Montana Department of Transportation
Research Programs
April 2020

EXPERIMENTAL PROJECTS PROGRAM

EVALUATION OF VARIOUS BITUMINOUS CONCRETE PAVEMENT SURFACE TREATMENTS

Location:	Highways US 89 & 287 - Counties: Lewis & Clark, Teton, Pondera, and Glacier
Project Name:	Augustus North/SE of Dupuyer/US 89 N of Dupuyer
Project Numbers:	STPP-NHTSA 3-3(23)6/STPP 9-1(20)40/Maintenance Project
Type of Project:	Pavement Surface Treatments
Principal Investigator:	Craig Abernathy, Experimental Projects Manager (ExPM)
Technical Contact:	Justun Juelfs, MDT Maintenance Reviewer
Date of Installations:	Summer 2014
Date of Documentation:	09/2014, 06/2015, 06/2016, 06/2017, 05/2018, 04/2019 & 03/2020

Description

Compare the following three types of surface applications under similar environmental and traffic conditions over time to determine benefits of each treatment:

-Chip Seal (CS)
-Fog Seal over Chip Seal (FSCS)
-Micro-Surfacing (MS)

Section Locations

-**CS**: SE of Dupuyer SE/Route 89/Approximate reference point 65-71
-**FSCS**: North of Dupuyer/Route 89/Approximate reference point 89-101
-**MS**: Augustus North/Route 287/Approximate reference point 39-52

Evaluation Procedures

The Experimental Program will conduct long-term documentation on the installations in an attempt to establish performance with the surface applications and to ascertain

applicable comparisons between the three projects and any other measurable outcomes. The measure of effectiveness (MOE) prevalent with this project will focus on:

- Long-term durability (e.g. chip embedment and retention, raveling, bleeding, etc.)
- Striping Durability (including retroreflectivity if collected)
- Skid Retention (when conducted)

Construction Documentation: Research participation in the project analysis is after the installations were completed. This report will only detail performance.

Post Documentation: Research will visually inspect the sites biannually (late fall/early spring) for inclusion into the annual report.

All project sections will be generally inspected (and visual pavement documentation if required) throughout their entire lengths. There are sites selected (at mileposts within each project) for specific examinations added concurrently to the ongoing reporting.

Skid reporting will be the responsibility of the Materials Bureau, Pavement Management Section.

Maintenance personnel will provide pavement striping retroreflectivity information as made available to be included in this report.

This report and other information located at: *http://www.mdt.mt.gov/research/projects/ac-seal.shtml*

The purpose of an experimental projects report is to document the phases and events of any given experimental feature to provide the reader with an understanding of the specific activities required to install or incorporate the research element into an active construction or maintenance project.

This report also establishes a baseline for defining performance for any given feature under actual service conditions to determine its relative merits.

The information in this report reflects digital documentation that represents the overall general condition for the three treatments. All values in this report are approximate.

Analysis to Date: June 2015

All sections, based on visual inspections, are performing well. Pavement marking condition is good; all mats are tight in appearance evidence of good chip retention. No evidence of raveling observed except the anomaly documented on a short section of the micro-surfacing project.

-The **CS** south end section has been reduced (estimated) in length at 1.5 miles that now begins close to the county road 33 RD. NW, due to a reconstruct project in progress.

-The **FSCS** section, as documented in September 2014, had a layer of residual bitumen on the surface exposed aggregate (page 9); which most of that layer has now flaked or

oxidized most likely due to environmental exposure and traffic (page 11). Visually the aggregate has a tight compaction within the residual asphalt content (RAC). During the inspection, faint impressions depicting underlying transverse cracks were visible on the pavement surface (page 12).

-The **MS** section shows slight topical oxidation with the dense graded aggregate. Longitudinal and transverse cracking has appeared but rated as low-severity (page 17).

Located approximately 1200' north of mile point 47 was area with surface distress (assumed raveling) which required spot velocity patching (see page 18). The length of this area of repair was at approximately 150'.

Analysis to Date: June 2016

All sections, based on visual inspections, are performing well with minimum to report from last year's inspection. Pavement marking condition is good; The CS and FSCS sections appear tight in appearance evidence of good chip retention to date.

The MS section has the most documented distress with transverse cracks (which are sealed). No evidence of additional raveling observed except the anomaly documented on a short section of the micro-surfacing (MS) section as documented in 2015. In addition, on the MS project, is an area of milled surface on the southbound lane at the south end of the Sun River Bridge (RP 43), see page 31.

It may take several more seasons before a performance trend with these three treatments is apparent.

