DEPARTMENT OF TRANSPORTATION

# A Qualitative and Quantitative Assessment of Pavement Sections That Have Remained in Poor Condition for Five-Plus Years

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16. Abstract (Limit: 250 words)

The 2014 Transportation Asset Management Plan calls for developing a method to annually track, monitor, and identify road segments that have been in poor condition for more than 5 years and consistently consider them when programming. In Minnesota, pavements are considered in poor condition when the ride quality index (RQI) is less than or equal to 2.0. There are still pavement segments that have remained in poor condition for more than 5 years. However, it is not clear if RQI and RSL metrics accurately quantify the "true" condition of the system. In this study, the roadway segments that have maintained a poor ride quality index over time were identified in each district and extensive additional information was obtained from interviews with district engineers and planners. The analysis of the additional information shows that most pavement sections that have remained in poor condition for extended periods are actually not in poor condition. They represent “anomalies” with unique characteristics, and new parameters must be established to quantify the true condition of these sections.

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# A QUALITATIVE AND QUANTITATIVE ASSESSMENT OF PAVEMENT SECTIONS THAT HAVE REMAINED IN POOR CONDITION FOR FIVE-PLUS YEARS

## FINAL REPORT

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# TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

# EXECUTIVE SUMMARY

There is a critical need to systematically identify and assess roadway segments that have maintained a poor ride quality index over time. The objective of this study is to identify these pavement sections in every district and obtain additional information for these pavement segments to determine if there are more appropriate metrics for programming future work.

The research methodology started with a literature review and survey to identify if deferring pavement preservation for longer periods of time was a common occurrence across agencies and to document the tools used to avoid this situation. The consensus from the literature review and survey responses was that none of the states have specific mechanisms for dealing with pavement sections that have been in poor condition for five or more years, since pavement sections of this type were not numerous enough to be relevant on a policy scale.

Next, roadway segments that have maintained a poor ride quality index over long periods of time were identified for each of the eight districts and interviews were conducted with district engineers and planners to obtain additional information about these sections. It was found that most pavement sections that have remained in poor condition for extended periods represent “anomalies” with unique characteristics that are mostly responsible for their condition rating. The most common characteristics were specific features that define these sections as “urban,” and to a lesser extent, the presence of bridge transitions or railroad crossings.

Based on this additional information and on the existing data in Highway Performance Management Application (HPMA), further analyses were conducted for these sections to provide support for potential changes in how their condition should be assessed in the future. Based on the results and additional feedback from the engineers and planners previously interviewed, several recommendations were made for obtaining a more realistic assessment of the condition of these sections. For urban sections, one option would be to develop a new parameter based on a combination of Surface Rating (SR) and Ride Quality Index (RQI), or by taking the difference between SR and ride quality index (RQI). Another option was to develop a new RQI formula specifically calibrated for urban roads. This would require an additional study in which individuals are driven on these sections and then asked to rate them based on ride comfort.

# CHAPTER 1: INTRODUCTION

## 1.1 BACKGROUND

One of the most important aspects of pavement management is the ability to accurately measure and represent the condition of the pavement network. MnDOT has used the remaining service life (RSL) measure for pavement condition for more than a decade. RSL is an estimation of the time until the next major rehabilitation of the pavement section. Using pavement deterioration curves, the time when a pavement section reaches a ride quality index (RQI) of 2.5 is predicted and the RSL is simply calculated as the difference between the predicted and the present time. However, it is not clear if RQI and RSL metrics accurately quantify the "true" condition of the system as there are pavement sections in MnDOT’s network that have remained in poor condition for more than 5 years.

## 1.2 OBJECTIVE

The objective of this study is to identify pavement sections that have remained in poor condition for more than 5 years and obtain additional information, which is not directly reflected in RQI, to determine if there are more appropriate metrics for programming future work. This study investigates pavement management and planning methods used by DOTs around the country as well as by MnDOT’s district offices. The purpose of this investigation is to identify any blind spots in MnDOT’s pavement management processes that could result in the aforementioned prolonged poor condition of certain pavement sections.

## 1.3 ORGANIZATION OF THE REPORT

First, a literature review is performed to document how different transportation agencies around the country identify, assess, and program the report of pavement network sections that are in poor condition. The review also documents published research investigating cases of prolonged deferral of maintenance and rehabilitation of pavements that remain in poor condition for long periods and the tools used by various agencies to avoid this situation. A survey is discussed that was developed and sent to DOTs to obtain current information on how agencies address the transportation asset management plan (TAMP) call for developing methods to annually track, monitor, and identify road sections that have been in poor condition for more than five years.

Then, an analysis of MnDOT’s HPMA pavement condition database is performed to identify pavement network sections that have been in poor condition for a prolonged period. Additional information is gathered on these sections. For each MnDOT district, the sections with the most prolonged poor condition are gathered. These sections as well as district pavement management and planning processes are discussed with MnDOT district materials engineers. Engineers from each of MnDOT’s eight districts provide their input over a series of interviews that prove invaluable in the identification of the reason why sections are allowed to reach prolonged poor condition. Summaries of these interviews are included.

Next, an analysis of condition parameters currently used by MnDOT to rate their roads is performed. The potential for using these parameters to identify pavement sections defined as “anomalies” is discussed. A summary of the study and the relevant conclusions and recommendations for further work are provided in the final chapter.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 INTRODUCTION

Each state DOT is responsible for a vast network of roads, bridges, and other assets. They are also responsible for collaborating with local transportation agencies from cities, counties, and metropolitan transportation organizations (MPOs) on projects that require state assistance in planning and/or funding. State DOTs are fairly autonomous from a national perspective, and they have each developed their own methods of pavement management. However, this posed a problem for the Federal Highway Administration (FHWA) that wanted to ensure that federally-owned and -aided roads are kept to an acceptable level of service. Over the last two decades, a series of federal funding acts have enacted rules on how states need to address this issue. These acts include the 1991 ISTEA Act, which established a National Highway System (NHS) [FHWA], the 1998 TEA-21 Act [FHWA, 2015], and most recently the 2012 MAP-21 Act and 2015 FAST Act. The Moving Ahead for Progress in the 21st Century (MAP-21) Act was an important step towards the standardization of state DOT pavement management practices. The act required each state to establish a risk- and performance-based asset management plan for their NHS roads [FHWA, 2012]. This act also set uniform performance goals and measurements for each state. This mandate triggered the beginning of a multi-year transportation asset management plan (TAMP) development and implementation process. This process culminated with the submittal of a final TAMP by each state DOT in the summer of 2019. The FAST Act was an extension of the MAP-21 Act. It provided additional funding to states and continued the TAMP mandate [FHWA, 2016].

Each state's TAMP must detail their pavement management procedures. These procedures include pavement condition data collection, life-cycle planning process, and determining funding allocations. This makes TAMP a good resource for learning about each state's pavement management methods. The downside is that states are only required to include methods related to NHS pavements. Some states chose to include their state highway system (SHS), but that is not always the case. This means that the methods laid out in a state's TAMP are not necessarily the methods used to manage all pavements in that state. For this reason, TAMP may not provide information about pavements that stay in poor condition for 5+ years, since most of them are low-volume roads.

However, because the NHS and SHS are the most heavily-traveled roads in each state, the methods presented in the TAMPs represent the best-practice methods followed by each state. Studying these methods should provide insight into the capabilities of state DOTs in terms of pavement management. Also, the makeup of each DOT's state-controlled road system varies. NHS can make up anywhere from 63% of the system [WSDOT, 2019] to 9% of the system [MDT, 2019]. So, even though the methods presented in this section may not be used by these DOTs on their most underserved roads, they can still be relevant to large portions of their road network. For this reason, a survey was conducted to determine whether state DOTs around the country have methods in place to annually track, monitor, and identify road sections that have been in poor condition for five or more years. Some of the results are presented in the next paragraphs. Detailed responses from the participants are presented in Appendix A.

## 2.2 AGENCY METHODS FOR PAVEMENT MANAGEMENT

### 2.2.1 Data Collection

The pavement management process begins with the collection of pavement condition data. Each state is responsible for annually collecting this data on its NHS roads in 0.1-mile increments. States typically collect condition data on their SHS every 1-2 years. States are required to annually submit inventory information on their public roads to FHWA's Highway Pavement Management System (HPMS) [FHWA, 2018]. To ensure consistency in their federally reported data, almost every state DOT collects condition data on all NHS pavements in their state, regardless of ownership. FHWA performance metrics require the collection of data types that identify roughness, visual distresses, rutting (for flexible pavements), and faulting (for rigid pavements). Some states choose to perform more extensive data collection for the calculation of their own performance metrics. For example, New Mexico DOT [NMDOT, 2019] and Ohio DOT [ODOT, 2019] collect skid resistance data, and Kentucky Transportation Cabinet [KYTC, 2019] collects roadway geometry data. While each state typically has its own data collection needs, they frequently overlap with the federal data collection requirements. State DOTs either collect the data in-house or through a vendor. Of the 20 reviewed states, 14 collect data through an internal office. Data collection is performed using survey vans equipped with automated data collection instruments including digital cameras, accelerometers, and 3D laser systems. The two most popular versions of the survey van are the Automated Road Analyzer (ARAN) Van from Fugro Roadware and the Pathways Survey Van from Pathway Services. States can own these vans or hire the manufacturer to collect data for them. Many states purchase one of these vans and outfit it to their needs. Once collected, the data is processed to produce the required condition metrics. Processing software depends on the agency and type of equipment used to capture data. For example, Roadware's Vision software can be used to perform crack detection, classification, and rating [MaineDOT, 2019]. Highway condition data is then stored in a database. Database software also varies by state. A popular database software is ESRI's Roads and Highways program. This program is used by Minnesota [MnDOT, 2019], Indiana [INDOT, 2019], and Louisiana [LADOTD, 2019] and can apply a universal linear referencing system to pavement sections for ease of organization. Other software include DigitalHIWAY [CTDOT, 2019], TAHI [LADOTD, 2019], and Oracle Pavement Condition Database [UDOT, 2019]. Some DOTs use the same software for data storage and analysis.

### 2.2.2 Pavement Performance Metrics

Once condition data is collected and organized, it must be used to judge the health of the pavement. This is done through the calculation of pavement performance metrics. As mentioned earlier, FHWA has a set of five standard performance metrics that must be reported for all NHS pavement sections. These metrics are International Roughness Index (IRI), Present Serviceability Rating (PSR), Cracking Percent, Rutting (for flexible), and Faulting (for rigid). PSR is only applied to roads that have a posted speed limit of less than 40 mph where accurate IRI data is not obtainable [NYSDOT, 2019]. The thresholds for FHWA metrics can be found in Figure 2.1. To be considered in "good" condition, all metrics must rate in the good range. To be considered in “poor” condition, at least two metrics must rate in the poor range. All other combinations are considered “fair” condition.

| Metric Thresholds for Pavement Condition | | | |
|---|---|---|---|
| **Rating** | **Good** | **Fair** | **Poor** |
| IRI (inches/mile) | <95 | 95-170 | >170 |
| PSR* (0.0-5.0 value) | >4.0 | 2.0-4.0 | <2.0 |
| Cracking Percent (%) | <5 | **CRCP: 5-10, Jointed: 5-15, Asphalt: 5-20 | >10, >15, >20 |
| Rutting (inches) | <0.20 | 0.20-0.40 | >0.40 |
| Faulting (inches) | <0.10 | 0.10-0.15 | >0.15 |

**Figure 2.1 FHWA performance metric thresholds [MoDOT, 2019].**

Every state DOT has their own performance metrics to keep track of pavement condition. Some states consider their metrics and thresholds to be more accurate in describing the condition of their network. Most DOTs use an overall condition metric that makes comparison between pavement sections easier. These metrics are a combination of weighted sub-metrics. A good example of this kind of metric is CTDOT’s Pavement Condition Index (PCI) which is calculated from the following weighted metrics [CTDOT, 2019]: IRI (10%), Rutting (15%), Cracking (25%), Disintegration (30%), and Drainage (20%)

Of the 20 reviewed states, 14 use an overall pavement condition metric. Most other states rely on a metric based on a single data type to indicate pavement condition. These states typically use a ride quality metric. A good example of this is MoDOT that has historically relied on smoothness as their singular pavement condition metric [MoDOT, 2019]. Other approaches include using a set of condition metrics that will trigger treatment if any fall under a certain threshold [WSDOT, 2019], or just using FHWA’s performance metrics for their SHS [Caltrans, 2019].

### 2.2.3 Pavement Management Modeling

As required by federal law, each state uses some kind of risk-based pavement management system (PMS) [FHWA, 2012]. A PMS is software that can take inputs related to a pavement network, analyze the network, and provide recommendations for treatment strategies. The key piece in this process is the model used by the PMS to predict future pavement condition given historic conditions and future funding availability. State DOTs develop models that accurately reflect the degradation of their pavement network and plug these models into their PMS software. Other PMS inputs include pavement condition data, performance metric thresholds, funding scenarios, decision trees, and construction unit costs. Only one of the reviewed state DOTs (Kentucky) is not using a PMS system as of 2019, although they are working to implement one. DOTs either use in-house-developed or third-party PMS software. The most popular third-party software is Deighton’s Total Infrastructure Management System (dTIMS). This software is used by eight of the reviewed DOTs. Other third-party software includes Agile Assets

Enterprise and Stantec's Highway Performance Management Application (HPMA). The in-house-developed PMS software vary in sophistication from fully developed program to spreadsheet tool.

A DOT can configure their PMS software's funding priorities using different investment scenarios. The goal of each state DOT is to successfully implement LifeCycle Planning (LCP), the process of managing assets while minimizing the overall life costs and providing the highest possible level of service [VTrans, 2018]. States will test different investment scenarios in their PMS to determine which comes closest to achieving LCP with a given budget. These investment scenarios generally fall into three categories: "worst first", "preservation first", and "right treatment at the right time". The "worst first" strategy involves making repairs to whichever pavement sections in the network are in the worst condition. DOTs are moving away from this strategy. Of the 20 reviewed DOTs, only Illinois [IDOT, 2019] and Alabama [ALDOT, 2019] are still using this strategy, and both have plans to move away from it. This move away from a "worst first" approach could explain why some pavement sections are left in poor conditions for multiple planning cycles. The "preservation first" strategy focuses on keeping the system in good condition using preventative maintenance. The effects of deferred maintenance will be discussed in the next section. This is a popular strategy, especially among DOTs that already have generally good pavement condition in their network. The "right treatment at the right time" approach involves using a variety of treatment types, from maintenance to reconstruction, to keep their road network in the best condition possible given a certain budget. This is the approach that most directly attempts to achieve LCP.

### 2.2.4 Maintenance and Rehabilitation Programming

Once DOTs have determined the current condition of their system, and have produced treatment recommendations through their PMS, they must program their annual maintenance and rehabilitation (M&R) schedule. Before this, DOTs typically set up a funding framework to determine what projects to fund in the near and distant future. This framework is made up of long-term and short-term funding plans. Almost every state has a 4-5 year statewide transportation improvement plan (STIP). STIPs are fiscally constrained by year and include financial information for the projects and project phases that are to be implemented using current and projected revenues [VTrans, 2019]. STIPs are usually created with the advice of local agencies and MPOs [NYSDOT, 2019]. FHWA requires states to provide 10-year funding projections, so many states also develop a 10-year STIP. Some states allocate funding to specific pavement classifications. For example, VTrans divides their roads into Customer Service Level (CSL) tiers based on vehicle miles traveled (VMT). During their funding allocation process, more investment may be made to the higher tiers [VTrans, 2019]. DOTs will also allocate money to their districts by formula. Once the funding framework has been put into place, programming can commence. The typical programming process begins with the DOT pavement management office sending the PMS-produced treatment recommendations to their district offices. Districts consult with local agencies and MPOs to form a prioritized list of M&R projects. This list is sent back to the pavement management office, where a complete list of projects is compiled and sent to a finance committee for approval. There are many variations to this process including how much freedom districts are given. ODOT requires districts to follow 75% of the recommendations made by their PMS [ODOT, 2019], while MoDOT districts have their own models that are used to determine M&R treatments [MoDOT, 2019]. KYTC follows their own system, called the SHIFT Program. This program puts more emphasis on prioritizing projects with statewide significance. Regardless of the programming method, the short-term STIP is updated annually to include the approved projects.

## 2.3 MAINTENANCE AND REHABILITATION DEFERRAL

The deferment of pavement maintenance and rehabilitation (M&R) activities leads to pavement degradation and distresses. Poor quality pavements are expensive for two groups: the operators and the users. Because agencies typically do not consider user costs when budgeting or programming, the increased agency costs are more relevant in the fight for increased M&R spending. Despite this, user costs will be explored in this section as they provide a potentially even stronger case for the damage done by M&R deferral.

### 2.3.1 Impact on Agencies

Larry Summers, former Secretary of the Treasury once stated, “Prevention is cheaper than cure” [Olson et al., 2017]. It is more cost-effective for agencies to pre-emptively maintain pavements rather than to fix them after they are too far gone for simple treatments. In a paper, *Analysis of the Effect of Deferring Pavement Maintenance*, the authors suggested that, when considering the initial cost of an M&R activity, one must split that cost into two parts: fixed and variable [Sharaf et al., 1988]. The fixed cost is the cost of actually performing the M&R activity. The variable cost is the cost to prepare the pavement surface for the M&R activity. This cost increases with the severity of the pavement distress. The paper includes an example surface preparation policy matrix. From the matrix, a pavement with low severity alligator cracking requires seal coat preparation ($0.12/ft$^2$) while a pavement with medium severity alligator cracking requires shallow patch preparation ($1.78/ft$^2$). The increase of one severity level increased the surface treatment cost nearly 15 times. The authors also performed an Equivalent Annual Uniform Cost (EUAC) analysis of different M&R activities for a variety of pavement classes in different PCI ranges. The analysis consistently showed a strong correlation between lower PCI scores and higher M&R costs.

The underfunding and subsequent M&R deferral on the nation’s roadways directly results in lower PCI scores. This is a problem that has existed for decades in the United States. A 1986 NCHRP report on alternative maintenance strategies pointed out that in the preceding years, maintenance expenditures on the state-administered highway system were cut by 27%. These cuts along with increased maintenance needs from an aging infrastructure system led to the doubling of the number of miles of interstate pavements falling into poor conditions every three years [Butler et al., 1986]. After years of continued underfunding, the federal highway system is experiencing a $420 billion backlog in delayed repair costs [ASCE, 2017]. Much of this backlog has built up due to the depletion of the Highway Trust Fund. This fund is filled mostly with money from the federal motor fuels tax, which has not been raised since 1993. In most cases, agencies decide to defer maintenance out of necessity. They simply do not have enough money to perform the M&R activities that each of their pavement sections requires. Underfunding M&R activities seems to be the primary form of M&R deferment today.

Although no historical case studies on the effects of deferred M&R activities could be found for this literature review, a simulation-based case study performed by the Colorado Department of Transportation (CDOT) can be used to illustrate the effects of both deferred rehabilitation and underfunding of M&R activities [Hafez et al., 2018]. CDOT wanted to test the effects of an asset management policy in which low-volume roads (LVRs) in a region of the state were treated only with general maintenance activities including thin overlays. CDOT uses a metric called Drivability Life (DL) to measure the remaining service life of the pavement. They consider pavements to be in poor condition when they reach a DL $\leq$ 3 years. The yearly maintenance budget was capped at $2.8 million per the observed maintenance expenditures from previous years. The DL of the LVRs in the specified region was predicted for each year from 2016 to 2026. In ten years, the weighted DL of the system dropped from 4.87 to 1.29. The weighted DL reached poor pavement levels within the first five years of this maintenance plan being in place. The failure of this asset management policy can be pinned to two major factors. The first factor was the existing condition of the system. The benefit of maintenance activities depends heavily on the existing condition of the pavement. CDOT recommends that thin overlays be used only on pavements that have 75% of their remaining service life. However, in 2016 about half of the LVRs in the system were already in poor condition. The general maintenance policy could not address these already poor pavements. The other factor was the annual budget for maintenance. The policy called for each pavement section in poor condition to receive the best possible treatment option, a thin overlay. Due to the relatively high costs of thin overlay treatments and the high quantity of poor condition pavements in the region, the provided budget was not enough. Each year, many poor condition pavements received no treatment at all, accelerating their degradation. A more cost-effective asset management policy, in which both M&R activities were allowed, was then tested. Although this new policy was designed to use their budget as effectively as possible, the weighted DL of the system still ended up at 2.49 by 2026. This is better than the previous policy, but it still shows a system in poor conditions. This case study shows that deferring certain types of treatments (maintenance or rehabilitation) is damaging for a road system, but underfunding that system can be equally, if not more damaging.

WSDOT developed a performance measure to specifically gauge the impact of deferred maintenance on their road network. The performance measure, called deferred preservation liability (DPL) is meant to capture the economic ramifications of missed preservation opportunities [Rydholm et al., 2014]. The liability is measured in dollars. If a pavement section is due for a certain activity at a given year in the predicted future, the liability would be equal to the difference in the cost of performing the activity that year versus performing the required activity the next year. At the least lifecycle cost (LLCC) state, DPL is $0. Because DPL is a measure of the cost of a construction activity, it is reliant on the assumption of average construction costs. Pavement sections do not start accumulating DPL until two years after their Due Year, which is the year that they are predicted to need some kind of M&R activity [Uhlmeyer et al., 2016]. DPL is a tool that can be used by any DOT to demonstrate the consequences of M&R deferral.

