2024 Pavement Conditions and Analysis Report

Final Report

Prepared for:

Bismarck-Mandan Metropolitan Planning Organization

Prepared by:

Quality Engineering Solutions, Inc.

180 N. Franklin Street, Suite G

PO Box 891

Cochranton, PA 16314

January 10, 2025

QES | Engineering Inspection

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 EXECUTIVE SUMMARY

1.1 Pavement Data Collection

In August of 2024, the Bismarck-Mandan Metropolitan Planning Organization (MPO) retained the services of Quality Engineering Solutions, Inc. (QES) to perform a pavement condition assessment of the functionally classified roadways within the MPO's jurisdiction. This project includes the Cities of Bismarck, Mandan, Lincoln and the Counties of Burleigh and Morton. The results of the pavement condition assessment will assist the MPO's five (5) member jurisdictions in planning future pavement maintenance and rehabilitation (M&R) projects. To achieve this goal, QES assessed the condition of approximately 243.4 centerline miles of functionally classified roadways, entered the collected condition data into a Pavement Management System (PMS), and evaluated the pavement maintenance and repair (M&R) needs for the jurisdictions.

For this project, QES collaborated with Roadway Asset Services, LLC (RAS) to conduct the pavement data collection. In the fall of 2024, RAS utilized their cutting-edge 3D Pavement Condition Survey Systems, known as Roadway Asset Collection (RAC) vehicles (shown in Figure 1), to automatically collect pavement condition data. These advanced RAC vehicles captured continuous, high-resolution data on pavement cracking, rutting, and roughness across the roadways. The collected data was subsequently processed and entered into the PAVER Pavement Management System (PAVER), where baseline pavement condition scores were calculated for each roadway. The pavement condition scores were then used to develop network-level M&R recommendations for the jurisdictions' consideration.

Figure 1. RAS Pavement Conditions Data Collection Systems

1.2 The PAVER Pavement Management System

PAVER uses Pavement Condition Index (PCI) scores to determine the most cost-effective maintenance and rehabilitation (M&R) strategies. It prioritizes preventive measures such as crack sealing, slurry sealing, and localized patching over expensive options like resurfacing or reconstruction. The system also maintains detailed records of pavement inventory, historical M&R activities, and unit cost data. This extensive dataset allows PAVER to forecast future pavement conditions, analyze network-wide deterioration trends, and define long-term M&R needs. Additionally, it enables jurisdictions to evaluate whether their current M&R practices are delivering the desired performance outcomes.

1.3 Project Scope

This project involved a network-level pavement condition survey for the functionally classified roadways within the MPO's five member jurisdictions. The collected data was integrated into the PAVER, specifically developed for the roadways covered by the project. Using the pavement condition data and PAVER's inventory, network-level M&R needs were identified and prioritized to support jurisdictions' strategic decision-making.

1.4 Results

Pavement Condition Index (PCI) values were determined for each roadway. These values provide an indication of both the structural integrity and surface operational condition of a pavement. PCI values range from 0 (a failed pavement) to 100 (a pavement in excellent condition). Table 1 shows the MPO's pavement condition categories, which are based on ranges of PCI values. For each category, typical pavement distresses and M&R recommendations are provided.

Table 1. MPO's pavement condition categories.

Category	Typical Distresses and Typical Level of M&R Needed	PCI Range
Adequate	More extensive longitudinal and transverse cracking and weathering of surface **Preventive maintenance:** *Crack sealing and surface treatments*	71-100
Degraded	Extensive longitudinal and transverse cracking, early-stage alligator (fatigue) cracking, early-stage rutting, and weathering of surface **Global preventive maintenance and localized repairs:** *Localized surface and/or full-depth patching, surface treatments, and thin overlays*	56-70
Unsatisfactory	More extensive and more severe longitudinal and transverse cracking, alligator (fatigue) cracking, rutting, weathering of surface, potholes **Major rehabilitation:** *Full-depth patching, mill and overlays, traditional overlays, and reconstruction*	0-55

At the time of inspection, the functionally classified pavements were found to have an average PCI of 84, indicating that the roadways are in overall "adequate" condition.

IRI values measure the roughness of a roadway:

- IRI values less than 200 inches/mile indicate "smooth" pavement.
- IRI values between 200 and 400 inches/mile indicate a "marginally rough" pavement.
- IRI values greater than 400 inches/mile indicate "rough" pavement.

The roadways were found to have an average IRI value of 181 inches/mile, which indicates overall "smooth" pavement.

Table 2 shows average PCI and IRI values for each jurisdiction. Pavement condition maps are also presented in Appendix A.

Table 2. Pavement conditions by jurisdiction.

Jurisdiction	Centerline Miles	PCI	PCI Category	IRI	IRI Category
City of Bismarck	137	84	Adequate	187	Smooth
City of Lincoln	1.4	90	Adequate	128	Smooth
City of Mandan	45.9	80	Adequate	237	Marginally Rough
Burleigh County	43.4	86	Adequate	123	Smooth
Morton County	15.7	85	Adequate	101	Smooth
Total	**243.4**	**84**	**Adequate**	**181**	**Smooth**

Pavement deterioration, reflected in PCI values, generally falls into three categories: vehicle load-related, climate or durability-related, and issues stemming from construction defects or material problems. The inspection revealed that the observed deterioration resulted from a combination of vehicle load and climate-related factors. Vehicle load-related distresses, such as alligator cracking and rutting, were prominent across many roadways and had the greatest impact on lowering PCI scores. Climate-related issues, including block cracking and weathering, were also evident and contributed significantly to the overall pavement condition.

1.5 Recommendations

To maximize the return on investment from this project, it is recommended that jurisdictions fully implement the PAVER system if they have not already done so. This will enable them to better identify roadways that would benefit from pavement preservation techniques, track pavement performance and M&R expenditures, and assess the effectiveness of maintenance activities to determine when resurfacing is no longer cost-effective and reconstruction is necessary. Additionally, the system will facilitate forecasting M&R needs and understanding the impact of funding levels on pavement conditions. With proper use, PAVER will become a reliable repository of accurate, up-to-date data and the primary tool for more proactive and cost-efficient M&R planning.

2 INTRODUCTION

This section of the report builds upon the Executive Summary by offering a detailed overview of the project's goals and objectives. It includes a conceptual introduction to pavement management and outlines the benefits and costs associated with conducting pavement condition surveys and implementing a PMS. Detailed discussions on the pavement condition survey and the implementation of the PAVER are presented in Sections 4, 5, and 6.

2.1 Background, Scope, and Objectives

In August 2024, the Bismarck-Mandan Metropolitan Planning Organization (MPO) retained the services of QES to conduct pavement management analyses on functionally classified roadways within its jurisdiction. The project's primary goals are to perform a network-level pavement condition survey, implement or update the PAVER, and evaluate network-level pavement M&R needs. This project aims to provide the MPO and its member jurisdictions with a comprehensive understanding of current roadway conditions, along with strategic recommendations for future M&R activities. Looking ahead, the PAVER system—if fully implemented by the jurisdictions—could function as a centralized repository for pavement condition data, historical M&R records, and insights into pavement condition trends over time.

2.2 Project Tasks

To achieve the objectives of this project, QES undertook several key tasks, which are detailed in Sections 4, 5, and 6 of this report. First, QES implemented/updated the PAVER of the participating jurisdictions. QES developed the PAVER inventory database and worked with the jurisdictions to update the PAVER database with the recent M&R projects and unit costs. This step established the foundational database for the analysis. Next, QES subcontracted RAS to conduct a network-level pavement condition survey by using the Laser Crack Measurements System (LCMS-2), which is the most advanced pavement imaging and profiling technology used across the United States. This survey was completed in the fall of 2024, and the collected data were then analyzed using a hybrid methodology that incorporates both automated crack detection and classification along with manual quality control providing comprehensive data on the condition of the roadway network. Finally, QES analyzed the collected pavement condition data using PAVER to determine the network-level M&R funding needs for the jurisdictions' functionally classified roadways. These analyses form the basis for informed decision-making on future maintenance and repair investments.

2.3 Conceptual Overview of Pavement Management

A PMS provides municipal agencies with a structured approach to efficiently manage their pavement networks, including roads, parking lots, and alleys. Defined by the American Public Works Association, it involves systematically collecting, storing, and analyzing data to maximize the utility of limited maintenance and construction budgets.

Central to this system is the Pavement Condition Index (PCI), an industry-standard method outlined in ASTM D6433. PCI uses field observations and measurements to assign a numerical value (0–100) to a pavement's condition, with 0 indicating failure and 100 representing excellent condition. PCI values guide M&R decisions, helping to prioritize improvements and optimize resource allocation.

Maintaining pavements above a "Critical PCI" is key to cost-effective management. Preventive maintenance can extend pavement life when conditions are good, but once a pavement deteriorates below its Critical PCI, preventive measures become less viable, and more expensive rehabilitation or reconstruction is often required. As shown in Figure 2, pavement management aims to keep pavements in good condition, minimizing costs and the need for extensive repairs.

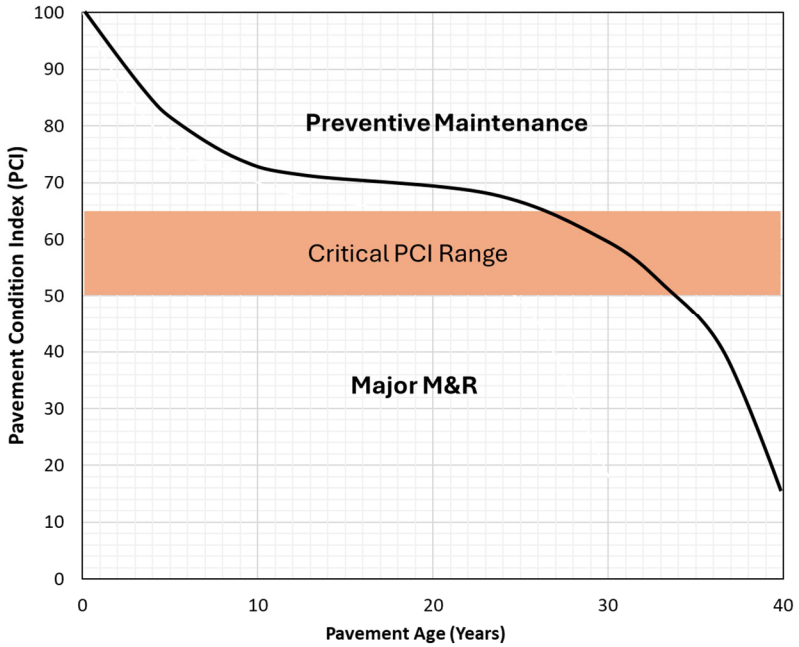


Figure 2. Example of the correct timing of preventive and major M&R relative to the Critical PCI.

Critical PCI value is established based on ongoing pavement condition measurements and the specific M&R policies of an agency. Typically ranging between 50 and 65, the Critical PCI marks the point at which pavement deterioration accelerates, necessitating more costly M&R. Agencies may adjust Critical PCI values depending on their priorities; for example, arterial roadways, which experience heavier traffic and higher speeds, often have higher Critical PCI values than local roads to ensure they are maintained to a higher standard. For the jurisdictions in this project, a Critical PCI value of 65 was applied to asphalt roadways and 75 to concrete roadways.

