Research & Technology Transfer

Alaska Department of Transportation & Public Facilities

Minnesota Drive Ramps Micro Surfacing Experimental Feature

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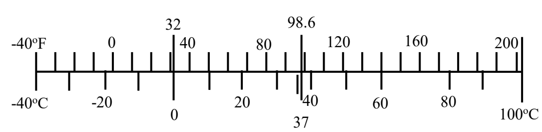
METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH					LENGTH		
In	inches	25.4		mm	mm	millimeters	0.039	inches	in
Ft	feet	0.3048		m	m	Meters	3.28	feet	ft
Yd	yards	0.914		m	m	Meters	1.09	yards	yd
mi	Miles (statute)	1.61		km	km	kilometers	0.621	Miles (statute)	mi
		AREA					AREA		
in^2	square inches	645.2	millimeters squared	cm^2	mm^2	millimeters squared	0.0016	square inches	in^2
ft^2	square feet	0.0929	meters squared	m^2	m^2	meters squared	10.764	square feet	ft^2
yd^2	square yards	0.836	meters squared	m^2	km^2	kilometers squared	0.39	square miles	mi^2
mi^2	square miles	2.59	kilometers squared	km^2	ha	hectares (10,000 m^2)	2.471	acres	ac
Ac	acres	0.4046	hectares	ha					
		MASS (weight)					MASS (weight)		
Oz	Ounces (avdp)	28.35	grams	g	g	Grams	0.0353	Ounces (avdp)	oz
Lb	Pounds (avdp)	0.454	kilograms	kg	kg	kilograms	2.205	Pounds (avdp)	lb
T	Short tons (2000 lb)	0.907	megagrams	mg	mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME					VOLUME		
fl oz	fluid ounces (US)	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces (US)	fl oz
gal	Gallons (liq)	3.785	liters	liters	liters	Liters	0.264	Gallons (liq)	gal
ft^3	cubic feet	0.0283	meters cubed	m^3	m^3	meters cubed	35.315	cubic feet	ft^3
yd^3	cubic yards	0.765	meters cubed	m^3	m^3	meters cubed	1.308	cubic yards	yd^3
Note: Volumes greater than 1000 L shall be shown in m^3									
		TEMPERATURE (exact)					TEMPERATURE (exact)		
ºF	Fahrenheit temperature	5/9 (ºF-32)	Celsius temperature	ºC	ºC	Celsius temperature	9/5 ºC+32	Fahrenheit temperature	ºF
		ILLUMINATION					ILLUMINATION		
Fc	Foot-candles	10.76	lux	lx	lx	Lux	0.0929	foot-candles	fc
Fl	foot-lamberts	3.426	candela/m^2	cd/cm^2	cd/cm^2	candela/m^2	0.2919	foot-lamberts	fl
		FORCE and PRESSURE or STRESS					FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N	N	newtons	0.225	pound-force	lbf
psi	pound-force per square inch	6.89	kilopascals	kPa	kPa	kilopascals	0.145	pound-force per square inch	psi

These factors conform to the requirement of FHWA Order 5190.1A *SI is the symbol for the International System of Measurements



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13. ABSTRACT (Maximum 200 words)

During the 2020 construction season, the Alaska DOT&PF Central Region installed its first application of micro surfacing at 17 locations on Minnesota Drive ramps in the city of Anchorage. This treatment offers the potential to be a more economical solution to the typical mill and fill hot mix asphalt (HMA) treatment used to address rutted roads.

Micro surfacing has not been used on roads in Central Region due to poor historical Prall testing (ATM 420) that is used to simulate studded tire wear. A new formulation of micro surfacing was evaluated in 2016 with significantly improved performance on the Prall test. This formulation uses fine aggregate and a high residual binder content with a PG64-40 modified asphalt binder and between 6%-8% SBS polymer. This is a very high percentages of both binder and polymer for a micro surfacing treatment.

There were difficulties encountered during construction with break and set times that made the micro surfacing prone to flushing and deformation rutting immediately after construction. Five ramps were removed and replaced during construction from these distresses. The remaining ramps range from good to poor conditions and the condition at the end of the three years of monitoring largely depends on the original ramp conditions. Ramps that had high severity cracks, or frost movement during the winter experienced snowplow damage, while ramps that were in good condition largely remain in good condition.

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Minnesota Drive Ramps Micro Surfacing

Experimental Feature

Year 3 Final Report

Alaska Department of Transportation and Public Facilities

Statewide Materials

January 2024

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Definitions

AASHTO	American Association of State Highway Transportation Officials
Crude Slate	The blend of crude received by a crude source
DFT	Dynamic Friction Tester
DOT&PF	Department of Transportation and Public Facilities
HMA	Hot Mix Asphalt
IRI	International Roughness Index – units of inches/mile
ISSA	International Slurry Seal Association
Jnr	Non-Recoverable Creep Compliance Parameter of MSCR Test
MSCR	Multiple Stress Creep Recovery
PG	Performance Grade
QAP	Quality Asphalt Paving
SBR	Styrene Butadiene Rubber
SBS	Styrene Butadiene Styrene
TB	Technical Bulletin
VSS	Valley Slurry Seal

Executive Summary

During the 2020 construction season, the Alaska Department of Transportation and Public Facilities (DOT&PF) installed its first application of micro surfacing at 17 locations on Minnesota Drive ramps in the city of Anchorage. The total area applied was 26,231 square yards. Micro surfacing is a preservation treatment that can be applied in thin layers (1/3" or less), consisting of a mixture of fine aggregate, emulsified asphalt and additives. It offers the potential to be a more economical solution to the typical mill and fill hot mix asphalt (HMA) treatment used to address rutted roads in Alaska DOT&PF's Central Region.

While this treatment is used widely in the contiguous United States, it has not been used on roads in Central Region due to poor historical Prall testing (ATM 420) that is used to simulate studded tire wear. A new formulation of micro surfacing was evaluated in 2016 with significantly improved performance on the Prall test. This formulation uses fine aggregate and a high residual binder content (10%-11%) with a PG64-40 modified asphalt binder and 6%-8% SBS polymer, which are very high percentage of both binder and polymer for a micro surfacing treatment. In 2017 the ramps on Minnesota Drive were selected for evaluating the micro surfacing treatment with this formulation as part of the larger *Minnesota Drive: Seward to Tudor Pavement Preservation Project (CFHWY00106)* as an experimental feature.

This application required surface preparation (including crack sealing and hot mix asphalt (HMA) tamped in place for cracks greater than ¾"), a tack coat, and a scratch course of micro surfacing to fill ruts and other surface deviations, with the final wearing course of micro surfacing being placed over the scratch course.

Construction took place in June of 2020. The primary contractor was Quality Asphalt Paving (QAP), with Colas performing the mix design. The micro surfacing application was sub-contracted to Valley Slurry Seal (VSS) out of California as no crews or equipment are locally available in Alaska.

On the first day of production, June 7th, it was discovered the crude slate for the crude source had changed since the mix design had been performed over the winter. The change in crude source caused an unacceptably long set time and a problem applying the micro surfacing in super elevated curves. This required a change in the additives used in the formulation and a slight delay to the project as the proper dosages in the new formulation were determined. A new test strip and mix design were performed.

Production resumed June 10th starting with a new test strip, which was successful. Production continued without issue and the application was completed June 13th.

On June 18th, Construction noted a flushing distress on two of the ramps connecting to International Airport Road. It appeared the coarse aggregate was depressed and the binder and fines were flushed to the surface, causing a loss of friction and a shiny surface. The ramps were investigated and this distress was noted on seven ramps, with varying severity.

In August 2020 the observed flushing distresses were considered to be severe enough to perform friction testing on five of the seven ramps, which validated the observed loss of friction. The micro surfacing on those ramps was removed by HMA mill and fill in September 2020.

In March of 2021, severe plow damage was noted on Ramp 12, the Strawberry Road ramp and plastic deformation had occurred on Ramp 6, Minnesota SB - International Airport Ramp. While cracks had reflected through the micro surfacing layer over the winter on all ramps, they remained less severe than the original cracking. Intermittent plow damage was noted on other ramps, especially where plows hit longitudinal and transverse cracks over the winter. Micro surfacing placed over ramps originally without significant cracking remained in good condition, while that placed over distressed ramps had increased plow damage.

In August of 2022, during the second year of post-construction monitoring, it was noted that additional cracks reflected through the micro surfacing and additional snowplow damage had occurred around reflected longitudinal cracks. The plow damage was likely from the cracks heaving during the winter, allowing the plow to catch and damage the micro surfacing along the crack edge.

Additionally, friction testing was performed during August of 2022 using a dynamic friction tester (DFT) to compare the friction values originally measured post construction to those two years later. The average friction value did decline from that originally constructed but was still near that of typical hot mix asphalt (outside of one location that tested slightly lower).

The final ramp inspection took place in September of 2023. Reflective cracking continues to increase in severity but largely remain in similar or better condition than the original cracks. A few of the ramps are showing an increase in raveling at reflective cracks and snowplow wear is continuing to increase at the crown and edges of some ramps.

Due to the construction complications, plastic deformation and flushing that appeared immediately after construction, and raveling that has appeared in 2023, a meeting was set up with the National Center for Pavement Preservation in November of 2023. The NCPP reviewed the mix design, Year 2 Monitoring Report, and 2023 condition photos prior to the meeting.

While nothing was able to be determined with absolute certainty, the set and break time issues that presented during construction indicate a compatibility issue between the aggregates and the crude source, which had the blend of crude it received change with the onset of COVID. The additives required to address the fast break time from the compatibility issue likely turned the micro surfacing into a slow set mix. With the high emulsion content and fine aggregates used, the slow set time made it susceptible to the deformation and flushing immediately after construction.

Largely, ramps that were in good condition at the time of the micro surfacing application remain in good condition. Those that were in fair condition remain in fair, and those that were in poor condition are back in poor.

Introduction

The Alaska DOT&PF installed the first application of micro surfacing in Central Region during the 2020 construction season as part of the *Minnesota Drive: Seward to Tudor Pavement Preservation Project (CFHWY00106)*. Micro surfacing is a preservation treatment that can be applied in thin lifts (1/3" or less) with the potential to offer the region significant cost savings over typical hot mix asphalt (HMA) mill and fill applications of 2" thickness used to address studded tire wear. Micro surfacing is a system composed of fine aggregate, emulsified asphalt and additives. The aggregate used on this project is ISSA (International Slurry Seal Association) Type II aggregate, which is 3/8" minus with the aggregate primarily passing the #8 sieve. The emulsion used is CSS-1P and is highly polymer-modified.

Although this treatment has been widely used in the contiguous United States, it has not been used on roads in Central Region of Alaska DOT&PF due to both poor historical Prall test results on micro surfacing samples to simulate the effect of studded tire wear and no equipment being locally available for placement. However, Central Region tested a new micro surfacing formulation in 2016 that performed well on the Prall test. With this confirmation of performance, Central Region selected the Minnesota Drive Ramps in 2017 for evaluating this treatment and it was constructed in June of 2020.

Project Scope

Micro surfacing was applied at 17 locations on Minnesota Drive Ramps, for a total of 26,231 SY surface course and 26,237 SY scratch course. Table 1 and Figure 1 show the locations of these ramps. All ramps received crack seal and fine HMA tamped in place for cracks exceeding ¾" in width. Three locations received rut fill using fine HMA prior to the micro surfacing placement as the ruts were near to or exceeding 1" in depth by the time this project entered construction. The micro surfacing was placed within the existing lane lines and did not extend onto the shoulders.

Table 1 - Micro surfacing Ramps

Ramp Name	Ramp Number	2019 AADT
International Airport EB - Minnesota WB On Ramp	1	4,995
Minnesota NB - International Airport Ramp	2	6,901
International Airport EB - Minnesota NB Loop	3	3,428
International Airport - Minnesota NB Ramp	4	2,926
Minnesota SB - International Airport Ramp	5	7,100
Minnesota SB - International Airport Ramp	6	5,852
International Airport WB - Minnesota SB Loop	7	1,401
Raspberry WB - Minnesota SB Ramp	8	1,020
Raspberry WB - Minnesota NB Ramp	9	1,441
Minnesota SB - Raspberry WB Ramp	10	5,862
Raspberry EB - Minnesota SB Ramp	11	2,902
Minnesota SB - Strawberry Ramp	12	1,825
Dimond - Minnesota SB Ramp	13	3,528
Minnesota SB - 100th Ramp	14	2,576
100th Avenue Minnesota SB Ramp	15	1,405
Minnesota NB - 100th Ramp	16	3,668
100th Avenue - Minnesota NB Ramp	17	2,967

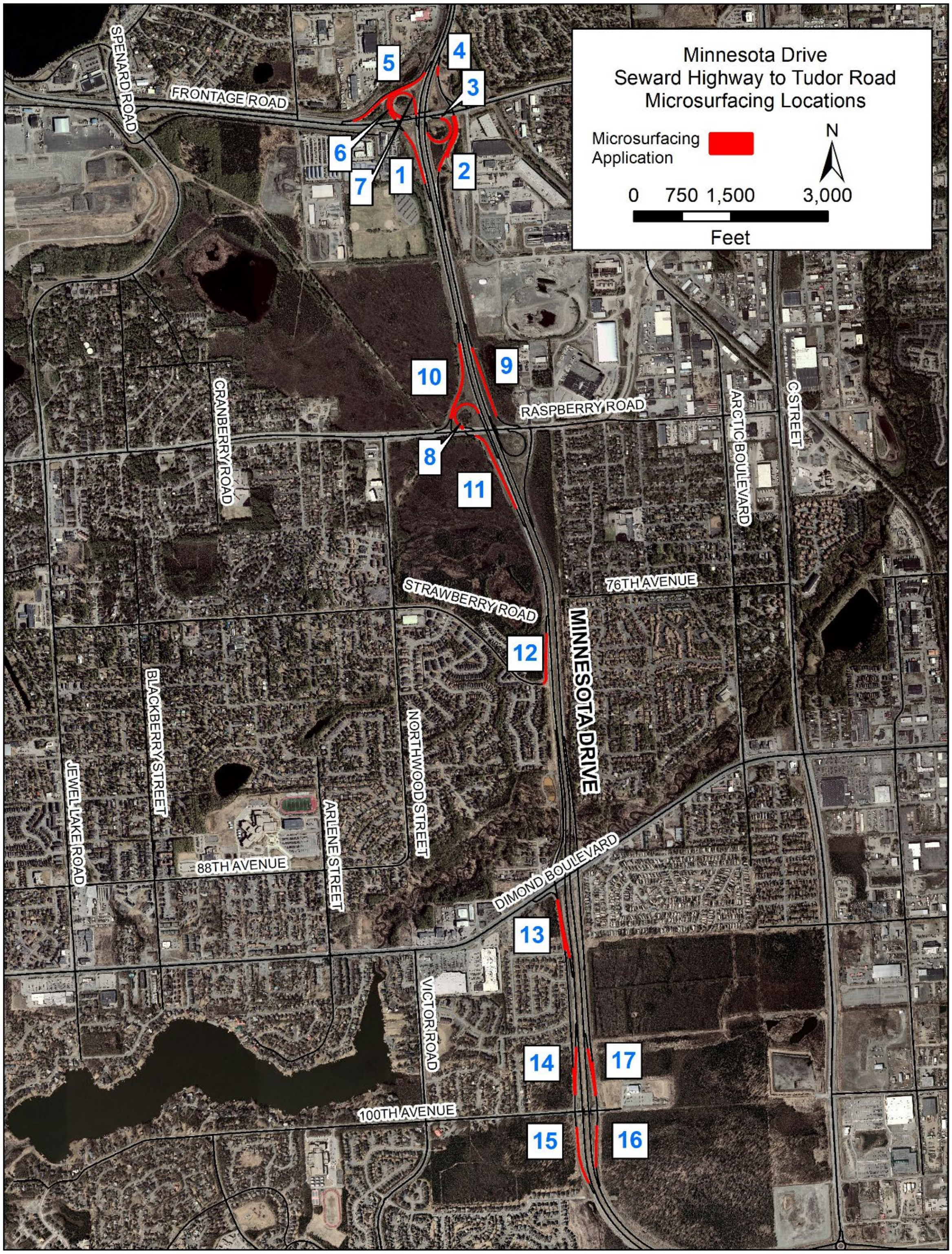


Figure 1 - Micro Surfacing Location Map

Experimental Feature

While micro surfacing has been widely used in the Lower 48, Alaska does not have proven performance with this pavement preservation technique. Traditionally, micro surfacing uses a stiff binder, such as PG 64-22 or PG 58-28. This project specified a binder with a PG of 64-40 which uses Kraton modifiers to achieve a high polymer content between 6%-8%, providing resistance to thermal cracking in cold temperatures with the -40 level and resistance to plastic deformation with the high polymer content. The -40 PG level was selected over -34 as Prall testing on HMA has indicated that softer binders provide superior studded tire wear resistance. Prall testing on HMA also indicated that higher binder contents with these softer binders improved studded tire wear resistance.

The Prall test (ATM 420) is a test for abrasion caused by studded tires on hot mix asphalt. It tests a cylindrical specimen 100mm in length and 30mm in height, abrading the specimen by impacting it with 40 stainless steel balls for 15 minutes at near-freezing temperature while water runs over the specimen. The resulting value is the loss of material in cubic centimeters, meaning the lower the number the better the results.

In 2016, Prall tests were performed on Type II micro surfacing samples with 16% emulsion and 13% emulsion contents using the same base binder specifications as used on this project. The Prall results came back with abrasion values of 19.5 cm^3 for the 16% emulsion and 27 cm^3 for the 13% emulsion, indicating that the micro surfacing performance behaves similarly to hot mix asphalt when using the Prall test and that the higher emulsion content would provide superior studded tire wear resistance. This project specified the Type II aggregate and higher emulsion content because of the testing performed.

While lab testing indicated this formulation would resist studded tire wear, the possibility that it could perform differently in the field remained. The micro surfacing mix design is very dependent on the chemistry of the materials being used, including the base binder and the aggregate. The Prall testing had been performed on specimens prepared using aggregates and binders from the Lower 48. The micro surfacing in this project used binders and aggregates that were locally available, and therefore used a different formulation and mix design than the samples originally prepared and tested.

Additionally, the Prall testing simulates the impact of the studs, not the scratching or plucking action of the studs. Field performance is required to truly see if micro surfacing will hold up to studded tire wear in the Anchorage area.

With this product being new to Alaska, DOT&PF was uncertain about its material performance in our harsh conditions and wanted to study its performance. Specifically, the Department wanted to study the impacts of:

- Studded tire wear
- Plastic deformation (load related rutting)
- Winter plowing operations
  - Plow trucks will run their blades as close to the pavement surface as possible to ensure clean, safe roads during the winter season. This may cause damage to the treatment.
- Freeze-thaw cycle (i.e. cracking, spalling, delamination)

Other aspects of this project that are considered experimental include:

- The high SBS (styrene-butadiene-styrene) polymer content used (between 6%-8%)
    - Typically, the upper range of emulsification for this polymer is 3% as it is difficult to emulsify, and at the time of this project the Kraton polymer used is one of the only SBS polymers that can be physically emulsified at a high dosage level in the base binder. The Kraton polymer was used on this project because it can be emulsified at the high polymer content that is required for the residual binder to meet the AASHTO T-350 Multiple Stress Creep Recovery (MSCR) Jnr and Percent Recovery specifications used on this project.
    - Routinely SBR (styrene butadiene rubber) latex is used as it is in the water phase and is easily emulsified but has an upper limit of 4% polymer before its adhesion to aggregate is impacted, limiting its dosage beyond that point. With SBS the polymer is in the asphalt phase which makes it more difficult to break down into an emulsion by shearing through a colloid mill due to the adhesion of the base binder.
- The softness of the binder
    - Most binders used for micro surfacing are stiff, such as a PG64-22 binder. The binder used in this project graded out at PG64-37 which has a lower end than is typically used, making it softer for cracking resistance and improved Prall results.

The primary objectives of the Experimental Feature Monitoring Plan are to:

1. Assess existing asphalt conditions.
2. Assess surface preparation and material application during construction.
3. Monitor micro surfacing performance.
4. Make recommendations on future micro surfacing project consideration in Alaska.

Details of this plan can be found in Appendix F: Work Plan for Micro surfacing Project.

Preconstruction Site Inspection

The project entered construction in fall 2019 and the pre-construction conditions of the ramps were assessed, but the micro surfacing was delayed to 2020 to allow for optimal summer construction weather. The preconstruction assessment was updated in spring 2020 and the ramp conditions varied in condition from being optimal candidates for pavement preservation with only minor surficial raveling, to ramps with severe longitudinal/frost cracks and the onset of fatigue-based cracking.

The specification called for HMA be tamped in place for cracks wider than ¾”. For ease of construction crack seal was used for smaller cracks, while a combination of crack seal and HMA was used for wider cracks. Portions of Ramps 1, 10, and 13 had ruts increase in depth to over 1” by the summer of 2020. HMA was used for rut fill at these locations prior to the micro surfacing being placed.

See Appendix A and B for detailed information, including photos, maps of distress locations and of rut, roughness and cracking conditions.

Application Method

Micro surfacing is a mix of fine aggregate, additives, and emulsified asphalt that are combined and applied at specific rates within the vehicle before the slurry reaches the spreader box and is applied onto the road surface. The equipment used for this application was two Valley Slurry Seal (VSS) Macropaver 12B units. See Photo 1 and Figure 2 for the equipment photo and material flow diagram.

Photo 1 - VSS Macropaver 12B Unit

Source: Ingevity – North Dakota Asphalt Conference – Future of Micro Surfacing, 2018

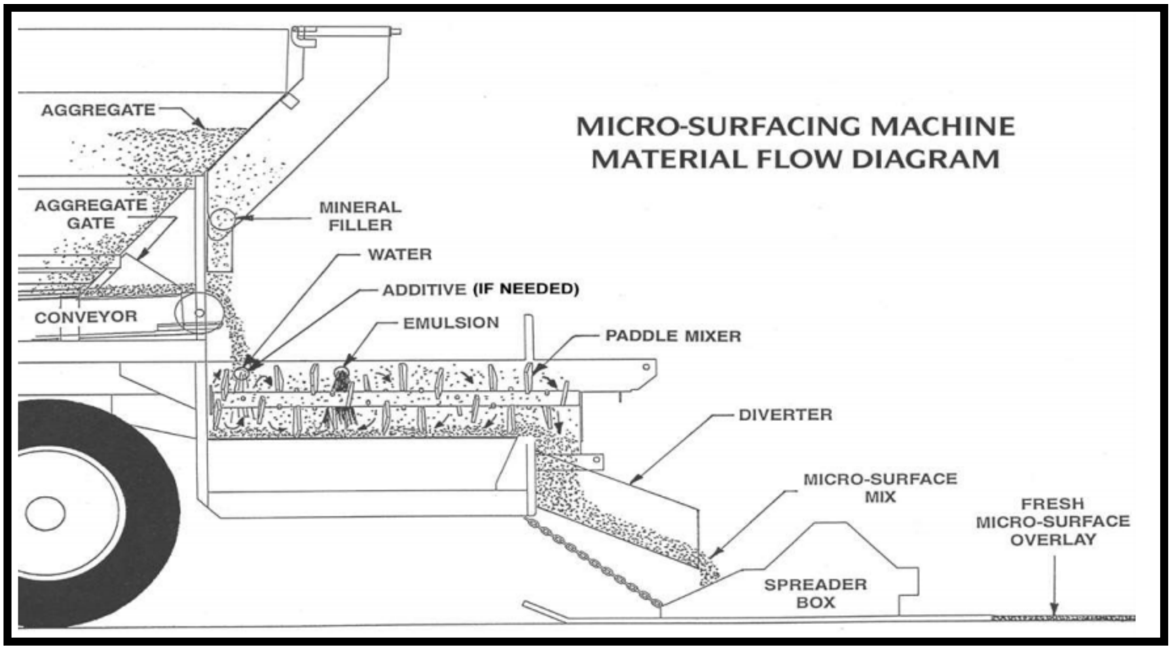


Figure 2 - Micro surfacing Material Flow

The sack on the end of the spreader box (Photo 2) is used for secondary strike-off to provide surface texture on the final micro surfacing overlay and remove surface defects.

It takes approximately 90 seconds for the materials to be mixed, travel through the Macropaver unit and enter the spreader box through the diverter. The crew hand works the micro surfacing using a squeegee at locations it is hard for the equipment to access, as well as removes drag marks and other surface imperfections (shown in Photo 2). Photo 3 shows an example of an area that was hand worked at the intersection of Ramp 6 and International Airport Road.

Photo 2 - Secondary Strike Off and Hand Working

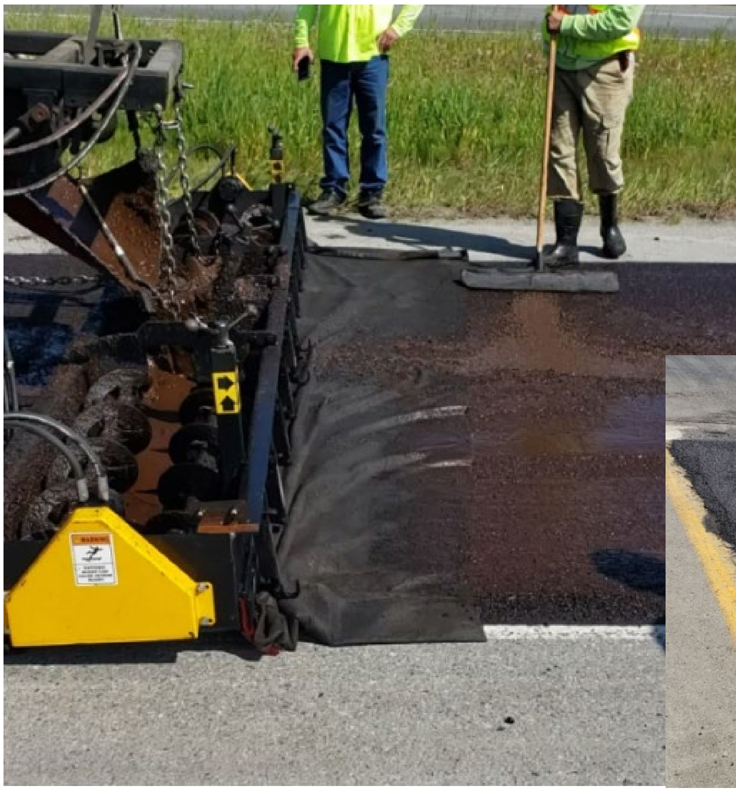


Photo 3 - Hand Worked Area on Ramp 6

This project required the existing surface be tack coated prior to the micro surfacing application to create a bond between the scratch course and the existing pavement and aid in resisting the lateral forces from traffic on the ramps.

After the tack coat, the scratch course was applied to fill ruts and provide a level application for the surface course. Most ramps had ruts less than ½" in depth, and the scratch course was able to fill these without requiring the use of a rut fill box, which was not required on this project. Three ramps did contain areas with ruts exceeding ¾" in depth and were considered enough of a concern to be addressed by using hot mix asphalt as rut fill. The length of rut fill performed was 1,000 feet.

The surface course was placed over the scratch course as the final wearing surface.

Construction

This project entered construction in the fall of 2019, which is the start of the rainy season. After discussions with Alaska DOT&PF construction the contractor, Quality Asphalt Paving (QAP), and Colas, who would be performing the mix design, it was decided to wait for the summer of 2020 to construct the micro surfacing and allow for optimal construction conditions.

Colas contacted Alaska DOT&PF during the winter of 2019 while performing the mix design and expressed concerns about the set time of the micro surfacing relating to the softness of the PG64-40 binder. Colas proposed using a base PG64-34 binder in place of the PG64-40 binder, and Alaska DOT&PF determined this change would be accepted based on Prall results from samples using the proposed PG64-34 binder. Specimens were also provided using the PG64-40 base binder to compare results between the two formulations. The Prall abrasion results came back at 14.9 cm^3 for the PG64-40 binder, and 16.4 cm^3 for the PG64-34 binder. These results were considered acceptable and the change to using the PG64-34 binder was allowed.

Alaska does not have any micro surfacing contractors, so QAP sub-contracted the work to Valley Slurry Seal (VSS) out of California. VSS mobilized up to Alaska on June 4th, 2020, and the test strip was performed on June 6th.

Test Strip – June 6th

The test strip was constructed at 1pm in QAP's yard off C Street and 68th Avenue in Anchorage. The weather was sunny with temperatures in the high 50's to low 60's. VSS used two Macropaver units, so both performed a test strip. The emulsion temperature was approximately 120° F and used 0.5% of lime instead of the intended 1% as the emulsion had recently been produced and the temperature was still higher than the intended 80 degrees F to be used in production. Alaska DOT&PF was informed the higher temperature increases the reaction speed between the lime and micro surfacing material, and in this case the full 1% lime with 120-degree emulsion would reduce the workability of the material and prevent placement. Once the emulsion temperature was reduced to 80 degrees F in production, the full dose of lime would be used.

Three test strips were performed. The initial test strip was placed prior to DOT&PF staff arriving on site. This test strip was performed to ensure the equipment was working properly and the slurry was acceptable. The pavement conditions for the first two test strips were in good condition. They were smooth with minimal ruts and distresses, while the third test strip had some areas with minor depressions.

This formulation using highly modified PG64-34 base binder is considered a slow-set system, meaning without mechanical assistance the set time would take a few hours. To improve the set time, pneumatic rollers are used to mechanically force the water out of the micro surfacing. The water brought to the surface by the pneumatic rolling on the test strip can be observed in the photo on the next page.

Photo 4 - Pneumatic Roller on Test Strip

It was intended for the pneumatic roller to finish rolling the mat within an hour of application so traffic would be able to return to the ramp shortly after. However, it took slightly over two hours for the pneumatic roller to begin rolling the test strip without damaging the fresh micro surfacing. The Department was informed this was due to the high emulsion temperature and the reduced lime content and that, with the full lime dosage and cooler emulsion, the pneumatic would be able to begin rolling the mat sooner.

The test strips were approved conditionally on the set time being reduced and were to be reviewed the next day in production.

Production – June 7th

Production began at 9:30am after the ramps had been tack coated with STE-1. The weather was sunny and 55° F, rising to 60° F by the end of production.

