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Transportation Research Division

Technical Report 02-3

The Use of Micro-Surfacing for Pavement Preservation

Interim Report - First Year, May 2004

Transportation Research Division

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Introduction

The Maine Department of Transportation (MDOT) is responsible for maintaining approximately 14,000 kilometers of public highways. Maintenance of these highways consists of rehabilitation or reconstruction when the road has deteriorated to an unacceptable level. With economic fluctuations and ever increasing traffic levels, this policy does not effectively address the needs of the highway system when maintenance is necessary and creates a backlog of deficient highways.

To reduce this trend, many states have adopted the policy of Pavement Preservation. This policy consists of applying preventative maintenance to the roadway before it has deteriorated to an undesirable level, maintaining the structural integrity and extending the service life of the pavement. Length of time between costly rehabilitation is increased, reducing the cost of maintaining the highway system. Several states have reported that they were able to improve the overall condition of their highway system after trying this approach and that every dollar spent using preventative maintenance could save up to six dollars in future spending.

Maine has two types of roads: “A” roads, which are built to state standards and “B” roads, which are not. Pavement Preventive Maintenance (PPM) can be used effectively on “A” roads to extend service life.

Examples of PPM treatments include Crack Sealing, Hot Maintenance Mulch, Thin Overlays, and Micro-Surfacing. Crack Sealing prevents water and debris from entering cracks in the pavement by sealing them with a rubberized material. Hot Maintenance Mulch is a hot mix asphalt pavement with little or no crushed aggregate and is typically used on “B” roads. Thin Overlays are dense - open graded Superpave mixes, with or without recycled asphalt pavement incorporated into the mix, that are typically used on “A” roads. Micro-Surfacing is a thin overlay of a mixture of polymer-modified asphalt emulsion, mineral aggregate, mineral filler, and water.

This report will examine the application of Micro-Surfacing to extend the service life of two projects in Aroostook County.

Scope

Project Identification Number (PIN) 9051.00 is located on Route 1 between the cities of Presque Isle and Caribou and PIN 9050.00 is located on Route 1A between Limestone and Caswell as depicted in Figure 1. Each project was resurfaced with Hot Mix Asphalt Overlay and Micro-Surfacing. Both projects have Test and Control Sections to evaluate and monitor frictional resistance, reflective cracking, rutting, and roughness.

PIN 9051.00 begins at station 10+000 and ends at 18+514. This project has two sections of Micro-Surfacing, one between stations 11+225 and 13+500 and another between 16+780 and 18+514. A Level 2 Overlay, comprised of a minimum depth of 13 mm of 9.5 mm Hot Mix Asphalt (HMA) Shim topped with

30 mm of 9.5 mm HMA Surface, was placed on the remaining sections. To evaluate each treatment, two 100-meter test and two 100-meter control sections were established. Micro-Surfaced test sections begin at station 13+300 (Section 1) and 16+880 (Section 4). Control sections begin at station 13+600 (Section 2) and 16+580 (Section 3).

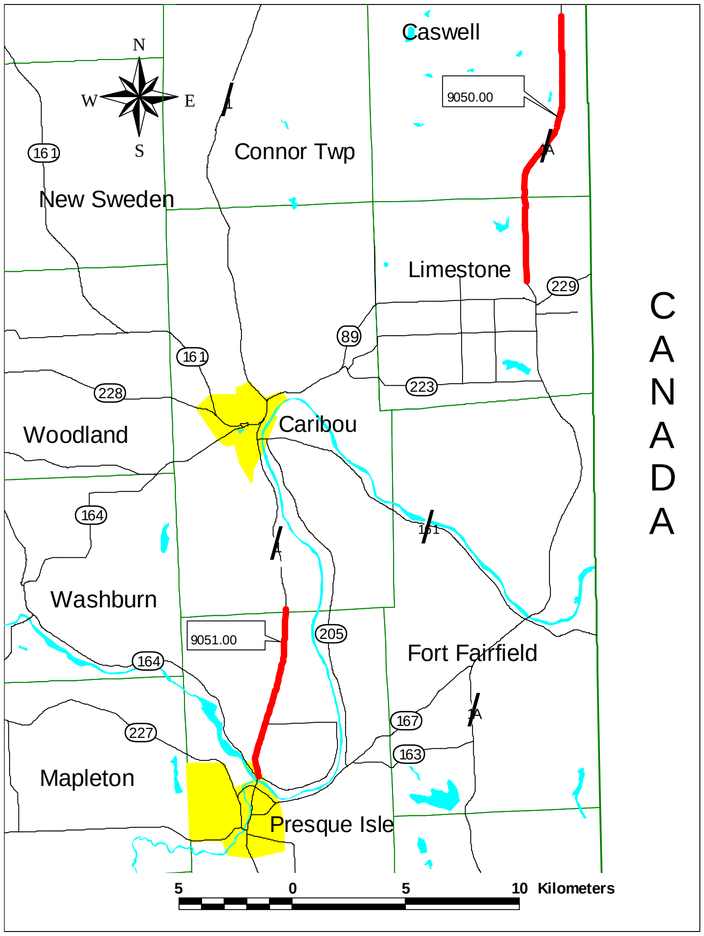

Figure 1: Project Location Map

Project limits for PIN 9050.00 are from station 9+990 to 23+600. Micro-Surfacing was placed between stations 9+990 and 16+000. A Level 2 Overlay with a minimum depth of 15 mm of 9.5 mm HMA shim and 30 mm of 9.5 mm HMA surface mix was placed between stations 16+000 and 23+600. One 100-meter test and one 100-meter control section were established. The Micro-Surfaced test section begins at station 15+800 (Section 5) and the control section begins at station 16+100 (Section 6).