2.4 Benefits and Costs of Implementing a PMS

A PMS offers centralized storage for pavement condition and inventory data, including construction, maintenance, and rehabilitation records. They provide decision-making tools to evaluate M&R alternatives, assess the impact of different funding levels on pavement conditions, and improve scheduling and coordination of M&R and infrastructure projects. These systems also include analysis tools to assess the effectiveness of past rehabilitation methods and reporting tools to simplify complex data for justifying funding needs to decision-makers.

The benefits of such systems increase over time as more data is collected, but there are ongoing costs associated with maintaining them. These costs include data collection and routine updates to the pavement inventory, regular pavement condition surveys (typically every two to three years, depending on the roadway type), annual evaluations of pavement performance, software acquisition and maintenance, and staff training.

Implementing a PMS provides the additional advantage of helping agencies identify pavements suitable for preventive maintenance. Applying preventive maintenance early in a pavement's life, before significant deterioration occurs, has proven to be a highly cost-effective strategy for extending its service life.

The following preventive maintenance treatments have proven effective when applied at the appropriate time during a pavement's service life: crack sealing, crack filling, and joint sealing for both flexible and rigid pavements; patching and edge repairs; surface treatments such as chip seals, fog seals, and slurry seals;

micro-surfacing; and thin overlays designed for functional or maintenance purposes.

Preventive maintenance strategies should be applied to pavements that are in relatively good condition, and the activities should be planned and applied systematically following either the resurfacing or reconstruction of a pavement. The following FHWA website provides additional information for pavement preservation: https://www.fhwa.dot.gov/pavement/preservation/.

2.5 Summary

This section offered an overview of the creation and implementation of the PAVER for the functionally classified roadways within the participating jurisdictions. It provided a conceptual introduction to pavement management, highlighting the benefits of implementing such a system, the anticipated costs of maintaining it, and its additional functionality in helping jurisdictions objectively optimize the allocation of M&R funding. Detailed discussions of the PAVER system's implementation are presented in Sections 3, 4, 5 and 6.

3 PAVEMENT MANAGEMENT SYSTEM IMPLEMENTATION

3.1 Introduction

This section provides an overview of PAVER, a brief description of the modules available to the jurisdictions in PAVER, and insight into the PAVER database development.

3.2 Objective

The objective of this task was to update the PAVER for the jurisdictions' functionally classified roadway pavements. PAVER was initially implemented for MPO's functionally classified roads in 2020 by another consultant. QES completed the PMS update by collecting current pavement condition data, importing the data into PAVER, customizing and running the analysis.

3.3 PAVER Overview

The PAVER offers agencies a robust framework for managing their pavement networks by determining the timing, location, and appropriate level of M&R, as well as estimating associated costs. It provides a range of specialized tools, known as "modules," that support jurisdictions in key activities. These include organizing pavement inventory, assessing current conditions, predicting future conditions, analyzing past and projected performance, creating funding- or condition-based M&R scenarios, and planning and prioritizing projects.

The system's modules are specifically designed to address different aspects of pavement management and include:

Inventory: Organizing and maintaining pavement data.
M&R History: Recording past maintenance and repair activities.
Inspection: Documenting current pavement conditions.
Prediction Modeling: Estimating future pavement performance.
Condition Analysis: Evaluating the state of pavements.
M&R Planning: Developing cost-effective maintenance strategies.
Project Planning: Prioritizing and scheduling M&R projects.
Reporting: Presenting data insights into informed decision-making.
By integrating these tools, PAVER equips jurisdictions with a data-driven approach to optimize pavement management and resource allocation.

A brief description of these modules is presented in the following sub-sections.

3.3.1 Inventory and M&R History Modules

The PAVER Inventory and M&R History modules are based on a hierarchical structure composed of networks (groups of roadways managed with one source of funding), branches (specific roadways), and sections. Sections are the smallest area for which conditions are reported and M&R activities recommended. Sections typically conform to existing GIS segmentation and are commonly defined from intersection to intersection by default. Figure 3 shows an example of roadway ranks stored in the PAVER Inventory module.

One network is defined for each jurisdiction and each roadway is a branch. Pavement sections are defined within each branch following the jurisdictions' existing GIS segmentation in the MPO's geodatabase. This structure allows the jurisdictions to easily organize their inventory and historical M&R data and provides a simple and efficient way for rolling-up data to higher levels of the pavement hierarchy.

3.3.2 Inspection Module

PAVER uses the PCI as the primary measure of pavement condition. The Inspection module enables agencies to store raw pavement condition survey data and then calculate PCI values.

3.3.3 Family Modeling Module

The Family Modeling module in PAVER allows users to categorize pavements with similar construction characteristics and exposure to comparable traffic, weather, and other performance-influencing factors into "families." It utilizes historical pavement condition data to create models that forecast future pavement performance. This interactive module requires jurisdictions to update prediction models after each condition survey. If historical pavement data is unavailable, PAVER offers default pavement prediction curves and supports the creation of customized prediction models for specific sites, as shown in Figure 4.

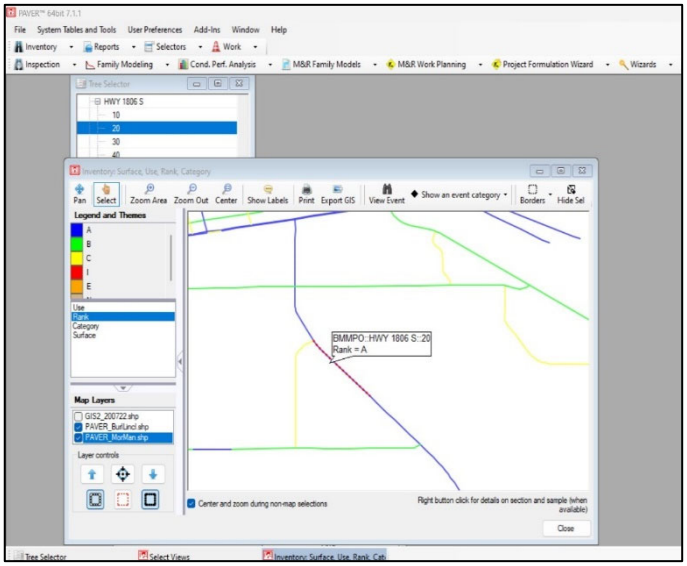


Figure 3. Example roadway ranks stored in inventory module.

3.3.4 Condition Performance Analysis Module

The Condition Performance Analysis module allows jurisdictions to predict the condition of their entire pavement network or any selected portions over time. It reports past conditions by interpolating historical condition data and projects future conditions by applying prediction models developed using the Prediction Modeling module.

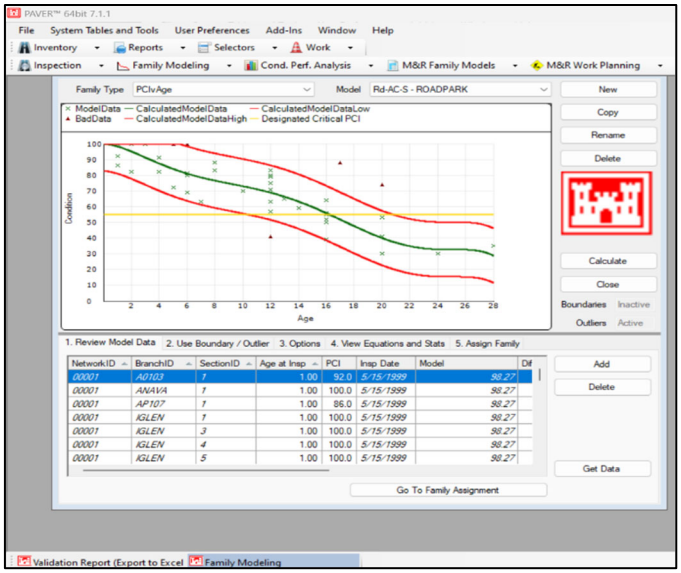


Figure 4. Example of a deterioration curve developed using the family modeling module

3.3.5 M&R work planning module

The M&R Work Planning module evaluates the impact of a specified funding level on pavement conditions and estimates the resulting backlog of major M&R work. This helps jurisdictions identify the funding needed to achieve their specific pavement condition goals. These features enable the development of more efficient M&R programs based on available resources and provide a basis for justifying M&R requirements.

3.3.6 Reporting module

Each module of PAVER can produce a variety of reports to support jurisdictions in analyzing, interpreting, and presenting pavement data. In addition to reports specific to each module, PAVER includes several pre-configured “canned” reports, such as:

GIS Reports: Internal and external reporting of inventory and condition data.
Summary Charts: Basic graphs and tables summarizing inventory and inspection data.
Inspection Reports: Overviews of collected pavement condition data.
Work History: Summaries of past maintenance, repair, and rehabilitation activities.

Branch Listing: Summaries of overall pavement inventory data.
Branch Condition: Summaries of overall pavement condition data.
Section Condition: Summaries of condition data for individual sections.

PAVER also supports on-the-fly "user-defined" reports, allowing users to customize reports to meet specific needs. This feature enables the extraction of any data stored in the system for export to GIS shapefiles, spreadsheets, or text files.

3.3.7 Summary

This section covered the initial task of the project: implementing a pavement management system. It provided an overview of the non-proprietary PAVER, a summary of the modules available for use by jurisdictions, and an explanation of the development of the PAVER database. The databases have been customized to include specific and relevant data for the functionally classified roadway networks within the jurisdictions. When fully implemented, PAVER's comprehensive analysis and planning tools will empower jurisdictions to manage their roadway pavement networks more efficiently.

4 PAVEMENT INVENTORY

4.1 Introduction

This section provides an overview of the jurisdictions' roadway pavement inventory as recorded in the PAVER. It outlines the data sources utilized to develop the inventory and presents a summary of the collected data.

4.2 Objective

The objective of this task was to update an inventory of the jurisdictions' functionally classified roadway pavements for inclusion in PAVER. The roadway pavement inventory provides the underlying data on which analysis and reporting is performed with PAVER. In addition, the inventory provides the framework in which all routinely collected pavement condition data and historical work data are stored.

4.3 PAVER Inventory Update

The jurisdictions' PAVER inventories were updated using GIS data provided by the MPO. Additional pavement information from aerial imagery and field observations was incorporated into the PAVER database, including details such as pavement surface type and the approximate length and width of each roadway section.

A shapefile generated from the GIS was linked to the PAVER database, allowing jurisdictions to easily navigate roadway data within PAVER and produce various map-based inventory and condition reports.

4.4 Inventory summary

The functionally classified roadway network consists of approximately 243.4 centerline miles of predominantly asphalt-surfaced roadways. Table 3 shows the distribution of the jurisdictions' roadway network in mileage and by pavement surface type.

Table 3. Roadway summary data by jurisdiction and pavement surface type.