Analysis to Date: June 2017

All sections, based on visual inspections, are performing well with minimum to report from last year's inspection. Pavement marking condition is good; The CS and FSCS sections appear tight in appearance evidence of good chip retention to date.

The MS section has the most documented distress with transverse cracks (which are sealed). No evidence of additional raveling observed except the anomaly located on a short section of the micro-surfacing (MS) segment as documented in 2015 (approximate RF 47). In addition, on the MS project, the area of milled surface on the southbound lane at the south end of the Sun River Bridge (RP 43) has been patched, see page 34.

It may take several more seasons before a performance trend with these three treatments is apparent.

Analysis to Date: May 2018

The spring 2018 site inspections mirror the same pavement condition as detailed in 2017 inspection. All pavement treatments are performing well (other than the specific sites detailed in the MS section of the project).

To date no specific trends of treatment performance is apparent; the next full project

inspection will be in the spring of 2019.

Analysis to Date: April 2019

The spring 2019 site inspections mirror the same pavement condition as detailed in 2018 inspection. All pavement treatments are performing well (other than the specific sites detailed in the MS section of the project).

To date no specific trends of treatment performance is apparent; the next full project inspection will be in the spring of 2020.

Analysis to Date: April 2020

All project sections still exhibit good performance on the respective treatments. The MS section which had (several seasons ago) received a crack seal, those cracks have mitigated through the seal.

Skid Resistance Numbers

The following skid numbers (SN) were collected on September 2014:

- Reconstruct with Chip Seal – SE of Dupuyer SE/Route 89/Approximate reference point 65-71: Average on both lanes – **SN 64**

- ***Fog Seal over Chip Seal – North of Dupuyer/Route 89/Approximate reference point 89-101: Average on both lanes – **SN 49**

- Micro Surfacing – Augustus North/Route 287/Approximate reference point 39-52: Average on both lanes – **SN 67**

*This SN may be initially low due to the emulsion coating on the aggregate. The SN may increase as this topical coating, worn off by traffic or environmental elements expose more surface area of the chips.

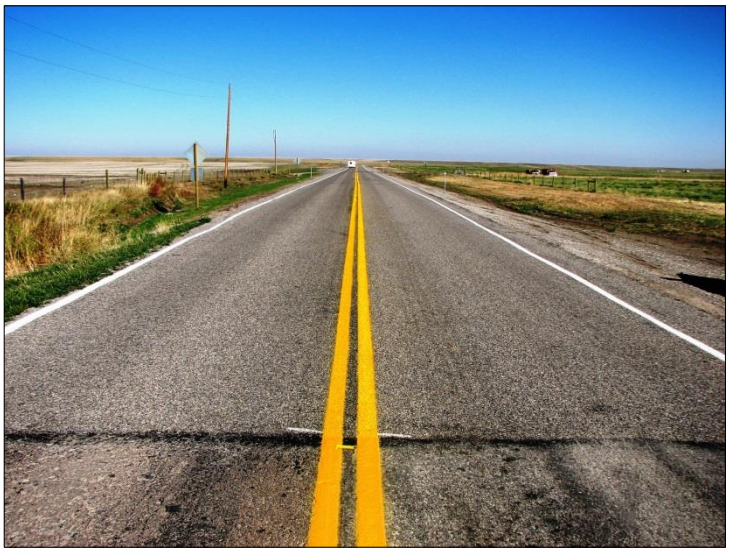
Skid data was not collected for 2015-2018. A request has been made to conduct skid testing in 2019.

Traffic Data: The average AADT through this corridor is 697.

The following are representative images of each of the three project treatments and supplemental information.

- **CS Project**; starting at Page 5
- **FSCS Project**; starting at page 19
- **MS Project**; starting at page 35

Chip Seal Section– Route 89/Approximate Reference Point 65-71: September 2014



🡸 Beginning of chip seal: Reference point 64.6; view north.



🡸 End of chip seal: Mile point 71 – view south.



🡸 Example image of selected location marked on site for visual documentation (MP 67).



Representative surface image of general condition of chip seal.

Close-up of chip embedment.



Chip Seal Section – Route 89/Approximate Reference Point 65-71: June 2015



🡸 Beginning of chip seal: A reconstruct project has encroached on the south end of the CS and reduced the section to the intersection of county road 33 RD. NW; near estimated to be at RP 66.5; view north.



🡸 Representative image of general condition of the CS section – reference point 67.



🡸 North end of project; view south.



⬆ Representative image of general condition of chip seal surface.

⬇ Close-up of chip embedment.



Chip Seal Section – Route 89/Approximate Reference Point 65-71: June 2016



🡸 Beginning of chip seal near intersection of county road 33 RD. NW; near estimated to be at RP 66.5; view north.



