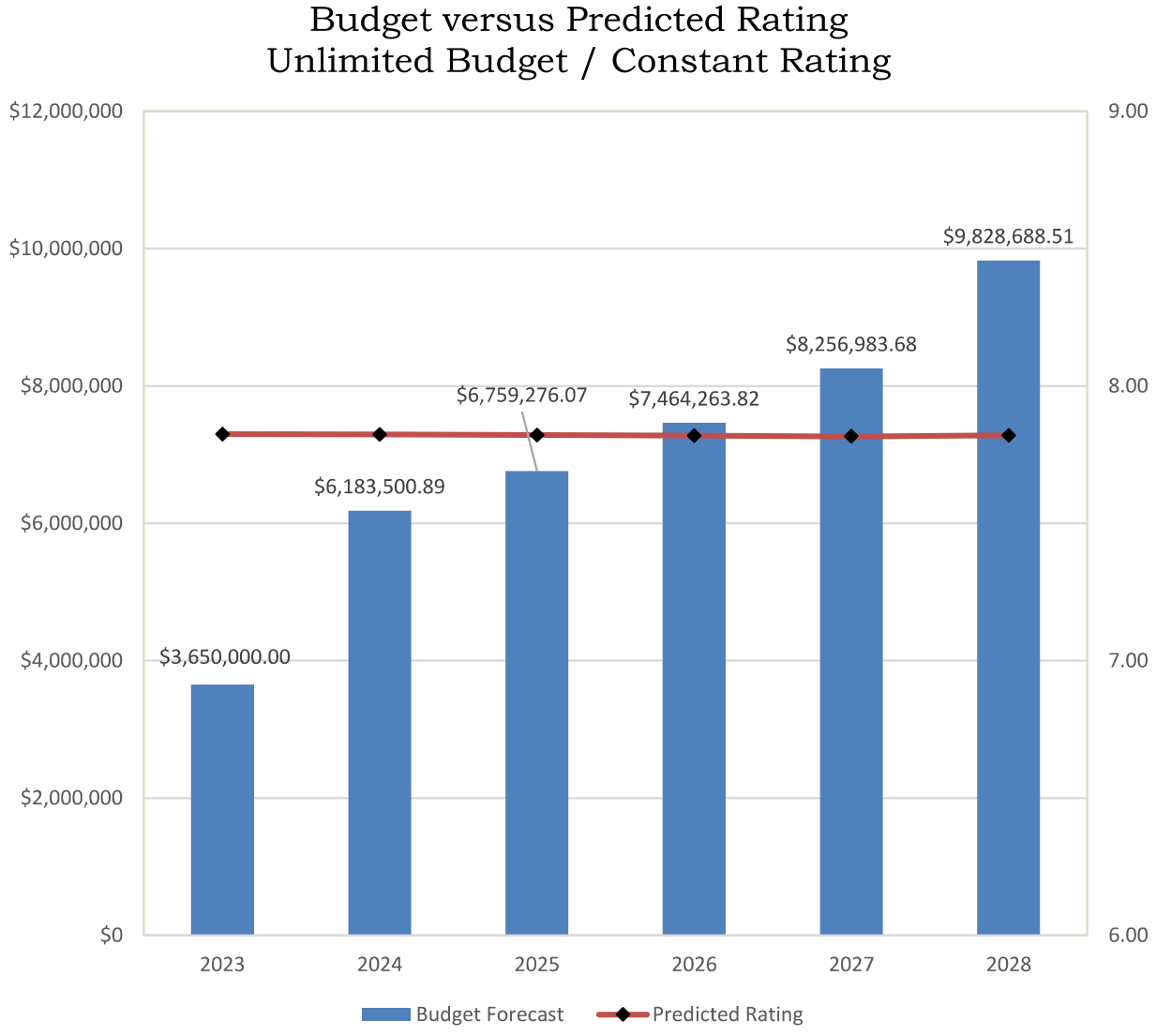


Figure 9

6. Summary and Recommended 5-Year Plan

Both the City's historical pavement data and the pavement prediction spreadsheet indicate that the City's concrete pavement system is degrading at current funding levels. These results validate Staff's annual commentary indicating that our pavement condition has been slowly degrading, even though this degradation may not be readily observable to all users. However, the City's overall concrete pavement system is still considered to be in "good to very good" condition. Figure 10 below depicts the future proposed budgetary requests in the Public Works Capital Replacement Plan (Appendix E) and the estimated composite pavement condition rating we can expect in future years. While not ideal, the chart shows that the requested funding levels will nearly hold our rating, with only a 0.12 decrease over the next five years.

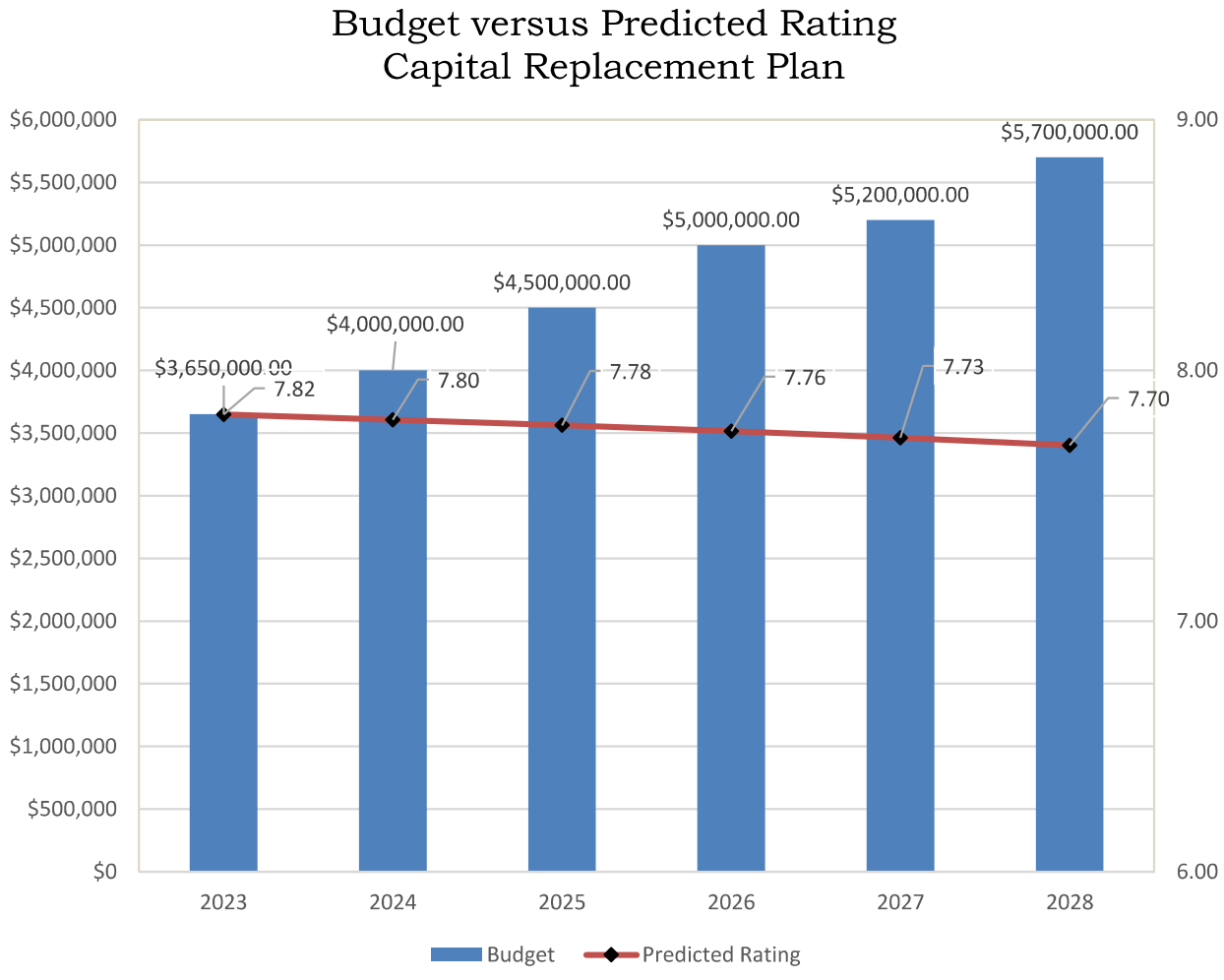


Figure 10

The Department of Public Works will continue to balance available funding and anticipated work to meet the City's expectations and deliver a reliable pavement system. However, as pavement management professionals it is also our responsibility to share unbiased information and help develop common performance expectations. To that end, the information in this report and pavement data will be re-evaluated and updated annually to continue to track historic spending and pavement condition, predict future condition, and help Staff refine future budgetary requests.