	Centerline Mileage			
Jurisdiction	**Asphalt**	**Concrete**	**Gravel**	**Total**
City of Bismarck	101	36	-	**137**
City of Lincoln	1.4	-	-	**1.4**
City of Mandan	34.8	11.1	-	**45.9**
Burleigh County	42.4	-	1.0	**43.4**
Morton County	14.7	1.0	-	**15.7**
Total	**194.3**	**48.6**	**1.0**	**243.4**

5 PAVEMENT CONDITION INSPECTION

5.1 Introduction

This section covers the second task of the project which is conducting a detailed pavement condition survey of the jurisdictions' functionally classified roadways. The survey involved collecting high-resolution pavement imagery and profile measurements using advanced pavement condition survey equipment. For this purpose, RAS utilized their RAC vehicles equipped with LCMS-2 systems, capable of capturing continuous, detailed 20-foot linear samples with crack measurements at a resolution of 1 millimeter per pixel. Right-of-way images were also captured using a 360-degree high-definition camera system. The high-resolution, geospatially referenced imagery collected by the RAC vehicles met and exceeded the technical requirements for the project. The collected data were analyzed to calculate PCI and IRI values for the surveyed roadways. This section details the pavement condition survey system, the data collection process, the analysis of the collected data, and field observations.

5.2 Objective

The purpose of the pavement condition survey is to evaluate the current structural integrity and surface operational state of the jurisdictions' roadways, offering a detailed snapshot of pavement conditions at the time of data collection.

To maintain and improve roadway performance, jurisdictions are encouraged to conduct pavement condition surveys regularly. Routine surveys can help objectively monitor pavement performance, identify immediate maintenance and repair (M&R) needs, assess the effectiveness of past M&R activities, track pavement deterioration trends, and forecast both short- and long-term M&R requirements.

5.3 Pavement Condition Data Acquisition

RAS deployed a state-of-the-art RAC pavement data collection system to capture high-resolution pavement imagery and surface data necessary to assess the roadway condition. The RAC system is shown in Figure 5.

Figure 5. RAC pavement condition data collection system.

The RAC system was deployed to survey all roadways included in the project scope, collecting data on the outermost lanes in both directions. During the survey, the RAC system continuously gathered the following data for each roadway:

- High-resolution 2D and 3D pavement images for identifying pavement distresses and calculating Pavement Condition Index (PCI) values.
- Transverse profiles for measuring rutting.
- Longitudinal profiles for determining International Roughness Index (IRI) values.
- High-resolution forward-facing right-of-way images for manual data review.

The collected data were processed using automated tools, with results verified through manual review to ensure accuracy. The final pavement condition assessments were then entered into the PAVER databases.

5.4 Pavement Condition Index (PCI) method

The pavement condition survey was conducted using the Pavement Condition Index (PCI) method, a standardized approach for evaluating pavement health. The PCI method involves identifying and quantifying pavement distress types, severities, and extents during a detailed field inspection. This data is then analyzed to calculate a PCI value, as shown in Figure 6. The PCI value serves as a reliable indicator of the structural integrity and surface operational performance of a pavement section. The PCI method is widely adopted as the best practice for assessing pavement conditions and supporting data-driven maintenance and repair decisions.

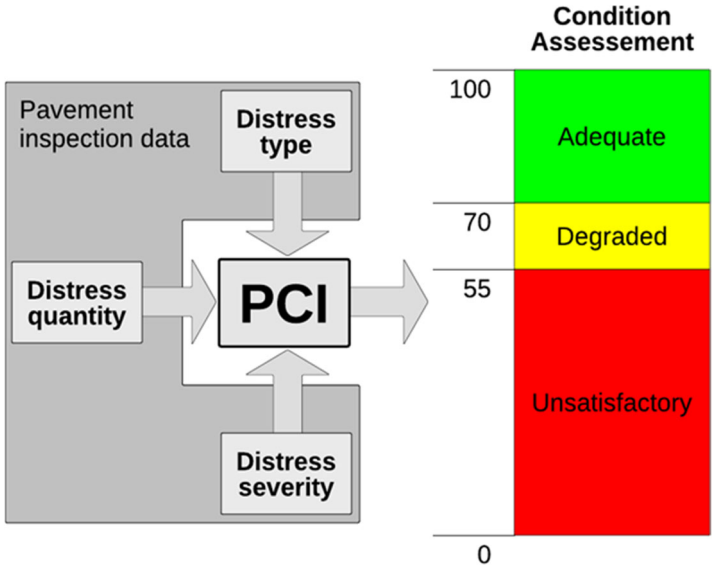


Figure 6. PCI inputs and the MPO's assessment scale

A newly constructed pavement has a PCI of 100. Over time, the pavement deteriorates due to factors such as vehicle loads, environmental conditions, and aging. Common distress types identified and assessed for asphalt and concrete pavements are summarized in Table 4. During inspections, points are deducted from the initial PCI of 100 for each observed distress based on its type, severity, and extent. When multiple types of distress are present, the deduct values are adjusted to avoid disproportionately compounding their impact, ensuring an accurate PCI calculation. For each roadway of jurisdictions, the severity and extent of observed distresses are carefully documented. These recorded data are then processed using the PCI calculation algorithm in PAVER, resulting in a PCI value that quantifies the pavement's condition.

Table 4. Asphalt and concrete pavement distress types.

Asphalt Pavement Distress	Cause	Concrete Pavement Distress	Cause
Block Cracking	Climate/Durability	Blowup/Buckling	Climate/Durability
Joint Reflection Cracking	Climate/Durability	Durability ("D") Cracking	Climate/Durability
Longitudinal and Transverse Cracking	Climate/Durability	Joint Seal Damage	Climate/Durability
Raveling	Climate/Durability	Shrinkage Cracks	Climate/Durability
Weathering	Climate/Durability	Spalling, Corner	Climate/Durability
Alligator Cracking	Load	Spalling, Joint	Climate/Durability
Edge Cracking	Load	Corner Break	Load
Pothole	Load	Divided Slab	Load
Rutting	Load	Linear Cracking	Load
Bleeding	Other	Punchout	Load
Bumps and Sags	Other	Faulting	Other
Corrugation	Other	Lane/Shoulder Drop-Off	Other
Depression	Other	Patching, Large and Utility Cuts	Other
Lane/Shoulder Drop-Off	Other	Patching, Small	Other
Patching and Utility Cut Patching	Other	Polished Aggregate	Other
Polished Aggregate	Other	Popouts	Other
Railroad Crossing	Other	Pumping	Other
Shoving	Other	Railroad Crossing	Other
Slippage Cracking	Other	Scaling, Map Cracking, and Crazing	Other
Swell	Other		

5.5 Pavement Condition Index (PCI) data interpretation and evaluation

The RAC system captured 2D and 3D images of the roadway surface from which pavement surface distresses are evaluated. The collected images and data are imported into the RAS Artificial Intelligence (AI) enhanced pavement rating tool RoadTRIP™ (Technical Rating Intelligence Program), as shown in Figure 7. The import process creates mappings to the data so that users do not need to keep track of where the data is stored on central data server. At this stage, major data processing tasks also occur, such as generation of right-of-way and pavement image streams, calculation of profile roughness, rutting, detection of cracks and other distresses.

The automated crack analysis in RoadTRIPTM detects cracks that are overlaid on the pavement images and offset to assist with the verification of the detected cracks. During reporting, the distress cracks are defined by road zone and accumulated according to the units defined in the client specification. The severity levels are identified based upon the defined limits (ASTM D6433) and verified for resolution through visual quality control checks of image files. Where density metrics are required, these are determined using the length of the interval being reported and the width of road zones included.

The RoadTRIPTM application was designed around the ASTM D6433 data collection protocols and even contains a PCI calculator that uses distress deduct curves and Q-correction. This PCI is used for Quality Assurance before importing detailed extent/severity distress data into PAVER software.

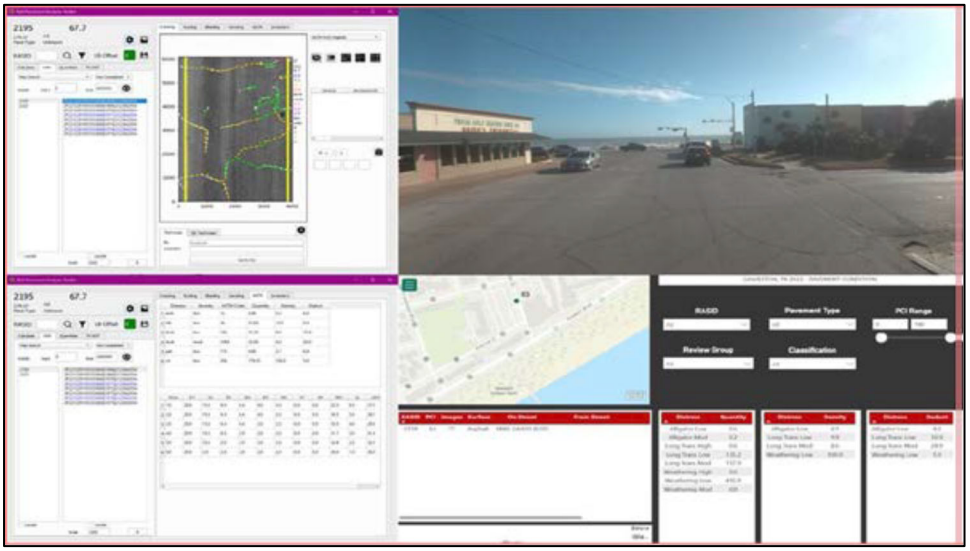


Figure 7. RAS RoadTRIP™ Pavement Evaluation Environment

The QC and QA ratings are the most important steps in the project. RAS uses RoadTRIPTM software for evaluating distresses using both automated algorithms and manual supplemental ratings. All QC/QA are performed by highly trained and experienced engineers in accordance with the principles of the ASTM D6433 standard, using the LCMS pavement images gathered during collection with the distresses superimposed and color-coded (Figure 8). Each detailed 20-foot LCMS sample is geocoded for real world distress location identification. In addition, the 20-foot level distress data is processed at the 2,500 sq.ft. sample size per ASTM D6433 protocols. This results in a localized failure heatmap deliverable of all samples with distress densities that are geotagged and available in the mapping interface.

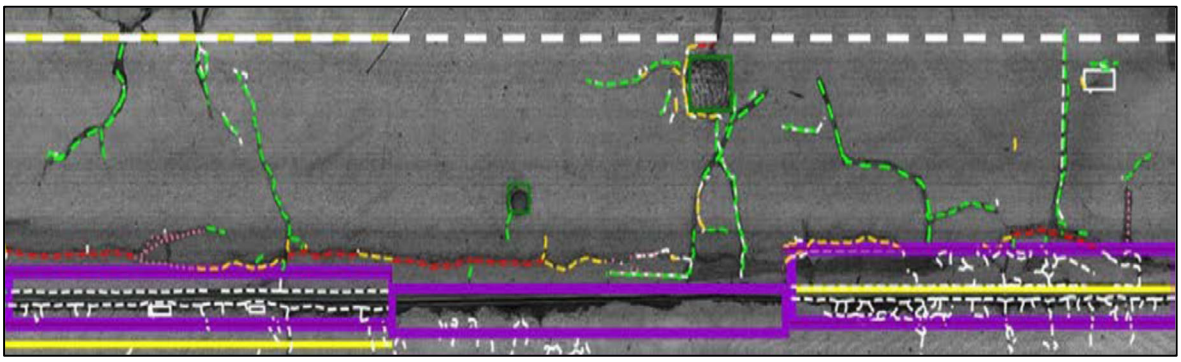


Figure 8. Automated and manual rating for QC/QA of pavements using RoadTRIP™

In addition to capturing 2D and 3D imagery from which pavement surface distresses are evaluated, the RAS system also captures high-resolution longitudinal and transverse profiles of the roadway surface. The longitudinal profile data are analyzed to determine the IRI values, and the transverse profiles are used to measure rutting.