Construction

Mix Design materials, properties, and trial batch information as well as construction equipment and Micro-Surface placement procedures are not included in this report but can be reviewed in the construction report titled Maine Department of Transportation Technical Report Number 02-3, The Use of Micro-Surfacing for Pavement Preservation (March, 2002).

Project Evaluation

The overall appearance of Micro-Surfacing resembles an open-graded mix with exposed stone as the wearing surface. After one year’s exposure to winter conditions, the Micro-Surfaced portions of each project are showing signs of snow plow abrasion at centerline, mid-point between wheel paths, and shoulder joint areas. Figure 2 displays the severity of wear at centerline and between wheel-path on the Limestone Route 1A project. Abrasion at centerline is primarily loss of the stone matrix whereas the wear between wheel-paths is down to the original Hot Mix Asphalt. The amount and severity of plow wear will be summarized for each test section later in the report.

Wheel path areas are also showing signs of wear. Much of the stone matrix has been abraded.

Figure 2: Between Wheel-Path and Centerline Plow Wear, Limestone Project.

Smoothness

Smoothness measurements were collected on October of 2001 and October of 2002 utilizing the departments Automatic Road Analyzer (ARAN). This is an ASTM Class I profile-measuring device that is capable of accurately measuring roadway smoothness. The ARAN uses lasers and accelerometers to measure the lateral profile of each wheel path every 12.5 mm (0.5 in) then averages those measurements every 20 meters (66 ft). Smoothness is displayed in International Roughness Index (IRI) units. Figure 3 contains a range of IRI values and descriptions for each range.

IRI (Meters/Kilometer)	IRI (Inches/Mile)	Verbal Description
1.02 - 1.57	65 – 99	Comfortable ride at 105/65 kph/mph. No noticeable potholes, distortions, or rutting. High quality pavement.
1.58 - 3.15	100 – 199	Comfortable ride at 88/55 kph/mph. Moderately perceptible movements induced by occasional patches, distortions, or rutting.
3.16 - 4.73	200 – 299	Comfortable ride at 72/45 kph/mph. Noticeable movements and swaying induced by frequent patches and occasional potholes. Some distortion and rutting.
Greater than 4.73	Greater than 299	Frequent abrupt movements induced by many patches, distortions, potholes, and rutting. Ride quality greatly diminished.

Figure 3: IRI Range and Descriptions

Smoothness test results obtained from the four test sections on the Presque Isle project are displayed in Figure 4. Micro-Surfaced sections experience a decrease in IRI values; this could be due to the loss of stone matrix in the wheel path. The Level 2 Overlay sections have remained the same.

PIN 9051.00 Presque Isle - Caribou IRI (m/km)		
Test Section	2001	2002
1 (Micro-Surface)	0.93	0.79
2 (9.5 mm HMA)	0.77	0.77
3 (9.5 mm HMA)	0.73	0.73
4 (Micro-Surface)	1.21	1.00

Figure 4: Presque Isle IRI Test Summary

Figure 5 contains IRI test results from the two Limestone test sections. IRI values on the Micro-Surfaced section have increased, just the opposite to the Presque Isle results. Level 2 IRI values have decreased resulting in a smoother ride.

PIN 9050.00 Limestone - Caswell IRI (m/km)		
Test Section	2001	2002
5 (Micro-Surface)	1.03	1.45
6 (9.5 mm HMA)	1.25	0.91

Figure 5: Limestone IRI Test Summary

All IRI values remain in the smooth range of 1.02 – 1.57 m/km (65-99 in/mi).

Rut Depth

The ARAN was utilized to collect rut depth measurements. Data is collected using ultrasonic transducers spaced 100 mm (4 inches) apart on a bar that traverses the roadway. Each sensor measures to an accuracy of 1 mm (0.04 in) to produce a transverse profile with an overall accuracy of 1.5 mm (0.06 in).

Measurements on both projects in 2001 demonstrate that Micro-Surfacing does not improve rut depths as well as HMA. This is attributed to raveling of the stone with increased traffic as stated in the construction report.

Figure 6 contains a summary of rut depth measurements on the Presque Isle project. Micro-Surface rut depths between 2001 and 2002 have decreased by 0.6 mm (0.02 in) in Section 1 and remained the same on Section 4. This could be the result of snow plow abrasion at centerline, shoulder, and between wheel path areas. If there was an increase in rut depth, it would be diminished by the amount of wear at these high points.

HMA rut depths have increased in depth by 1.9 mm (0.07 in) in Section 1 and 0.9 mm (0.04 in) in Section 3. This is typical of HMA for this time period.

PIN 9051.00 Presque Isle - Caribou Rut Depth (mm)		
Test Section	2001	2002
1 (Micro-Surface)	8.1	7.5
2 (9.5 mm HMA)	4.6	6.5
3 (9.5 mm HMA)	4.4	5.3
4 (Micro-Surface)	7.3	7.3

Figure 6: Presque Isle Rut Depth Summary

Figure 7 contains a summary of rut depth measurements on the Limestone project. Rutting on both test sections has increased.

Micro-Surface rutting has increased 1.2 mm (0.05 in) to a depth of 7.2 mm (0.28 in).

HMA rutting increased slightly from 3.9 to 4.3 mm (0.15 to 0.17 in) and increase of 0.4 mm (0.02 in).

PIN 9050.00 Limestone - Caswell Rut Depth (mm)		
Test Section	2001	2002
5 (Micro-Surface)	6.0	7.2
6 (9.5 mm HMA)	3.9	4.3

Figure 7: Limestone Rut Depth Summary

Frictional Resistance

Frictional Resistance readings were randomly collected in the left wheel path along the length of each project. Figure 8 contains a summary of frictional numbers for each project. Frictional numbers of 35 or higher are considered by the Federal Highway Administration (FHWA) to be acceptable.