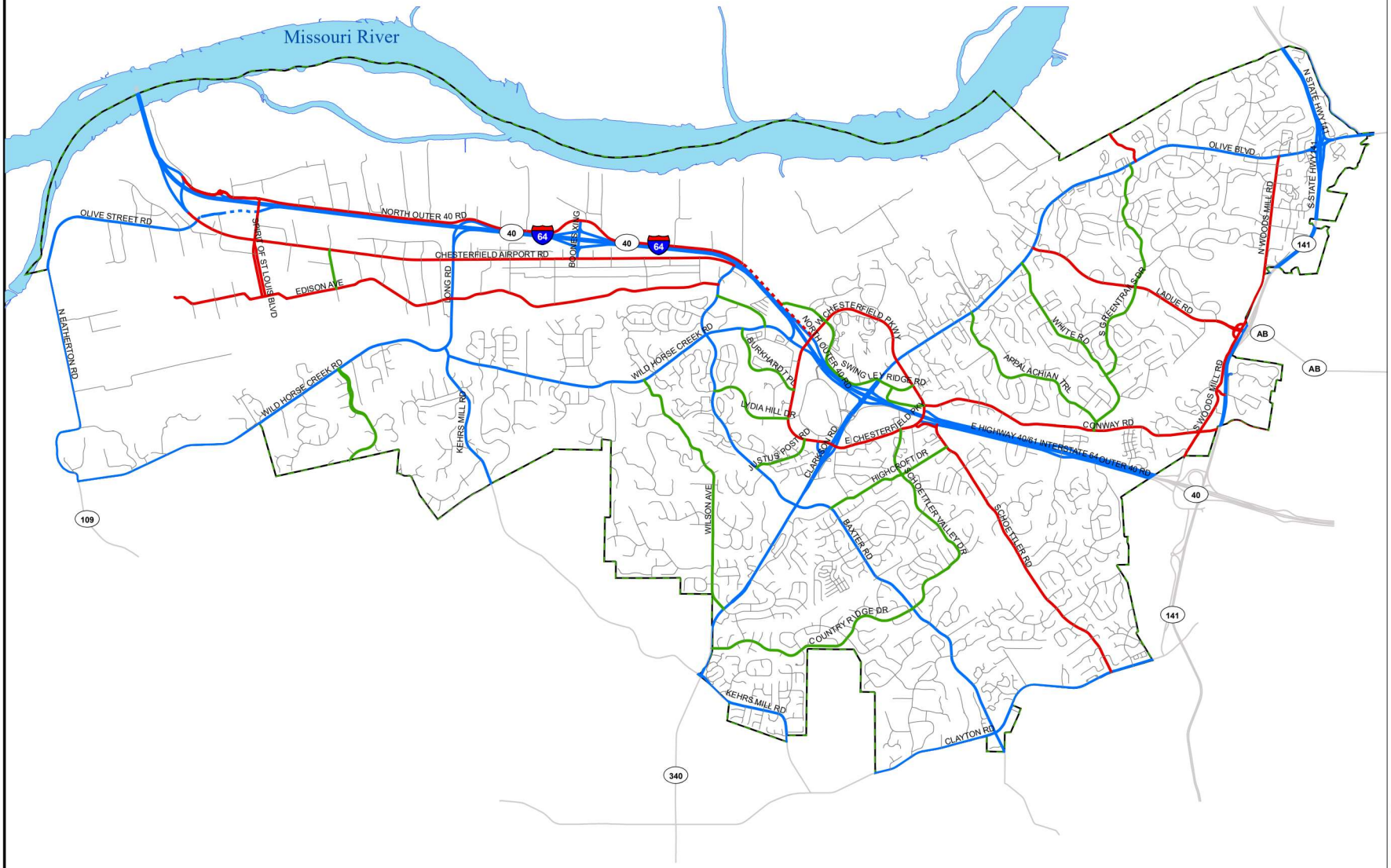
APPENDICES

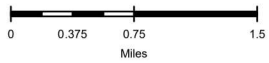
Appendix A

Concrete Pavement Inventory Data						Slab Replacement/Capital Project			
Year	Rating	# of Slabs Rated	Inspection Area	Size of City System (SY)	Additions (SY)	Spending	Pavement Replaced (SY)	Cost/SY	Projects Included
2015	8.13	136,048	City Wide	2,738,671	12669	$2,345,059	56,064	$59.80	2015-PW-03A,2015-PW-03B,2015-PW-03C,2015-PW-03D
2016	8.17	140,443	City Wide	2,751,340	28621	$2,569,384	62,524	$59.22	2016-PW-03A,2016-PW-03B
2017	8.20	59,068	A, B, C	2,779,961	5413	$1,881,634	32,507	$57.88	2017-PW-03A,2017-PW-03B
2018	8.21	56,795	D, E, F	2,785,374	0	$1,739,731	29,742	$58.49	2018-PW-03A,2018-PW-03B
2019	8.23	54,883	G, H, I	2,785,374	8,679	$2,339,305	37,274	$62.76	2019-PW-03A,2019-PW-03B
2020	8.11	57,563	A, B, C	2,794,053	0	$2,100,179	34,266	$61.29	2020-PW-03A,2020-PW-03B
2021	8.00	47,511	D, E, F	2,794,053	7621	$2,048,216	35,006	$58.51	2021-PW-03A,2021-PW-03B
2022	7.81	56,098	G, H, I	2,801,674	3,134	$2,174,600	34,268	$63.46	2022-PW-03A,2022-PW-03B
2023	In Progress	51,564	A, B, C	2,804,808	TBD	TBD	TBD	TBD	

Appendix B

Street Classification Map





- Major Arterial
- Minor Arterial
- Collector
- Local
- Future Major Arterial
- Future Minor Arterial
- Future Collector

Information Provided By:
CITY OF CHESTERFIELD
DEPARTMENT OF
INFORMATION TECHNOLOGY
MAPPING/GIS

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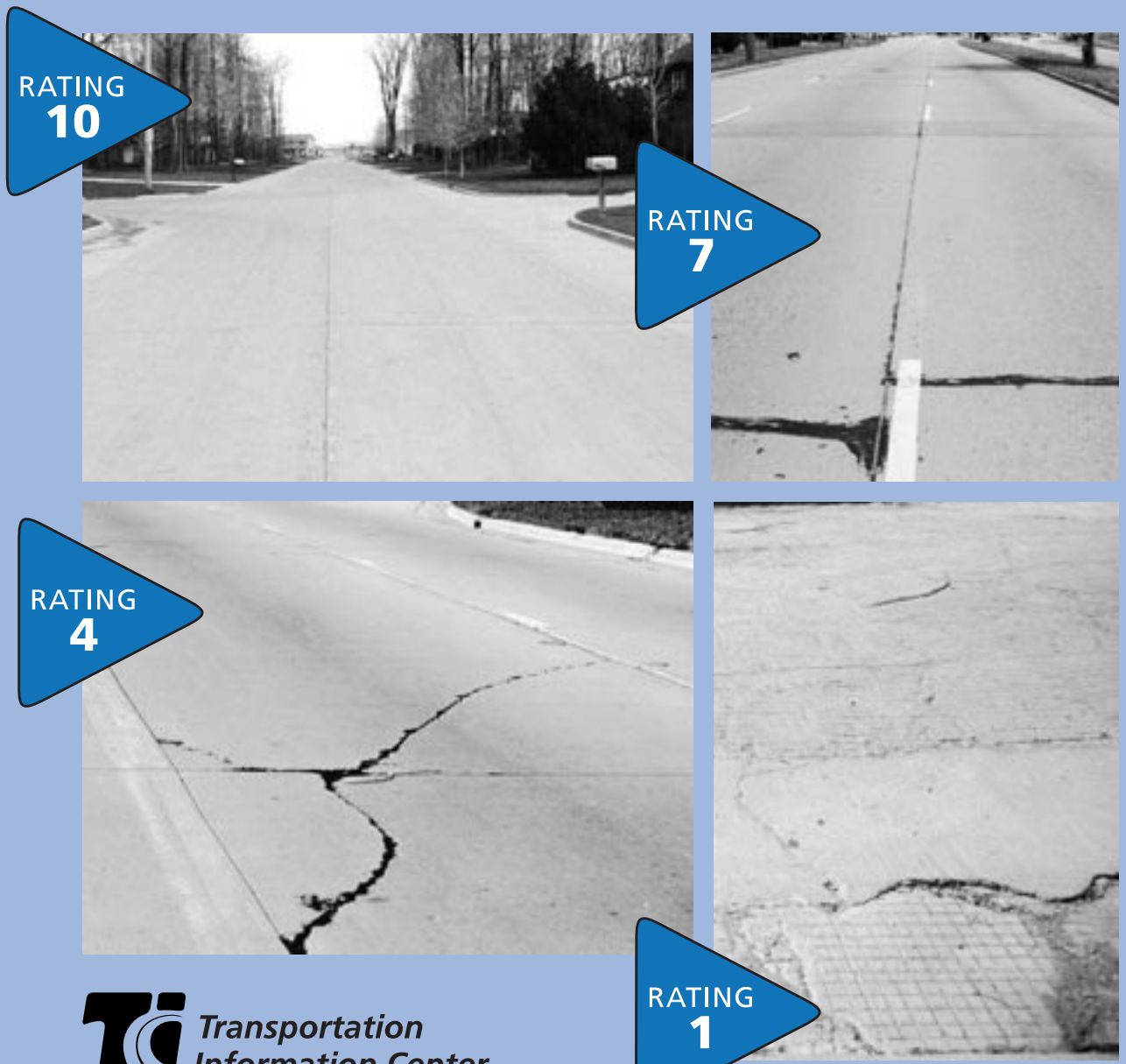
Appendix C

Pavement Surface Evaluation and Rating

PASER Manual

Concrete Roads



Transportation Information Center
University of Wisconsin–Madison

Pavement Surface Evaluation and Rating

PASER Manual

Concrete Roads

Donald Walker, T.I.C. Director, *author*
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Susan Kummer, Artifax, *designer*

Transportation Information Center
University of Wisconsin–Madison

Pavement Surface Evaluation and Rating

Concrete PASER Manual

Many local agencies are responsible for maintaining roadways with concrete pavements. This manual offers useful information for planning maintenance and managing Portland Cement Concrete pavements. It discusses common problems and typical repairs and includes a visual system for evaluating and rating concrete pavements.