🡸 Representative image of general condition of the CS section – reference point 67.



🡸 North end of project; view south.



⬆ Representative image of general condition of chip seal surface.

⬇ Close-up of chip embedment.



Chip Seal Section – Route 89/Approximate Reference Point 65-71: June 2017



🡸 Beginning of chip seal near intersection of county road 33 RD. NW; estimated to be at RP 66.5; view north.



🡸 Representative image of general condition of the CS section – approximate reference point 67.



🡸 North end of project; view south.



Representative image of general condition of chip seal surface.

Close-up of chip embedment.



Chip Seal Section – Route 89/Approximate Reference Point 65-71: May 2018



🡸 Beginning of chip seal near intersection of county road 33 RD. NW; estimated to be at RP 66.5; view north.



🡸 Representative image of general condition of the CS section – approximate reference point 68.



🡸 North end of project; view south.



⬆ Representative image of general condition of chip seal surface.

⬇ Close-up of chip embedment texture.



Chip Seal Section – Route 89/Approximate Reference Point 65-71: April 2019



🡸 Beginning of chip seal near intersection of county road 33 RD. NW; estimated to be at RP 66.5; view north.



🡸 Representative image of general condition of the CS section – approximate reference point 67.



🡸 North end of project; view south.



Representative image of general condition of chip seal surface.

Close-up of chip embedment texture.



Chip Seal Section – Route 89/Approximate Reference Point 65-71: March 2020



🡅 Beginning of chip seal near intersection of county road 33 RD. NW; estimated to be at RP 66.5; view north.

🡇 North end of project, approximate reference point 70.5; view south.





🡸 🡻 General condition of the chip seal surface.

Other than anomalous areas of the project (such as minor scrapes, gouges, etc.) the overall condition of the treatment is good.



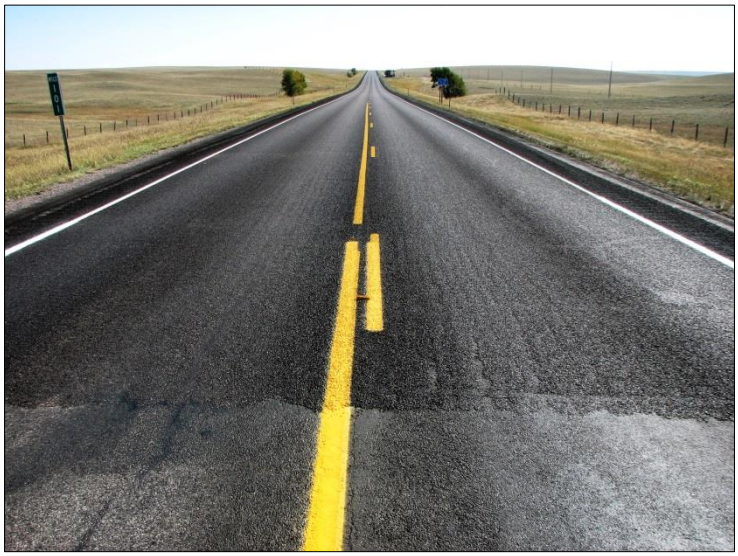


🡸 Closer view of the chip seal surface.

Fog Seal over Chip Seal (FSCS) – Route 89/Mile Point 89-101: September 2014



🡸 Beginning of fog seal over chip seal (FSCS): Mile point 89 – view north.



🡸 End of fog seal: Mile point 101 – view south.



🡸 Example image of selected location marked on site for visual documentation (reference point 95).

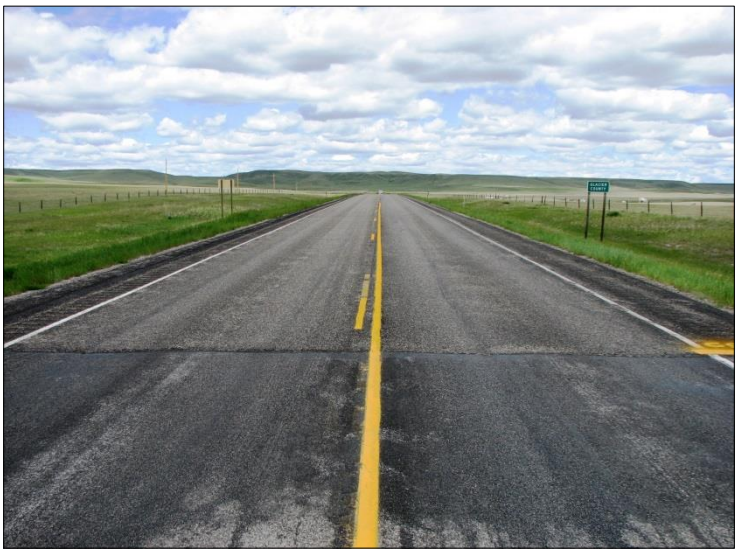


Sample image of general condition of fog seal surface.