The micro surfacing scratch course was first applied to Ramp 1, the International Airport EB – Minnesota SB Ramp, beginning at the base of the ramp and applying uphill toward International Airport Road. The initial micro surfacing was applied over an area that had been rut filled with hot mix, which extended for 400'. The scratch course was then applied over approximately 50' of pavement with rut depths between ½" and ¾", which decreased to approximately ½" for the rest of the ramp.

The second ramp to receive the scratch course was Ramp 6, the Minnesota SB – International Airport Ramp. The scratch course was then placed on the western portion of Ramp 5, Minnesota SB – International Airport WB Wye. The ruts and surface deviations were minimal on both of these ramps, not exceeding ½”.

A problem was encountered during the application on the western side of the Wye portion of the ramp. This ramp has a moderately superelevated curve, requiring the spreader box to be filled with additional material to be able to apply a full lane width in this section. If not filled sufficiently, the spreader box would have the slurry pool to one side, not giving a full lane width application. In this case, when the box filled, the mix began to break, requiring the equipment to stop and clean the breaking/clumping material out. In the next pass the equipment was able to finish application on this portion of the ramp.

The equipment moved to the eastern portion of Ramp 5 and ran into a similar problem in the superelevated section of the ramp, with the spreader box and material clumping. This time however, the equipment was unable to proceed after cleaning out the spreader box. The other Macropaver unit attempted to place the micro surfacing at this location and encountered the same problem.

Initially, it was thought the high polymer content in the slurry was clogging a valve in the Macropaver. However, after evaluation and testing by Colas and the mix design expert on site, it was discovered the crude slate received at the source for the binder had changed since the mix design was performed over the winter. This affected the chemistry of the micro surfacing, and the lime was not reacting as expected with the emulsion to break and set the slurry at the expected times, causing it to become chunky in the spreader box at superelevated locations preventing placement.

The mix design expert had gone to the lab to determine possible solutions, and over two hours had passed since the first scratch course had been placed. Upon returning to the ramp, the pneumatic roller had been unable to begin rolling the ramp. This ramp appeared to be taking longer to set than the test strip, and when the pneumatic roller had attempted to roll the ramp it had experienced pickup, damaging the fresh mat. After 3.5 hours the roller was able to roll the 400’ that had been rut filled, but after proceeding onto the area with the ¾” ruts it once again experienced pickup.

The observations made at this time showed that the micro surfacing appeared to be curing from the top down, instead of the bottom up, as it should be. There was a slightly hardened crust at the surface that appeared to be trapping water in the system, delaying the set time far too much.

After 4 hours the roller was able to proceed up the ramp and finish rolling the remaining ramps without issue. The set time on these ramps was unacceptable, but Colas and the mix design expert had determined that aluminum sulfate and cement worked in place of lime with the binder from the new crude slate, and this increased the break time from 30 seconds to 120 seconds. This would allow the material to pass through the Macropaver, which takes 90 seconds, and for 30 seconds in the spreader box for placement through the superelevated areas prior to the slurry beginning to break. This change in formulation would also provide faster set times to allow traffic to return to the ramps sooner.

This change was allowed conditionally on a new mix design being submitted and a new test strip being performed. The next day, June 8th, experienced rain in the forecast and was determined to be a weather day. This allowed for time to refine the micro surfacing formulation in preparation for the new test strip.

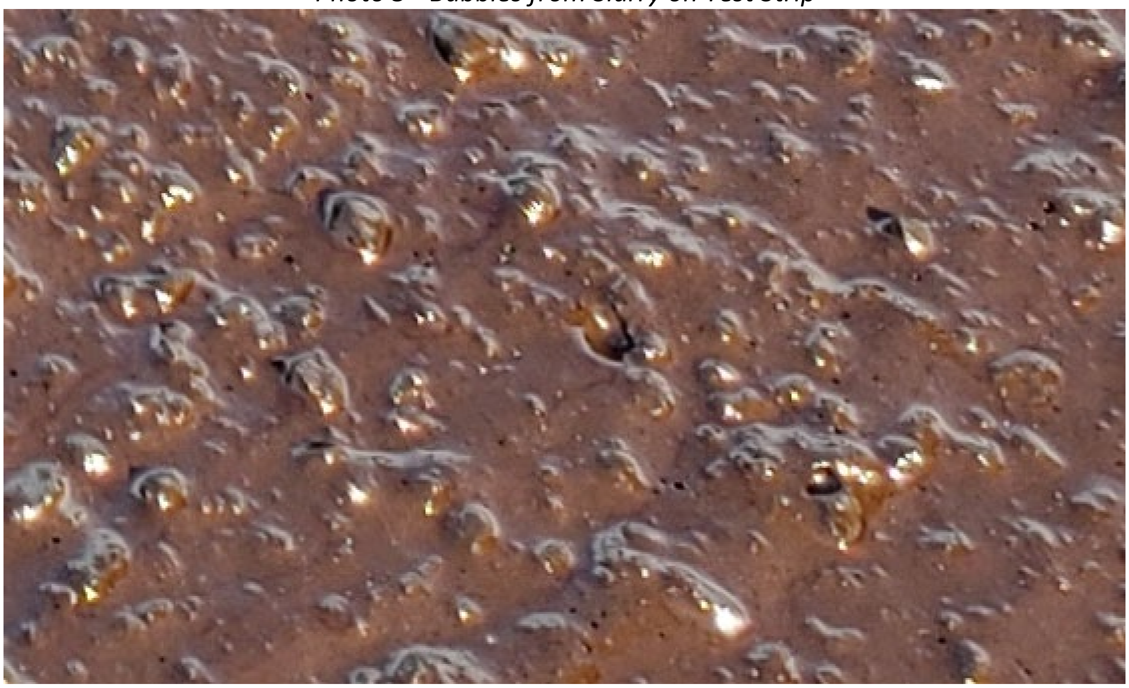
Production and Test Strip– June 10th

Both June 8th and 9th experienced rain, and the production resumed on June 10th with the new test strip in QAP's yard.

The weather was partly cloudy, and the test strip started at 10am with temperatures increasing up to 65 degrees over the course of the day. The new micro surfacing formulation removed the 1% lime and replaced with 2% cement and 1% aluminum sulfate to allow for acceptable break and set times.

After the micro surfacing was placed on the test strip, small holes/bubbles were observed on the surface which were not seen with the previous formulation using lime. This indicates water is escaping the system as it sets and, while difficult to see, can be observed in the photo below.

Photo 5 - Bubbles from Slurry on Test Strip



After 1.5 hours the roller was able to begin rolling and mechanically curing the system. While the 1.5 hours was over the 1-hour window desired to get the roller on the micro surfacing, it was a drastic improvement over the 4 hours experienced previously, and the test strip was considered successful. The crews mobilized back to Minnesota Drive to finish the International Airport Ramps and then moved to the Raspberry Ramps.

The portions of Ramps 5 and 6 that had been left unfinished received the scratch course using the new micro surfacing system, and no issues were experienced through the superelevated portion that had previously caused issues.

The equipment then moved to Ramp 11, the Raspberry EB – Minnesota SB Ramp. This ramp had some ruts nearly 0.75" toward the middle where traffic would be accelerating prior to preparing to merge, but was in otherwise good condition. The micro surfacing was applied without issue on this ramp as well as Ramp 7, the International Airport WB - Minnesota SB Loop cloverleaf ramp that required application in significant super-elevations.

The rollers were able to get on all the ramps within 1.5 hours as had been experienced on the test strip and production continued using this formulation.

Production – June 11th, 12th and 13th

The micro surfacing application went well and remained on track. Production ended on June 13th. The only issue encountered was some roller pickup on Ramp 2, the Minnesota NB - International Airport Ramp, which was remedied by another pass with micro surfacing to cover it.

Postproduction – June 18th

Comment was received from construction that Ramps 1 and 2 were not performing well. On Ramp 1 (photo below on the left) flushing was observed over most of the wheel paths on the ramp. While no deformation or rutting in the wheel paths was visible, it appeared that the coarse aggregate had been depressed and the fines were flushed to the surface. On Ramp 2 (photo below on the right) the center left hand turn lane had severe flushing and deformation/shoving of the micro surfacing material.

Photo 6 - Ramp 1 Flushing Distress

Photo 7 - Ramp 2 Flushing Distress

Construction had noted Ramps 1 and 2 were being used on a haul route for borrow material being transported to Anchorage International Airport for construction work. On Ramp 2 the damage occurred directly in front of a signalized intersection within a few days of application. It is likely the trucks coming to a stop and then accelerating into the turn onto International Airport Road that caused significant damage on the fresh micro surfacing, including flushing and material pickup.

It was observed the trucks returning to the pit from Anchorage International Airport used Ramp 1 onto Minnesota and then took Ramp 10 onto Raspberry and likely caused flushing damage to the recently placed micro surfacing on both of those ramps.

The other ramps were inspected, and some moderate flushing was observed on Ramps 5 and 13, with minor flushing on Ramps 11 and 16.

Postproduction – August 10th through August 13th

Construction continued to review and monitor the ramp performance, and on August 10th determined that there had been sufficient flushing distress with loss of friction to warrant friction testing and potential removal. On August 12th a site visit was conducted with the construction project manager and Project Engineer to review the ramps proposed for removal.

Photo 8 is from August 13th where severe flushing and shoving occurred at the signalized intersection on Ramp 2. The resulting surface was not sticky, and tracking was not observed at any locations, but there was a loss of friction and the fines were visible at the surface.

Photo 8 - Ramp 2 Flushing Distress

Ramps 1, 2 and 10 were a part of the haul route for QAP hauling borrow material to the airport. Ramp 5 was the ramp with the second highest AADT, being the exit ramp for traffic travelling from downtown Anchorage to the Anchorage International Airport, and experiences heavy traffic loading. Ramps were opened to traffic approximately three to four hours after the micro surfacing was placed, and with the formulation being slow set, the heavy loads likely damaged the surface after application.

Friction testing was performed on August 13th on the five ramps displaying the flushing/bleeding distress with loss of friction. Tests were performed on locations with flushing/bleeding, on non-distressed areas as a control for micro surfacing, and on hot mix pavement outside the application for a standard pavement control value. The results from the five distressed locations tested using a Dynamic Friction Tester (DFT) can be seen in Table 2.

Table 2 - Friction Testing Results

Ramp Number	Distressed Micro	Non-Distressed Micro	Hot Mix
1	0.31	0.54	0.54
2	0.28	0.45	0.47
5	0.28	0.47	0.48
10	0.35	0.53	0.55
13	0.45	0.52	0.57
Average:	0.33	0.50	0.52

While Ramp 13, the Dimond SB On Ramp, had a higher friction value in the distressed area than the other distressed ramps, there was visible flushing and it was decided to pursue removal of the portion of the ramp with visible flushing while performing the other repairs.

The final list of ramps determined to have sufficient loss of friction to warrant friction testing and removal were Ramps 1, 2, 5, 10 and 13. The area for 2020 removal due to a loss of friction from bleeding flushing/bleeding was 8,960 SY. This removal took place in October and replaced the micro surfacing with 1.5" of hot mix asphalt.

Recommendations from Construction

1) A gradation should be included in the specifications for the cement and additives.
2) Micro surfacing should not be applied greater than 13' in width.
    a. There were areas that required 15' – 18' wide micro surfacing that led to material being hand applied instead of mechanically applied, which looks rougher than mechanically applied areas. This was partially due to the fact that the pavers imported for this project were typically used for ramps/driveways. Their mainline paving equipment remained in the Lower 48. In the future, unless a large quantity is applied, the plans should be based around placing 13' width of micro surfacing and avoid small areas outside of that which would require hand application.
3) Either cover the striping with the micro surfacing or apply the micro surfacing between the stripes so there is not an elevation difference in the MMA and adjacent surfaces.
4) Specify where pre-leveling of ruts is required.

Monitoring Plan

The three-year post-construction monitoring plan consists of monitoring micro surfacing conditions in the following areas:

- Overall micro surfacing condition
    - Ramps will be visually inspected and photographed annually to document overall performance, including raveling and shoving.
- Micro surfacing condition by rut depth, reflective cracking and roughness (IRI)
    - To be collected as part of the annual pavement management data collection.
- Annual friction data collected by DFT to evaluate friction loss
- Performance of micro surfacing placed over existing pavement compared to that over new pavement

- This will not be possible as locations placed over new pavement or pre-leveled locations were removed due to bleeding/flushing failures in September 2020.

Observations and Results

Mix Design

The unexpected change in the crude slate from the binder source led to difficulties during the first day of production and a short delay while the additives were altered from lime to cement and aluminum sulfate. This required a new test strip and mix design be performed. This change in additives was to increase the mix time to above 120 seconds and reduce the set time to allow traffic to return sooner. Aluminum sulfate is used to extend mix time while cement is used to shorten the curing time. Lime is typically used with highly reactive aggregates, but with the change in crude source it no longer reacted properly to reduce the cure time and did not allow for a sufficient mix time before breaking.

The results from the new mix design indicate that the mix may have some long-term moisture susceptibility as the wet track abrasion loss was above the specified limit on the six-day soak procedure (ISSA TB-100). The wet cohesion test (ISSA TB-139) was 18, just under the 20 kg-cm minimum value at 60 minutes, indicating it would take over an hour for the mix to be able to withstand straight rolling traffic. The mix being a slow set system was understood, and it took approximately an hour and a half for the system to be rolled by the pneumatic rollers allowing it to then be opened to traffic.

The mix did pass the Excess Asphalt by Loaded Wheel Tester (ISSA TB-109) that is intended to establish maximum limits for asphalt contents to avoid asphalt flushing/bleeding under heavy traffic loads. It also passed the Lateral Displacement Test (ISAA TB-147) that measures the displacements characteristics of multilayered slurries under simulated rolling traffic compaction.

With the mix design passing both the Excess Asphalt and Lateral Displacement tests it is surprising there were both flushing and rutting failures in the field. Most likely, with the micro surfacing system being slow set, the trucks on the distressed ramps were able to cause the flushing damage prior to the system achieving its full strength. The lab tests were performed on oven cured samples that may have achieved higher strength than would have been seen in the field when the damage occurred within the first few days of application.

The long-term ISSA moisture susceptibility test results indicate there is a need for monitoring of long-term abrasion performance during the three years of this project. During year 2 of monitoring, most of the abrasion damage was from snowplows at the crown of the road or over longitudinal cracks that heave during the winter. During year 3 monitoring raveling and spalling around cracks was observed. It is possible the damage is exacerbated from an abrasion and raveling susceptibility caused by greater than 1.5% aluminum sulphate being used, but it cannot be known for certain. See Appendix D for the mix design and materials testing results.

To understand the reason for the flushing failures, truck counts and AADT data were pulled from the traffic server database. Table 3 displays 2019 data, and there appears to be a correlation between the high AADTs, truck counts and ramps with flushing failures removed by mill/fill (highlighted in red) and minor flushing (in orange) that remain on ramps.

Table 3 – 2019 AADT and Truck Traffic

Ramp #	Name	AADT	Class 6+	Percentage (6+)
1	INTERNATIONAL AIRPORT EB - MINNESOTA SB RAMP	4,995	30	0.6
2	MINNESOTA NB - INTERNATIONAL AIRPORT RAMP	6,901	40	0.6
3	INTERNATIONAL AIRPORT EB - MINNESOTA NB LOOP	3,428	25	0.7
4	INTERNATIONAL AIRPORT - MINNESOTA NB RAMP	2,926	11	0.4
5	MINNESOTA SB - INTERNATIONAL AIRPORT WB WYE	7,100	37	0.3
6	MINNESOTA SB - INTERNATIONAL AIRPORT RAMP	5,852	24	0.6
7	INTERNATIONAL AIRPORT WB - MINNESOTA SB LOOP	1,401	9	0.6
8	RASPBERRY WB - MINNESOTA SB RAMP	1,020	10	1.0
9	RASPBERRY WB - MINNESOTA NB RAMP	1,441	14	1.0
10	MINNESOTA SB - RASPBERRY WB RAMP	5,862	65	1.1
11	RASPBERRY EB - MINNESOTA SB RAMP	2,902	29	1.0
12	MINNESOTA SB - STRAWBERRY RAMP	1,825	20	1.1
13	DIMOND - MINNESOTA SB RAMP	3,528	40	1.1
14	MINNESOTA SB - 100TH RAMP	2,576	18	0.7
15	100TH AVE - MINNESOTA SB RAMP	1,405	9	0.7
16	MINNESOTA NB - 100TH RAMP	3,668	23	0.6
17	100TH AVE - MINNESOTA NB RAMP	2,967	25	0.9

The emulsification of the PG 64-37E binder with a very high SBS polymer content (6% - 8%) maintained the original binder Jnr and Percent Recovery properties when the residual binder was tested according to AASHTO T-350 MSCR. This was considered critical to the success of the project as the mix has a high residual binder content (10%), with the low end of the binder being soft at -37 with a fine aggregate structure. The Jnr and recovery properties would be needed to resist plastic deformation from the traffic loading.

Unfortunately, the mix was very slow set and deformation was able to occur prior to the micro surfacing achieving its full strength. It is also possible the base binder was too soft, and in the future it should be considered to use a binder not below -34 for the low end due to softness.

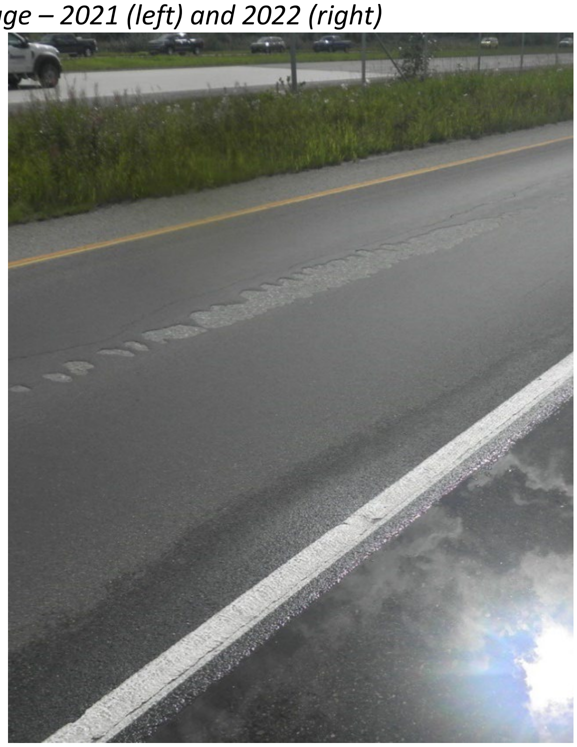
Ramp Monitoring

In October of 2020, prior to the first snowfall, the ramps remained in good condition, although it was noted that hand worked areas did look rough and there was deformation observed on Ramp 6 and flushing was present on Ramp 11 (noted in orange in Table 3). Ramp 6 was one of two ramps with stoplights, the other being Ramp 2, which was removed by mill and fill in September of 2020. The deformation on Ramp 6 was likely from static loading of the trucks as the deformation occurred at the stoplight (see Photo 9). Rut depth data collected at Ramp 6 in 2021 and 2023 did not show a significant increase in rutting between those years.

Photo 9 - Ramp 6 Deformation

In March of 2021, after a freezing rain, significant plow damage was noted along the centerline and edge of the lane on Ramp 12, the Strawberry Ramp. There was likely significant down pressure on the snowplow to clear the ice off the ramp that caught the micro surfacing along the longitudinal crack near the centerline that reflected through over the winter. This damage had increased when inspected in 2022 and 2023.

Photo 10 - Ramp 12 Plow Damage – 2021 (left) and 2022 (right)



In May of 2021 the summer inspection was performed. Ramps with micro surfacing applied over significant cracking saw more plow damage than those with minimal cracking, which held true in 2022 and 2023 as well.

Also noted in May of 2021 was that Ramps 16 and 17 had flushing present, although lower in severity than seen on Ramp 11. The flushing had not worsened in 2022 or 2023 inspections.

Photo 11 shows the condition on Ramp 7, the International Airport Cloverleaf, in May of 2021 (left) and September 2022 (right). It displays the typical condition on ramps where there is damage at transverse cracking. While the transverse crack is still smaller than it was previously, as indicated by the shoulder condition, the crack spalled over the winter between 2021 and 2022. Spalling has continued to increase. See photos in the appendix for cracking conditions.

Photo 11 - Ramp 7 – General Transverse Cracking Conditions 2021 (left) and 2022 (right)

Table 4 summarizes the ramp conditions after three winters. For monitoring photos of ramp conditions and maps of rut, roughness and cracking data, refer to Appendix A.

Table 4 – Ramp Condition Summary (Year 3 Monitoring)

Ramp	Condition	Comments
1	Removed	Removed due to severe flushing distress.
2	Removed	Removed except for turn lane, which remains in good condition
3	Fair	A few longitudinal cracks reflected through but remain in low to moderate severity. Some plow damage present on the crown of the road where it has worn through the micro surfacing and bare pavement is visible. A reflective crack is raveling along the centerline and the ramp remains in good to moderate condition.
4	Good	Very small section – slight plow damage on edge of lane and raveling
5	Removed	Removed due to observed flushing distress.
6	Poor	Deformation observed at traffic signal, with rut depths between 0.5” – 0.75” and the original pavement is visible near the intersection where the micro surfacing is worn through. Plow damage observed along centerline stripe and right lane. Cracking reflected and remained in fair condition with spalling around the crack.
7	Fair	Cloverleaf is in moderate to good condition. The reflective cracking is low and moderate severity. Two locations with plow damage, one being along a longitudinal crack and the other along the edge of lane.

Ramp	Condition	Comments
8	Poor	Plow damage along the right side of the lane and significant reflective cracking, although it remains in low and moderate severity. Two locations where the plow caught a crack and tore along the centerline and edge of lane. Spalling is present around the most severe cracks.
9	Fair	Light block cracking reflected through the micro surfacing and some transverse cracks are of moderate severity. Plow damage on the Raspberry end of the ramp on the right side and rut depths near 0.5” for a portion of the ramp. Condition is fair to poor.
10	Removed	Removed due to severe flushing distress.
11	Poor	Significant plow scraping at the crown and right edge of the lane at Raspberry. Transverse cracks have reflected through and both flushing and spalling are present, although studded tires have worn through most of the flushing and is down to bare pavement. Shoving/flushing is present near the end of the ramp where there was deeper initial rutting that is now slightly over 0.75” in depth. But again, studded tire wear is revealing the coarse aggregate and reducing the flushing. Moderate to severe damage along the centerline where a plow caught it midway down the ramp and it has spalled.
12	Poor	There is significant plow damage along the centerline and left-hand side of the lane. There is spalling present at several cracks and are high severity. Other cracks have reflected but are low to moderate severity.
13	Good	The left portion of the ramp onto Minnesota was removed in 2020 by mill and fill, but the remaining micro is in good condition. Transverse cracks have reflected through but are of low severity outside of one. At one location a tracked vehicle or teeth from equipment caused damage and at another a plow damaged the micro along the crown.
14	Fair	Teeth from machinery caused spot damage, possibly during construction while the micro surfacing was soft. Transverse cracks have reflected through and there is some material loss at the edges of the ramp and crown from plows. The ramp remains in reasonably good condition outside of the plow damage.
15	Fair	Longitudinal and transverse cracks have reflected through and near the roundabout are increasing in severity, but the ramp remains in good condition outside of that.
16	Poor	There is flushing and possibly shoving in the wheel paths near the roundabout and the longitudinal cracks reflected through at the roundabout and are in poor condition. These cracks were high severity prior to application and have returned to high severity.
17	Poor	There is plow damage along the right side of the lane and a severe transverse crack near the roundabout. The micro surfacing has been worn through at the beginning of the ramp where vehicles are accelerating and hitting the high severity crack. After the damage at the beginning of the ramp it remains in fair condition.

There was minimal studded tire wear observed during the May 2021 and August 2022 site investigations. However, in 2023, bare pavement was observed at several locations where the micro surfacing had been worn through. It was worn through from a combination of plow damage abrading the micro surfacing, deformation rutting that occurred shortly after construction and one ramp that has high speeds that is subject to studded tire wear.

Ramp 17 had deformation at the beginning of the ramp and sees a high amount of truck traffic since the 100th Avenue Extension has been constructed. This truck traffic caused some deformation and a high severity transverse crack immediately reflected through the treatment and has caused tires to impact and abrade the material surrounding it. This combination of abrasion and deformation that has worn through the micro surfacing treatment to bare pavement and is expanding the crack width.

Ramp 11 had deformation in the construction season as well. There is bare pavement visible in the initial curve at Raspberry and going up the hill towards Minnesota. The initial damage is from plows, but going up the hill where vehicles are accelerating the damage is from a combination of deformation and studded tire wear as the underlying aggregate is visible in both wheel paths and is offset from the plow damage.

Ramp 3 also has bare pavement visible along the crown of the road from plow damage. There was no studded tire wear visible on this ramp and there was minimal deformation in the construction season.

The deformation/flushing distresses occurred during the summer and fall of 2020 while the micro surfacing was still setting. There was no significant increase in rut depths in 2022 or 2023 as the micro surfacing was set and not prone to further rutting from deformation. The remaining increases in rut depth were from studded tire erosion. See Table 5, below, for annual rut depth measurements. 2019 data is preconstruction while the 2020 data was collected after construction took place. Rut depths in 2020 indicate the amount the rutting that occurred from deformation while rut depths in subsequent years would be mostly from studded tire abrasion.

Table 5 – Ramp Rut Conditions 2019 - 2023

			Rut Depth (in)				
Ramp	Route Name	Ramp Number	2019	2020	2021	2022	2023
2281216N052	Minn. NB On-Ramp (Int. Airport EB)	3	0.13	0.12	0.14	0.12	0.10
2281216F051	Minn. SB Off-Ramp (Int. Airport)	6	0.19	0.24	0.25	0.23	0.23
2281216N053	Minn. SB On-Ramp (Int. Airport WB)	7	0.21	0.14	0.13	0.14	0.13
2281216N043	Minn. SB On-Ramp (Raspberry EB)	8	0.11	0.11	0.08	0.13	0.08
2281216N040	Minn. NB Off-Ramp (Raspberry)	9	0.57	0.30	0.38	0.38	0.41
2281216N041	Minn. SB On-Ramp (Raspberry WB)	11	0.45	0.40	0.45	0.48	0.53
2281216R011	Minn. SB Off-Ramp (Strawberry)	12	0.25	0.26	0.21	0.23	0.23
2281216N031	Minn. SB On-Ramp (Dimond)	13	0.30	0.28	0.17	0.11	0.17
2281216F021	Minn. SB Off-Ramp (100th)	14	0.23	0.23	0.24	0.24	0.25
2281216N021	Minn. SB On-Ramp (100th)	15	0.36	0.29	0.28	0.31	0.34
2281216F020	Minn. NB Off-Ramp (100th)	16	0.27	0.23	0.22	0.21	0.29
2281216N020	Minn. NB On-Ramp (100th)	17	0.52	0.38	0.41	0.44	0.50

Friction Testing

Friction testing was performed on the remaining ramps in September of 2022 to determine if there was a loss of friction since construction. Note that cloverleaf ramps were not tested due to safety concerns and friction testing was performed in 2021 but rendered unusable from an equipment calibration problem.

Table 6 – 2022 Friction Values

Ramp Name	Ramp Number	2022 Friction Value
Minnesota SB - International Airport Ramp	6	0.45
Raspberry WB - Minnesota NB Ramp	9	0.44
Raspberry EB - Minnesota SB Ramp	11	0.32
Minnesota SB - Strawberry Ramp	12	0.43
Dimond - Minnesota SB Ramp	13	0.46
Minnesota SB - 100th Ramp	14	0.44
100th Avenue Minnesota SB Ramp	15	0.44
Minnesota NB - 100th Ramp	16	0.42
100th Avenue - Minnesota NB Ramp	17	0.43

Original non-distressed micro surfacing friction values ranged between 0.45 and 0.54. Hot mix asphalt friction values varied between 0.47 and 0.57. It can be seen that 2022 friction values have all dropped to the lower end of the originally tested values, averaging just below at 0.43. Ramp 11 is the one ramp with a friction value below that of typical hot mix asphalt at 0.32. Testing was planned in 2023 but was unable to be performed due to staff availability. Ramp 11, where the low friction value was present, has seen the most significant studded tire wear and bare pavement or coarse micro surfacing aggregate is now visible where the flushing led to the low value in 2022 and should have increased friction. Testing is planned on this ramp in 2024 to validate an increase in friction at this location and that the friction value has not decreased elsewhere.

National Center for Pavement Preservation

In November of 2023 a meeting was set up with a representative of the National Center for Pavement Preservation to review the project mix designs and discuss the problems encountered during construction. During the discussion it became apparent the behavior of the micro surfacing was far from typical on this project. With the change in the crude slate between the original mix design in the fall of 2019 and the mix design performed in the summer of 2020, a major compatibility issue appeared between the emulsion and aggregates. The aggregate used on this project were highly reactive and this compatibility issue led to a very fast break time. To address that problem the cement and aluminum sulphate were used in place of the originally planned additive of lime.

This change in additives resolved the fast break time that caused the problems during the first day of production and allowed the micro surfacing to be placed. But they likely led to the long set time that caused the flushing and rutting distresses shortly after construction.

If a lower emulsion content and coarser aggregate had been used the flushing and rutting may not have occurred. The fine aggregate and high emulsion content was selected for studded tire resistance and, unfortunately, the slow set time made the mix susceptible to those distresses until it had fully set.

The aluminum sulphate used to control the fast break time is not detrimental to the long-term performance of micro surfacing if the amount used is under 1% to 1.5%. The mix design calls for 1% but with certain ramps now showing moderate to severe spalling and raveling, those ramps may have had amounts greater than 1.5% used to aid in constructability as those distresses can be a result of high amounts of aluminum sulphate.

In talks with the NCPP representative, this compatibility issue could likely have been addressed during emulsion production. Since it was not identified until after the emulsion was produced it had to be addressed using additives as was done on this project.

Specification

The micro surfacing specification should be modified to include the requirement that if more than six months go by from when the mix design is performed to construction then the mix and set times should be verified. This would have prevented the issues encountered during the first day of production on this project and allowed the resulting compatibility issues to be addressed through emulsion production.

Additionally, future micro surfacing applications should consider using the coarser ISSA aggregate gradation and lower emulsion content to allow for additional aggregate structure to resist deformation. This will result in a lower Prall value but will better resist the flushing and deformation rutting that impacted this project.