PIN 9051.00 Presque Isle - Caribou Frictional Resistance		
	2001 Mean (Std. Dev.)	2002 Mean (Std. Dev.)
Micro-Surfacing	53.3 (1.49)	49.9 (4.04)
9.5 mm HMA	47.5 (3.00)	47.3 (3.48)

PIN 9050.00 Limestone - Caswell Frictional Resistance		
	2001 Mean (Std. Dev.)	2002 Mean (Std. Dev.)
Micro-Surfacing	53.1 (1.75)	57.5 (1.41)
9.5 mm HMA	53.0 (2.28)	54.8 (1.52)

Figure 8: Frictional Resistance Summary

Mean Frictional Numbers on Micro-Surfaced and 9.5 mm HMA treatments are well above FHWA's minimum specification. Micro-Surfaced areas have greater frictional resistance than the 9.5 mm HMA areas. The Presque Isle project had a slight decrease in frictional resistance on Micro-Surface and 9.5 mm HMA treatments as compared to 2001 tests. In contrast, the Limestone project has experienced an increase in frictional resistance for both treatments.

Crack Survey

Figure 9 – 14 contain crack surveys of each test section. Cracks are displayed using separate colors for each year: preconstruction – black, 2002 – red, 2003 – blue, 2004 – orange, 2005 – green, and 2006 – violet. Each year that cracks develop, the preconstruction cracks will be mirrored using the appropriate color for the year it was observed. Figures 9 – 12 represent the Presque Isle project, Figures 13 and 14 the Limestone project.

A crack survey of Section 1 with Micro-Surfacing is depicted in Figure 9. This section had the lowest amount of preconstruction longitudinal cracking and only one partial transverse crack. There were no visible cracks observed in 2002. Snow plow wear was observed at centerline and is displayed in Figure 15. It appears that the plow bounced on the surface, gouging the Micro-Surfaced treatment. Similar plow wear was mentioned in the Construction Report on the I-95 Oakfield project after one winter season.

Figure 10 contains a crack survey of Control Section 2. Two transverse cracks have reflected thru at stations 13+620 and 13+650. No longitudinal cracking was observed. Figure 16 contains a photo of the transverse crack at station 13+620.

Figure 11 displays the amount of cracking on Control Section 3. All three transverse cracks have reflected thru with no longitudinal cracking. A transverse crack is pictured in Figure 17.

Micro-Surfaced Section 4 in Figure 12 had no longitudinal cracking but both transverse cracks have reflected thru. The centerline is experiencing snow plow wear as displayed in Figure 18.

Micro-Surfaced Section 5 is displayed in Figure 13. There were no visible cracks after one year's exposure to traffic. As mentioned earlier, and displayed in Figure 2, plow wear was visible on most of the centerline and a few small areas between wheel paths.

A crack survey for Control Section 6 is exhibited in Figure 14. A transverse crack and a portion of edge cracking on either side has reflected thru. Figure 19 contains a photo of the transverse crack.

Discussion of Results

After one year of exposure to traffic and weather, Micro-Surfaced sections are showing slightly more wear and tear than the 9.5 mm HMA sections. IRI values are slightly higher and rut depths are deeper. In contrast, Micro-Surfacing has slowed the progression of reflective cracking and Frictional Resistance is higher.

Snow plow wear is evident on high points within the Micro-Surfaced roadway. Abrasion areas do not affect Frictional Resistance of the roadway.

Overall Micro-Surfacing is performing as well as 9.5 mm HMA at a lower cost. Evaluation of the test sections over a five year period will determine if Micro-Surfacing is a cost-effective treatment. At the end of this evaluation, life cycle cost analysis will be done to compare the microsurfacing and 9.5 mm HMA treatments.

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Additional Literature:
The Use of Micro-Surfacing for Pavement Preservation, Construction Report, March 2002

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Figure 9
PIN 9051.00 Crack Survey Section 1 Micro-Surfacing