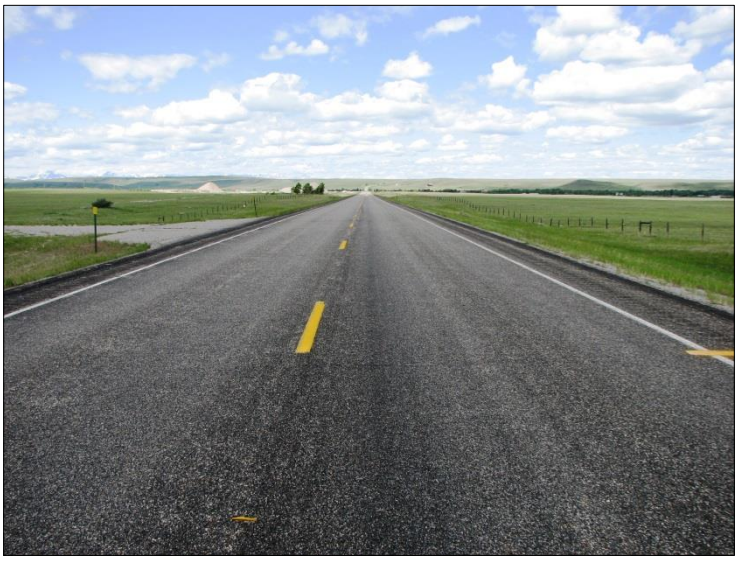
Close-up of fog seal chip embedment.



Fog Seal over Chip Seal (FSCS) – Route 89/Mile Point 89-101: June 2015



🡸 Beginning of fog seal over chip seal (FSCS): Mile point 89; view north.



🡸 Representative image of general condition of the FSCS section – reference point 95.



🡸 North end of fog seal over chip seal (FSCS): Mile point 101; view south.



Representative image of general condition of fog seal surface.

Close-up of fog seal chip embedment.





⬆ No active transverse cracking observed to date, however shadowing of milled and sealed cracking is apparent.

Fog Seal over Chip Seal (FSCS) – Route 89/Mile Point 89-101: June 2016



🡸 Beginning of fog seal over chip seal (FSCS): Mile point 89; view north.



🡸 Representative image of general condition of the FSCS section; view north.



🡸 North end of fog seal over chip seal (FSCS): Mile point 101; view south.



⬆ Representative image of general condition of fog seal surface.

⬇ Close-up of fog seal chip embedment.





⬆ No active transverse cracking observed to date, however shadowing of milled and sealed cracking is apparent.

Fog Seal over Chip Seal (FSCS) – Route 89/Mile Point 89-101: June 2017



🡸 Beginning of fog seal over chip seal (FSCS): Mile point 89; view north.



🡸 Representative image of general condition of the FSCS section; view north.



🡸 North end of fog seal over chip seal (FSCS): Mile point 101; view south.



Representative image of general condition of fog seal surface.

Close-up of fog seal chip embedment.



Fog Seal over Chip Seal (FSCS) – Route 89/Mile Point 89-101: May 2018



🡄 Beginning of fog seal over chip seal (FSCS): Mile point 89; view north.



🡄 Representative image of general condition of the FSCS section; mile point 94, view north.



🡄 North end of fog seal over chip seal (FSCS): Mile point 101; view south.

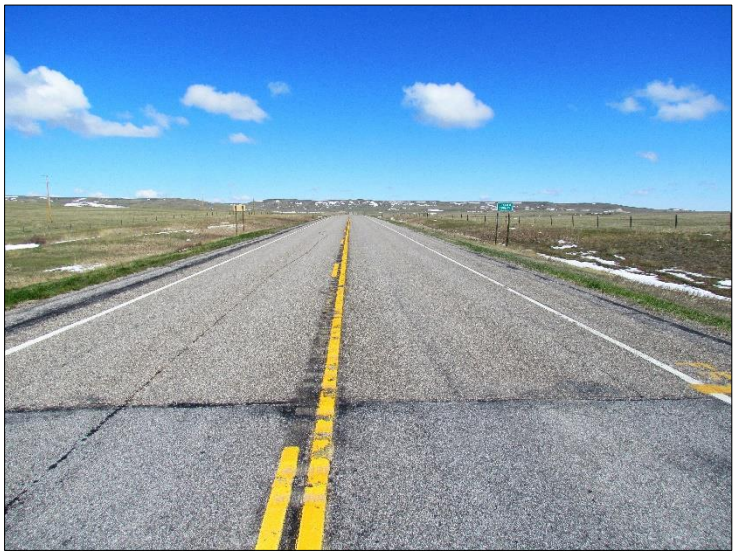


⬆ Representative image of general condition of fog seal surface.