5.6 Existing pavement conditions and field observations

The collected pavement survey data were used to calculate PCI value for each pavement section. Table 5 shows the pavement condition assessment criteria used to analyze the pavement network.

Table 5. City's pavement condition categories.

Category	Typical Distresses and Typical Level of M&R Needed	PCI Range
Adequate	More extensive longitudinal and transverse cracking and weathering of surface **Preventive maintenance:** *Crack sealing and surface treatments*	71-100
Degraded	Extensive longitudinal and transverse cracking, early-stage alligator (fatigue) cracking, early-stage rutting, and weathering of surface **Global preventive maintenance and localized repairs:** *Localized surface and/or full-depth patching, surface treatments, and thin overlays*	56-70
Unsatisfactory	More extensive and more severe longitudinal and transverse cracking, alligator (fatigue) cracking, rutting, weathering of surface, potholes **Major rehabilitation:** *Full-depth patching, mill and overlays, traditional overlays, and reconstruction*	0-55

At the time of inspection, the functionally classified pavements were found to have an average PCI of 84, indicating that the roadways are in overall "adequate" condition. Pavement condition data summarized by jurisdiction is presented in Table 6. Overall average PCI values for each jurisdiction at the time of inspection are shown in Figure 9. The condition distribution of each jurisdictions' pavements at the time of inspection is shown in Figure 10, and a detailed condition map can be found in Appendix A.

Table 6. Roadway summary condition data by jurisdiction.

Jurisdiction	Centerline Miles	PCI	PCI Category	IRI	IRI Category
City of Bismarck	137	84	Adequate	187	Smooth
City of Lincoln	1.4	90	Adequate	128	Smooth
City of Mandan	45.9	80	Adequate	237	Marginally Rough
Burleigh County	43.4	86	Adequate	123	Smooth
Morton County	15.7	85	Adequate	101	Smooth
Total	**243.4**	**84**	**Adequate**	**181**	**Smooth**

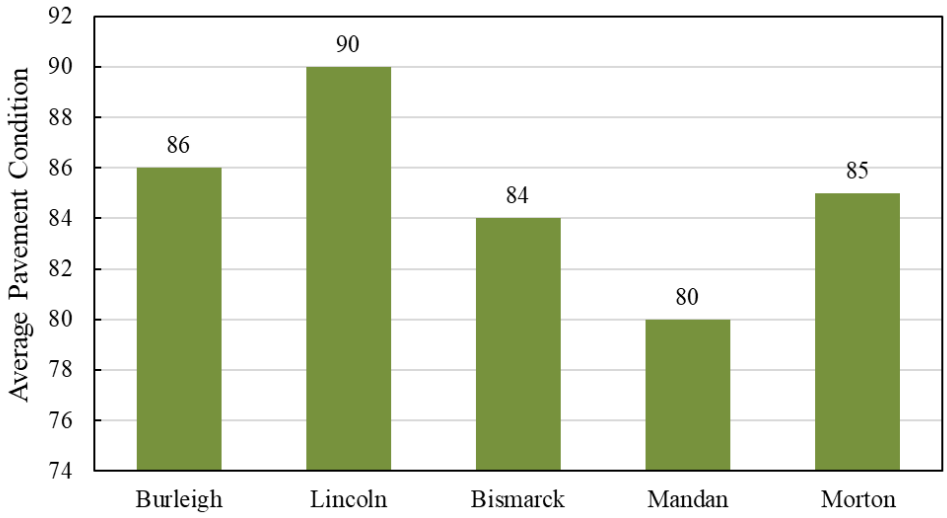


Figure 9. Overall pavement conditions by jurisdiction.

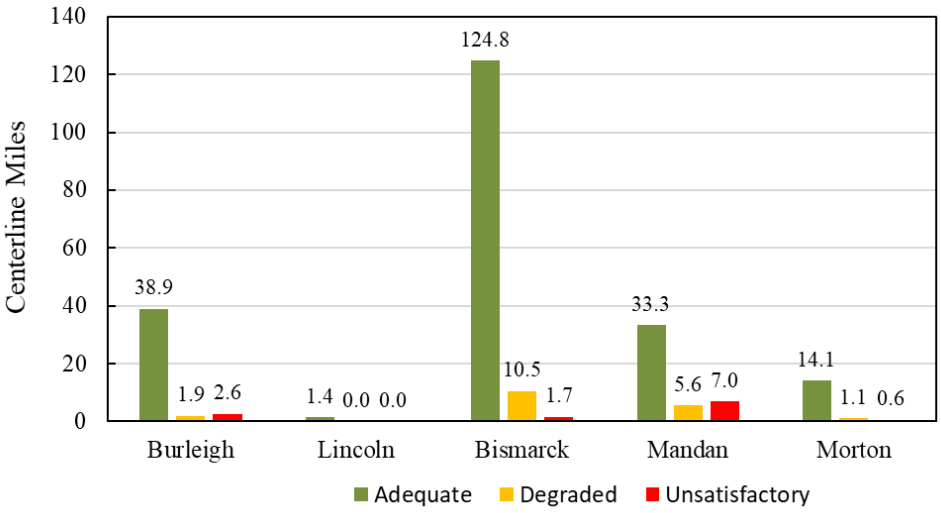


Figure 10. Pavement condition category distributions by jurisdiction.

The causes of pavement deterioration, as quantified by the Pavement Condition Index (PCI), can be broadly categorized into three main areas: vehicle load-related, climate and durability-related, and other factors such as construction defects or material issues. Pavement deterioration and eventual failure is a complex process often driven by the interaction of multiple mechanisms. Across the observed jurisdictions, the primary contributors to pavement deterioration were a combination of load- and climate-related distresses. Vehicle load-related issues, such as alligator cracking and rutting, were particularly prevalent and significantly impacted roadway conditions. Additionally, climate-related distresses, including longitudinal and transverse cracking, were widespread throughout the pavement inventory.

In practice, visually observed pavement distresses collected during network-level condition surveys are used to infer the likely mechanisms contributing to roadway deterioration. However, before developing M&R strategies, it is essential to identify the root causes of deterioration. This can be achieved through a combination of techniques, including traffic load analysis, drainage assessments, structural testing, coring,

and material testing.

For instance, vehicle load-related issues like alligator cracking can be analyzed through load studies and material evaluations. These issues may stem from sustained exposure to loads exceeding the roadway's design capacity or from the pavement simply reaching the end of its design life. On the other hand, climate- or durability-related distresses, such as transverse cracking, often result from freeze-thaw cycles and oxidation or embrittlement of asphalt layers. Distresses attributed to "other" causes, such as construction or material defects, are best diagnosed through coring, boring, and detailed material testing. Understanding these underlying mechanisms is critical for developing targeted and effective repair strategies.

In addition to PCI values, IRI values were determined for each of the roadways. IRI values, reported in inches per mile, describe the amount of roughness in both wheel paths over a given length of pavement. The IRI is a standard measure of roughness used worldwide. The IRI assessment scale is shown in Table 7.

Table 7. IRI assessment criteria

Category	IRI Value
Smooth	0-200
Marginal	201-400
Rough	>401

At the time of inspection, the pavement sections were found to be in overall “smooth” condition, with an average IRI of 181 inches/mile. Detailed condition maps can be found in Appendix A.

5.7 Summary

This section provided an overview of the methodology employed for the 2024 pavement condition survey and summarized its findings. A cutting-edge RAC pavement condition survey system was utilized to capture detailed pavement imagery and profile data across the jurisdictions’ roadways. The collected data were systematically analyzed to calculate PCI and IRI values for each road surveyed. The results indicated that the roadways were generally in "adequate" condition, with an average PCI score of 84. Also, the roadways were found to be in overall “smooth” condition with an average IRI of 181 inches/mile.

6 MAINTENANCE AND REHABILITATION FUNDING ANALYSES

6.1 Introduction

This section focuses on the third task of the project: the analysis of maintenance and rehabilitation (M&R) needs. It presents the results of the analyses conducted for the jurisdictions, outlines the assumptions that informed the analyses, and details the findings. Recommendations based on these analyses are included in this section, with additional details provided in Appendix B.

6.2 Objective

The M&R Planning module in PAVER offers preliminary recommendations regarding the timing, location, and estimated costs of pavement maintenance and rehabilitation (M&R) activities. These recommendations serve as a foundation for jurisdictions to develop comprehensive, programmatic M&R plans. Such plans can be tailored to align with anticipated annual funding levels or to achieve and maintain a desired pavement condition standard.

A seven-year analysis was conducted for the functionally classified roadways within each jurisdiction to

estimate the funding levels required to address the major maintenance and rehabilitation (M&R) backlog. The primary objective of this analysis was to identify the roadways that should be prioritized over the next seven years to bring functionally classified roadways to an adequate condition. Additional analyses can also be undertaken to evaluate the effects of anticipated funding levels or to determine the funding required to achieve a desired network-wide average pavement condition.

6.3 Assumptions

The M&R analyses were based on the results of the fall 2024 PCI survey and the pavement inventory. The following assumptions were made in the analysis.

- Critical PCI values (the PCI value below which a pavement is considered a candidate for major M&R) of 65 and 75 were assumed for all asphalt and concrete roadways, respectively. Pavements at or below the Critical PCI during the analysis period triggered major M&R recommendations.

- The M&R unit costs used in these analyses were obtained from the information provided by the City of Bismarck.

- A pavement deterioration rate of approximately 2 points per year was applied to asphalt roadways, corresponding to an estimated pavement life of around 17.5 years between major rehabilitations. For concrete roadways, a deterioration rate of about 1 point per year was used, resulting in an estimated pavement life of roughly 25 years between major rehabilitations. These rates are regularly refined as additional historical work records are incorporated into PAVER and as more PCI inspection data becomes available over time.

- The starting date for the analysis was set as January 1, 2025, with an assumed annual inflation rate of 3% applied over the seven-year period from 2025 to 2031.

Results

The results of the PAVER M&R analysis are summarized in Table 8, which illustrates the estimated seven-year pavement M&R costs required to eliminate major M&R backlog. Additionally, it highlights the projected change in PCI resulting from the total estimated funding by 2031.

Appendix B provides a detailed list of all roadways recommended for major M&R over the next seven years to address each jurisdiction's rehabilitation backlog. The table specifies the roadways identified by PAVER for rehabilitation each year. These recommendations are solely based on the results of the image-based pavement condition survey conducted for this project and do not account for factors such as pavement structural characteristics (e.g., subgrade or base stiffness), specific traffic loadings, drainage issues, or geographic proximity. Therefore, these recommendations should be subject to project-level engineering evaluations before being incorporated into programming.