The Wisconsin Transportation Information Center has developed PASER manuals for other pavement types (see page 29). The rating systems are similar and compatible so that local road agencies can work with a comprehensive condition rating method. The rating procedure can be used as condition data for the Wisconsin DOT local road inventory (WISLR) and as part of a computerized pavement management system like PASERWARE.

Taking an organized approach to roadway management has many benefits. By documenting the actual conditions of roads you can set realistic budgets, make timely repairs, and set up cost effective maintenance procedures. Developing an overall plan for the roadway system lets local agencies develop budgets and plan for future needs. When detailed information is available, local officials can respond more effectively to questions from the public. A planned approach is easier to explain and receives greater public support.

Several key steps are necessary to develop a meaningful roadway management plan. First, you must inventory the existing condition. This is normally done by dividing the roadway into segments with similar conditions. During the inventory you collect information on construction history, roadway width, etc. Then you need some method for assessing the condition of the existing roadway. This ***Concrete PASER Manual*** uses a visual approach. Other information from material sampling, testing, and traffic counts can be useful when planning specific projects.

Another necessary step is setting priorities for roadway improvements. You can use roadway condition and the local importance of these roads to assign priorities. Then budgets can be developed based on cost estimates for the projected improvements. Since not all improvements can be made in one year, you can set up a 3-5 year budget and capital improvement plan. Normally this is updated annually.

Rigid pavement performance

Most concrete pavements on local roads are either plain (non-reinforced) or reinforced concrete. Reinforcement is usually provided by steel wire mesh placed approximately at mid slab depth. The reinforcement is intended to limit crack opening and movement in the concrete slab.

Since concrete slabs need to move (expand and contract) while curing and as temperature changes, pavements are constructed with contraction joints to control cracking. These are usually sawn into the pavement shortly after initial curing. This joint gives the slab a place to crack and makes a straight, well-formed groove to seal.

Expansion joints are occasionally provided. These are wider, full depth, and filled with a material to allow expansion. If used, they are placed adjacent to structures that cannot move with the pavement such as bridges, manholes, and other utility structures.

So-called rigid pavements (concrete) carry traffic loadings differently than flexible pavements (asphalt). Concrete pavements are designed to act like a beam and use the bending strength of the slabs to carry the load. Therefore load transfer across cracks and joints is important, especially on roads with heavy truck and bus traffic. Hairline and narrow cracks still have interlocked concrete aggregate and can effectively transfer loads. Because wide cracks and widely-spaced joints open up, they cannot transfer loads and must take higher edge loads. These higher edge loads can cause further cracking and deterioration along the joint or crack edges.

Some concrete pavements use joints that have load transfer dowels. These are smooth steel bars placed across the joint. They transfer traffic loads between adjacent concrete slabs while allowing opening and closing of the joint. These bars can rust and sometimes cause problems. The corrosion causes forces on the concrete which lead to spalling, cracking and general joint deterioration. Epoxy coated dowels are now commonly used.

Unsupported slab edges will deflect or bend under a load. If the supporting soil is saturated it can squirt up through joints or cracks when the slab bends. This is called *pumping*. Eventually the loss of supporting soil through pumping creates an empty space or void under the slab. The slabs may then crack further under loads and joints deteriorate more.

Undoweled joints under heavy truck traffic may *fault*. This is when one slab edge is lower than the next slab. The downstream traffic slab will be lower than the upstream slab, creating a step. Faulting creates a poor ride.

You can often detect pumping by the soil stains around pavement joints or cracks. The resulting voids can be filled with grout. Slabs can be leveled by slab jacking or mud jacking. Obviously, sealing cracks and joints and improving drainage of the subsoils will help reduce pumping, faulting, and joint failures.

Pavement conditions and defects

It is helpful to separate various conditions common to concrete pavements. These are described individually in some detail. We also include causes for deterioration and common strategies for repair. Some defects are localized while others indicate that problems may develop throughout the pavement. It is important to distinguish between local and widespread defects. Assessing the conditions of actual roadways also involves looking for combinations of these individual defects.

Surface defects
Wear and polishing, map cracking, pop-outs, scaling, shallow reinforcing, spalling.

Joints
Longitudinal joint, transverse joints.

Pavement cracks
Transverse slab cracks, D-cracking, corner cracks, meander cracks.

Pavement deformation
Blow ups; faulting; pavement settlement or heave; utility repairs, patches and potholes; manhole and inlet cracking; curb or shoulder deformation.

In reviewing the different defects it is important to consider both their severity and extent. Generally, conditions begin slowly and progressively become more serious. Slight defects may grow into moderate and then severe conditions. In addition, the defects might initially be indicated only in a few isolated cases. Examples in the rating section will help you identify how bad a condition is and how extensive it is.

SURFACE DEFECTS

Wear and polishing

A worn or polished surface may appear from traffic wearing off the surface mortar and skid resistant texture. Extensive wear may cause slight ruts where water can collect and cause hydroplaning. Sometimes traffic may polish aggregates smooth, causing the surface to be slippery. An asphalt overlay or grinding of the concrete surface can restore skid resistance and remove ruts.

► **Surface mortar worn away exposing larger aggregate. Accidents or friction testing may indicate a slippery surface in need of improved texture.**

▲ **Close-up of a polished pavement surface.**

Map cracking

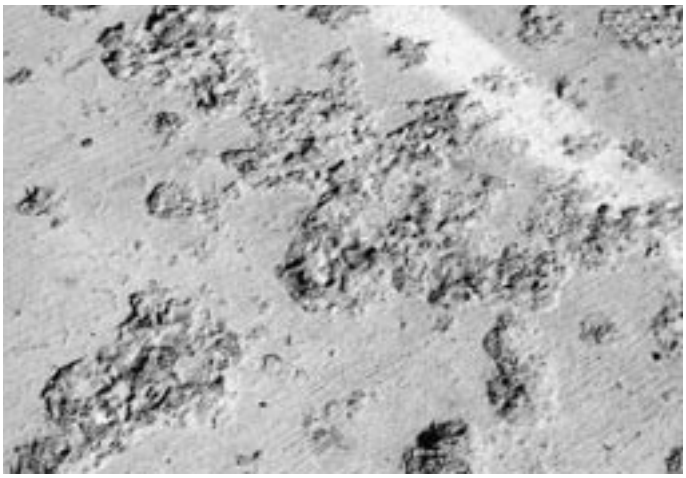
A pattern of fine cracks usually spaced within several inches is called map cracking. It usually develops into square or other geometrical patterns. Can be caused by improper cure or overworking the surface during finishing. If severe, cracks may spall or surface may scale. Repair is usually limited to very severe conditions. An asphalt overlay or partial depth patching may then be necessary.

◄ **Hairline surface cracks, probably shallow in depth. May not cause any long term performance problems.**

Pop-outs

Individual pieces of large aggregate may pop out of the surface. This is often caused by chert or other absorbent aggregates that deteriorate under freeze-thaw conditions. Surface patching can be done temporarily with asphalt. For severe areas, a more permanent partial depth concrete patch may be necessary.

◄ **Extensive pop-outs of large aggregate from surface. Pop-outs alone have not affected pavement serviceability.**



► **Moderate surface scaling. Loss of mortar and fines from the surface beginning to expose larger aggregate.**

Scaling

Scaling is surface deterioration that causes loss of fine aggregate and mortar. More extensive scaling can result in loss of large aggregate. Often caused by using concrete which has not been air-entrained, the surface becomes susceptible to freeze-thaw damage. Scaling is also aggravated by the use of deicing chemicals.

Scaling can occur as a general condition over a large area or be isolated to locations where poor quality concrete or improper finishing techniques caused loss of air entrainment. In severe cases, deterioration can extend deep into the concrete. Traffic action may accelerate scaling in the wheel paths.

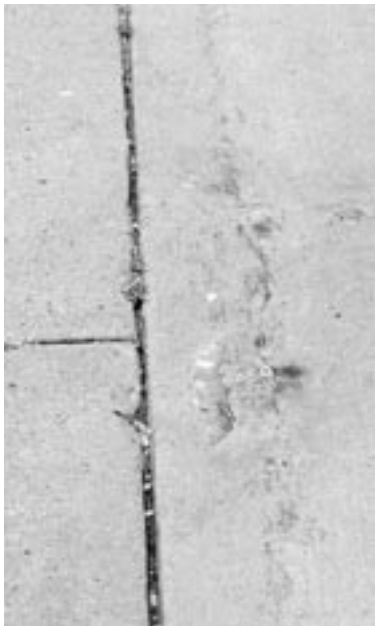
Grinding may remove poor quality surface concrete. Asphalt overlays or a bonded concrete resurfacing can prolong the life of the pavement. Partial depth patching of isolated areas may also be used.

► **Severe scaling. Some larger aggregate is loose.**

Reinforcing bar exposed. Shallow concrete cover caused large spall to develop around it. ▼

Shallow reinforcing

If the steel reinforcing bar or mesh is placed too close to the concrete surface it will lead to concrete spalling. Corrosion of the steel creates forces that break and dislodge the concrete. Often you can see rust stains in the surface cracks before spalling occurs. Can be temporarily patched with asphalt. Permanent repairs are difficult and usually involve replacing the steel and making a partial depth or full depth concrete repair.