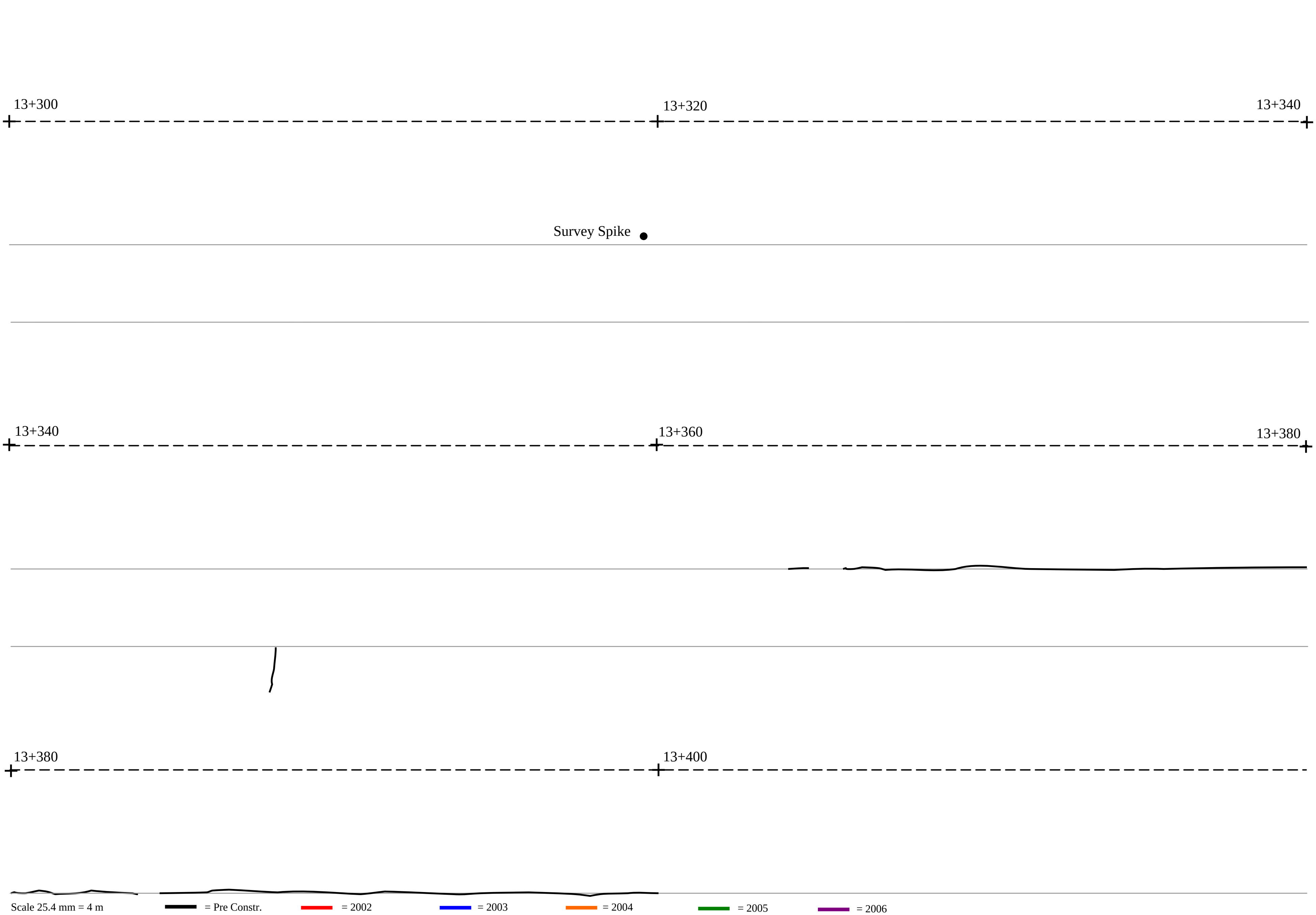


Figure 10
PIN 9051.00 Crack Survey Section 2 Control

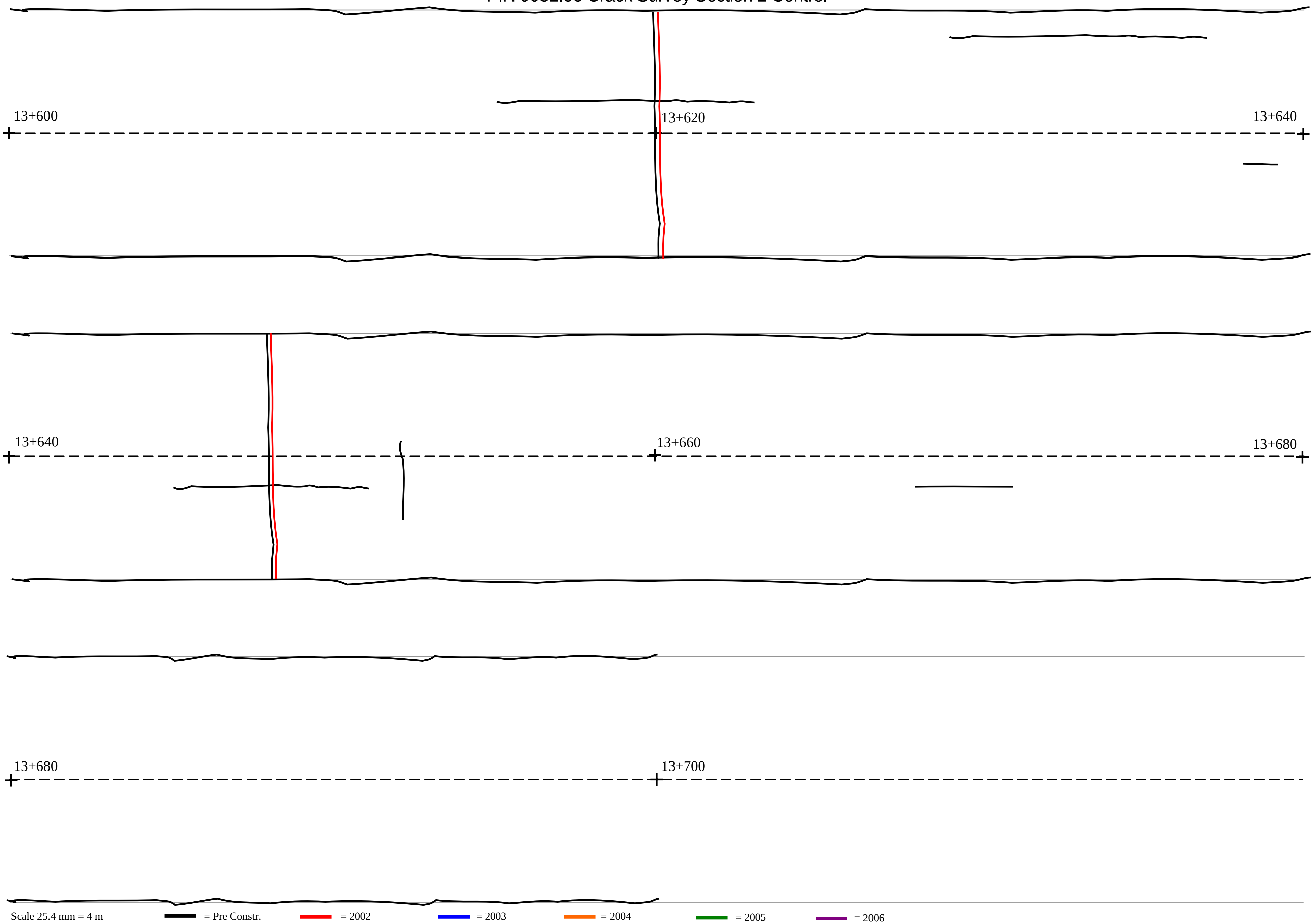