Table 8. Estimated Seven-Year Pavement M&R Costs to Eliminate Major M&R Backlog

Jurisdiction	1st Year Funding	Est. Annual Funding for 2nd to 7th Year	Est. Total Funding (2025-2031)	2025 PCI	2031 PCI
City of Bismarck	$8.9M	$2.1M	$21.7M	84	82
City of Lincoln	-	-	-	90	78
City of Mandan	9.1M	$645K	$13M	80	84
Burleigh County	2.9M	$541K	$6.2M	86	80
Morton County	$762K	$105K	$1.4M	85	78

It should be noted that due to the relatively high PCI value recorded in 2025 for most of the jurisdictions, the funding level required to eliminate the backlog results in an overall lower forecasted average PCI value in 2031. Preventive maintenance activities are required to increase the average PCI value. Also, the PCI values for the City of Lincoln network are greater than the critical PCI from 2025 to 2031, so there is no major M&R backlog for the City of Lincoln.

7 SUMMARY AND RECOMMENDATIONS

7.1 Summary

In August 2024, the Bismarck-Mandan MPO engaged QES to conduct a pavement condition assessment for the functionally classified roadways within its jurisdiction and to project network-level maintenance and rehabilitation (M&R) needs for the participating jurisdictions. QES collaborated with RAS for pavement data collection, utilizing RAS's advanced 3D Pavement Condition Survey Systems, known as Roadway Asset Collection (RAC) vehicles, to automatically gather data in the fall of 2024. The collected pavement condition data was analyzed using PAVER, which facilitated network-level evaluations and predictions for future pavement M&R requirements. These analyses specifically estimated the funding required by each jurisdiction to address its backlog of major M&R over a seven-year planning period.

To maximize the return on investment from this project, it is recommended that jurisdictions fully implement PAVER if they have not already done so. This implementation will allow jurisdictions to:

1. Effectively identify roadways that would benefit most from pavement preservation techniques.
2. Monitor pavement performance and track M&R expenditures.
3. Evaluate the effectiveness of M&R activities, such as determining when resurfacing is no longer cost-effective, and reconstruction is necessary.
4. Simplify the forecasting of M&R needs and assess how funding levels affect pavement conditions

QES presents the following broad recommendations based on the initial analysis and PCI data collection for the roadways:

7.2 Recommendations

7.2.1 Implementing Pavement Preservation Treatments

pavement preservation activities like crack sealing, localized patching, and chip sealing offer a cost-effective approach to extending pavement lifespan. Jurisdictions are encouraged to continue integrating these strategies into their M&R plans. Additionally, they should prioritize routine preventive maintenance for roadways that have been recently resurfaced or reconstructed.

7.2.2 Use of Structural Testing to Determine the Root Causes of Pavement Deterioration

As pavements age and undergo multiple resurfacing cycles, the effectiveness of subsequent resurfacing projects diminishes due to ongoing deterioration of the underlying pavement structure, often caused by moisture infiltration, freeze-thaw cycles, and vehicular loading. To address these challenges, jurisdictions should integrate structural testing methods such as Falling Weight Deflectometer (FWD) testing and coring, along with material testing and traffic load analyses, to identify the root causes of pavement deterioration before developing a specific M&R strategy.

While visually observed pavement distresses collected during network-level condition surveys can indicate likely mechanisms of deterioration, a more in-depth investigation is essential. Determining the root cause may involve a combination of traffic load analyses, drainage investigations, structural testing, coring, and material testing.

By leveraging these techniques alongside M&R history and performance tracking of resurfaced roadways, jurisdictions can pinpoint when reconstruction is more appropriate than resurfacing. This data-driven approach ensures the selection of the most cost-effective and durable M&R strategies, extending the service life of pavement networks while optimizing resource allocation.

7.2.3 Conduct Routine Pavement Condition Monitoring

To enhance pavement management and maximize the benefits of the current condition survey, jurisdictions should implement a regular cycle for PCI surveys. Consistent inspections will allow for improved tracking of pavement deterioration, identification of trends to better predict future conditions, and more strategic application of M&R funding. These inspections will also support the assessment and monitoring of the effectiveness of preservation and major rehabilitation activities.

7.2.4 Routine Update of the PAVER Database

To optimize pavement management, it is recommended that jurisdictions routinely update the PAVER with current data. The City of Bismarck's decade of successful PAVER use demonstrates its value in generating meaningful recommendations for maintenance and rehabilitation (M&R) strategies. To fully leverage PAVER, other jurisdictions should consider its implementation and commit to annual updates following the paving season. These updates should capture major M&R activities, routine maintenance efforts, and any changes to the pavement inventory, such as the addition of new roadways, jurisdictional changes, or realignments.

Routine updates ensure that PAVER provides accurate and actionable insights, improving the ability to track pavement deterioration, predict future conditions, and strategically allocate resources for preservation and rehabilitation. This approach supports proactive pavement management, reduces the need for costly emergency repairs, and extends the service life of roadways. With consistent updates, PAVER can become a reliable tool for optimizing pavement performance, prioritizing maintenance needs, and ensuring efficient use of available resources across all jurisdictions.

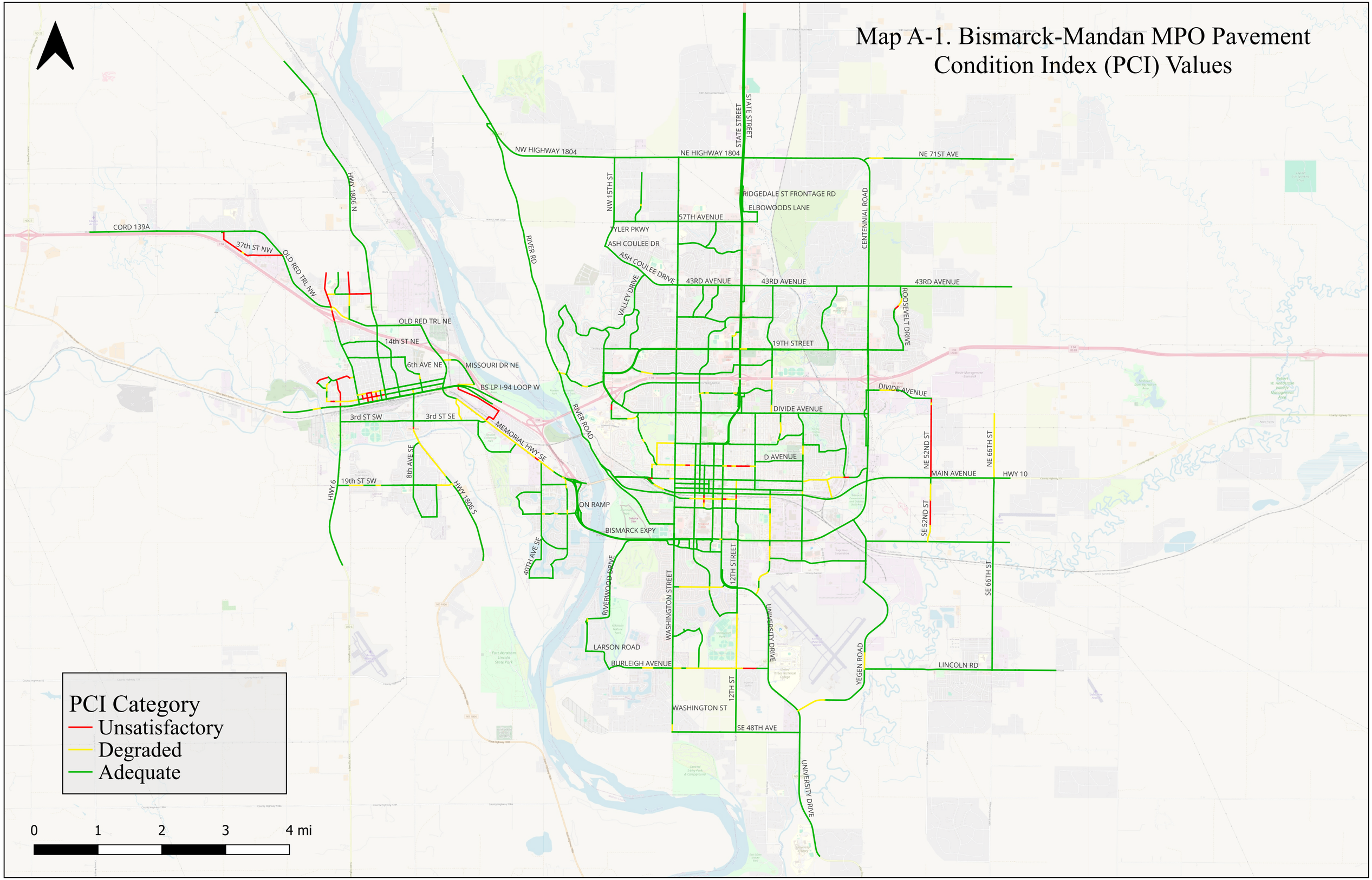
Appendix A – Pavement Condition Map

Map A-2. Bismarck-Mandan MPO
International Roughness Index (IRI) Values

IRI Category
- Smooth
- Marginal
- Rough

0 1 2 3 4 mi

Map A-1. Bismarck-Mandan MPO Pavement Condition Index (PCI) Values



Appendix B – Network Level Maintenance and Rehabilitation Recommendations

Jurisdiction: City of Bismarck

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
05TH_ST	15	AC	372	51	2025	Rehabilitation	$101,713
05TH_ST	20	AC	228	56	2025	Rehabilitation	$57,395
09TH_ST	35	PCC	107	73	2025	Rehabilitation	$11,277
12TH_ST	100	AC	380	61	2025	Rehabilitation	$28,861
12TH_ST	4	AC	418	63	2025	Rehabilitation	$27,145
12TH_ST	85	AC	462	51	2025	Rehabilitation	$90,346
12TH_ST	95	AC	381	61	2025	Rehabilitation	$29,265
17TH_ST	25	AC	378	64	2025	Rehabilitation	$80,319
19TH_ST	135	PCC	379	72	2025	Rehabilitation	$41,566
43RD_AV	10	AC	955	54	2025	Rehabilitation	$170,387
43RD_AV	100	AC	1,827	26	2025	Rehabilitation	$319,213
43RD_AV	105	AC	1,882	26	2025	Rehabilitation	$328,823
43RD_AV	15	AC	1,790	61	2025	Rehabilitation	$234,178
43RD_AV	20	AC	1,103	55	2025	Rehabilitation	$188,349
43RD_AV	25	AC	874	53	2025	Rehabilitation	$162,431
43RD_AV	5	AC	600	64	2025	Rehabilitation	$73,942
43RD_AV	50	AC	1,018	51	2025	Rehabilitation	$175,380
43RD_AV	70	AC	1,387	26	2025	Rehabilitation	$242,337
43RD_AV	75	AC	1,278	26	2025	Rehabilitation	$223,292
43RD_AV	80	AC	2,648	26	2025	Rehabilitation	$462,658
43RD_AV	85	AC	507	26	2025	Rehabilitation	$88,583
43RD_AV	90	AC	471	26	2025	Rehabilitation	$82,293
43RD_AV	95	AC	533	26	2025	Rehabilitation	$93,126
52ND_ST	55	AC	1,577	61	2025	Rehabilitation	$104,068
52ND_ST	65	AC	5,275	64	2025	Rehabilitation	$307,160
52ND_ST	70	AC	667	60	2025	Rehabilitation	$45,638
AIRPO_RD	30	AC	472	63	2025	Rehabilitation	$96,035
AIRPO_RD	45	AC	481	64	2025	Rehabilitation	$93,933
AIRPO_RD	75	AC	473	60	2025	Rehabilitation	$104,216
AIRPO_RD	80	AC	477	59	2025	Rehabilitation	$108,173
ASH C_DR	75	AC	2,395	51	2025	Rehabilitation	$429,615
BELL_ST	15	AC	567	55	2025	Rehabilitation	$85,169
BISMA_EX	60	PCC	118	64	2025	Rehabilitation	$27,933
BOULE_AV	105	PCC	366	74	2025	Rehabilitation	$30,974
BOULE_AV	115	PCC	308	68	2025	Rehabilitation	$11,595
BOULE_AV	120	PCC	338	72	2025	Rehabilitation	$10,187
BURLE_AV	65	AC	1,120	65	2025	Rehabilitation	$81,989
BURLE_AV	70	AC	605	63	2025	Rehabilitation	$46,201
C_AV	100	AC	380	62	2025	Rehabilitation	$28,229
C_AV	105	AC	380	52	2025	Rehabilitation	$51,091
C_AV	110	AC	380	60	2025	Rehabilitation	$40,348
C_AV	115	AC	369	51	2025	Rehabilitation	$54,534
C_AV	120	AC	381	36	2025	Rehabilitation	$123,033

