Montana Department of Transportation
Research Programs
June 2020

EXPERIMENTAL PROJECTS FINAL REPORT

HIGH FRICTION SURFACE TREATMENTS (HFSTs) FOR BRIDGE DECKS

Location:
- [1]Kalispell-Flathead River: Highway 35
- [2]Roundup-Musselshell River: Highway 87
- [3]Big Timber-Yellowstone River: Highway 191
- [4]Bigfork-Swan River Bridge: Highway 35

Project Name:
- [1]East of Kalispell (constructed 2014)
- [2]South of Roundup (constructed 2014)
- [3]Big Timber North (constructed 2014)
- [4]Safety Improvement Bigfork (constructed 2015)

Project Number:
- [1]HSIP 52-2(38)49
- [2]HSIP 16-2(14)47
- [3]STPP 45-1(26)0
- [4]HSIP 52-2(44)31

Project Type:
- [1]Poly-Carb Mark: 135 Safe-T-Seal/163 Flexogrid
- [2]Poly-Carb Mark: 135 Safe-T-Seal/163 Flexogrid
- [3]Dayton Superior: Unitex High Surface Friction
- [4]Dayton Superior: Unitex High Surface Friction

FHWA Project Number: MT-12-10/13-01/14-05

Principal Investigator: Craig Abernathy, Experimental Project Manager (ExPM)

Date of Installations: [1,2,3]June 2014/[4]June 2015

Date of Inspections: March 2015/April-May 2016/May-October 2017/April 2018 April 2019/April & May 2020

Objective

HFSTs are pavement surfacing systems that provide skid-resistant, and deck sealing properties not typically associated with conventional materials. The spot application of a thin layer of durable, high friction aggregates as a topping on specially engineered resin or a polymer binder affords long-lasting traction (as stated by manufacturer information), while making the overlay much more resistant to wear and polishing.

The Montana Department of Transportation (MDT) has initiated this project to apply these

treatments to the selected decks in effort to validate the added friction and durability claims.

Evaluation Procedures

The purpose of an experimental features report is to document the phases and events of any given project to provide the reader with an understanding of the general 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.

Construction Documentation: Will include information specific to the installation process.

Post Documentation: Will entail semiannual inspections of the HFSTs for visual distress; in addition, an initial friction skid test on all decks (excluding Bigfork) will be conducted after installation and then annually for the next four years. As the friction data are completed and collected, they will be added to this report.

Product Descriptions and Installation Issues

▪The Kalispell and Roundup projects were performed by the vendor **Poly-Carb** using their **135 Safe-T-Seal** as an initial crack seal repair then followed by the **163 Flexogrid Overlay System**.

▪The Big Timber Site was managed by the contractor Z & Z Asphalt Inc. The Bigfork project was managed by L & J Construction. Both used the vendor **Dayton Superior** as the supplier of the **Unitex High Surface Friction** (Pro-Poxy) Components.

Each vendor's procedures were similar in applications in applying two (2) courses (or lifts) of aggregate using a two-part epoxy binder blended onsite during application.

Each vendor used the same **Armor Stone** (basalt quartzite granite) 100% fractured aggregate, supplied by Washington Rock Quarries Inc.

Other than necessary deck repairs required (Class A), the first critical element of the process was the preparation of the deck surface for adequate adhesion of the epoxy binder and subsequent aggregate courses which will be detailed in this report.

One main difference between the Poly-Carb and Dayton process is Poly-Carb promotes the addition of an initial crack-welding, low-viscosity polymer (135 Safe-T-Seal) application prior to the overlay system. The Dayton approach is to apply an initial heavy coat of epoxy in an effort to seal any existing cracks or porous surfaces.

Each epoxy and aggregate course required a curing time based on ambient atmospheric conditions and judgment based on the vendor's knowledge of the product attributes.

After each course was applied and allowed to cure the loose aggregate was broom swept and air blasted to a clean surface. In some cases, the recovered stone was reused.

Kalispell Deck: One issue was reported, beginning on the east-end of the westbound lane of the Poly-Carb application at the Kalispell project. During the initial start of the 163-epoxy

application, the vendor noticed a visual inconsistency with the epoxy treatment, about a linear length section of about fifty feet. The run was halted and determined the epoxy blend proportion was inconsistence.

This was corrected, and the run continued on the eastbound lane. The section of inconsistent application was allowed to cure with no application of stone. The deck area was then shot blasted to remove the suspect epoxy and the 135 &165 system reapplied.

Bigfork Deck: MDT staff noticed the base of the Bobcat sweeper was scraping the surface of the aggregate leaving noticeable scuff marks during operation. The contractor was directed to raise the sweeper and adjust the angle so that only the brush attachment was contacting the surface.

Ongoing inspections will take place for the next five years for all sites in late fall and early spring to document any potential visual distress. That information will be added to this report.

Pavement friction testing will be performed after installation and annually thereafter to determine a potential trend with reduction in friction due to deterioration, weathering, or other characteristics.

Initial Friction Resistance (Skid) Numbers- Conducted July 2014

Kalispell: Average skid number 82
Roundup: Average skid number 81
Big Timber: Average skid number 83

Current scale of acceptable friction rates a number above 35 as sufficient with any rating below 30 as an indicator which may require an onsite inspection to determine if some type of remedial action to the pavement surface to restore suitable friction (per MDT requirements) is required.

The friction testing was conducted using an ICC Cybernetic Model SFT5041 single tire skid unit. The trailer has two tires, but only the left tire conducts the skid test, as seen in the image below.

Post-installation Skid Test Data

2015: On average skid numbers conducted in the fall of 2015 for the decks all averaged at 60.

2016: Due to equipment issues skid testing did not take place.

2017: The Kalispell deck was tested with an average of recorded skid number of 20 within the wheel path. The Big Timber and Roundup decks tested at (on average) 52 & 53, respectively.

See additional skid data results on pages 74 & 75.

March 2015 Site Inspections

During these inspections, both the Poly-Carb and the Unitex decks applied in 2014 exhibited no abnormal wear or any other visual anomaly which may attribute to performance.

Topical aggregate mat appeared tight, with no areas of delamination or debonding of the binder apparent. Skid data on average for all decks were 60.

April/May 2016 Site Inspections

Deck surface condition on all sites reflect the same condition as noted in 2015; aggregate treatments are tight with no apparent distress to document to date other than some areas of plow abrasion as noted on the Bigfork project (see page 32).

Skid data was not collected in 2016.

June-October 2017 Site Inspections

All deck surfaces inspected show intact treatments with no spalling or delamination's visible. However, the HFST surfaces are beginning to develop a polished look with pocked mark texture due to lose of topical aggregate. Since this condition (visually) is uniform across the lanes it may be attributable to snowplow abrasion.

As stated earlier in the report the Kalispell deck (PolyCarb) within the wheel paths (WP) had a reported (average) skid number of 20. Where outside the WP skid numbers were averaging in the fifties. This may be attributed to the dynamics of studded tires or the frequency of traffic on an urban bridge.

The Big Timber and Roundup decks tested at (on average) 52 & 53, respectively. The Big Fork deck has not been skid tested to date.

April 2018 Site Inspections

All deck surfaces reflect the same condition as noted in the 2017 documentation. With exception on the MT35 Kalispell deck which now has areas of polymer delamination on the east span of the deck approach.

In September of 2018, due to poor skid numbers and increased delamination of the polymer overlay the District elected to repair the failed sections and apply another single layer lift to the deck. Page 65-68 details some of the repair; additional information will be added to this report when made available.