◄ **Surface stain parallel to joint. Indicates reinforcing steel too close to surface.**

◄ **Wire reinforcing mesh placed close to surface. Corrosion of the reinforcing steel causes the surface mortar to spall. Very difficult to patch and repair.**

Spalling

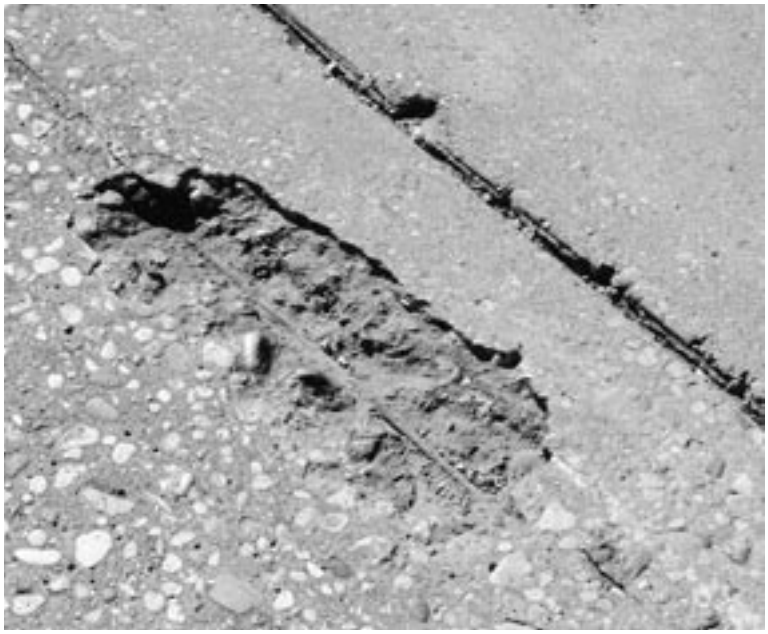
Spalling is the loss of a piece of the concrete pavement from the surface or along the edges of cracks and joints. Cracking or freeze-thaw action may break the concrete loose, or spalling may be caused by poor quality materials. Spalling may be limited to small pieces in isolated areas or be quite deep and extensive.

Repair will depend on the cause. Small spalled areas are often patched. Spalling at joints may require full depth joint repair.

► **Small surface spalls that have been patched.**

► **Spalling along longitudinal joints.**

▼ **A severely spalled crack.**



Spalling over shallow reinforcing. ►

◄ New, well-sealed longitudinal joint.

▲ Joint open about ½".

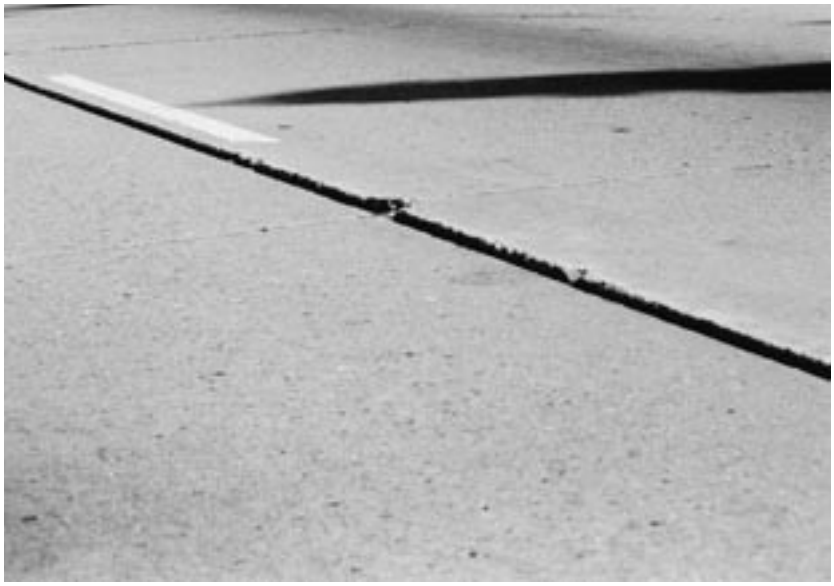
JOINTS

Longitudinal joints

Longitudinal paving joints are constructed to be narrow in width and usually well sealed. As pavements age and materials deteriorate, joints may open and further deteriorate. Cracks parallel to the initial joint may develop and accelerate into spalling or raveling of the longitudinal joint. Settlement, instability, or pumping of the subgrade soil can cause longitudinal joints to fault. One common cause of cracks parallel to the longitudinal joints is waiting too long after the pour to saw the joint. Then, during initial cure the slab will crack roughly parallel (but not exactly) to the sawn joint.

Maintaining a tight joint seal can prevent intrusion of water and reduce freeze-thaw damage and pumping. Severe joint deterioration may require full depth patching and replacement of the joint.

▲ Additional joint cracking, spalling, and broken pavement. Full depth repair is needed.



▲ Faulted longitudinal joint (over ½") with slight edge spalling.

Transverse joints

Transverse joints are constructed in concrete pavements to permit movement of the concrete slabs. Some joints are constructed with load transfer dowels. If the pavement has poor subsurface drainage, traffic may eventually create voids under the joints due to pumping and cause the slabs to settle or fault. Freeze-thaw deterioration at the joint can cause spalling and create additional cracks parallel to the joint. Load transfer bars may corrode, creating expansive forces that further deteriorate the concrete at the joint.

Occasionally, severe joint deterioration may develop from poor quality aggregate and so-called D-cracking. Joint sealing will help, but complete replacement is usually necessary.

Overall, lack of joint maintenance and rehabilitation is a common problem. Maintaining a tight, well sealed joint can reduce water intrusion and thereby reduce freeze-thaw damage, pumping, blow-ups, D-cracking, and spalling. Early repair of minor defects can often reduce the need for complete joint repair or replacement.

▼ **New, well-sealed transverse joint.**

▼ **Transverse joint has slight faulting and spalling.**

► **Severe spalling of a transverse joint.**

►► **Cracks parallel to joint. Dark color next to transverse joint likely indicates D-cracking and additional deterioration. Full depth repair required.**

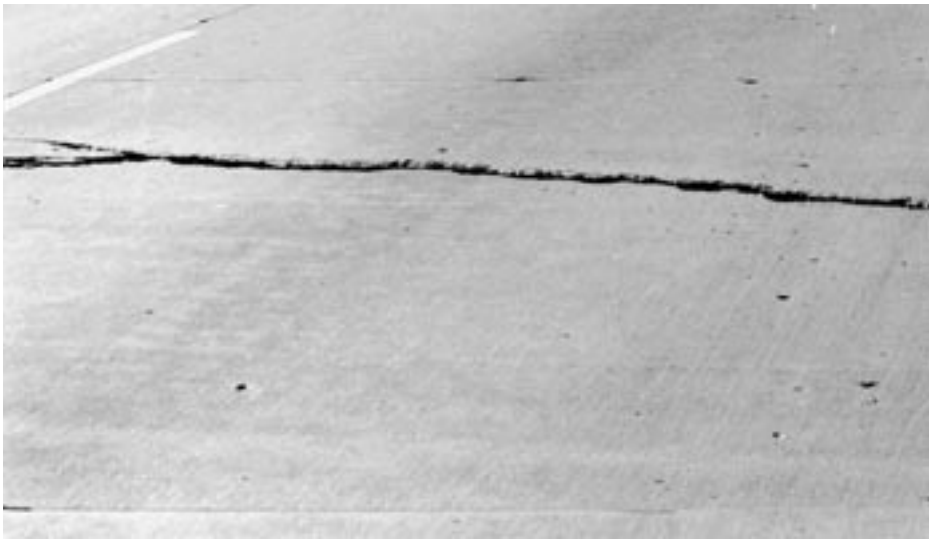
► **Severe spalling has required temporary patching. Complete joint replacement is necessary.**

PAVEMENT CRACKS

Transverse slab cracks

Transverse cracks may appear parallel to joints and can be caused by thermal stresses, poor subgrade support, or heavy loadings. They are sometimes related to slabs having joints spaced too widely. Joints spaced more than 15′ apart commonly develop mid-slab transverse cracks.

◄ **Transverse, open crack.**



◄ **Faulted transverse crack with slight edge spalling.**

As with joints, these cracks may deteriorate further if not sealed well. Slabs can fault at cracks which can spall and develop additional parallel cracking. Severe deterioration may require patching individual cracks. Multiple transverse cracks in individual slabs indicate further deterioration. Extensive transverse cracking indicates pavement failure and the need for complete replacement.

◄ **Closely spaced, hairline transverse cracks. Indicates slab is broken and in need of replacement.**

D-cracks

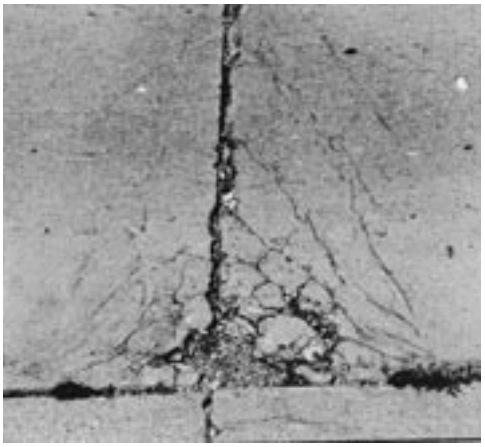
Occasionally, severe deterioration may develop from poor quality aggregate. So called D-cracking develops when the aggregate is able to absorb moisture. This causes the aggregate to break apart under freeze-thaw action which leads to deterioration. Usually, it starts at the bottom of the slab and moves upward.