Jurisdiction: City of Bismarck

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
C_AV	125	AC	381	52	2025	Rehabilitation	$69,815
C_AV	130	AC	380	60	2025	Rehabilitation	$42,370
C_AV	25	AC	379	64	2025	Rehabilitation	$36,873
C_AV	30	AC	381	63	2025	Rehabilitation	$38,430
C_AV	40	AC	380	63	2025	Rehabilitation	$38,247
C_AV	55	APC	380	62	2025	Rehabilitation	$31,558
CAPIT_AV	90	AC	208	61	2025	Rehabilitation	$26,437
CENTU_AV	175	PCC	489	64	2025	Rehabilitation	$44,083
CENTU_AV	190	PCC	1,101	75	2025	Rehabilitation	$62,165
CENTU_AV	215	PCC	682	65	2025	Rehabilitation	$57,693
DIVID_AV	100	AC	343	50	2025	Rehabilitation	$96,420
DIVID_AV	110	AC	319	53	2025	Rehabilitation	$78,163
DIVID_AV	115	AC	329	47	2025	Rehabilitation	$132,623
DIVID_AV	125	AC	865	56	2025	Rehabilitation	$180,200
DIVID_AV	15	AC	347	51	2025	Rehabilitation	$93,384
DIVID_AV	20	AC	1,265	48	2025	Rehabilitation	$456,025
DIVID_AV	25	AC	254	61	2025	Rehabilitation	$40,063
DIVID_AV	90	AC	166	59	2025	Rehabilitation	$28,575
DIVID_AV	95	AC	333	52	2025	Rehabilitation	$85,609
EASTD_DR	10	AC	380	58	2025	Rehabilitation	$59,049
FRONT_AV	25	AC	761	62	2025	Rehabilitation	$96,532
FRONT_AV	30	AC	367	65	2025	Rehabilitation	$48,462
FRONT_AV	40	AC	379	61	2025	Rehabilitation	$48,985
FRONT_AV	45	AC	384	57	2025	Rehabilitation	$60,955
FRONT_AV	50	AC	382	58	2025	Rehabilitation	$56,944
FRONT_AV	60	AC	384	64	2025	Rehabilitation	$46,416
GRIFF_ST	40	AC	431	64	2025	Rehabilitation	$42,232
INTER_AV	20	AC	981	62	2025	Rehabilitation	$122,515
MAIN_AV	35	PCC	933	71	2025	Rehabilitation	$49,377
MAIN_AV	45	PCC	858	63	2025	Rehabilitation	$191,026
MAIN_AV	46	PCC	881	69	2025	Rehabilitation	$118,377
MAIN_AV	95	PCC	385	72	2025	Rehabilitation	$54,319
MEMOR_HY	10	AC	502	63	2025	Rehabilitation	$28,568
ROOSE_DR	45	AC	361	58	2025	Rehabilitation	$47,605
ROOSE_DR	50	AC	395	63	2025	Rehabilitation	$43,419
ROSSE_AV	11	AC	180	36	2025	Rehabilitation	$93,016
ROSSE_AV	15	AC	234	46	2025	Rehabilitation	$44,348
ROSSE_AV	210	AC	380	63	2025	Rehabilitation	$56,832
ROSSE_AV	220	AC	349	51	2025	Rehabilitation	$95,803
ROSSE_AV	5	AC	352	59	2025	Rehabilitation	$14,098
SCHAF_ST	20	AC	446	50	2025	Rehabilitation	$115,266
WACHT_AV	40	AC	935	64	2025	Rehabilitation	$112,666
WASHI_ST	310	PCC	50	64	2025	Rehabilitation	$11,356

Jurisdiction: City of Bismarck

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
WEISS_AV	10	AAC	410	61	2025	Rehabilitation	$52,657
YEGEN_RD	15	AC	1445	59	2025	Rehabilitation	$138,593
YEGEN_RD	5	AC	2431	58	2025	Rehabilitation	$237,949
06TH_ST	20	AC	382	64	2026	Rehabilitation	$42,767
12TH_ST	5	AC	4178	65	2026	Rehabilitation	$270,437
26TH_ST	105	AC	871	65	2026	Rehabilitation	$129,781
52ND_ST	75	AC	620	63	2026	Rehabilitation	$38,821
AIRPO_RD	50	AC	559	63	2026	Rehabilitation	$115,973
AIRPO_RD	60	AC	589	64	2026	Rehabilitation	$118,318
AIRPO_RD	70	AC	274	63	2026	Rehabilitation	$56,330
BELL_ST	30	AC	380	64	2026	Rehabilitation	$37,868
BOULE_AV	80	PCC	387	75	2026	Rehabilitation	$32,373
BURLE_AV	75	AC	1577	65	2026	Rehabilitation	$119,346
C_AV	45	APC	379	63	2026	Rehabilitation	$31,666
C_AV	60	APC	381	64	2026	Rehabilitation	$31,584
CENTU_AV	205	PCC	677	74	2026	Rehabilitation	$39,369
EASTD_DR	15	AC	538	63	2026	Rehabilitation	$67,340
EASTD_DR	5	AC	712	63	2026	Rehabilitation	$89,491
GRIFF_ST	35	AC	1353	64	2026	Rehabilitation	$138,088
ROOSE_DR	55	AC	327	64	2026	Rehabilitation	$36,204
ROSSE_AV	195	AC	328	64	2026	Rehabilitation	$50,451
ROSSE_AV	215	AC	423	64	2026	Rehabilitation	$63,794
WACHT_AV	35	AC	890	63	2026	Rehabilitation	$111,123
19TH_ST	130	PCC	504	75	2027	Rehabilitation	$51,755
19TH_ST	80	AC	298	64	2027	Rehabilitation	$37,678
22ND_ST	60	AC	941	64	2027	Rehabilitation	$118,535
26TH_ST	55	AC	373	65	2027	Rehabilitation	$62,644
AIRPO_RD	15	AC	1140	64	2027	Rehabilitation	$239,524
AIRPO_RD	40	AC	315	63	2027	Rehabilitation	$67,332
AIRPO_RD	55	AC	255	64	2027	Rehabilitation	$52,764
BOULE_AV	10	AC	381	63	2027	Rehabilitation	$40,648
BOULE_AV	195	AC	122	64	2027	Rehabilitation	$15,464
BOULE_AV	5	AC	371	64	2027	Rehabilitation	$38,999
BURLE_AV	55	AC	794	65	2027	Rehabilitation	$62,133
BURLE_AV	85	AC	1744	64	2027	Rehabilitation	$138,702
C_AV	50	APC	544	64	2027	Rehabilitation	$46,095
C_AV	75	AAC	380	64	2027	Rehabilitation	$47,269
CAPIT_AV	95	AC	210	64	2027	Rehabilitation	$26,707
CENTU_AV	180	PCC	371	75	2027	Rehabilitation	$22,219
DIVID_AV	285	AC	1364	63	2027	Rehabilitation	$238,093
FRONT_AV	55	AC	374	64	2027	Rehabilitation	$47,788
ROSSE_AV	200	AC	342	65	2027	Rehabilitation	$52,745
ROSSE_AV	205	AC	322	63	2027	Rehabilitation	$51,415

Jurisdiction: City of Bismarck

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
WACHT_AV	45	AC	627	64	2027	Rehabilitation	$80,160
WACHT_AV	50	AC	1035	65	2027	Rehabilitation	$129,935
WASHI_ST	145	PCC	162	75	2027	Rehabilitation	$24,276
WASHI_ST	150	PCC	133	75	2027	Rehabilitation	$19,892
WASHI_ST	155	PCC	366	75	2027	Rehabilitation	$54,732
05TH_ST	10	AC	387	63	2028	Rehabilitation	$69,419
09TH_ST	30	PCC	463	75	2028	Rehabilitation	$44,043
19TH_ST	110	AC	846	64	2028	Rehabilitation	$110,669
19TH_ST	75	AC	330	64	2028	Rehabilitation	$43,537
AIRPO_RD	25	AC	790	65	2028	Rehabilitation	$166,604
AIRPO_RD	5	AC	550	64	2028	Rehabilitation	$117,922
AIRPO_RD	65	AC	405	65	2028	Rehabilitation	$86,032
BOULE_AV	140	PCC	214	74	2028	Rehabilitation	$7,052
BOULE_AV	15	AC	753	63	2028	Rehabilitation	$82,003
BOULE_AV	70	PCC	372	75	2028	Rehabilitation	$20,996
BURLE_AV	40	AC	1043	63	2028	Rehabilitation	$79,782
BURNT_DR	5	AC	579	64	2028	Rehabilitation	$40,470
C_AV	35	AC	379	63	2028	Rehabilitation	$41,318
C_AV	65	APC	380	64	2028	Rehabilitation	$32,973
CALGA_AV	65	AC	418	64	2028	Rehabilitation	$57,977
CAPIT_AV	70	AC	325	64	2028	Rehabilitation	$35,156
CAPIT_AV	80	AC	110	65	2028	Rehabilitation	$11,657
CENTU_AV	200	PCC	677	75	2028	Rehabilitation	$41,784
CENTU_AV	210	PCC	682	75	2028	Rehabilitation	$42,059
COLLE_DR	15	AC	904	64	2028	Rehabilitation	$118,050
FRONT_AV	20	AC	382	63	2028	Rehabilitation	$62,658
FRONT_AV	35	AC	393	65	2028	Rehabilitation	$51,295
GALLE_PL	5	PCC	313	75	2028	Rehabilitation	$27,225
LASAL_DR	100	AC	84	64	2028	Rehabilitation	$10,148
ROSSE_AV	185	AC	1394	64	2028	Rehabilitation	$225,700
ROSSE_AV	190	AC	322	63	2028	Rehabilitation	$52,761
ROSSE_AV	225	AC	664	64	2028	Rehabilitation	$106,247
ROSSE_AV	45	AC	398	64	2028	Rehabilitation	$64,764
WACHT_AV	30	AC	527	64	2028	Rehabilitation	$69,220
WHISP_DR	30	AC	203	65	2028	Rehabilitation	$9,342
03RD_ST	125	AAC	381	64	2029	Rehabilitation	$63,439
03RD_ST	30	AC	320	64	2029	Rehabilitation	$43,036
19TH_ST	125	PCC	413	75	2029	Rehabilitation	$44,944
43RD_AV	45	AC	1631	64	2029	Rehabilitation	$191,767
52ND_ST	50	AC	2157	63	2029	Rehabilitation	$255,047
BOULE_AV	85	PCC	302	75	2029	Rehabilitation	$28,786
BURLE_AV	80	AC	792	63	2029	Rehabilitation	$134,875
BURNT_DR	15	AC	367	64	2029	Rehabilitation	$49,486
CALGA_AV	15	AAC	300	64	2029	Rehabilitation	$40,504
CAPIT_AV	50	AC	264	65	2029	Rehabilitation	$28,790