The first and strongest line of defense of most state agencies in the battle against deferred M&R activities is their PMS. The general purpose of the PMS is to determine the most cost-efficient use of an agency's resources. A common tool in PMS is the decision tree. Decision trees are a series of simple questions that result in a directive. Decision trees are used by agencies to choose the correct M&R activity based on a series of pavement factors. As part of their study into LVRs, CDOT developed a decision tree that would help choose the appropriate M&R activity for the situation [CDOT, 2018]. This decision tree can be seen in Figure 2.2. CDOT's survey of several state DOTs showed that many agencies use decision trees to decide what maintenance action they should take. [Hafez et al., 2018]

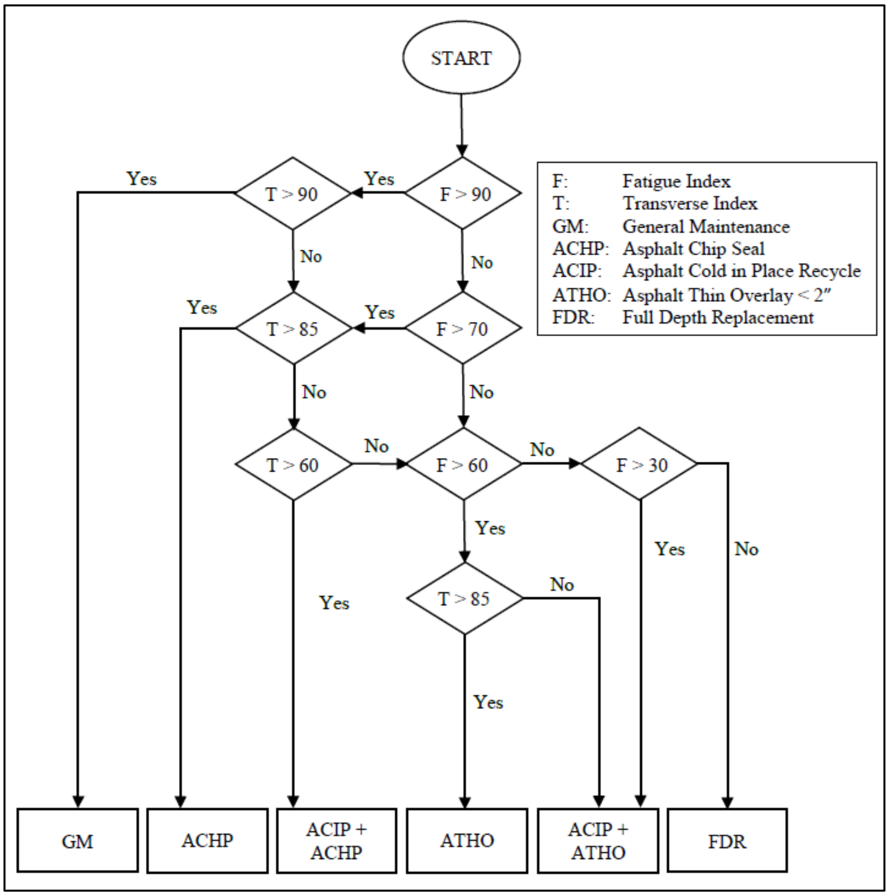


**Figure 2.2 Example decision tree for the treatment of LVRs in Colorado. [Hafez et al., 2018]**

### 2.3.2 Impact on Users

Transportation agencies are not the only ones hurt financially by worsening road conditions. Users end up paying for these conditions through increased fuel consumption, travel times, and vehicle depreciation. In a study done by Janoff et al. [1985], the authors concluded that higher roughness in roads causes users to feel uncomfortable and thus drive at lower speeds. This in turn can lead to congestion and increased travel time for users, both of which increase fuel consumption. These increased costs are a direct result of increased pavement roughness [Islam et al., 2012]. Fuel costs make up roughly 50-75% of total user costs. An increase in IRI of 129in/mi can lead to a decrease in a vehicle's fuel economy of 1-2%. In 2008, the total highway fleet consumed 175.2 billion gallons of fuel. This decrease in fuel economy would increase fuel consumption across the nation by 1.75-3.5 billion gallons and cost users billions of dollars.

Islam et al. [2012] performed a study in which four alternative M&R strategies were tested over a simulated 35-year period. This study showed that highway agencies spend about 2.3-3.6% of the amount on pavements that that is spent by users as a result of pavement roughness. This study also showed that increased maintenance activities resulting in smoother pavement condition have roughly a 50-fold return in terms of reduced user costs over the life of the pavement. By avoiding the deferral of M&R activities, agencies can reduce user costs by a considerable amount.

## 2.4 SURVEY OF DOTS

A survey was developed to determine whether or not state DOTs around the country have methods in place to annually track, monitor, and identify road sections that have been in poor condition for five or more years. The development of such methods represents one of MnDOT's highest priorities for risk mitigation strategies going forward [MnDOT, 2019].

The survey was created using Qualtrics XM, a user-friendly surveying software, and was sent to State DOTs through the AASHTO Research Advisory Committee (RAC) mailing list. The survey questions were as follows:

1. Name, position/Title, Name of Organization, and email address.
2. Does your organization have a method to annually track, monitor, and identify road sections that have been in poor condition for more than five years and consistently consider them when programming? If yes, please provide additional details and include any references/links to your method.
3. Was your method developed in response to TAMP call?
4. How does your organization prioritize pavement sections to be repaired?

Representatives from 20 state DOTs responded to the survey. Respondents varied in job titles, from Maintenance Engineers to Research Coordinators and Executive Managers. All respondents had in-depth knowledge of their department's pavement asset management and programming operations. The complete survey responses can be found in Appendix A.

### 2.4.1 Survey Results

The consensus from the responses received was that none of the states have specific mechanisms in place for dealing with pavement sections that have been in poor condition for five or more years. Most respondents stated that either all poor condition pavements are treated the same by their PMS, or their programming prioritization process is set up so that pavement sections of this type are not numerous enough to be relevant on a policy scale.

An example of the former came from NYSDOT. The respondent stated their PMS tracks the number of years a pavement is at a condition score, but that "multiple years at a poor condition score does not automatically change the prioritization for working on the section in the system."

An example of the latter comes from FDOT. The respondent stated that because Florida statute requires 80% of the SHS to meet department standards, roadways are generally not in poor condition for five years or more. Certain DOTs (MDOT, NMDOT, IDOT) responded more ambiguously, saying that individual district or region offices are responsible for tracking section conditions and prioritizing sections for repair. In these cases, the districts usually act autonomously, so the survey respondent could not say whether they give special consideration to pavement sections in poor condition for five or more years.

Answers to the fourth survey question generally consisted of a brief overview of how DOTs perform their annual pavement management activities. The information obtained from this question can also be found in the TAMP documentation of the respective DOT.

While more detailed information on how district personnel from different states make their programming decisions would be valuable, from the responses received, it appears that this type of information might be difficult to obtain. For this project, it is more effective to survey MnDOT district personnel, which is part of Task 3 of the report. In addition to different metrics related to pavement condition and traffic, information related to the jurisdictional status of pavement sections over time and the source of funding could help provide a more informed answer to the question of why some pavement sections remained in poor condition for longer periods.

# CHAPTER 3: IDENTIFICATION AND ASSESSMENT OF ROADWAY SECTIONS THAT HAVE MAINTAINED A POOR RIDE QUALITY INDEX OVER TIME

## 3.1 INTRODUCTION

In this chapter, pavement sections that have been in poor condition (RQI ≤ 2.0) for 5 or more years were identified based on the information provided by the pavement management group in the Office of Materials and Road Research (OMRR). Once identified, additional information about the selected sections was collected to identify the most significant factors responsible for maintaining the poor condition of the roads for extended periods. Since the distribution of pavement conditions varies significantly among districts, the analysis was performed on a district-by-district basis to identify district-specific factors that may affect investment decisions. Most of the additional information was obtained from interviews with district engineers and planners.

## 3.2 IDENTIFICATION OF ROAD SECTIONS IN POOR CONDITION

The first step in this process was obtaining the necessary data. This data was gathered from MnDOT's Highway Performance Management Application (HPMA) in two separate files.

The first file contains the condition history of each pavement section monitored by MnDOT from 2000-2018, with data from each year in a separate row. This file included data from 15,925 pavement sections from many unique route directions. A unique route direction is a unique combination of route type, route number, auxiliary identifier, and collection direction (e.g., IS-35E-D, US-952A-I, etc.). Not every route direction has an auxiliary identifier. The collection direction identifier allows for the separation of data on the same stretch of road for divided highways, meaning data is collected and can be analyzed individually for the decreasing ("D") and increasing ("I") directions. Data is only collected in one direction for undivided ("U") highways. The second file contains additional information about the district in which each pavement section is located.

Macros were created in Excel to transfer the district information from the second file to the first file and to conveniently organize the data, such that all relevant data for a pavement section could be found in one row, instead of up to eighteen rows. Once this operation was complete, a single file, containing the complete database of pavement condition in the state for the past two decades, was obtained. The file contains information about each section in each year, including M&R activities performed, AADT, and four different pavement condition parameters (RQI, SR, PQI, and IRI).

An additional macro was then created to determine which years each section was in poor condition; poor condition corresponds to a value of RQI less than or equal to 2.0. The macro was also used to identify the most recent year in poor condition and the highest number of consecutive poor condition years. The total number of sections that had been in poor condition at some point in time between

2000-2018 is 3945. The overall and per district results for pavement sections currently (as of 2018) in poor condition are shown in Table 3.1.

**Table 3.1: An overall and per district breakdown of sections currently in poor condition (as of 2018).**

| District | Total # of Sections | Currently Poor | | | | | |
|---|---|---|---|---|---|---|---|
| | | Currently Poor Sections | 3+ Years Poor | 5+ Years Poor | 10+ Years Poor | % 5+ Years Poor (of current poor) | % 10+ Years Poor (of current poor) |
| 1 | 2,076 | 191 | 113 | 65 | 10 | 34.00% | 5.20% |
| 2 | 2,107 | 32 | 15 | 6 | 4 | 18.80% | 12.50% |
| 3 | 2,230 | 26 | 7 | 6 | 1 | 23.10% | 3.80% |
| 4 | 1,937 | 38 | 12 | 3 | 0 | 7.90% | 0.00% |
| Metro | 2,086 | 100 | 50 | 37 | 7 | 37.00% | 7.00% |
| 6 | 2,006 | 70 | 35 | 19 | 12 | 27.10% | 17.10% |
| 7 | 1,840 | 180 | 75 | 40 | 13 | 22.20% | 7.20% |
| 8 | 1,643 | 21 | 12 | 11 | 6 | 52.40% | 28.60% |
| Overall | 15,925 | 658 | 319 | 187 | 53 | 28.40% | 8.10% |

Further analysis of the data showed that the sections do not have the same length; they can range from 0.038 miles to 2.033 miles. To get the total length of sections in poor condition, the individual lengths of poor sections were summed. Results for each district are presented in Table 3.2.

**Table 3.2: An overall and per district breakdown of pavement lengths currently in poor condition (as of 2018).**

| District | Total Length [mi] | Currently Poor | | | | | |
|---|---|---|---|---|---|---|---|
| | | Currently Poor [mi] | 3+ Years Poor [mi] | 5+ Years Poor [mi] | 10+ Years Poor [mi] | 5+ Years Poor Length (% of current poor) | 10+ Years Poor Length (% of current poor) |
| 1 | 1,866.7 | 160.2 | 93 | 51.6 | 6.5 | 32.20% | 4.10% |
| 2 | 1,954.5 | 25.8 | 10.6 | 2.9 | 1.6 | 11.30% | 6.00% |
| 3 | 2,011.7 | 19.3 | 4.3 | 3.7 | 0.1 | 19.00% | 0.50% |
| 4 | 1,791.0 | 22.3 | 4.8 | 0.6 | 0 | 2.80% | 0.00% |
| Metro | 1,755.3 | 64.1 | 31.1 | 23.7 | 5.2 | 37.00% | 8.20% |
| 6 | 1,814.0 | 50.6 | 20.9 | 8.2 | 4.1 | 16.10% | 8.20% |
| 7 | 1,656.7 | 131.3 | 47.3 | 23.3 | 6.8 | 17.80% | 5.20% |
| 8 | 1,459.0 | 9.5 | 4.7 | 4.4 | 2.2 | 46.30% | 23.40% |
| Overall | 14,308.8 | 483 | 216.8 | 118.4 | 26.5 | 24.50% | 5.50% |

The total length value and the total number of sections are different. Since the number of miles is lower than the number of sections, it appears that a large portion of the sections in poor condition are less than one mile in length.

## 3.3 EFFECTIVENESS OF M&R ACTIVITIES

To better understand the effect of certain repair activities used by districts on improving poor conditions, an analysis of the effectiveness of different maintenance and rehabilitation (M&R) activities was performed.

HPMA uses 45 different designations for M&R activities. Some of these unique designations are combinations of different activities performed at once (CPR/Pl/Dr), and some are varying levels of the same activity (thick vs medium vs thin OL). Activity names were taken as they were given from the HPMA software. A macro was created to find the parameter values of each section before and after each one of its activities was performed.

Because MnDOT collects pavement condition data throughout the year, data from any particular year can't be guaranteed to have been collected before or after an activity was performed on the section. To accurately show how the activity affected the condition of the section, the condition parameters from the year after the activity were compared to those from the year before the activity. As a consequence, the activity data was then split into two categories: individual cases and consecutive cases.

Individual cases are cases where no activities were performed on a section the year before or after the activity in question was performed. Consecutive cases are cases where activities were performed on a section during consecutive years. The consecutive activities were taken as a single event or "activity chain", and the effectiveness of the activity chain was evaluated based on the parameter values the year before the activity chain began and the year after the activity chain ended.

The analysis of both individual and consecutive case types showed that patching is by far the most used activity in Minnesota. It also showed that patching failed to bring sections out of poor condition more times than any other. Table 3.3 lists the top five activities in terms of the number of times failed to bring a section out of poor condition.

**Table 3.3: Top five activities in terms of times failed to bring a section out of poor condition.**

| Activity | Individual Cases Since 2000 | # Times Stayed Poor |
|---|---|---|
| Patching | 9448 | 601 |
| Spot OL | 619 | 28 |
| Rut Fill | 293 | 23 |
| Crack Fill | 4678 | 19 |
| Chip Seal | 5882 | 14 |

Patching also leads all activities in the number of times appearing in a consecutive activity chain, as well as in the number of times where the chain left the section in poor condition. It was also the leader in the number of times it was the first activity in a chain. This is not surprising, since patching is typically used as a measure of slowing the degradation of pavement until funding for a more substantial repair becomes available. This can also be seen in Table 3.4. There are 15 different types of activity chains that left a section in poor condition at least once, and patching occurred in 10 of these types, either as the first or last activity.

**Table 3.4: The top consecutive activity types that left a section in poor condition the year after the activity chain ended**

| Activity Chain | Cases Since 2000 | # Times Left Poor | % # Times Left Poor |
|---|---|---|---|
| Patching -> Patching | 74 | 11 | 14.90% |
| Minor CPR -> Crack Seal | 7 | 4 | 57.10% |
| Major CPR -> Major CPR | 3 | 3 | 100% |
| Patching -> Med M&OL | 396 | 3 | 0.80% |
| Patching -> Chip Seal | 52 | 3 | 5.80% |
| Patching -> Thin M&OL | 112 | 2 | 1.80% |
| Patching -> Thick M&OL | 78 | 2 | 2.60% |
| Patching -> Major CPR | 21 | 2 | 9.50% |
| Minor CPR -> Minor CPR -> Maj CPR/Pl | 1 | 1 | 100% |
| Patching -> Whitetop-U | 1 | 1 | 100% |
| Rut Fill -> Patching | 3 | 1 | 33.30% |
| Spot OL -> Patching | 7 | 1 | 14.30% |
| Spot OL -> Thin M&OL | 20 | 1 | 5.00% |
| Thin M&OL -> Crack Fill | 17 | 1 | 5.90% |
| Patching -> Spot OL | 11 | 1 | 9.10% |

## 3.4 INTERVIEWS WITH DISTRICT ENGINEERS AND PLANNERS

Due to the current pandemic, it was not possible to meet in person with engineers and planners from each district. With critical help from David Solsrud, Asset Management Project Manager at MnDOT, interviews were scheduled and conducted via Zoom with each district. Before the date of the interview, an Excel file with information about the pavement sections in poor condition was sent to each district. The file contained a notable poor section summary and a route breakdown summary for each district. The notable poor section summary is a table of the worst sections in the district in terms of the number of years the section has been in poor condition as of 2018. The table includes relevant information about the sections, including section length, AADT, surrounding poor length, and activities performed since the section went poor. The route breakdown is a table listing all unique route directions within the district. For each route direction, the length of data, the length of currently poor pavement, and the percentage of currently poor data were found. The tables and summaries of the interview discussions are included in Appendix A.

The general conclusion gained from the interviews is that most sections that have remained in poor conditions for long periods have unique characteristics that significantly affect how these pavements are rated and repaired. The most common characteristics are listed below:

- Many of the poor sections were identified as “urban sections”, defined as a section of pavement that has curb and gutter, manholes, sewer grates, or dramatic shifts in grade due to intersection crossings. These unique characteristics increase the roughness of pavement sections that are otherwise in good condition. Several districts suggested including surface rating as the condition metric for these sections.
- For some urban sections, especially in smaller cities, substantial project costs for ADA requirements have resulted in repair delays due to lack of funding.
- Many of the poor smaller sections contain bridge transitions or railroad crossings. Bridge transitions and railroad crossings can cause significant roughness that, unless properly identified, would indicate that the pavements in these sections are in poor condition when their structure is fine.
- Individual repair of isolated small sections in poor condition is not feasible unless a larger portion of the road is scheduled for a major repair that improves the condition rating.
- Some roads that are part of the MnDOT system mainly serve one community. Some of these roads are considered for “turnbacks”, which gives jurisdiction of the section to the local entity, usually a county. Before a change in jurisdiction occurs, the road has to be brought to good condition. Scheduling such repairs is not a priority given that most roads have low traffic volumes and are in very poor condition

The overall conclusion is that most pavement sections that have remained in poor condition for extended periods represent “anomalies” that have unique characteristics that are mostly responsible for their condition rating. The frequent use of reactive maintenance activities, such as patching, represents the most cost-effective approach to prevent further degradation of these sections until the road is scheduled for a costlier repair that would also improve the condition rating.

# CHAPTER 4: SUMMARY, ADDITIONAL ANALYSES, AND RECOMMENDATIONS

At the end of Chapter 3, it was concluded that most pavement sections that have remained in poor condition for extended periods represent "anomalies" with unique characteristics that are mostly responsible for their condition rating. The most common characteristics are specific features that define these sections as "urban," and to a lesser extent, the presence of bridge transitions or railroad crossings. In this chapter, additional analyses of these sections are conducted to provide support for potential changes in how the condition of these pavements is assessed in the future. Based on these analyses, and additional feedback from the engineers and planners interviewed in Chapter 3, several recommendations are made for creating a classification system for urban pavement sections within MnDOT's HPMA system.

## 4.1 URBAN PAVEMENT SECTIONS

### 4.1.1 Goal of Analysis

Urban sections are those that have features like manholes, catch basins, and intersection crossings that lead to increased roughness without the existence of structural issues. Many MnDOT districts use SR to evaluate these sections instead of RQI because it provides a better understanding of the actual condition of the pavement.

Based on this finding, the research team decided to further analyze the HPMA condition data to develop criteria for identifying which pavement sections can be labeled "urban." The following goal was to determine if those urban sections tend to have healthy SR even when they are labeled poor by RQI standards (RQI<2.0). The results can be used in support of the idea that urban sections should be given special consideration on a system-wide scale during yearly programming efforts.

It should be noted that the factors considered in this analysis to determine an urban classification are not necessarily those used by each MnDOT district. Each district has its own qualifications for what it considers "urban." Some districts consider each section individually while others have more concrete rules. For example, District 4 classifies each city within its jurisdiction as urban or non-urban based on a series of factors including speed limit, utilities, number of crossroads, and the existence of curbing or sidewalks along the highway. Because there is no uniform system for urban classification, this analysis uses attributes available in HPMA that best fit this classification.

### 4.1.2 Identifying Urban Section Characteristics

MnDOT's HPMA system contains a wide variety of information for each pavement section in MnDOT's highway network. Three of the most promising data for identifying urban sections are drainage type, city code, and functional classification. Many district engineers mentioned during their interviews that they base the urban distinction on the structural design of the section, specifically whether it has curb and gutter. Drainage type identifies sections that have curb and gutter facilities (C&G). City code indicates whether a section is within a city or not. Functional classifications include urban major arterial (UMA), urban principal arterial (UPA), rural interstate (RIN), and others. A full list of the functional classifications used in HPMA can be found in Table 4.1. These classifications make a clear distinction between urban and rural roads and are useful in identifying urban sections.

**Table 4.1: Functional classification used for sections in HPMA.**

| Functional Classification | Code |
|---|---|
| Rural Interstate | RIN |
| Rural Local | RLO |
| Rural Minor Arterial | RMA |
| Rural Minor Collector | RMI |
| Rural Major Collector | RMJ |
| Rural Principal Arterial | RPA |
| Urban Collector | UCO |
| Urban Interstate | UIN |
| Urban Local | ULO |
| Urban Minor Arterial | UMA |
| Urban Principal Arterial | UPA |
| Urban Principal Arterial Freeway | UPF |

To identify which data can be best used to identify urban sections, an analysis was performed to determine which types are most represented in the system's sections with the longest poor condition ratings. Each section in the system has a "total years in poor condition" value. This is the total number of years the sections had an RQI less than or equal to 2.0 from 2000-2018. It is meant to be an overall gauge of how poor the section was over time.

The first step in this analysis is to find the total length of sections in the overall system corresponding to the possible total poor year values (from 0 to 19). Let's assume a hypothetical example in which, out of a system of 1000 mi, we have ten sections that each have a total poor year value of 19, and their combined length is 10 mi. The length proportion for these sections is found by dividing the total length of the sections by the total length of the system, which in this case is 10/1000 = 0.01 = 1%. Let's also assume that half of the 10 miles that have been in poor condition for a total of 19 years are C&G, and the total number of C&G miles in the system is 100. The length proportion, with respect to C&G type only, can be calculated as 5/100 = 0.05 = 5%. This means it is 5 times (5% divided by 1%) more likely that a C&G section will have 19 total poor years than a randomly selected section in the overall system. For simplification, we will call this ratio the proportion ratio.

Following the example shown above, we can perform equivalent calculations for each of the data types (C&G, within a city, functional classes) for each of the possible total poor year values (0-19 years). The results are shown in Table 4.2 and 4.3 and indicate that C&G, City, UMA, and UPA sections (and UPF sections somewhat) are the most likely to be in poor condition most often from 2000 to 2018. The results shown provide support to the conclusions drawn from the district engineer interviews that most of the longest poor sections in each district were identified as "urban" sections. Therefore, it can be assumed that the data types that are most likely to be left poor the longest (C&G, city, UMA, and UPA) fit best the "urban" classification. This is not a definitive description of urban sections, but it can be used as evidence that sections with urban characteristics are uniquely allowed to stay in poor condition for long periods.