The next project level inspection will be conducted in the spring of 2019.

April 2019 Site Inspections

All deck surfaces reflect the same condition as noted in the 2018 documentation. After the Kalispell single lift reapplied in fall of 2018 the skid test conducted in spring of 2019 came in at approximately 38. The last project inspection will be in 2020.

March/April 2020 Site Inspections

The Kalispell and Bigfork decks continue to show progressive loss of surface friction (based on skid data tests) since installation. Due to perceived traffic attributes (level of AADT, heavy traffic, studs, chains, etc.) may be the contributing factor in the loss of stone angularity (topical loss of aggregate to the point of a smooth surface).

The Roundup and Big Timber are maintaining adequate friction since installation.

The following images are representative of the practice regarding the Poly-Carb and Dayton applications and subsequent site evaluations.

-**Big Timber**/Dayton: **Pages 7-23**

-**Bigfork**/Dayton: **Pages 24-41**

-**Roundup**/Poly-Carb: **Pages 42-56**

-**Kalispell**/Poly-Carb: **Pages 57-72**

Project skid test data (taken in the wheel paths) and average annual daily traffic (AADT) for all decks may be found on **pages 74-75**.

Project locations on **page 76**.

The traffic data (AADT) presented in this report was supplied by the Rail, Transit and Planning Division.

This report and other project information is available at:
http://www.mdt.mt.gov/research/projects/polycarb.shtml

Big Timber – Yellowstone River: Dayton Superior Unitex: June 2014

🡐 Bridge over Yellowstone River prior to start of project; view north.

🡐🡓 Sample images of average deck surface condition. Most of the deck exhibited polished aggregate, minor pop outs and longitudinal cracking.

← Portions of the deck (mainly on the south end) needed repair due to deterioration of the deck surface.

← Areas that needed repair (class A) were delineated by concrete saw cut; damaged concrete was removed to the first layer of rebar.

The exposed patch is sandblasted and blown free of loose material and dust.

← Exposed rebar was coated with two-component aerosol epoxy.

← The repair material used is the Dayton Sure Patch.

This is an epoxy resin mixture consisting of three parts: component “A” epoxy resin, component “B” modified amine curing agent, and component “C” specially graded aggregate.

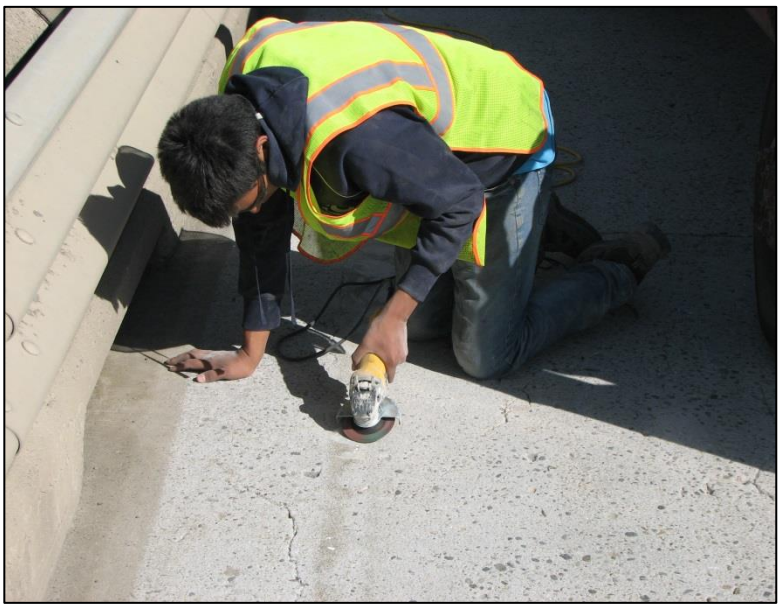
A conventional mortar mixer is used to blend the resin components.

← ↓ Once the patch components are thoroughly mixed, it is placed, screed and troweled as conventional mortar.

The patch goes to gel state in twenty minutes and may allow traffic in 2-3 hours based on atmospheric conditions.

🡸 Preparation of the Unitex applications begins with a metal shot abrasive blasting of the deck surface.

Note that the southbound lane will initially receive the HFST to allow the northbound lane for active traffic. Once the southbound lane is completed, the northbound lane will begin preparation for the HFST process of deck preparation and application of epoxy and aggregate.

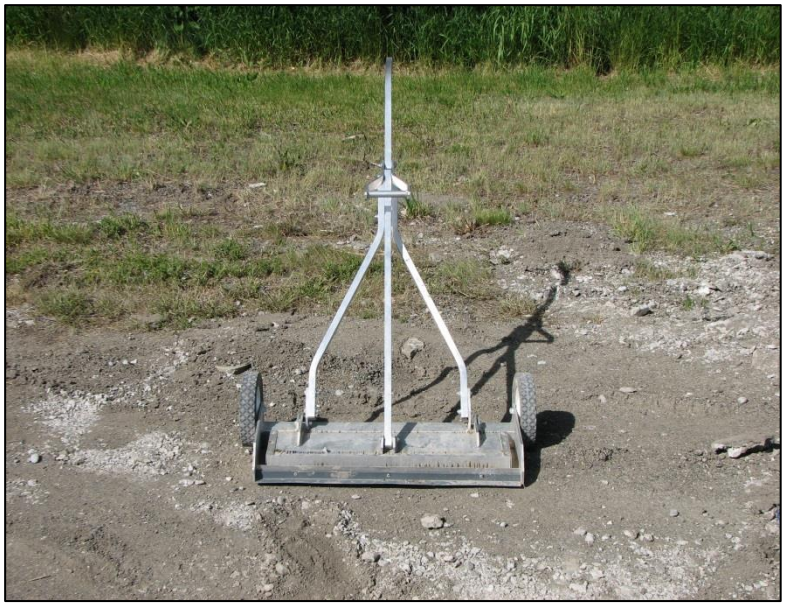


🡸 Areas of the deck (such as pavement marking residual) were removed by a hand grinder.

🡸 Areas where the shot blast equipment was unable to reach was completed by hand-held sand blasting.

⬅ Representative image of deck surface prepared for HFST treatment.

⬅ Bridge expansion joints were covered with duct tape.



⬅ A magnetic sweeper is used to remove any remaining metal shot on the deck surface.

← The Unitex epoxy distribution unit and Pro-Poxy parts A & B product tanks are positioned to begin the epoxy application phase.

Deck temperature was approximately 84°F (29° C).

← The aggregate is applied using a conventional TurfEx Model MS2000 agricultural truck mounted spreader.

The aggregate totes are on the truck ready to fill the spreader bin as needed.

← Close-up of the Armor Stone aggregate.

⬅ A flexible 1/4" (inch) notched squeegee is used to spread the epoxy.

⬅ The Unitex epoxy distribution unit ensures the correct proportion of epoxy elements is dispersed through the product hoses; a two foot (2') static mixing nozzle is added to the product dispensing unit to complete the blending process.

⬅ The blended epoxy is applied directly on the deck in an initial heavy coat to ensure all cracks and pores of the surface are saturated.

Although difficult to view in this the image, the workman with the squeegee is wearing an over shoe with one-inch spikes which will minimize the creation of air pockets and maintain consistent material thickness when walking on the epoxy.

🡸 Once the epoxy layer is determined adequate, the spreader truck is calibrated to apply the necessary amount of aggregate defined by the lane width.