Fine cracking and a dark discoloration adjacent to the joint often indicate a D-cracking problem. Once this is visible on the surface the pavement material is usually severely deteriorated and complete replacement is required.

Joint or crack sealing helps slow D-cracking deterioration. This is a serious defect because it may indicate a material quality problem throughout the pavement.

Surface discoloration near joints and cracks indicates D-cracking and severe slab deterioration.
▼ ►

►
Multiple crack patterns adjacent to joints. Common D-cracking pattern.



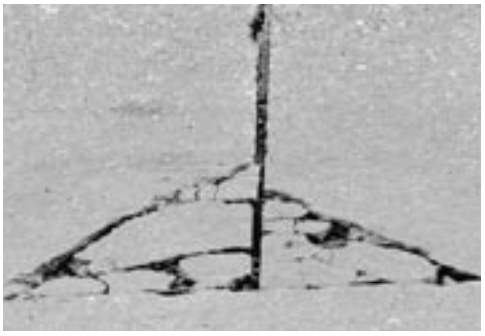
Corner cracks

Diagonal cracks near the corner of a concrete slab may develop, forming a triangle with a longitudinal and transverse joint. Usually these cracks are within one foot of the corner of the slab. They are caused by insufficient soil support or concentrated stress due to temperature related slab movement. The corner breaks under traffic loading. They may begin as hairline cracks.

Some corner cracks extend the full depth of the slab while others start at the surface and angle down toward the joint. With further deterioration, more cracking develops; eventually the entire broken area may come loose. This may be a localized failure or may point to widespread maintenance problems.

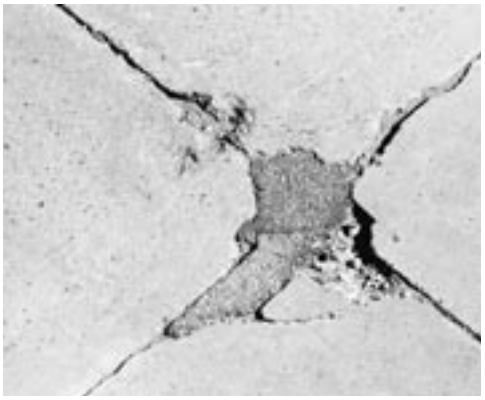
Partial or full depth concrete patching or full depth joint replacement may be necessary when corner cracking is extensive.

Corner cracking with ► broken concrete pieces.



▲ First signs of corner cracking.

►
Severely spalled corner crack with missing pieces and patching.



Meander cracks

Some pavement cracks appear to wander randomly. They may cross a slab diagonally or meander like a serpent. Meander cracks may be caused by settlement due to unstable subsoil or drainage problems, or by utility trench settlement. Frost heave and spring thaw can also cause them. They are often local in nature and may not indicate general pavement problems.

Minor cracks may benefit from sealing to minimize water intrusion. Extensive or severe meander cracking may require replacing the slab, stabilizing the subsurface, or improving drainage.

◄ **Meander crack roughly parallel to longitudinal joint.**

◄ **Meander crack caused by settlement. Lack of maintenance allows water to intrude and debris to collect in crack.**

◄ **Faulting and spalling of a meander crack.**

PAVEMENT DEFORMATION

Blowups

Concrete slabs may push up or be crushed at a transverse joint. This is caused by expansion of the concrete where incompressible materials (sand, etc.) have infiltrated into poorly sealed joints. As a result, there is no space to accommodate expansion. It is more common in older pavements with long joint spacing. Pressure relief joints can be installed and blowup areas must be patched or reconstructed.

Faulting

Joints and cracks may fault or develop a step between adjacent slabs. Faulting is caused by pumping of subgrade soils and creation of voids. Heavy truck or bus traffic can rapidly accelerate faulting. Longitudinal joints may fault due to settlement of an adjacent slab.

Faulting creates a poor ride and may cause slab deterioration. Minor faulting can be corrected by surface grinding. Voids can be subsealed, or slabs mud jacked back to level position. Severe cases may need joint replacement.

◄ **Internal pressure has partially raised slab at the joint. Complete replacement is required.**

A pavement blowup in progress. Concrete is crushed and slabs buckled. ▼

▲ **Minor faulting of transverse joints. Aggravated by heavy traffic. Surface grinding will improve ride.**

▲ **Faulted longitudinal joint.**

► **Severely faulted joint. Slab jacking is necessary.**

► Settlement caused meander crack with faulting.

Extensive cracking and patching caused by settlement. Pavement was built on unstable subgrade soils. ▼

Pavement settling or heave

Unstable or poorly drained subgrade soils may cause pavements to settle after construction. Poorly compacted utility trenches may also settle. This may be a gentle swale or a fairly severe dip.

Frost-susceptible soils and high water tables can cause pavements to heave during the winter months. Extensive pavement cracking and loss of strength during the spring can result in severe deterioration. Improved drainage and stabilization of subgrade soils are usually necessary, along with pavement reconstruction.

Utility repairs, patches and potholes

Replacement or repair of utilities will require cuts or utility openings. When repaired these pavement patches may show settlement, joint deterioration, or distress under continued traffic loading. Patches from previous repairs may perform like original pavement or experience joint deterioration or settlement.

Localized failures of materials or subgrade soil can cause individual potholes. Surface spalling or other material defects may develop into localized potholes. Full depth patching is usually required.

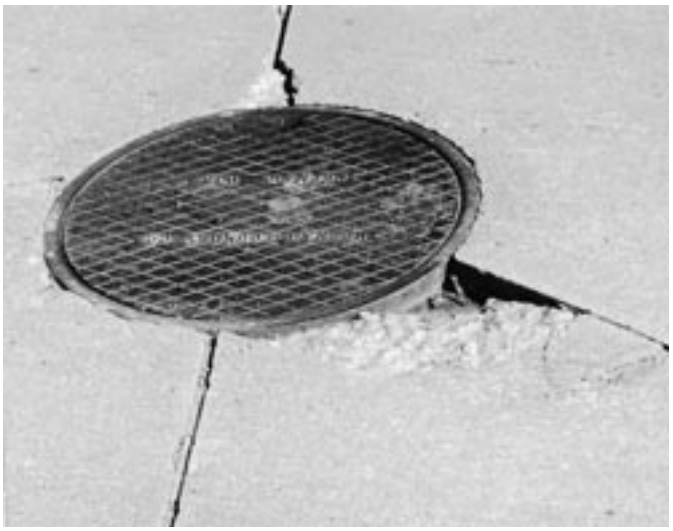
▲ Utility repair or full depth joint repair. Very good condition.

▲ Asphalt patches. Poor (top) and fair (bottom) condition.

▲ Potholes caused by severe joint deterioration. Need repair.

Manhole and inlet cracks

Normal pavement movement due to frost heaving and movements due to changes in temperature often cannot be accommodated in the pavement adjacent to a manhole or a storm sewer inlet. Cracks and faulting may develop and the concrete slab may deteriorate further. These are often localized defects that may not indicate a general pavement problem. Sealing and patching may slow the deterioration. Eventually full depth repairs may be required.



Two spalls at manhole in a new pavement. Partial depth patching would be beneficial. ◄

Extensive cracking and spalling at manhole requiring full depth repairs. ▼

Curb or shoulder deformation

Concrete curb and gutter, or paved concrete shoulders, may separate from or settle along the main pavement. The longitudinal joints between the pavement and curb or shoulder may open, fault, or deteriorate like other longitudinal joints. When severe enough to disrupt drainage, the curb and gutter need to be replaced. Shoulder deterioration may require patching or replacement.

Settled gutter and joint filled with debris. Joint maintenance is needed. ▼

Extensive curb deterioration. Freeze-thaw damage to curb adjacent to inlet, and gutter is displaced. New curb and gutter are needed. ►

Rating pavement surface condition

With an understanding of roadway conditions and distress, you can evaluate and rate concrete pavements. The rating scale ranges from **10–excellent** condition to **1–failed**. In general, most pavements will deteriorate through the phases listed in the rating scale. However, it is common for pavements to skip several levels when major defects appear or when the pavement is repaired. The time it takes to go from an excellent (10) to a very poor condition (1) depends largely on the quality of the original construction and the amount of heavy traffic loading.

Once significant deterioration begins it is common to see pavements deteriorate rapidly. This is usually due to the combined effects of loading and additional moisture. As a pavement ages and additional cracking develops, more moisture can enter the pavement and accelerate the rate of deterioration.

Look at the photographs which follow and become familiar with the descriptions of the individual rating categories. To evaluate an individual pavement segment, first determine its general condition. Is it relatively new, toward the top end of the scale? In very poor condition and at the bottom of the scale? Or somewhere in between? Next, think generally about the appropriate maintenance method.

Finally, review the individual pavement condition and distress and select the appropriate pavement rating. Remember that individual pavements will not have all of the types of distress listed for any particular rating. They may have only one or two types. Use the categories in the table below and on page 16.

We have found that relating a normal maintenance or rehabilitation procedure to the surface rating scheme helps you use the rating system. However, choosing an individual surface rating should not automatically dictate the final maintenance or rehabilitation technique.

You should consider safety, future traffic projections, original construction, and pavement strength since these may dictate a more comprehensive rehabilitation. On the other hand, it may be appropriate under special conditions to do nothing and let the pavement fully deteriorate and then rebuild when funds are available.