⬇ Close-up of fog seal chip embedment.



Fog Seal over Chip Seal (FSCS) – Route 89/Mile Point 89-101: April 2019



🡸 Beginning of fog seal over chip seal (FSCS): Mile point 89; view north.



🡸 Representative image of general condition of the FSCS section; mile point 93, view north.



🡸 North end of fog seal over chip seal (FSCS): Mile point 101; view south.

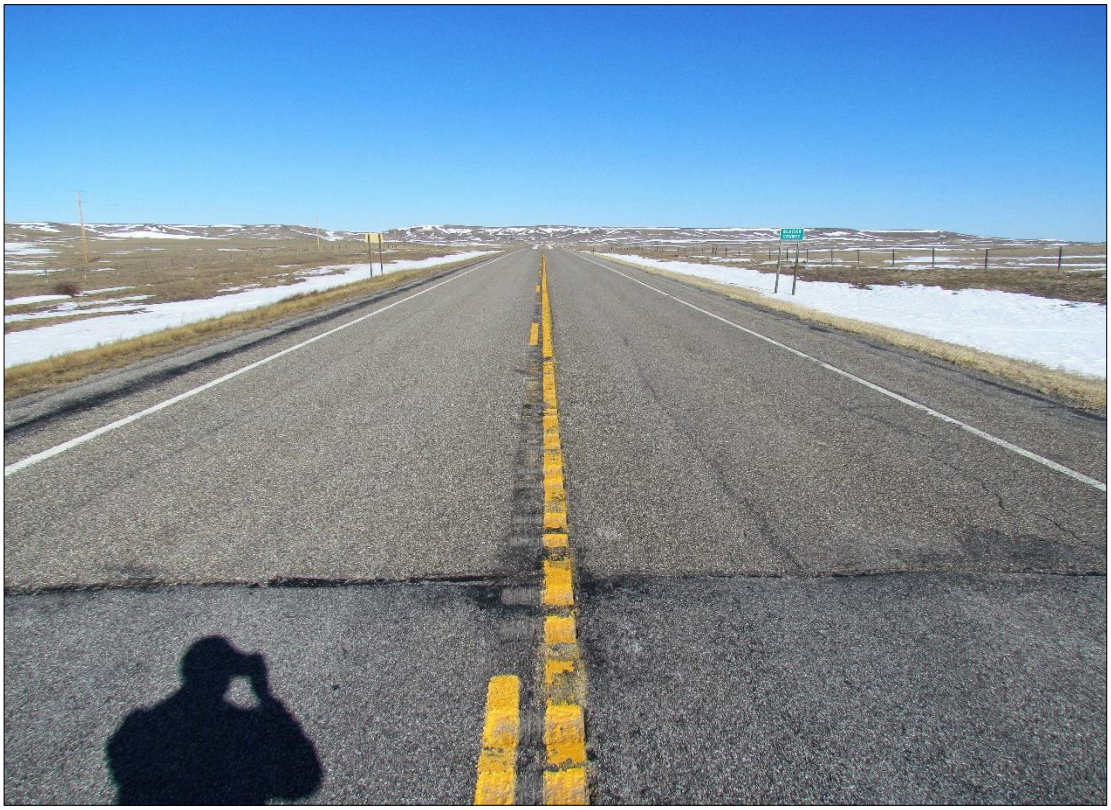


⬆ Representative image of general condition of fog seal surface.

⬇ Close-up of fog seal chip embedment.