🡸 The workman adjusts the output of aggregate for the initial run to insure complete coverage.

The contractor stated that the first lift (or layer) of aggregate is place at a greater density than the second application.

🡸 With the calibration complete, the spreader truck proceeds with the run as the workman manages the filling of the hopper.

The contractor has a window of approximately twenty (20) minutes from application of the epoxy to the broadcast of the aggregate.

Cure time on average is 3-4 hours. Each completed lift will be broom swept.

These images show the level of aggregate layer with the first of run about midway through the length of the bridge. Note there are areas of epoxy bleeding through the aggregate. The contractor was not concerned since it was stated that they apply a very heavy first coat and material bleed through was common. The second lift will create a more uniform appearance.

Each cured course is broom swept and air blasted.

⬆ Completed project with two fully cured lifts of epoxy and stone, view north.

⬇ Close-up of Armor Stone aggregate in cured polymer epoxy base.

Big Timber – Dayton Superior Unitex: March 2015

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST.

No issues to date to report; aggregate surface has uniformity in texture and appearance. No areas of raveling or debonding visible.

Big Timber – Dayton Superior Unitex: April 2016

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST.

No issues to date to report; aggregate surface has uniformity in texture and appearance. No areas of raveling or debonding visible.

Big Timber – Dayton Superior Unitex: August 2017

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in 2017.

No areas of raveling or debonding visible. However, the surface textures appear polished with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST deck treatment is uniform, and may be attributed to snowplow activity

Big Timber – Dayton Superior Unitex: May 2018

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in spring of 2018.

As reported in 2017; no areas of raveling or debonding visible. However, the surface textures appear polished with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

Visually the topical condition of the HFST deck treatment is uniform and may be attributed to snowplow activity and/or general traffic attributes.

Big Timber – Dayton Superior Unitex: May 2019

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in spring of 2019.

As reported in 2018; no areas of raveling or debonding visible. However, the surface textures appear polished with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

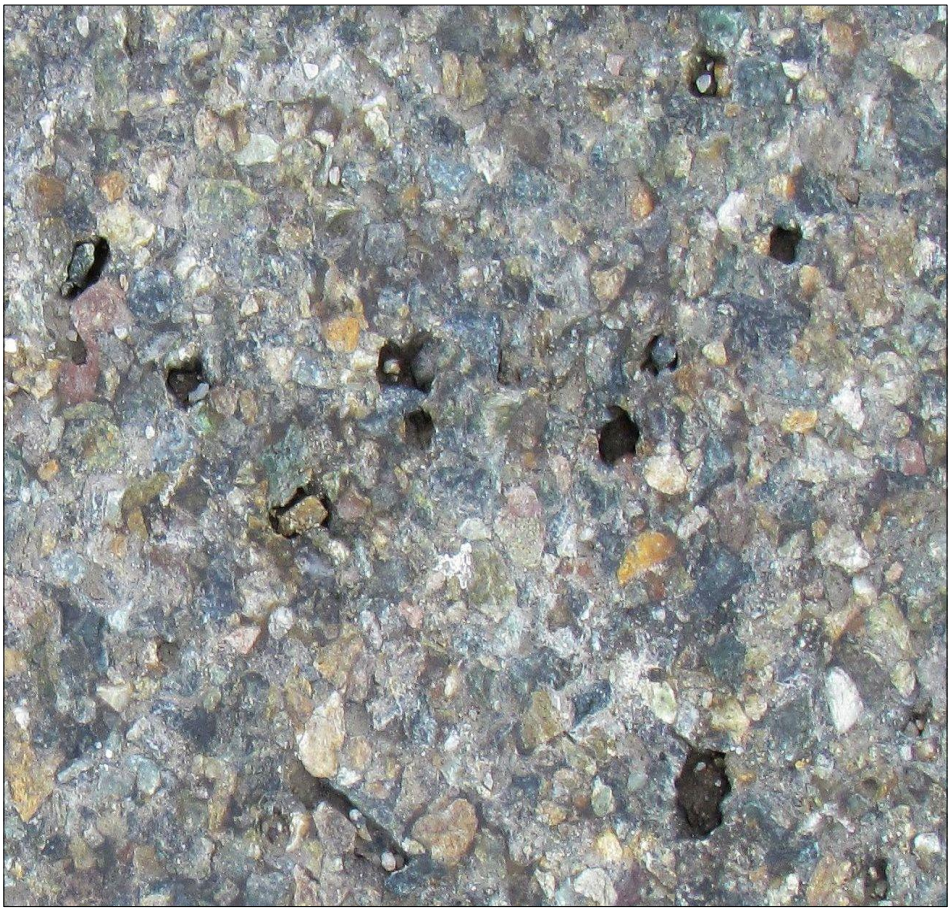
Visually the topical condition of the HFST deck treatment has topical aggregate pop-outs and surface polishing and may be attributed to snowplow activity and/or general traffic attributes.

Big Timber – Dayton Superior Unitex: April 2020

🡅 Deck as seen in April 2020.

As reported in 2019; no areas of raveling or debonding visible. However, the surface textures continue to appear polished with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

🡄 Close-up of class A deck repair at south end of deck, northbound lane.



🡸🡻 Several close-ups of surface texture.

Lower image shows continued polishing of aggregates and pop-outs, mainly in the wheel paths.

Bigfork – Swan River Bridge: Dayton Superior Unitex: June 2015

- The project begins with the Class A deck repairs; orange paint delineates selected areas to be chiseled out to the top layer of rebar. Image on right shows completed section using Dayton Sure Patch: See pages 6 & 7 (Big Timber site), for specific examples of the repair which were similar to this deck.

- Class A repair completed on the north bound lane, view south.

🡸🡻 The contractor applied several different applications of deck preparation as seen with scarification to remove striping material (top photo).

The center image shows sandblasting the edge of the deck.

Final phase of using shot blast to prepare the deck for the first coat of epoxy (bottom photo).

🡸 A Blastrac 2-20D portable shot blaster coupled with a Blastrac 854 dust collector finished the prep work with a single pass at a 20" width shot pattern.

The southbound deck lane received the first application of the polymer overlay.

←🡻 Several close-up images of the PCCP deck and repair patch after a shot blast past.

← A magnetic sweeper removed any stray shot from the blasting phase.

🡸 Duct tape is applied to the deck's drain channel to prevent epoxy from exiting the deck.

🡸 To insure even blending of the two-part epoxy a 2' static mixing nozzle is used; part of the internal mixing element is exposed (red arrow).

🡸 The static mixing nozzle is attached to the dual polymer applicator (yellow arrow).

The applicator receives precisely metered polymer epoxy (parts A & B) to the entrance of the mixing nozzle.

← This device pulls part A & B epoxies from loaded carboys and delivers it to the polymer applicator in a 50/50 ratio.

← Workers, who spread the blended polymer by squeegee, wear spiked overshoes to eliminate any potential air pockets that may be formed by wearing flat-sole shoes.

Air pockets may inhibit the curing properties of the epoxy.

← The application of polymer begins and is spread consistently by squeegee.

🡸 Broadcasting of the Armor Stone aggregate begins after about one-third length of the polymer epoxy is placed on the deck.

This first course of stone is applied in a thick layer.

The contractor used a Saltdogg Salt Spreader to apply the chips.

🡸 The first pass of the polymer application is almost completed.

Deck temperature was 95°F, average ambient air temperature was 80°F with relative humidity at 55%.