Figure 11
PIN 9051.00 Crack Survey Section 3 Control

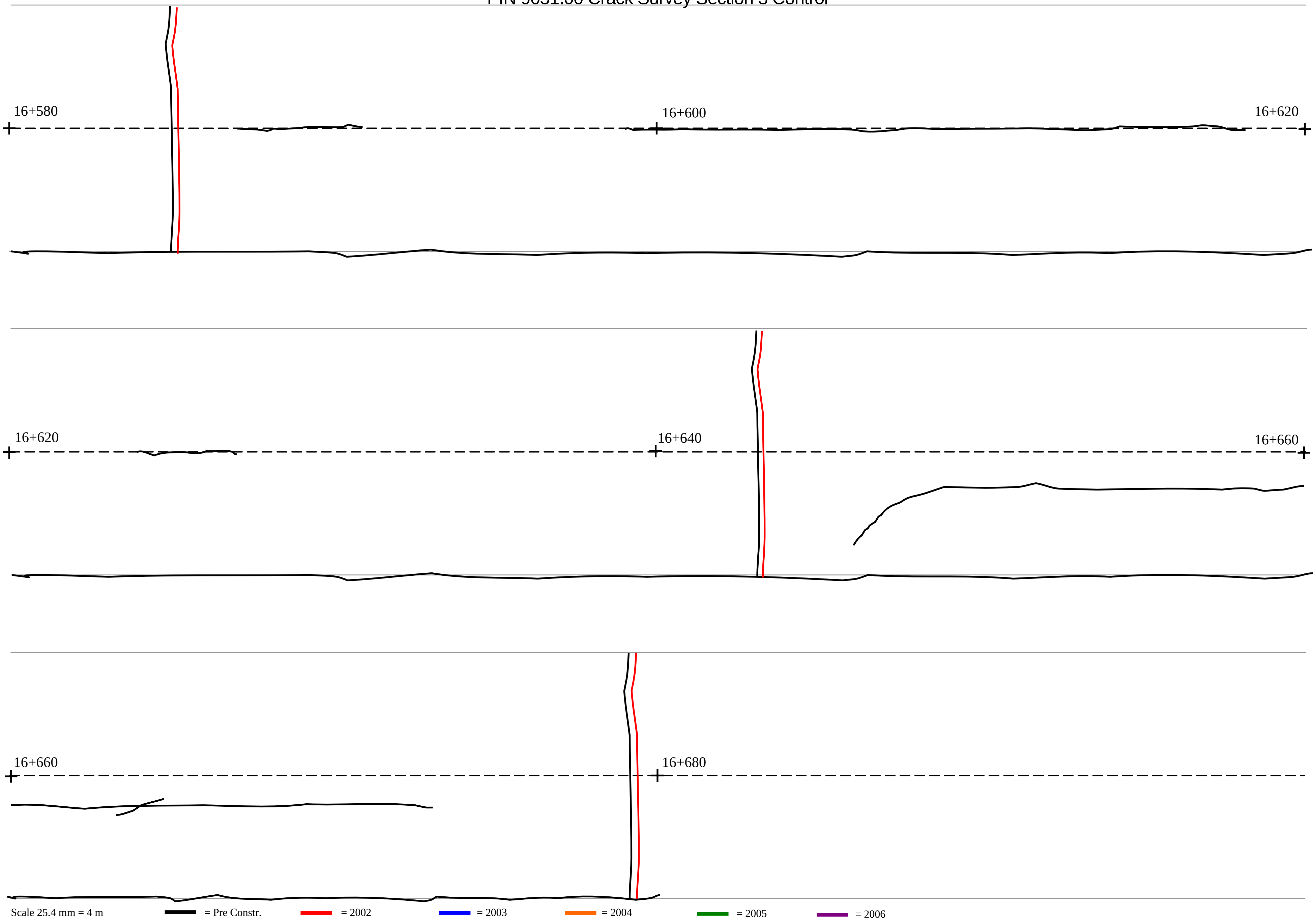


Figure 12
