Memorandum

To: Distribution

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From: Mary Gayle Padmos, Pavement Management Unit Engineer

Review: Jeff Jackson, Pavement and Geotech Bureau Chief

Date: March 31, 2022

Subject: 2021 Pavement Performance and Condition Report

The Pavement Analysis Section has completed its 2021 Pavement Condition and Treatment Report. The report concentrates on the current pavement condition, recommended treatments, and estimated cost of performing the recommended treatment for each management section on the Interstate, NHS, Primary, and Secondary Systems.

Recommended treatments are available electronically. Print copies are available on request.

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PvMS Files
1.0 Executive Summary
This report discusses statewide pavement condition and performance based on data collected in 2021. The analysis addresses performance highlights, potential treatments, and financial needs to keep Montana’s Interstate, Non-Interstate NHS, STP-Primary and Secondary in good repair.

1.1 Pavement Performance and Condition
Montana’s highway network pavement is in good to fair condition. Pavements in good to fair condition may have visible traffic wear with low to moderate severity cracking and minimal to slight rutting. Poor pavements have prevalent cracking and heavy rutting and patching. MDT’s Overall Performance Index (OPI) combines ride, rutting and cracking as a measure to assess overall health of the pavement network. Figure 1 depicts the pavement health for each district.

All five districts have most of their mileage in the good category. Both Missoula and Glendive have three percent or more measuring poor. Statewide the poor percentage reduced slightly on the NHS in the 2021 data. The Great Falls and Billings districts both had two percent move from good to fair. In the Billings district the good to fair movement was on the Interstate system and in the Great Falls district it was on the NHS system.

![Figure 1 – OPI by District](image)

Ride Quality is a functional performance metric and is the term for pavement smoothness. Figure 2 presents the percentages of good, fair, and poor for each system. The Interstate with the highest percentage in the good category had a movement of 2.8 percent good to fair. The blue dot depicts the average System Ride Index for each system. The Ride trend is shown in Figure 7.
Rutting is evaluated by measuring rutting depth of the wheel paths in inches and converted to an index. Rut averages 0.5 inches or more are considered a poor condition. Overall, in terms of rutting, the Montana highway network is in good condition. Of the four systems, the Non-Interstate NHS demonstrates the most rutting with the lowest percentage in the good rut category at 76 percent. The NHS Rut Index trend line depicts a decreasing trend since 2013.

The FAST Act established measures by which FHWA monitors pavement performance. The Interstate and Non-Interstate NHS are tracked in one-tenth mile intervals. Each individual interval assigns the metrics (Ride, Rut, and Cracking) a good, fair, or poor rating. The three individual ratings are combined for an overall classification. A “Good” classification represents the Ride, Rut, and Cracking (wheel path) ratings are all in good category. For a “Fair” classification, any combination of good, fair, or poor where only one of the three is rated poor. A “Poor” classification represents two or all three of the metrics are rated poor. Figure 4 depicts the statewide pavement health combined by the Federal measures for ride, rut, and cracking.
Fiscal Needs

Fiscal needs represent the total estimated cost generated by the treatments recommended to bring road segments to a good condition. The 2022 network fiscal need for the four systems is $1.26 billion. This is a $130 million increase over the 2021 projection. Increased materials costs in 2021 and additional need for pavement preservation account for the growth in fiscal need for the Montana highway network. A more detailed discussion of the recommended treatments and the associated need can be found in Section 2.

In comparison to 2021, the total miles needing Crack Seal and Cover (CS&C) almost doubled. The new Preservation decision tree incorporated in to the PvMS decision trees improves selection timing of the pavement preservation treatments and documents preservation need in the pavement life cycle. The new decision tree accounted for eighty percent of the increase in the CS&C treatment recommendation. Thin overlay is second highest recommended mileage for 2022. Overlays had a 24 percent cost increase in 2021. Figure 5 distributes the fiscal need by treatment types. The preservation category combines the crack seal, chip seal and overlay treatment needs and is approximately 60 percent of the needs on MDT’s network.