🡸 Photo shows near completion of the first course of Armor Stone aggregate.

🡸 After approximately 60 minutes, the contractor, by checking the firmness of the stone to polymer by touch, determines the excess stone may be removed for the application of the second course.

🡸 Removal of the excess stone is done by broom sweeper and compressed air.

🡸 As with the first course, the second application of polymer begins at the south end of the deck.

🡸 Nearing completion of the second course of polymer and aggregate lift.

🡸 Prior to removal of excess material, the deck is inspected prior to cleaning.

Deck temperature was 109°F, average ambient air temperature was 91°F with the relative humidity at 38%.

🡸 Southbound lane is now open to traffic with work beginning on the northbound lane deck preparation, view south.

There will be an approximate 6" overlap of overlay between lanes.

Close-up photo of cured first course.

Close-up photo of cured second course.

⬆ June 30, 2015: Project completed; view south.

No issues were reported during the placement of the Dayton Superior polymer overlay which may affect future performance of the application.

Bigfork Project – June 2015: Supplemental

🡸🡻 Wood fragments were seen embedded in the deck concrete of enough quantity to be noted in this report.

MDT project staff assumed the aggregate for the deck (constructed in 1954), was dredged from the old Flathead Riverbed.

At this time, this issue is not considered detrimental to the polymer performance.

🡸 After the first course had cured and swept, this hole (assuming a wood chip) did not have any stone embedded on the epoxy surface.

To date, no explanation can be found for this anomaly.

Bigfork Project/Dayton Superior – June 2016:

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST.

No issues to date to report; aggregate surface has uniformity in texture and appearance. No areas of raveling or debonding visible.

Bigfork Project-Supplemental – June 2016:

June 2016; view north.

Several areas on the deck, mainly at the shoulder, displayed minor abrasion (assuming from snowplow passes); most likely due to an uneven layer of epoxy and aggregate during application.

Bigfork Project/Dayton Superior – June 2017:

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in 2017 (top image view north).

No areas of raveling or debonding visible. However, the surface textures appear polished and less textured since the last inspection, with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST is uniform across the deck and may be attributed to snowplow activity.

Skid testing will be performed as weather permits.

Bigfork Project/Dayton Superior – April 2018

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in spring of 2018 (top image view north).

No areas of raveling or debonding visible. However, as reported in earlier inspections; the surface textures appear polished and less textured since installation, with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST appears uniform across the deck; and may be due to snowplow activity or other traffic attributes.

Bigfork Project/Dayton Superior – April 2019

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in spring of 2019 (top image view north).

No areas of raveling or debonding visible. However, as reported in earlier inspections; the surface textures appear polished and less textured since installation.

Although difficult to see in the middle image; noticeable pock marks indicative of loss aggregate is apparent.

Lower image is close-up of surface texture).

The topical condition of the HFST appears uniform across the deck; and may be due to snowplow activity or other traffic attributes.

Bigfork Project/Dayton Superior – April 2020

🡅 South end of deck; view north.

🡇 South end of deck showing polished appearance of aggregate; view south.

↑ Close-up of pavement texture in wheel path.

← Closer view of pavement surface; red arrow shows where aggregate has popped out of epoxy matrix difficult to see in the above image.

Roundup – Musselshell River: Poly-Carb 135 Safe-T-Seal/163 Overlay: June 2014

🡸 Musselshell River Bridge prior to Poly-Carb treatment.

🡸 Representative image of condition of deck surface prior to treatment.

🡸 A previous maintenance patch placed a layer asphalt cement (AC) beyond both approaches of the PCCP deck which will require removal prior to the HFST.

🡸 A Bobcat 18" (inch) planer attachment is used to remove the excess asphalt.

🡸 A hand grinder completes the asphalt removal process.

🡸 The approaches are now ready for the shot blasting phase of the process.

🡸 The Bobcat planer is used to lightly scarify the existing pavement markings prior to shot blasting.

The southbound lane will receive the HFST initially to allow the northbound to remain active to traffic.

Once the overlay application is complete the southbound lane will be open to active traffic and the northbound lane will be prepared for the HFST overlay.

🡸 The metal shot blasting unit being prepared.

This process (as related to all the HFSTs in this report) removes contamination and micro-fractured concrete and creates a mechanical profile for the polymer base to bond to.

🡸Areas of pavement markings that still remain after shot blasting are removed by hand chisel.

🡸Sections of the deck that the shot blasting machine could not reach are shot by hand.

Once the shot blasting phase is completed the deck is swept with a rotary bucket sweeper, followed by magnetic sweeper, and then cleaned with high-pressure air.

🡸 Duct tape is applied to delineate the southbound prepared deck to the untreated northbound lane.

🡸 The first phase Poly-Carb Mark process is the application of the blended 135 Safe-T-Seal low-viscosity, polymer gravity fed crack welding system.

The 135 is applied directly at the front end of the Poly-Carb Systems truck.

🡸 Close-up of 135 Safe-T-Seal on deck surface.

The lag time between the application of the 135 seal and the 163 overlay is immediate.

🡸 Overview of the Poly-Carb Flexogrid machine being prepared for 163 overlay.

This vehicle houses all components of the Poly-Carb 135 Safe-T-Seal and 163 Flexogrid Overlay system.

🡸The blended copolymer epoxy is being injected on the deck through a single tube at the rear of the vehicle (yellow arrow).

Workman have spread the epoxy in an area that may allow the material spreader to start broadcasting the aggregate.

← The hopper begins the application run of the aggregate.

← The hopper is continually supplied with aggregate as it progresses along the deck.

← Workman supplements the aggregate application by adding to any observed thin spots.

← The first lift of the overlay is completed and allowed to cure overnight (It was too late in the previous day to perform the second lift, which may be applied 2-4 hours after the first under normal conditions).

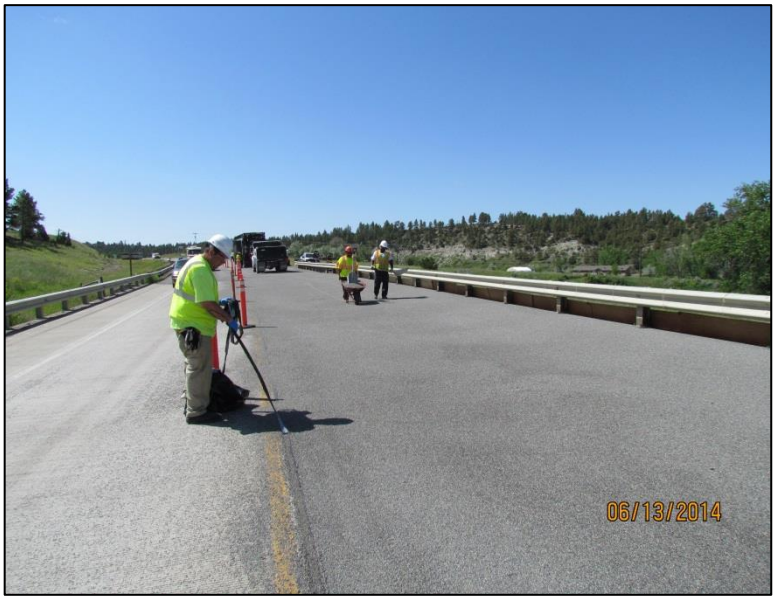
The first lift is broom swept and air blasted prior to the second application.

Note plywood planks were hung from the edge of the deck from the guardrails in an effort to prevent epoxy from entering the stream (red arrow).