PIN 9051.00 Crack Survey Section 4 Micro-Surfacing

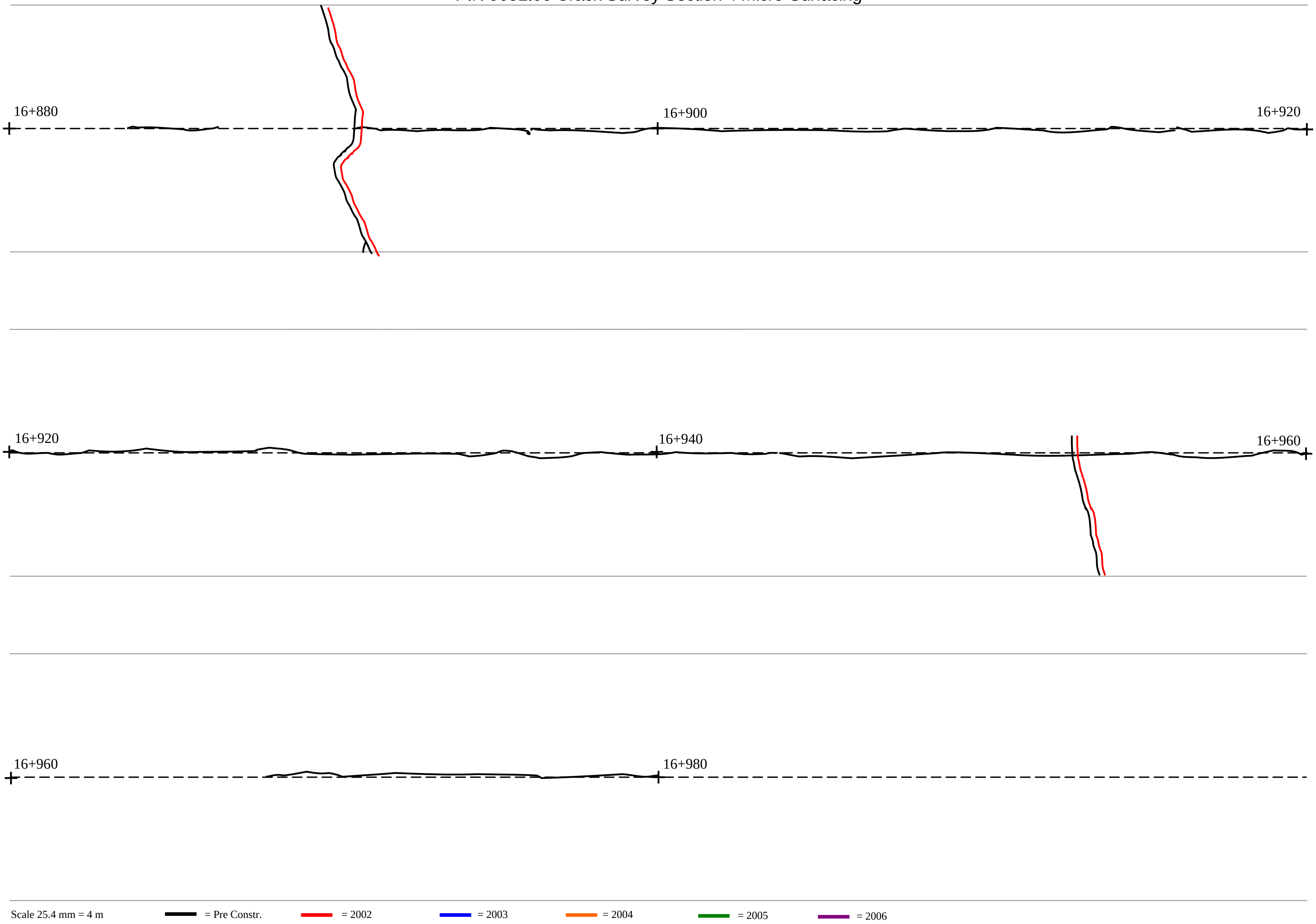


Figure 13