Figure 5 – 2022 Fiscal Needs by Surfacing Category

Figure 6 categorizes the fiscal need by system. The Non-Interstate NHS and Secondary systems both have approximately $400 million in need. The NHS is funded through Px3 distribution for MDT’s pavement assets. The Secondary system is funded through legislative directives. Current
funding is inadequate to curtail the current growth needed in improvements. Additional funding in conjunction with a pavement preservation management plan addressing the levels of treatment needs may inhibit the growth on the Secondary system.

Figure 6 – 2022 System Needs

**Recommendations**
Currently, Montana’s highway systems are performing well, with the systems in fair to good condition. The data demonstrates the several areas of concern. Approximately 40 percent of the pavement needs in Missoula and Glendive districts need an overlay or higher treatment. Emphasis on preservation treatments in those districts will provide a firewall to expansion of degradation. Continued use of treatments like microsurfacing address rutting conditions. Chip seals continue to be the primary method to rejuvenate the surface and provide protection to the subsurface.

The Secondary system ride performance has 10 percent in the good quality. The system has approximately 1400 miles of Thin Overlay recommendations. Funding for the secondary pavement preservation should be increased to keep good segments in good condition. Recycling treatments may help address those segments closer to rehabilitation or that have width limitations.

2.0 Discussion: Pavement Condition, Treatments, and Needs Analysis

The following provides additional discussion of the pavement condition and trends of Montana’s highway systems based on 2021 data. The discussion includes the recommended treatments and funding implications of the treatments to maintain the highway systems in a state of good repair.

**Data Analysis Improvement**

Pavement Management continued efforts in 2021 to improve the Pavement Management System (PvMS) performance analysis. Decision trees in the PvMS predict future treatments based on projected condition by the performance curves. The decision tree branches recommend treatments for each level of condition ranging from Do Nothing to Reconstruction depending on visible pavement distress levels.

In 2021 Pavement Management implemented a Preservation decision tree to address timing issues with the Crack Seal and Cover treatment recommendations. The original decision trees recommended Crack Seal and Cover (CS&C) during a five-year window between years 7 and 12
after a surfacing. After a segment reached age 13 years or more, a good performing pavement sections wouldn’t be captured for preservation treatments until a condition metric, like ride triggered an overlay treatment. The new Preservation decision tree screens for pavement sections seven years and older without a recorded chip seal within the last seven years. This incorporates the cyclic need for CS&C into the PvMS pavement life cycle. The preservation treatment recommendations increased with this additional decision tree.

**Pavement Performance and Condition**
The pavement performance and condition metrics for the Interstate, Non-Interstate NHS, Primary and Secondary systems depict fair to good level of each metric. The following metrics will be discussed further below: ride, rut, alligator cracking and miscellaneous cracking.

**Ride**
The functional performance metric and the term for pavement smoothness is Ride Quality. In Figure 1 above, the distribution of good, fair, and poor mileage is depicted for each system. The blue dot represents the average 2021 Ride Index for each system. This value becomes the last point on the trend line chart in Figure 7. The Interstate system continues to have the highest performance level in 2021 with 71.8 percent good. The good ride category decreased 2.8 percent compared to 2020. The ride index measures remained stable in 2021 for all systems.

**Figure 7 – Average Ride Index by System**

**Cracking**
Pavement condition is measured by distress assessment for rutting and cracking. The two cracking measures report environmental and structural (load related). The system level metric for environmental, known as Miscellaneous Cracking Index (MCI), is in good condition for all the systems with an average index of 94 or higher. Alligator cracking (ACI) or structural cracking is in good condition for all systems at an average index of 97. Figure 8 shows the percent of the combined systems below an index level of 90.
Rutting
For the rutting metric, the Non-Interstate NHS is the lowest performing system. Figure 9 depicts the good-fair-poor distribution by system. The total poor rutting for all four systems is 63 miles. Project segments totaling 38 miles on the NHS Non-Interstate system rate as poor. The Missoula district has 29.6 miles in poor rut condition. Of those miles, the Kalispell Division has 20 miles on the NHS in addition the Primary system has 19 miles in this category.
Figure 10 – 2021 Poor Rut by District and System

Figure 11 below depicts the rutting trends for the four systems. Rutting on NHS system trends downward over the last 10 years. The average Rut index decreased by six percent statewide over these 10 years. The three districts with a larger percent decrease are Missoula, Butte, and Great Falls.