Fog Seal over Chip Seal (FSCS) – Route 89/Mile Point 89-101: March 2020



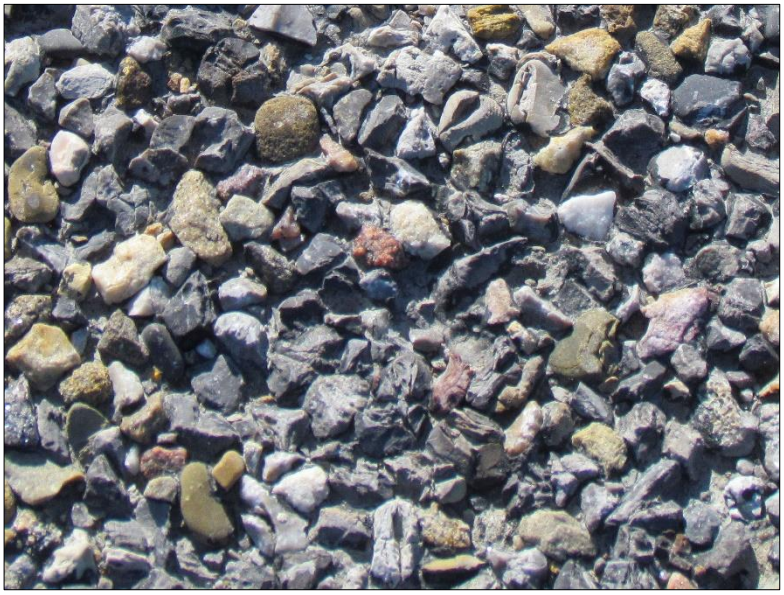
🡅 Beginning of project at mile point 89; view north.

🡇 Project end at mile point 101; view north.





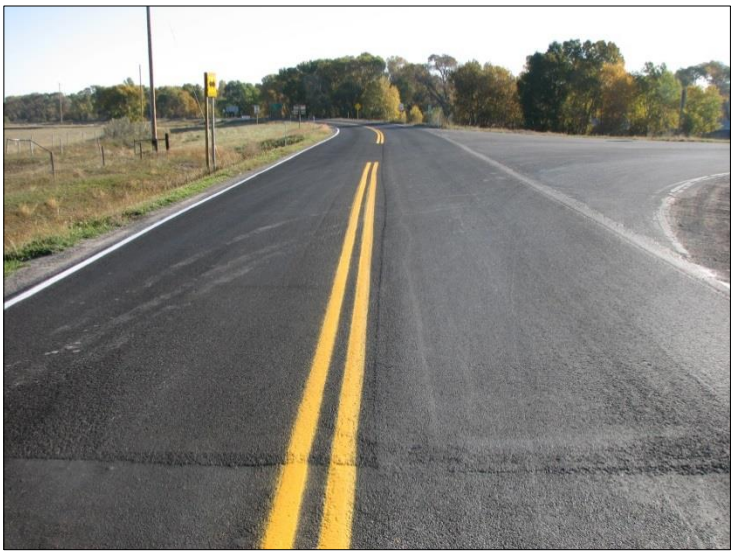




🡸🡻 Representative images of general condition of FSCS application.

Chip integrity appears good throughout the project.

Micro-Surfacing (MS) – Augustus North/Rt. 287/Mile Point 39-52 – September 2014



🡄 Beginning of micro-seal project: Reference point 39 – view north.



🡄 End of micro-surfacing: reference point 52 – view south.



🡄 Example image of selected location marked on site for visual documentation (RP 42).



Sample image of general condition of micro-seal surface.

Close-up of micro-seal chip embedment.



Micro-Surfacing (MS) – Augustus North/Route 287/Mile Point 39-52 – June 2015



🡸 Beginning of micro-seal project: Reference point 39 – view north.



🡸 Representative image of general condition of the MS section; reference point 50.



🡸 End of MS section: reference point 52 – view south.



⬆ Sample image of general condition of micro-seal surface.

⬇ Close-up of micro-seal chip embedment.







🡸🡻 Longitudinal cracking was documented during this inspection; the frequency is minor and at low severity.

Transverse cracking is also rated at low severity with an average frequency of 80 cracks per mile.



⬆⬇ Location: Approximately 1200' north of mile point 47.

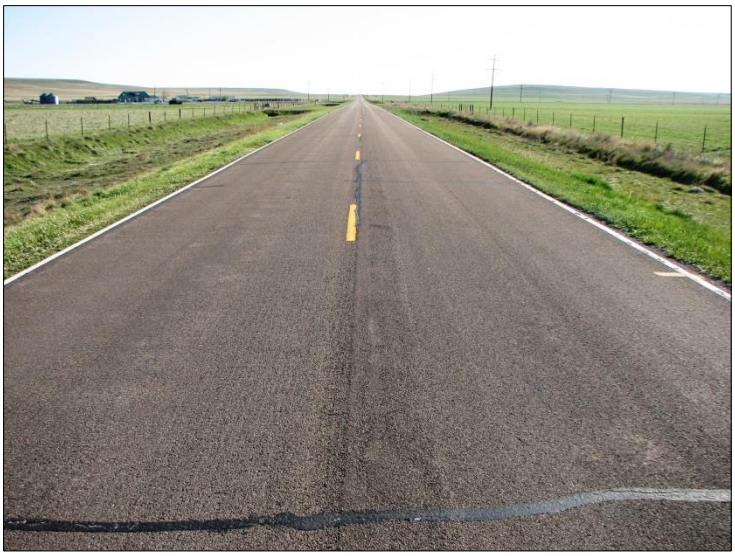
Section of pavement where presumed velocity patching was applied to correct the effects of either raveling or debonding; estimated length of random patching at 150'. No other areas of this type distress observed on the project.