**Table 4.2: Proportion ratios for C&G, City, RIN, RMA, and RMJ sections.**

| Total Years in Poor Condition | All Sections Length Proportion | C&G Sections Proportion Ratio | City Sections Proportion Ratio | RIN Sections Proportion Ratio | RMA Sections Proportion Ratio | RMJ Sections Proportion Ratio |
|---|---|---|---|---|---|---|
| 19 | 0.03% | 12.1 | 4.4 | 0 | 0 | 0 |
| 18 | 0.03% | 10.7 | 3.9 | 0 | 0 | 0.9 |
| 17 | 0.07% | 11.5 | 4.2 | 0 | 0.4 | 0.7 |
| 16 | 0.03% | 11.9 | 4.4 | 0 | 0 | 0 |
| 15 | 0.04% | 11.5 | 4.4 | 0 | 0.2 | 1.3 |
| 14 | 0.04% | 11 | 4.4 | 0 | 0.5 | 0 |
| 13 | 0.04% | 11.5 | 4.2 | 0 | 1.1 | 0 |
| 12 | 0.07% | 7 | 3.1 | 0 | 0.5 | 2.9 |
| 11 | 0.14% | 6 | 2.7 | 0.6 | 0.1 | 4.7 |
| 10 | 0.17% | 6.3 | 3.2 | 0 | 0.2 | 3.8 |
| 9 | 0.28% | 3.9 | 1.6 | 1.1 | 1.1 | 1.2 |
| 8 | 0.45% | 3.8 | 1.7 | 0.6 | 1.1 | 2.8 |
| 7 | 0.78% | 3.4 | 1.7 | 0.1 | 0.9 | 4.3 |
| 6 | 0.99% | 2.5 | 1.4 | 0.7 | 1.3 | 2.2 |
| 5 | 1.71% | 1.8 | 1.1 | 0.8 | 1.3 | 1.8 |
| 4 | 2.26% | 1.6 | 1.2 | 0.7 | 1.3 | 1.6 |
| 3 | 3.27% | 1 | 0.8 | 0.6 | 1.4 | 1.8 |
| 2 | 4.53% | 1.3 | 1 | 0.7 | 1.2 | 1.6 |
| 1 | 8.48% | 1 | 1 | 0.9 | 1.2 | 1.4 |
| 0 | 76.59% | 0.8 | 1 | 1.1 | 0.9 | 0.8 |

Table 4.3: Proportion ratios for RPA, UIN, UMA, UPA, and UPF sections.

| Total Years in Poor Condition | All Sections Length Proportion | RPA Sections Proportion Ratio | UIN Sections Proportion Ratio | UMA Sections Proportion Ratio | UPA Sections Proportion Ratio | UPF Sections Proportion Ratio |
|---|---|---|---|---|---|---|
| 19 | 0.03% | 0 | 0 | 25.7 | 4.4 | 0 |
| 18 | 0.03% | 0.4 | 0 | 19.4 | 4.4 | 0 |
| 17 | 0.07% | 0 | 0 | 21.1 | 3.2 | 0 |
| 16 | 0.03% | 0.6 | 0 | 9 | 4.2 | 11.8 |
| 15 | 0.04% | 0.1 | 0 | 5.5 | 6.9 | 0 |
| 14 | 0.04% | 0 | 0 | 8.5 | 4 | 10.3 |
| 13 | 0.04% | 0.2 | 3.1 | 11.3 | 1.2 | 0.6 |
| 12 | 0.07% | 0.6 | 0 | 3.1 | 3.9 | 4.5 |
| 11 | 0.14% | 0.2 | 2.8 | 7.9 | 0.9 | 5.1 |
| 10 | 0.17% | 0.3 | 1 | 8.7 | 2.8 | 3.4 |
| 9 | 0.28% | 0.3 | 1.7 | 4.1 | 1.2 | 1.1 |
| 8 | 0.45% | 0.2 | 0.8 | 3.5 | 2.1 | 1 |
| 7 | 0.78% | 0.3 | 1.1 | 3.7 | 1.6 | 0.8 |
| 6 | 0.99% | 0.4 | 1.2 | 1.9 | 1.2 | 0.5 |
| 5 | 1.71% | 0.5 | 0.6 | 2.7 | 0.8 | 0.5 |
| 4 | 2.26% | 0.6 | 0.6 | 2.2 | 1.1 | 0.3 |
| 3 | 3.27% | 0.5 | 0.8 | 1.1 | 0.9 | 0 |
| 2 | 4.53% | 0.7 | 0.5 | 1.4 | 1 | 0.8 |
| 1 | 8.48% | 0.8 | 0.8 | 1.3 | 0.9 | 0.6 |
| 0 | 76.59% | 1.1 | 1.1 | 0.7 | 1 | 1.1 |

### 4.1.3 RQI-SR Comparative Analysis

For the sections that fall under each data type, we performed an RQI-SR comparative analysis. Because MnDOT has no specific standard for what a healthy SR score is, a poor SR score threshold was established for this study. This was done by using trends of all RQI and SR score populations for the entire system for 2000 to 2018: 288,355 RQI measurements and 173,693 SR measurements, respectively. Histograms were created using this data, as shown in figures 4.1 and 4.2. It is important to note that SR has a max rating of 4.0, while RQI has a max rating of 5.0.

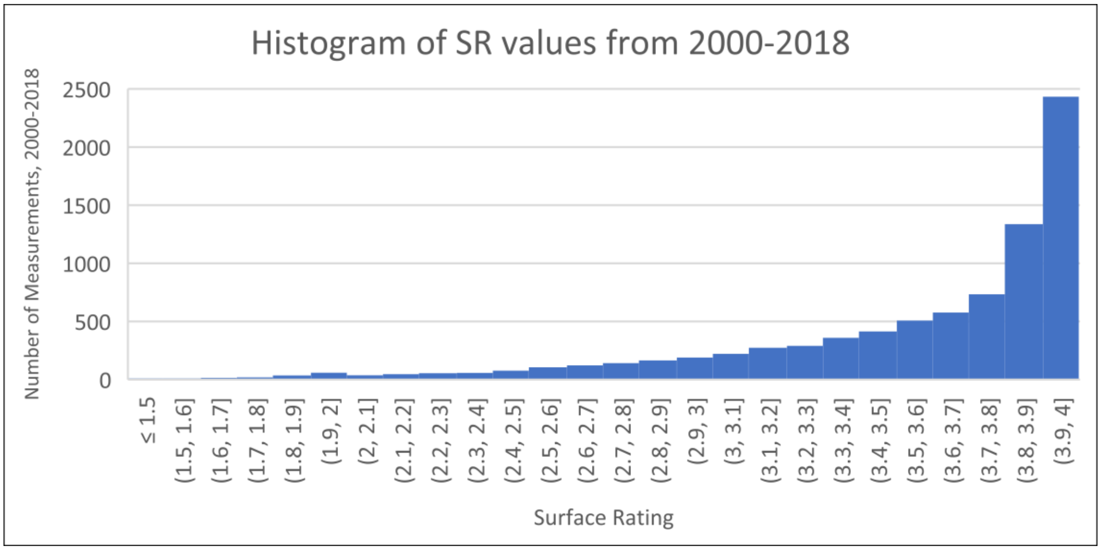


**Figure 4.1 Histogram of all measured SR values in the HPMA database from 2000 to 2018.**

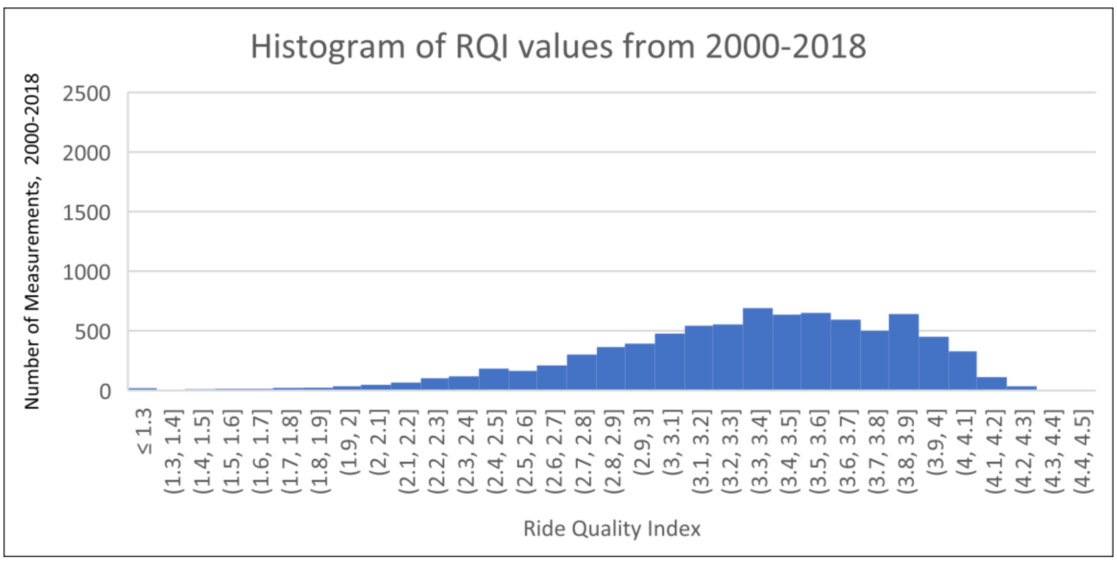


**Figure 4.2 Histogram of all measured RQI values in the HPMA database from 2000 to 2018.**

The trends of the two data populations were different, and therefore, the poor threshold value for RQI could not be used as the poor threshold value for SR. To solve this issue, we made the argument that a fair poor SR threshold must represent the same proportion of sections in the system as the poor RQI threshold. From the entire RQI dataset from 2000-2018, the percentile of an RQI of 2.0 was 0.033697928 or ~3.4%. This means that only about 3.4% of the entire dataset was at or below an RQI of 2.0. The corresponding SR score for the same bottom percentile of 3.4% was found to be equal to 1.9. In this analysis, and we considered this value the poor SR threshold.

To further compare the RQI and SR data, we calculated the median RQI and SR scores for all sections that were in poor condition for at least 1 year. Poor condition was identified based on RQI ≤ 2.0. The median was selected to eliminate the effect of possible outliers, especially for sections that had been in poor condition for longer periods. The median scores were calculated using all years during which the section was in poor condition (RQI ≤ 2.0). For example, if a section was in poor condition in 2005 and 2010, the median RQI for that section would be the median of the 2005 and 2010 RQI scores for that section. Since, unlike RQI data, SR data was typically gathered every other year, SR data was not available for all the years the section was in poor condition.

As expected, many sections with RQI ≤ 2.0 had SR values above the threshold value for poor SR condition. To better understand how many sections had both poor RQI and SR median values, the following calculations were performed:

1. First, the "total length of sections" identified by median RQI poor condition was calculated for the entire system and individual section types.
2. Since SR data was not available for all the years the section was in poor condition, the "SR data length" was calculated as the total length of sections for which SR data was available. This length was less than the "total length of sections" given by RQI poor condition.
3. Then, for the sections identified in step 1, the sections with a median SR ≤ 1.9 were identified. The "SR poor length" was calculated for each section type by summing up the lengths of sections with available "poor year" SR data.
4. Next, the "poor SR length proportion" was calculated by dividing each "poor SR length" value by the corresponding "SR data length" value. This value represented the proportion of pavement length for each section type that typically had both poor SR and RQI values.
5. Finally, the "poor SR length proportion ratio" was calculated by dividing the "poor SR length proportion" for each data type by the same value for the overall system. A ratio value less than 1.0 indicated it was more likely for that section type to be in the RQI poor with fair or good SR compared to any random section in the system.

The "poor SR length proportion" values for each data type are shown in Table 4.4.

**Table 4.4: RQI/SR analysis results for several pavement data types.**

| Section Type | Data Type | Total Length of Poor Sections [mi] | Poor SR Length [mi] | SR Data Length [mi] | Poor SR Length Proportion | Poor SR Length Proportion Ratio |
|---|---|---|---|---|---|---|
| All Poor Sections | All sections in the system that have been in poor condition for at least one year | 3350.11 | 673.26 | 2737.54 | 0.25 | 1 |
| C&G | Curb and Gutter Drainage | 454.34 | 46.97 | 392.93 | 0.12 | 0.486 |
| City | Within a City | 877.61 | 104.38 | 717.53 | 0.15 | 0.591 |
| UMA | Urban Minor Arterial | 177.27 | 21.98 | 152.39 | 0.14 | 0.586 |
| UPA | Urban Principal Arterial | 238.42 | 29.35 | 196.86 | 0.15 | 0.606 |
| UPF | Urban Principal Arterial Freeway | 47.11 | 3.35 | 37.31 | 0.09 | 0.365 |
| UIN | Urban Interstate | 98.89 | 6.36 | 82.68 | 0.08 | 0.313 |
| RPA | Rural Principal Arterial | 666.6 | 98.89 | 507.03 | 0.2 | 0.793 |
| RMJ | Rural Major Collector | 389.86 | 99.79 | 316.9 | 0.31 | 1.28 |
| RMA | Rural Minor Arterial | 1495.32 | 377.91 | 1227.32 | 0.31 | 1.252 |
| RIN | Rural Interstate | 216.06 | 35.64 | 200.7 | 0.18 | 0.722 |

The four data types highlighted in the previous analysis (C&G, City, UMA, and UPA) are on the lower end of the "poor SR length proportion ratio" spectrum while the rural classifications have the highest "poor SR length proportion ratio" values. This result provides support to another conclusion drawn from the district materials engineer interviews: "urban" sections often have exaggerated RQI scores, so their SR scores are used as a more reliable judgment of their structural condition. The types of sections identified in the previous analysis as most likely to be "urban" (C&G, city, UMA, and UPA) are among the most likely to be in fine condition according to SR when they are in poor condition according to RQI. This is further evidence that these section types should be considered when creating a definitive description of an "urban" section.

Only RMA and RMJ sections are more likely than any random section in the system to be in SR poor condition when they are in RQI poor condition. SR measures pavement distresses, which means repairing distresses like bleeding or all kinds of cracking may not be as much of a priority for these section types. RMA (rural minor arterial) roads are typically used to connect cities and larger towns, and RMJ (rural major collector) roads are typically used for intercounty travel (NYDOT, n.d.). Out of the four rural section types considered, these are the two with the lowest typical traffic load and thus provide the least incentive for repairing distresses.

The "poor SR proportion ratio" value for each data type is significant because it is a measure that provides quantitative support for the way most districts already look at urban sections. As mentioned earlier, districts will often use SR as the measure of condition for urban sections instead of RQI. The highlighted data types (C&G, within a city, UMA, and UPA) are relatively often in fine SR condition when in poor RQI condition and are also the most likely to be in poor RQI condition for extended periods.

### 4.1.4 Results of Analysis

Interviews with MnDOT district materials engineers introduced the idea that districts will give special consideration to “urban” sections whose RQI scores do not truly reflect their structural condition. It has been shown that sections with urban characteristics are most likely to be in poor condition over the last 20 years. This gives some evidence that these urban sections have been treated differently than their counterparts during programming. It has also been shown that sections with urban characteristics have relatively good SR scores when they are deemed to be in poor condition due to roughness. This gives some evidence to support the method districts have used to gauge the condition of urban sections (considering SR over RQI).

Two sections are identified as good examples, 14669 and 11340. Section 14669 is a 1-mile stretch near the beginning of MN-156 in South St. Paul. This section has multiple urban section characteristics. It has curb and gutter drainage, is located within a city, and is on a UMA highway. The RQI and SR measurements for this section for 2000-2018 are shown in Figure 4.3. The section is labeled poor for this entire period due to sub-2 RQI scores. However, the SR for this section stays high for most of the period.

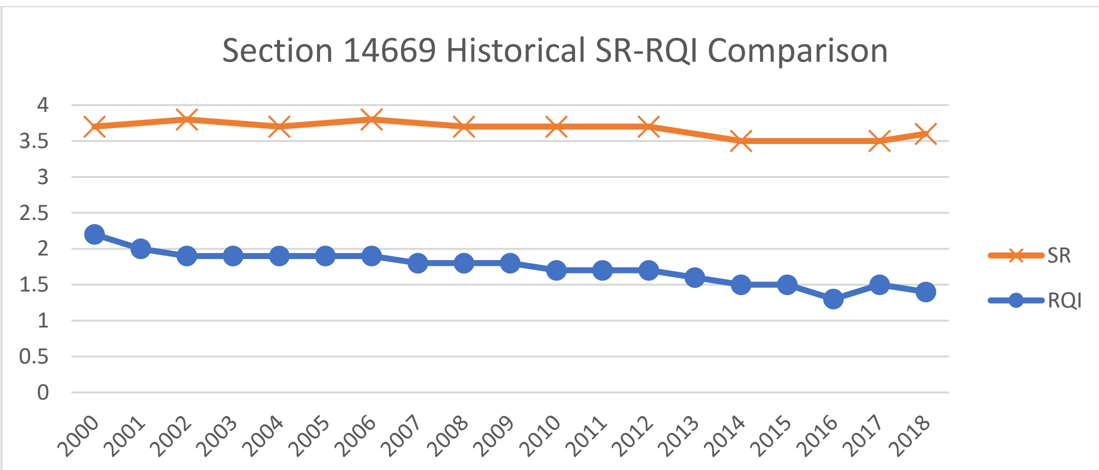


**Figure 4.3 Historical SR and RQI data for section 14669 from the years 2000 to 2018.**

Section 11340 is a 0.937-mile stretch near the beginning of MN-47 in Minneapolis. It is very similar to 14669. It has all the same urban characteristics and it has low RQI and high SR throughout the 2000-2018 period as shown in Figure 4.4.

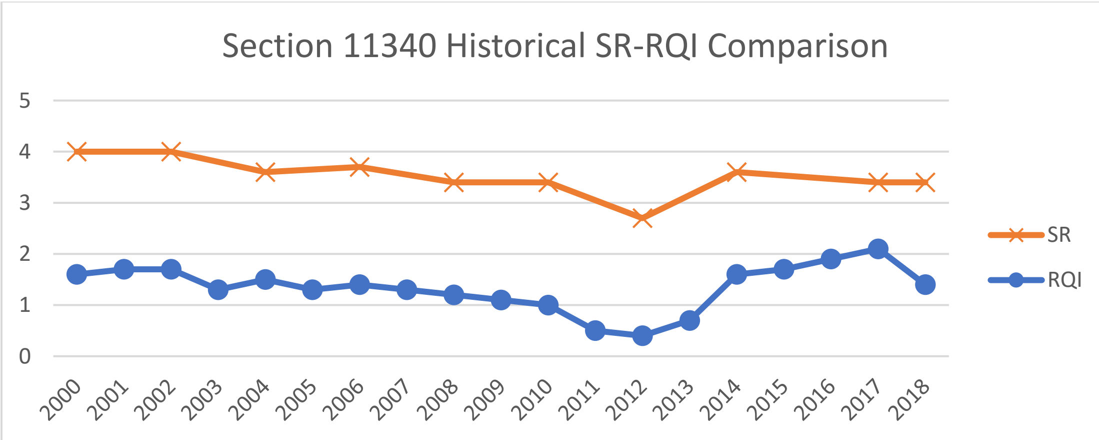


**Figure 4.4 Historical SR and RQI data for section 11340 from the years 2000 to 2018.**

## 4.2 BRIDGE TRANSITIONS AND RAILROAD CROSSINGS

In addition to the urban sections, other section types could be described as "anomalous," with characteristics that either cannot be accounted for or are difficult to quantify during pavement rating. The second most significant one was the presence of bridge transitions or railroad crossings within a pavement section. These two elements can greatly increase the roughness, and therefore decrease the RQI of a section. In the current rating system, this would degrade the condition of the section even when the structure of the pavement is fine.

A good example is section 2408, located at the beginning of MN-2. This section starts in the middle of a bridge over the Red River and thus contains a bridge transition. This is a short section (0.28 miles), but it has been in poor condition since at least 2001. Since then, it has often had a near-maximum SR score as shown in Figure 4.5. Similar to with urban sections, a separate condition parameter, such as SR – RQI difference, could be used to evaluate the condition of these sections instead of automatically defining them as poor from their RQI scores.

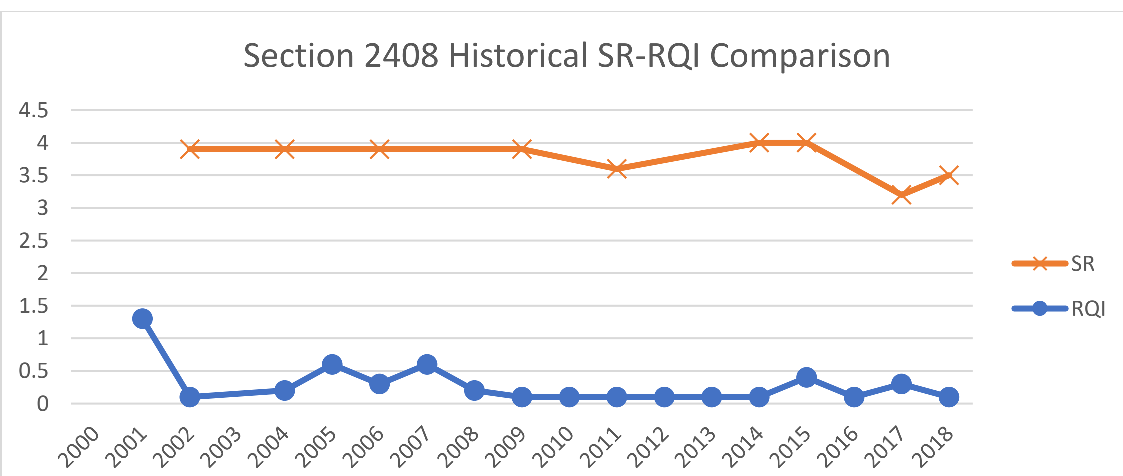


**Figure 4.5 Historical SR and RQI data for section 2408 from the years 2000 to 2018.**

## 4.3 FOLLOW-UP QUESTIONS TO DISTRICT MATERIALS ENGINEERS AND PLANNERS

To better understand what future work will be needed to reach a uniform definition for an urban section, follow-up interviews with the eight districts were performed to obtain additional information. The responses were included in Appendix C.

In general, the respondents identified similar characteristics of urban sections; however, there were some differences of opinion. The most common identifiers were the presence of curb and gutter, and stop signs or stoplight traffic control. Other identifiers mentioned were lower speed limits, being within city limits, and having multiple crossroads within a specific length of pavement.

Two other unique characteristics that repeatedly came up during the interviews were sections that require expensive fixes due to ADA requirements and sections that are potential turnbacks. These sections were much more difficult to identify, and the prospect of adjusting the current rating system to take them into account is unlikely.

Several respondents also indicated the need to identify sections that have either bridge transitions or railroad crossings. Currently, no statewide database contains information on the locations of each bridge transition and railroad crossings in MnDOT's highway system.

## 4.4 RECOMMENDATIONS

The analysis performed in this investigation showed that most pavement sections that have remained in poor condition for extended periods represent "anomalies" with unique characteristics that are mostly responsible for their condition rating. For this reason, a uniform definition of these anomalies must be established by MnDOT, especially for the "urban" sections as the current definition varies by district. Sections with bridge transitions and railroad crossings are straightforward. Once these definitions are established, sections must be identified as such.