Figure 11 – Average Rut Index by System

Overall Performance Index
MDT has an Overall Performance Index (OPI) as a comprehensive health index with weighted combination of ride, rut, and cracking. The four highway systems are combined in Figure 12 for the trend comparison. MDT’s project selection and maintenance efforts continues to keep the majority of MDT’s network is fair to good with two percent poor. The segments with poor OPI total 257 miles and have an average age of 44 years.
Combined Interstate, Non-Interstate NHS, Primary and Secondary – Overall Performance Index (OPI) is a mathematical calculation combining Ride, Rut and Cracking indices into one index.

**Figure 12 – Network* Condition – OPI Trend**

In Figure 12 below, the district OPI distributions demonstrate every district has more than 50 percent of its highway systems categorized as good. The Missoula district has the largest percentage of OPI categorized as poor at 120 miles. Of which the Primary system has the most with 50 miles and the Interstate with 7 miles. Two-thirds of Glendive district’s poor rating is on the Secondary system totaling 64 miles.

**Figure 13 – OPI by District**

**FHWA Pavement Condition**

MDT quantifies condition reporting at the project segment length (construction project limits) in comparison to the FHWA Federal condition reporting requirements for the Interstate and Non-Interstate NHS systems quantify condition at one-tenth mile intervals. Each individual interval assigns the metrics (Ride, Rut, and Cracking) a good, fair, or poor rating. The three individual
ratings are combined for an overall classification. A “Good” classification represents the Ride, Rut, and Cracking (wheel path) ratings are all in good category. For a “Fair” classification, any combination of good, fair, or poor where only one of the three is rated poor. A “Poor” classification represents two or all three of the metrics are rated poor.

Figure 10 depicts the 2021 data assessed by the Federal metrics with a fair to good distribution for both systems. When combining ride, rut, and cracking, 56 percent of the Interstate rates as good. A two percent increase from 2020. The Non-Interstate NHS distribution remained the same as 2020 with a very slight increase from 1.25 to 1.37 percent in poor condition. The NHS has 33.5 miles rate poor by the Federal metrics. Missoula district accounts for 14.9 miles and Glendive district accounts for 11.1 miles. Thirty-two routes have between 0.1 and 7.2 miles rated poor.

![Pie charts showing Interstate and Non-Interstate NHS ratings](image)

**Figure 14 – FHWA Performance Measures**

**Work Program Recommendations for 2022**

Pavement preservation philosophy addresses keeping good roads good. The addition of the ‘Preservation decision tree’ emphasizes light preservation like Crack Seals and Covers. The new tree added approximately 2100 miles which had seven or more years since the previous seal treatment.
The age of a roadway segment is calculated from the last construction project with plant mix surfacing. Figure 16 depicts the annual length of new projects completed, as well as the associated Ride Index by year. Initially the Ride Index averages above an 80 before beginning to decrease. Comparing the average accumulated miles of two 10-year periods, 2012-21 and 2002-11, the last period decreased in annual treated mileage from 296 miles to 277 miles. Table 1 below lists each system’s 2021 average age. The Primary system average age decreased from 18 to 17 years.

* Combined Interstate, Non-Interstate NHS, Primary and Secondary

Table 1 - Average System Age in Years Since Last Treatment with Surfacing
As shown in Figure 15, the predominant recommended treatment is Crack Seal and Cover with 5800 miles. As a light preservation treatment, the age clock does not reset. Thin Overlays do reset the age clock with the new surfacing and the 2022 projection has 1900 miles of needed overlays.

The overlay miles on the Secondary system continues to increase with a total of 1100 miles. Most of the minor rehabilitations are also on the Secondary system. Both are indicators of underfunding this system where the higher-level treatments account for more miles than the lighter preservation treatments.