Prall Testing

Cores taken in September 2022 were tested for Prall resistance in the summer of 2023. The change in the mix design led to a resulting Prall value of 31.7 cm^3 of loss. This indicates the final mix design was not resistant to studded tire wear and the value was almost twice that of the original formulation with 16.4 cm^3 of loss.

The exact reason for this significant increase in Prall value is not known but may be from higher amounts of aluminum sulphate being used in the mix. Amounts higher than 1.5% can contribute to raveling susceptibility, and if higher amounts were used where cores were taken that may be contributing to the high value on this abrasion test.

Conclusions

The performance of the micro surfacing is not what was anticipated. Typically, micro surfacing is easy to construct and will set within an hour allowing traffic to return and behaves like a fine HMA. The on-the-fly changes required during construction to address the fast break time led to the mix being susceptible to deformation rutting immediately after construction, and both long-term studded tire abrasion and raveling. This unfortunately required five ramps being replaced by a mill and fill with HMA and has led to faster than expected deterioration of several other ramps.

Ultimately, this application will extend the life of the ramps it was placed on. Outside of a few exceptions, it has reduced the width of cracks and is sealing the pavement surface. It has not reduced the rut from the original depths due to the deformation that occurred immediately post construction and subsequent studded tire abrasion.

The ramp condition after three years of monitoring is dependent on the original condition with the micro surfacing returning to the original condition of the ramp. It was placed on several ramps that were in poor condition at the time of application where a rehabilitation treatment or mill and fill would have been more applicable. With the micro surfacing being highly modified with SBS polymer and using a high binder content it was anticipated it would better mitigate the reflective cracking. It is not known if it would have performed better if the original mix design had been used, or if the change in mix design reduced the cracking resistance of the mix.

Many lessons were learned throughout this project, and if micro surfacing is chosen as a treatment in the future there is no reason to believe it will not perform well and resist both rutting from deformation and studded tire wear. Three elements led to the deformation rutting and flushing problems encountered on this project. The first was the fine gradation and high emulsion content. This would not have been a problem except for the change in the crude slate between the original mix design and construction leading to the fast break time and slow setting, which was the second problem. This change was not caught prior to emulsion production, which was the third.

If any one of these three elements had not taken place the deformation rutting and flushing problems would likely not have occurred. If a coarser aggregate and less emulsion was used, even with the slow set time, the aggregate structure would have been able to provide support for the traffic loads and mitigated the rutting and flushing.

If the crude slate had not changed, the micro surfacing would have set with the lime additive within an hour based on the original mix design and been able to support the traffic loads, even with the fine aggregates and high emulsion content.

If the change in the crude slate had been detected prior to emulsion production the compatibility problem could have been resolved through the emulsion production process without using the additives that caused the mix to be very slow set and resulted in the rutting and flushing distresses.

It was a series of unfortunate events that led to the problems encountered on the project. But having evaluated and documented the problems, if a micro surfacing project is performed in the future, the lessons learned from this project will set it up for success.

Appendix A

Photolog & Map Documentation

Ramp 1 – International Airport EB - Minnesota WB On Ramp

Pre-construction Photos

Ramp contained significant longitudinal cracking as well as moderate to high rut depths. This ramp was removed by mill/fill in 2020 due to flushing.

Ramp 1 Surface Preparation Example

Ramp 1 Prior to Surface Preparation

Ramp 1 After Surface Preparation

Ramp 2 – Minnesota NB - International Airport Ramp

Pre-construction Photos

Ramp had moderate rut depths at the intersection with International Airport Road, and moderate raveling and isolated high severity transverse cracking.

This ramp was removed by mill/fill in 2020 outside of the right-hand turn lane.

Year 1 Monitoring Photo

The right lane is microsurfacing in good condition while the other three turn lanes are hot mix asphalt. The ramp remained in similar condition in 2023.

Year 3 Monitoring Photo

Ramp 3 – International Airport EB - Minnesota NB Loop

Pre-construction Photos

This ramp is a cloverleaf with minimal rutting, minor raveling and isolated moderate severity cracking.

Year 1 Monitoring Photos

The ramp remained in good condition although cracks on the ramp did reflect through the micro and plows have worn through the microsurfacing at the crown of the road.

Year 2 Monitoring Photos

There is increased severity in reflective cracking and plow damage along the centerline.

Year 3 Monitoring Photos

Ramp 4 – International Airport - Minnesota NB Ramp

Pre-construction Photos

Microsurfacing was applied over a small portion of this ramp to cover an area of raveling and cracking.

Year 1 Monitoring Photo

The microsurfacing still remains in good condition with slight plow damage and reflective cracking.

Year 2 Monitoring Photo

There is a slight increase in plow damage, but it remains in similar condition to the prior year.

Year 3 Monitoring Photo

Ramp 5 – Minnesota SB - International Airport Ramp

Pre-construction Photos

The initial part of this ramp had high severity longitudinal cracking. The worst of this was fixed as part of the earthquake repair portion of the project and did not receive microsurfacing. The rest of the cracking received crackseal and hot mix tamped in place. The later part of the ramp had moderate severity transverse and longitudinal cracking and minor raveling.

This ramp was removed by mill/fill in 2020.

Ramp 6 – Minnesota SB - International Airport Ramp

Pre-construction Photos

This ramp had minor rut depths but moderate to high severity longitudinal cracking.

Year 1 Monitoring Photos

During year 1 of monitoring the cracks reflected through the microsurfacing, plow damage was present on the striping at the center of the lane and rutting from deformation was noted at the signalized intersection.

Year 2 Monitoring Photos

There is increased plow damage at the signalized intersection and cracks have reflected at higher severity than year 1.

Year 3 Monitoring Photos

The right lane had a significant increase in raveling and bare pavement is visible throughout a portion of the lane. Cracks have reflected and there is some plow damage and slight spalling.

Ramp 7 – International Airport WB - Minnesota SB Loop

Pre-construction Photos

There were low rut depths, but high severity longitudinal cracking was present in the middle of the ramp that may have been related to embankment movement as well as underlying frost susceptible soils. At the base of the ramp there was transverse cracking with potholing.

Year 1 Monitoring Photos

Cracks reflected through the microsurfacing but remained in low severity on this ramp, which is in good condition overall.

Year 2 Monitoring Photos

There is increased damage along longitudinal cracks where plows are catching and damaging the surfacing treatment.

Year 3 Monitoring Photos

Cracks have continued to widen but are still largely of lessened severity. There is some plow damage along cracks, but the ramp remains in good condition.

Ramp 8 – Raspberry WB - Minnesota SB Ramp

Pre-construction Photos

The entire ramp was blocked cracked with a centerline crack present for the entire length. Fatigue cracking was beginning to develop in the inside wheelpath.

Year 1 Monitoring Photos

Cracks reflected through the ramp and plow damage was present having caused damage along the centerline and right side of the lane.   The ramp is in moderate to poor condition.

Year 2 Monitoring Photos

There is additional plow damage on the ramp in year 2 and increased damage over reflective cracking.

Year 3 Monitoring Photos

Cracking continues to reflect through the microsurfacing and there is plow damage and some spalling.

Ramp 9 – Raspberry WB - Minnesota NB Ramp

Pre-construction Photos

At the beginning of this ramp there was high severity center crack with fatigue cracking forming in the right wheelpath. The conditions improved at the International Airport sign, although faint wheelpath cracking was beginning to form in areas.

Year 1 Monitoring Photos

The block cracking and fatigue cracking reflected through the microsurfacing, but the largest cracks to reflect and experience damage were the transverse cracks on the ramp. The ramp remains in moderate condition.

Year 2 Monitoring Photos

The quantity of reflecting cracking has increased from 2021 to 2022 and the ramp has deformation rutting that occurred post construction, but did not significantly increase in depth from 2021 to 2022.

Year 3 Monitoring Photos

At the beginning of the ramp there is an area in poor condition with a spalling transverse crack and some patched potholes that are beginning to ravel out. The block and wheelpath cracking has fully reflected through, although spalling or raveling is minimal.

Ramp 10 – Minnesota SB - Raspberry WB Ramp

Pre-construction Photos

The beginning of this ramp had high rut depths that received hot mix for rut fill prior to the micorsurfacing application. Farther down the ramp there was moderate to high severity longitudinal and transverse cracking with less severe rut depths. This ramp was removed by mill/fill in 2020.

Ramp 11 – Raspberry EB - Minnesota SB Ramp

Pre-construction Photos

The primary distress on this ramp was a longitudinal joint crack and intermittent transverse cracks with associated potholes. The rut depths were minor with the exception of the southern end where traffic accelerates to begin merging with Minnesota where it neared ½" on average.

Year 1 Monitoring Photos

There was moderate flushing present on this ramp in the curve at Raspberry and near the end of the ramp. There was also damage along the centerline joint from plows.

Year 2 Monitoring Photos

There is significant flushing on this ramp, especially at the beginning of the ramp in the curve and at the end where the deepest ruts were. The reflective transverse cracks are still significantly less severe than they were originally, but the joint raveling along the centerline is opening up since 2021.

Year 3 Monitoring Photos

There is significant plow and studded tire damage in the initial curve and going up the hill. It drops to moderate wear for the rest of the ramp where some of the underlying HMA is visible. The high severity joint crack reflected through and has begun to severely spall.

Ramp 12 – Minnesota SB - Strawberry Ramp

Pre-construction Photos

There were low rut depths on this ramp, but it did have high severity longitudinal cracking, transverse cracking and potholing that worsen towards the end of the ramp.

Year 1 Monitoring Photos

This ramp is in poor condition from plow damage along the centerline and edges of the ramp. The damage was noted after a night of freezing rain when there was likely a large amount of down pressure put on the snowplow to remove ice.

Year 2 Monitoring Photos

The ramp remains in poor condition with an increased amount of surfacing worn off the center of the road from plows.

Year 3 Monitoring Photos

The ramp remains in similar condition to the prior year with significant plow damage and reflective cracking.

Ramp 13 – Dimond - Minnesota SB Ramp

Pre-construction Photos

There were moderate rut depths on the left portion of the ramp that accelerates and merges onto Minnesota, which received pre-level prior to the micro surfacing application. The rest of the ramp was in good condition with ruts less than half an inch and low severity raveling.

The portion of the ramp that received pre-level was removed and replaced with a mill/fill due to observed flushing in 2020. The micro surfacing remains on the rest of the ramp.

Year 1 Monitoring Photos

The photo below provides a comparison of the removal area (left) with hot mix, while the microsurfacing remains on the right. The ramp remains in overall good condition with some plow damage on transverse cracks that have reflected through the microsurfacing.

Year 2 Monitoring Photos

The ramp remains in good condition outside of one location near the end of the application where the plowed removed a portion along the centerline.

Year 3 Monitoring Photos

Outside of some isolated wear at the start of the ramp and one moderate severity transverse crack the ramp remains in good condition.

Ramp 14 – Minnesota SB - 100th Ramp

Pre-construction Photos

The ramp had isolated potholes, low rut depths but higher severity longitudinal and transverse cracking near 100th Avenue.

Year 1 Monitoring Photos

The ramp has some plow damage along the left-hand side and centerline of the off ramp and transverse cracks reflected through the microsurfacing. The ramp remains in moderate to good condition.

Year 2 Monitoring Photos

The ramp remains in moderate condition with some isolated plow damage and reflective cracking.

Year 3 Monitoring Photos

There is some isolated plow damage and reflective cracking, but the ramp remains in moderate to good condition.

Ramp 15 – 100th Avenue Minnesota SB Ramp

Pre-construction Photos

There was high severity longitudinal cracking and joint cracking near 100th Avenue that improved farther down the ramp.

After Surface Preparation:

Year 1 Monitoring Photos

The high severity longitudinal cracking reflected through the microsurfacing near 100th Avenue, but it remined at low severity. Transverse cracks reflected, but overall, the ramp remains in good condition outside of the distress near 100th Avenue.

Year 2 Monitoring Photos

There are significant cracks at 100th Avenue, but the ramp remains in good condition outside of that and isolated plow damage.

Year 3 Monitoring Photos

The ramp remains in similar condition to the prior year with significant cracking at 100th Avenue, but in good condition outside of that.

Ramp 16 – Minnesota NB - 100th Ramp

Pre-construction Photos

Near the beginning of the ramp there was low severity transverse cracking and raveling, but closer to 100th Avenue there was high severity longitudinal cracking.

Year 1 Monitoring Photos

The beginning of the ramp remains in good condition with some low severity reflective cracking, but near 100th Avenue the major cracking reflected and is in poor condition at the cracks. Some flushing was present on the ramp with a slight loss of friction.

Year 2 Monitoring Photos

There was significant reflective cracking adjacent to 100th Avenue with some flushing, but outside of the area next to 100th Avenue the ramp remains in moderate to good condition.

Year 3 Monitoring Photos

The ramp condition adjacent to 100th Avenue is poor from the severe reflective cracking and some flushing but is in moderate to good condition outside of that area.

Ramp 17 – 100th Avenue - Minnesota NB Ramp

Pre-construction Photos

There is moderate longitudinal and transverse cracking near 100th Avenue with isolated potholes and some high severity transverse cracking where the ramp merges into Minnesota Drive.

Year 1 Monitoring Photos

This ramp is in moderate condition from some plow damage at the end of the lanes and reflective transverse cracking.

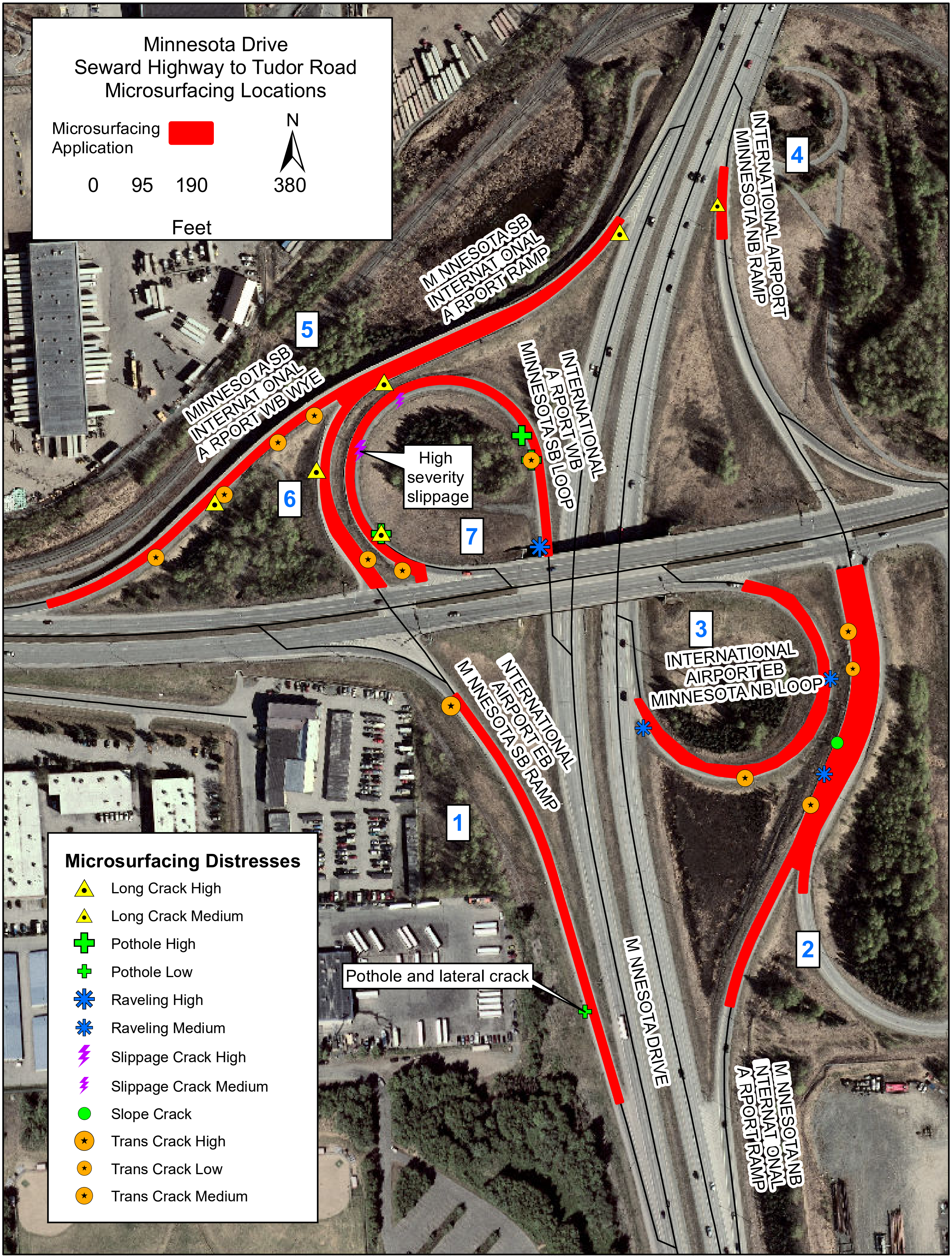
Year 2 Monitoring Photos

There is a severe transverse crack near the beginning of the application that has opened up. Plow damage can be seen where there was likely high down pressure that abraded the surfacing treatment and ripped out the material sealing the underlying crack.

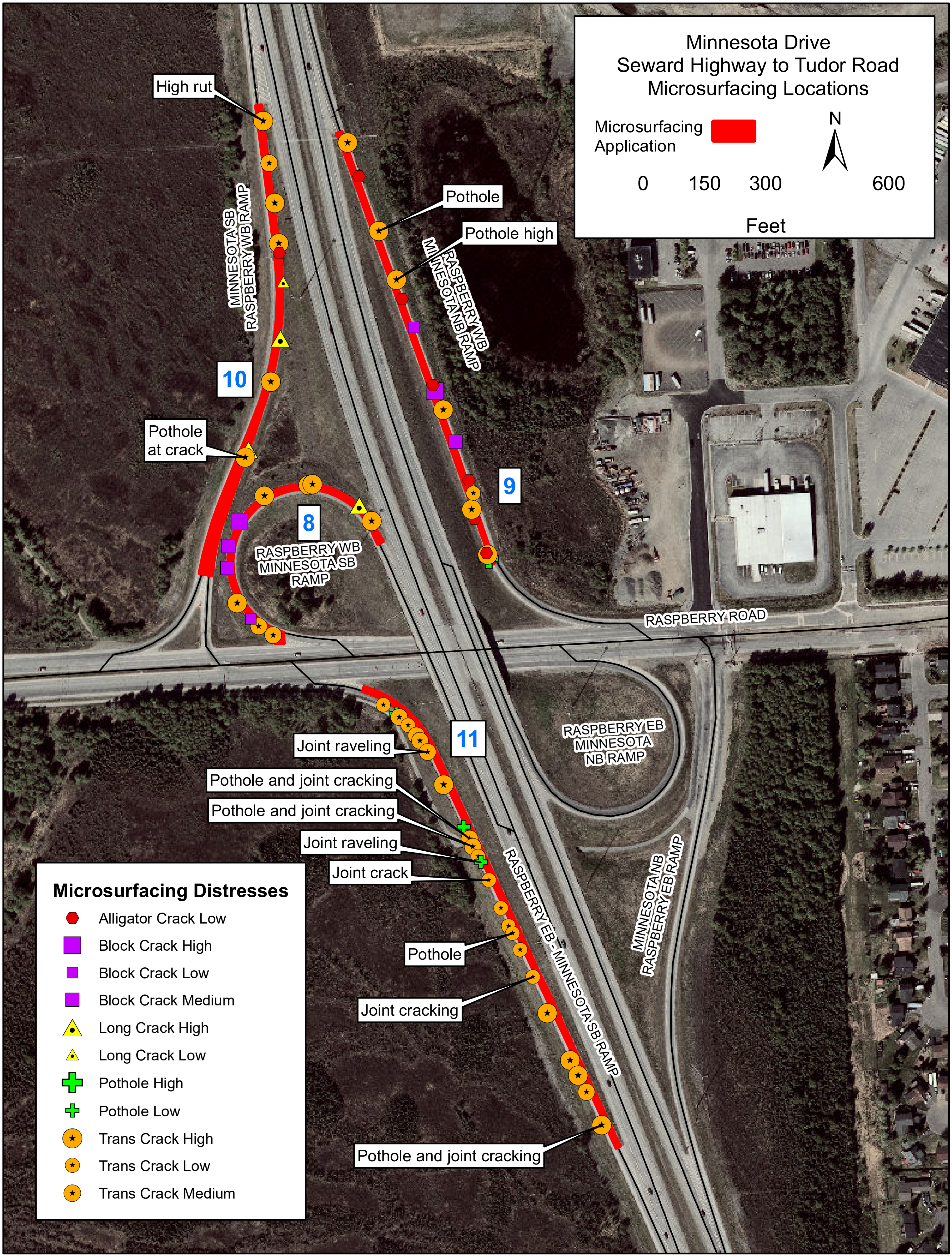
Year 3 Monitoring Photos

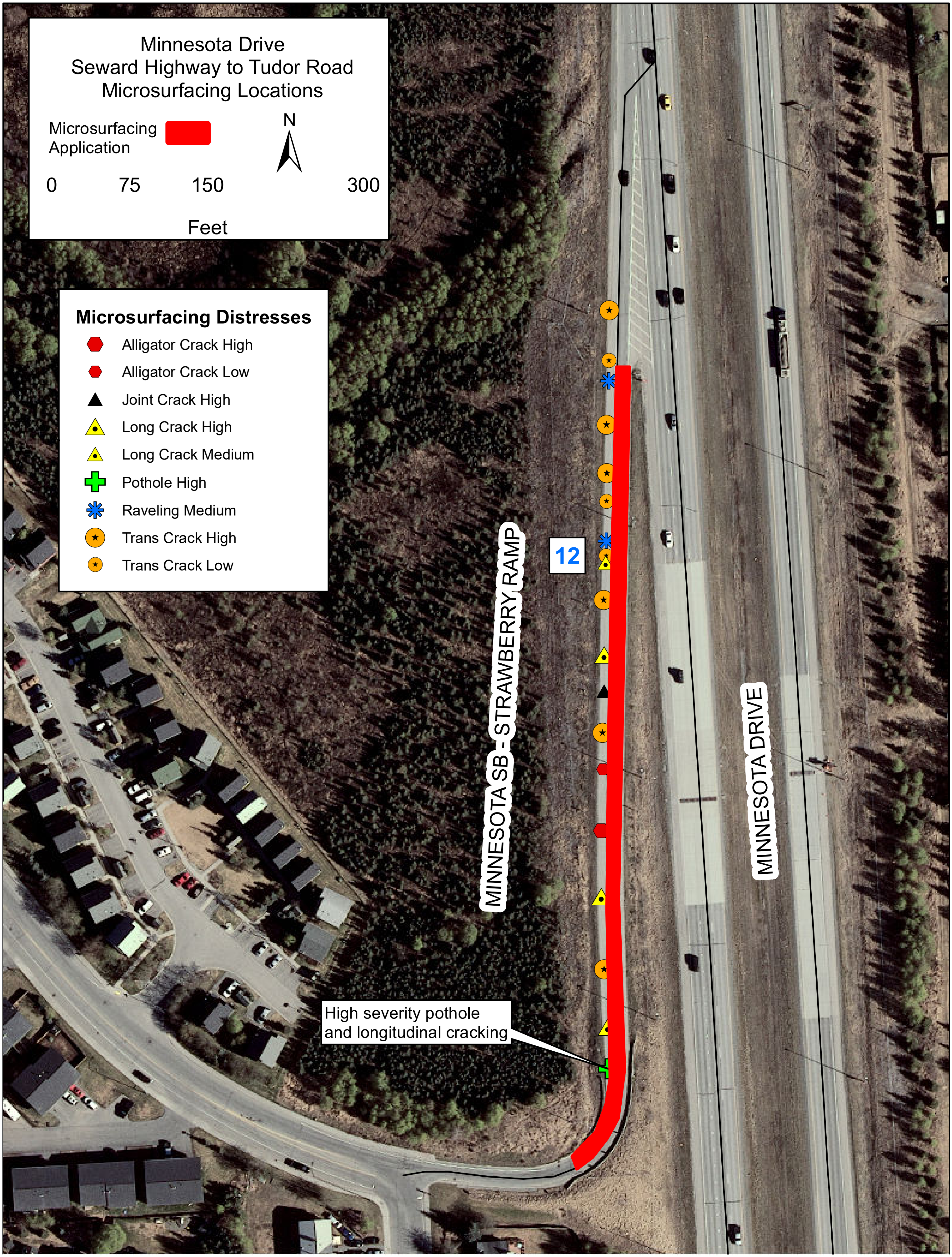
The severe transverse crack has continued to see increase in wear and there is slight spalling around transverse cracks. There is also some isolated plow damage farther down the ramp.

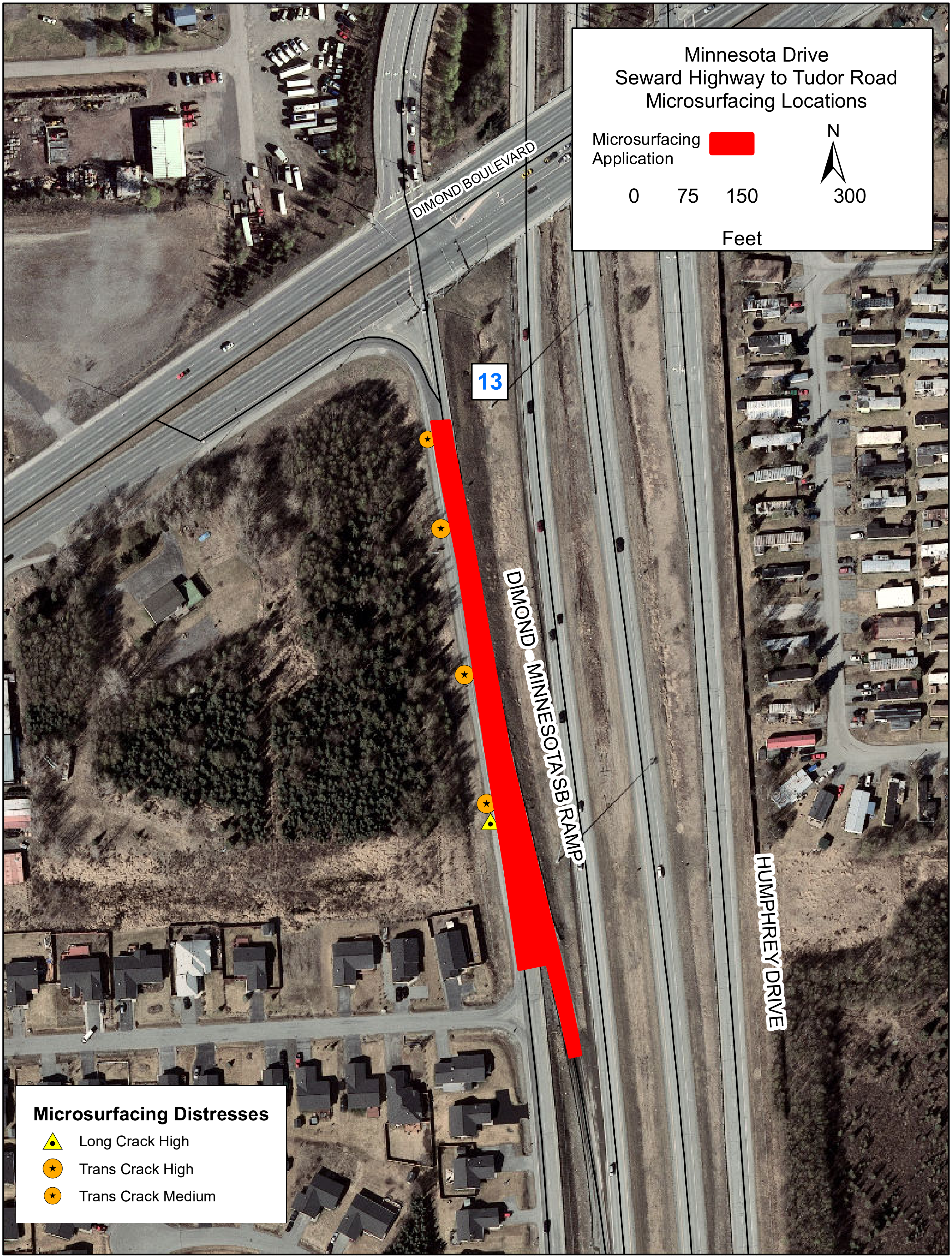
Pre-Construction Conditions



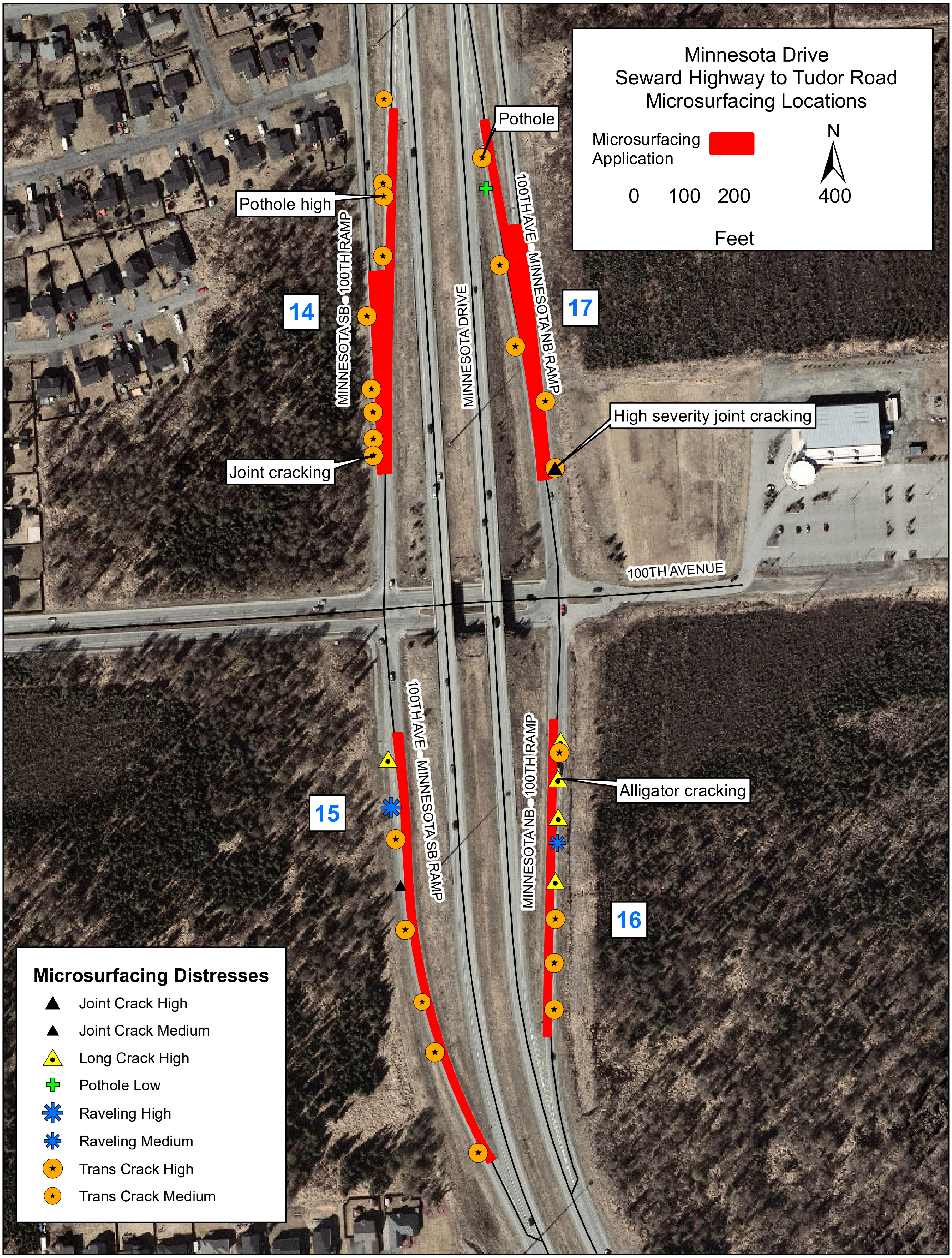
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
Microsurfacing Application
N
0 95 190 380
Feet
M NNESOTA SB INTERNAT ONAL A RPORT RAMP
MINNESOTA SB INTERNAT ONAL A RPORT WB WYE
INTERNATIONAL A RPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
High severity slippage
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB M NNESOTA SB RAMP
M NNESOTA DRIVE
M NNESOTA NB INTERNAT ONAL A RPORT RAMP
Pothole and lateral crack
1
2
3
4
5
6
7
Microsurfacing Distresses
Long Crack High
Long Crack Medium
Pothole High
Pothole Low
Raveling High
Raveling Medium
Slippage Crack High
Slippage Crack Medium
Slope Crack
Trans Crack High
Trans Crack Low
Trans Crack Medium