Micro-Surfacing (MS) – Augustus North/Route 287/Mile Point 39-52 – June 2016



🡸 Beginning of micro-seal project: Reference point 39 – view north.



🡸 Representative image of general condition of the MS section.



🡸 End of MS section: reference point 52 – view south.



⬆ Representative image of general condition of micro-seal surface.

⬇ Close-up of micro-seal chip embedment and texture.





⬆ Small section of milled pavement on southbound lane at south end of the North Fork of the Sun River Bridge; approximate RF 43.

⬇ As documented in previous inspections; a section about 150 ft. of roadway with areas of patching; located at approximate RP 47.



Micro-Surfacing (MS) – Augustus North/Route 287/Mile Point 39-52 – June 2017



🡸 Beginning of micro-seal project: Reference point 39 – view north.



🡸 Representative image of general condition of the MS section.



🡸 End of MS section: reference point 52 – view south.



⬆ Representative image of general condition of micro-seal surface.

⬇ Close-up of micro-seal chip embedment and texture.





⬆ Small section of repaired pavement on southbound lane at south end of the North Fork of the Sun River Bridge; approximate RF 43.

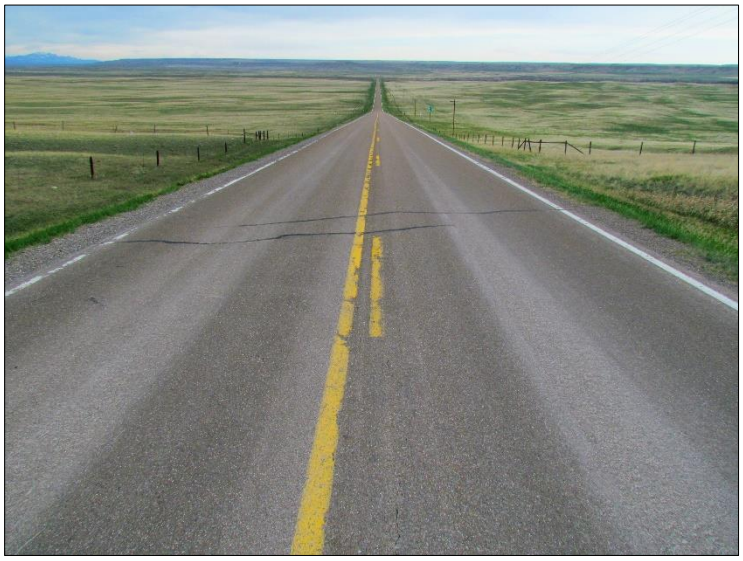
⬇ As documented in previous inspections; a section about 150 ft. of roadway with areas of patching; located at approximate RP 47.



Micro-Surfacing (MS) – Augustus North/Route 287/Mile Point 39-52 – May 2018



🡸 Beginning of micro-seal project: Reference point 39; view north.



🡸 Representative image of general condition of the MS section; near mile point 42.



🡸 End of MS section: reference point 52; view south.



⬆ Representative image of general condition of micro-seal surface.

⬇ Close-up of micro-seal chip embedment and texture.



Micro-Surfacing (MS) – Augustus North/Route 287/Mile Point 39-52 – May 2019



🡸 Beginning of micro-seal project: Reference point 39; view north.



🡸 Representative image of general condition of the MS section; near mile point 42.



🡸 End of MS section: reference point 52; view south.



⬆ Representative image of general condition of micro-seal surface.

⬇ Close-up of micro-seal chip embedment and texture.



Micro-Surfacing (MS) – Augustus North/Route 287/Mile Point 39-52 – March 2020



🡅 Beginning of MS project at mile point 39 north of Augusta; view north.

🡇 Project end at mile point 52; view south.









🡸🡻 Representative images of general condition of MS application.

Other than the previous anomalies stated in this report (page 43), overall, the pavement texture is tight.

Transverse cracks previously sealed have reappeared.