Self-reporting by the districts can be useful for identifying turnback sections. This could be helpful for the identification of urban, bridge, and railroad sections as well. However, if a statewide definition were to be established, these sections could be identified through means of data.

There are several parameters (C&G, city, UMA, UPA) in HPMA that can be used to identify urban sections. It is possible that other parameters stored in HPMA could be used, and further analysis of the available data within HPMA is warranted. For example, the high-definition digital video taken each year by MnDOT's Pathways survey vans, which captures many of the characteristics that qualify an urban section including manholes, curb and gutter, intersections, stoplights, and stop signs can be further analyzed. This video could also be used to identify bridge transitions and railroad crossings.

Once the anomalous sections are identified, a more realistic assessment of the condition of these sections needs to be performed. For urban sections, one option is to develop a new parameter based on a combination of SR and RQI or by taking the difference between SR and RQI. As shown in figures 4.3

and 4.4, consistently large differences between these two values could be used as a metric to indicate whether the section needs treatment. Another option would be to develop a new RQI formula specifically calibrated for urban roads. This would require an additional study in which individuals are driven on these sections and asked to rate them based on ride comfort. The study could also include roundabouts, for which, due to the geometry of the roundabout, the measurements are less accurate. Once the anomalous sections are identified and new condition parameters are developed, site-specific decision trees, based on the new trigger values, can be developed for HPMA.

MnDOT district personnel already have been dealing with these anomalies during project programming each year. Most districts, in addition to the HPMA data, visually inspect the sections that need repair and make decisions accordingly. A better rating system has the potential of reducing the workload required to consider all of these additional characteristics and provide metrics that are better tailored to show the "true" condition of unique pavement sections. Such a tool would help planners and decision-makers make more informed decisions and, therefore, optimize the use of available funds.

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# APPENDIX A, SURVEY TO ASSESS AGENCY ASSET MANAGEMENT PROCEDURES FOR PAVEMENTS IN POOR CONDITION FOR 5+ YEARS.

A survey was distributed through AASHTO's RAC listserv to all 50 state DOTs about their pavement/asset management practices. Specifically, the survey asked if their state had procedures in place to track and monitor road sections that have been in poor condition for more than 5 years. The survey also asked them to describe the general process they use to decide which pavement sections receive treatment each year. 20 state DOTs responded to the survey. Their responses are recorded in the tables below.

## QUESTIONS

1. Contact Information
2. Does your organization have a method to annually track, monitor, and identify road sections that have been in poor condition for more than five years and consistently consider them when programming? If yes, please provide additional details and include any references/links to your method.
3. Was your method developed in response to TAMP call?

   3a. If Other, Please Explain

4. How does your organization prioritize pavement sections to be repaired?

## SURVEY RESPONSES

**Table A1: Responses to DOT Survey Question #1**

| Question 1 | | | |
|---|---|---|---|
| Name | Position/Title | Name of Organization | Email Address |
| Jarrod Stanley | Research Coordinator | Kentucky Transportation Cabinet | jarrod.stanley@ky.gov |
| Susan Gresavage | Executive Manager | NJDOT | susan.gresavage@dot.nj.gov |
| Kim Alexander | State Pavement Management Engineer | WSDOT | alexank@wsdot.wa.gov |
| Reid Kiniry | Asset Mgt. Bureau | Vermont Agency of Transportation | reid.kiniry@vermont.gov |
| Tamara P. Haas | Division Director, Capital Program & Investments | NMDOT | tamarap.haas@state.nm.us |
| Russell Thielke | Chief of Pavement Management Systems | New York State Dept. of Trans. | russell.thielke@dot.ny.gov |
| Rupinder "Bobby" Dosanjh | Supervisory TE | Caltrans | rupinder.dosanjh@dot.ca.gov |
| Sarah McDougall | Pavement Management Engineer | DelDOT | sarah.mcdougall@delaware.gov |
| James Ashman | Unit Supervisor | Michigan Department of Transportation | ashmanj@michigan.gov |
| Austin Baysinger | Statewide Pavement Engineer | Utah Department of Transportation | abaysinger@utah.gov |

| | | | |
|---|---|---|---|
| Anne E Carter | Highway Management Engineer | MaineDOT | anne.carter@maine.gov |
| Mary Gayle Padmos | Pavement Management Engineer | Montana Dept of Transportation | mpadmos@mt.gov |
| Mike Shea | Maintenance | Missouri DOT | michael.shea@modot.mo.gov |
| Frank Bell | Pavement Management Engineer | Alabama Department of Transportation | bellf@dot.state.al.us |
| Laura Heckel | Asset Management Engineer | Illinois Department of Transportation | laura.heckel@illinois.gov |
| Christophe Fillastre | Pavement Management Engineer | LADOTD | cnf01@aol.com |
| Bouzid Choubane | State Pavement Materials Engineer | Florida DOT | bouzid.choubane@dot.state.fl.us |
| Andrew Williams | Administrator | Ohio Department of Transportation | andrew.williams@dot.ohio.gov |
| Louis Feagans | Managing Director of Asset Management | Indiana Department of Transportation | lfeagans@indot.in.gov |
| John Henault | Transportation Supervising Engineer | CT DOT | john.henault@ct.gov |

### Table A2: Responses to DOT Survey Question #2

| **Question 2** | |
|---|---|
| KYTC | Yes - Pavements are visually inspected every 3 years and IRI data is collected annually. A database is kept at KYTC |
| NJDOT | No |
| WSDOT | We track and identify road sections by condition, but do not necessarily consider them for programming on a consistent basis. |
| VTrans | All road sections are always considered as part of regular pavement management system analysis. |
| NMDOT | No, NMDOT does not have a written process, procedure, or protocol to track roadway sections that have been in poor condition more than 5 years. We did not put a statement like this in our TAMP. |
| NYSDOT | Our Pavement Management System tracks years at condition score to recommend the right treatment at the right time. Multiple years at a poor condition score does not automatically change the prioritization for working on the section in the system. Region Maintenance and Planning staff determine the priority based on additional factors. |
| Caltrans | Yes. Our organization uses a Pavement Management System (PaveM) to annually track, monitor, and identify pavement condition. PaveM is the Department's Pavement Management System. PaveM stores information on pavement history and current condition. It also predicts future pavement condition as well as prioritizes preservation, rehabilitation, and maintenance projects within budgetary constraints. PaveM supports Pavement Program in complying with the Moving Ahead for Progress in the 21st Century Act (MAP-21). PaveM utilizes input from various data sources including Automated Pavement Condition Survey (APCS), pavement projects' as-built records, Transportation Systems Network (TSN), and funding programs such as SHOPP and HM-1. PaveM's optimization tool, known as Pavement Analyst, uses current condition, segmentations, and decision trees to maximize or minimize objectives (depending on the type of objective) while meeting constraint(s). When given dollars to spend, PaveM goes through prescribed decision trees |

| | |
|---|---|
| | and recommends projects as well as prioritizes those projects based on established selection priorities. |
| DelDOT | No. We do not specifically track road sections that have been in poor condition for more than five years. We have our overall priority process and optimization processes that we rely on to keep our network in overall good condition. Please see the pavements section of the attached Delaware State TAMP document. |
| MDOT | Each individual MDOT region offices track road sections that meet this criterion and these sections are supposed to be prioritized when projects are programmed as part of our reconstruction and rehabilitation work. |
| UDOT | No, we do not track it at the .1 mile segmentation nor for the federal measure. We track them by construction sections and at state performance metrics. |
| MaineDOT | For our higher priority roads, we are following the MAP-21 reporting of % Poor miles for IRI, Rutting and Percent cracking. While we track the overall % Poor, we do not have a separate mechanism for tracking which sections have been in poor condition for more than five years. We likely do have such sections and, among the higher priority roads, such sections often (but not always) are sections that have never been built to modern standards. We have been systematically addressing these through reconstruction but doing maintenance paving on them until we are able to fund reconstruction. For our lowest priority state roads, we do maintenance paving only, mostly on a 7 year cycle. |
| MDT | MDT does not track individual sections individually. Area Districts keep lists for reconstruction which may include condition in addition to geometric and operational issues. Headquarters does not. |
| MoDOT | Yes, the department has Transportation Management System application that stores pavement data for 5 years. A query can be ran to filter for pavement in poor condition. |
| ALDOT | Not specifically. |
| IDOT | Not across the agency. The districts program pavement sections relatively autonomously. |
| LADOTD | Yes, we track the condition of state roads as part of our Pavement Management System which is collect every 2 years statewide and every year on Interstate, NHS On System and NHS Off-System. We output excel report each year with recommended treatments and 3 cycles of IRI and Rutting data. So, the districts can see the condition of their road before the latest year. We create maps showing the condition of the roads by Roughness, Rutting and Performance Index. |
| FDOT | The Florida Department of Transportation conducts annual Pavement Condition Surveys (PCS) to monitor and report on the performance and condition of pavements on the State Highway System per Florida Statutes 334.24, 334.046 and 335.07 as well as the Federal Highway Administration (FHWA)/FDOT Federal Aid Partnership Agreement No. 700-000-005-a. For the Department's performance measurement reporting for the SHS, Florida statutes require that 80 percent of the pavement on the SHS meets the Department standard. Pavement meeting Department standards is defined as pavement for which each of the three rating factors (ride quality, crack severity and rutting) are scored 6.5 or above on a ten-point scale. Considering this, roadways generally are not in poor condition for five years or more. There are parameters within our system that can be used to determine how long a section has been deficient. |
| ODOT | Our Department has a very mature Asset Management Program, that develops a work plan that includes both Capital and Maintenance work all in one. That plan identifies roadway sections that is at various condition states and is analyzed in our Pavement Management System fully optimized. We have also set up a special pot of funding for what we call poor performers, which are roadway sections that have had accelerated deterioration and also multiple projects/treatments in a specified time. The goal is to ensure that these problem pavements are treated appropriately to get them on an acceptable life cycle. |
| INDOT | Yes, we use GIS/roads and highway to track issues as well as dTIMS modeling system. |
| CTDOT | We perform annual surveys to rate the condition of every section of roadway in CT, but we do not have a method to specifically monitor road sections that have been in poor condition for more than five years. |

**Table A3: Responses to DOT Survey Question #3**

| Question 3 | | | |
|---|---|---|---|
| # | Answer | % | Count |
| 1 | Yes | 5 | 1 |
| 2 | No | 70 | 14 |
| 3 | Other | 25 | 5 |

**Table A4: Responses to DOT Survey Question #3a**

| Question 3a (if other, explain why) | |
|---|---|
| NMDOT | we don't have a method and it wasn't in our TAMP |
| DelDOT | We do not have a specific method for these sections |
| ALDOT | N/A |
| IDOT | We don't have a method |
| CTDOT | Not applicable, as we don't have a method to specifically track pavements that have been in poor condition for over 5 years. |

**Table A5: Responses to DOT Survey Question #4**

| Question 4 | |
|---|---|
| KYTC | A pavement distress index that includes visual inspection, IRI and ADT is used to list sections of roadway. The District Office staff then review this list and can modify the list based on other projects and/or private development projects. |
| NJDOT | Based on annual data collection of cracking, rutting, and IRI, we develop a surface distress index (SDI) on a 5 point scale, apply a 10% weighting factor for traffic volume which results in a project benefit rating. Based on our budget, we select the locations with the highest benefit rank and advance them for project level pavement screening and design. We also have been growing our pavement preservation program which is a time based selection and focuses on pavements in good and fair condition. |
| WSDOT | Mainly by cost-effectiveness ($/lane-mile/year) or cost per lane-mile per truck |
| VTrans | From a network level it is an optimization of B/C using a budget constraint and there are some treatments specifically associated with very poor condition sections. |
| NMDOT | Currently, NMDOT has a decentralized process for prioritizing pavement sections to repair. Each of our 6 Districts identify sections to repair utilizing their internal process which may not be consistent amongst the 6 Districts. More experienced districts consult and rely heavier on the NMDOT Pavement Management System database. All districts consider funding, construction, and maintenance personnel input in section selection for funding and repair. |
| NYSDOT | NYSDOT uses a traffic weighted benefit cost model to initially prioritize projects for consideration. Region Maintenance and Planning staff consider the list along with other factors. |
| Caltrans | As alluded to in Q1, we utilize the pavement analyst software to predict future pavement condition. In conjunction with predicting the future condition, we have decision trees within the software that trigger a "recommended project" based on a combination of distresses (see attached document). |
| DelDOT | Our pavement management system helps us prioritize using its optimization functionality, which considers cost and desirable treatments. We also look at factors of functional class, traffic counts, and road usage when prioritizing. |
| MDOT | Currently, MDOT does not have a formal pavement prioritization process or tool that generates a prioritized list of individual road sections. MDOT is working on developing a tool to assist in those efforts. However, through our investment strategy development process certain road networks are prioritized in that funds are targeted for specific geographic areas and road networks through data driven formulas. For example, pavement preservation funds are distributed to each of MDOT's seven regions through a funding allocation formula that considers things like condition, regional project cost data, population, and traffic. Once those |

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|---|---|
| | funds are distributed to the regions, a certain percentage of those funds must be spent on each network with a greater weight and emphasis on networks deemed to be higher priority. MDOT has a tiered priority for its four networks with the interstates at the top with the highest priority followed by non-interstate freeways, the non-freeway NHS system, and then non-NHS pavement at the bottom. This process is referred to as Strategic Direction. |
| UDOT | We use pavement management system that is based off benefit over cost ratios as well as years since past treatment and inspection ranking for preservation and rehabilitation. For these systems we do not use worst first considerations. Worst first is only considered for reconstruct program.<br>Detail on Q3: Not directly. We have been following a pavement preservation policy (as described in #4 below) for many years, for our own asset management purposes. This of course has been influenced by FHWA directives over the years. One specific example is with the "Percent Cracking" reporting required for MAP-21. We modified our dTIMS data processing to work with the Wheelpath Fatigue Cracking extent that Fugro-Roadware's Vision software detects/reports in each wheelpath. dTIMS calculates with the fatigue cracking extent and lane width, to produce the Percent Cracking we need to report through HPMS. We do not use Percent Cracking in our own process, but we do calculate a Structural Cracking Index, which makes uses of lane width and the wheelpath fatigue cracking (and also includes non-wheelpath alligator cracking). |
| MaineDOT | Q4: As described in more detail in our Roads Report (https://www.maine.gov/mdot/docs/2016/roadsreport2016.pdf), we have developed Highway Corridor Priority (HCP) 1-4 for our state-responsibility roads. HCP 1 includes all interstate, plus key NHS, and other principal arterials. HCP 4 roads are all minor collectors, but a few minor collectors have been designated as HCP 3. We have different preservation strategies for each HCP, all driven by MaineDOT's overall goal of preserving and operating the existing system. For the most important roads (HCP 1 and 2) our first priority is keeping the good roads good. We do this with a combination of light and heavy pavement preservation treatments (3/4" Overlay, Ultra-Thin Bonded Wearing Course, 1-1/4" Overlay, Mill and Fill, and certain pavement rehabilitation treatments to address the pavement only - and don't get into the base, e.g. Hot-in-Place Recycle, Cold-in-Place Recycle). In recent years we have been moving closer to our stated goal of fully funding preservation needs before funding any reconstruction work. (As noted in #1 above, those higher priority roads that need reconstruction can be held in serviceable condition with low-cost maintenance paving.) If we don't fully fund preservation needs, we run the risk of having Built roads fall into such disrepair that they are no longer preservable. We would rather preserve good roads (at a lower cost per mile) than let them fall to needing rehabilitation (at a much higher cost per mile). In order to carry out the strategy just stated, we use the following process:<br>• Collect ARAN 9000 data (images, IRI, rutting, cracking) on the HCP 1, 2 and 3 roads<br>• Process that data using Fugro-Roadware's Vision software<br>• Aggregate the raw ARAN data into 4 index values: IRI, Rutting, Functional Cracking and Structural Cracking. We start with raw data reported at 0.01 mile intervals, then use Deighton's dTIMS BA software to compute the values (all on a 0-100 scale, where 0 is the worst and 100 is perfect). We also calculate an overall Pavement Condition Rating (PCR) on a 0-5 scale, where 0 is the worst and 5 is perfect).<br>• For MAP-21 reporting purposes, and also for tracking historical pavement data, we aggregate this data up to 0.10 mile sections.<br>• We divide our state network by HCP, committed work and completed work to develop longer analysis sections.<br>• We then use our dTIMS BA software to run Life Cycle Cost Analysis that generates a proposed Construction Program for the expected funding.<br>• Our Highway Management group coordinates a field review and negotiation process that includes riding each candidate and considering factors that dTIMS cannot track (e.g. guard rail condition).<br>• Final decisions about which candidates to fund are made during Synergies meetings that include Highway Management and Bridge Management as well as people from our regions, Project Development, Environment, Safety, Traffic, and regional planning organizations (MPOs). |
| MoDOT | Vehicle Miles Traveled (VMT). Based on VMT MoDOT separates out Major Routes and Minor Routes which have different performance expectations. |
| ALDOT | The state's geographic Areas are provided with a report detailing pavement condition with roughness, cracking, rutting, and age metrics, as well as a composite score. Areas then use this information along with additional local data to submit a list of candidate projects and intended treatments to the Maintenance |

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|---|---|
| | Bureau in the Central Office. Additional project and plan development occurs after approval of the resurfacing/preventive maintenance plan. |
| IDOT | Each district is given funding targets for the 6 years of the program, along with a relative split between pavements and bridges to work toward our TAMP goals. They are also given relative percentages for each system (interstate, other NHS, marked routes, unmarked routes). They should program pavements on each system based on condition, rate of deterioration, traffic volumes, and any other factor they believe is pertinent. |
| LADOTD | Pavement Management sends a Priority List that contains all state roads to the Districts and Pavement Preservation. Then, each district proposes a list of projects that they believe should be priority for the next 5 years. A project selection committee reviews those projects and confirms if the projects or sends comments back to district justify if treatment is different than Pavement Management. |
| FDOT | Pavement condition is monitored annually. Roadway sections with any pavement condition rating (ride quality, crack severity, and rutting) less than a 6.5 (out of a 1-to-10 scale) are programmed for rehabilitation. Districts prioritize each project based on the pavement condition, capacity improvement requirements and number of projects. |
| ODOT | We utilize a pavement management system and a very mature work plan development process which combines capital and maintenance plans into one plan. http://www.dot.state.oh.us/AssetManagement/Pages/tam_links.aspx |
| INDOT | we have developed business rules to score and rank project that meets our goals of improving our roads to 5% poor in 20 years. |
| CTDOT | We use dTIMS Infrastructure Management in combination with other programs to prioritize pavement sections to be repaired. |

# APPENDIX B, SUMMARY OF SECTIONS IN POOR CONDITION AND SUMMARY OF INTERVIEWS WITH DISTRICT MATERIALS ENGINEERS AND PLANNERS

Each of the MnDOT district materials engineers was interviewed about their district's pavement management practices. Before the interviews, the engineers were provided with a table of notable poor sections in their district, a summary table of all of the routes in their district, and several questions that were to be asked in the interview. The tables provided to the districts are given below. Each field of these tables is explained in the "description of data tables sent to districts". The definition of "notable poor section" is dependent on the district. Generally, it refers to the sections in that district that had been in poor condition for the greatest number of consecutive years. Certain districts had many sections that had been in poor condition for an extended period, others did not. The definition for these notable sections will be given on a district-by-district basis below. A summary of the findings from the interviews is also given for each district.