Jurisdiction: City of Bismarck

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
CAPIT_AV	60	AC	291	64	2029	Rehabilitation	$32,271
CAPIT_AV	75	AC	327	64	2029	Rehabilitation	$36,270
COLEM_ST	20	AC	156	64	2029	Rehabilitation	$17,074
CROCU_AV	15	AC	367	63	2029	Rehabilitation	$41,360
D_AV	95	AC	381	64	2029	Rehabilitation	$42,590
DIVID_AV	130	AC	277	63	2029	Rehabilitation	$59,462
LASAL_DR	75	AC	816	65	2029	Rehabilitation	$99,155
MAIN_AV	25	PCC	1114	75	2029	Rehabilitation	$61,947
NORMA_ST	5	AC	817	64	2029	Rehabilitation	$89,235
RIVER_RD	25	AC	168	64	2029	Rehabilitation	$11,516
ROSSE_AV	230	AC	1237	65	2029	Rehabilitation	$214,778
ROSSE_AV	35	AC	363	65	2029	Rehabilitation	$59,168
WARD_RD	15	AC	289	63	2029	Rehabilitation	$32,547
03RD_ST	35	AC	333	65	2030	Rehabilitation	$45,652
04TH_ST	30	AAC	381	65	2030	Rehabilitation	$47,723
19TH_ST	105	AC	356	64	2030	Rehabilitation	$49,249
19TH_ST	95	AC	130	64	2030	Rehabilitation	$18,157
22ND_ST	55	AC	486	65	2030	Rehabilitation	$66,433
26TH_ST	65	AC	379	63	2030	Rehabilitation	$72,150
AIRPO_RD	10	AC	597	63	2030	Rehabilitation	$138,402
AIRPO_RD	20	AC	912	64	2030	Rehabilitation	$209,742
AIRPO_RD	35	AC	487	64	2030	Rehabilitation	$110,082
ARBOR_AV	15	AC	389	64	2030	Rehabilitation	$44,713
BOULE_AV	190	AC	937	64	2030	Rehabilitation	$128,933
BOULE_AV	45	AC	187	64	2030	Rehabilitation	$34,973
BURLE_AV	50	AC	909	65	2030	Rehabilitation	$77,034
BURNT_DR	10	AC	1748	63	2030	Rehabilitation	$131,971
C_AV	70	AAC	382	64	2030	Rehabilitation	$51,458
CAPIT_AV	110	AC	262	65	2030	Rehabilitation	$35,929
CAPIT_AV	130	AC	507	64	2030	Rehabilitation	$70,009
CENTE_RD	15	PCC	773	75	2030	Rehabilitation	$50,616
CENTE_RD	5	PCC	222	74	2030	Rehabilitation	$46,590
CENTU_AV	50	PCC	274	75	2030	Rehabilitation	$17,907
CROCU_AV	5	AC	458	64	2030	Rehabilitation	$52,817
D_AV	100	AC	379	63	2030	Rehabilitation	$43,825
DAYTO_DR	5	AAC	204	64	2030	Rehabilitation	$25,725
DENVE_AV	20	AC	307	64	2030	Rehabilitation	$34,770
DENVE_AV	25	AC	311	63	2030	Rehabilitation	$36,225
INTER_AV	40	AC	564	64	2030	Rehabilitation	$78,011
LASAL_DR	105	AC	273	65	2030	Rehabilitation	$34,139
MORRI_AV	17	PCC	979	75	2030	Rehabilitation	$120,133
NEBRA_DR	22	AC	263	65	2030	Rehabilitation	$32,635
NEBRA_DR	25	AC	643	64	2030	Rehabilitation	$81,102
NORMA_ST	10	AC	870	64	2030	Rehabilitation	$96,520
RIVERS_RD	20	AC	634	64	2030	Rehabilitation	$72,870
ROOSE_DR	10	AC	515	64	2030	Rehabilitation	$63,335

Jurisdiction: City of Bismarck

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
ROOSE_DR	5	AC	284	64	2030	Rehabilitation	$35,291
TURNP_AV	10	AC	1930	65	2030	Rehabilitation	$264,537
TURNP_AV	45	AC	322	65	2030	Rehabilitation	$40,144
WACHT_AV	55	AC	289	64	2030	Rehabilitation	$39,940
WASHI_ST	90	AC	488	64	2030	Rehabilitation	$92,241
WASHI_ST	95	AC	489	65	2030	Rehabilitation	$100,185
03RD_ST	130	APC	381	65	2031	Rehabilitation	$66,191
03RD_ST	135	APC	380	64	2031	Rehabilitation	$60,372
03RD_ST	45	AC	870	63	2031	Rehabilitation	$126,854
04TH_ST	40	AAC	472	64	2031	Rehabilitation	$61,949
10TH_ST	75	AC	536	63	2031	Rehabilitation	$55,492
19TH_ST	120	PCC	993	75	2031	Rehabilitation	$114,785
19TH_ST	85	AC	295	63	2031	Rehabilitation	$43,060
19TH_ST	90	AC	169	65	2031	Rehabilitation	$23,770
35TH_ST	25	AC	1146	64	2031	Rehabilitation	$134,857
ARBOR_AV	20	AC	469	63	2031	Rehabilitation	$71,235
BISMA_EX	65	PCC	170	75	2031	Rehabilitation	$28,643
BOULE_AV	200	AC	247	65	2031	Rehabilitation	$28,586
BOULE_AV	75	PCC	457	75	2031	Rehabilitation	$28,163
BOULE_AV	95	PCC	328	75	2031	Rehabilitation	$33,208
BURLE_AV	45	AC	623	64	2031	Rehabilitation	$51,281
BURLE_AV	60	AC	371	64	2031	Rehabilitation	$33,242
BURLE_AV	90	AC	917	63	2031	Rehabilitation	$82,495
CALGA_AV	70	AC	1290	64	2031	Rehabilitation	$183,468
CAPIT_AV	120	AC	202	64	2031	Rehabilitation	$28,916
CENTU_AV	160	PCC	606	75	2031	Rehabilitation	$40,837
COLLE_DR	10	AC	750	64	2031	Rehabilitation	$116,188
CROCU_AV	10	AC	702	63	2031	Rehabilitation	$83,737
CROCU_AV	20	AC	739	64	2031	Rehabilitation	$86,306
D_AV	90	AC	380	65	2031	Rehabilitation	$44,044
FRAIN_RD	35	AC	62	63	2031	Rehabilitation	$5,423
INTER_AV	60	AC	328	64	2031	Rehabilitation	$46,991
INTER_AV	70	AC	333	65	2031	Rehabilitation	$47,019
INTER_AV	80	AC	268	63	2031	Rehabilitation	$51,986
LASAL_DR	80	AC	507	64	2031	Rehabilitation	$66,120
NEBRA_DR	20	AC	241	65	2031	Rehabilitation	$31,049
RIVER_DR	65	AAC	589	65	2031	Rehabilitation	$75,270
RIVERS_RD	5	AC	1201	63	2031	Rehabilitation	$143,349
ROOSE_DR	15	AC	133	63	2031	Rehabilitation	$17,091
ROOSE_DR	25	AC	827	64	2031	Rehabilitation	$105,737
VALLE_AV	10	AC	260	65	2031	Rehabilitation	$30,045
VALLE_DR	70	AC	229	64	2031	Rehabilitation	$38,609
WARD_RD	20	AC	310	64	2031	Rehabilitation	$36,088
WASHI_ST	25	AC	1070	64	2031	Rehabilitation	$83,214
WASHI_ST	305	AC	250	65	2031	Rehabilitation	$73,571
WASHI_ST	50	AAC	801	64	2031	Rehabilitation	$99,903

Jurisdiction: City of Bismarck

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
YEGEN_RD	10	AC	5041	64	2031	Rehabilitation	$478,734

Jurisdiction: Burleigh County

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
NE 52ND ST	10	AC	3,046	53	2025	Rehabilitation	$617,934
NE 52ND ST	20	AC	1,773	39	2025	Rehabilitation	$893,622
NE 52ND ST	30	AC	456	34	2025	Rehabilitation	$230,071
NE 52ND ST	40	AC	667	43	2025	Rehabilitation	$274,657
NE 52ND ST	50	AC	225	62	2025	Rehabilitation	$30,786
NE 52ND ST	60	AC	533	49	2025	Rehabilitation	$132,171
NE 71S AVE	120	AC	1,086	64	2025	Rehabilitation	$141,924
SE 52ND ST	10	AC	1,334	65	2025	Rehabilitation	$172,981
SE 52ND ST	20	AC	1,117	52	2025	Rehabilitation	$237,494
SE 52ND ST	30	AC	1,028	54	2025	Rehabilitation	$199,399
SE 52ND ST	40	AC	253	55	2025	Rehabilitation	$46,768
CENTE_RD	130	AC	3,375	65	2028	Rehabilitation	$474,515
WASHI_ST	5	AC	699	63	2028	Rehabilitation	$101,573
12TH_ST	2	AC	1,561	65	2029	Rehabilitation	$227,100
SE 48T AVE	20	AC	1,129	63	2029	Rehabilitation	$169,403
SE 48T AVE	30	AC	2,290	64	2029	Rehabilitation	$337,176
CENTE_RD	100	AC	872	64	2030	Rehabilitation	$132,505
NE 71S AVE	60	AC	1,456	64	2030	Rehabilitation	$220,115
CENTE_RD	110	AC	727	64	2031	Rehabilitation	$114,827
CENTE_RD	120	AC	1,715	64	2031	Rehabilitation	$270,938
CENTE_RD	90	AC	1,989	65	2031	Rehabilitation	$306,721
NE 71S AVE	10	AC	924	64	2031	Rehabilitation	$143,117
NE 71S AVE	50	AC	1,231	64	2031	Rehabilitation	$194,484
SE 48T AVE	50	AC	2,651	65	2031	Rehabilitation	$405,817
WASHI_ST	10	AC	941	64	2031	Rehabilitation	$148,352