Supplemental: Project Field Delineations



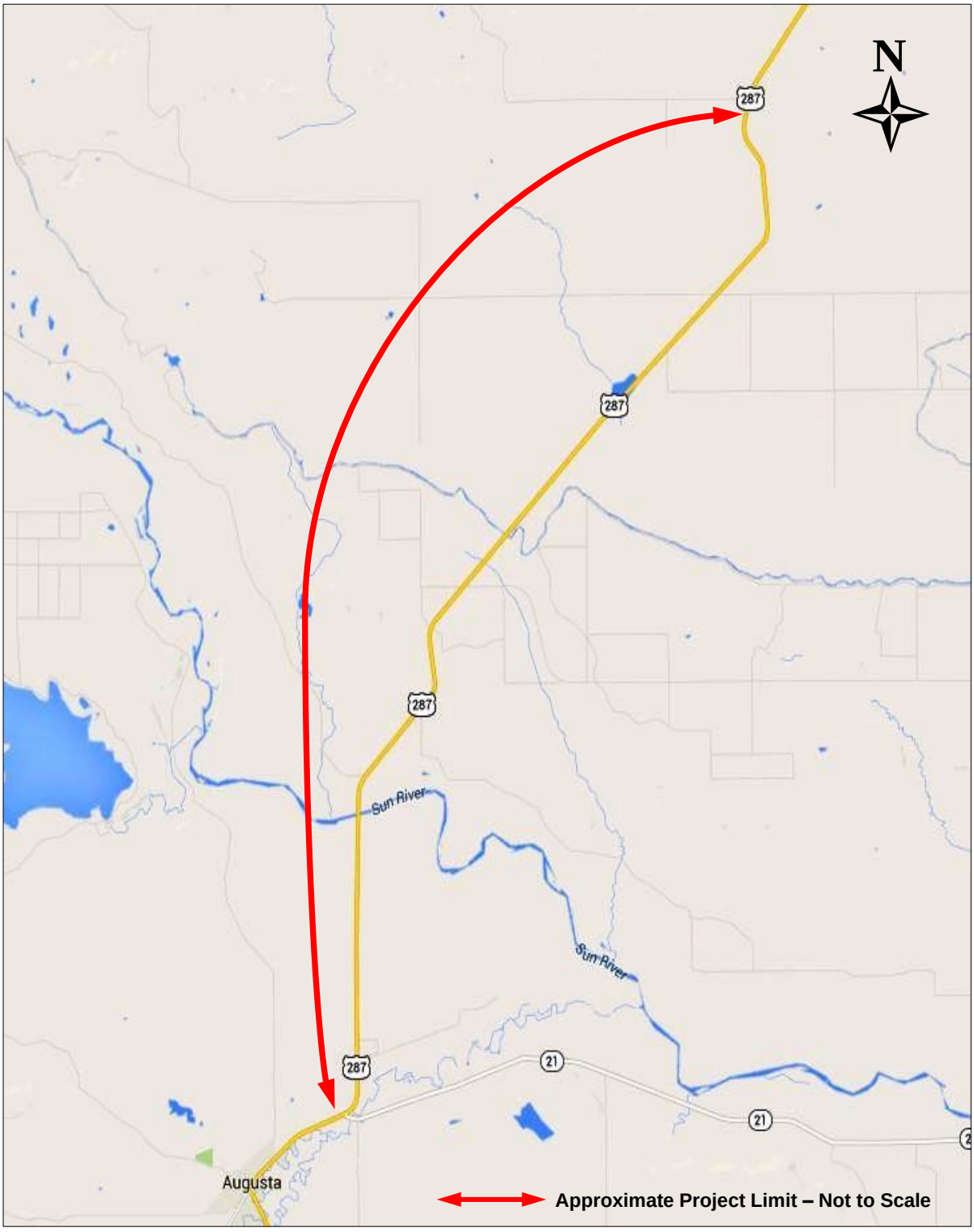




⬅⬇ Sections as marked at beginning and end of each project: Micro surfacing, chip seal, and fog seal respectively.

Project: **Augustus North** – Micro-Surfacing

Located on State Primary Highway 9/US 287 (C000009), beginning north of Augusta city limits at reference point (R.P.) 39.4 (junction of Montana Highway 21), extends north for 12.8 miles to R.P. 52.2: Lewis & Clark and Teton Counties.



Project: **North of Dupuyer** (Reference A): Maintenance Fog Seal over Chip Seal

Located on State Primary 3/US 89 (C000003), R.P. 89.2-101.4: 12.2 miles: Glacier County.

Project: **SE of Dupuyer SE** (Reference B): Reconstruct with Chip Seal

Located on State Primary 3/US 89 (C000003), R.P. 64.6-70.5: 5.5 miles: Teton and Pondera Counties.