**Table B1: District Personnel Present at Interviews**

| District | Person | Job Title |
|---|---|---|
| 1 | Amy Thorson | Materials Engineer |
| | Maren Webb | Senior Planner |
| | Robert Ege | Traffic Engineer |
| | Bryan Anderson | Planning Director |
| 2 | Jeremy Hadrava | Materials Engineer |
| 3 | Sara Johnson | Materials Engineer |
| 4 | Chris Thorson | Materials Engineer |
| Metro | David Van Deusen | Materials Engineer |
| 6 | Tom Meath | Materials Engineer |
| 7 | Charles Kremer | Materials Engineer |
| 8 | Lowell Flaten | Materials Engineer |
| | Cody Brand | Soils Engineer/Supervisor |

| Table Name | Table Purpose | Field | Field Description |
|---|---|---|---|
| Notable Poor Sections | This table contains a number of sections from a specific district that have been in poor condition for an extended period of time and were still in poor condition as of 2018. The sections shown are those that have been in this poor condition for the longest period within this district. The criteria of what makes a "notable poor section" depends on the district. | Section | Section Number |
| | | Routetype | Type of Route |
| | | RouteNum | Route number designation |
| | | RouteAux | Route auxillary designation (i.e. IS-35**W**, IS-35**E**) |
| | | Direction | Direction data was collected on<br>I = Increasing mile markers<br>D = Decreasing mile markers<br>U = Undivided (data is only collected in one direction) |
| | | Start | Starting location of the section in terms of miles |
| | | End | Ending location of the section in terms of miles |
| | | Total Years in Poor Condition | Total number of years since the year 2000 that this section has been in poor condition |
| | | Highest number of consecutive poor years | Highest number of consecutive years the sections was in poor condition |
| | | Current number of consecutive poor years | The number of consecutive years that the section had been in poor condition as of 2018 |
| | | Section Length | Length of the section in miles |
| | | 2018 RQI | Ride Quality Index rating of the section for 2018 |
| | | AADT | Annual Average Daily Traffic of the section |
| | | Surrounding Currently Poor Sections | Number of consecutive sections surrounding the section in question that are in poor condition (**Doesn't** count the section in question) |
| | | Surrounding Currently Poor Length | Length of continuous pavement surrounding the section in question that is in poor condition (**Does** count the section in question) |
| Route Breakdown | This table contains a breakdown of the pavements in each district separated by route direction. A route direction is a specific collection direction of a certain route. The direction notation is explained in the data column to the right. Note that because certain routes span multiple districts, the data shown in the route breakdown table of a certain district only applies ot that district. The route directions are sorted by length of pavement currently in poor condition (as of 2018). | Length of Data | Total length of data (in miles) collected for each route direction in this district (Not all route directions are completely covered during data collection) |
| | | Number of Sections | Number of sections of this route direction located in this district |
| | | Currently Poor Sections | Number of sections of this route direction located in this district that were in poor condition as of 2018 |
| | | Currently Poor Length | Total length (in miles) of currently poor sections (mentioned in the cell above) |
| | | % of Data Currently Poor | Currently poor length divided by length of data (check definitions above) |

**Figure B1 Screenshot of Definition Table for Fields in Tables Sent to Districts**

## DISTRICT 1

### Notable Poor Sections (top ~5% of sections in terms of number of consec. poor years)

| Section | Routetype | RouteNum | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|
| 14736 | MN | 194 | 0.8 | 1 | 16706 | 1 | 1.4 |
| 14742 | MN | 194 | 0.8 | 0.9 | 16706 | 1 | 1.4 |
| 13348 | MN | 73 | 0.089 | 0.8 | 6181 | 2 | 0.95 |
| 12922 | MN | 65 | 0.977 | 0.4 | 49 | 11 | 11.474 |
| 15215 | MN | 217 | 0.647 | 1.1 | 1252 | 0 | 0 |
| 12959 | MN | 65 | 0.23 | 1.7 | 189 | 0 | 0 |
| 12386 | MN | 61 | 0.354 | 1.8 | 4200 | 0 | 0 |
| 12881 | MN | 65 | 0.612 | 0.9 | 2428 | 1 | 0.871 |
| 12919 | MN | 65 | 0.997 | 1 | 49 | 11 | 11.474 |
| 12920 | MN | 65 | 0.992 | 0.6 | 49 | 11 | 11.474 |

| Section | Routetype | RouteNum | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor years | Current number of consecutive poor years |
|---|---|---|---|---|---|---|---|---|
| 14736 | MN | 194 | D | 15.992 | 16.792 | 19 | 19 | 19 |
| 14742 | MN | 194 | I | 15.992 | 16.792 | 18 | 18 | 18 |
| 13348 | MN | 73 | U | 88.175 | 88.264 | 13 | 13 | 13 |
| 12922 | MN | 65 | U | 222.128 | 223.105 | 12 | 12 | 12 |
| 15215 | MN | 217 | U | 0 | 0.647 | 13 | 12 | 12 |
| 12959 | MN | 65 | U | 256.491 | 256.721 | 11 | 11 | 11 |
| 12386 | MN | 61 | U | 38.974 | 39.328 | 12 | 10 | 10 |
| 12881 | MN | 65 | U | 177.61 | 178.222 | 10 | 10 | 10 |
| 12919 | MN | 65 | U | 219.16 | 220.157 | 10 | 10 | 10 |
| 12920 | MN | 65 | U | 220.157 | 221.149 | 10 | 10 | 10 |

## Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 65 | | U | 180.768 | 193 | 66 | 61.725 | 34% |
| MN | 73 | | U | 105.109 | 113 | 33 | 28.135 | 27% |
| MN | 1 | | U | 158.379 | 173 | 26 | 24.594 | 16% |
| MN | 61 | | U | 126.625 | 146 | 10 | 8.034 | 6% |
| MN | 6 | | U | 27.573 | 29 | 6 | 5.766 | 21% |
| MN | 135 | | U | 36.16 | 41 | 6 | 4.962 | 14% |
| IS | 35 | | I | 94.25 | 101 | 4 | 3.499 | 4% |
| MN | 210 | | U | 65.866 | 71 | 4 | 3.296 | 5% |
| US | 2 | | U | 72.859 | 79 | 4 | 2.683 | 4% |
| IS | 35 | | D | 94.266 | 101 | 3 | 2.487 | 3% |
| MN | 27 | | U | 25.993 | 28 | 2 | 2.226 | 9% |
| US | 53 | | U | 72.555 | 77 | 4 | 1.503 | 2% |
| US | 53 | | U | 72.555 | 77 | 4 | 1.503 | 2% |
| MN | 194 | | D | 3.812 | 6 | 2 | 1.4 | 37% |
| MN | 194 | | I | 3.812 | 6 | 2 | 1.4 | 37% |
| IS | 535 | | D | 1.095 | 2 | 2 | 1.095 | 100% |
| IS | 535 | | I | 1.095 | 2 | 2 | 1.095 | 100% |
| MN | 39 | | U | 1.079 | 1 | 1 | 1.079 | 100% |
| MN | 169 | | U | 21.529 | 25 | 1 | 0.889 | 4% |
| MN | 37 | | D | 1.109 | 3 | 2 | 0.883 | 80% |
| MN | 37 | | I | 1.109 | 3 | 2 | 0.883 | 80% |
| MN | 38 | | U | 46.766 | 51 | 2 | 0.714 | 2% |
| MN | 217 | | U | 17.342 | 20 | 1 | 0.647 | 4% |
| MN | 73 | | D | 1.201 | 2 | 1 | 0.354 | 29% |
| MN | 23 | | U | 61.948 | 67 | 1 | 0.299 | 0% |
| US | 169 | | D | 53.339 | 64 | 1 | 0.212 | 0% |
| US | 169 | | I | 53.339 | 62 | 1 | 0.19 | 0% |
| MN | 11 | | U | 21.381 | 31 | 2 | 0.141 | 1% |
| US | 2 | | D | 17.992 | 23 | 0 | 0 | 0% |
| US | 2 | | I | 17.992 | 23 | 0 | 0 | 0% |
| US | 53 | | D | 91.583 | 99 | 0 | 0 | 0% |
| US | 53 | | I | 91.583 | 97 | 0 | 0 | 0% |
| US | 71 | | U | 27.816 | 30 | 0 | 0 | 0% |
| US | 169 | | U | 21.081 | 23 | 0 | 0 | 0% |
| MN | 11 | | D | 1.712 | 3 | 0 | 0 | 0% |
| MN | 11 | | I | 1.712 | 3 | 0 | 0 | 0% |
| MN | 18 | | U | 33.108 | 35 | 0 | 0 | 0% |
| MN | 23 | | D | 4.957 | 6 | 0 | 0 | 0% |
| MN | 23 | | I | 4.957 | 6 | 0 | 0 | 0% |
| MN | 33 | | D | 19.748 | 23 | 0 | 0 | 0% |
| MN | 33 | | I | 19.748 | 23 | 0 | 0 | 0% |
| MN | 37 | | U | 21.931 | 25 | 0 | 0 | 0% |
| MN | 45 | | D | 0.299 | 1 | 0 | 0 | 0% |
| MN | 45 | | I | 0.299 | 1 | 0 | 0 | 0% |
| MN | 45 | | U | 2.329 | 3 | 0 | 0 | 0% |
| MN | 48 | | U | 23.527 | 25 | 0 | 0 | 0% |
| MN | 61 | | D | 22.163 | 27 | 0 | 0 | 0% |
| MN | 61 | | I | 22.163 | 27 | 0 | 0 | 0% |
| MN | 70 | | U | 18.913 | 21 | 0 | 0 | 0% |
| MN | 73 | | I | 1.201 | 2 | 0 | 0 | 0% |
| MN | 123 | | U | 8.037 | 8 | 0 | 0 | 0% |
| MN | 194 | | U | 7.637 | 8 | 0 | 0 | 0% |
| MN | 200 | | U | 25.963 | 27 | 0 | 0 | 0% |
| MN | 210 | | D | 1.531 | 2 | 0 | 0 | 0% |
| MN | 210 | | I | 1.531 | 2 | 0 | 0 | 0% |
| MN | 286 | | U | 4.302 | 5 | 0 | 0 | 0% |
| MN | 289 | | U | 0.512 | 1 | 0 | 0 | 0% |

### Interview Summary: Zoom meeting with Amy Thorson, Maren Webb, Robert Ege, and Bryan Anderson on May 19, 2020.

Most of the sections included in the notable poor sections, identified by the research team, had already been repaired in the last two years, and the rest are scheduled to be fixed in the next 2 years. It was mentioned that Section 13348 on MN-73 has a concrete section that makes the ride bad even though the surface rating is good. In their programming process, they also consider the surface rating. Both MN-65 and MN-1 have very low traffic sections of less than 50 AADT, and D1 tries to program them as much as is appropriate, given their traffic levels.

Most of the patching work is reactive and is triggered by the immediate need for safety. All reactive repair activities are done by the maintenance division. During individual project scoping, if there were sections that had been in poor shape for more than a year, D1 engineers would talk to maintenance to make more substantial repairs, such as a subgrade correction.

The primary factor in D1's decision-making process is funding availability. The district also considers traffic level, complaints from the public, and "economy of scales". This means if there is an area that needs work done on it, the surrounding areas are more likely to have work done too, and, therefore, it is more efficient to work on a larger area at the same time.

The district receives guidance from the MnDOT central office every year through the distribution of funds from the District Risk Management Program (DRMP) and the Statewide Performance Program (SPP). The district uses current HPMA data and prediction scenarios from HPMA in their programming process, and they submit their draft package to the central office for review. The district also submits its list of needs to the ATP, but they typically don't get a lot of feedback.

There is a slight backlog of urban sections that are costly due to safety and ADA requirements. A project in International falls had about 40% costs attributed to ADA features.

The new project selection policy could have a long-term impact on the decision-making process. Right now, the policy does not make districts delay maintenance, but it could do so in the future. The new policy requires districts to post the entire list of candidate projects with their corresponding scores, as part of a legislative mandate. Maren Webb, Senior Planner for District 1, provided several useful links related to the new policy:

Link to the general process and project selection policy:
https://www.dot.state.mn.us/projectselection/background.html.

The direct link to the guide D1 uses, which includes the points system overview, is located here: http://dotapp7.dot.state.mn.us/eDIGS_guest/DMResultSet/download?docId=3565817. Pages 19 and 20 provide the tables explaining what drives the pavement scores, in NHS, non-NHS, and urban pavements.

Maren does not believe that this is having a significant impact on the program right now, but there is potential over time and may be worth looking more at how it may encourage poor pavements to stay at that status (especially if the fix needed is cost-prohibitive). She also provided a link to the list of candidate projects listed by district, with District 1 as an example: https://www.dot.state.mn.us/projectselection/districts/district1.html.

## DISTRICT 2

### Notable Poor Sections (sections in poor condition for 3+ consec. years as of 2018)

| Section | Routetype | RouteNum | RouteAux | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor | Current number of consecutive poor |
|---|---|---|---|---|---|---|---|---|---|
| 1967 | US | 2 | | D | 26.534 | 26.831 | 19 | 19 | 19 |
| 2408 | US | 2 | B | U | 0 | 0.28 | 17 | 15 | 15 |
| 2139 | US | 2 | | I | 26.534 | 26.831 | 18 | 12 | 12 |
| 14720 | MN | 175 | | U | 9.751 | 10.428 | 13 | 11 | 11 |
| 13265 | MN | 72 | | U | 76.323 | 76.81 | 8 | 8 | 8 |
| 7501 | MN | 6 | | U | 83.064 | 83.958 | 7 | 5 | 5 |
| 13668 | MN | 87 | | U | 48.503 | 49.483 | 10 | 6 | 4 |
| 8101 | MN | 11 | | U | 70.702 | 70.984 | 4 | 4 | 4 |
| 13664 | MN | 87 | | U | 44.525 | 45.523 | 9 | 6 | 3 |
| 13669 | MN | 87 | | U | 49.483 | 50.477 | 9 | 6 | 3 |
| 13665 | MN | 87 | | U | 45.523 | 46.52 | 8 | 5 | 3 |
| 13666 | MN | 87 | | U | 46.52 | 47.503 | 8 | 5 | 3 |
| 5751 | US | 75 | | U | 350.104 | 350.92 | 8 | 3 | 3 |
| 4932 | US | 71 | | D | 317.758 | 319.071 | 4 | 3 | 3 |
| 6904 | MN | 1 | | U | 154.642 | 154.949 | 3 | 3 | 3 |

| Section | Routetype | RouteNum | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|
| 1967 | US | 2 | 0.297 | 1.4 | 4793 | 0 | 0 |
| 2408 | US | 2 | 0.28 | 0.1 | 12133 | 0 | 0 |
| 2139 | US | 2 | 0.297 | 2 | 4793 | 0 | 0 |
| 14720 | MN | 175 | 0.677 | 1.1 | 1446 | 0 | 0 |
| 13265 | MN | 72 | 0.487 | 1.2 | 1608 | 0 | 0 |
| 7501 | MN | 6 | 0.894 | 1.3 | 3780 | 0 | 0 |
| 13668 | MN | 87 | 0.98 | 1.2 | 871 | 5 | 5.952 |
| 8101 | MN | 11 | 0.282 | 1.8 | 6072 | 0 | 0 |
| 13664 | MN | 87 | 0.998 | 1.6 | 871 | 5 | 5.952 |
| 13669 | MN | 87 | 0.994 | 1.7 | 787 | 5 | 5.952 |
| 13665 | MN | 87 | 0.997 | 1.8 | 871 | 5 | 5.952 |
| 13666 | MN | 87 | 0.983 | 1.7 | 871 | 5 | 5.952 |
| 5751 | US | 75 | 0.816 | 1.5 | 2801 | 0 | 0 |
| 4932 | US | 71 | 1.313 | 1.8 | 6366 | 0 | 0 |
| 6904 | MN | 1 | 0.307 | 1.7 | 726 | 0 | 0 |

## Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 87 | | U | 18.72 | 20 | 7 | 6.585 | 35% |
| MN | 200 | | U | 93.156 | 103 | 4 | 3.988 | 4% |
| US | 71 | | I | 7.673 | 8 | 3 | 3.313 | 43% |
| US | 71 | | U | 125.774 | 135 | 2 | 1.991 | 2% |
| US | 71 | | D | 7.673 | 8 | 1 | 1.313 | 17% |
| MN | 32 | | U | 108.364 | 114 | 1 | 1.001 | 1% |
| MN | 371 | | U | 33.93 | 35 | 1 | 1.001 | 3% |
| MN | 6 | | U | 37.138 | 37 | 1 | 0.894 | 2% |
| US | 75 | | U | 140.629 | 157 | 1 | 0.816 | 1% |
| US | 59 | | I | 0.771 | 1 | 1 | 0.771 | 100% |
| MN | 1 | | U | 174.812 | 188 | 2 | 0.734 | 0% |
| MN | 175 | | U | 21.2 | 22 | 1 | 0.677 | 3% |
| MN | 92 | | U | 71.526 | 76 | 1 | 0.637 | 1% |
| MN | 72 | | U | 70.042 | 73 | 1 | 0.487 | 1% |
| MN | 222 | | U | 1.474 | 2 | 1 | 0.474 | 32% |
| US | 2 | | D | 130.98 | 148 | 1 | 0.297 | 0% |
| US | 2 | | I | 130.98 | 150 | 1 | 0.297 | 0% |
| MN | 11 | | U | 186.784 | 197 | 1 | 0.282 | 0% |
| US | 2 | B | U | 2.818 | 4 | 1 | 0.28 | 10% |
| US | 2 | | U | 38.748 | 47 | 0 | 0 | 0% |
| US | 59 | | D | 0.771 | 1 | 0 | 0 | 0% |
| US | 59 | | U | 114.142 | 125 | 0 | 0 | 0% |
| MN | 9 | | U | 43.092 | 45 | 0 | 0 | 0% |
| MN | 34 | | U | 38.175 | 42 | 0 | 0 | 0% |
| MN | 46 | | U | 46.377 | 48 | 0 | 0 | 0% |
| MN | 64 | | U | 29.53 | 32 | 0 | 0 | 0% |
| MN | 89 | | U | 109.889 | 113 | 0 | 0 | 0% |
| MN | 102 | | U | 19.297 | 20 | 0 | 0 | 0% |
| MN | 113 | | U | 9.036 | 9 | 0 | 0 | 0% |
| MN | 171 | | U | 1.886 | 1 | 0 | 0 | 0% |
| MN | 172 | | U | 11.515 | 12 | 0 | 0 | 0% |
| MN | 197 | | D | 6.997 | 8 | 0 | 0 | 0% |
| MN | 197 | | I | 6.997 | 8 | 0 | 0 | 0% |
| MN | 219 | | U | 15.331 | 16 | 0 | 0 | 0% |
| MN | 220 | | D | 0.905 | 1 | 0 | 0 | 0% |
| MN | 220 | | I | 0.905 | 1 | 0 | 0 | 0% |
| MN | 220 | | U | 67.856 | 70 | 0 | 0 | 0% |
| MN | 223 | | U | 7.643 | 8 | 0 | 0 | 0% |
| MN | 226 | | U | 1.494 | 2 | 0 | 0 | 0% |
| MN | 308 | | U | 1.277 | 1 | 0 | 0 | 0% |
| MN | 310 | | U | 10.495 | 11 | 0 | 0 | 0% |
| MN | 313 | | U | 6.267 | 6 | 0 | 0 | 0% |
| MN | 317 | | U | 1.405 | 2 | 0 | 0 | 0% |

## Interview Summary: Zoom meeting with Jeremy Hadrava on May 18, 2020.

Jeremy provided relevant details for each of the notable sections identified by the research team. For simplification, they are included in the table below. Most comments are similar to comments received from other districts: urban sections where the ride is worse than the true road condition, railroad crossing and bridge sections, delays due to the possibility of future turnback that requires a bigger fix, low volume roads. Most of these sections are already slated to be fixed in the next 3 to 5 years.

Jeremy mentioned that ride is a good general indicator, but it cannot replace engineering experience with the roads. He was in favor of the idea of a different criterion for urban sections since many urban sections have bad ride, but the overall condition of the pavement is good, and they last much longer.

Some areas have good ride but bad cracking that patching would take care of. The maintenance department needs to act as the eyes and ears of the engineering department. If there are bad sections in a district, engineers will get more complaints from maintenance than anybody.

In some cases, cities have wide pavements that are more expensive to maintain. This can lead to pavements remaining in prolonged poor condition. Also, ADA regulations on roads running through towns contribute to increased costs to fix them.

The district does AADT measurements only in summer and does not consider the winter traffic from ice fishing. Most people have heavy ice shacks. This is also common for areas in other districts as well.

Jeremy said that during the programming process, trying to balance funding across the entire district is the highest priority and, therefore, it is very important to get input and partner with others. The district gets input from the central office, but the final decision remains with the district.

Curt Turgeon mentioned that, based on MnDOT performance measures specified in TAMP, the bottom 5% of the roads could remain in poor condition indefinitely.

**Table B2: Comments given by D2 on Notable Poor Sections**

| Section | Route type | Route No | Direction | Start [mi] | End [mi] | Comments |
|---|---|---|---|---|---|---|
| 1967 | US | 2 | D | 26.5 | 26.8 | Downtown Crookston, concrete, urban section. Major rehabilitation is too expensive. |
| 2139 | US | 2 | I | 26.5 | 26.8 | In the town of Crookston, concrete, urban section. Ride is not telling the whole story. It wouldn't be worth it to do a major reconstruction. Same stretch as the top one |
| 2408 | US | 2 | U | 0 | 0.28 | Through town east of Grand Forks. Railroad tracks. Needs bigger fix and possible turnback to the local authority. Had been discussed for the past 5 years |
| 14720 | MN | 175 | U | 9.8 | 10.4 | Through the city of Hallock. Had a complete reconstruction in 2001. There is a lot of trench settlement in the city utilities and poor cross slopes. The project is slated to be fixed in 2023. |
| 13265 | MN | 72 | U | 76.3 | 76.8 | In the city of Baudette, near the Canadian border. Slated for complete reconstruction in 2023. Delayed due to decision on bridge replacement. |
| 7501 | MN | 6 | U | 83.1 | 84 | This section is in district 3. Need to check HPMA records. |
| 13668 | MN | 87 | U | 48.5 | 49.5 | All MN87 are planned for reconstructs for 2024. From 45.5 to approx. 51. They are going to work with maint because they have put a lot of patches on this stretch. There is a hauling company that brings potatoes over it, but otherwise, it is a very low-volume road. They will do a thin overlay this summer. It is asphalt. It was originally a county road that the state took over. |
| 8101 | MN | 11 | U | 70.7 | 71 | In the city of Roseau. It was reconstructed in 2003 - 2004. There were issues with raveling. Mill and fill scheduled for 2022 through town. |
| 13664 | MN | 87 | U | 44.5 | 45.5 | Sections have heavy commercial traffic from potato companies. Otherwise, low volume road. Work with maintenance to keep the road functional until a major fix becomes possible. |
| 13669 | MN | 87 | U | 49.5 | 50.5 | |
| 13665 | MN | 87 | U | 45.5 | 46.5 | |
| 13666 | MN | 87 | U | 46.5 | 47.5 | |
| 5751 | US | 75 | U | 350.1 | 350.9 | Section in Warren getting paved this summer. |
| 4932 | US | 71 | D | 317.8 | 319.1 | Dropped 0.8 from the previous year. They're doing some scoping right now. Trying to get some short-term relief. |
| 6904 | MN | 1 | U | 154.6 | 154.9 | TH1 to TH19 is in poor condition. It has only 45-50 cars per day and there is not a lot of heavy commercial traffic. Cannot afford to fix it. |

## DISTRICT 3

### Notable Poor Sections (sections in poor condition for 3+ consec. years as of 2018)

| Section | Routetype | RouteNum | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor years | Current number of consecutive poor years |
|---|---|---|---|---|---|---|---|---|
| 15062 | MN | 210 | U | 77.718 | 77.806 | 16 | 14 | 14 |
| 15079 | MN | 210 | U | 93.537 | 93.768 | 9 | 8 | 8 |
| 3130 | US | 12 | U | 130.961 | 131.968 | 6 | 6 | 6 |
| 7306 | MN | 4 | U | 144.522 | 145.329 | 6 | 6 | 6 |
| 2665 | US | 10 | D | 213.939 | 214.772 | 5 | 5 | 5 |
| 14032 | MN | 95 | U | 40.652 | 41.358 | 6 | 5 | 5 |
| 9713 | MN | 24 | U | 30.754 | 31.43 | 4 | 3 | 3 |

| Section | Routetype | RouteNum | Direction | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|---|
| 15062 | MN | 210 | U | 0.088 | 0.7 | 1050 | 0 | 0 |
| 15079 | MN | 210 | U | 0.231 | 1 | 6647 | 0 | 0 |
| 3130 | US | 12 | U | 1.007 | 2 | 10984 | 0 | 0 |
| 7306 | MN | 4 | U | 0.807 | 1.7 | 1400 | 1 | 1.853 |
| 2665 | US | 10 | D | 0.833 | 1.8 | 26943 | 0 | 0 |
| 14032 | MN | 95 | U | 0.706 | 2 | 12346 | 0 | 0 |
| 9713 | MN | 24 | U | 0.676 | 1.7 | 2639 | 0 | 0 |

## Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 4 | | U | 22.614 | 24 | 7 | 6.849 | 30% |
| MN | 210 | | U | 67.573 | 82 | 4 | 1.861 | 3% |
| MN | 25 | | U | 106.438 | 118 | 2 | 1.82 | 2% |
| MN | 6 | | U | 73.126 | 79 | 2 | 1.361 | 2% |
| US | 12 | | U | 28.198 | 32 | 1 | 1.007 | 4% |
| MN | 47 | | U | 89.892 | 96 | 1 | 1.001 | 1% |
| MN | 18 | | U | 30.797 | 33 | 1 | 0.995 | 3% |
| MN | 55 | | U | 76.293 | 84 | 2 | 0.993 | 1% |
| US | 10 | | D | 123.221 | 134 | 1 | 0.833 | 1% |
| US | 10 | | I | 123.221 | 136 | 1 | 0.833 | 1% |
| MN | 95 | | U | 50.146 | 59 | 2 | 0.768 | 2% |
| MN | 24 | | U | 17.078 | 19 | 1 | 0.676 | 4% |
| MN | 241 | | D | 3.56 | 5 | 1 | 0.29 | 8% |
| IS | 94 | | D | 90.532 | 93 | 0 | 0 | 0% |
| IS | 94 | | I | 90.567 | 98 | 0 | 0 | 0% |
| US | 10 | | U | 2.397 | 3 | 0 | 0 | 0% |
| US | 71 | | U | 99.504 | 107 | 0 | 0 | 0% |
| US | 169 | | D | 61.503 | 70 | 0 | 0 | 0% |
| US | 169 | | I | 61.503 | 67 | 0 | 0 | 0% |
| US | 169 | | U | 59.486 | 68 | 0 | 0 | 0% |
| MN | 15 | | D | 10.147 | 13 | 0 | 0 | 0% |
| MN | 15 | | I | 10.147 | 13 | 0 | 0 | 0% |
| MN | 15 | | U | 15.027 | 19 | 0 | 0 | 0% |
| MN | 22 | | U | 9.927 | 11 | 0 | 0 | 0% |
| MN | 23 | | D | 36.516 | 42 | 0 | 0 | 0% |
| MN | 23 | | I | 36.516 | 39 | 0 | 0 | 0% |
| MN | 23 | | U | 52.692 | 58 | 0 | 0 | 0% |
| MN | 25 | | D | 3.144 | 3 | 0 | 0 | 0% |
| MN | 25 | | I | 3.144 | 3 | 0 | 0 | 0% |
| MN | 27 | | U | 92.483 | 98 | 0 | 0 | 0% |
| MN | 28 | | U | 34.844 | 37 | 0 | 0 | 0% |
| MN | 47 | | D | 0.732 | 1 | 0 | 0 | 0% |
| MN | 47 | | I | 0.732 | 1 | 0 | 0 | 0% |
| MN | 55 | | D | 2.725 | 4 | 0 | 0 | 0% |
| MN | 55 | | I | 2.725 | 4 | 0 | 0 | 0% |
| MN | 64 | | U | 33.76 | 34 | 0 | 0 | 0% |
| MN | 65 | | D | 15.53 | 17 | 0 | 0 | 0% |
| MN | 65 | | I | 15.53 | 17 | 0 | 0 | 0% |
| MN | 65 | | U | 37.078 | 43 | 0 | 0 | 0% |
| MN | 70 | | U | 7.223 | 7 | 0 | 0 | 0% |
| MN | 84 | | U | 29.865 | 31 | 0 | 0 | 0% |
| MN | 87 | | U | 20.007 | 22 | 0 | 0 | 0% |
| MN | 95 | | D | 1.999 | 2 | 0 | 0 | 0% |
| MN | 95 | | I | 1.999 | 2 | 0 | 0 | 0% |
| MN | 107 | | U | 17.571 | 21 | 0 | 0 | 0% |
| MN | 115 | | U | 8.948 | 10 | 0 | 0 | 0% |
| MN | 200 | | U | 30.171 | 30 | 0 | 0 | 0% |
| MN | 210 | | D | 8.013 | 10 | 0 | 0 | 0% |
| MN | 210 | | I | 8.013 | 10 | 0 | 0 | 0% |
| MN | 237 | | U | 2.754 | 3 | 0 | 0 | 0% |
| MN | 238 | | U | 34.709 | 41 | 0 | 0 | 0% |
| MN | 241 | | I | 3.56 | 5 | 0 | 0 | 0% |
| MN | 287 | | U | 14.423 | 16 | 0 | 0 | 0% |
| MN | 301 | | U | 1.059 | 1 | 0 | 0 | 0% |
| MN | 371 | | D | 49.318 | 58 | 0 | 0 | 0% |
| MN | 371 | | I | 49.318 | 58 | 0 | 0 | 0% |
| MN | 371 | | U | 24.163 | 29 | 0 | 0 | 0% |
| MN | 371 | B | D | 1.047 | 2 | 0 | 0 | 0% |
| MN | 371 | B | I | 1.047 | 2 | 0 | 0 | 0% |
| MN | 371 | B | U | 5.437 | 6 | 0 | 0 | 0% |

## Interview Summary: Zoom meeting with Sara Johnson on May 18, 2020

District 3 does not have too many issues with poor pavements and most pavement sections in very poor condition are “anomalies” since they have unique characteristics. For example, the worst section (15062) is a bridge section, and the second-worst section (15079) has a railroad crossing in it. Other sections are very short urban design sections that are in good shape but have a poor ride from the beginning, similar to what is seen in District 6.

Another notable section was MN-4 that was milled and overlaid in 1996. Most likely, it was not a substantial enough fix; however, the poor section of that route was fixed last year. All other poor sections are programmed to be fixed by 2030 in the next 10-Year Capital Highway Investment Plan (CHIP).

The district is responsible for more substantial fixes, such as mill and overlay. Preventive and reactive maintenance activities, such as patching, are handled by maintenance. Maintenance supervisors decide on IDIQ contracts. D3 would like to see more preventive maintenance done. The STIP budget for preventive maintenance has increased to $6 million.

The main factors considered during the programming process are available funding (the most significant), condition of the road, number of maintenance activities that have been performed on the pavement section (the more activities, the more likely it will receive a more substantial treatment), RQI, age of the pavement, AADT, heavy truck traffic, etc.

The district uses HPMA data and prediction curves. The district does not contact Dave Janisch (pavement management office) unless there is a unique situation where there is a road on the boundary between two districts and the fixes are different.

As part of the decision process, D3 engineers ask the maintenance supervisors to provide a list of the worst roads. Video logs are used, and Sara drives the roads herself. She has a review of the roads with maintenance and she also considers Dave Janisch’s recommendations.

The district had turnbacks, but the MnDOT State Aid Office handles that process. They fix the pavements before turning them back to the local jurisdiction.

## DISTRICT 4

### Notable Poor Sections (sections in poor condition for 3+ consec. years as of 2018)

| Section | Routetype | RouteNum | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor years | Current number of consecutive poor years |
|---|---|---|---|---|---|---|---|---|
| 4298 | US | 59 | U | 262.196 | 262.286 | 8 | 8 | 8 |
| 9967 | MN | 27 | U | 58.303 | 58.345 | 7 | 7 | 7 |
| 9931 | MN | 27 | U | 23.525 | 24.025 | 6 | 6 | 6 |
| 5371 | US | 75 | D | 249.529 | 250.148 | 14 | 8 | 4 |
| 5372 | US | 75 | D | 250.148 | 250.308 | 14 | 8 | 4 |
| 10180 | MN | 28 | U | 57.465 | 58.002 | 5 | 4 | 4 |
| 5383 | US | 75 | I | 249.529 | 250.148 | 12 | 8 | 3 |
| 2444 | US | 10 | D | 0.516 | 0.76 | 8 | 5 | 3 |
| 2701 | US | 10 | I | 0.516 | 0.76 | 8 | 3 | 3 |
| 11669 | MN | 55 | U | 37.994 | 38.295 | 4 | 3 | 3 |
| 13625 | MN | 87 | U | 0.562 | 1.074 | 4 | 3 | 3 |
| 14297 | MN | 106 | U | 0 | 0.924 | 3 | 3 | 3 |

| Section | Routetype | RouteNum | Direction | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|---|
| 4298 | US | 59 | U | 0.09 | 0.8 | 11377 | 0 | 0 |
| 9967 | MN | 27 | U | 0.042 | 0.1 | 2550 | 0 | 0 |
| 9931 | MN | 27 | U | 0.5 | 1.9 | 2351 | 0 | 0 |
| 5371 | US | 75 | D | 0.619 | 1.8 | 16452 | 1 | 0.779 |
| 5372 | US | 75 | D | 0.16 | 0.9 | 16452 | 1 | 0.779 |
| 10180 | MN | 28 | U | 0.537 | 2 | 2255 | 0 | 0 |
| 5383 | US | 75 | I | 0.619 | 1.9 | 16452 | 0 | 0 |
| 2444 | US | 10 | D | 0.244 | 1.9 | 9498 | 1 | 0.672 |
| 2701 | US | 10 | I | 0.244 | 1.6 | 9498 | 1 | 0.672 |
| 11669 | MN | 55 | U | 0.301 | 1.6 | 2032 | 2 | 2.276 |
| 13625 | MN | 87 | U | 0.512 | 1.8 | 1081 | 1 | 1.025 |
| 14297 | MN | 106 | U | 0.924 | 1.5 | 916 | 5 | 5.953 |

### Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 106 | | U | 7.365 | 8 | 7 | 6.356 | 86% |
| MN | 55 | | U | 82.943 | 90 | 6 | 4.052 | 5% |
| US | 75 | | U | 138.477 | 147 | 4 | 2.131 | 2% |
| MN | 119 | | U | 19.57 | 21 | 2 | 2.101 | 11% |
| MN | 119 | | U | 19.57 | 21 | 2 | 2.101 | 11% |
| MN | 87 | | U | 31.29 | 34 | 3 | 2.028 | 6% |
| US | 75 | | I | 4.248 | 9 | 2 | 1.135 | 27% |
| MN | 28 | | U | 90.253 | 103 | 2 | 0.92 | 1% |
| US | 75 | | D | 4.248 | 9 | 2 | 0.779 | 18% |
| US | 10 | | D | 87.492 | 92 | 2 | 0.672 | 1% |
| US | 10 | | I | 87.492 | 94 | 2 | 0.672 | 1% |
| MN | 210 | | U | 73.013 | 83 | 2 | 0.64 | 1% |
| MN | 27 | | U | 76.704 | 81 | 2 | 0.542 | 1% |
| MN | 79 | | U | 12.128 | 14 | 1 | 0.147 | 1% |
| US | 59 | | U | 156.18 | 168 | 1 | 0.09 | 0% |
| IS | 94 | | D | 115.06 | 125 | 0 | 0 | 0% |
| IS | 94 | | I | 115.06 | 121 | 0 | 0 | 0% |
| US | 10 | | U | 3.051 | 3 | 0 | 0 | 0% |
| US | 12 | | U | 59.538 | 62 | 0 | 0 | 0% |
| MN | 7 | | U | 50.092 | 56 | 0 | 0 | 0% |
| MN | 9 | | U | 156.015 | 162 | 0 | 0 | 0% |
| MN | 29 | | D | 4.746 | 6 | 0 | 0 | 0% |
| MN | 29 | | I | 4.746 | 6 | 0 | 0 | 0% |
| MN | 29 | | U | 95.069 | 102 | 0 | 0 | 0% |
| MN | 32 | | U | 34.452 | 36 | 0 | 0 | 0% |
| MN | 34 | | U | 48.336 | 55 | 0 | 0 | 0% |
| MN | 54 | | U | 10.851 | 11 | 0 | 0 | 0% |
| MN | 78 | | U | 46.694 | 51 | 0 | 0 | 0% |
| MN | 104 | | U | 26.43 | 28 | 0 | 0 | 0% |
| MN | 108 | | U | 52.103 | 59 | 0 | 0 | 0% |
| MN | 113 | | U | 45.556 | 47 | 0 | 0 | 0% |
| MN | 114 | | U | 19.292 | 20 | 0 | 0 | 0% |
| MN | 117 | | U | 1.797 | 2 | 0 | 0 | 0% |
| MN | 200 | | U | 24.327 | 25 | 0 | 0 | 0% |
| MN | 210 | | D | 0.439 | 1 | 0 | 0 | 0% |
| MN | 210 | | I | 0.439 | 1 | 0 | 0 | 0% |
| MN | 329 | | U | 1.112 | 1 | 0 | 0 | 0% |
| MN | 336 | | D | 2.18 | 2 | 0 | 0 | 0% |
| MN | 336 | | I | 2.18 | 2 | 0 | 0 | 0% |

### Interview Summary: Zoom meeting with Chris Thorson on May 20, 2020

Most of the sections in poor condition on the notable list for District 4 are in urban areas. A similar concern with District 7, regarding the slower speed of measurement by the survey van in these urban areas, was expressed. Due to the presence of manholes and drainage, which affect the ride quality, the district also looks at SR values for these urban sections. If there is an RQI-SR disparity, they go out and ride the section to determine why there is a poor ride, and whether there is a need to work on that section. Chris provided below additional information for the list of notable poor sections sent by the research team.

**Table B3: Comments from D4 on Notable Poor Sections**

| Section | Route type | Route No | AADT | 2018 RQI | 2018 SR | Description |
|---|---|---|---|---|---|---|
| 4298 | US | 59 | 11,377 | 0.8 | 3.9 | CITY OF DETROIT LAKES<br>LOWER SPEED & INTERSECTIONS<br>(RECENT 2015 PROJECT) |
| 9967 | MN | 27 | 2,550 | 0.1 | 3.4 | CITY OF HOFFMAN<br>URBAN AREA AND RR XING - (220') |
| 9931 | MN | 27 | 2,351 | 1.9 | 3.6 | CITY OF WHEATON<br>URBAN AREA - (2019 PAVEMENT PROJECT) |
| 5371 | US | 75 | 16,452 | 1.8 | 3.1 | CITY OF MOORHEAD<br>URBAN AREA - (2025 PROJECT SCHEDULED) |
| 5372 | US | 75 | 16,452 | 0.9 | 3.6 | CITY OF MOORHEAD<br>URBAN AREA - (2025 PROJECT SCHEDULED) |
| 10180 | MN | 28 | 2,255 | 2 | 2.6 | CITY OF CYRUS<br>URBAN AREA - (2024 PROJECT SCHEDULED) |
| 5383 | US | 75 | 16,452 | 1.9 | 3.3 | CITY OF MOORHEAD<br>URBAN AREA - (2025 PROJECT SCHEDULED) |
| 2444 | US | 10 | 9,498 | 1.9 | 4 | CITY OF MOORHEAD<br>URBAN AREA - (OVERLAY PROJECT IN 2016) |
| 2701 | US | 10 | 9,498 | 1.6 | 3.8 | CITY OF MOORHEAD<br>URBAN AREA - (OVERLAY PROJECT IN 2016) |
| 11669 | MN | 55 | 2,032 | 1.6 | 3.1 | NORTH OF THE CITY OF BARRETT<br>(2023 PROJECT SCHEDULED) |
| 13625 | MN | 87 | 1,081 | 1.8 | 2.9 | CITY OF FRAZEE<br>URBAN AREA - (2022 PROJECT SCHEDULED) |
| 14297 | MN | 106 | 916 | 1.5 | 4 | CITY OF DEER CREEK<br>URBAN AREA - (CIR PROJECT IN 2018) |

Chris also mentioned that in the Red River Valley and the western edge of the district, they have to deal with tougher soils, such as heavier clays and silts, which have a negative effect on pavement condition.

Patching is a reactive activity to an issue that needs to be fixed quickly, and there is no time to wait for planning and getting funding for a bigger project. Patching is primarily used to prevent raveling and potholes from expanding and accelerating the deterioration of the pavement.

Chris has looked at the sections that had FDR and thick mill and overlays done since the early 2000s and found that the RQI values for these fixes are still in the upper 3's.

Similar to the other districts, the number one factor influencing the decision on performing or further delaying maintenance and/or rehabilitation of pavement sections already in poor condition is funding availability. Choosing the right strategy is a balancing act between lack of funding and effectiveness of the repairs. For example, for some sections, FDR is a better solution than mill and overlay in the long run, but FDR is more expensive and cannot be done.

Timing is also very important, especially when working with municipalities that need to perform utility work. For example, the city of Moorhead has concrete sections that were built for the last 30 years. The city also has old clay tile pipes that need to be replaced with PVC pipes. Fixing the concrete pavement sections needs to be synchronized with the utility work required to replace the old pipes.

The district interacts with the Maplewood (pavement management) office when selecting their fixes. They propose a list of activities and consult with the office to make sure they're on the right track. The district also works with counties when they need to use county routes as detours for their projects.

## DISTRICT 5 (METRO)

### Notable Poor Sections (top ~10% of sections in terms of number of consec. poor years)

| Section | Routetype | RouteNum | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor years | Current number of consecutive poor years |
|---|---|---|---|---|---|---|---|---|
| 12638 | MN | 65 | D | 1.861 | 2.934 | 19 | 19 | 19 |
| 12690 | MN | 65 | I | 1.861 | 2.934 | 19 | 19 | 19 |
| 14669 | MN | 156 | U | 2 | 3 | 18 | 18 | 18 |
| 11520 | MN | 51 | I | 2.775 | 3.276 | 17 | 17 | 17 |
| 12639 | MN | 65 | D | 2.934 | 3.759 | 17 | 16 | 16 |
| 14670 | MN | 156 | U | 3 | 3.403 | 16 | 16 | 16 |
| 11338 | MN | 47 | D | 20.704 | 21.059 | 13 | 10 | 10 |
| 7153 | MN | 3 | U | 38.367 | 38.966 | 10 | 9 | 9 |
| 7350 | MN | 5 | D | 69.696 | 71.349 | 17 | 9 | 9 |
| 1784 | IS | 494 | D | 0 | 1.009 | 10 | 8 | 8 |
| 1832 | IS | 494 | I | 0 | 1.009 | 9 | 8 | 8 |
| 14586 | MN | 121 | I | 0.483 | 0.545 | 12 | 8 | 8 |
| 14659 | MN | 149 | U | 8.217 | 8.459 | 8 | 8 | 8 |

| Section | Routetype | RouteNum | Direction | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|---|
| 12638 | MN | 65 | D | 1.073 | 1.6 | 14960 | 1 | 1.898 |
| 12690 | MN | 65 | I | 1.073 | 1.9 | 14960 | 2 | 1.967 |
| 14669 | MN | 156 | U | 1 | 1.4 | 8198 | 1 | 1.403 |
| 11520 | MN | 51 | I | 0.501 | 1.4 | 27184 | 1 | 0.903 |
| 12639 | MN | 65 | D | 0.825 | 1.8 | 15002 | 1 | 1.898 |
| 14670 | MN | 156 | U | 0.403 | 1.4 | 8198 | 1 | 1.403 |
| 11338 | MN | 47 | D | 0.355 | 1.5 | 18300 | 0 | 0 |
| 7153 | MN | 3 | U | 0.599 | 1.3 | 6869 | 0 | 0 |
| 7350 | MN | 5 | D | 1.653 | 1 | 16283 | 0 | 0 |
| 1784 | IS | 494 | D | 1.009 | 1.9 | 112043 | 0 | 0 |
| 1832 | IS | 494 | I | 1.009 | 1.9 | 112162 | 0 | 0 |
| 14586 | MN | 121 | I | 0.062 | 2 | 7500 | 0 | 0 |
| 14659 | MN | 149 | U | 0.242 | 1.3 | 7800 | 1 | 0.964 |

## Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 5 | | I | 19.368 | 22 | 5 | 5.356 | 28% |
| IS | 94 | | D | 52.978 | 60 | 5 | 4.449 | 8% |
| IS | 94 | | D | 52.978 | 60 | 5 | 4.449 | 8% |
| US | 952 | A | I | 8.412 | 12 | 7 | 3.736 | 44% |
| MN | 5 | | D | 19.368 | 22 | 3 | 3.64 | 19% |
| MN | 149 | | U | 5.107 | 10 | 5 | 3.085 | 60% |
| MN | 65 | | D | 30.495 | 35 | 3 | 2.897 | 9% |
| US | 61 | | U | 27.038 | 35 | 5 | 2.64 | 10% |
| US | 952 | A | D | 7.112 | 10 | 5 | 2.45 | 34% |
| MN | 51 | | I | 10.517 | 16 | 3 | 2.092 | 20% |
| MN | 55 | | D | 31.932 | 40 | 3 | 2.04 | 6% |
| MN | 65 | | I | 30.495 | 34 | 3 | 1.967 | 6% |
| MN | 55 | | I | 31.932 | 38 | 2 | 1.961 | 6% |
| MN | 5 | | U | 17.782 | 22 | 2 | 1.75 | 10% |
| MN | 51 | | D | 10.517 | 16 | 3 | 1.564 | 15% |
| MN | 156 | | U | 2.557 | 4 | 2 | 1.403 | 55% |
| US | 61 | | D | 33.87 | 42 | 3 | 1.371 | 4% |
| IS | 494 | | D | 42.856 | 48 | 2 | 1.368 | 3% |
| IS | 494 | | I | 42.856 | 50 | 2 | 1.367 | 3% |
| MN | 47 | | U | 13.136 | 13 | 1 | 1.304 | 10% |
| MN | 47 | | D | 11.567 | 12 | 2 | 1.292 | 11% |
| IS | 94 | | I | 52.943 | 58 | 1 | 1.108 | 2% |
| US | 52 | | D | 32.237 | 38 | 1 | 0.997 | 3% |
| US | 52 | | I | 32.455 | 39 | 1 | 0.997 | 3% |
| MN | 21 | | U | 10.238 | 12 | 1 | 0.992 | 10% |
| MN | 120 | | U | 6.675 | 8 | 2 | 0.979 | 15% |
| MN | 47 | | I | 11.567 | 12 | 1 | 0.937 | 8% |
| IS | 394 | | D | 9.735 | 10 | 1 | 0.843 | 9% |
| US | 169 | | D | 58.888 | 67 | 1 | 0.773 | 1% |
| MN | 13 | | U | 22.656 | 24 | 2 | 0.65 | 3% |
| MN | 3 | | U | 27.913 | 33 | 1 | 0.599 | 2% |
| MN | 95 | | U | 63.394 | 69 | 1 | 0.595 | 1% |
| US | 61 | | I | 33.87 | 42 | 1 | 0.59 | 2% |
| MN | 100 | | D | 16.178 | 20 | 1 | 0.518 | 3% |
| MN | 156 | | D | 1.644 | 3 | 1 | 0.517 | 31% |
| MN | 156 | | I | 1.644 | 3 | 1 | 0.517 | 31% |
| MN | 149 | | D | 3.728 | 5 | 1 | 0.515 | 14% |
| MN | 95 | | I | 3.462 | 6 | 1 | 0.507 | 15% |
| MN | 41 | | D | 1.662 | 3 | 1 | 0.442 | 27% |
| MN | 101 | | U | 3.293 | 4 | 1 | 0.409 | 12% |
| MN | 280 | | I | 3.71 | 7 | 1 | 0.399 | 11% |
| MN | 7 | | I | 12.542 | 17 | 1 | 0.387 | 3% |
| MN | 284 | | U | 5.651 | 7 | 1 | 0.307 | 5% |
| MN | 110 | | D | 5.245 | 8 | 1 | 0.301 | 6% |
| MN | 13 | | I | 17.087 | 21 | 1 | 0.272 | 2% |
| MN | 280 | | D | 3.71 | 8 | 1 | 0.253 | 7% |
| MN | 36 | | D | 20.211 | 27 | 1 | 0.211 | 1% |
| MN | 316 | | U | 9.809 | 15 | 1 | 0.197 | 2% |
| MN | 25 | | U | 25.656 | 29 | 1 | 0.183 | 1% |
| MN | 13 | | D | 17.087 | 21 | 1 | 0.113 | 1% |
| MN | 97 | | U | 12.816 | 16 | 1 | 0.088 | 1% |
| MN | 97 | | U | 12.816 | 16 | 1 | 0.088 | 1% |
| MN | 101 | | D | 6.93 | 9 | 1 | 0.075 | 1% |