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
Microsurfacing Application
0 150 300 600
Feet
N
High rut
Pothole
Pothole high
Pothole at crack
10
9
8
11
MINNESOTA SB RASPBERRY WB RAMP
RASPBERRY WB MINNESOTA NB RAMP
RASPBERRY WB MINNESOTA SB RAMP
RASPBERRY ROAD
RASPBERRY EB MINNESOTA NB RAMP
MINNESOTA NB RASPBERRY EB RAMP
RASPBERRY EB - MINNESOTA SB RAMP
Joint raveling
Pothole and joint cracking
Pothole and joint cracking
Joint raveling
Joint crack
Pothole
Joint cracking
Pothole and joint cracking
Microsurfacing Distresses
Alligator Crack Low
Block Crack High
Block Crack Low
Block Crack Medium
Long Crack High
Long Crack Low
Pothole High
Pothole Low
Trans Crack High
Trans Crack Low
Trans Crack Medium


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
Microsurfacing Application
N
0
75
150
300
Feet
Microsurfacing Distresses
Alligator Crack High
Alligator Crack Low
Joint Crack High
Long Crack High
Long Crack Medium
Pothole High
Raveling Medium
Trans Crack High
Trans Crack Low
12
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
High severity pothole
and longitudinal cracking



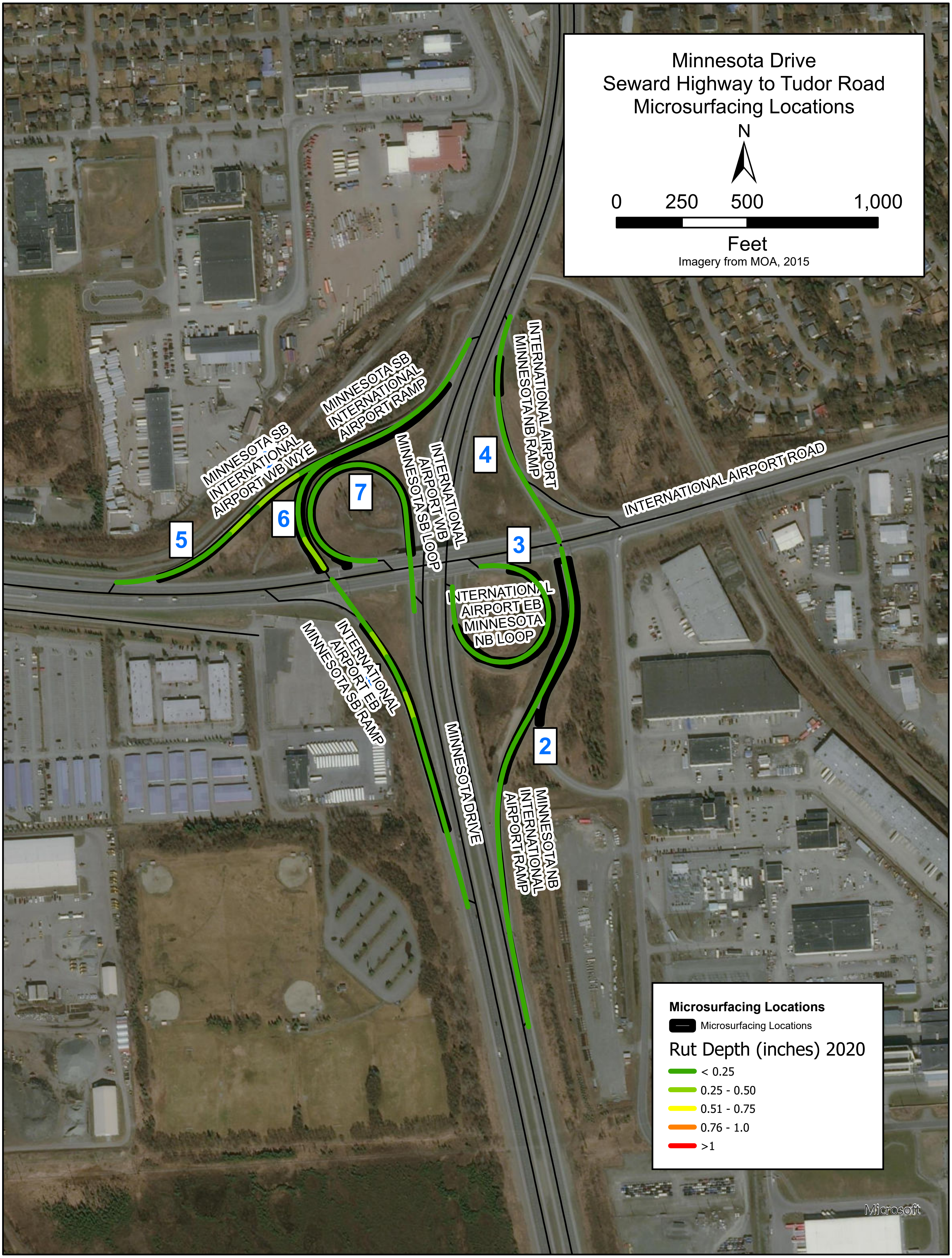
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
Microsurfacing Application
N
0 75 150 300
Feet
DIMOND BOULEVARD
13
DIMOND - MINNESOTA SB RAMP
HUMPHREY DRIVE
Microsurfacing Distresses
Long Crack High
Trans Crack High
Trans Crack Medium



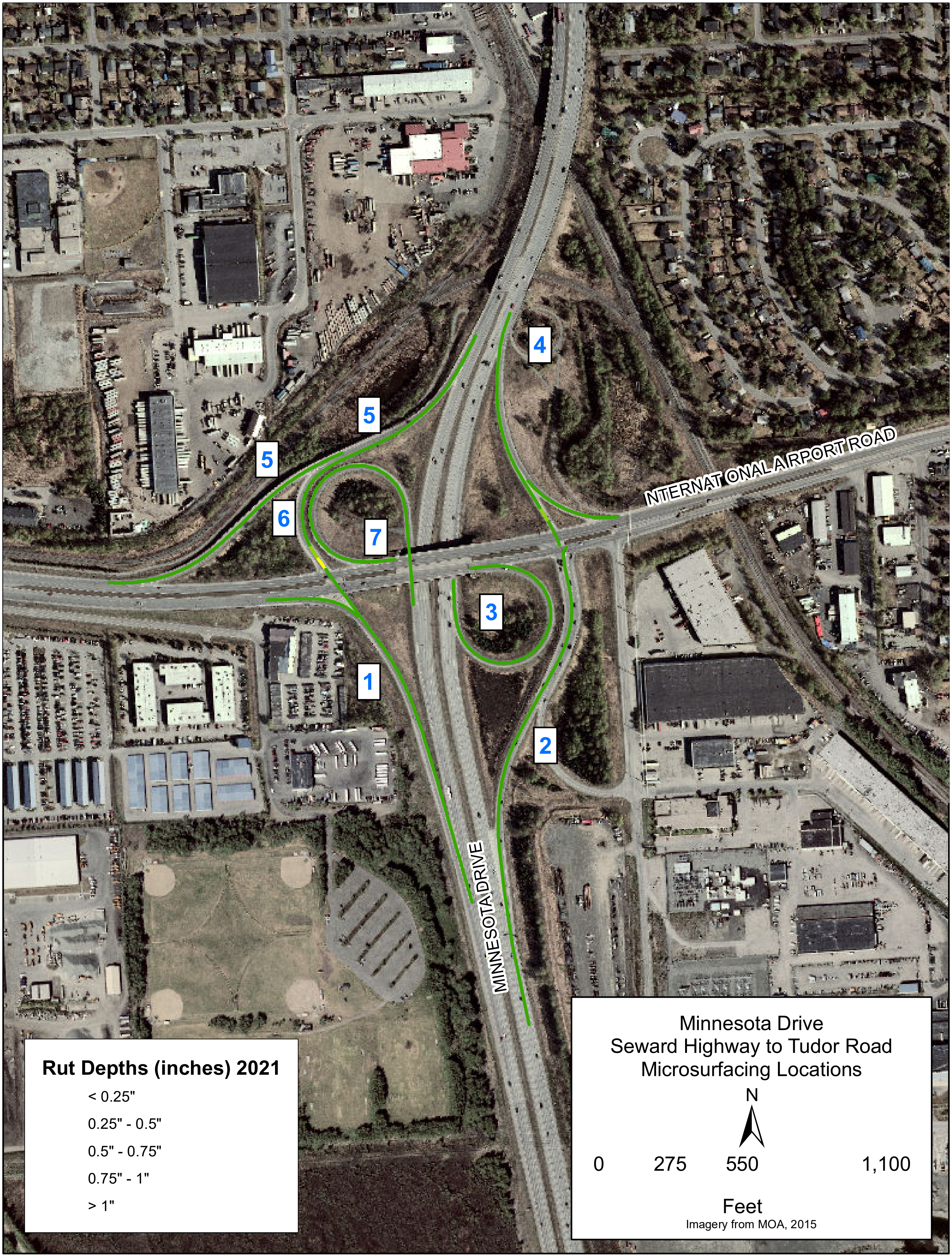
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
Microsurfacing Application
0 100 200 400
Feet
N
Pothole
Pothole high
Joint cracking
High severity joint cracking
Alligator cracking
14
15
16
17
MINNESOTA SB - 100TH RAMP
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
Microsurfacing Distresses
Joint Crack High
Joint Crack Medium
Long Crack High
Pothole Low
Raveling High
Raveling Medium
Trans Crack High
Trans Crack Medium

Post Construction

Rut, IRI and Cracking Conditions



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
250
500
1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
5
6
7
Microsurfacing Locations
Microsurfacing Locations
Rut Depth (inches) 2020
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0 275 550 1,100
Feet
Imagery from MOA, 2015
Rut Depths (inches) 2021
< 0.25"
0.25" - 0.5"
0.5" - 0.75"
0.75" - 1"
> 1"
NTERNAT ONAL A RPORT ROAD
MINNESOTA DRIVE
1
2
3
4
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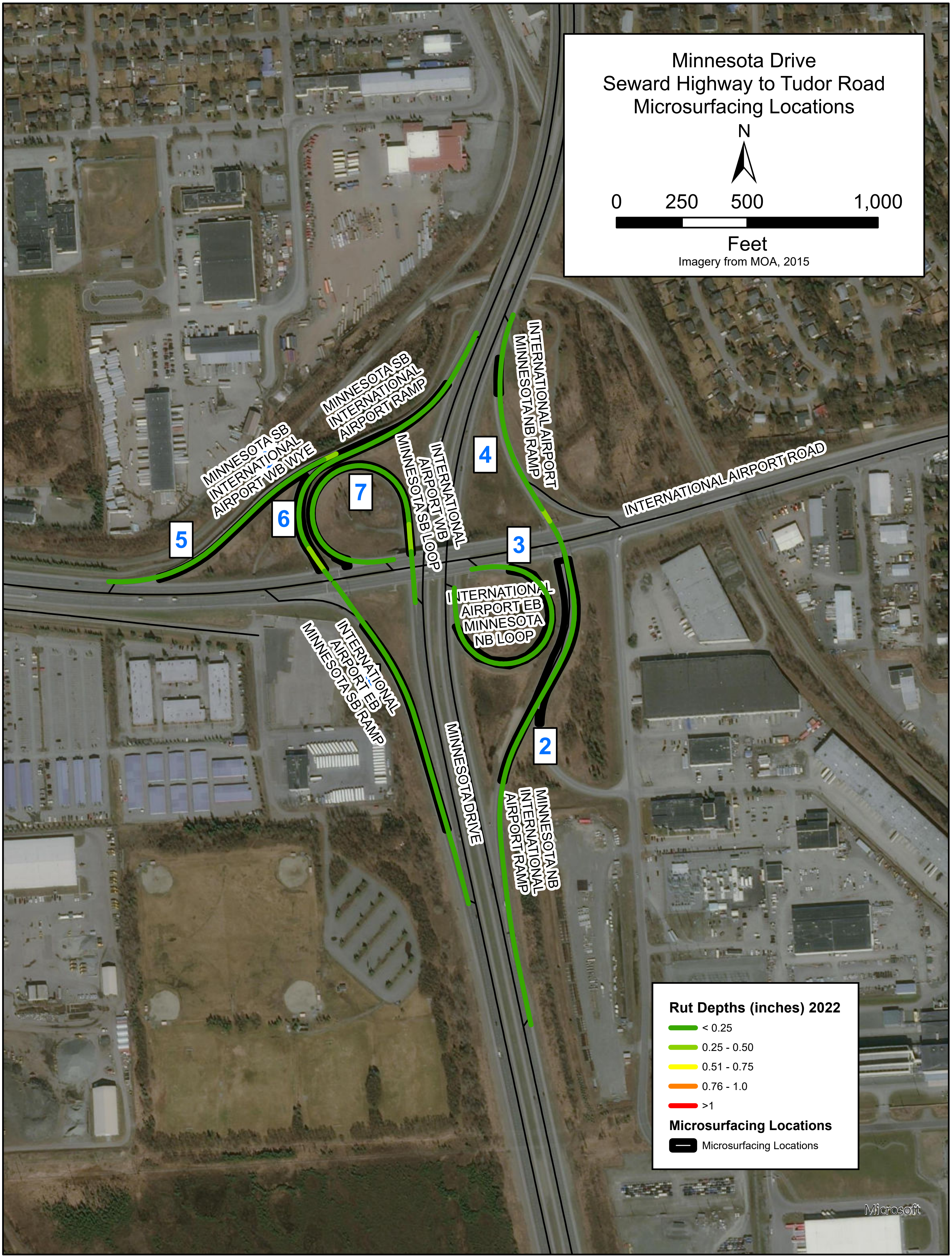
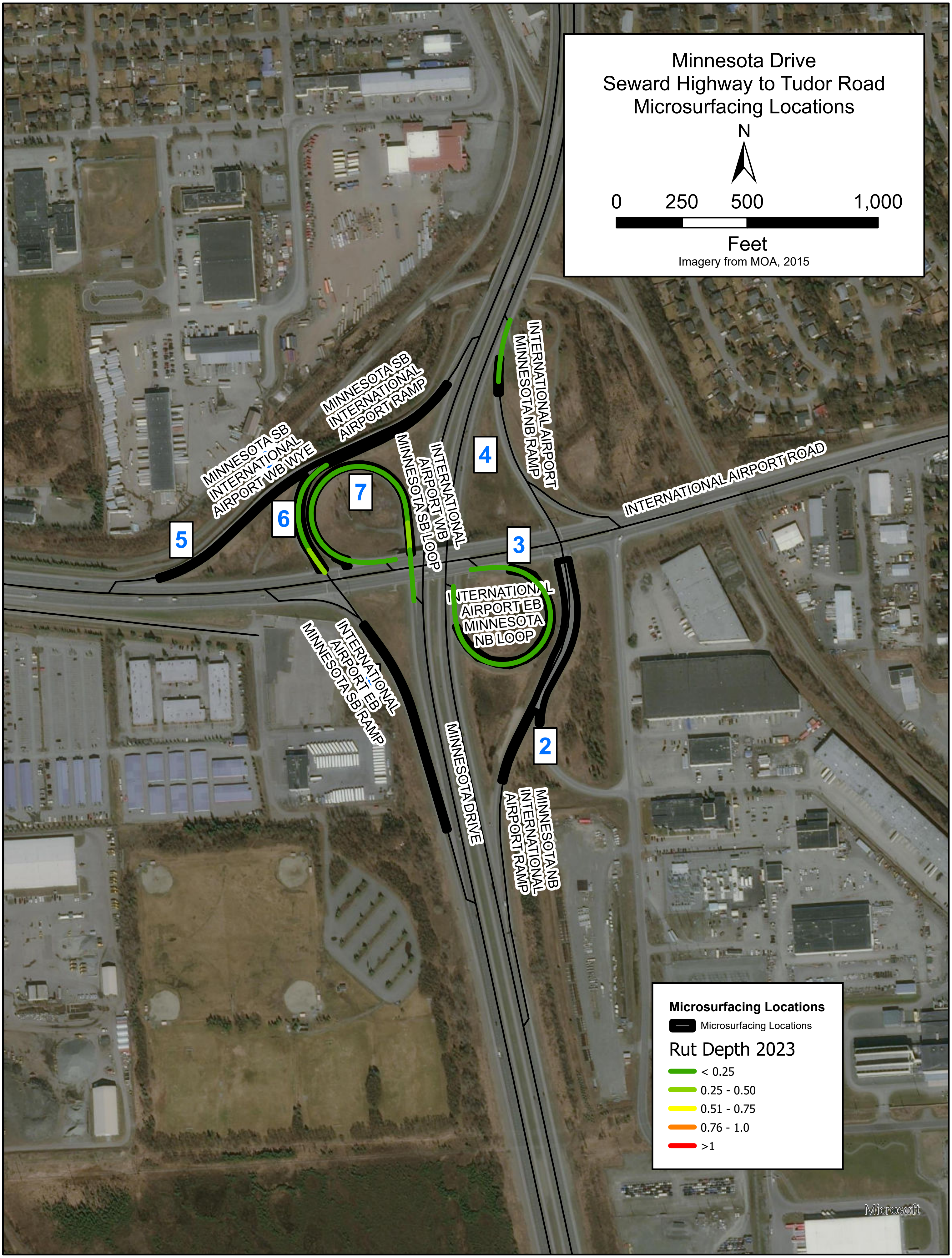
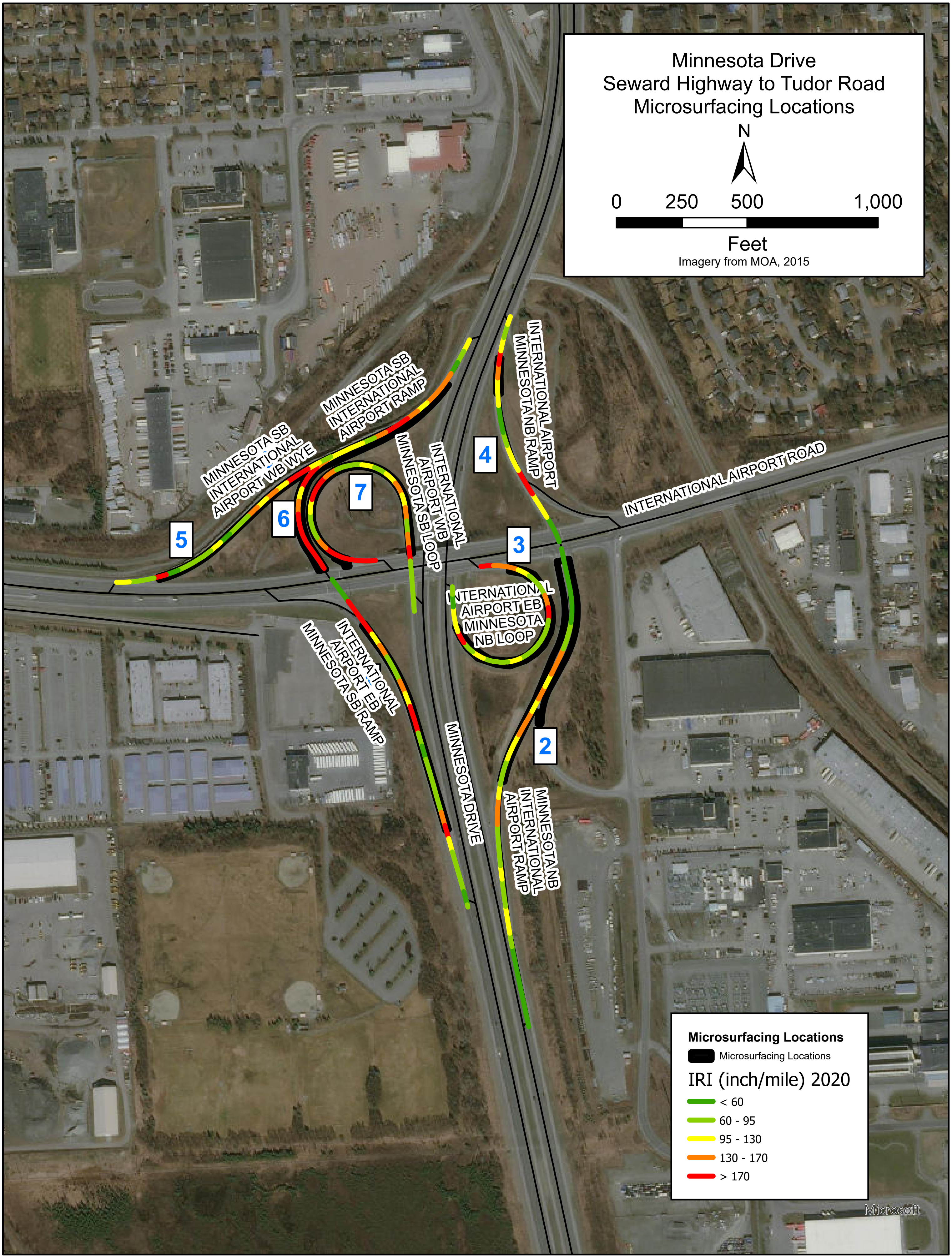
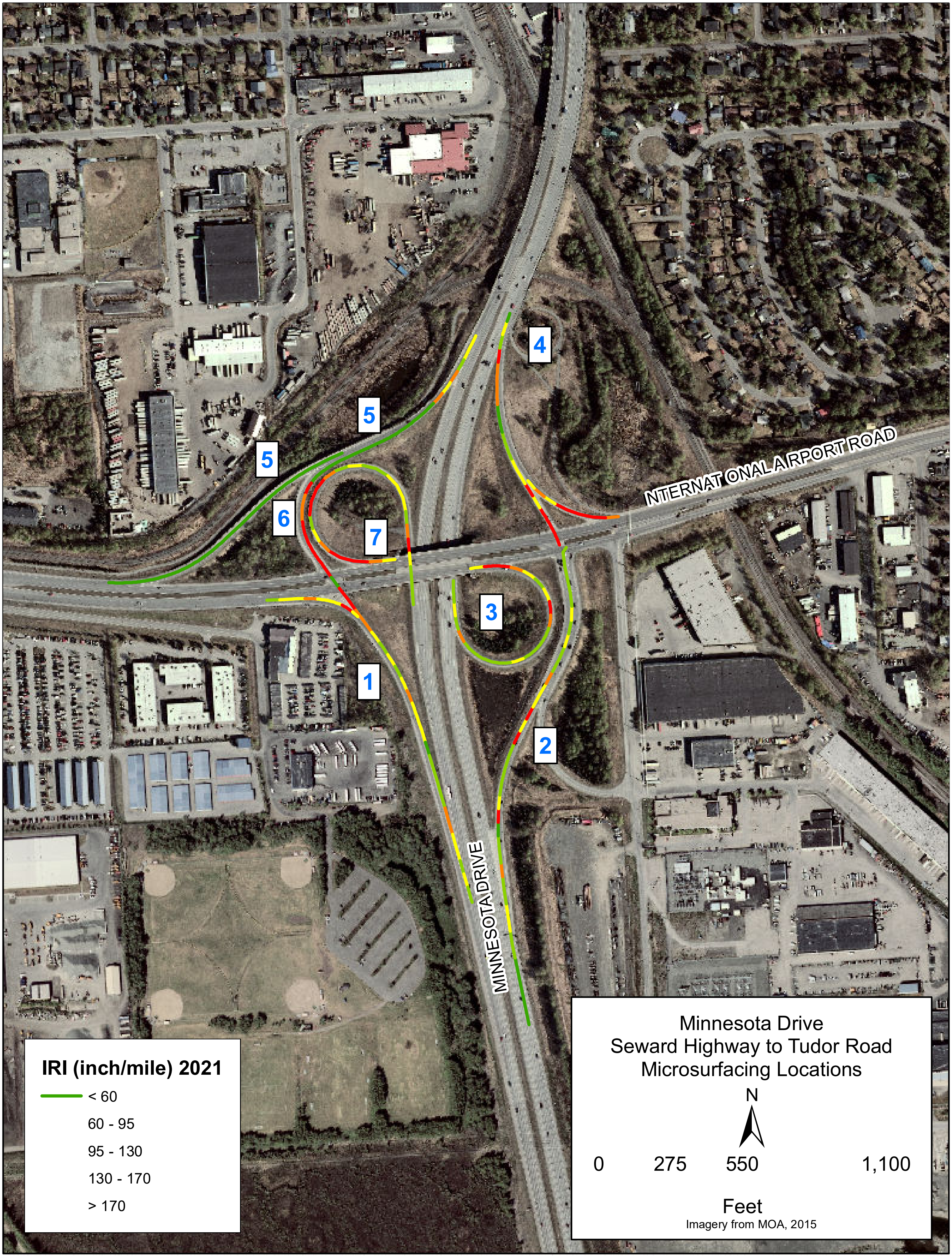
5
6
7


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
250
500
1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
5
6
7
Rut Depths (inches) 2022
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsurfacing Locations
Microsurfacing Locations
Microsoft

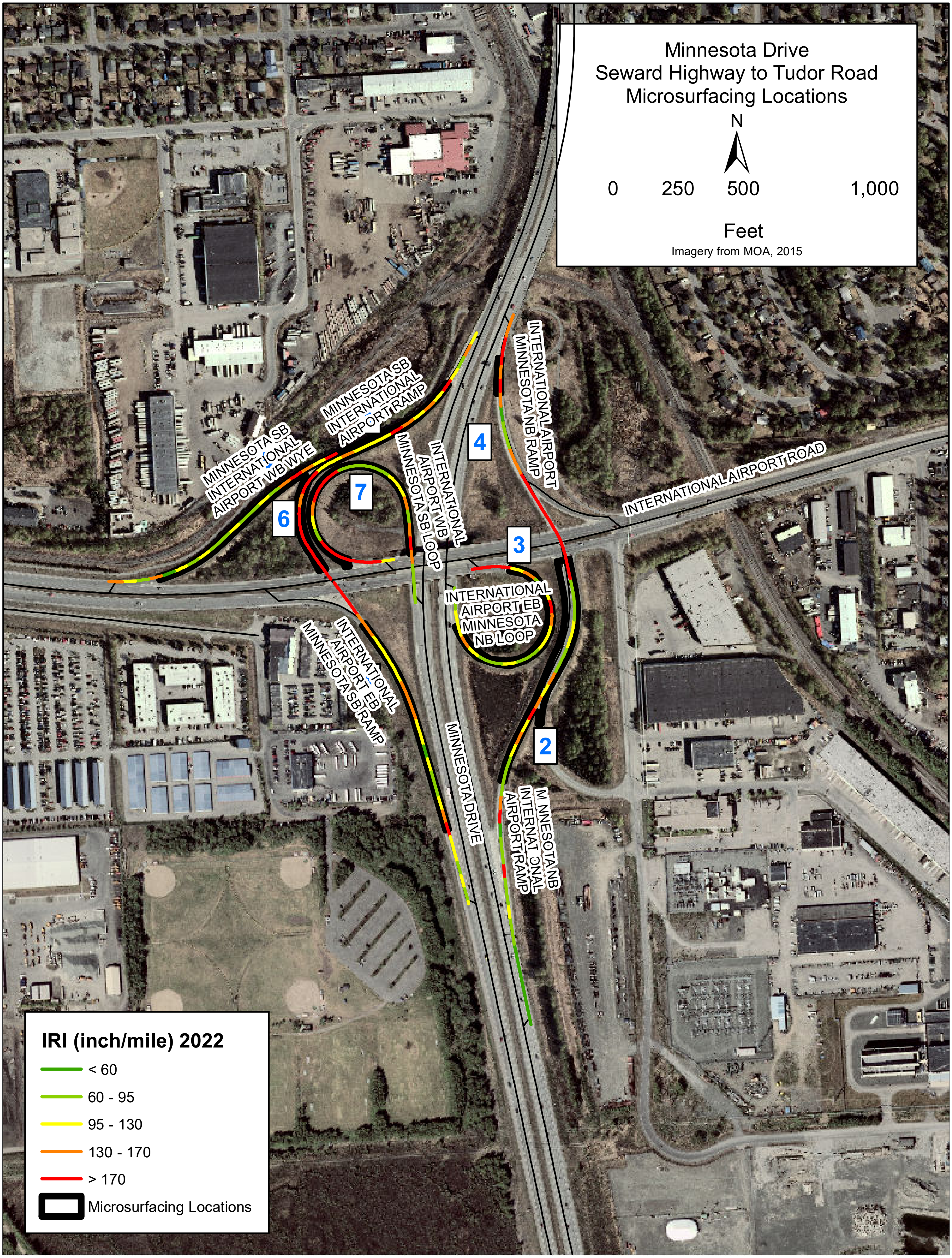

Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0 250 500 1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
5
6
7
Microsurfacing Locations
Microsurfacing Locations
Rut Depth 2023
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsoft

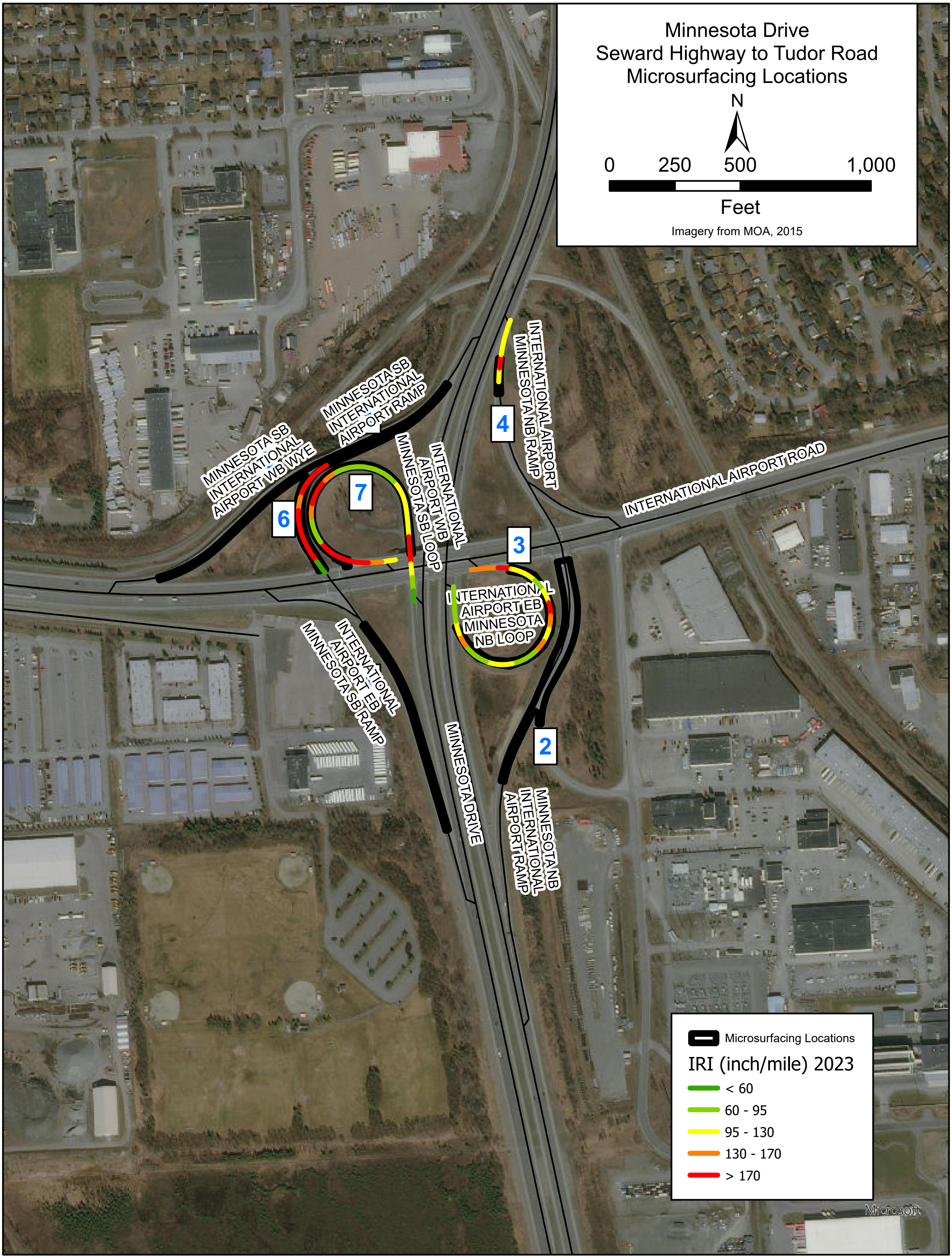


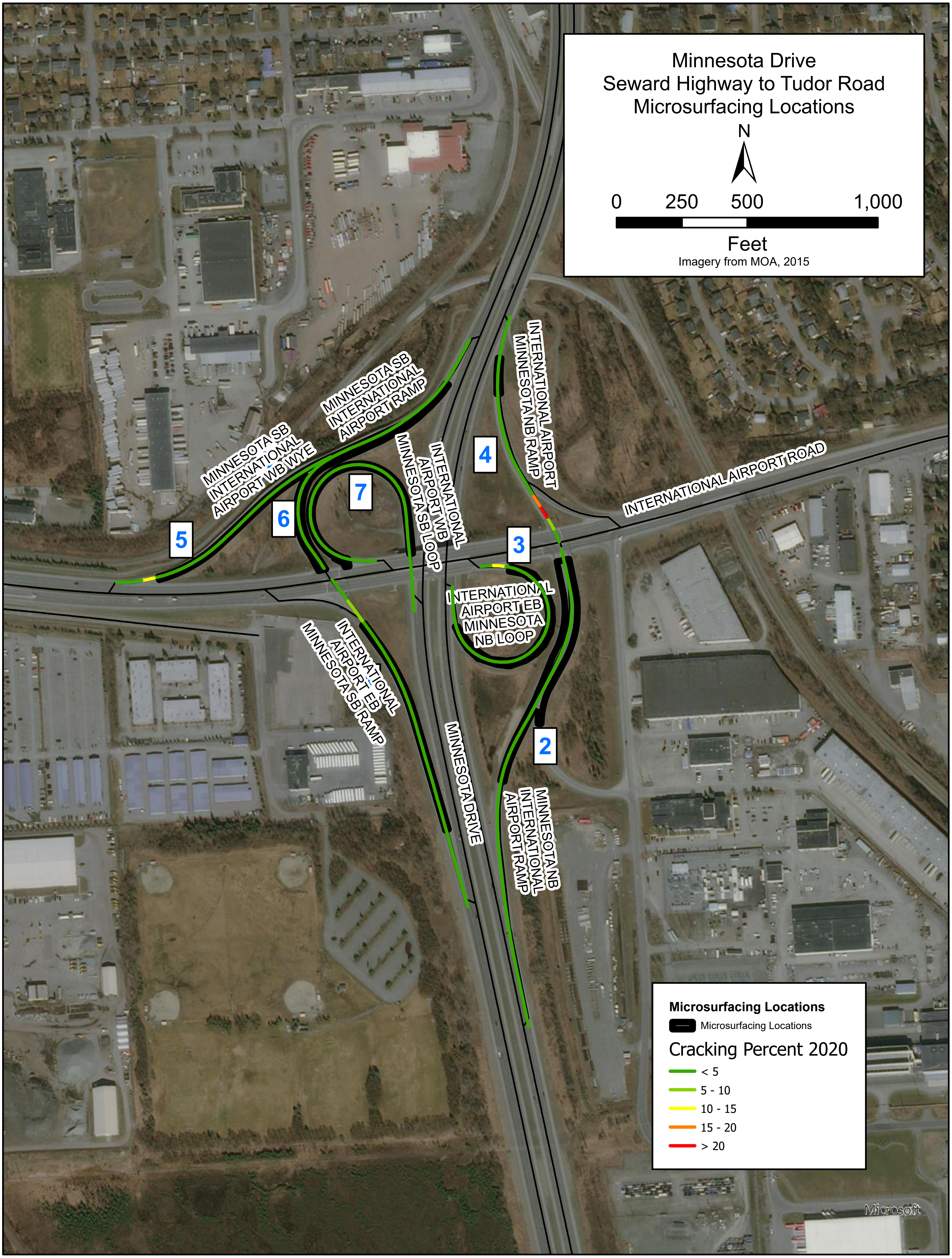
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
250
500
1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
5
6
7
Microsurfacing Locations
Microsurfacing Locations
IRI (inch/mile) 2020
< 60
60 - 95
95 - 130
130 - 170
> 170
Microsoft



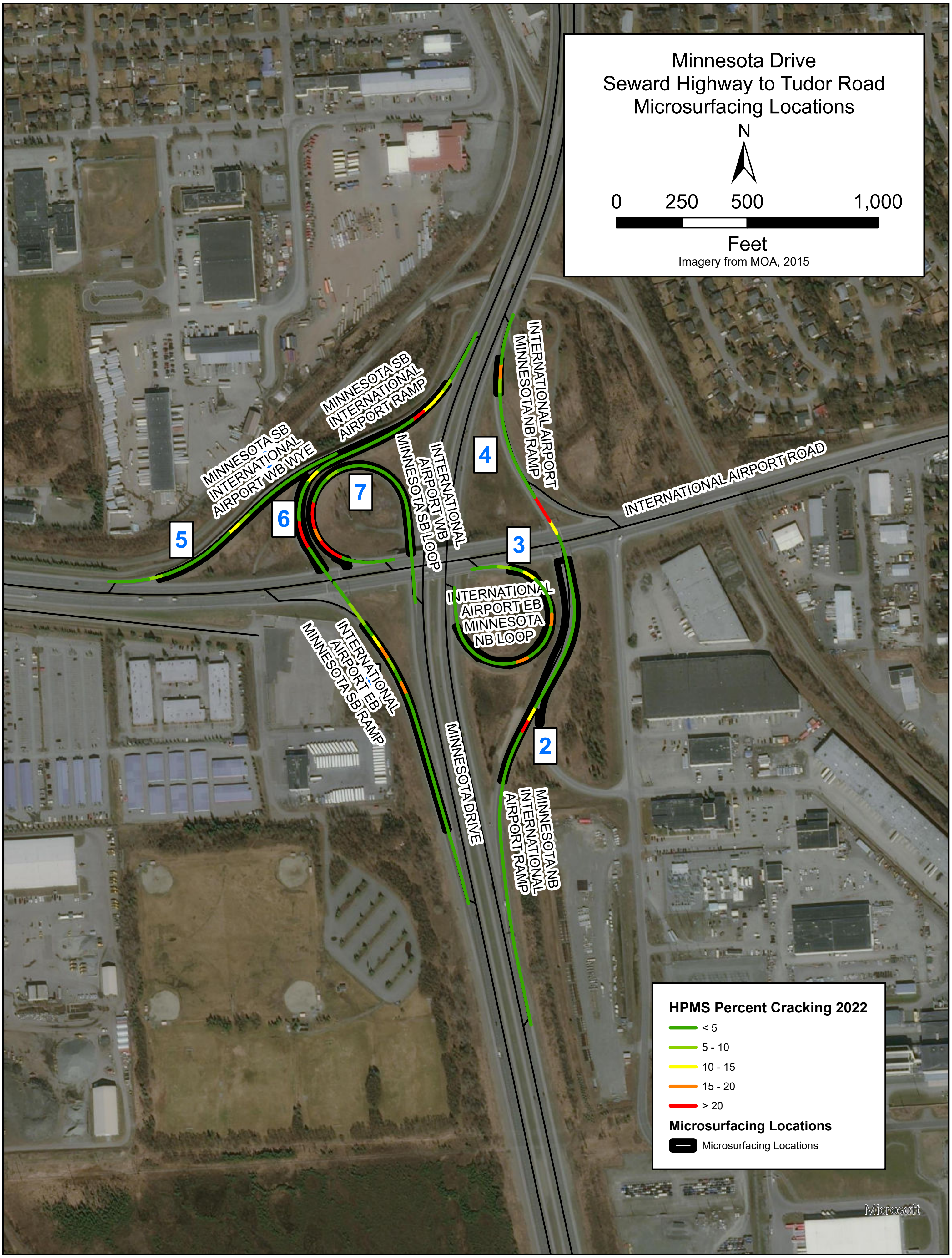
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0 275 550 1,100
Feet
Imagery from MOA, 2015
IRI (inch/mile) 2021
< 60
60 - 95
95 - 130
130 - 170
> 170
NTERNAT ONAL A RPORT ROAD
MINNESOTA DRIVE
1
2
3
4
5
5
6
7


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
250
500
1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
M NNESOTA NB INTERNAT ONAL AIRPORT RAMP
2
3
4
6
7
IRI (inch/mile) 2022
< 60
60 - 95
95 - 130
130 - 170
> 170
Microsurfacing Locations

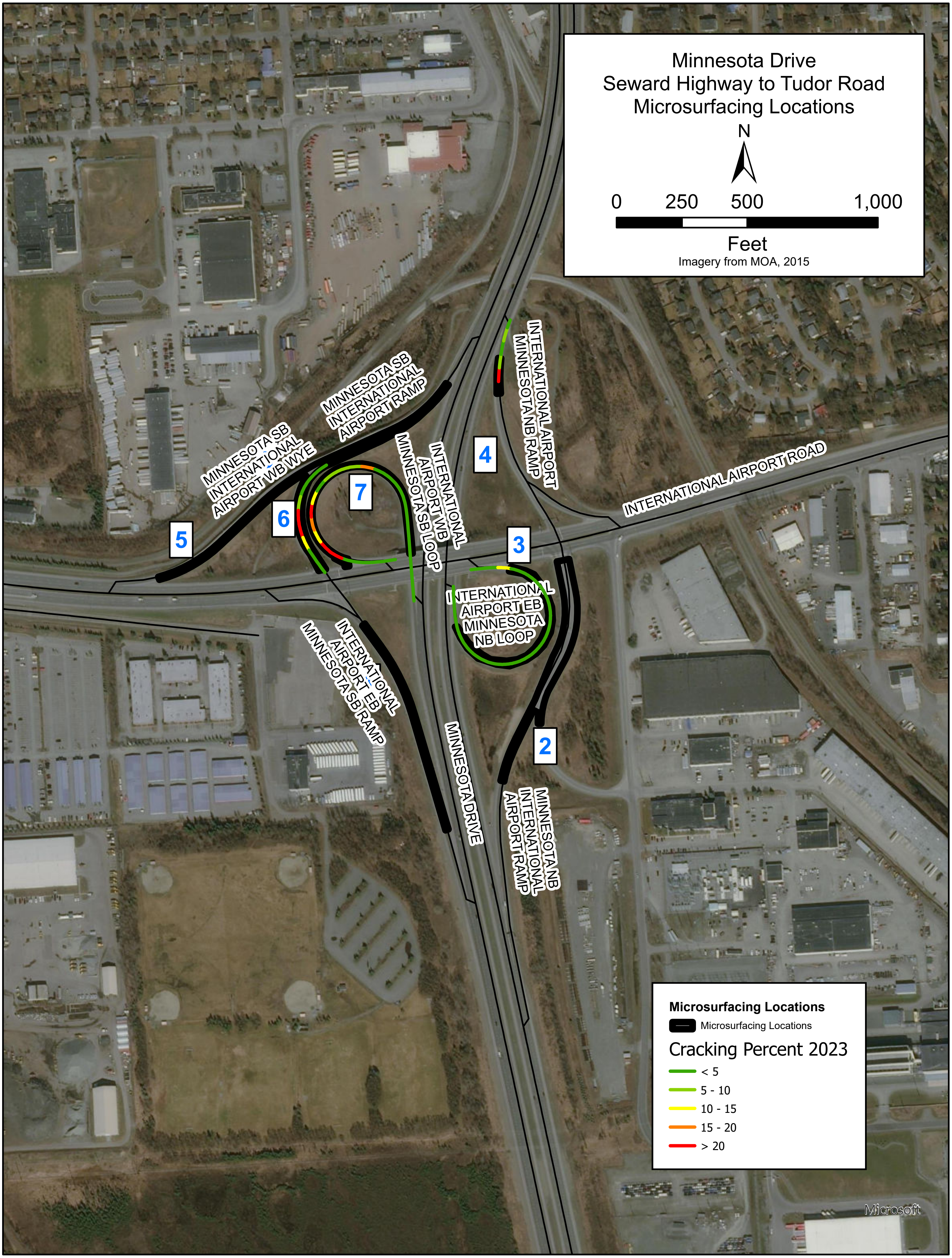

Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
250
500
1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
6
7
Microsurfacing Locations
IRI (inch/mile) 2023
< 60
60 - 95
95 - 130
130 - 170
> 170
Microsoft

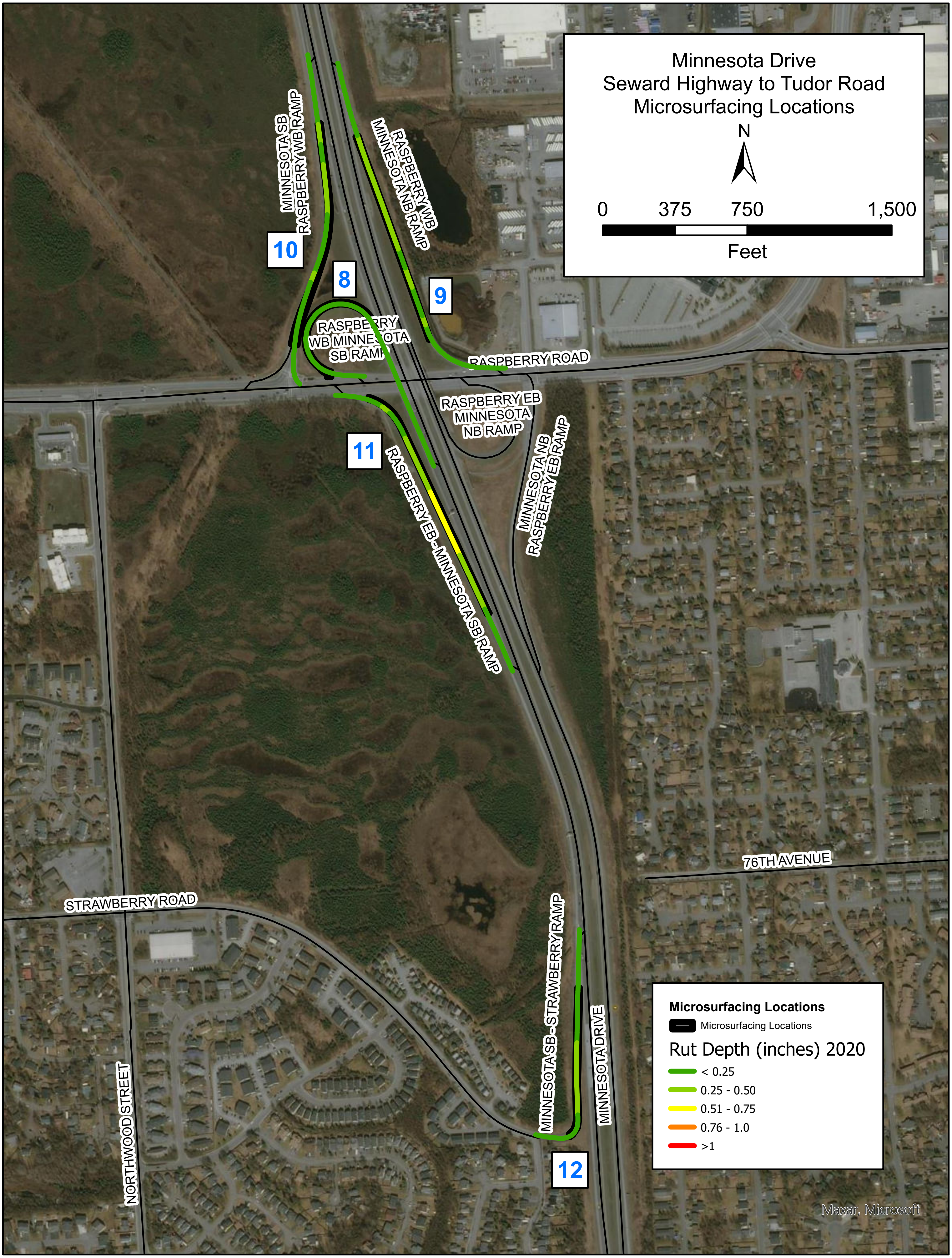


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
250
500
1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
5
6
7
Microsurfacing Locations
Microsurfacing Locations
Cracking Percent 2020
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsoft

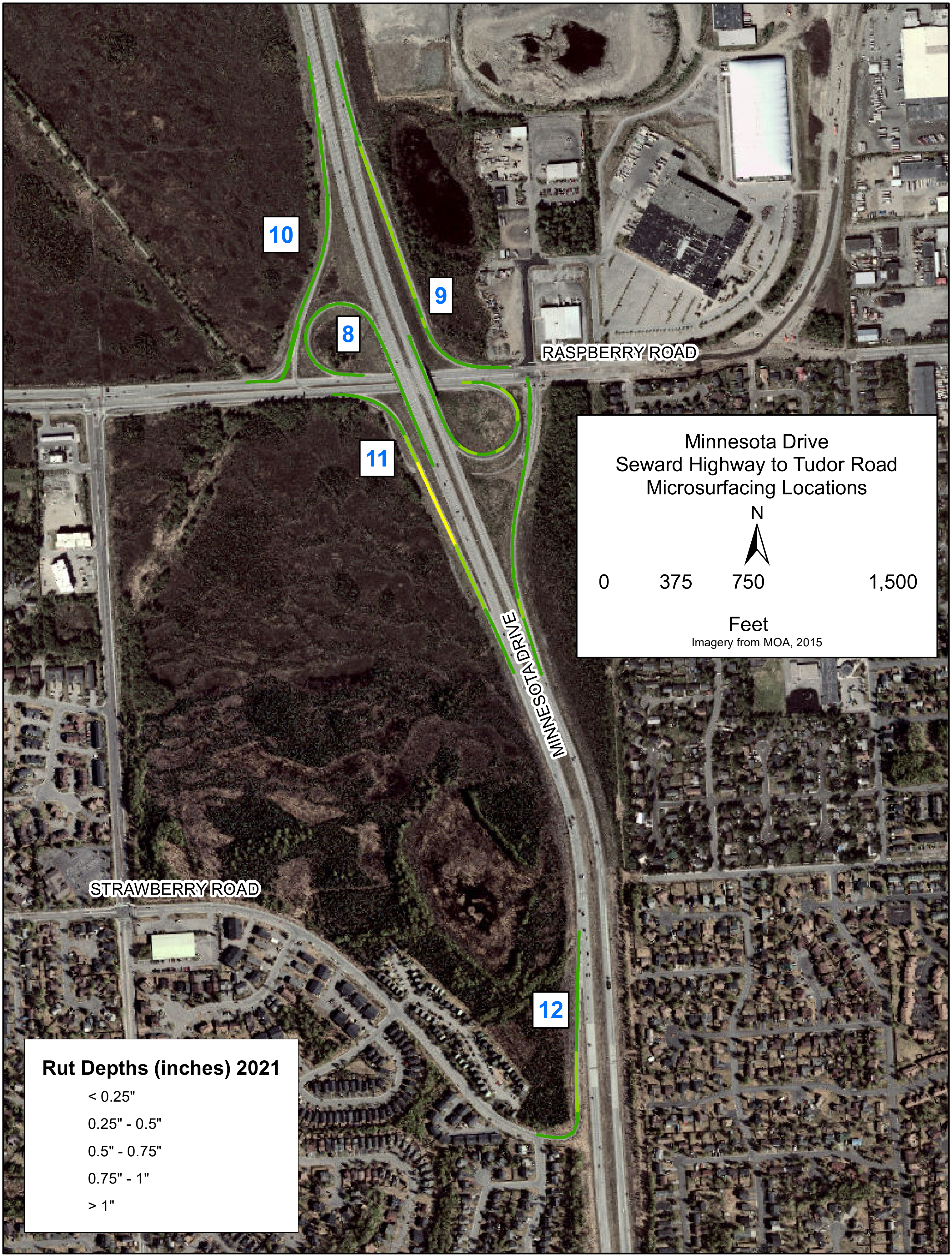


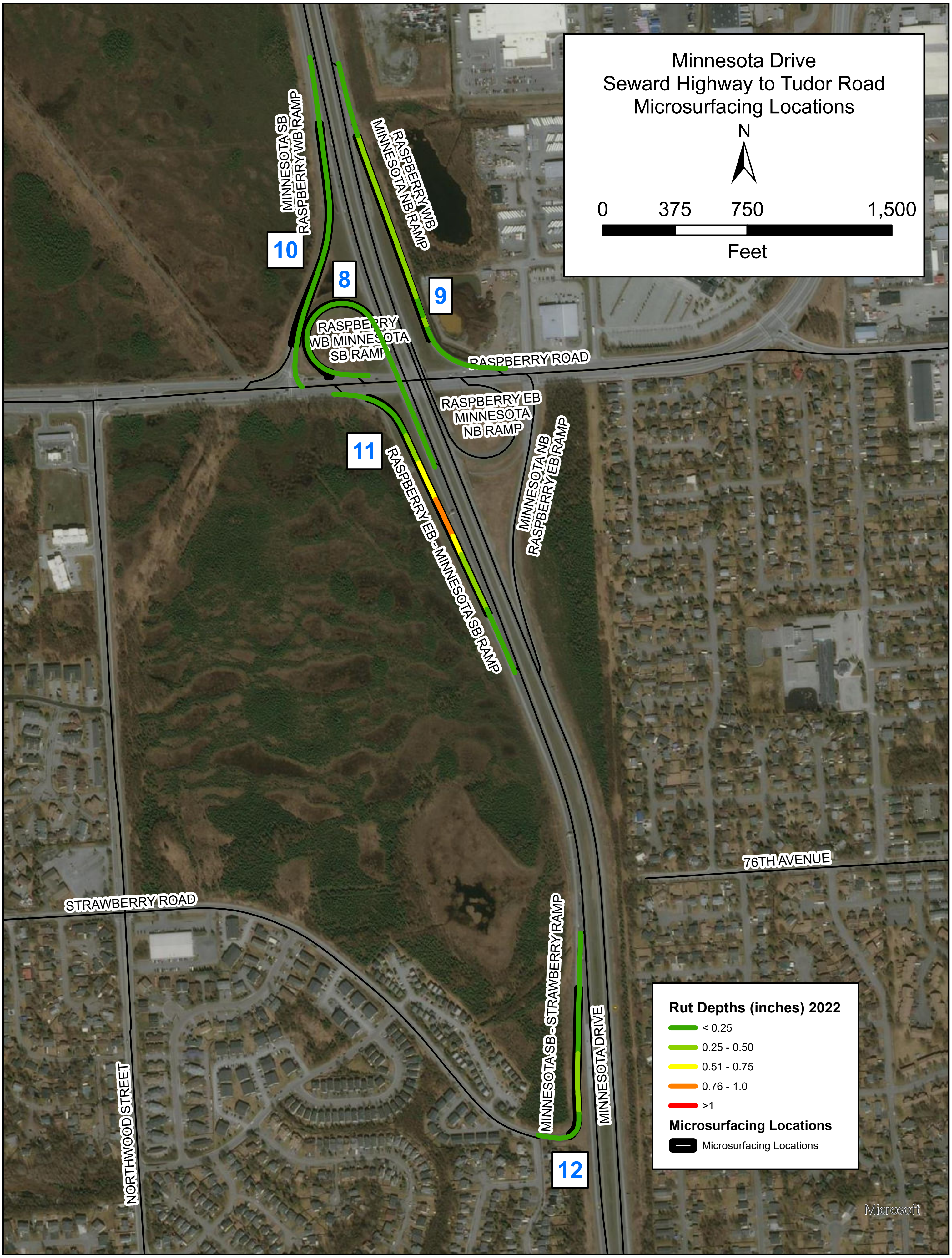
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
250
500
1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
5
6
7
HPMS Percent Cracking 2022
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsurfacing Locations
Microsurfacing Locations
Microsoft

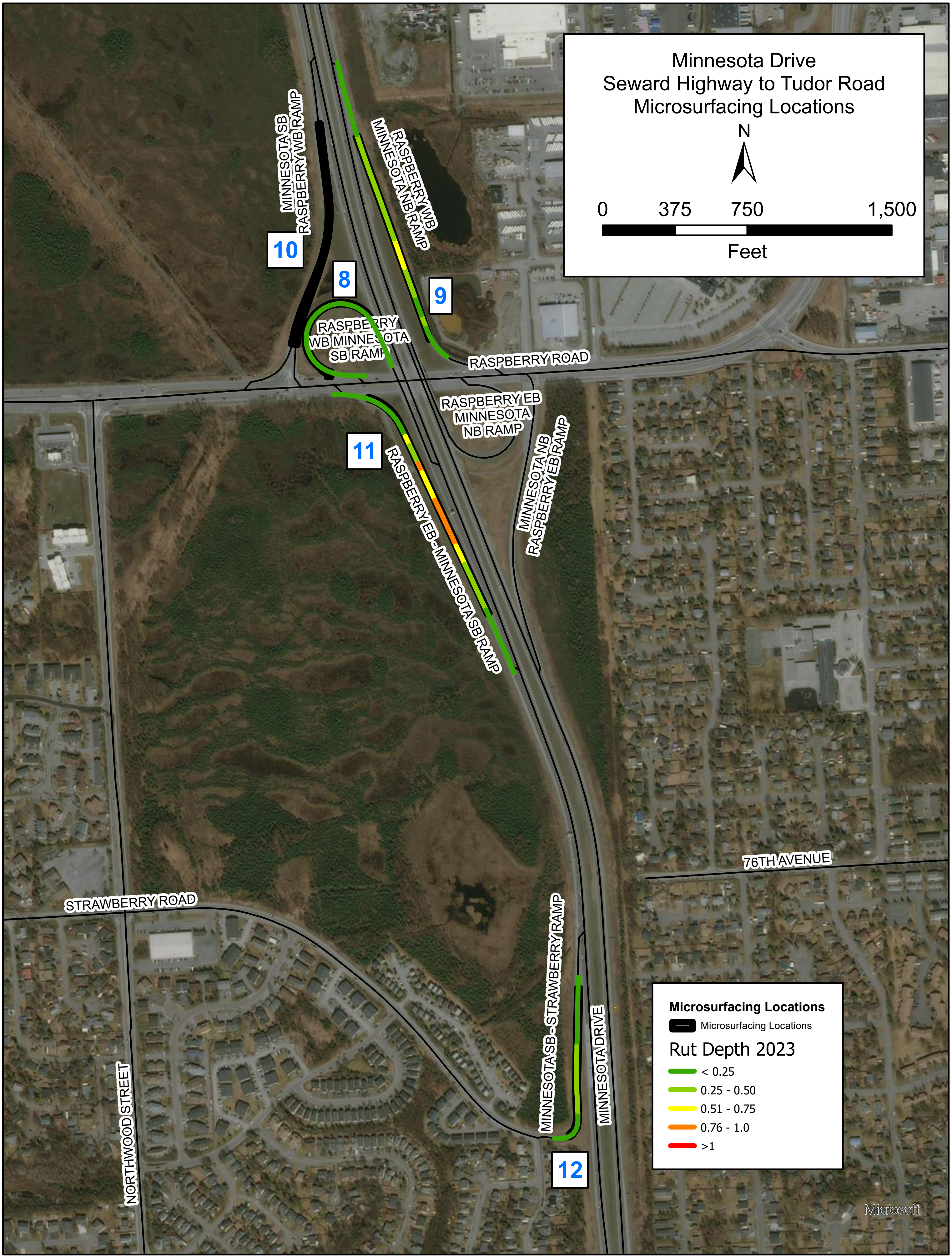

Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0 250 500 1,000
Feet
Imagery from MOA, 2015
MINNESOTA SB INTERNATIONAL AIRPORT RAMP
MINNESOTA SB INTERNATIONAL AIRPORT WB WYE
INTERNATIONAL AIRPORT MINNESOTA NB RAMP
INTERNATIONAL AIRPORT WB MINNESOTA SB LOOP
INTERNATIONAL AIRPORT ROAD
INTERNATIONAL AIRPORT EB MINNESOTA NB LOOP
INTERNATIONAL AIRPORT EB MINNESOTA SB RAMP
MINNESOTA DRIVE
MINNESOTA NB INTERNATIONAL AIRPORT RAMP
2
3
4
5
6
7
Microsurfacing Locations
Microsurfacing Locations
Cracking Percent 2023
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsoft



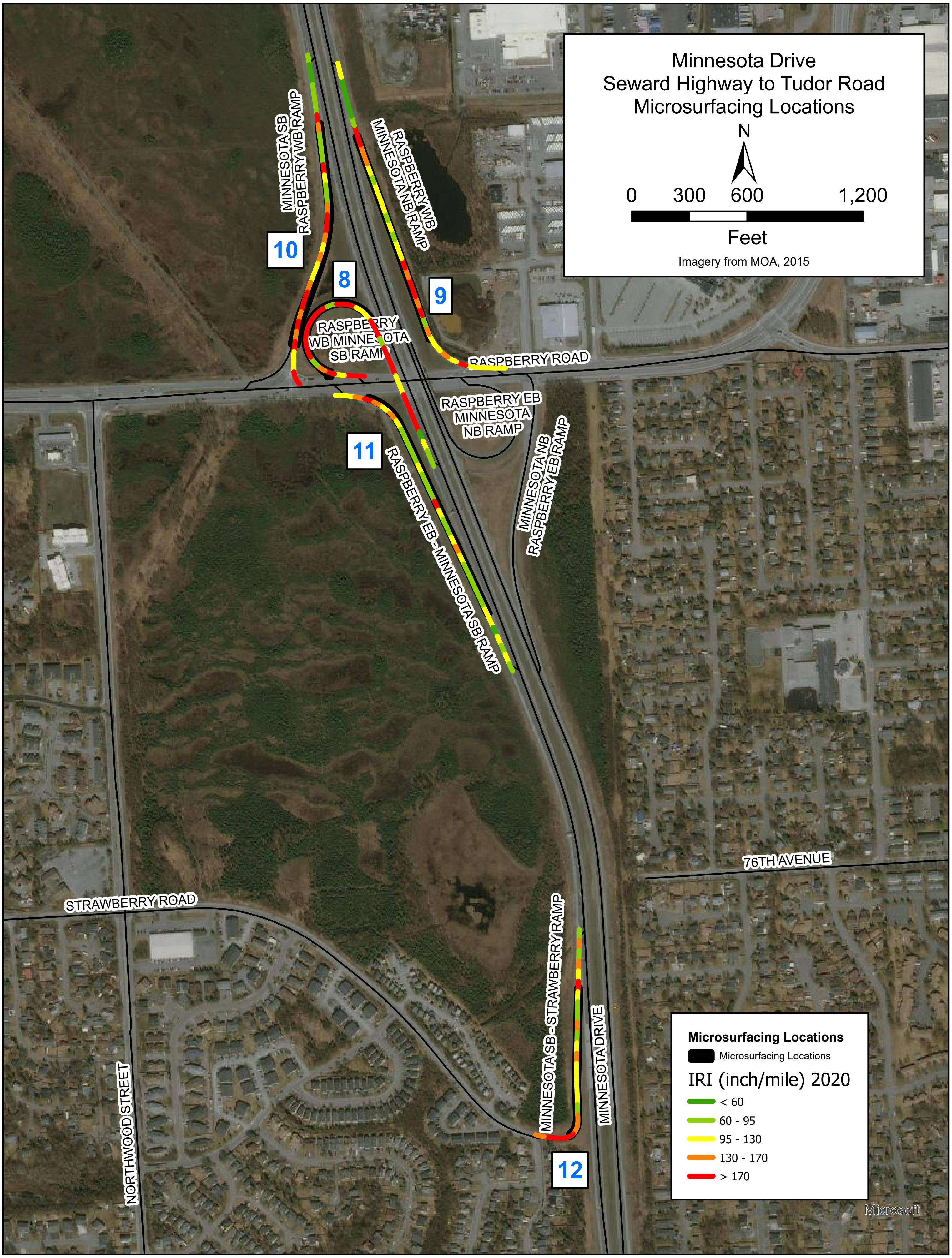
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
375
750
1,500
Feet
MINNESOTA SB RASPBERRY WB RAMP
RASPBERRY WB MINNESOTA NB RAMP
10
8
9
RASPBERRY WB MINNESOTA SB RAMP
RASPBERRY ROAD
RASPBERRY EB MINNESOTA NB RAMP
11
MINNESOTA NB RASPBERRY EB RAMP
RASPBERRY EB - MINNESOTA SB RAMP
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
12
Microsurfacing Locations
Microsurfacing Locations
Rut Depth (inches) 2020
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Maxar, Microsoft


10
9
8
11
12
RASPBERRY ROAD
MINNESOTA DRIVE
STRAWBERRY ROAD
Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
375
750
1,500
Feet
Imagery from MOA, 2015
Rut Depths (inches) 2021
< 0.25"
0.25" - 0.5"
0.5" - 0.75"
0.75" - 1"
> 1"


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
375
750
1,500
Feet
MINNESOTA SB
RASPBERRY WB RAMP
RASPBERRY WB
MINNESOTA NB RAMP
10
8
9
RASPBERRY
WB MINNESOTA
SB RAMP
RASPBERRY ROAD
RASPBERRY EB
MINNESOTA
NB RAMP
MINNESOTA NB
RASPBERRY EB RAMP
11
RASPBERRY EB - MINNESOTA SB RAMP
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
12
Rut Depths (inches) 2022
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsurfacing Locations
Microsurfacing Locations
Microsoft

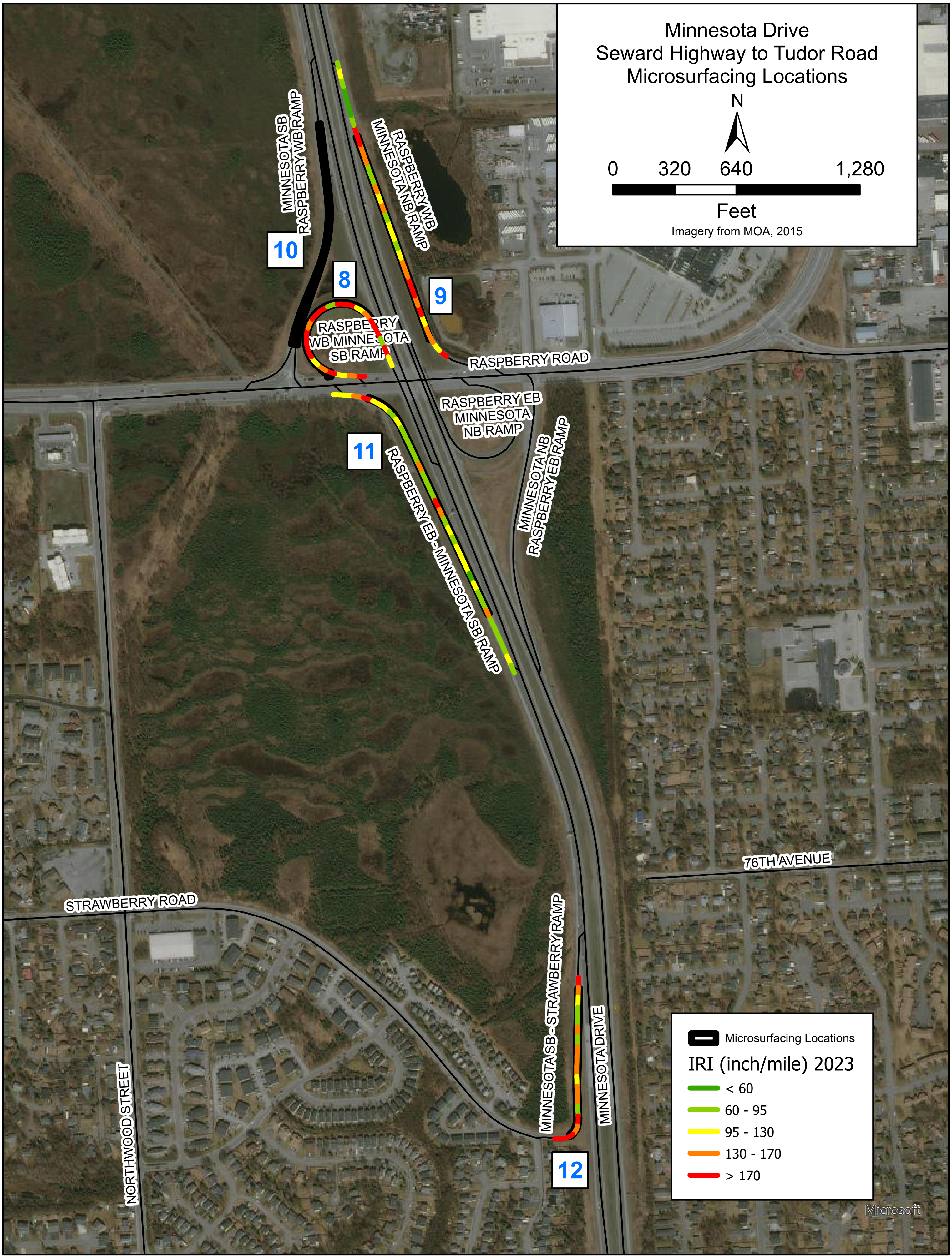


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
375
750
1,500
Feet
MINNESOTA SB RASPBERRY WB RAMP
RASPBERRY WB MINNESOTA NB RAMP
10
8
9
RASPBERRY WB MINNESOTA SB RAMP
RASPBERRY ROAD
RASPBERRY EB MINNESOTA NB RAMP
MINNESOTA NB RASPBERRY EB RAMP
11
RASPBERRY EB - MINNESOTA SB RAMP
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
12
Microsurfacing Locations
Microsurfacing Locations
Rut Depth 2023
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsoft


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
300
600
1,200
Feet
Imagery from MOA, 2015
MINNESOTA SB
RASPBERRY WB RAMP
RASPBERRY WB
MINNESOTA NB RAMP
10
8
9
RASPBERRY
WB MINNESOTA
SB RAMP
RASPBERRY ROAD
RASPBERRY EB
MINNESOTA
NB RAMP
11
RASPBERRY EB - MINNESOTA SB RAMP
MINNESOTA NB
RASPBERRY EB RAMP
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
12
Microsurfacing Locations
Microsurfacing Locations
IRI (inch/mile) 2020
< 60
60 - 95
95 - 130
130 - 170
> 170
Microsoft


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
375
750
1,500
Feet
Imagery from MOA, 2015
RASPBERRY ROAD
MINNESOTA DRIVE
STRAWBERRY ROAD
8
9
10
11
12
IRI (inch/mile) 2021
< 60
60 - 95
95 - 130
130 - 170
> 170

Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
375
750
1,500
Feet
Imagery from MOA, 2015
MINNESOTA SB RASPBERRY WB RAMP
RASPBERRY WB MINNESOTA NB RAMP
RASPBERRY WB MINNESOTA SB RAMP
RASPBERRY ROAD
RASPBERRY EB MINNESOTA NB RAMP
MINNESOTA NB RASPBERRY EB RAMP
RASPBERRY EB - MINNESOTA SB RAMP
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
IRI (inch/mile) 2022
< 60
60 - 95
95 - 130
130 - 170
> 170
Microsurfacing Locations



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Microsurfacing Locations
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0
320
640
1,280
Feet
Imagery from MOA, 2015
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RASPBERRY WB MINNESOTA NB RAMP
10
8
9
RASPBERRY WB MINNESOTA SB RAMP
RASPBERRY ROAD
RASPBERRY EB MINNESOTA NB RAMP
11
RASPBERRY EB - MINNESOTA SB RAMP
MINNESOTA NB RASPBERRY EB RAMP
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
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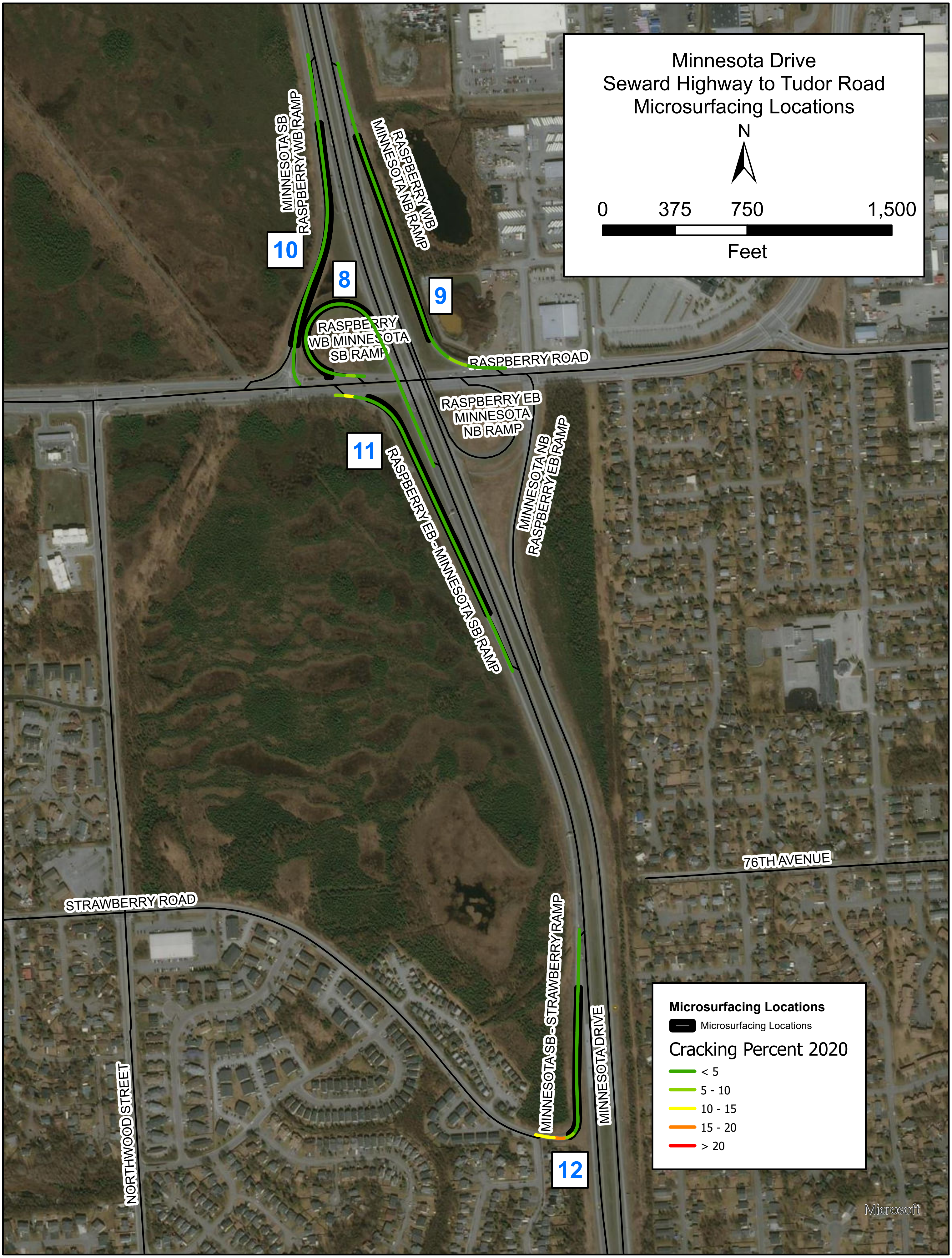
95 - 130
130 - 170
> 170
Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
375
750
1,500
Feet
MINNESOTA SB RASPBERRY WB RAMP
RASPBERRY WB MINNESOTA NB RAMP
RASPBERRY WB MINNESOTA SB RAMP
RASPBERRY ROAD
RASPBERRY EB MINNESOTA NB RAMP
MINNESOTA NB RASPBERRY EB RAMP
RASPBERRY EB - MINNESOTA SB RAMP
10
8
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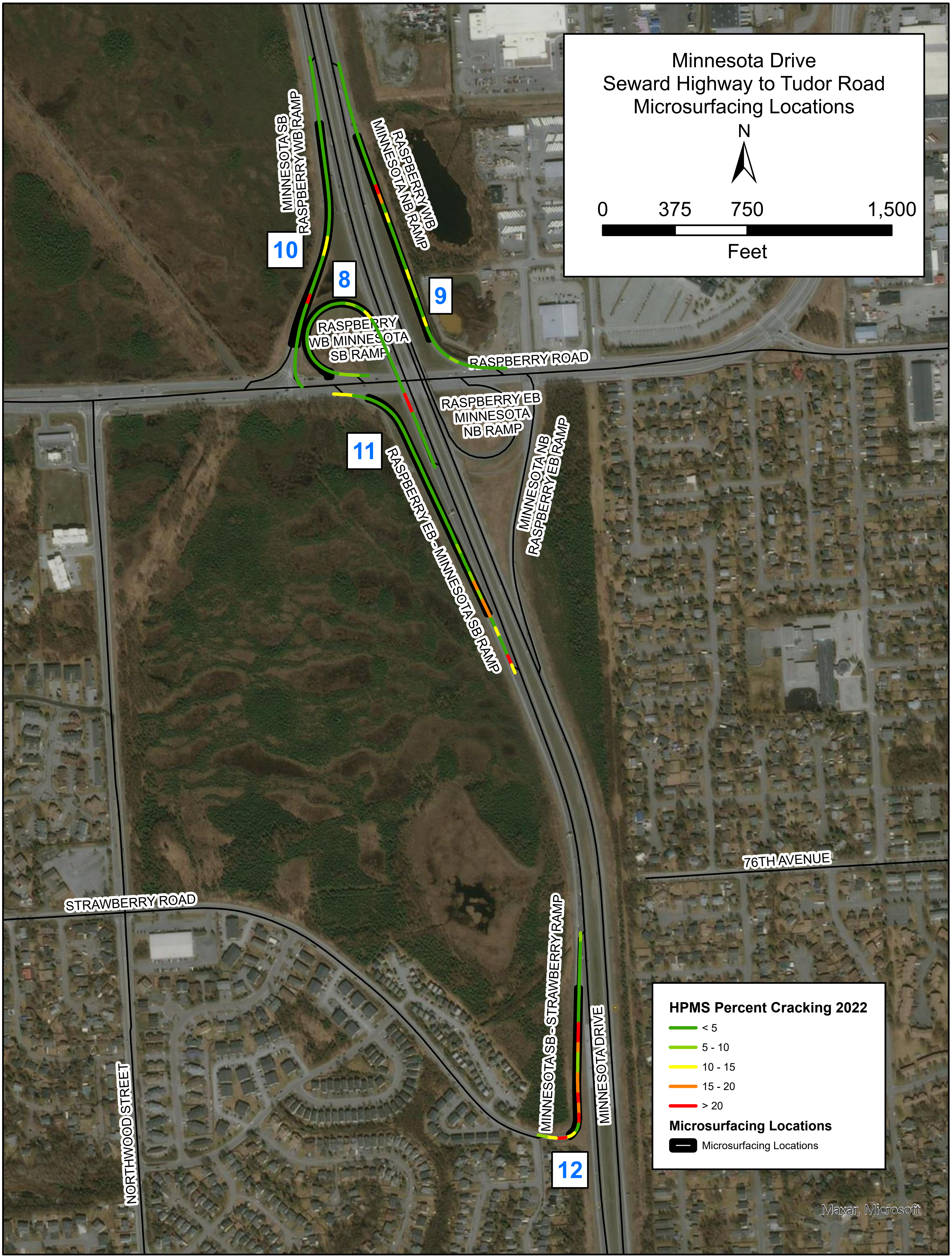
12
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
Microsurfacing Locations
Microsurfacing Locations
Cracking Percent 2020
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsoft



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Seward Highway to Tudor Road
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375
750
1,500
Feet
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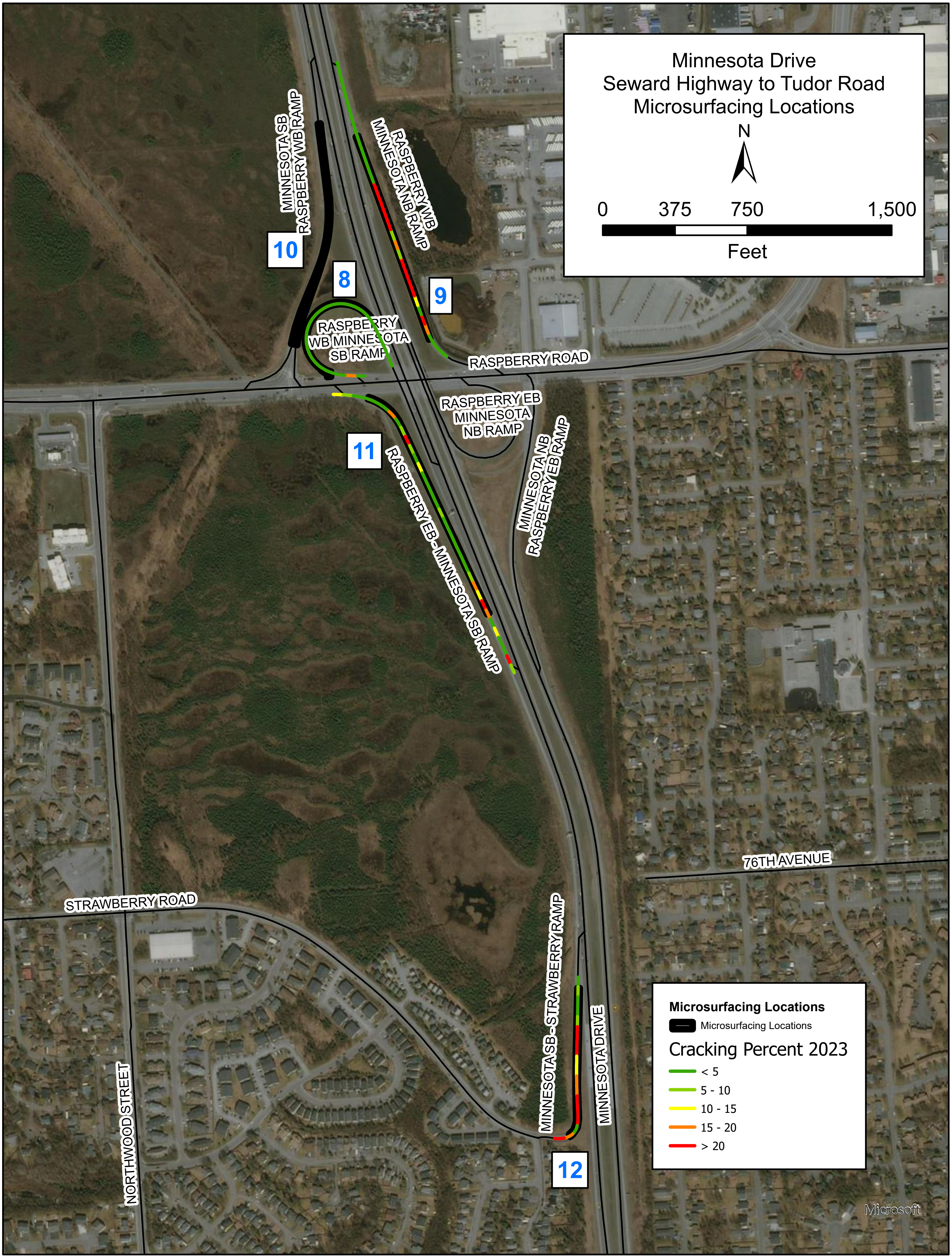
10
8
9
RASPBERRY WB MINNESOTA SB RAMP
RASPBERRY ROAD
RASPBERRY EB MINNESOTA NB RAMP
MINNESOTA NB RASPBERRY EB RAMP
11
RASPBERRY EB - MINNESOTA SB RAMP
76TH AVENUE
STRAWBERRY ROAD
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
12
HPMS Percent Cracking 2022
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsurfacing Locations
Microsurfacing Locations
Maxar, Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
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375
750
1,500
Feet
MINNESOTA SB
RASPBERRY WB RAMP
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RASPBERRY WB
MINNESOTA NB RAMP
RASPBERRY
WB MINNESOTA
SB RAMP
RASPBERRY ROAD
RASPBERRY EB
MINNESOTA
NB RAMP
11
MINNESOTA NB
RASPBERRY EB RAMP
RASPBERRY EB - MINNESOTA SB RAMP
76TH AVENUE
STRAWBERRY ROAD
STRAWBERRY RAMP
MINNESOTA SB - STRAWBERRY RAMP
MINNESOTA DRIVE
NORTHWOOD STREET
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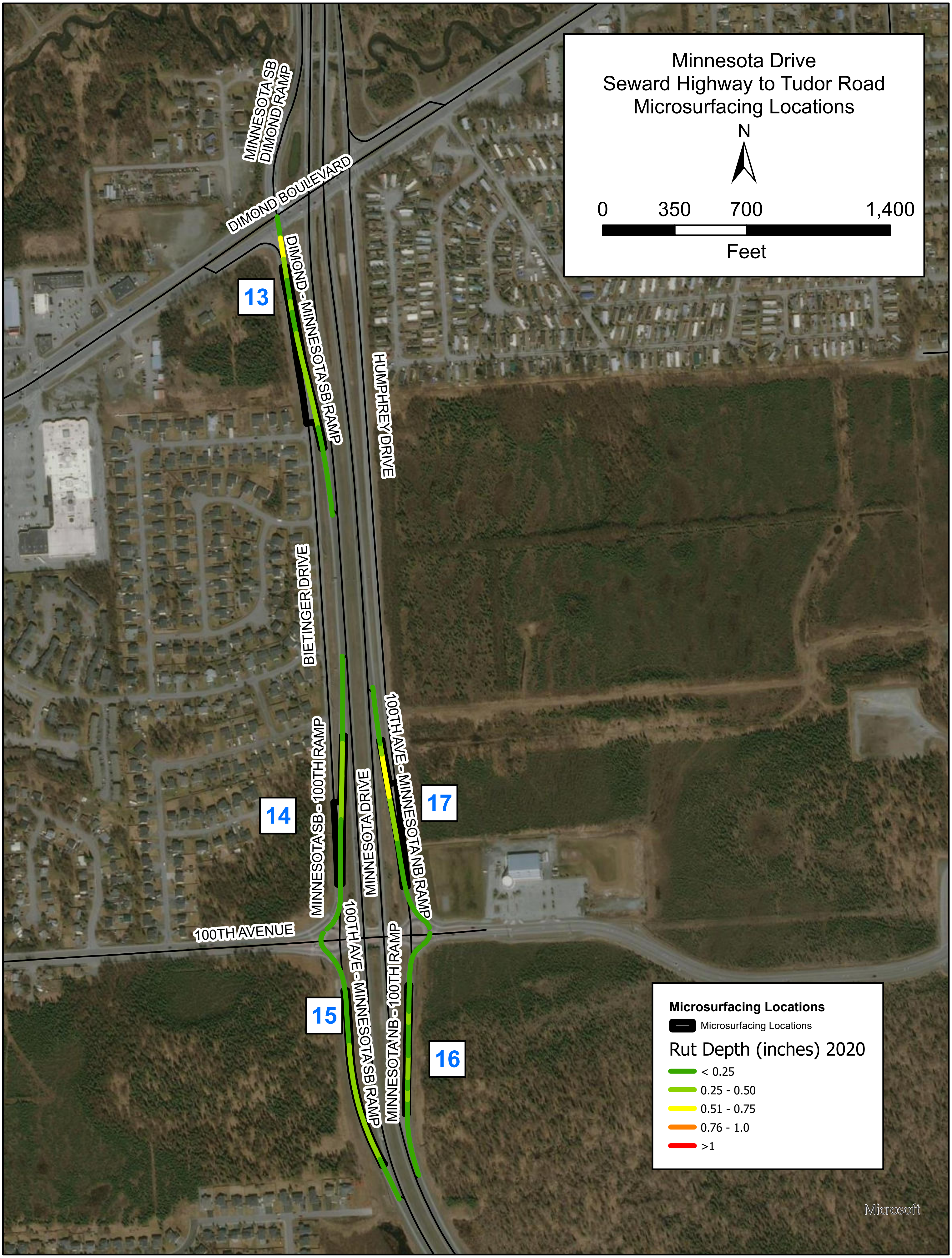
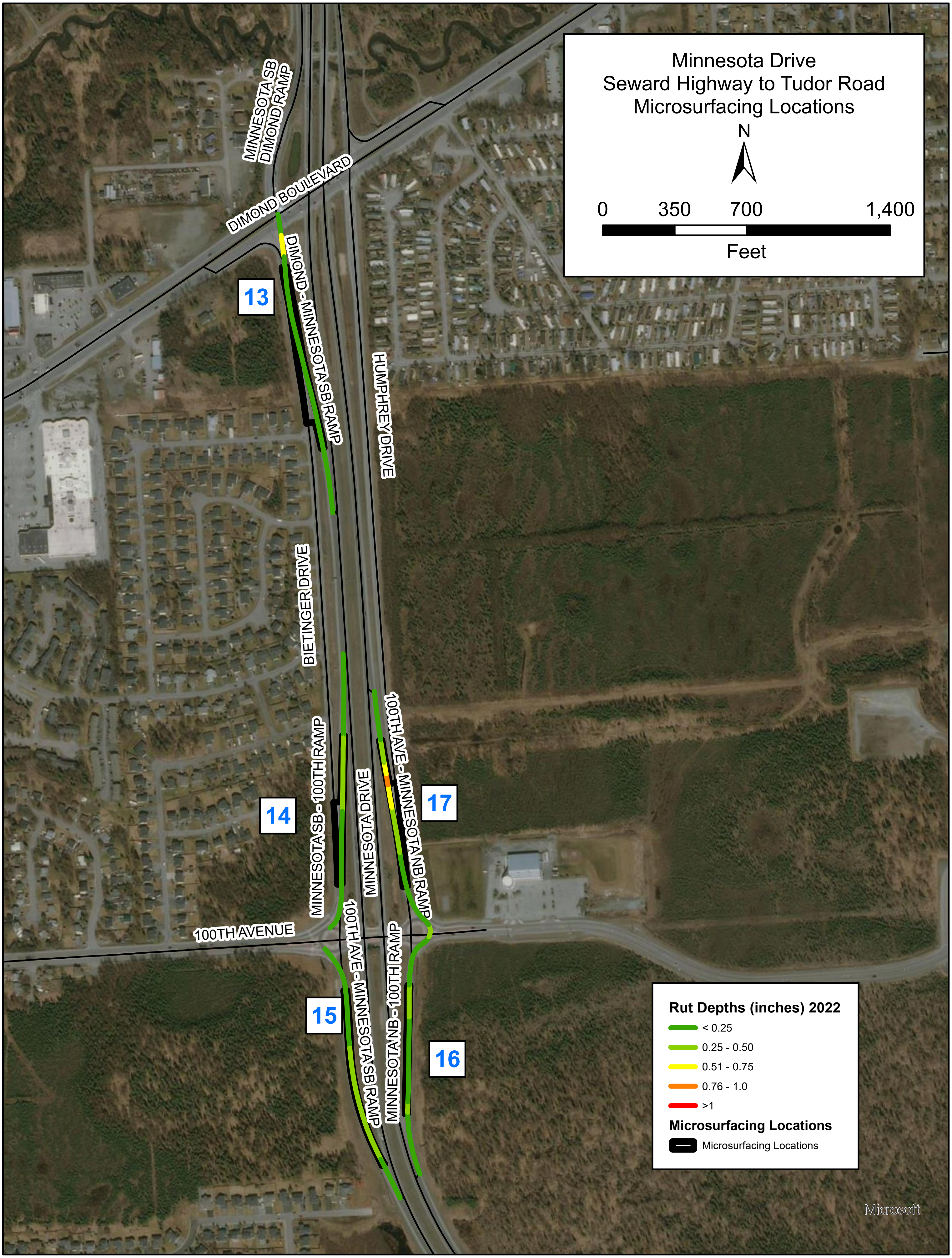
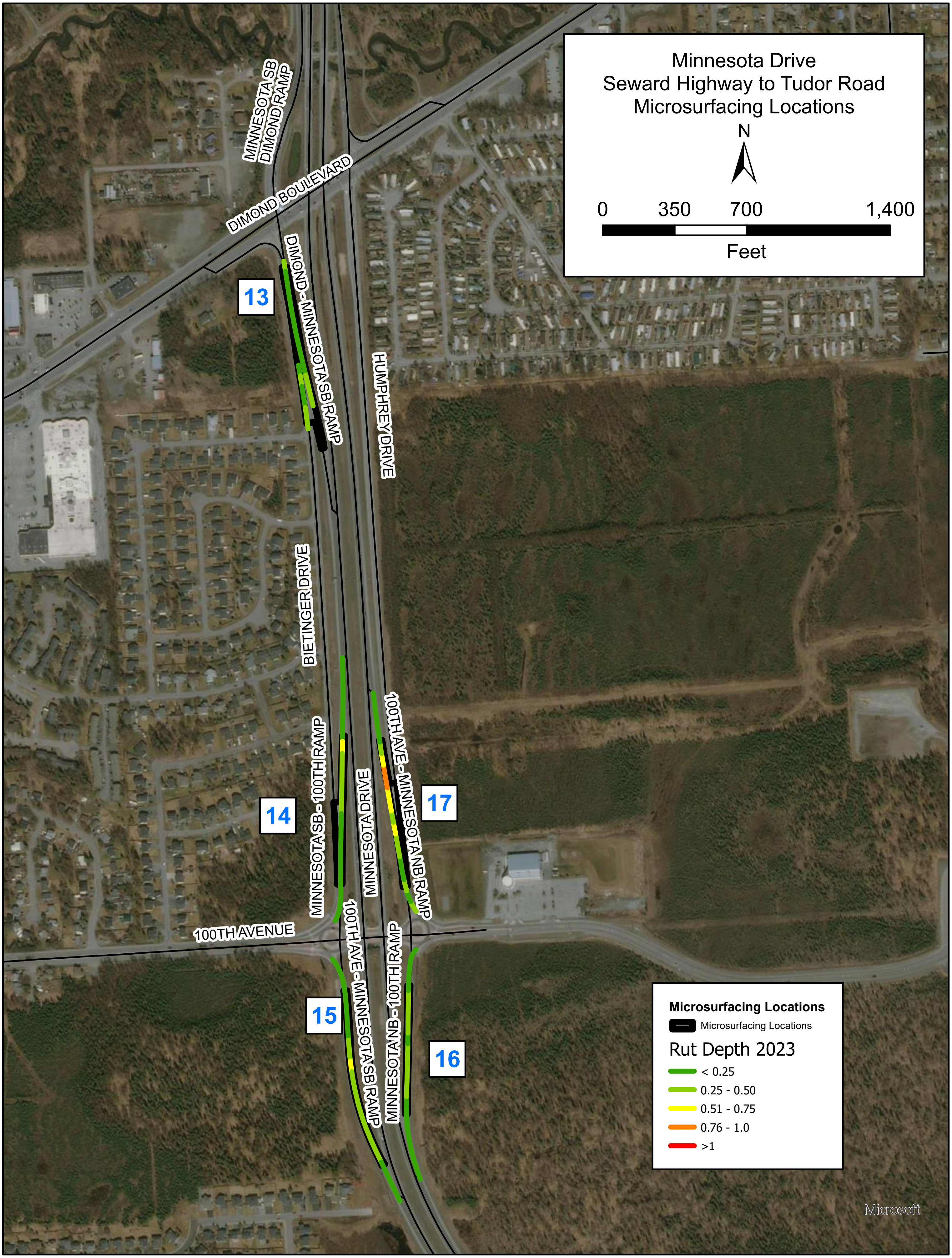
10 - 15
15 - 20
> 20
Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
350
700
1,400
Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
HUMPHREY DRIVE
BIETINGER DRIVE
MINNESOTA SB - 100TH RAMP
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
13
14
15
16
17
Microsurfacing Locations
Microsurfacing Locations
Rut Depth (inches) 2020
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsoft


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
350
700
1,400
Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
HUMPHREY DRIVE
13
BIETINGER DRIVE
100TH AVE - MINNESOTA NB RAMP
MINNESOTA SB - 100TH RAMP
MINNESOTA DRIVE
14
17
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
15
16
Rut Depths (inches) 2022
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsurfacing Locations
Microsurfacing Locations
Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
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350
700
1,400
Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
HUMPHREY DRIVE
BIETINGER DRIVE
MINNESOTA SB - 100TH RAMP
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
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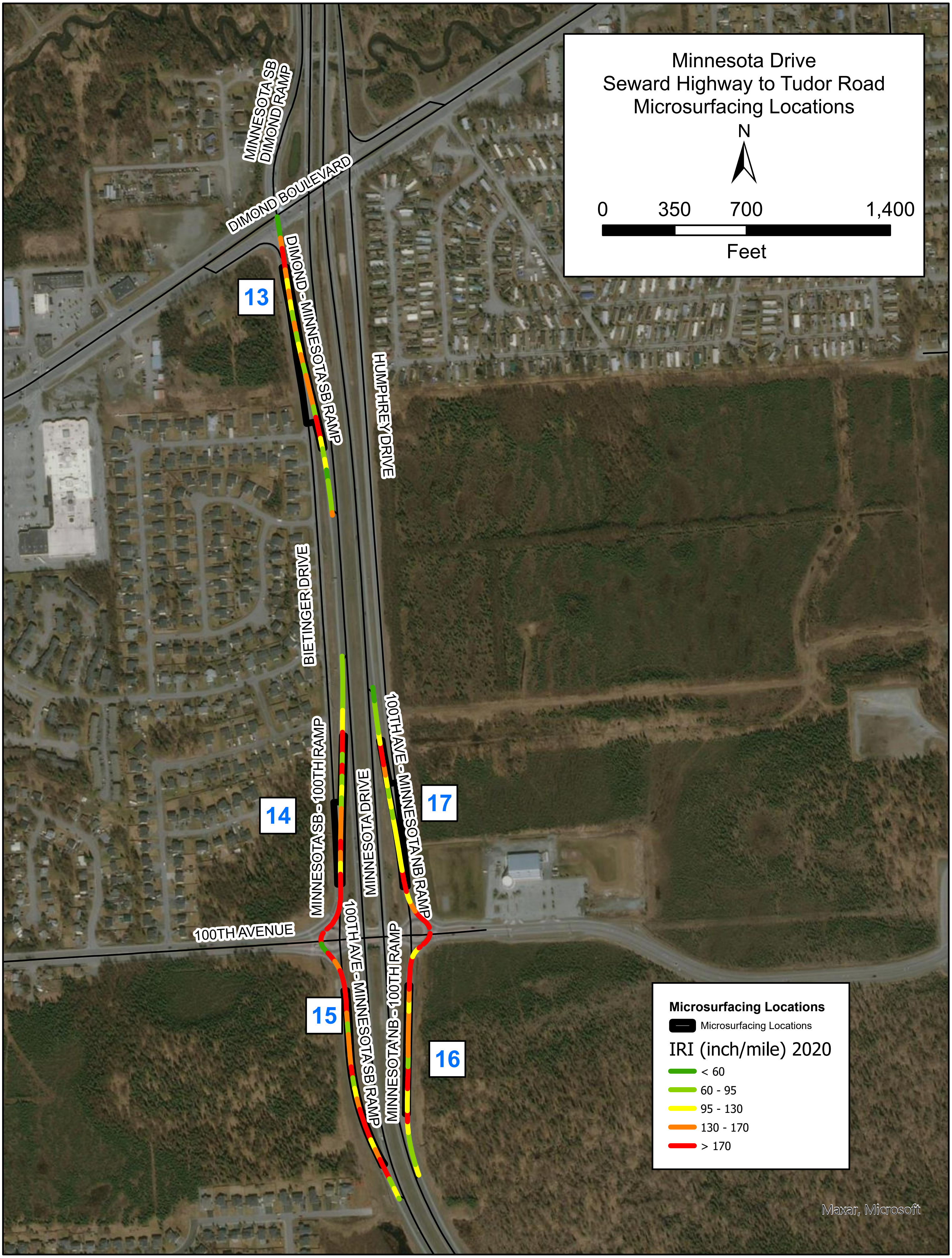
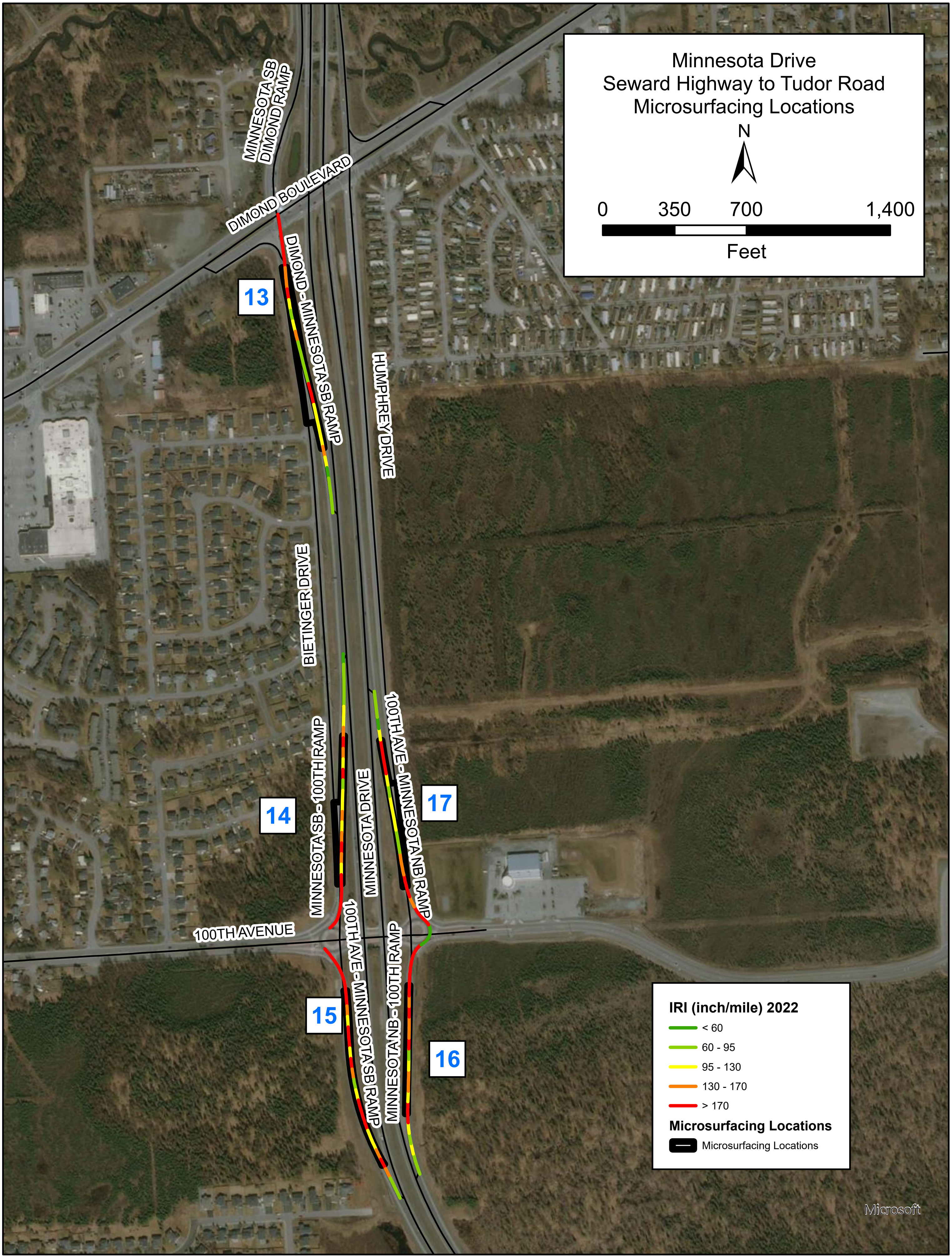
17
Microsurfacing Locations
Microsurfacing Locations
Rut Depth 2023
< 0.25
0.25 - 0.50
0.51 - 0.75
0.76 - 1.0
>1
Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
350
700
1,400
Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
13
HUMPHREY DRIVE
BIETINGER DRIVE
MINNESOTA SB - 100TH RAMP
14
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
17
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
15
16
Microsurfacing Locations
Microsurfacing Locations
IRI (inch/mile) 2020
< 60
60 - 95
95 - 130
130 - 170
> 170
Maxar, Microsoft


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
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Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
HUMPHREY DRIVE
BIETINGER DRIVE
MINNESOTA SB - 100TH RAMP
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
13
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17
IRI (inch/mile) 2022
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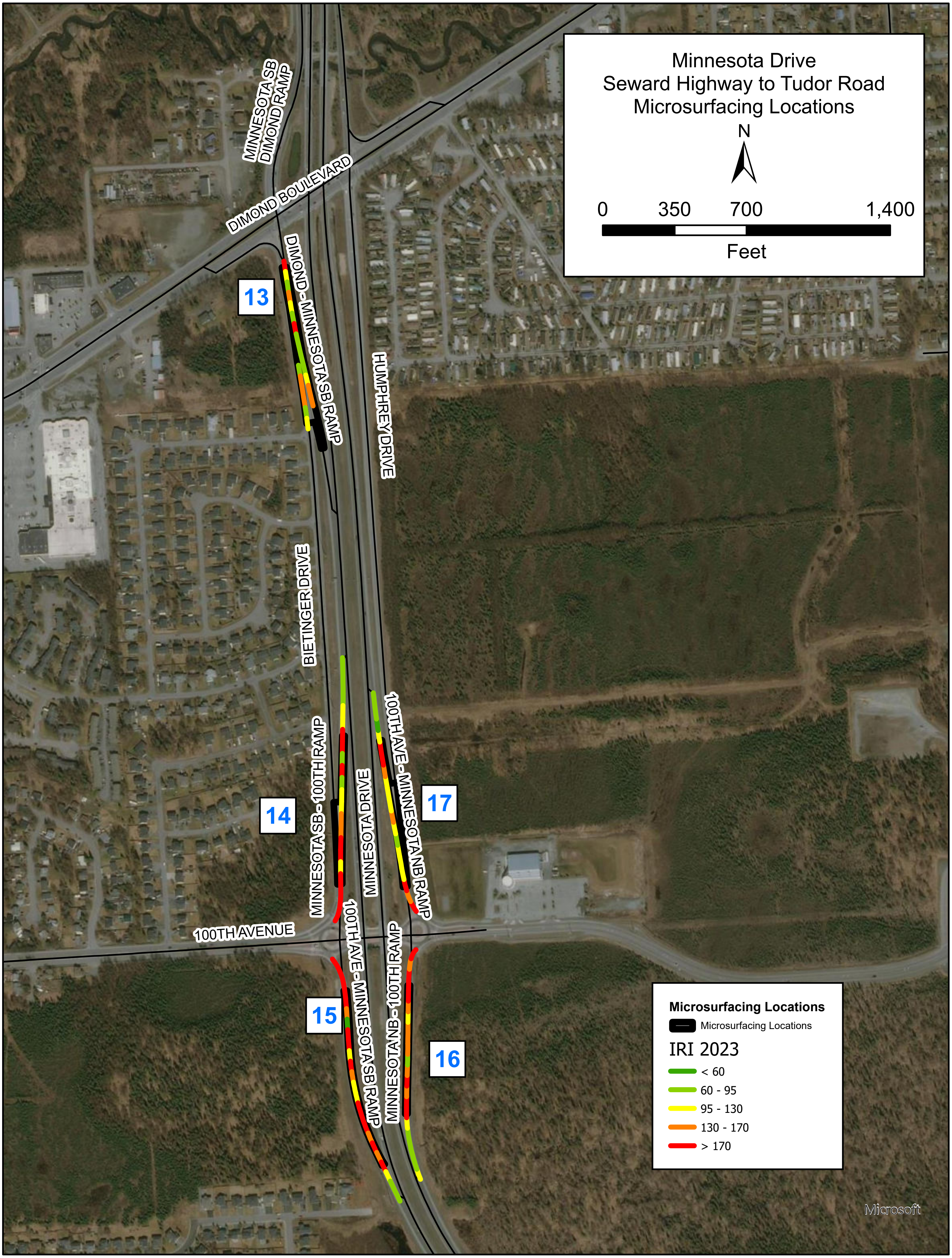
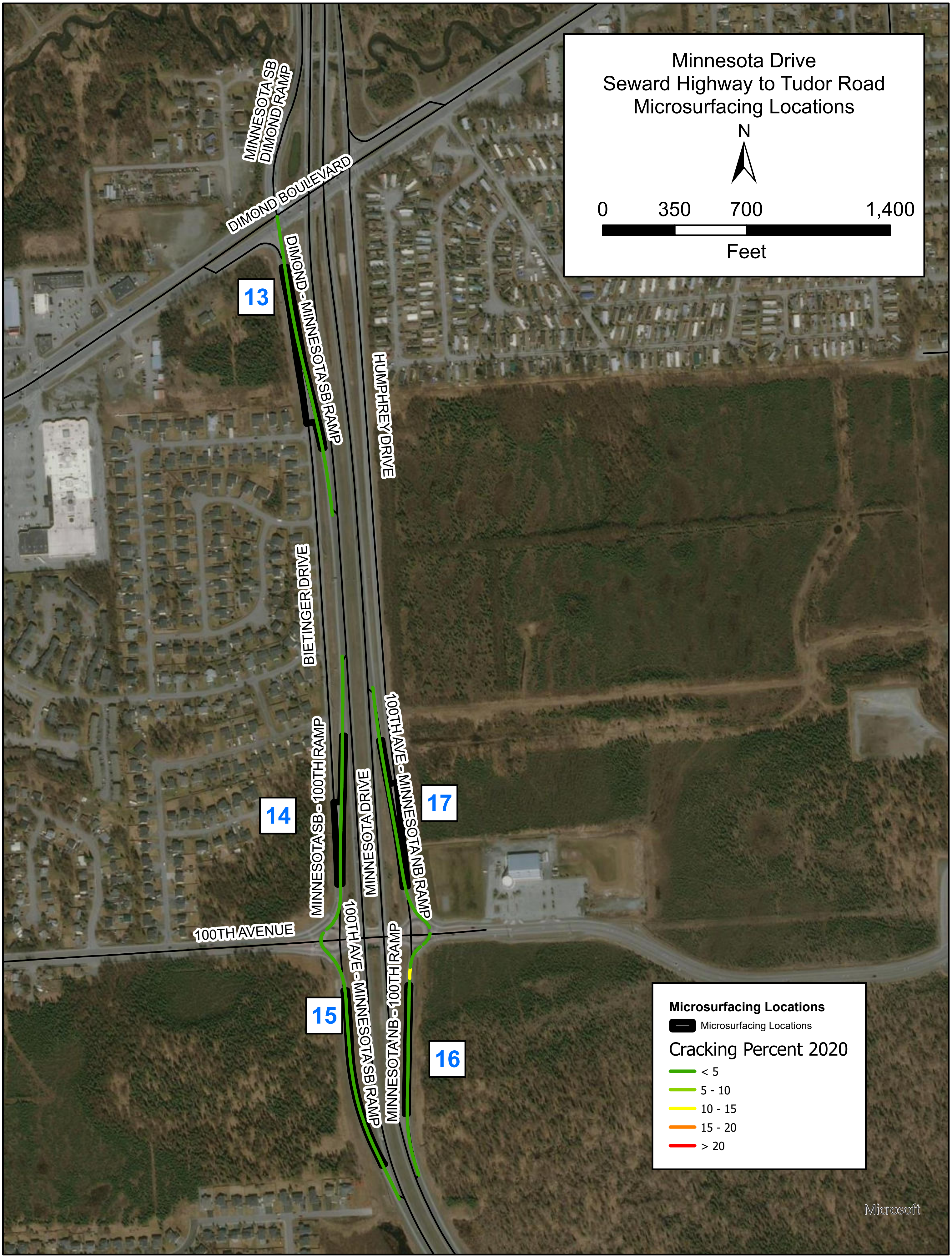
60 - 95
95 - 130
130 - 170
> 170
Microsurfacing Locations
Microsurfacing Locations
Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
350
700
1,400
Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
13
HUMPHREY DRIVE
BIETINGER DRIVE
100TH AVE - MINNESOTA NB RAMP
17
MINNESOTA SB - 100TH RAMP
14
MINNESOTA DRIVE
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
15
16
Microsurfacing Locations
Microsurfacing Locations
IRI 2023
< 60
60 - 95
95 - 130
130 - 170
> 170
Microsoft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Seward Highway to Tudor Road
Microsurfacing Locations
N
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350
700
1,400
Feet
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DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
HUMPHREY DRIVE
BIETINGER DRIVE
MINNESOTA SB - 100TH RAMP
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
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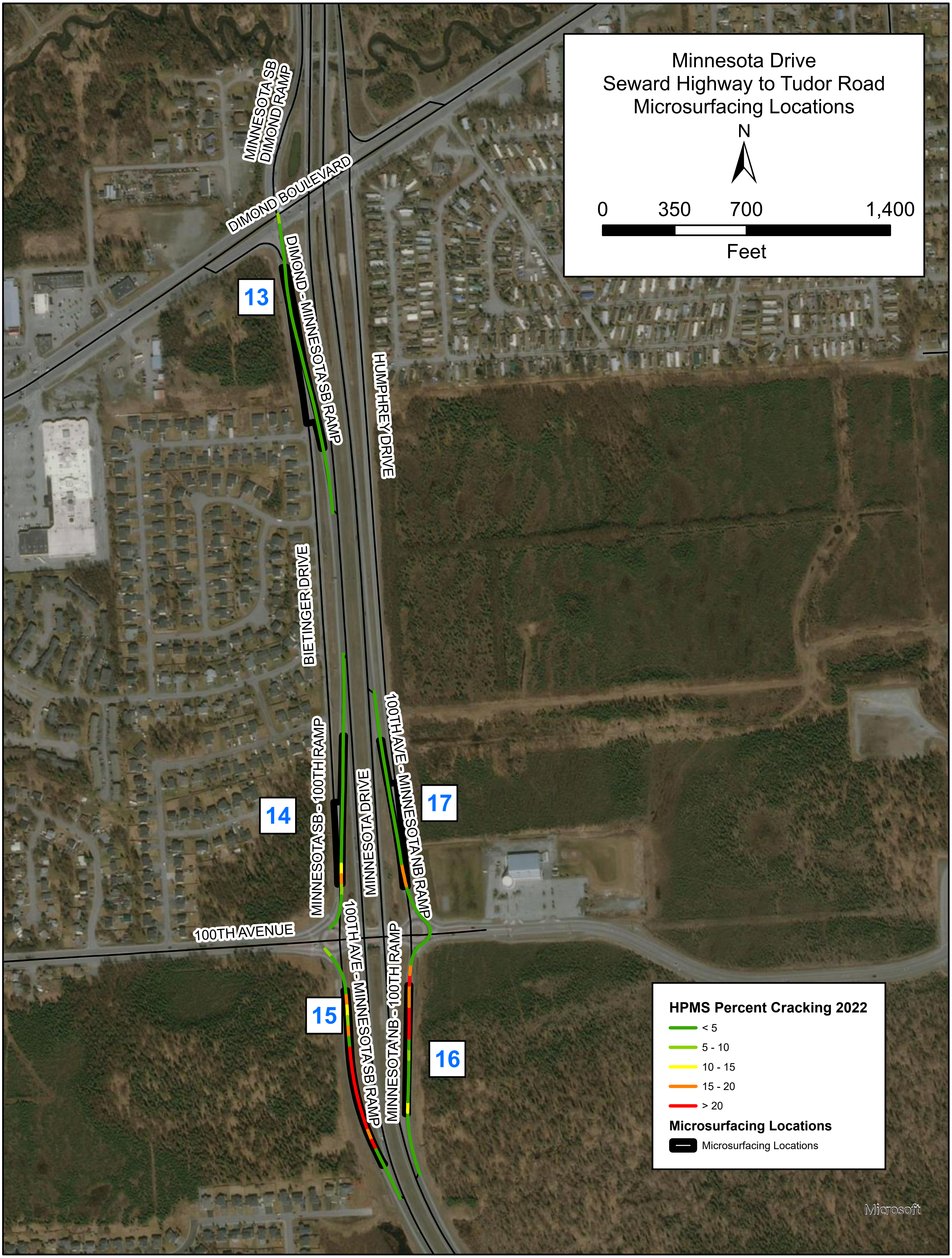
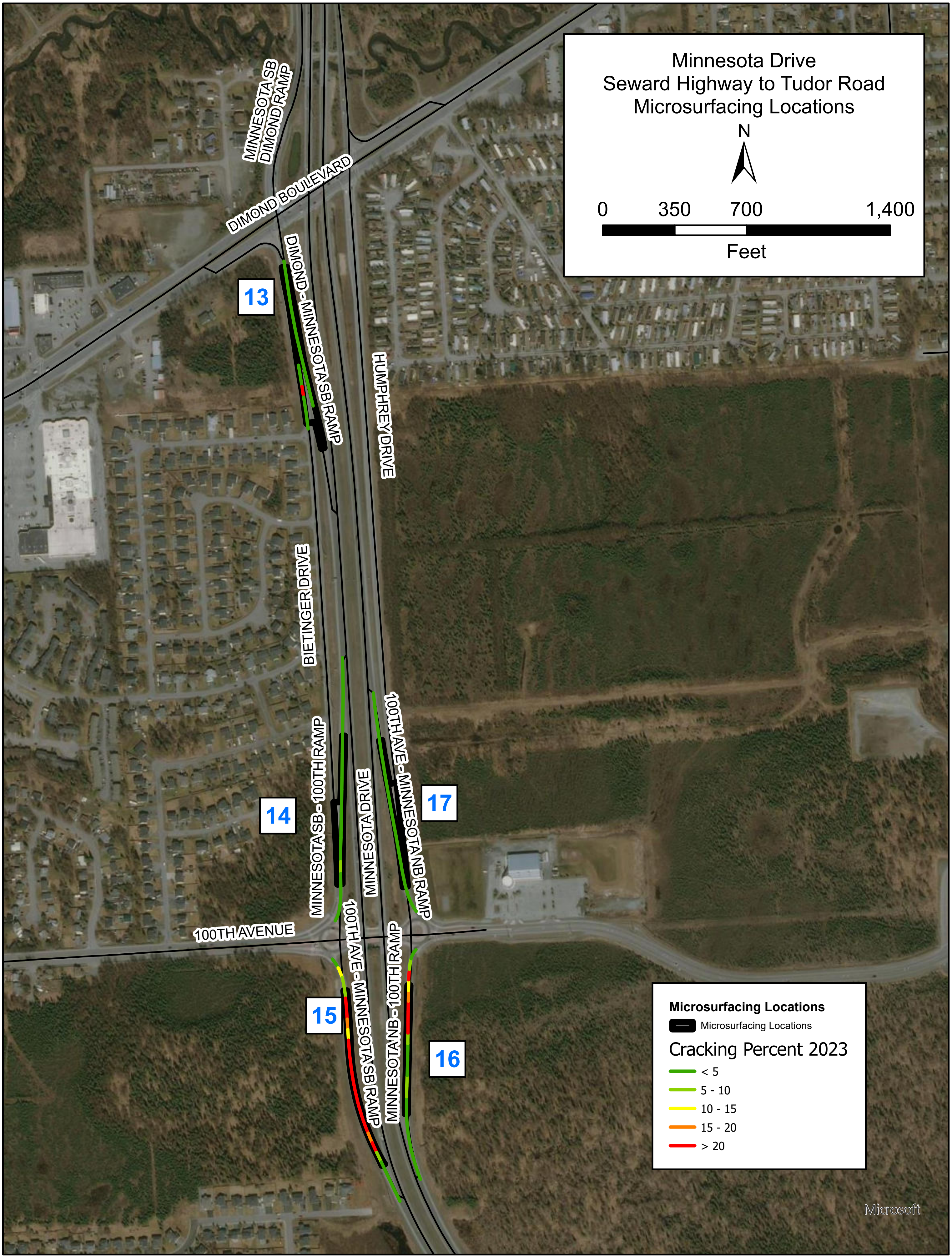
14
15
16
17
Microsurfacing Locations
Microsurfacing Locations
Cracking Percent 2020
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsoft



Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
350
700
1,400
Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
HUMPHREY DRIVE
BIETINGER DRIVE
MINNESOTA SB - 100TH RAMP
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
13
14
15
16
17
HPMS Percent Cracking 2022
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsurfacing Locations
Microsurfacing Locations
Microsoft


Minnesota Drive
Seward Highway to Tudor Road
Microsurfacing Locations
N
0
350
700
1,400
Feet
MINNESOTA SB DIMOND RAMP
DIMOND BOULEVARD
DIMOND - MINNESOTA SB RAMP
13
HUMPHREY DRIVE
BIETINGER DRIVE
MINNESOTA SB - 100TH RAMP
14
MINNESOTA DRIVE
100TH AVE - MINNESOTA NB RAMP
17
100TH AVENUE
100TH AVE - MINNESOTA SB RAMP
MINNESOTA NB - 100TH RAMP
15
16
Microsurfacing Locations
Microsurfacing Locations
Cracking Percent 2023
< 5
5 - 10
10 - 15
15 - 20
> 20
Microsoft

Appendix B

Preconstruction Site Inspection

Ramp 1: International Airport EB – Minnesota WB On-Ramp

The primary distress is high severity longitudinal cracking down the center and right of the lane starting near International Airport Road. There is low raveling, and studded tire wear that deepens near the bottom of the ramp near Minnesota, which received rut fill using hot mix. At the end of the guardrail, pattern cracking has formed around the cracks. The cracks are near 1.5" at the widest and received crackseal and HMA to fill. The photo on the left is prior to surface preparation, and the right is after, with the larger crack being filled with both crackseal and hot mix.