← Workmen begin to apply the second coat of epoxy to the first cured course.

← The second broadcast of aggregate is applied to the south bound lane.

← The second lift is nearing completion and as in the first lift, the workman is applying additional aggregate to thin spots.



← The duct tape separating the completed overlay and untreated lane is removed.

←Once the second lift cure is complete, the deck is swept, and air blasted clean.

⬆ The second lift is complete, and the workmen remove the guardrail boards to begin preparation of the northbound lane to receive the PolyCarb overlay.

⬇ Close-up of the difference in surface appearance between the first overlay application (right side of image) and the second overlay (left side of image).

Roundup – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: March 2015

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST (view north).

No issues to date to report; aggregate surface has uniformity in texture and appearance. No areas of delamination or debonding visible.

A snow shower was beginning during the inspection.

Roundup – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: April 2016

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST (view south).

No issues to date to report; aggregate surface has uniformity in texture and appearance. No areas of delamination or debonding visible.

Roundup – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: November 2017

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in 2017 (view north).

No areas of raveling or debonding visible. However, the surface textures appear polished and less textured since the last inspection, with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST may be attributed to snowplow activity.

Current skid test numbers are at 53 for the deck surface.

Roundup – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: March 2018

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in the spring of 2018 (view north).

No areas of raveling or debonding visible. However, the surface textures appear polished and less textured since the last inspection, with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST may be attributed to snowplow activity and/or other traffic attributes.

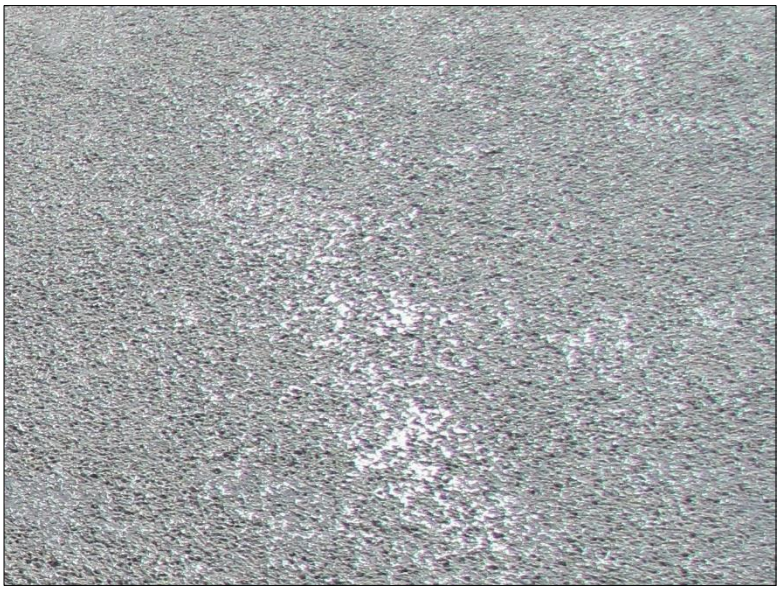
Roundup – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: April 2019

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in the spring of 2019 (view north).

No areas of raveling or debonding visible. However, the surface textures appear polished and less textured since the last inspection, with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST may be attributed to snowplow activity and/or other traffic attributes.

Roundup – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: April 2020



🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST (view north).

No areas of raveling or debonding visible, the surface textures appears polished and less textured since the last inspection and continued noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST may be attributed to snowplow activity and/or other traffic attributes (AADT, studded tires, etc.).

Kalispell–Flathead River: Poly-Carb 135 Safe-T-Seal/163 Overlay: June 2014

Due to time constraints, documentation of the Kalispell project recorded only the second HFST application of the west bound lane which completed the overlay project. Other than the construction issue identified on page two of this report, the MDT project manager and inspector stated the application of the Poly-Carb overlay went as planned with no additional issues to report.

← Representative image of deck prior to overlay (view east).

← The eastbound lane (left side of image) has the completed Flexogrid overlay.

The Poly-Carb Systems truck is positioned on the west bound lane to begin its second lift application.

← Starting on the east end of the deck, workmen begin applying the second lift of epoxy on the west bound lane.

← The spreader begins a uniform placement of the aggregate.

As stated on page 34 of this report (Roundup section), workman will apply additional aggregate to apparent thin areas.

← About midway through the run, the Poly-Carb truck was replenished with a tote of the Armor Stone aggregate.

← The bridge finger plate joints were covered with heavy plastic and secured with durable duct tape prior to the polymer overlay.

← Drainage inlets were plugged with black plastic and a conventional plastic cup was used as a stopper.

← Drain inlet with plastic block and cup removed after cured second lift.

⬆ Close-up of the difference of surface texture of the first lift (right side of image) and the second lift (left side of image).

⬇ Completed project, (view west). Image taken during active rain.

Kalispell – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: March 2015

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST (view east).

No issues to date to report; aggregate surface has uniformity in texture and appearance. No areas of delamination or debonding visible.

The deck surface was wet during the inspection.

Kalispell – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: May 2016

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST (view east).

No issues to date to report; aggregate surface has uniformity in texture and appearance. No areas of delamination or debonding visible.

Kalispell – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: July 2017

🡸🡻 The following are images (deck overview and surface texture) depicting the general condition of the HFST as documented in 2017.

No areas of raveling or debonding visible. However, the surface textures appear polished and less textured since the last inspection, with noticeable pock marks indicative of loss aggregate (lower image is close-up of surface texture).

The topical condition of the HFST may be attributed to snowplow activity.

Current skid test numbers (wheel path area) are at (on average) 20 for the deck surface.

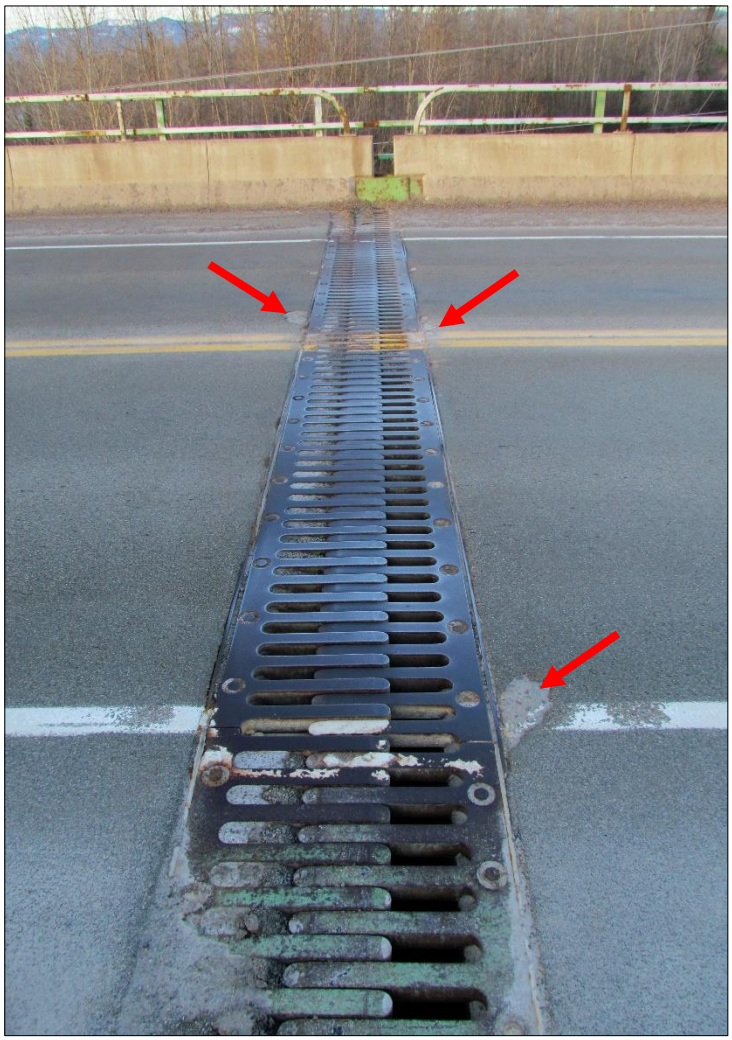
Kalispell – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: May 2018

🡅 Overview of deck approach; west span, view east.