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 121 | | I | 0.937 | 3 | 1 | 0.062 | 7% |
| IS | 35 | | D | 49.161 | 53 | 0 | 0 | 0% |
| IS | 35 | | I | 49.161 | 54 | 0 | 0 | 0% |
| IS | 35 | E | D | 39.34 | 43 | 0 | 0 | 0% |
| IS | 35 | E | I | 39.34 | 45 | 0 | 0 | 0% |
| IS | 35 | W | D | 41.778 | 44 | 0 | 0 | 0% |
| IS | 35 | W | I | 41.778 | 46 | 0 | 0 | 0% |
| IS | 394 | | I | 9.218 | 11 | 0 | 0 | 0% |
| IS | 694 | | D | 22.211 | 25 | 0 | 0 | 0% |
| IS | 694 | | I | 23.292 | 27 | 0 | 0 | 0% |
| US | 8 | | D | 2.258 | 4 | 0 | 0 | 0% |
| US | 8 | | I | 2.258 | 4 | 0 | 0 | 0% |
| US | 8 | | U | 19.871 | 23 | 0 | 0 | 0% |
| US | 10 | | D | 25.489 | 31 | 0 | 0 | 0% |
| US | 10 | | I | 25.489 | 33 | 0 | 0 | 0% |
| US | 10 | | U | 3.126 | 4 | 0 | 0 | 0% |
| US | 12 | | D | 3.817 | 4 | 0 | 0 | 0% |
| US | 12 | | I | 3.817 | 4 | 0 | 0 | 0% |
| US | 12 | | U | 7.678 | 12 | 0 | 0 | 0% |
| US | 169 | | I | 58.888 | 66 | 0 | 0 | 0% |
| US | 212 | | D | 24.015 | 29 | 0 | 0 | 0% |
| US | 212 | | I | 24.015 | 29 | 0 | 0 | 0% |
| US | 212 | | U | 9.452 | 10 | 0 | 0 | 0% |
| MN | 3 | | D | 1.807 | 2 | 0 | 0 | 0% |
| MN | 3 | | I | 1.807 | 2 | 0 | 0 | 0% |
| MN | 7 | | D | 12.542 | 17 | 0 | 0 | 0% |
| MN | 7 | | U | 14.887 | 17 | 0 | 0 | 0% |
| MN | 20 | | U | 7.471 | 8 | 0 | 0 | 0% |
| MN | 36 | | I | 20.211 | 25 | 0 | 0 | 0% |
| MN | 41 | | I | 1.662 | 3 | 0 | 0 | 0% |
| MN | 41 | | U | 7.631 | 10 | 0 | 0 | 0% |
| MN | 50 | | U | 15.082 | 14 | 0 | 0 | 0% |
| MN | 51 | | U | 0.807 | 1 | 0 | 0 | 0% |
| MN | 55 | | U | 15.901 | 18 | 0 | 0 | 0% |
| MN | 56 | | U | 6.153 | 7 | 0 | 0 | 0% |
| MN | 62 | | D | 12.35 | 17 | 0 | 0 | 0% |
| MN | 62 | | I | 12.35 | 17 | 0 | 0 | 0% |
| MN | 77 | | D | 9.519 | 10 | 0 | 0 | 0% |
| MN | 77 | | I | 9.519 | 10 | 0 | 0 | 0% |
| MN | 95 | | D | 3.462 | 6 | 0 | 0 | 0% |
| MN | 96 | | U | 10.194 | 12 | 0 | 0 | 0% |
| MN | 100 | | I | 16.178 | 19 | 0 | 0 | 0% |
| MN | 101 | | I | 6.93 | 9 | 0 | 0 | 0% |
| MN | 110 | | I | 5.245 | 8 | 0 | 0 | 0% |
| MN | 120 | | D | 0.559 | 1 | 0 | 0 | 0% |
| MN | 120 | | I | 0.559 | 1 | 0 | 0 | 0% |
| MN | 121 | | D | 0.937 | 2 | 0 | 0 | 0% |
| MN | 149 | | I | 3.728 | 5 | 0 | 0 | 0% |
| MN | 243 | | U | 1.23 | 1 | 0 | 0 | 0% |
| MN | 244 | | U | 4.705 | 5 | 0 | 0 | 0% |
| MN | 252 | | D | 4.353 | 7 | 0 | 0 | 0% |
| MN | 252 | | I | 4.353 | 7 | 0 | 0 | 0% |
| MN | 282 | | U | 7.655 | 8 | 0 | 0 | 0% |
| MN | 610 | | D | 12.314 | 16 | 0 | 0 | 0% |
| MN | 610 | | I | 12.314 | 15 | 0 | 0 | 0% |

## Interview Summary: Zoom meeting with David van Deusen on May 22, 2020

Before the meeting, Dave sent the research team additional information for the list of notable poor sections provided. He mentioned that most of these road sections were very old, urban sections, some with lots of utilities, manholes, etc. An example is TH 5 through St. Paul, which is also West 7th St, which represents a section very expensive and complicated to reconstruct that has been overlaid many times. In many locations, there are streetcar rails and cobblestone pavers very close to the surface. The year after the last resurfacing project, the city came through with utility improvements, and the resulting cuts/patches eliminated most of the ride improvement from the project. A summary is presented below.

**Table B4: Comments from D5 on Notable Poor Sections**

| Section | Route type | Route No | Comment | Total Years in Poor Condition | Length [mi] | 2018 RQI | AADT |
|---|---|---|---|---|---|---|---|
| 12638 | MN | 65 | Urban; includes 3rd Ave Bridge; Central Ave; | 19 | 1.073 | 1.6 | 14,960 |
| 12690 | MN | 65 | Urban; includes 3rd Ave Bridge; Central Ave; | 19 | 1.073 | 1.9 | 14,960 |
| 14669 | MN | 156 | Urban; Turnback? | 18 | 1 | 1.4 | 8,198 |
| 11520 | MN | 51 | Urban; Macalaster to I-94; | 17 | 0.501 | 1.4 | 27,184 |
| 12639 | MN | 65 | Urban; Central Ave; | 17 | 0.825 | 1.8 | 15,002 |
| 14670 | MN | 156 | Urban; Butler Ave to County Line;<br>Turnback? | 16 | 0.403 | 1.4 | 8,198 |
| 11338 | MN | 47 | JCT TH 10 to Fairgrounds; Urban; | 13 | 0.355 | 1.5 | 18,300 |
| 7153 | MN | 3 | Reconstructed in 2018; | 10 | 0.599 | 1.3 | 6,869 |
| 7350 | MN | 5 | Urban; Kellogg to Mounds; | 17 | 1.653 | 1 | 16,283 |
| 1784 | IS | 494 | Includes River bridge;<br>TH 5 interchange; | 10 | 1.009 | 1.9 | 112,043 |
| 1832 | IS | 494 | Includes River bridge;<br>TH 5 interchange; | 9 | 1.009 | 1.9 | 112,162 |
| 14586 | MN | 121 | Short and crummy stub;<br>nobody wants it; | 12 | 0.062 | 2 | 7,500 |
| 14659 | MN | 149 | Smith/Dodd to JCT TH 13; | 8 | 0.242 | 1.3 | 7,800 |

Some sections contain bridge decks that can be quite rough. Metro Materials is not responsible for the work on them, although they coordinate with their bridge group on the pavement jobs. The 3rd Avenue Bridge is slated for a major makeover starting this summer. The I-494 Bridge is slated for re-decking within the next 5 years. He did not believe the inclusion of bridge decks in the study is useful.

A few sections are just short roads that go nowhere, e.g., TH 121 that receives very little use. They have looked at turning it back to the locals, but it is a very complicated process.

Dave also mentioned that the timing of pavement profiling data collection could play a role. In the Metro district, the roads are typically run in spring, just when construction projects are kicking off. Construction usually wraps up by Thanksgiving, depending on the size of the job. In the case of TH 3, they reconstructed that section in 2018 and the pavement management van likely traveled through this stretch while construction was going.

Metro district's maintenance division handles most of the patching work. On roads that aren't going to receive larger treatments for a while, it is common for maintenance to do activities like patching on them. They don't look at maintenance costs against the service provided. It's more of an issue with communication with maintenance that informs them when they need to do something fast. Examples are MN-52 and I-94.

Turnbacks happen occasionally. In Metro, the amount of frontage road work they have to do can be significant. It's not always well known during the scoping process whether they have to do work on those roads. An example is a frontage road in Bloomington that was planned to be returned to the city.

Availability of resources is the biggest factor in the decision-making process. There are only so many resources to go around. District Risk Management Program (DRMP) funding is smaller than the Statewide Performance Program (SPP) funding focused on NHS roads. Political pressure plays an important role, especially when there is a special program and they need to adjust priorities.

There is a lot of competition for funding with mobility, safety, and congestion management. Traffic management is very important because it is expensive. Other factors need to be taken into consideration in the Metro area, such as bridge and hydraulic infrastructure, and ADA requirements. Metro has by far the most comprehensive transportation program in the state.

The MnDOT Central Office provides information regarding the funding that goes to the NHS and non-NHS roads and the district works with their planning unit and Dave Janisch (from the pavement management office) to pick up the projects to be fixed. The district has a backlog list of sections of road that need work based on HPMA data. Every year, they identify projects to put in the plan and check HPMA to see if they have been deteriorating faster than expected. HPMA provides very good data, but it is no substitute for going out and looking at the roads. The district does a five-year-out scoping so that by the third year, they have a pretty good idea of cost and scope. In the process, they consult with the concrete and bituminous offices in Maplewood as well as with Curt Turgeon.

The district works with locals, especially in cases where roads go through a municipality. Sometimes the city will be doing maintenance, and when the pavement gets down to poor condition, the district will work with the city for patching work and other repair activities. Metro has area managers who manage different programs and represent the liaisons with the locals.

## DISTRICT 6

### Notable Poor Sections (top ~10% of sections in terms of number of consec. poor years)

| Section | Routetype | RouteNum | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor years | Current number of consecutive poor years |
|---|---|---|---|---|---|---|---|---|
| 11931 | MN | 57 | I | 0 | 0.455 | 19 | 19 | 19 |
| 11232 | MN | 43 | U | 43.877 | 44.017 | 18 | 18 | 18 |
| 11930 | MN | 57 | D | 0 | 0.455 | 18 | 18 | 18 |
| 6702 | US | 218 | U | 28.345 | 28.917 | 17 | 16 | 16 |
| 8255 | MN | 13 | D | 0 | 0.246 | 17 | 16 | 16 |
| 8283 | MN | 13 | I | 0 | 0.246 | 17 | 16 | 16 |
| 12195 | MN | 60 | I | 150.9 | 151.06 | 17 | 16 | 16 |
| 15441 | MN | 250 | U | 0.66 | 0.965 | 15 | 15 | 15 |
| 10632 | MN | 30 | U | 265.329 | 265.84 | 13 | 13 | 13 |
| 13412 | MN | 74 | U | 54.696 | 54.996 | 11 | 11 | 11 |
| 4884 | US | 65 | I | 313.007 | 313.275 | 11 | 10 | 10 |
| 15626 | MN | 292 | U | 0 | 0.47 | 14 | 10 | 10 |

| Section | Routetype | RouteNum | Direction | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|---|
| 11931 | MN | 57 | I | 0.455 | 1.6 | 11226 | 0 | 0 |
| 11232 | MN | 43 | U | 0.14 | 1.3 | 5817 | 0 | 0 |
| 11930 | MN | 57 | D | 0.455 | 1.5 | 11226 | 0 | 0 |
| 6702 | US | 218 | U | 0.572 | 0.8 | 5932 | 0 | 0 |
| 8255 | MN | 13 | D | 0.246 | 1.8 | 8674 | 1 | 0.961 |
| 8283 | MN | 13 | I | 0.246 | 1.8 | 8674 | 1 | 0.961 |
| 12195 | MN | 60 | I | 0.16 | 1.8 | 7091 | 1 | 0.859 |
| 15441 | MN | 250 | U | 0.305 | 1.5 | 724 | 0 | 0 |
| 10632 | MN | 30 | U | 0.511 | 1.3 | 1055 | 3 | 3.454 |
| 13412 | MN | 74 | U | 0.3 | 1.2 | 501 | 0 | 0 |
| 4884 | US | 65 | I | 0.268 | 1.6 | 15154 | 1 | 0.77 |
| 15626 | MN | 292 | U | 0.47 | 1 | 292 | 0 | 0 |

## Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 30 | | U | 88.299 | 97 | 18 | 16.024 | 18% |
| MN | 60 | | U | 81.329 | 89 | 6 | 5.762 | 7% |
| MN | 246 | | U | 18.221 | 20 | 6 | 5.291 | 29% |
| US | 61 | | I | 72.878 | 81 | 3 | 2.469 | 3% |
| IS | 90 | | D | 129.834 | 136 | 2 | 1.998 | 2% |
| MN | 250 | | U | 9.479 | 11 | 3 | 1.802 | 19% |
| MN | 13 | | I | 4.805 | 7 | 3 | 1.547 | 32% |
| US | 65 | | D | 6.485 | 9 | 3 | 1.488 | 23% |
| US | 14 | | I | 39.828 | 46 | 2 | 1.349 | 3% |
| MN | 56 | | U | 89.428 | 100 | 1 | 1.074 | 1% |
| MN | 105 | | U | 13.645 | 15 | 1 | 1.003 | 7% |
| US | 52 | | D | 52.174 | 59 | 1 | 1 | 2% |
| MN | 13 | | D | 4.805 | 7 | 2 | 0.961 | 20% |
| MN | 60 | | I | 2.981 | 6 | 2 | 0.859 | 29% |
| US | 65 | | I | 6.485 | 9 | 2 | 0.77 | 12% |
| MN | 16 | | U | 83.297 | 91 | 1 | 0.705 | 1% |
| US | 61 | | D | 72.878 | 81 | 1 | 0.602 | 1% |
| US | 218 | | D | 2.836 | 3 | 1 | 0.591 | 21% |
| US | 218 | | U | 38.045 | 39 | 1 | 0.572 | 2% |
| MN | 57 | | U | 24.123 | 28 | 1 | 0.522 | 2% |
| MN | 44 | | U | 35.978 | 39 | 1 | 0.522 | 1% |
| MN | 43 | | D | 1.37 | 3 | 1 | 0.519 | 38% |
| MN | 43 | | I | 1.37 | 3 | 1 | 0.519 | 38% |
| MN | 292 | | U | 0.47 | 1 | 1 | 0.47 | 100% |
| MN | 57 | | D | 0.455 | 1 | 1 | 0.455 | 100% |
| MN | 57 | | I | 0.455 | 1 | 1 | 0.455 | 100% |
| US | 63 | | U | 53.035 | 60 | 1 | 0.424 | 1% |
| MN | 58 | | U | 19.724 | 24 | 1 | 0.36 | 2% |
| MN | 74 | | U | 27.931 | 30 | 1 | 0.3 | 1% |
| MN | 43 | | U | 40.078 | 48 | 1 | 0.14 | 0% |
| IS | 35 | | D | 74.812 | 78 | 0 | 0 | 0% |
| IS | 35 | | I | 74.812 | 78 | 0 | 0 | 0% |
| IS | 90 | | I | 129.874 | 138 | 0 | 0 | 0% |
| US | 14 | | D | 39.828 | 44 | 0 | 0 | 0% |
| US | 14 | | U | 52.016 | 55 | 0 | 0 | 0% |
| US | 52 | | I | 52.174 | 56 | 0 | 0 | 0% |
| US | 52 | | U | 46.271 | 54 | 0 | 0 | 0% |
| US | 61 | | U | 25.593 | 29 | 0 | 0 | 0% |
| US | 63 | | D | 11.544 | 12 | 0 | 0 | 0% |
| US | 63 | | I | 11.544 | 13 | 0 | 0 | 0% |
| US | 65 | | U | 8.98 | 9 | 0 | 0 | 0% |
| US | 69 | | D | 0.529 | 1 | 0 | 0 | 0% |
| US | 69 | | I | 0.529 | 1 | 0 | 0 | 0% |
| US | 69 | | U | 11.966 | 12 | 0 | 0 | 0% |
| US | 218 | | I | 2.836 | 3 | 0 | 0 | 0% |
| MN | 3 | | D | 3.264 | 5 | 0 | 0 | 0% |
| MN | 3 | | I | 3.264 | 5 | 0 | 0 | 0% |
| MN | 3 | | U | 10.765 | 11 | 0 | 0 | 0% |
| MN | 13 | | U | 14.777 | 17 | 0 | 0 | 0% |
| MN | 16 | | D | 0.839 | 2 | 0 | 0 | 0% |
| MN | 16 | | I | 0.839 | 2 | 0 | 0 | 0% |
| MN | 19 | | U | 51.706 | 59 | 0 | 0 | 0% |
| MN | 21 | | D | 2.798 | 3 | 0 | 0 | 0% |
| MN | 21 | | I | 2.798 | 3 | 0 | 0 | 0% |
| MN | 21 | | U | 8.088 | 8 | 0 | 0 | 0% |
| MN | 26 | | U | 21.121 | 22 | 0 | 0 | 0% |
| MN | 42 | | U | 30.717 | 34 | 0 | 0 | 0% |
| MN | 58 | | D | 3.814 | 5 | 0 | 0 | 0% |
| MN | 58 | | I | 3.814 | 5 | 0 | 0 | 0% |
| MN | 60 | | D | 2.981 | 6 | 0 | 0 | 0% |
| MN | 76 | | U | 32.779 | 33 | 0 | 0 | 0% |
| MN | 80 | | U | 8.431 | 10 | 0 | 0 | 0% |
| MN | 139 | | U | 3.869 | 5 | 0 | 0 | 0% |
| MN | 247 | | U | 12.604 | 13 | 0 | 0 | 0% |
| MN | 248 | | U | 11.219 | 12 | 0 | 0 | 0% |
| MN | 251 | | U | 16.374 | 17 | 0 | 0 | 0% |
| MN | 298 | | U | 0.457 | 1 | 0 | 0 | 0% |
| MN | 299 | | U | 0.674 | 1 | 0 | 0 | 0% |

## Interview Summary: Zoom meeting with Tom Meath on May 18, 2020

The vast majority of the notable sections in District 6 are small, urban curb and gutter sections. The presence of curb and gutter, manholes, water valves, etc. result in poor ride values even for newly constructed urban sections. Urban is related to the pavement design type, and not the location since most of these sections are in the countryside. For these particular sections, PQI and SR provide a better representation of the true condition of the pavement. For many of these sections, RQI is low and SR is high. While D records rely on ride, surface ratings should be included. Tom would like to see a way to differentiate these sections in HPMA.

A few of the notable sections are large rural sections with low AADT. Many have thin structures and subgrades with plastic soils, which make any significant repairs very expensive. An example is MN-30, which has low AADT. It is a good candidate for turning back to the county, however, the reconstruction cost required before turnback would be extremely high. The section was patched for a long period, but at some point, state legislators pressured the district to overlay it and turn it back to the county. Due to the high costs of major rehabilitation, a vast majority of turnbacks do not happen. Sometimes, it requires changing state statutes. Two-digit roads are the hardest to turn back.

In general, for the first 10 years after new construction or major rehabilitation, the district will do preventative maintenance activities, such as chip seals and crack seals. For the last five years or more, it is mostly reactive maintenance, like patching, until funds for the next major activity become available.

Regarding the method used for programming, every year the district selects 10 roads. The selection is based on estimated costs of different fixes and a simple life cycle cost comparison. The list is then compared with the list sent by Dave Janisch (of the pavement management office) based on HPMA data, and the two lists are merged to create a final one. The district uses the HPMA data, however, the final decision is based on engineering judgment resulting from inspecting the roads in person. There have been a few occasions in which HPMA flagged a project the district missed. The district mostly considers projects about 10-15 miles in length.

Tom mentioned that one of the most challenging problems in his district is BOC (Bituminous over Concrete) roads that have old concrete structures below. Many concrete pavements have been built in the 1920s and 1930s in districts 6, 7, and 8. While concrete roads have good performance and last long, very old ones are very costly to repair and remain in poor condition for long periods since major rehabilitation funding is not available. Some have poor underlying soil types, which makes fixing them even more expensive.