RATINGS ARE RELATED TO NEEDED MAINTENANCE OR REPAIR

Rating 9 & 10	New pavement or recent concrete rehabilitation. No maintenance required.
Rating 7 & 8	First signs of wear, scaling, or cracking. Needs routine maintenance.
Rating 5 & 6	First signs of corner cracks, faulting, and joint or crack spalling. Requires surface repairs, sealing or partial depth patching.
Rating 3 & 4	Moderate to severe faulting, multiple slab cracking, and joint failure. Requires extensive slab or joint rehabilitation.
Rating 1 & 2	Pavement failure requiring complete reconstruction.

Rating system

Surface rating	*Visible distress**	*General condition/ treatment measures*
10 Excellent	None.	New pavement. No maintenance required.
9 Excellent	Traffic wear in wheelpath. Slight map cracking or pop-outs.	Recent concrete overlay or joint rehabilitation. Like new condition. No maintenance required.
8 Very Good	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.	More surface wear or slight defects. Little or no maintenance required.
7 Good	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.	First sign of transverse cracks (all tight); first utility patch. More extensive surface scaling. Seal open joints and other routine maintenance.
6 Good	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").	First signs of shallow reinforcement or corner cracking. Needs general joint and crack sealing. Scaled areas could be overlaid.
5 Fair	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.	First signs of joint or crack spalling or faulting. Grind to repair surface defects. Some partial depth patching or joint repairs needed.
4 Fair	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 Poor	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 Very Poor	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 Failed	Restricted speed. Extensive potholes. Almost total loss of pavement integrity.	Total reconstruction.

** Individual pavements will not have all of the types of distress listed for any particular rating. They may have only one or two types.*

RATING 10 & 9

EXCELLENT —
No maintenance required

Rating 10 is for new pavement. Rating 9 is used for recent concrete rehabilitation or like-new condition. Some traffic wear. Slight map cracking or pop-outs. No maintenance required.

◄
RATING 10
New pavement with integral curb.

COC Notes 10 - No cracks, asphalt patches or partial depth patches. No displacement, scaling or popouts. May have minor imperfections in the original pouring of the slab (e.g. rough edges from surface scrapes, rounded corners that show no sign of continuing wear.

◄
RATING 9
Like new condition.

COC Notes 9 - The slab may have one minor hairline crack and no asphalt or partial depth patch. Minor imperfections are allowed such as minor scaling or few popouts. No raveling of the joints.

◄
RATING 9
Recent joint rehabilitation. Like new condition.

RATING 8

VERY GOOD — Little or no maintenance required

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. Little or no maintenance required.

► **Slight scaling.**

COC Notes 8 - The slab may have one minor crack separating it into two pieces, but no displacement. May have partial depth patch in excellent condition, but no asphalt patches. Some minor scaling alllowed or few

► **Isolated spall at manhole.**

▲ **Partial loss of joint sealant.**

► **Isolated meander crack, tight and well sealed.**

RATING 7

GOOD — May require some routine sealing or maintenance

First signs of transverse cracking, patching or repair; more extensive pop-outs or scaling; some manhole displacement, isolated heave or settlement. May need some sealing or routine maintenance.

◄ **Residential street pavement in good condition after many years of service. May only need periodic joint sealing maintenance.**

◄ **Extensive pop-outs. Pavement is unsightly but still provides good level of service.**

◄ **Recent full depth pavement repair. In very good condition.**

◄ **Transverse crack. Tight, sound pavement.**

◄ **Well sealed transverse crack. Joint repairs in good condition.**

COC Notes 7 - Slab may have one crack separating it into two pieces. Joints may have asphalt patching, but not more than 2" wide. May have partial depth patches in good condition. No patches inside the slab.

RATING 6

GOOD — Joint and crack sealing needed

First signs of corner cracking or shallow reinforcement. More frequent transverse cracks. Open (¼") joints and cracks. Moderate scaling. Needs joint and crack sealing.

COC Notes 6 - Slab is broken into 3 sections. Asphalt patches at the joints not more than 2" wide. May have partial depth patching in good condition.

▶ **Several transverse cracks. Tight or well sealed.**

▶ **Moderate scaling.**

Surface rust stain. Indicates shallow reinforcing.

▼

▲ **First signs of corner cracks.**

▲ **Isolated, tight meander crack. Several pop-outs. Remaining joints and cracks all tight and sound.**

RATING 5

FAIR — Partial depth patching and joint repairs may be needed

First signs of joint or crack spalling, or faulting. Multiple cracking at corners with broken pieces. Patching in fair condition. Surface texturing repairs may be necessary. Some partial depth patching and joint repairs may be needed.

◄ **Faulting at longitudinal joint and spalling along joint edge.**

COC Notes 5 - Slab is cracked into more than 3 sections. Asphalt patches at the joints are more than 3" wide. Partial depth patches are failing.

◄ **First signs of transverse joint faulting. Grinding will improve ride.**

▲ **Open cracks with edge spalling. Corner crack and broken corner piece.**

▲ **Isolated manhole problems and joint spalling. Full depth repair required adjacent to manhole.**

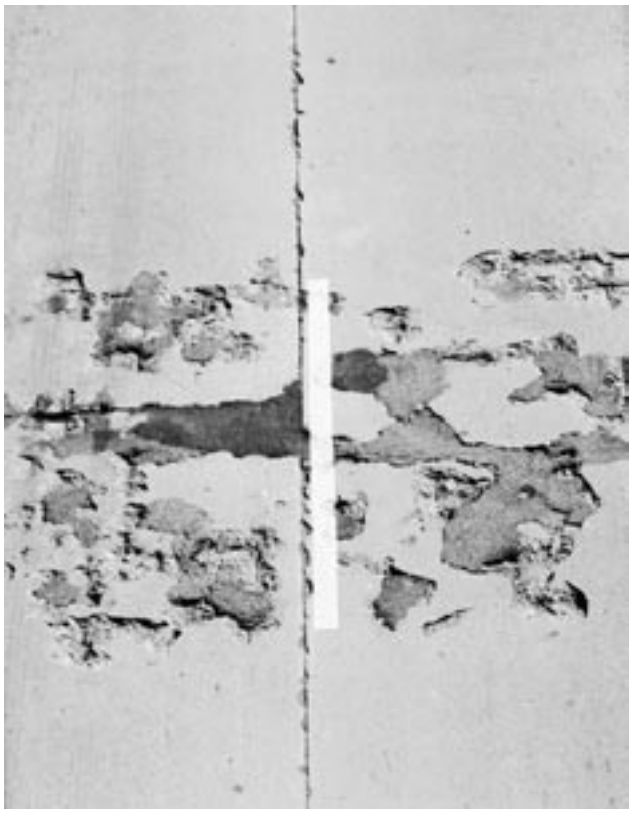
RATING 5

FAIR — (continued)
Partial depth patching and joint repairs may be needed

► **Broken corner pieces. Some joint spalling.**

Patching in ▼ fair condition.

▲ **Severe scaling over extensive areas. Patching or overlay needed.**



▲ **Spalling caused by shallow reinforcing steel. Temporary patching needs to be followed by extensive partial depth repairs.**

Wide open meander crack (1") with edge spalling.
▼ Corner crack with spalling.

RATING 4

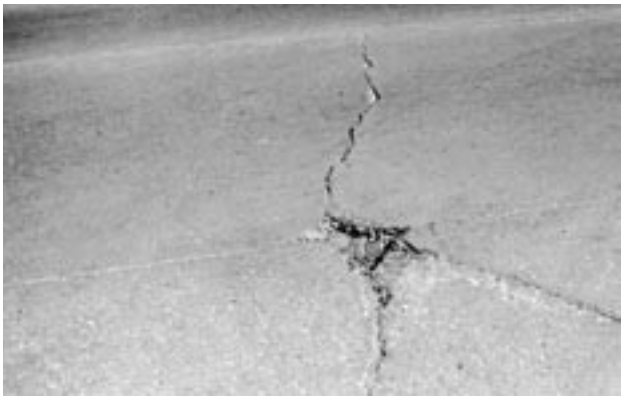
FAIR — Some full depth joint or crack repair required

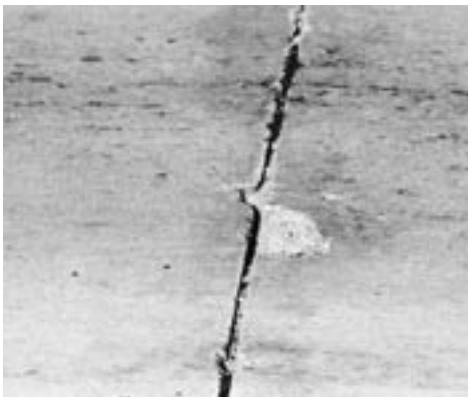
Severe surface distress requires asphalt overlay or extensive surface texturing. Multiple transverse cracks with spalling and broken pieces. Corner cracking with potholes or patches. Blowups. Some full depth joint or crack repair required.

◄
All joints show some deterioration and spalling.

COC Notes 4 - Slab has patches that cover 30% of its surface. Joints are unraveled 3" or more.

◄
Multiple open transverse cracks. Failed corner crack. Patches in fair condition.





◄
Moderate spalling at transverse joint.

▲
Corner cracking developed into small hole; moderate spalling of transverse crack.

◄
Moderate to severe longitudinal joint faulting. Transverse joint also has spalling.

RATING 3

POOR — Extensive full depth patching plus some full slab replacement required

Most joints and cracks are open (1"), spalled, or patched. D-cracking is evident. Severe (1") faulting. Extensive full depth patching required plus some full slab replacement.