The backlog of recommended treatments is depicted in Figure 17. Glendive district has the most mileage with more than 2500 miles including 1186 miles of overlay and rehabilitation treatments. The Missoula district has the most rutting treatment recommendations for 164 miles and reconstruction with 68 miles.

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*Figure 17 – Recommended Treatment Backlog by System*
Pavement preservation is a strategy to keep good roads in good condition by choosing the right treatment at the right time. The balance between maintaining good roads in good condition and addressing segments in a deteriorating condition is a difficult choice. Sealing treatments offer a lower cost choice to keep the surface treatment rejuvenated and help mitigate the substructure from moisture damage. Preservation approaches adapting multi-level treatments with varying life extensions provide the best opportunity to address more miles. For example, annual preservation nominations should include standalone crack seal and chip seals to maintain surface conditions, while including plant mix treatments like overlays and recycling to address surface distress.

**Fiscal Need Highlights for 2022**

Fiscal need represents the financial implications of the recommended treatments generated by a scenario using unlimited funding. This allows a pavement condition metric to trigger a roadway treatment. The 2022 fiscal need for the Interstate, Non-Interstate NHS, Primary and Secondary systems pavement is $1.26 billion. This is a $130 million increase to the 2021 projection. The increase comes from the new ‘Preservation decision tree’ which provides an improved mechanism for recommending Crack Seal and Covers; as well as the increased material costs in projects during 2021 bid lettings. The inflation impacts from early 2022 are not included in the increase.

Figure 19 compares the 2021 and 2022 need distribution. The $130 million increase affects all four systems, with the Interstate having the largest portion. Overall, the Secondary continues to be the highest at $412M, an $18 million increase from 2021. Figure 20 depicts the statewide need distribution by treatment. Lighter preservation treatments account for $800 million.
Most of the need on the Interstate is light preservation treatments. The Non-Interstate NHS has significant needs in Glendive and Missoula districts with approximately $130 million each. In addition to the needs on the NHS, the Glendive district has equivalent needs on the Primary and Secondary systems. The Great Falls district fiscal need is heavily swayed by the Secondary system. The scenario analysis for this report projects a Pavement preservation funding need of $800 million for the entire state. While challenges of funding the Secondary continue, emphasis on preservation is needed to prevent growth in the rehabilitation treatment needs. Further delay addressing the Secondary preservation needs will result in decreased performance and condition, requiring more expensive construction techniques to repair.
3.0 COST ANALYSIS

Annually, Pavement Management determines pavement treatment costs using the current year’s construction costs. Pavement project bid tabulations are evaluated by determining the project’s treatment type (i.e., Reconstruction, Rehabilitation, Thin Overlay, or Seal & Cover). To minimize variability bid items must occur in at least 75% of projects within each treatment type and will reflect most projects in the treatment type. For example, a few items not included in pavement preservation treatment cost analysis are seeding, cattle guards and signs. The cost per square yard (cost/yd²) is the project cost divided by the project’s pavement surface area. Each treatment cost are averaged for the Federal fiscal year and used to develop the individual project costs for the year and summarized in the fiscal need section. The costs are shown in Figure 22.

Materials costs increased in 2021 reversing the decrease in 2020. The light and medium preservation treatments calculated higher than 2019. The complexity of Major Rehabilitation and Reconstruction projects affect the cost averages. These increased over 2020 but continue to be less than 2019.
Montana’s highway systems continue to perform well overall, with 98 percent of the system being in good/fair condition. The travelling public may notice visible traffic wear with low to moderate severity cracking and minimal to slight rutting. From a statewide perspective, light pavement preservation category represents most centerline miles in need of treatment. The addition of the Preservation decision tree highlights CS&C keeping the good roads good. The backlog of overlays emphasizes the necessity of the right treatment on the right road at the right time to prevent degradation to minor rehabilitation.