Jurisdiction: City of Mandan

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
10th E NW	10	AC	69	59	2025	Rehabilitation	$10,319
10th E NW	20	AC	142	45	2025	Rehabilitation	$49,956
10th E NW	30	AC	212	64	2025	Rehabilitation	$27,501
10th E NW	40	AC	387	47	2025	Rehabilitation	$115,078
10th E NW	50	AC	408	41	2025	Rehabilitation	$199,737
10th E NW	60	AC	422	35	2025	Rehabilitation	$212,437
10th E NW	70	AC	639	43	2025	Rehabilitation	$271,746
13th E NW	50	AC	290	62	2025	Rehabilitation	$39,722
19th ST SE	10	AC	898	64	2025	Rehabilitation	$117,446
1st ST NW	10	AC	380	63	2025	Rehabilitation	$50,629
1st ST NW	110	AC	378	52	2025	Rehabilitation	$77,667
1st ST NW	120	AC	381	55	2025	Rehabilitation	$69,851
1st ST NW	130	AC	381	38	2025	Rehabilitation	$192,040
1st ST NW	140	AC	380	25	2025	Rehabilitation	$191,274
1st ST NW	150	AC	382	42	2025	Rehabilitation	$168,099
1st ST NW	20	AC	189	56	2025	Rehabilitation	$33,663
1st ST NW	30	AC	191	54	2025	Rehabilitation	$37,111
1st ST NW	50	AC	193	65	2025	Rehabilitation	$24,943
1st ST NW	60	AC	379	62	2025	Rehabilitation	$52,034
1st ST NW	70	AC	380	61	2025	Rehabilitation	$52,915
1st ST NW	80	AC	364	59	2025	Rehabilitation	$54,635
1st ST NW	90	AC	383	59	2025	Rehabilitation	$59,772
27th ST N	10	AC	571	30	2025	Rehabilitation	$287,692
27th ST N	20	AC	480	21	2025	Rehabilitation	$242,000
27th ST N	30	AC	73	18	2025	Rehabilitation	$36,654
27th ST N	40	AC	663	30	2025	Rehabilitation	$334,343
2nd AVE NW	10	AC	408	64	2025	Rehabilitation	$53,714
2nd AVE NW	20	AC	382	49	2025	Rehabilitation	$92,154
2nd ST NE	20	PCC	383	29	2025	Rehabilitation	$205,760
2nd ST NE	30	PCC	379	46	2025	Rehabilitation	$97,432
2nd ST NW	10	AC	384	59	2025	Rehabilitation	$57,940
2nd ST NW	20	AC	383	59	2025	Rehabilitation	$58,089
2nd ST NW	30	AC	380	43	2025	Rehabilitation	$155,523
2nd ST NW	40	AC	381	57	2025	Rehabilitation	$64,021
2nd ST NW	50	AC	382	60	2025	Rehabilitation	$54,426
2nd ST NW	60	AC	384	57	2025	Rehabilitation	$65,413
37th ST NW	10	AC	387	44	2025	Rehabilitation	$156,048
37th ST NW	20	AC	364	44	2025	Rehabilitation	$141,707
37th ST NW	30	AC	339	41	2025	Rehabilitation	$165,253
37th ST NW	40	AC	339	35	2025	Rehabilitation	$170,736
37th ST NW	50	AC	323	35	2025	Rehabilitation	$162,567
37th ST NW	60	AC	379	57	2025	Rehabilitation	$63,732
37th ST NW	70	AC	280	55	2025	Rehabilitation	$52,477

Jurisdiction: City of Mandan

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
37th ST NW	80	AC	913	30	2025	Rehabilitation	$459,979
37th ST NW	90	AC	1,941	53	2025	Rehabilitation	$384,324
3rd AVE NW	10	AC	407	43	2025	Rehabilitation	$168,613
3rd AVE NW	20	AC	382	29	2025	Rehabilitation	$192,600
40th E NW	20	AC	346	49	2025	Rehabilitation	$89,180
40th E NW	30	AC	233	37	2025	Rehabilitation	$117,552
43rd ST NW	10	AC	156	40	2025	Rehabilitation	$78,727
46th E SE	80	AC	395	62	2025	Rehabilitation	$54,872
4th AVE NW	10	AC	404	36	2025	Rehabilitation	$203,743
4th AVE NW	20	AC	385	42	2025	Rehabilitation	$167,939
5th AVE NW	10	AC	382	33	2025	Rehabilitation	$192,486
6th AVE SE	100	AC	732	59	2025	Rehabilitation	$111,064
6th AVE SE	80	AC	201	54	2025	Rehabilitation	$39,377
6th ST NW	10	AC	276	62	2025	Rehabilitation	$37,660
6th ST NW	50	AC	261	48	2025	Rehabilitation	$73,930
6th ST NW	60	AC	334	43	2025	Rehabilitation	$137,342
6th ST NW	70	AC	599	54	2025	Rehabilitation	$117,166
6th ST NW	80	AC	374	64	2025	Rehabilitation	$49,050
E MAI ST E	10	AC	61	48	2025	Rehabilitation	$17,096
E MAI ST E	20	AC	433	65	2025	Rehabilitation	$56,123
MEMOR Y SE	100	AC	175	60	2025	Rehabilitation	$24,932
MEMOR Y SE	120	AC	303	64	2025	Rehabilitation	$40,114
MEMOR Y SE	140	AC	399	64	2025	Rehabilitation	$51,974
MEMOR Y SE	40	AC	1,969	62	2025	Rehabilitation	$273,823
MEMOR Y SE	50	AC	1,173	64	2025	Rehabilitation	$153,235
MEMOR Y SE	70	AC	1,173	57	2025	Rehabilitation	$197,986
MEMOR Y SE	80	AC	361	58	2025	Rehabilitation	$56,506
OLD R L NW	20	AC	1,868	64	2025	Rehabilitation	$246,977
RIVER E SE	10	AC	1,908	64	2025	Rehabilitation	$251,008
SUNSE R NW	100	AC	675	48	2025	Rehabilitation	$185,346
SUNSE R NW	90	AC	441	53	2025	Rehabilitation	$87,736
1st ST NW	40	AC	186	63	2026	Rehabilitation	$25,436
27th ST NW	10	AC	654	63	2026	Rehabilitation	$89,621
46th E SE	10	AC	466	64	2026	Rehabilitation	$63,172
MEMOR Y SE	10	AC	1,588	63	2026	Rehabilitation	$218,927
13th E NW	10	AC	381	65	2027	Rehabilitation	$52,005
19th ST SE	20	AC	1,116	64	2027	Rehabilitation	$154,756
6th AVE SE	90	AC	155	64	2027	Rehabilitation	$21,646
8th AVE NW	10	AC	925	64	2027	Rehabilitation	$128,496
DIVIS T NE	10	AC	625	64	2027	Rehabilitation	$86,793
MAIN ST E	10	AC	811	63	2027	Rehabilitation	$115,178
MCKEN R SE	50	AC	362	64	2027	Rehabilitation	$50,682
MEMOR Y SE	110	AC	937	63	2027	Rehabilitation	$132,949

Jurisdiction: City of Mandan

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
MEMOR Y SE	20	AC	2,195	63	2027	Rehabilitation	$309,782
MEMOR Y SE	30	AC	782	64	2027	Rehabilitation	$109,812
MEMOR Y SE	60	AC	709	64	2027	Rehabilitation	$99,446
MEMOR Y SE	90	AC	150	64	2027	Rehabilitation	$21,109
13th E NW	30	AC	130	64	2028	Rehabilitation	$18,835
13th E NW	40	AC	192	64	2028	Rehabilitation	$27,794
19th ST SW	20	AC	1,218	64	2028	Rehabilitation	$174,494
19th ST SW	30	AC	875	65	2028	Rehabilitation	$122,774
19th ST SW	40	AC	576	64	2028	Rehabilitation	$82,593
40th E SE	60	AC	185	64	2028	Rehabilitation	$26,514
46th E SE	20	AC	263	64	2028	Rehabilitation	$38,071
46th E SE	60	AC	161	65	2028	Rehabilitation	$22,630
9th AVE NE	40	AC	382	63	2028	Rehabilitation	$56,102
DIVIS T NW	10	AC	180	64	2028	Rehabilitation	$25,544
MCKEN R SE	40	AC	122	65	2028	Rehabilitation	$17,131
MCKEN R SE	90	AC	426	64	2028	Rehabilitation	$60,538
MISSO R NE	30	AC	294	64	2028	Rehabilitation	$41,959
SUNSE R NW	80	AC	355	64	2028	Rehabilitation	$50,653
24th E SE	10	AC	239	64	2029	Rehabilitation	$35,142
46th E SE	30	AC	571	65	2029	Rehabilitation	$82,815
MCKEN R SE	110	AC	48	63	2029	Rehabilitation	$7,196
MCKEN R SE	130	AC	318	65	2029	Rehabilitation	$46,136
13th E NW	20	AC	383	64	2030	Rehabilitation	$58,317
2nd ST NE	90	AC	381	65	2030	Rehabilitation	$57,256
46th E SE	140	AC	478	65	2030	Rehabilitation	$71,296
46th E SE	70	AC	223	64	2030	Rehabilitation	$33,580
MEMOR Y SE	130	AC	819	64	2030	Rehabilitation	$124,120
MEMOR Y SE	160	AC	379	65	2030	Rehabilitation	$56,835
SUNSE R NW	60	AC	372	65	2030	Rehabilitation	$55,820
19th ST SE	30	AC	667	63	2031	Rehabilitation	$106,358
2nd ST NE	130	AC	380	65	2031	Rehabilitation	$58,174
2nd ST NE	80	AC	376	63	2031	Rehabilitation	$60,051
32nd E SE	10	AC	851	65	2031	Rehabilitation	$130,274
3rd ST SE	130	AC	424	64	2031	Rehabilitation	$66,776
3rd ST SE	60	AC	874	64	2031	Rehabilitation	$136,105
46th E SE	40	AC	582	65	2031	Rehabilitation	$89,751
9th AVE NE	20	AC	378	64	2031	Rehabilitation	$59,033
MEMOR HWY	10	AC	595	64	2031	Rehabilitation	$93,122

Jurisdiction: Morton County

Branch ID	Section ID	Surface	Section Length (ft)	PCI Before	Year	M&R Level	Cost
19th ST SE	110	AC	332	64	2025	Rehabilitation	$43,737
BS LP LOOP	30	AC	289	63	2025	Rehabilitation	$38,716
HWY 1806 S	20	AC	2,304	64	2025	Rehabilitation	$303,239
HWY 1806 S	30	AC	296	65	2025	Rehabilitation	$38,124
HWY 1806 S	40	AC	916	60	2025	Rehabilitation	$135,294
HWY 1806 S	60	AC	261	64	2025	Rehabilitation	$34,392
SUNSE R NW	70	AC	915	55	2025	Rehabilitation	$169,230
HWY 1806 S	10	AC	275	65	2026	Rehabilitation	$36,577
BS LP LOOP	20	AC	402	64	2029	Rehabilitation	$60,037
19th ST SE	120	AC	892	64	2030	Rehabilitation	$135,838
HWY 1806 S	50	AC	838	65	2030	Rehabilitation	$125,562
MANDA PY W	10	AC	788	64	2030	Rehabilitation	$118,855
OFF RAMP	20	AC	1,064	65	2030	Rehabilitation	$158,194