🡇 Overview of deck approach; east span, view west.

🡸🡻 Several images of the decks surface texture (middle image closer view).

🡸 Sample image of overlay delamination located on east span of deck at the west approach.



🡅 During the spring 2018 inspection, several delamination's of the HFST were noted: specifically, at the east end approach in the westbound lane.

🡄 Overlay delamination was also documented adjacent to the finger plate joints at the west end of the deck. (red arrows).

Supplemental: Kalispell Deck Repair – September 2018

🡸 Due to the progressive deterioration of skid resistance mainly in the wheel paths; the District elected to repair the delaminated areas and to reapply a single layer of the Unitex polymer to the entire deck.

The east span approach was chain dragged in both lanes to determine the extent of the polymer delamination and level of repair.

🡸🡻 Delaminated sections were removed by being marked, scored, and saw cut.

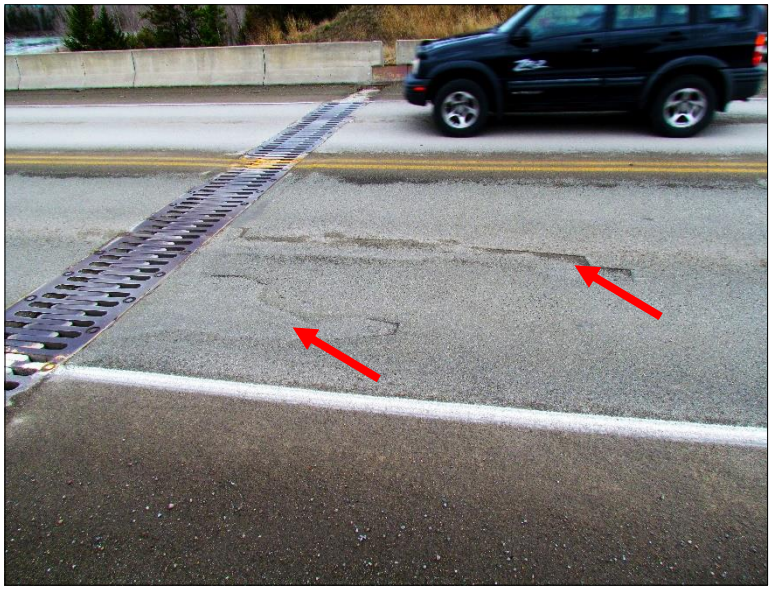
Repairs were conducted by L&J Construction using the Dayton Superior (DS) process in adding a single lift of HFST.

The DS factory rep instructed the contractor crew how to fill in the cut-out polymer area to achieve a solid and smooth repair.

The next deck inspection in the spring of 2019 will document the completed repair.

Kalispell – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: April 2019

🡸 Overview of reapplied single layer of Unitex Polymer layer installed in September 2018 (view east).



🡸 Areas of repaired delamination's; eastbound/east end of deck approach.

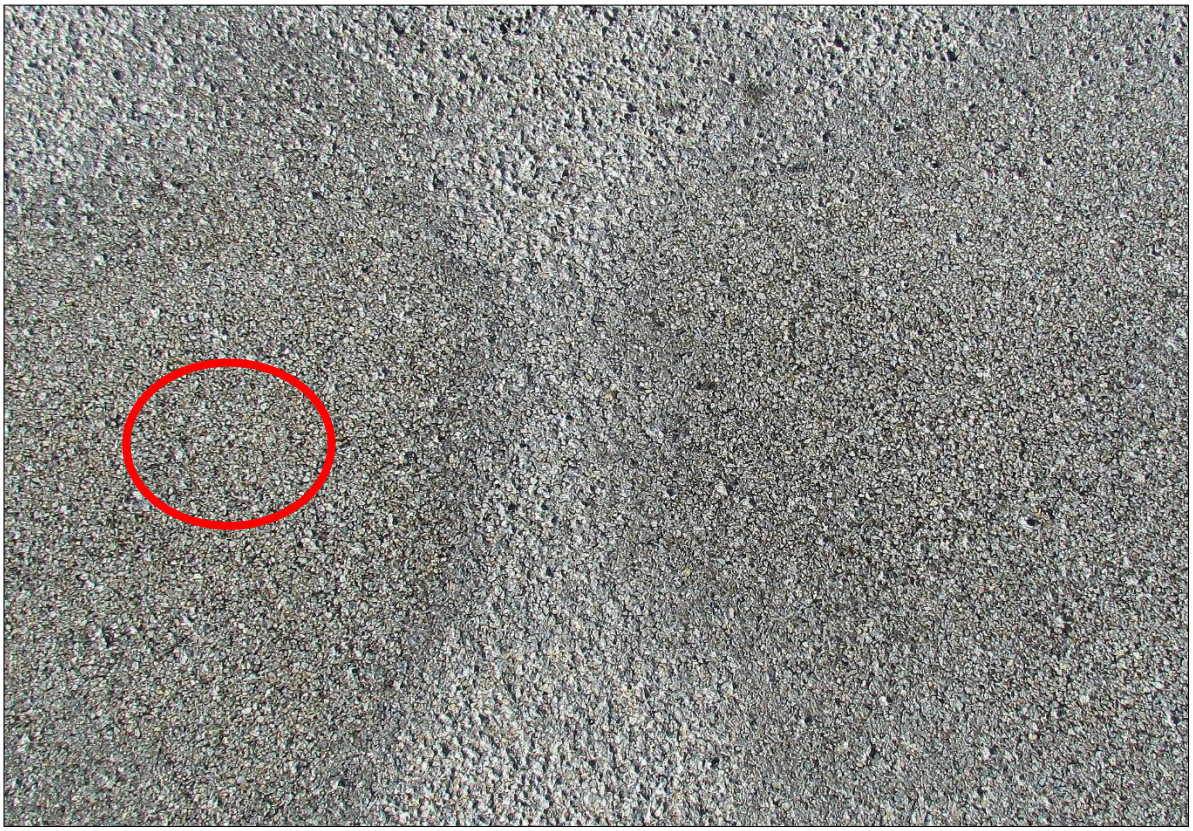
🡸 Areas of repaired delamination around the finger plate joints; west end of deck (refer to page 62).

⬆⬇ Representative images of surface texture of reapplied HFST layer.

Kalispell – Poly-Carb 135 Safe-T-Seal/163 Flexogrid Overlay: April 2020

⬆ West end of Flathead River/MT 35 bridge deck; view east.

⬇ East end of Flathead River/MT 35 bridge deck; view west.



Several representative images of the overlay surface texture in the wheel paths; the image below is a close-up of the area specified in the red circle in the above image, which shows the polished aggregate. The red arrow in the image below shows aggregate that has popped out of the epoxy matrix.