## DISTRICT 7

### Notable Poor Sections (top ~5% of sections in terms of number of consec. poor years)

| Section | Routetype | RouteNum | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor years | Current number of consecutive poor years |
|---|---|---|---|---|---|---|---|---|
| 12067 | MN | 60 | D | 72.582 | 73.096 | 18 | 18 | 18 |
| 13828 | MN | 91 | U | 13.044 | 13.307 | 18 | 18 | 18 |
| 15488 | MN | 253 | U | 5.989 | 6.472 | 17 | 17 | 17 |
| 3460 | US | 14 | U | 88.77 | 88.989 | 16 | 16 | 16 |
| 3461 | US | 14 | U | 88.989 | 89.632 | 16 | 16 | 16 |
| 8345 | MN | 13 | U | 32.901 | 33.204 | 15 | 13 | 13 |
| 12142 | MN | 60 | I | 41.309 | 41.945 | 12 | 11 | 11 |
| 15487 | MN | 253 | U | 4.996 | 5.989 | 11 | 11 | 11 |
| 6326 | US | 169 | U | 19.615 | 19.897 | 15 | 10 | 10 |
| 12039 | MN | 60 | D | 41.309 | 41.945 | 10 | 10 | 10 |
| 14452 | MN | 112 | U | 1.657 | 1.875 | 15 | 10 | 10 |
| 15482 | MN | 253 | U | 0 | 0.986 | 10 | 10 | 10 |
| 15493 | MN | 254 | U | 10.003 | 10.648 | 10 | 10 | 10 |

| Section | Routetype | RouteNum | Direction | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|---|
| 12067 | MN | 60 | D | 0.514 | 1.2 | 6300 | 0 | 0 |
| 13828 | MN | 91 | U | 0.263 | 1.2 | 3367 | 2 | 1.407 |
| 15488 | MN | 253 | U | 0.483 | 0.8 | 623 | 6 | 6.472 |
| 3460 | US | 14 | U | 0.219 | 1 | 7558 | 3 | 1.903 |
| 3461 | US | 14 | U | 0.643 | 0.8 | 7558 | 3 | 1.903 |
| 8345 | MN | 13 | U | 0.303 | 1.5 | 8985 | 0 | 0 |
| 12142 | MN | 60 | I | 0.636 | 1 | 7939 | 4 | 2.662 |
| 15487 | MN | 253 | U | 0.993 | 0.9 | 623 | 6 | 6.472 |
| 6326 | US | 169 | U | 0.282 | 1.3 | 3676 | 1 | 1.132 |
| 12039 | MN | 60 | D | 0.636 | 1.5 | 7939 | 3 | 1.966 |
| 14452 | MN | 112 | U | 0.218 | 0.9 | 6280 | 2 | 1.373 |
| 15482 | MN | 253 | U | 0.986 | 1.7 | 623 | 6 | 6.472 |
| 15493 | MN | 254 | U | 0.645 | 1.7 | 904 | 4 | 4.796 |

## Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 22 | | U | 94.611 | 111 | 27 | 21.108 | 22% |
| MN | 30 | | U | 86.902 | 93 | 18 | 17.487 | 20% |
| MN | 4 | | U | 78.227 | 87 | 14 | 11.344 | 15% |
| MN | 112 | | U | 15.012 | 20 | 11 | 7.752 | 52% |
| MN | 111 | | U | 9.719 | 12 | 9 | 7.246 | 75% |
| MN | 60 | | I | 86.241 | 94 | 10 | 7.22 | 8% |
| MN | 253 | | U | 6.472 | 7 | 7 | 6.472 | 100% |
| MN | 60 | | D | 86.241 | 97 | 9 | 6.369 | 7% |
| MN | 99 | | U | 39.636 | 47 | 12 | 5.901 | 15% |
| MN | 19 | | U | 60.566 | 71 | 8 | 4.821 | 8% |
| MN | 254 | | U | 4.796 | 5 | 5 | 4.796 | 100% |
| US | 14 | | U | 44.858 | 50 | 6 | 3.918 | 9% |
| MN | 263 | | U | 11.226 | 11 | 4 | 3.711 | 33% |
| IS | 90 | | I | 145.827 | 152 | 3 | 3 | 2% |
| MN | 13 | | U | 48.303 | 56 | 4 | 2.917 | 6% |
| MN | 91 | | U | 28.192 | 31 | 4 | 2.399 | 9% |
| MN | 21 | | U | 9.2 | 11 | 4 | 2.37 | 26% |
| MN | 264 | | U | 7.394 | 8 | 2 | 2.004 | 27% |
| US | 75 | | U | 24.758 | 26 | 2 | 1.994 | 8% |
| US | 75 | | D | 2.477 | 3 | 2 | 1.464 | 59% |
| US | 75 | | I | 2.477 | 3 | 2 | 1.464 | 59% |
| US | 169 | | U | 44.977 | 48 | 3 | 1.419 | 3% |
| US | 169 | | D | 38.844 | 46 | 3 | 1.003 | 3% |
| MN | 62 | | U | 23.992 | 24 | 1 | 0.785 | 3% |
| MN | 15 | | U | 62.976 | 68 | 2 | 0.674 | 1% |
| MN | 60 | | U | 24.399 | 27 | 2 | 0.503 | 2% |
| US | 71 | | D | 1.494 | 3 | 1 | 0.335 | 22% |
| MN | 5 | | U | 21.027 | 26 | 1 | 0.328 | 2% |
| US | 169 | | I | 38.844 | 46 | 1 | 0.195 | 1% |
| MN | 93 | | U | 4.724 | 6 | 1 | 0.156 | 3% |
| US | 59 | | D | 1.533 | 4 | 1 | 0.083 | 5% |
| US | 59 | | I | 1.533 | 4 | 1 | 0.083 | 5% |
| IS | 90 | | D | 145.867 | 150 | 0 | 0 | 0% |
| US | 14 | | D | 52.257 | 56 | 0 | 0 | 0% |
| US | 14 | | I | 52.257 | 58 | 0 | 0 | 0% |
| US | 59 | | U | 19.981 | 23 | 0 | 0 | 0% |
| US | 71 | | I | 1.494 | 3 | 0 | 0 | 0% |
| US | 71 | | U | 51.383 | 54 | 0 | 0 | 0% |
| MN | 15 | | D | 12.18 | 15 | 0 | 0 | 0% |
| MN | 15 | | I | 12.18 | 13 | 0 | 0 | 0% |
| MN | 22 | | D | 5.128 | 9 | 0 | 0 | 0% |
| MN | 22 | | I | 5.128 | 9 | 0 | 0 | 0% |
| MN | 23 | | U | 17.362 | 19 | 0 | 0 | 0% |
| MN | 68 | | U | 33.044 | 34 | 0 | 0 | 0% |
| MN | 83 | | U | 23.76 | 29 | 0 | 0 | 0% |
| MN | 86 | | U | 22.85 | 23 | 0 | 0 | 0% |
| MN | 109 | | U | 32.659 | 36 | 0 | 0 | 0% |
| MN | 257 | | U | 3.991 | 4 | 0 | 0 | 0% |
| MN | 270 | | U | 7.659 | 8 | 0 | 0 | 0% |

## Interview Summary: Zoom meeting with Charles Kremer on May 20, 2020

District 7 has many cohesive soils that are very bad for pavement construction. This partially explains why the district has many struggling sections. Very few areas have good quality sands.

Most of the sections identified by the research team are less than a mile in length and represent "orphan type" sections. Some sections have a bridge in them, in which case a rough transition to the bridge can lower the ride, and the rest of the pavement does not drive the condition of the road. For example, sections 51 to 53 on US 169 have four bridges and a railroad track. The SR looks good and the ride data does not tell the whole story.

Charles mentioned it would be beneficial to filter out areas of localized roughness, such as bridge transitions and railroad crossings, in the condition data. He also said that some of the sections are in towns, and the IRI might be higher since the measurement was taken at a lower driving speed. Dr. Bernard Izevbekhai clarified that the pathways van software considers the lower speed, but it cannot eliminate the presence of manholes, joints, and curb and gutter in urban sections. Similar to comments received from other districts, Charles proposed comparing SR and RQI; if a large disparity is noticed, further evaluation needs to be done.

The district is behind on fixing some concrete pavement sections, including a few problematic alkali-silica reaction (ASR) sections. Although the ride and the SR are good, the pavement life would significantly benefit from a major CPR, but it is hard to convince people to allocate money for a pavement that looks ok. In many cases, the pavements are covered up using cheaper fixes, since major rehabilitation is very expensive.

MN-270, a flexible pavement road, has not had any major repairs since the late 80s. It is still in fair condition, although it is highly oxidized. It needs a few million dollars for a mill and overlay project. However, it is hard to argue for doing this project, since the ADT is under 1000.

Patching to fill potholes and fixing other distresses may not have a significant effect on RQI. However, it prevents water from getting inside the pavement structure, which helps reduce the deterioration rate of the pavement.

In general, the major factors that affect the decision process are funding availability, AADT, and length of the road section. It is not cost-effective to go out and work on a short section, especially when those short sections are transition sections that fall between past projects. The district plans to clean up its D records soon. There are a fair number of small D records that could be eliminated by merging them into larger surrounding sections.

The district has done five turnbacks and has a list of turnback-eligible roads. Since most counties want the roads returned in almost new condition, the district has to minimally fix sections until funding from the turnback state fund becomes available. Typically, the roads that are in the worst condition get turnback funds first, so there isn't much of an incentive to fix them. The process typically takes about 3-5 years. Most of the turnback roads are dead-end type roads that only serve one community. The county can be more responsive to the residents and users of these roads. Sections 253 and 254 are two examples. It is worth noting that when the counties take the road back, they get an almost new road that increases the size of their CSAH system, which also increases their percentage of the gas tax return.

As part of the decision process, the district consults with Curt Turgeon and the pavement management office, as well as the bituminous engineer and the concrete engineer. The planning section does go out and meet with cities and counties every year. The discussions with maintenance are very important since maintenance people will see a road turning a corner before the pavement management van can detect it.

## DISTRICT 8

### Notable Poor Sections (sections in poor condition for 4+ consec. years as of 2018)

| Section | Routetype | RouteNum | Direction | Start [mi] | End [mi] | Total Years in Poor Condition | Highest number of consecutive poor years | Current number of consecutive poor years |
|---|---|---|---|---|---|---|---|---|
| 8857 | MN | 19 | U | 71.937 | 72.699 | 17 | 17 | 17 |
| 9230 | MN | 22 | U | 142.257 | 142.357 | 18 | 17 | 17 |
| 8561 | MN | 15 | U | 101.146 | 101.431 | 14 | 14 | 14 |
| 8578 | MN | 15 | U | 114.982 | 115.109 | 12 | 12 | 12 |
| 9244 | MN | 22 | U | 156.186 | 156.426 | 11 | 11 | 11 |
| 5030 | US | 71 | U | 74.738 | 75.44 | 10 | 10 | 10 |
| 9274 | MN | 23 | D | 102.794 | 103.158 | 8 | 7 | 7 |
| 9193 | MN | 22 | U | 106.608 | 107.348 | 10 | 6 | 6 |
| 13855 | MN | 91 | U | 38.707 | 38.926 | 6 | 6 | 6 |
| 15538 | MN | 271 | U | 3.182 | 3.633 | 7 | 6 | 6 |
| 2980 | US | 12 | I | 72.903 | 73.298 | 8 | 5 | 5 |
| 9363 | MN | 23 | I | 102.794 | 103.158 | 4 | 4 | 4 |

| Section | Routetype | RouteNum | Direction | Section Length [mi] | 2018 RQI | AADT | Surrounding Currently Poor Sections | Surrounding Currently Poor Length |
|---|---|---|---|---|---|---|---|---|
| 8857 | MN | 19 | U | 0.762 | 1.3 | 10538 | 0 | 0 |
| 9230 | MN | 22 | U | 0.1 | 0.8 | 7992 | 0 | 0 |
| 8561 | MN | 15 | U | 0.285 | 1.7 | 11001 | 0 | 0 |
| 8578 | MN | 15 | U | 0.127 | 1.1 | 4513 | 0 | 0 |
| 9244 | MN | 22 | U | 0.24 | 1.9 | 3014 | 0 | 0 |
| 5030 | US | 71 | U | 0.702 | 1.8 | 5021 | 0 | 0 |
| 9274 | MN | 23 | D | 0.364 | 1.6 | 5381 | 0 | 0 |
| 9193 | MN | 22 | U | 0.74 | 1.5 | 6174 | 0 | 0 |
| 13855 | MN | 91 | U | 0.219 | 1.6 | 1153 | 1 | 0.547 |
| 15538 | MN | 271 | U | 0.451 | 1.6 | 1336 | 0 | 0 |
| 2980 | US | 12 | I | 0.395 | 1.9 | 9536 | 0 | 0 |
| 9363 | MN | 23 | I | 0.364 | 1.9 | 5381 | 1 | 1.364 |

## Route Breakdown

| RouteType | RouteNum | Aux | Direction | Length of Data [mi] | Number of Sections | Currently Poor Sections | Currently Poor Length [mi] | % of Data Currently Poor |
|---|---|---|---|---|---|---|---|---|
| MN | 271 | | U | 8.591 | 10 | 3 | 2.433 | 28% |
| MN | 23 | | I | 33.248 | 41 | 2 | 1.364 | 4% |
| MN | 22 | | U | 46.022 | 54 | 3 | 1.08 | 2% |
| MN | 19 | | U | 92.646 | 105 | 1 | 0.762 | 1% |
| US | 71 | | U | 75.623 | 80 | 1 | 0.702 | 1% |
| MN | 91 | | U | 32.959 | 41 | 2 | 0.547 | 2% |
| US | 75 | | U | 99.126 | 106 | 1 | 0.453 | 0% |
| MN | 15 | | U | 52.289 | 62 | 2 | 0.412 | 1% |
| US | 12 | | I | 1.908 | 3 | 1 | 0.395 | 21% |
| MN | 23 | | D | 33.248 | 41 | 1 | 0.364 | 1% |
| MN | 23 | | U | 108.235 | 122 | 1 | 0.343 | 0% |
| MN | 275 | | U | 6.519 | 8 | 1 | 0.279 | 4% |
| MN | 267 | | U | 5.353 | 7 | 1 | 0.176 | 3% |
| US | 12 | | U | 55.562 | 67 | 1 | 0.157 | 0% |
| US | 12 | | D | 1.908 | 3 | 0 | 0 | 0% |
| US | 14 | | U | 67.541 | 73 | 0 | 0 | 0% |
| US | 59 | | U | 79.151 | 89 | 0 | 0 | 0% |
| US | 71 | | D | 9.319 | 11 | 0 | 0 | 0% |
| US | 71 | | I | 9.319 | 11 | 0 | 0 | 0% |
| US | 212 | | D | 12.266 | 15 | 0 | 0 | 0% |
| US | 212 | | I | 12.266 | 16 | 0 | 0 | 0% |
| US | 212 | | U | 116.054 | 128 | 0 | 0 | 0% |
| MN | 4 | | U | 55.605 | 60 | 0 | 0 | 0% |
| MN | 7 | | D | 3.841 | 6 | 0 | 0 | 0% |
| MN | 7 | | I | 3.841 | 6 | 0 | 0 | 0% |
| MN | 7 | | U | 96.458 | 110 | 0 | 0 | 0% |
| MN | 9 | | U | 17.697 | 18 | 0 | 0 | 0% |
| MN | 15 | | D | 0.313 | 1 | 0 | 0 | 0% |
| MN | 15 | | I | 0.313 | 1 | 0 | 0 | 0% |
| MN | 19 | | D | 0.443 | 1 | 0 | 0 | 0% |
| MN | 19 | | I | 0.443 | 1 | 0 | 0 | 0% |
| MN | 22 | | D | 1.544 | 2 | 0 | 0 | 0% |
| MN | 22 | | I | 1.544 | 2 | 0 | 0 | 0% |
| MN | 24 | | U | 15.608 | 16 | 0 | 0 | 0% |
| MN | 29 | | U | 18.285 | 19 | 0 | 0 | 0% |
| MN | 30 | | D | 0.672 | 1 | 0 | 0 | 0% |
| MN | 30 | | I | 0.672 | 1 | 0 | 0 | 0% |
| MN | 30 | | U | 50.77 | 54 | 0 | 0 | 0% |
| MN | 40 | | U | 66.656 | 70 | 0 | 0 | 0% |
| MN | 67 | | U | 66.281 | 72 | 0 | 0 | 0% |
| MN | 68 | | U | 74.604 | 83 | 0 | 0 | 0% |
| MN | 269 | | U | 2.653 | 3 | 0 | 0 | 0% |
| MN | 274 | | U | 8.515 | 10 | 0 | 0 | 0% |
| MN | 277 | | U | 11.025 | 11 | 0 | 0 | 0% |
| MN | 330 | | U | 2.02 | 2 | 0 | 0 | 0% |

## Interview Summary: Zoom meeting with Lowell Flaten and Cody Brand on May 22, 2020

For the sections in poor condition, the district takes into consideration whether maintenance can hold these sections together until a larger project is warranted and funds are obtained. In many cases, the sections in poor condition are very short and their repair is delayed until they can be combined with other surrounding sections.

Cody mentioned that some of these poor sections are either urban or represent a bridge replacement or culvert replacement. Many of these projects have poor smoothness, but not a high amount of deterioration. They score a low RQI from the beginning, but they are not deteriorated or have settlement issues.

Similar to other districts, they proposed looking at the disparity between RQI and SR values to better understand the true condition of the pavement. They expressed their concern with the low speed of the pathways van when taking measurements on urban sections, and the need to go out and look at the pavement. If there are manholes, utilities, etc., they can't do much about it. They also expected concrete sections to maintain a lower ride score for longer periods because they degrade slower. They had some concrete sections, with significant alkali-silica reaction (ASR), that received a bituminous overlay.

Regarding patching, maintenance generally handles most of the activities on their own. District engineers do not tell maintenance when to do patching.

Based on HPMA data, the district deals first with the sections that fall into the 2.5-3 RQI range and they look to see if they have money for M&OL. Sometimes, they let some sections drop to 2-2.5 and use a more in-depth fix. An example is MN-277, with traffic from grain elevators and beet industry, which was recently turned back to the county. The district used an Ultra-Thin Bonded Wearing Course (UTBWC) before turning it back.

The district uses HPMA data, and, for NHS roads, they also get a considerable amount of guidance from the pavement management office in Maplewood. For the lower-level roads, they make most of the decisions themselves. The district planner meets with each county and presents the CHIP and STIP and asks for feedback. They also get feedback from the public. The district materials engineer talks to the local industry about spring load restrictions. There are many large dairies (over 25,000 cows) that have very large operations, and any load restrictions could negatively impact them. The district has also done a few freight studies in the past few years.

Lowell and Cody thought that most of the sections identified by the research team were anomalies rather than serious issues of pavement degradation. In general, the district deals with a pavement section before RQI drops below 2.5. Lowell mentioned their performance targets are based on RQI, and, therefore, they focus on ride quality.

# APPENDIX C, FOLLOW-UP QUESTIONS TO MNDOT DISTRICT MATERIALS ENGINEERS ON CLASSIFYING AND IDENTIFYING ANOMALY SECTIONS

Each MnDOT district material engineer interview was followed up with questions about how their office defines "urban section". The responses, while showing some uniformity, were each unique. This appendix contains the questions posed to those engineers and the responses received. These questions were sent over email during the Fall of 2020. The interviews took place in Spring 2020.

## PREFACE TO QUESTIONS

"We came away from those interviews with a good idea of the types of "anomaly" sections whose conditions aren't fully represented by the measure of their ride. The two most common types are "urban" sections, and sections that have either a bridge transition or railroad crossing in them. We would like to identify these sections to perform further analysis, and we need your help by answering the following questions."

## QUESTIONS

1. What characteristics lead you to label a section as "urban"? Possible characteristics include drainage type (C&G), highway functional class, being within a city, etc.
2. We need to identify whether a bridge transition or railroad crossing is present within a section. HPMA doesn't consistently provide information that would indicate if this is the case. Is this information available in a different database that you have access to?
3. Do you keep a list of sections in your district that includes unique characteristics, which can be used to identify these anomalous types? If so, could you share that list with us?

**Table C1: Respondents to Follow-Up MnDOT District Survey**

| District | Respondent |
|---|---|
| 1 | Amy Thorson |
| 3 | Sara Johnson |
| 4 | Chris Thorson |
| Metro | David Van Deusen |
| 8 | Lowell Flaten |

**Table C2: Responses to Follow-Up MnDOT District Survey Question #1**

| Question 1 | |
|---|---|
| District 1 | Slow speed limit. Possible stop signs, curb, and gutter. |
| District 3 | I think of urban as areas with curb and gutter, that usually fall within city limits, and lower speed limits, and may contain signal systems or stop signs. |

| | |
|---|---|
| District 4 | I would label a section as urban that have most or all of the following characteristics:<br>a) Reduced speed limit (as compared to a rural speed limit of 55 or higher)<br>b) Multiple cross road/street intersections within a limited length<br>(block by block intersections)<br>c) Possible stop conditions (stop sign or traffic signal)<br>d) Are within an identified corporate limit of a municipality<br>e) Curb and gutter with storm sewer system for drainage |
| Metro District | You mentioned all of the criteria below that qualify a section as urban. Not sure about functional classifications but will check into this. |
| District 8 | If there is a significant stretch of C&G with storm sewer, we would consider it to be urban. This usually occurs within a city. At times, small sections of C&G may be used to minimize R/W but if the section is mainly a ditch section, we would consider it to be rural, even if it occurs in a city. |

**Table C3: Responses to Follow-Up MnDOT District Survey Question #2**

| Question 2 | |
|---|---|
| District 1 | See attached. Don't know if it's actually kept up somewhere, it was just something my former boss passed me. |
| District 3 | I would think the information is available somewhere, but I am not aware of a specific database. |
| District 4 | No database that I have knowledge of. |
| Metro District | As for bridges and RR x-ings let me do some checking into that. I'm more hopeful when it comes to bridges, not so much as far as RRs. |
| District 8 | MnDOT maintains a bridge inventory system. I think it is called BRIM. |

**Table C4: Responses to Follow-Up MnDOT District Survey Question #3**

| Question 3 | |
|---|---|
| District 1 | No. |
| District 3 | I don't keep a list of sections with unique characteristics. If the Ride Numbers are lower in a particular area, I usually take a look on our Videolog or Google Earth, to see if I can find out why the Ride Numbers may be lower, if there is a bridge or railroad crossing, for example. |
| District 4 | ATTACHED |
| Metro District | I am attaching a list of road sections that Metro considers "urban." It's probably the best I can provide at this point. |

| | |
|---|---|
| District 8 | We don’t keep a system for this. During the scoping process, staff visits the proposed project. The project environment is noted in the Scoping Report. |

**Table C5: Attachments and Further Comments Provided in response to Follow-Up MnDOT District Survey**

| Attachments and Further Comments | |
|---|---|
| District 1 | Amy provided a .pdf file of log points on highways in District 1. Each of these points has a description, a reference post location, and other information. The log points that mentioned bridges were highlighted. |
| District 3 | N/A |
| District 4 | Chris sent an excel file with the reference post boundaries of each of the cities within District 4. This file specified which cities are considered urban, which are not, and what the criteria for that determination were. The criteria include water/sewer utilities, speed limit, curbing/sidewalk/trail, development on both sides of the road, and local arterials (5 or more city streets with access to TH). A city must meet at least 3 of these criteria to be considered urban. |
| Metro District | David sent an excel file with a list of areas in the Metro District that are considered urban. Each of these locations had associated start and end reference post locations. Dave also reached out to people at MnDOT to ask about starting and ending points of bridges. There is currently no tool for finding the start and endpoint of each bridge in the district. However, there is a publicly available bridge structure inventory that can be used to find a point in the middle (but not necessarily the exact middle) of each bridge. |
| District 8 | N/A |