PIN 9050.00 Crack Survey Section 5 Micro-Surfacing

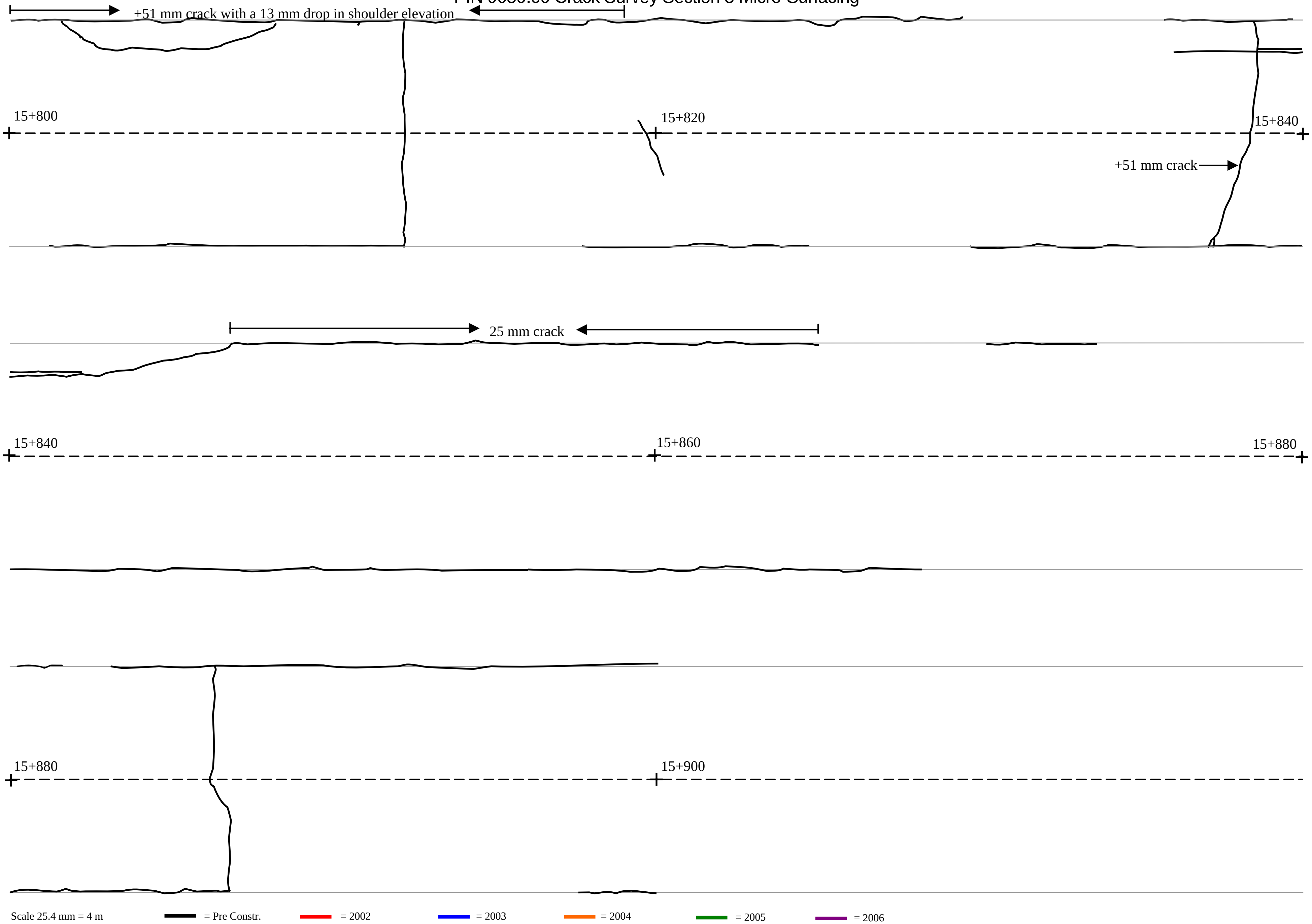
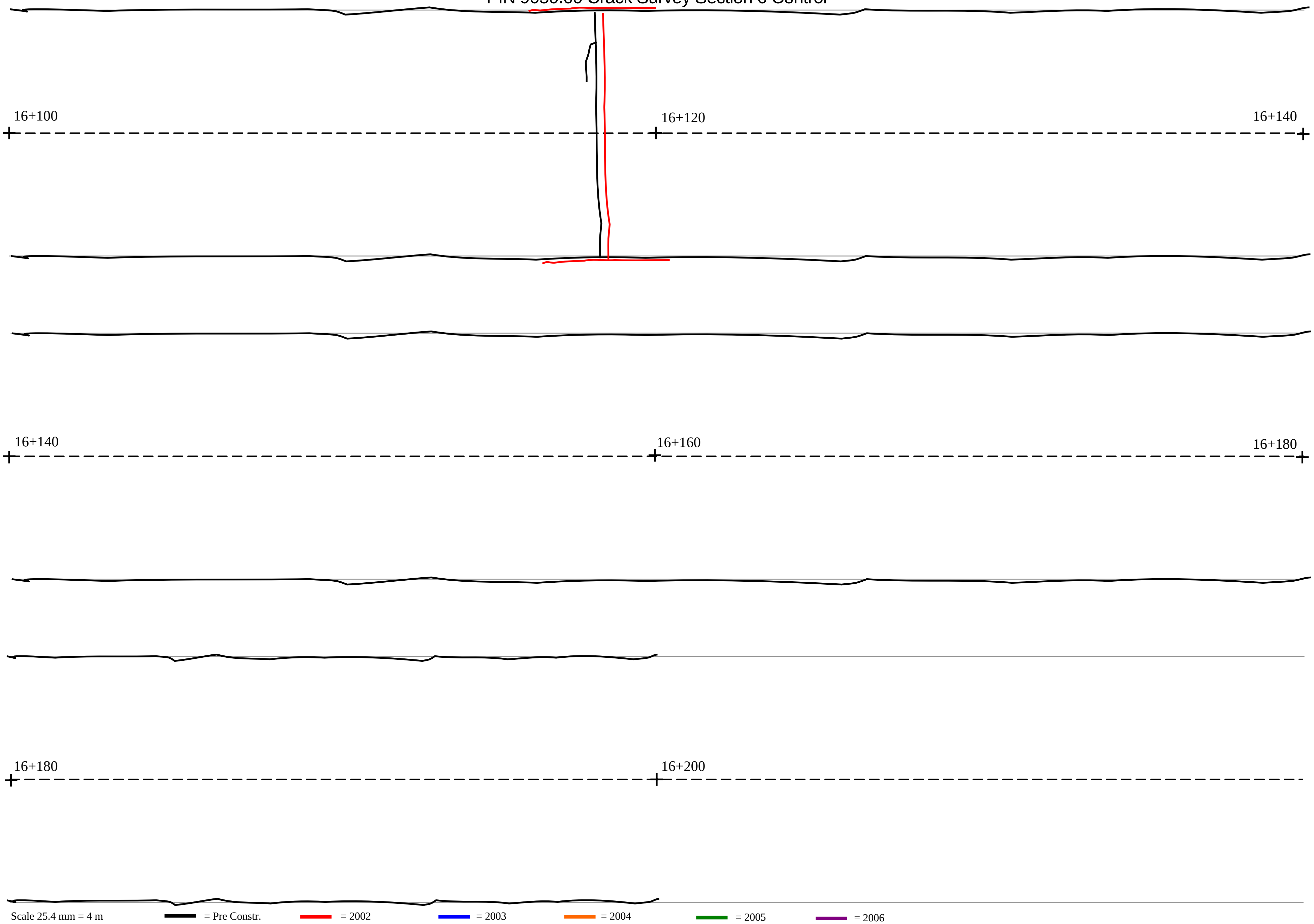