⬆ Repaired section and reapplication of deck overlay conducted in September 2018, eastbound lane, west end.

Updated Skid Test Results:

Bigfork Bridge	
Polymer System:	Dayton Superior-Unitex
Aggregate Type:	Washington Rock Quarries ArmorStone
Test Year	Average Skid Numbers
2018	35.8
2017	46.5
2016	Not Tested
2015	Installed
2014	N/A

← **Bigfork AADT**: 2015-8,950
2017-10,551

Kalispell Bridge	
Polymer System:	Poly-Carb
Aggregate Type:	Washington Rock Quarries ArmorStone
Test Numbers	Average Skid Numbers
2018	17.1
2017	23.8
2016	Not Tested
2015	60.0
2014	82.0

← **Kalispell AADT**: 2014-10,240
2017-12,714

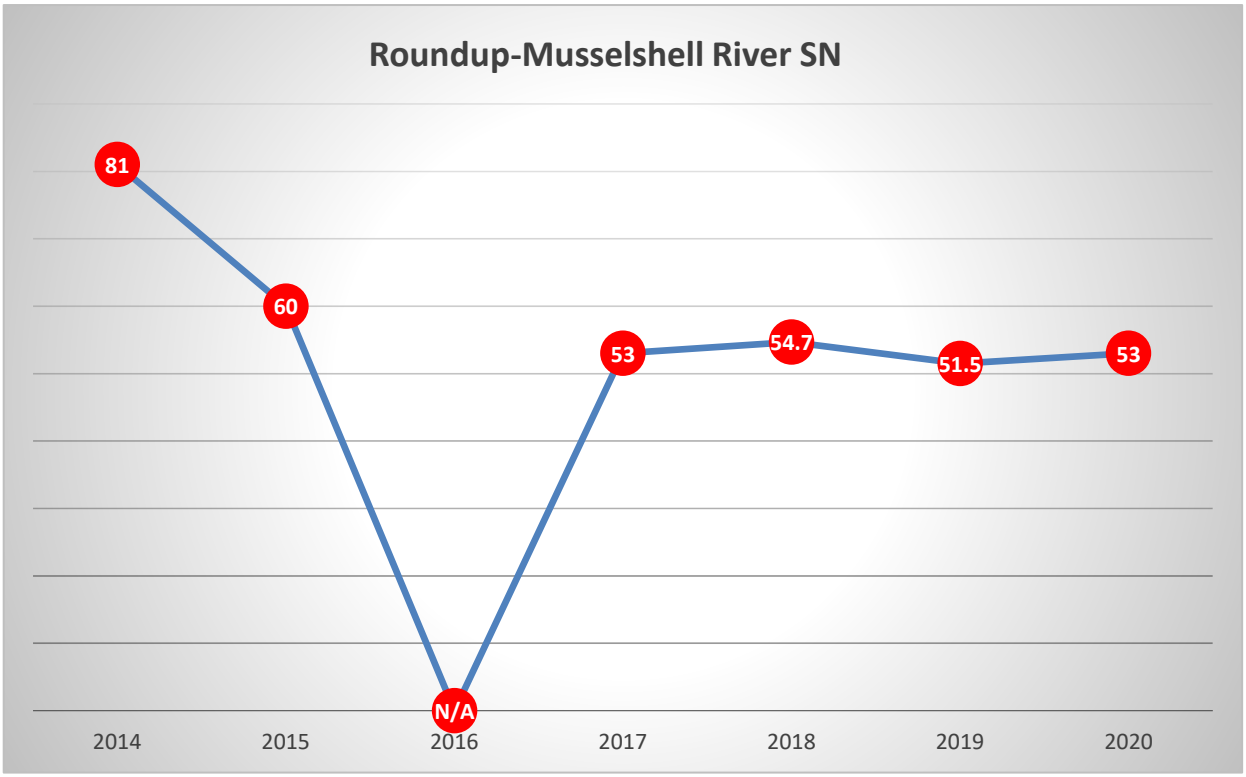
Big Timber-Yellowstone River	
Polymer System:	Dayton Superior-Unitex
Aggregate Type:	Washington Rock Quarries ArmorStone
Test Year	Average Skid Numbers
2018	53.1
2017	52.0
2016	Not Tested
2015	60.0
2014	83.0

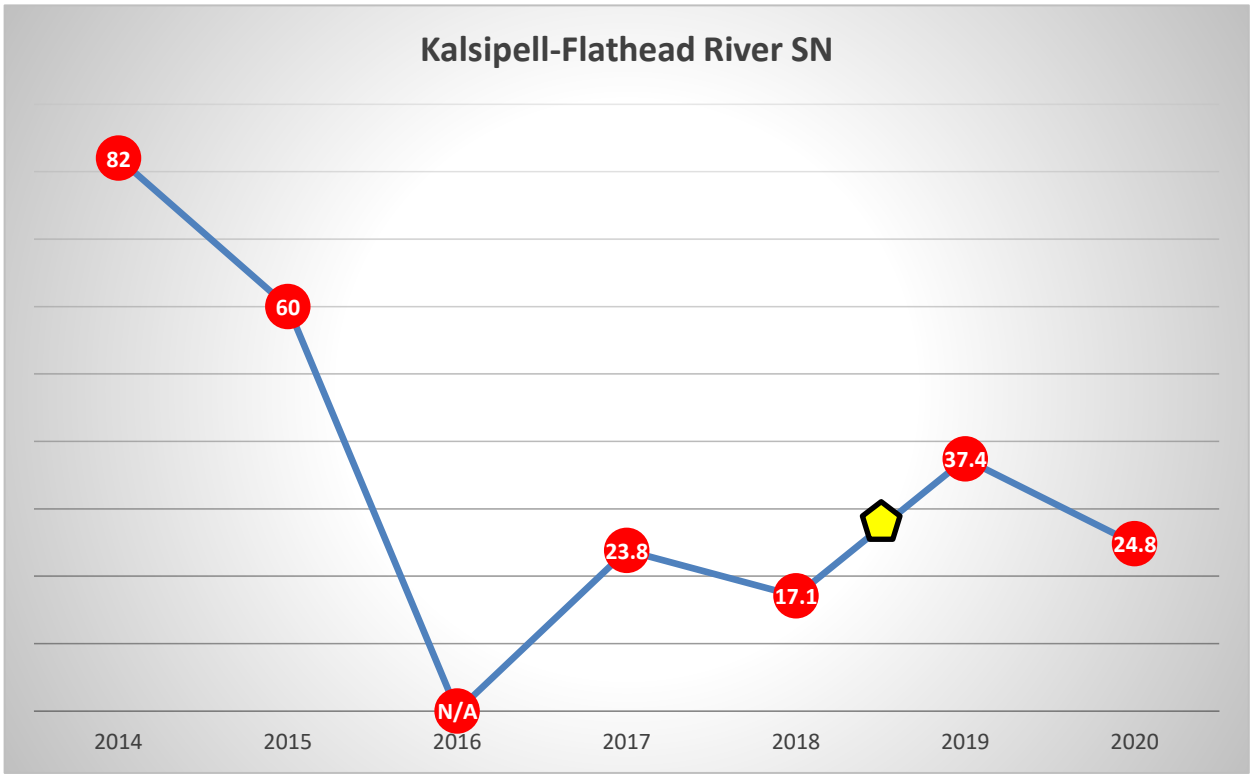
← **Big Timber AADT**: 2014-1,569
2017-1,453