▶ **Joints and cracks badly spalled. Patching is failing. Full depth repairs required.**

▼ **Multiple transverse cracks. Poor longitudinal joint with spalling.**

COC Notes 3 - Slab has asphalt or partial depth patches that cover 30-50% of its surface. Joints un-raveling more than 3" wide. Cracked and displaced slab in need or repair.

▶ **D-cracking (discoloration) at transverse joint and corner cracking. Needs full-depth repair.**

▶ **Discoloration at joints indicates D-cracking. Slab replacement needed.**

▶ **Badly spalled joint and open crack. Slab or joint replacement needed.**

▲ **Failed joint needs replacement.**

COC Notes 2 - Slab has asphalt or partial depth patches that cover over 50% of its surface. Slab is undermined or displaced. Severe deterioration of the joints and surface. The slab may create unsafe driving conditions.

RATING 2

VERY POOR — Pavement recycling and reconstruction necessary

◄ Failed patches. Replace entire portion of lane.

▲ Remove and replace pavement around manhole and inlet.

◄ Closely spaced transverse cracks and poor longitudinal joint. Replace slab.

▲ Extensive joint failure. Major rehabilitation or complete replacement needed.

◄ Severe deterioration. Requires extensive reconstruction.

RATING 1

FAILED — Complete reconstruction necessary

► **Slab and patch failure.**

► **Broken slabs require complete rebuilding.**

► **Total failure.**

Practical advice on rating roads

Inventory and field inspection

Most agencies routinely observe roadway conditions as a part of their normal work and travel. However, an actual inspection means looking at the entire roadway system as a whole and preparing a written summary of conditions. This inspection has many benefits over casual observations. It can be helpful to compare segments, and ratings decisions are likely to be more consistent because the roadway system is considered as a whole within a relatively short time.

An inspection also encourages a review of specific conditions important in roadway maintenance, such as drainage, adequate strength, and safety.

A simple written inventory is useful in making decisions where other people are involved. You do not have to trust your memory, and you can usually answer questions in more detail. Having a written record also improves your credibility with the public.

Finally, a written inventory is very useful in documenting changing roadway conditions. Without records over several years, it is impossible to know if your overall road conditions are improving, holding their own, or declining.

Annual budgets and long range planning are best done when based on actual needs as documented with a written inventory.

The Wisconsin DOT local road inventory (WISLR) is a valuable resource for managing your local roads. Adding PASER surface condition ratings is an important improvement.

Averaging and comparing sections

For evaluation, divide the local road system into individual segments which are similar in construction and condition. Rural segments may vary from ½ mile to a mile long, while sections in urban areas will likely be 1-4 blocks long or more. If you are starting with the WISLR Inventory, the segments have already been established. You may want to review them for consistent road conditions. Obviously no roadway segment is entirely consistent. Also, individual pavements will not have all of the types of distress listed for any particular rating. They may have only one or two types. Therefore, some "averaging" is necessary.

The objective is to rate the condition that represents the majority of the roadway. Small or isolated conditions should not influence the rating. It is useful to note special conditions on the inventory form so this information can be used in project design. For example, some spot repairs may be required.

Occasionally pavement conditions will vary significantly. For example, short sections of good condition may be followed by sections of poor pavement conditions. In this case, it is best to rate the pavement according to the worst conditions and note the variation on the form.

The overall purpose of condition rating is to be able to compare each segment relative to all the other segments in your roadway system. On completion you should be able to look at any two pavement segments and find that the better surface has a higher rating.

Within a given rating, say 6, not all pavements will be exactly the same. However, they should all be considered to be in better condition than those with lower ratings, say 5. Sometimes it is helpful in rating a difficult segment to compare it to other previously rated segments. For example, if it is better than one you rated 5, and worse than a typical 7, then a rating of 6 is appropriate. Having all pavement segments rated in the proper relative order is important and useful.

Assessing drainage conditions

Moisture and poor pavement drainage are significant factors in pavement deterioration. Some assessment of drainage conditions during pavement rating is highly recommended. While you should review drainage in detail at the project level, at this stage simply include an

▼ **Urban drainage. RATING: Excellent**

▲ **Adequate rural ditch and good erosion control. RATING: Good**

overview drainage evaluation at the same time as you evaluate surface condition.

Look at the roadway crown and check for low surface areas that permit ponding. Paved surfaces should have approximately a 2% cross slope or crown across the roadway. Rural shoulders should have a greater slope to improve surface drainage.

Good drainage improves a pavement's ability to resist pumping, faulting and joint damage. Some new concrete pavements are being constructed with a special drainage layer and drain system to reduce water-related deterioration. These systems require inspection and periodic maintenance.

You should also check curb and gutter, culverts, and storm drain systems. Storm drainage systems that are silted in, have a large accumulation of debris, or are in poor structural condition will also degrade pavement performance.

The T.I.C. publication, *Drainage Manual: Local Road Assessment and Improvement,* describes the elements of drainage systems, depicts them in detailed photographs, and explains how to rate their condition. Copies are available from the T.I.C.

▲ **Reshape terrace behind curb to restore drainage and prevent damage to curb and street.**

RATING: Fair

► **Flooding. Curb and gutter need reconstruction.**

RATING: Poor

Planning annual maintenance and repair budgets

We have found that relating a normal maintenance or rehabilitation procedure to the surface rating scheme helps local officials use the rating system. However, an individual surface rating should not automatically dictate the final maintenance or rehabilitation technique.

You should consider safety, future traffic projections, original construction, and pavement strength since these may dictate a more comprehensive rehabilitation than the rating suggests. On the other hand, it may be appropriate under special conditions to do nothing and let the pavement fully deteriorate, then rebuild when funds are available.

Summary

Using local road funds most efficiently requires good planning and accurate identification of appropriate rehabilitation projects. Assessing roadway conditions is an essential first step in this process. This concrete pavement surface condition rating procedure has proved effective in improving decision making and using roadway funds more efficiently. It can be used directly by local officials and staff. It may be combined with additional testing and data collection in a more comprehensive pavement management system.

Transportation Information Center Publications

Pavement Surface Evaluation and Rating (PASER) Manuals

Asphalt PASER Manual, 2002, 28 pp.

Brick and Block PASER Manual, 2001, 8 pp.

Concrete PASER Manual, 2002, 28 pp.

Gravel PASER Manual, 2002, 20 pp.

Sealcoat PASER Manual, 2000, 16 pp.

Unimproved Roads PASER Manual, 2001, 12 pp.

Drainage Manual
Local Road Assessment and Improvement, 2000, 16 pp.

SAFER Manual
Safety Evaluation for Roadways, 1996, 40 pp.

Flagger's Handbook (pocket-sized guide), 1998, 22 pp.

Work Zone Safety, Guidelines for Construction, Maintenance, and Utility Operations, (pocket-sized guide), 2002, 58 pp.

Wisconsin Transportation Bulletins

#1 Understanding and Using Asphalt
#2 How Vehicle Loads Affect Pavement Performance
#3 LCC—Life Cycle Cost Analysis
#4 Road Drainage
#5 Gravel Roads
#6 Using Salt and Sand for Winter Road Maintenance
#7 Signing for Local Roads
#8 Using Weight Limits to Protect Local Roads
#9 Pavement Markings
#10 Seal Coating and Other Asphalt Surface Treatments
#11 Compaction Improves Pavement Performance
#12 Roadway Safety and Guardrail
#13 Dust Control on Unpaved Roads
#14 Mailbox Safety
#15 Culverts-Proper Use and Installation
#16 Geotextiles in Road Construction/Maintenance and Erosion Control
#17 Managing Utility Cuts
#18 Roadway Management and Tort Liability in Wisconsin
#19 The Basics of a Good Road
#20 Using Recovered Materials in Highway Construction
#21 Setting Speed Limits on Local Roads

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PASER

Concrete Roads

Appendix D

Pavement Budget and Condition Prediction Spreadsheet

Inputs	2022	2023	2024	2025	2026	2027	2028	
Slab Replacement Budget	$2,174,600.00	$3,650,000.00	$4,000,000.00	$4,500,000.00	$4,500,000.00	$4,700,000.00	$5,000,000.00	← Requires Input
Projected Cost per sq. yd	$80.00	$82.40	$84.87	$87.42	$90.04	$92.74	$95.52	← Requires Input
Add'l Sq. yd. of Capital Improvement	-		-	-	-	-		← Requires Input
Total sq. ft. of Concrete Replaced	244,643	398,665	424,168	463,290	449,797	456,104	471,085	← Calculated
Total sq. yd. of Concrete Replaced	27,183	44,296	47,130	51,477	49,977	50,678	52,343	← Calculated
Average Rating (end of year)	7.81	7.82	7.80	7.78	7.75	7.72	7.69	← Calculated
Approx. Average Age of Network	16.92	16.79	16.99	17.20	17.45	17.74	18.06	← Calculated
% of Total City Pavement Replaced	0.97%	1.58%	1.68%	1.84%	1.78%	1.81%	1.87%	← Calculated
	0	1	2	3	4	5		

Average Rating at end of year 0 (2022)	7.81	← From GIS	Total sq. ft. of Pavement	25,243,840	← From GIS
Approx. Average Age @ yr 0	16.92	← Calculated	Total sq. yd. of Pavement	2,804,871	← Calculated

Polynomial Model	x^3	x^2	x	Constant	
Coefficient	-0.0002	0.0109	-0.2525	10	← From 2023 Analysis
	a	b	c	d	

Proj. Construction Cost Inflation Rate	0.03	← Requires Input

Appendix E

Public Works Capital Replacement Plan
2024

Personnel				Potential Grant	
	Account	Description	Cost	Funding?	Amount
Personnel	5111-5130	1 Mechanic, 2 Project Managers	$308,000	No	