Figure 14
PIN 9050.00 Crack Survey Section 6 Control



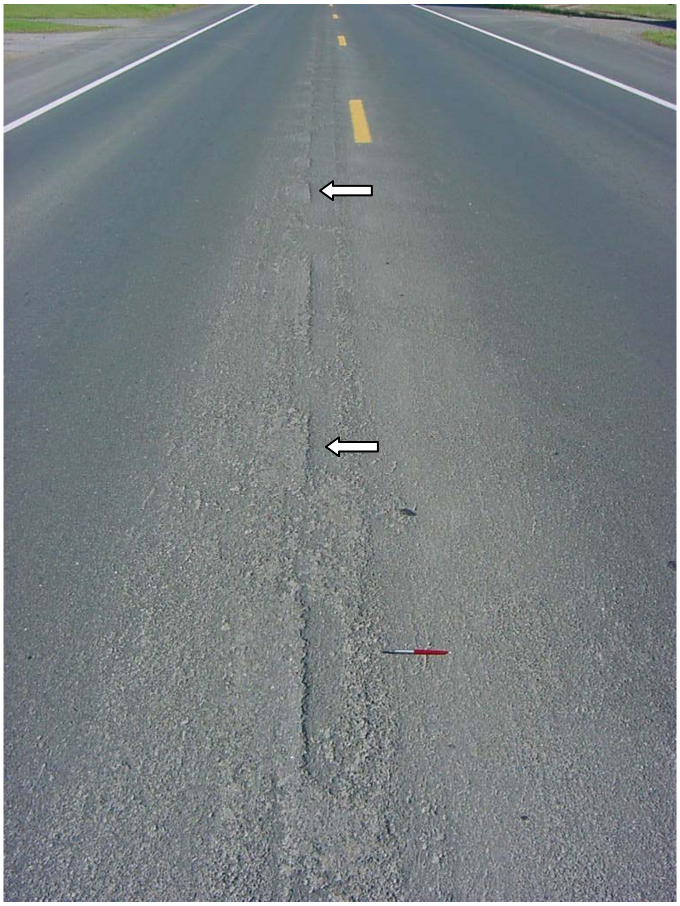


Figure 15: Micro-Surface Section 1 snow plow wear

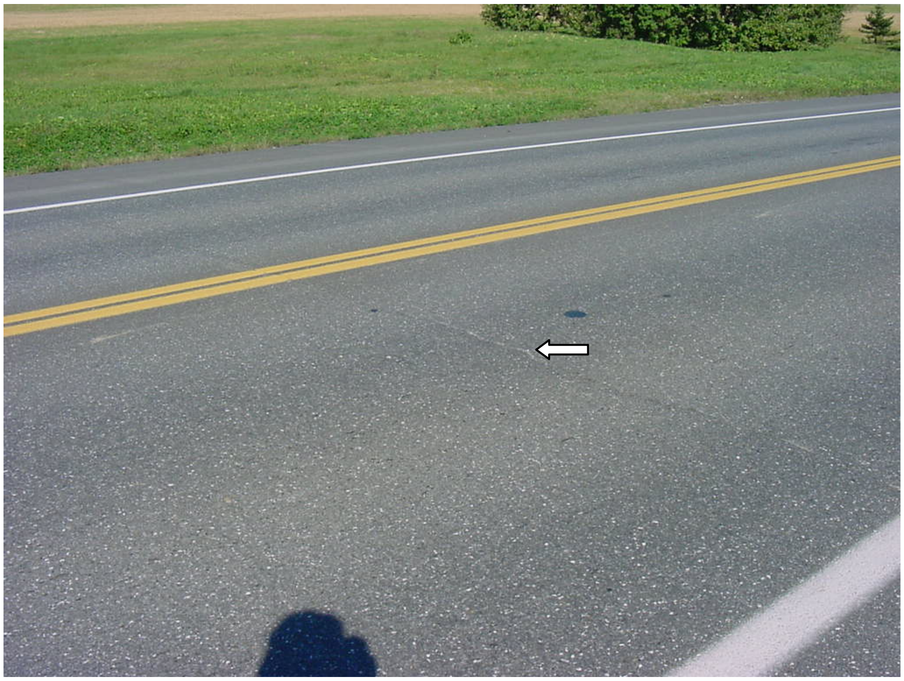


Figure 16: Control Section 2 transverse crack

Figure 17: Control Section 3 transverse crack.

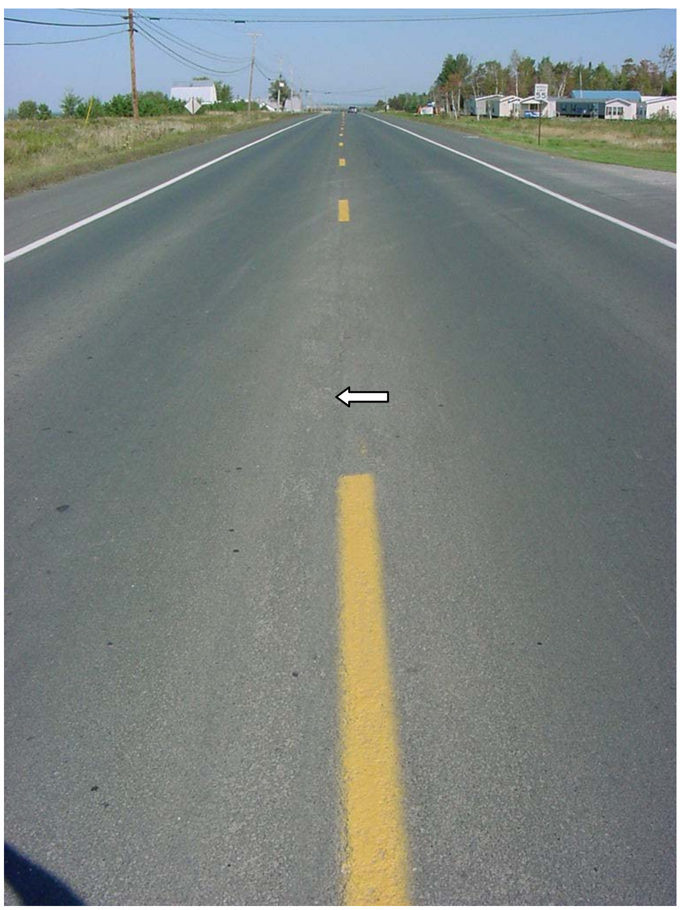


Figure 18: Micro-Surface Section 4 centerline plow wear

Figure 19: Control Section 6 transverse crack