Roundup-Musselshell River	
Polymer System:	Poly-Carb
Aggregate Type:	Washington Rock Quarries ArmorStone
Test Year	Average Skid Numbers
2018	54.7
2017	53.0
2016	Not Tested
2015	60.0
2014	81.0

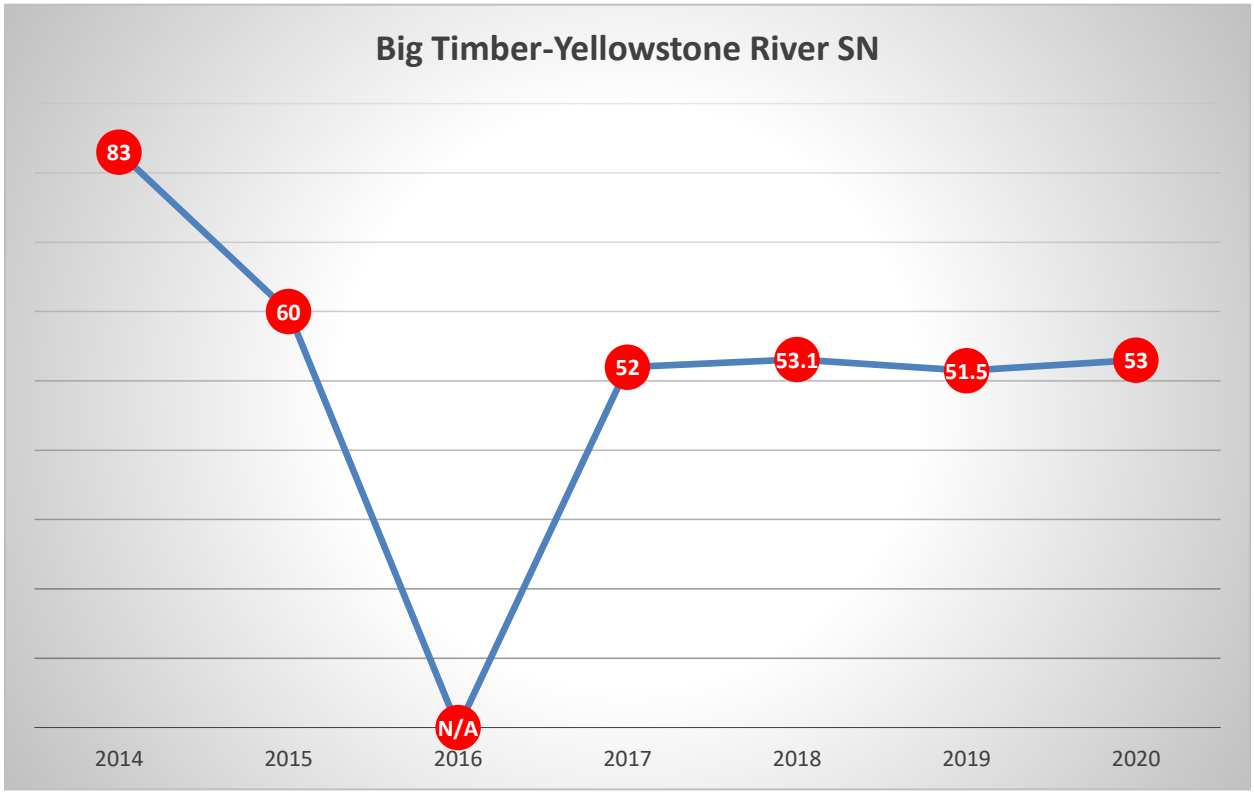
← **Roundup AADT**: 2014-2,430
2017-2,620

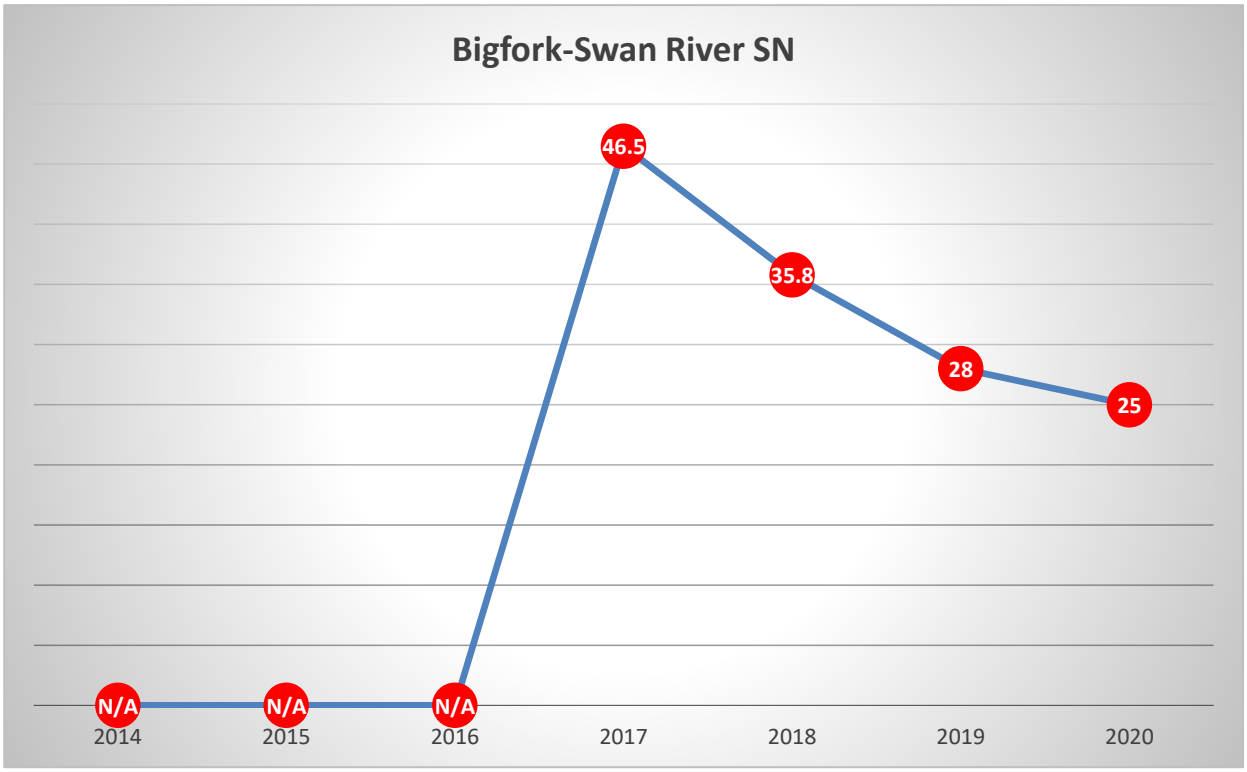
*Project Skid Numbers (SN): 2014-2019





Due to low skid numbers documented in 2018 and several areas of HFST delamination; the District repaired the delamination and reapplied a single lift of HFST in September of 2018.





*For all listed decks, the 2016 Skid Tests did not take place. The Bigfork Deck was applied in 2015 but was not skid tested until 2017.

***Project Locations**

1 – **Roundup**-Musselshell River: Highway 87; Poly-Carb Mark

2 – **Kalispell**-Flathead River: Highway 35; Poly-Carb Mark

3 – **Bigfork**-Swan River Bridge: Highway 35; Dayton Superior

4 – **Big Timber**-Yellowstone River: Highway 191; Dayton Superior

*Approximate; not to scale

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