Contractual				Potential Grant	
	Account	Description	Cost	Funding?	Amount
Contractual	5251	Annual Capital Contracts	$10,000	No	
Contractual	5251	Semi-Annual Crack Sealing	$100,000	No	
		Rejuvenators - Schoettler	$50,000		
Professional Services	5261	Annual Capital Project Design	$10,000	No	
	5261	Annual Inspection and Testing Services	$100,000	No	
	5261	TIP Grant Applications	$15,000	No	$0
	5261	Wilson Avenue right of way	$415,000	Yes	$311,250
		Schoettler Road Sidewalk Design	$140,000	Yes	$91,000

Capital Outlay	Account	Description	Cost	Potential Grant Funding?	Amount
Machinery and Equipment	5440	None		No	
Automobiles and Trucks	5460	See Detail	$306,000	No	
Improvements Building and Grounds	5470	See Detail	$98,400	No	
		PWF Garage Area Improvements	$220,000	No	
Street Improvements	5490	See Street Five Year Plan	$4,000,000	No	
	5490	Asphalt Overlay	$1,800,000	No	
Storm Sewer Improvements	5495	Grated Troughs	$10,000	No	
Sidewalk Improvements	5497	Annual Sidewalk Project	$300,000	No	
	5497	CDBG Project	$50,000	Yes	$45,000
		SUB-TOTAL	$7,932,400		$447,250
		TOTAL MINUS GRANT	$447,250		
		TOTAL 2024 Expenditures	$7,485,150		
		Estimated 2024 Revenue	$6,780,000		
		Estimated Capital Projects Fund Balance 1/1/2024	$2,500,000		
		Plan reduces Fund Balance by approx.	$705,150		
		Estimated Capital projects Fund Balance 1/1/2025	$1,794,850		

Public Works Capital Replacement Plan
2025

Personnel

	Account	Description	Cost	Potential Grant Funding?	Amount
Personnel	5111-5130	1 Mechanic, 2 Project Managers	$317,000	No	

Contractual

	Account	Description	Cost	Potential Grant Funding?	Amount
Contractual	5251	Annual Capital Contracts	$10,000	No	
Contractual	5251	Semi-Annual Crack Sealing	$100,000	No	
Professional Services	5261	Annual Capital Project Design	$10,000	No	
	5261	Annual Inspection and Testing Services	$100,000	No	
	5261	TIP Grant Applications	$15,000	No	$0
	5261	Ladue Farm Bridge Design	$150,000	Yes	$120,000
		Schoettler Road Sidewalk Right of way	$29,000	Yes	$18,850

Capital Outlay

	Account	Description	Cost	Potential Grant Funding?	Amount
Machinery and Equipment	5440	None		No	
Automobiles and Trucks	5460	See Detail	$424,000	No	
Improvements Building and Grounds	5470	See Detail	$129,000	No	
		Seal parking lots	$180,000		
Street Improvements	5490	See Street Five Year Plan	$4,500,000	No	
	5490	Asphalt Overlay - Levee Trail	$1,100,000	No	
		Edison Avenue overlay if postponed			
		Rejuvenator program	$50,000		
Storm Sewer Improvements	5495	Grated Troughs	$40,000	No	
Sidewalk Improvements	5497	Annual Sidewalk Project	$300,000	No	
	5497	CDBG Project	$50,000	Yes	$45,000
		SUB-TOTAL	$7,504,000		$183,850
		TOTAL MINUS GRANT	$183,850		
		TOTAL 2025 Expenditures	$7,320,150		
		2025 Estimated Revenues	$6,920,000		
		Estimated Capital Projects Fund Balance 1/1/2025	$1,794,850		
		Plan reduces Fund Balance by approx.	$400,150		
		Estimated Capital projects Fund Balance 1/1/2026	$1,394,700		

Public Works Capital Replacement Plan
2026

Personnel	Account	Description	Cost	Potential Grant Funding?	Amount
Personnel	5111-5130	1 Mechanic, 1 Project Manager, 1 Asst City Engineer	$326,000	No	

Contractual	Account	Description	Cost	Potential Grant Funding?	Amount
Contractual	5251	Annual Capital Contracts	$10,000	No	
Contractual	5251	Semi-Annual Crack Sealing	$100,000	No	
Professional Services	5261	Annual Capital Project Design	$10,000	No	
	5261	Annual Inspection and Testing Services	$100,000	No	
	5261	TIP Grant Applications	$15,000	No	$0
	5261	Ladue Farm Bridge Right of Way	$50,000	Yes	$40,000
		Wilson Avenue Construction Engineering	$170,000		$127,500
		Schoettler Road SW Construction Engineering	$101,000	Yes	$65,650

Capital Outlay	Account	Description	Cost	Potential Grant Funding?	Amount
Machinery and Equipment	5440	None		No	
Automobiles and Trucks	5460	See Detail	$426,000	No	
Improvements Building and Grounds	5470	See Detail	$350,000	No	
Street Improvements	5490	See Street Five Year Plan	$5,000,000	No	
	5490	Wilson Avenue Construction	$1,700,000	yes	$1,275,000
Storm Sewer Improvements	5495	Grated Troughs	$40,000	No	
Sidewalk Improvements	5497	Annual Sidewalk Project	$300,000	No	
	5497	CDBG Project	$50,000	Yes	$45,000
	5497	Schoettler Road Sidewalk	$1,012,000	Yes	$657,800
		SUB-TOTAL	$9,760,000		$2,210,950
		TOTAL MINUS GRANT	$2,210,950		
		TOTAL	$7,549,050		
		Estimated 2026 revenues	$7,055,000		
		Estimated Capital Projects Fund Balance 1/1/2026	$1,394,700		
		Plan reduces Fund Balance by approx.	$494,050		
		Estimated Capital projects Fund Balance 1/1/2026	$900,650		

Public Works Capital Replacement Plan
2027

Personnel	Account	Description	Cost	Potential Grant Funding?	Amount
Personnel	5111-5130	1 Mechanic, 1 Project Manager, 1 Asst City Engineer	$336,000	No	

Contractual	Account	Description	Cost	Potential Grant Funding?	Amount
Contractual	5251	Annual Capital Contracts	$10,000	No	
Contractual	5251	Semi-Annual Crack Sealing	$150,000	No	
Professional Services	5261	Annual Capital Project Design	$10,000	No	
	5261	Annual Inspection and Testing Services	$100,000	No	
	5261	TIP Grant Applications	$15,000	No	$0
	5261	Ladue Farm Bridge Construction Engineering	$50,000	Yes	$40,000

Capital Outlay	Account	Description	Cost	Potential Grant Funding?	Amount
Machinery and Equipment	5440	None		No	
Automobiles and Trucks	5460	See Detail	$618,000	No	
Improvements Building and Grounds	5470	See Detail	$100,000	No	
		Other			
Street Improvements	5490	See Street Five Year Plan	$5,200,000	No	
	5490	Ladue Farm Bridge	$600,000	Yes	$480,000
		Bridge Overlays	$300,000		
		Asphalt Mill and Overlay	$220,000		
Storm Sewer Improvements	5495	Grated Troughs	$40,000	No	
Sidewalk Improvements	5497	Annual Sidewalk Project	$300,000	No	
	5497	CDBG Project	$50,000	Yes	$45,000
		SUB-TOTAL	$8,049,000		$565,000
		TOTAL MINUS GRANT	$565,000		
		TOTAL	$7,484,000		
		2027 Estimated Revenue	$7,200,000		
		Estimated Capital Projects Fund Balance 1/1/2026	$900,650		
		Plan reduces Fund Balance by approx.	$284,000		
		Estimated Capital projects Fund Balance 1/1/2026	$616,650		

Public Works Capital Replacement Plan
2028

Personnel	Account	Description	Cost	Potential Grant Funding?	Amount	
Personnel	5111-5130	1 Mechanic, 1 Project Manager, 1 Asst City Engineer	$346,000	No		

Contractual	Account	Description	Cost	Potential Grant Funding?	Amount	
Contractual	5251	Annual Capital Contracts	$10,000	No		
Contractual	5251	Semi-Annual Crack Sealing	$150,000	No		
Professional Services	5261	Annual Capital Project Design	$10,000	No		
	5261	Annual Inspection and Testing Services	$100,000	No		
	5261	TIP Grant Applications	$15,000	No		$0

Capital Outlay	Account	Description	Cost	Potential Grant Funding?	Amount	
Machinery and Equipment	5440	None		No		
Automobiles and Trucks	5460	See Detail	$336,000	No		
Improvements Building and Grounds	5470	See Detail	$126,000	No		
		Other				
Street Improvements	5490	See Street Five Year Plan	$5,700,000	No		
		Bridge Overlays	$0			
		Asphalt Mill and Overlay	$380,000			
Storm Sewer Improvements	5495	Grated Troughs	$40,000	No		
Sidewalk Improvements	5497	Annual Sidewalk Project	$300,000	No		
	5497	CDBG Project	$50,000	Yes		$45,000
		SUB-TOTAL	$7,513,000			$45,000
		TOTAL MINUS GRANT	$45,000			
		TOTAL	$7,468,000			
		Estimated Revenue	$7,340,000			
		Estimated Capital Projects Fund Balance 1/1/2026	$616,650			
		Plan reduces Fund Balance by approx.	$128,000			
		Estimated Capital projects Fund Balance 1/1/2026	$488,650			