At the current funding levels for pavement preservation and increased costs due to inflation, it is expected the overall minor rehabilitation and major rehabilitation backlog will continue to grow. Particularly in the Glendive and Missoula districts where 40 percent of their recommended treatments are beyond light pavement preservation. Pavement Management recommends increasing pavement preservation funding statewide and use of innovative treatments to expand the treated miles.

While securing a funding solution for the Secondary system is problematic, there are other ways each District can work to improve or maintain the condition of their roadways. Light preservation treatments provide rejuvenation and protection of the pavement structure investment. A varied program mix of light preservation with medium preservation will extend the life of more miles and projects will have differing lifespans before the next treatment. Pavement preservation projects must be nominated and constructed in the two-year period.

Each district has unique challenges impacting the condition of their roadways. It is beyond the scope of this report to detail the options each district could take to improve the condition of their
roadways. The Pavement Management Unit would like to offer our services to help with each District formulating a long-term plan to maintain and/or improve their roadway conditions. Each district is encouraged to set up a consultation with Pavement Management to develop a pavement condition improvement plan.

5.0 Pavement Distress Data Collection Summary and Reporting

MDT’s Pavement Analysis Section annually conducts a Pavement Condition Survey (PCS) of Montana’s Interstate, Primary and Secondary highway systems.

Data Quality Management

One requirement of implementing the Transportation Asset Management Plan (TAMP), included a Data Quality Management Plan (DQMP). The DQMP implemented by the Pavement Management unit includes multiple steps to quality check and verify collected data. The unit utilizes a “ground truth” site for manually comparing visual cracking distress to distress identified by the analysis algorithm.

Annually, the Pavement Management unit verifies that the automated system has identified the correct distress, severity, and extent of cracking. The weekly random samples passed verification matching at 94 percent. Pavement Management personnel assessed 2200 samples for post collection quality checks. A sample passes when it matches 80 percent or better between the observed distress and the computer identified distress. The 2020 data collection passed the quality check with 92 percent.

The Pavement Analysis Section maintains a database which includes annual PCS data, and maintenance and construction history. The database is used to conduct a systematic, objective evaluation identifying the maintenance, rehabilitation, and reconstruction needs.

Reporting

The current pavement condition, recommendations for future pavement treatments, and an estimation of the fiscal resources required to keep the highway systems in good condition are available in multiple formats listed below as well as in print. The “Report Development Section” details collection and condition metric information. It is available with the district printed reports and on the Intranet.

Report is available on both MDT Intranet and the Jasper Reports

This year’s report is also available electronically as follows:

1. Jasper Reports. The report can be accessed by logging into MDT’s Jasper Reports on the Intranet. “Resources”>“Online Applications”>“Jasper Reports” under GENERAL heading> click “View” >“Library”> scroll to ”PvMS Condition Treatment Dashboard” Leave ‘Year” blank for current year. Select report by district or route.

2. MDT Intranet: The trend analysis portion of the report can be found by clicking on “Resources”>“Reports”>”Pavement Analysis -- Pavement Condition and Treatment Report”.


3. MDT Intranet: Condition and recommended treatments portion of the report can be found by clicking on “Resources”>“Online Applications”>“Pavement Analysis -- Pavement Condition Treatment Report Report” or “Field Review Report”.

**Definitions of Recommended Treatments**

The definitions of recommended treatments follow the Guidelines for Nomination and Development of Pavement Projects. This document, approved by the Federal Highway Administration, MDT and the Transportation Commission, provides clear guidance for the development of Preventive Maintenance, Rehabilitation and Reconstruction projects.

**Feedback and Additional Analysis**

Your input and feedback are very important to us. Specific system, route, management section, treatment, or condition reports and summaries can be generated upon request. If you have an idea or suggestion on how to improve our analysis and/or reporting, please contact Mary Gayle Padmos mpadmos@mt.gov or DJ Berg djberg@mt.gov.

**Acknowledgements**

The production of this report was greatly benefited by the efforts of numerous individuals both within and outside the Pavement Analysis Section.

Mary Gayle Padmos, Pavement Management Engineer and her staff:
Billy Hancock, Kim D’Arcy, Trent Rouse, AJ VanDaele and Grace Ludlow