Ramp 1 Prior to Surface Preparation

Ramp 1 After Surface Preparation

Ramp 2: Minnesota NB – International Airport Ramp

This ramp has low rutting for the majority of the ramp. The ruts deepen to near ¾" at the International Airport intersection. There are low to moderate severity transverse cracks, with one high severity transverse crack near International Airport Road.

Ramp 3: International Airport EB – Minnesota NB Loop

The primary pavement distresses are occasional low severity raveling and transverse cracking. There is one moderate severity transverse crack near the middle of the ramp, but looks to be an ideal pavement preservation candidate.

Ramp 4: International Airport – Minnesota NB Ramp

The end of this ramp has low severity rutting and low severity longitudinal and transverse cracking.

Ramp 5: Minnesota SB – International Airport Ramp

This ramp contains high severity longitudinal cracking near Minnesota Drive. An earthquake repair incorporated into this project addressed the worst of the longitudinal cracking near the middle of the ramp. After the earthquake repair, which ends near where Ramp 6 extends to International Airport Road, the ramp is in much better condition, with only transverse cracking being the pavement distress.

Ramp 6: Minnesota SB International Airport Ramp

The primary distress on this ramp is longitudinal cracking of moderate severity, with one high severity crack near International. There is low severity rutting and low to moderate severity raveling.

Ramp 7: International Airport WB – Minnesota SB Loop

This ramp is a cloverleaf with low severity rutting and raveling. There is moderate severity transverse cracking where some potholes have formed. There is slippage cracking that may be caused by slope movement midway down the ramp near an earthquake repair patch.

Ramp 8: Raspberry WB – Minnesota SB Ramp

This cloverleaf ramp has block cracks of moderate severity for nearly the entire length along with a wide joint crack. Fatigue based cracking is beginning to appear in the wheel paths in addition to the block cracking. See photo below to the left that shows the general ramp condition.

Photo 1 - Ramp 8 General Condition

Photo 2 - Ramp 9 General Condition

Ramp 9: Raspberry WB – Minnesota NB Ramp

A longitudinal joint crack is present for the majority of the ramp, along with block cracking that has developed into alligator cracking in the right wheel-path that extends to near the end of the ramp at the International Airport sign. From then on, faint block cracking is beginning to develop along with moderate severity transverse cracks. See the photo above and to the right.

Ramp 10: Minnesota SB – Raspberry WB Ramp

There is high severity rutting near Minnesota (approximately 1” in depth) that received rut fill. The ruts outside of that area are approximately ½” in depth, not requiring additional treatment. There are high severity transverse and longitudinal cracks midway down the ramp.

Ramp 11: Raspberry EB – Minnesota SB Ramp

The predominant distresses are low to moderate severity thermal cracking and a low-density joint that is raveling and losing aggregate. Potholes have been forming at the transverse cracks, with two major potholes approximately 50’ from the end of the micro surfacing near Minnesota. There is intermittent longitudinal cracking on the ramp. See the photo below and to the left.

Photo 3 - Ramp 11 Prior to Surface Preparation

Photo 4 - Ramp 12 - Cracks after Surface Preparation

Ramp 12” Minnesota SB – Strawberry Ramp

There is high severity longitudinal cracking and potholing beginning approximately halfway down the ramp. Transverse cracking varies between low to high severity throughout the ramp. See the above right photo.

Ramp 13: Dimond – Minnesota SB Ramp

The majority of this ramp has ruts below ½”, but where the ramp merges into Minnesota and traffic is actively accelerating, the ruts increase in depth to between ¾” to 1”. Moderate severity raveling and transverse cracks are also present. The area that merges into Minnesota received rut fill to address the rutting.

Ramp 14: Minnesota SB – 100th Ramp

The rut depths are low, but there is high severity longitudinal cracking near 100th Avenue.

Ramp 15: 100th Avenue – Minnesota SB Ramp

There is high severity longitudinal cracking for the first 200' of the ramp near 100th Avenue. There is also moderate to high severity joint raveling consistently along the ramp that has opened up to near ¾" in width. High severity transverse cracking is present where the ramp ties into Minnesota.

Photo 5 - Ramp 15 After Surface Preparation

Ramp 16: Minnesota NB – 100th Ramp

There is high severity longitudinal cracking near 100th Avenue. The rut depths are low and raveling is low severity and isolated to joints. High severity transverse cracking is located near the Minnesota end of the ramp.

Photo 6 - Ramp 16 After Surface Preparation

Ramp 17: 100th Avenue – Minnesota NB Ramp

There is high severity transverse cracking, joint cracking and raveling at 100th Avenue. The rut depths are approximately ½", and increase in depth near Minnesota to nearly ¾".

Appendix C

Construction Photolog

Test Strip

Macropaver equipment with burlap sack for secondary strike off for surface texture

A view of the spreader box with burlap sack. In later photos it can be observed that the spreader box was witched and instead of burlap is appears that canvas was used for secondary strike off.

Hand working a portion of the application.

Micro surfacing slurry as it is setting on tack coated pavement

The pneumatic roller mechanically forcing the water out of the system to improve the set time. The water is visible/shiny on the surface after the roller passes over.

A mask on the micro surfacing test strip after the roller has made its passes and it has set.

Production

Scratch course being placed on Ramp 1

Ramp 1 – Hand worked portion at the joint where the aggregate bin ran out on the first Macropaver and the second Macropaver took over application while it was refilling.

Scratch course on Ramp 1 prior to rolling. It can be observed where the water escaping is shiny in the ruts. The shininess ends where the ruts were filled by hot mix at the base of the ramp.

Scratch course on Ramp 1 after rolling. Production was halted after rolling this ramp and placing scratch course on Ramps 5 and 6 due to the set time issues and the time it took to get the pneumatic roller on these ramps.

Scratch course being placed over tack coat on Ramp 6

Scratch course placed on Ramp 5 prior to stopping production.

Second day of production on Ramp 11, the Minnesota SB On Ramp off of Raspberry. The spreader box was changed out from the first day of production along with the canvas in place of the burlap sack.

A hand worked area on the right side of the ramp on the scratch course on Ramp 11.

A pneumatic roller finishing a portion of Ramp 6 that was unable to be completed on the first day of production due to the crude source changing for the emulsion. The ramps were able to be rolled and opened to traffic in between 1.5 -2 hours instead of the 4 hours it was taking the first day of production.

Hand worked areas on the scratch course on Ramp 3 on the fourth day of production.

There was some pickup by traffic on the scratch course on Ramp 2 on the fourth day of production. This is at the signalized intersection that the major pickup and deformation occurred on the surface course.

Construction continued on the surface course without issue until Saturday, June 13th when distress was reported on the surface course of Ramps 1 and 2 at International Airport Road. The flushing distress on Ramp 1 at the transition of the rut fill that extends down the ramp as indicated by QAP mark on the left.

Ramp 2, shown below, had extreme flushing and pickup, caused by the static loading and turning motion of trucks hauling material to the Anchorage International Airport.

Ramp 3 was reviewed while out looking at Ramps 1 and 2 and no flushing, bleeding or other distresses were present on the ramp. This is the same location that was hand worked in the previous photos.

Appendix D

Mix Design, Materials Testing and Specification

Special Provision

Add the following Section:

SECTION 413
MICRO-SURFACING

413-1.01 DESCRIPTION. This work consists of constructing micro-surfacing on a prepared pavement within the existing pavement markings. Micro-surfacing is a mixture of: polymer modified asphalt emulsion, well-graded crushed mineral aggregate, mineral filler, water and other additives.

Provide an experienced foreman to supervise the construction with a minimum of 5 successful projects and provide a resume documenting the projects.

Provide the Engineer who designed the micro-surface mix design, or technical representative, on site, to supervise the duration of the micro-surfacing.

MATERIALS

413-2.01 EMULSIFIED ASPHALT. Provide a polymer-modified CQS-1P or CSS-1P for emulsified asphalt for micro-surfacing that meets the requirements in the table below. The supplier must certify the oil used to produce the emulsion meets the requirements for PG 64E-40 in table 702-2.01-1 and provide lab test results to the Engineer. Recover residual asphalt for testing per AASHTO PP72-11, Procedure B.

A one gallon sample of the binder used to produce the emulsified asphalt will be provided with the mix design and production certification, and one gallon sample of the emulsified asphalt will be provided for testing.

Tests on Emulsified Asphalt		
Test	**Test Method**	**Specification**
Viscosity, Saybolt Furol, 25°C	AASHTO T 59	20 to 100 seconds
Particle charge test	AASHTO T 59	Positive
Sieve test, %	AASHTO T 59	0.10 maximum
Distillation of emulsified asphalt at 175°C, %	AASHTO T 59	62 minimum
Tests on Emulsified Asphalt Residue		
Test	**Test Method**	**Specification**
Jnr at 3.2 kPa, 3.2 kPa at 64°C, kPa^{-1}	AASHTO T 350	0.1 maximum
Average percent recovery at 3.2 kPa, %	AASHTO T 350	95 minimum

413-2.02 AGGREGATE. Provide aggregate in accordance with Table 413-1 Micro-Surfacing Aggregates.

Table 413-1 Micro-Surfacing Aggregates			
Sieve Size	**Type 2 (ISSA Type II)**	**Type 3 ISSA Type III**	**QC TOLERANCES Percent for each sieve size**
9.5 mm **[3/8 inch]**	100	100	
4.75 mm **[# 4]**	90 – 100	70 – 90	±5
2.38 mm **[# 8]**	65 – 90	45 – 70	±5
1.18 mm **[# 16]**	45 –70	28 – 50	±5
600 µm **[# 30]**	30 – 50	19 – 34	±5
300 µm **[#50]**	18 – 30	12 – 25	±4
150 µm **[#100]**	10 – 21	7 – 18	±3
75 µm **[#200]**	9 – 15	5 – 15	±2

413-2.03 MINERAL FILLER. Provide Portland cement or hydrated lime, based on the mix design results and in accordance with the following:

a. Portland cement, Type I or II per Section 701 or
b. Hydrated lime, conform to AASHTO M 17.

These will be considered part of the aggregate gradation.

413-2.04 WATER. Provide potable water used for concrete in accordance with 712-2.01.

413-2.05 ADDITIVES. Additives may be used to accelerate or retard the break/set of the micro-surfacing. Appropriate additives, and their applicable use range, should be approved by the laboratory as part of the mix design.

413-2.06 MIX DESIGN. Submit a complete mix design 10 business days before beginning production. List the source of materials used for the mix design. Provide informational test results on the mix design for the ISSA tests in Table 413-2 Testing procedures may be obtained from the International Slurry Surfacing Association (ISSA) or as approved by the Engineer.

Table 413-2
Mix Design Test Requirements

Test	Description	Specification
ISSA TB-114	Wet stripping	≥ 90%
ISSA TB-100	Wet track abrasion loss, 1 h soak	≤ 1.8 oz/sq. ft [538 g/sq. m]
ISSA TB-100	Wet track abrasion loss, 6 day soak	≤ 2.6 oz/sq. ft [807 g/sq. m]
ISSA TB-144	Saturated abrasion compatibility	≤ 3 g loss
ISSA TB-113	Mix time at 77 °F [25° C]	Controllable to ≥120 s
ISSA TB-113	Mix time at 100 °F [37.4° C]	Controllable to ≥35 s

Provide a mix design containing from 10.0 percent to 11.0 percent of residual asphalt by dry weight of aggregate and 0 percent to 3.0 percent mineral filler by dry weight of aggregate. Micro-surfacing will be applied at night and mix set time is to be adjusted to be applied at 50° degrees F.

Submit a mix design to the Engineer, if aggregate source, aggregate blend, cement, additives or asphalt emulsion sources change.

Submit the final mix design with information in the following format:

1. Source of each individual material.

2. Aggregate:
   - 2.1 Gradation
   - 2.2 Sand equivalent
   - 2.3 Abrasion resistance
   - 2.4 Soundness.

3. Field simulation tests:
   - 3.1 Wet stripping test
   - 3.2 Wet track abrasion loss (1 hour & 6 day)
   - 3.3 Saturated abrasion compatibility
   - 3.4 Trial mix time at 50°F [10 °C] and 70 °F [21 °C]

4. Interpretation of results and the determination of a mix design:
   - 4.1 Minimum and maximum percentage of mineral filler
   - 4.2 Minimum and maximum percentage of water, including aggregate moisture
   - 4.3 Percentage of mix set additive (if necessary)
   - 4.4 Percentage of modified emulsion
   - 4.5 Residual asphalt content of modified emulsion

4.6 Percentage of residual asphalt

5. Signature and date.

CONSTRUCTION REQUIREMENTS

413-3.01 MIXING EQUIPMENT. Conform to ISSA A143.

413-3.02 PROPORTIONING DEVICES. Conform to ISSA A143.

413-3.03 WEIGHTING EQUIPMENT. Use calibrated portable scales to weigh material certified in accordance with Section 109, and as modified as follows:

(1) Re-certify the scale after any change in location and
(2) Randomly spot check the scale once per week or once per project, whichever is greater.

413-3.04 SPREADING EQUIPMENT. Conform to ISSA A143 with the exception that augers within the spreader box are not required.

413-3.05 SWEEPER.

1. Self-propelled;
2. Vertical broom pressure control
3. Vacuum capability

413-3.06 AUXILLARY EQUIPMENT. Furnish hand squeegees, shovels, and other equipment necessary to perform the work. Provide power brooms, air compressors, water flushing equipment, and hand brooms to clean the pavement surface.

413-3.07 MICRO-SURFACING TYPES (all within the existing pavement markings)

1. Rut Fill - Type 3. Rut fill pavement segments longer than 1,000 feet, if the average rut depth is greater than ½ inch. Provide a rut box for each designated wheel track. Provide a clean overlap and straight edges between wheel tracks. Construct each rutted wheel track with a crown ¼ inch per inch of rut depth to allow for proper consolidation by traffic. (not required for this project)

2. Scratch Course- Type 2 or Type 3. Apply full lane width in one course. Use a metal strike off bar on the spreader box. Do not allow excess buildup or uncovered areas.

3. Surface Course - Type 2. Apply full lane width in one course. Do not allow excess buildup or uncovered areas.

413-3.08 PRE-PAVING MEETING. Hold a pre-paving meeting with the Engineer on-site before beginning work to discuss the following:

(1) Mix design review with the engineer who designed the mix. Mix design engineer is required to attend
(2) Equipment condition
(3) Equipment calibration
(4) Test strips
(5) Detailed work schedule and daily quantity and process control records
(6) Traffic control plan

413-3.09 CALIBRATION. Calibrate each mixing machine before use. Maintain documentation showing individual calibrations of each material at various settings relating to the machine's metering devices. Supply materials and equipment, including scales and containers for calibration (ISSA MA 1). Recalibrate machines on the project after a change in aggregate, asphalt emulsion source, or repairs are made to the aggregate feeding belt, gate or emulsion pump.

413-3.10 TEST STRIP. Construct a test strip in a location approved by the Engineer.

For each machine used, construct a one-lane wide test strip 300 feet long. Compare the machines for variances in surface texture and appearance.

Do not construct the test strip until the emulsion temperature falls below 122 °F unless recommended by the Engineer that developed the mix design.

If any of the following elements of the system used with a mix design change or field evidence shows that the system is out of control, construct a new test strip:

(1) Type of emulsion,
(2) Type and size of aggregate
(3) Type of mineral filler and
(4) The lay down machine.

Allow traffic on the test strip within 1 hour after application; the Engineer will evaluate whether any damage occurs. The Engineer will inspect the completed test strip again after 12 hours of traffic to determine if it is acceptable. The Contractor may begin full production after the Engineer accepts a test strip.

The Engineer will consider any spot check or test strip failure as unacceptable work in accordance with 105-1.11.

413-3.11 SURFACE PREPERATION. Clean the surface immediately before placing the micro-surfacing. Clean the surface of all loose material, vegetation, plastic markings, and other objectionable material. Clean loose material from cracks. Fill the cleaned cracks, wider than ¾ inch, with HMA tamped in place. Surface preparation of the roadway surface is incidental to the cost of Micro-surfacing.

413-3.12 FOG SEAL OR TACK COAT. Apply fog seal to surfaces before the first course of micro-surfacing. Provide and apply a CSS-1 or STE-1 emulsion and the following:

1. Apply the emulsion at a rate of 0.05 gallon per square yard to 0.10 gallon per square yard.

2. Limit the daily application of fog seal to the pavement area receiving micro-surfacing that day. Do not open fog sealed areas to traffic until after applying and curing the first course of micro-surfacing. Allow the fog seal to cure before applying micro-surfacing.

3. Protect drainage structures, monument boxes and water shut-offs during the application of the fog seal and during micro-surfacing.

413-3.13 SURFACE QUALITY. Except for areas within 12 inch of the edge line, lane line, or center line, ensure the transverse cross section of the restored pavement surface is no greater than ⅜ inch if measured using a 10-foot straight edge or 3/16 inch if measured with a 6-foot straight edge.

Construct the surface course without excessive scratch marks, tears, rippling, and other surface irregularities. Repair tear marks wider than ½ inch and longer than 4 inch and tear marks wider than 1 inch and longer than 1 inch. Repair transverse ripples or streaks deeper than ¼ inch as measured by a 10-foot straight edge.

Construct longitudinal joints with no greater than ¼ inch overlap thickness if measured with a 10 foot straight edge, and less than 3 inch overlap on adjacent passes. Locate longitudinal construction joints and lane edges to coincide with the proposed painted lane lines shown on the plans or as directed by the Engineer. Place overlapping passes on the uphill side to prevent water from ponding.

Construct transverse joints with no greater than ⅛ inch difference in elevation across the joint if measured with a 10-foot straight edge.

Construct edge lines along curbs and shoulders, with no greater than 2 inch of horizontal variance in any 100 feet length. Do not allow runoff in these areas.

Stop micro-surfacing work, if the system is out of control and cannot meet the requirements of this section. Correct the micro-surfacing system, as approved by the Engineer, before resuming work.

Protect drainage structures, monument boxes and water shut-offs.

Make repairs to micro-surfacing defects to the full width of paving pass with spreader box. Do not perform hand repairs after micro surfacing mix has set.

413-3.14 TRAFFIC LOADING. Do not open the micro-surface to traffic until the micro-surface cures sufficiently to prevent pickup by vehicle tires. The Department considers properly constructed micro-surface as micro-surface capable of carrying normal traffic within 1-hour of application without damage. Confirm that the micro-surfacing cured within 1-hour on the first day of production, after the construction of the test strip. The Engineer will conduct three 1-hour spot checks. If a spot check fails, stop work and construct a new test strip.

Protect the new surface from potential damage at intersections and driveways. Repair damage to the surface caused by traffic at no additional cost to the Department.

413-3.15 WEATHER AND TIME LIMITATIONS. Begin construction when the air and pavement surface temperatures are at least 50 °F and rising. Do not place micro-surfacing during rain, or if the forecast indicates a temperature below 40 °F within 48-hour of the planned micro-surfacing. Do not start work after September 15 or if freezing temperatures are possible within 24 hours after application.

413-3.16 CONTRACTOR QUALITY CONTROL (QC) AND DOCUMENTATION. Perform Quality Control (QC) sampling and testing. Sample and test according to 413-3.21.

1. Emulsion. Provide a material Bill of Lading (BOL) for each batch of emulsion used. Include the supplier's name, plant location, emulsion grade, residual asphalt content, volume (gross and net, gallons) and batch number.

2. Aggregate. Provide QC test results daily to the Engineer and a summary upon completion of the work.

   a. Gradation and Mix Design Tolerance. Provide companion samples to the Engineer. The QC tolerances for the mix design are listed in Table 413-1. The tolerance range may not exceed the limits set in 413-1.

   b. Sand Equivalent Test. The Sand Equivalent quality control tolerance is ±7% of the value established in the mix design (60% minimum) as determined by ATM 307.

   c. Moisture Content. Determine the moisture content of the aggregate in accordance with ATM 202. Perform additional testing upon a visible change in moisture. Use the average daily moisture to calculate the oven dry weight of the aggregate.

413-3.17 ASPHALT CONTENT. Calculate and record the percent asphalt content of the mixture from the equipment counter readings, randomly, a minimum of three times a day. The quality control tolerance is ±0.5 percent for a single test and the average daily asphalt content is ±0.2 percent from the mix design.

413-3.18 DESIGN APPLICATION RATE. The design application rate shall be the total amount of micro-surfacing material placed to meet the requirements for cross section and surfacing. This amount will be the combination of all courses placed.

413-3.19 DOCUMENTATION. Provide a daily report containing the following information to the Engineer within one working day:

(1) Date and air temperature at work start up
(2) Beginning and ending locations for the day's work
(3) Length, width, total area (square yards) covered for the day

(4) Application rate (pounds per square yard) of aggregate
(5) Daily asphalt spot check reports, gallons of emulsion, weight of emulsion (pounds per gallon)
(6) Asphalt emulsion bill of lading
(7) Beginning, ending, and total counter readings
(8) Control settings, calibration values, percent residue in emulsion
(9) Percent of each material, percent of asphalt binder
(10) Calibration forms
(11) Aggregate certification or shipment of tested stock report
(12) Contractor's authorized signature.

413-3.20 MICRO-SURFACING MIX DESIGN ENGINEER OR TECHNICAL REPRESENTATIVE. The Contractor shall provide the Engineer than designed the mix or a technical representative to supervise the micro-surfacing process and the related process control of the product on the test strip and for the full duration of production. This Engineer, or representative, shall have a minimum of 5 years supervising successful projects using micro-surfacing with similar base material and equipment. The representative must be qualified to develop a micro-surfacing mix design and supervise the process control.

Provide a submittal that includes the following information:

1. Resume of Engineer or representative
2. A list of successful projects; provide owners contact, address, and telephone number; location of projects.
3. Description of micro-surfacing equipment used on the project.

413-3.21 AGENCY QUALITY ACCEPTANCE (QA) TESTING. Sample and test according to the following:

1. Asphalt Emulsion (1 per day at point of shipment or delivery, 1 from distributor truck)
2. Aggregate Gradation (2 per day per stockpile), as determined by ATM 304
3. Moisture Content of the Aggregate (2 per day), as determined by ATM 202

The Engineer may request additional testing at any time.

413-3.22 HOLD POINT. Any failing test creates a Hold Point, whereby no additional material may be placed until Corrective action and passing retest(s) have occurred, or accepted by the Engineer. All additional material placed before corrective action and passing retest(s) occur constitutes Unauthorized Work.

413-4.01 METHOD OF MEASUREMENT. By the ton and square yard per Section 109. Provide weight tickets for:

1. Micro-Surfacing Emulsion

413-5.01 BASIS OF PAYMENT. Fog seal or tack coat shall be paid in accordance with Section 402 if pay item exists otherwise it is subsidiary to pay item 413(2) Micro-Surfacing Surface Course.

Payment will be made under:

Pay Item No.	Pay Item	Pay Unit
413(1)	Micro-Surfacing Emulsion	Ton
413(2)	Micro-Surfacing Surface Course	Square Yard
413(3)	Micro-Surfacing Scratch Course	Square Yard
413(4)	Micro-Surfacing Mobilization & Demobilization	Lump Sum

CFHWY00106

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Quality

Laboratory Report

Laboratory No.: 2020A-1494

Name: Minnesotta Dr: Seward to Tudor Pavement Pres. Project No.: 00106 / 0421098
Sample: Microsurfacing Mix Design Item/Spec No.: 413(2) Field No.: Q-MSII-MD-2
Sampled From: Manufacturers Stock Submitted By: Emulsion Products Date Sampled: 07/04/2020
Source: Emulsion Products/QAP Sampled By: Emulsion Products Date Received: 07/24/2020
Location: Cst / Viking Dr. / Anchorage Quantity Represented: Source Date Completed: 07/24/2020
Examined For: Report of Supplier Submitted Mix Design Date Reported: 07/24/2020

Mix Parameters

Material Component	Target	Source	Allowable Range
Aggregate	Type II Grade	AGGPRO/ Mp 78 Parks Highway/ Cst	(See table)
CSS-1P (PG 64-34 base)	16.0%	Emulsion Products, Viking Dr., Anchorage	15.9%-16.9%
Residual AC content of CSS-1P	64%		63%-66%
Portland Type I/II Cement (ABI)	2.0%	QAP	0.5% - 11.5%
Aluminium Sulfate (48% sol)	1.0%	QAP	10.0%-11.2%
Residual AC in Mix	10.5%		10.0%-11.2%
Total Water	11.6%		

Test	Lab Result	Spec	Standard
Wet Stripping	95% +	≥ 90%	ISSA TB-114
Wet Track Abrasion loss, 1hr soak	177	≤ 538 g/m	ISSA TB-100
Wet Track Abrasion loss, 6 day soak	1116	≤ 807 g/m^2	ISSA TB-100
Saturated abrasion Compatability	0.9	≤ 3 g los	ISSA TB-144
Mix Time @ 77° F	160s	Controllable to ≥ 120s	ISSA TB-113
Mix Time @ 100° F		Controllable to ≥ 35s	ISSA TB-113
Wet Cohesion	16	12 kg-cm min @ 30 min	ISSA TB-139
	18	20 kg-cm min @ 60 min	
Lateral Displacement after 1000 cycles of 145 lb	1.70%	5% max	ISSA TB-147
SpG		2.10 max	
Excess Asphalt by LWT Sand Adhesion	35.8	50 g/ft^2 max	ISSA TB-109

Aggregate Gradation

Seive	% Passing	Spec Range
1/2" (12.5mm)	100	
3/8" (9.5mm)	100	100
#4 (4.75mm)	96	91-100
#8 (2.38mm)	70	65-75
#16 (1.18mm)	48	45-53
#30 (600µm)	35	30-40
#50 (300µm)	23	19-27
#100 (150µm)	16	13-19
#200 (075µm)	10.5	8.5-12.5

Aggregate Qualities

Wet Stripping

Remarks:

Mix design technical expert relays that Lateral Displacement does not accurately predict mix performance due to high binder content. Mix time @ 100°F not applicable with regional climate.

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

Signature:
Mike Yerkes, P.E.
Regional Materials Engineer

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

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Acceptance

Laboratory Report

Laboratory No.: 2020A-0769

Name: Minnesotta Dr: Seward to Tudor Pavement Pres. Project No.: 00106 / 0421098

Sample: Micro Surfacing Emulsion Item/Spec No.: 413.2000.0000 Field No.: MSE-1

Sampled From: Flowline on delivery truck Submitted By: R. Kelley #1058 Date Sampled: 06/07/2020

Source: Emulsion Products Sampled By: R. Kelley #1058 Date Received: 06/08/2020

Location: Anchorage Quantity Represented: 1/day Date Completed: 06/09/2020

Examined For: Conformance Date Reported: 06/09/2020

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.005**	
Lbs. per Gal. @ 60°F	**8.370**	
Viscosity, Saybolt 77°F	**17**	**20-100**
Sieve Test, % Retained	**0.04**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**60.3**	**62 min**
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**167**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:

T-350 MSCR results : Creep Recovery - 96.9% (95%min)
3200Jnr - 0.07 (0.1 max)

Percent residue result acceptale pending successful application in the field.

D1 The Material as Submitted Conforms to Specifications
Yes [ ] No [**X**] NA [ ]

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

Signature: DRAFT

Mike Yerkes, P.E.
Regional Materials Engineer

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Acceptance

Laboratory Report

Laboratory No.: 2020A-0770

Name: Minnesotta Dr: Seward to Tudor Pavement Pres. Project No.: 00106 / 0421098
Sample: Micro Surfacing Emulsion Item/Spec No.: 413.2000.0000 Field No.: MSE-2
Sampled From: Delivery Truck On-site SB Inter off-ramp Submitted By: R. Kelley #1058 Date Sampled: 06/07/2020
Source: Emulsion Products Sampled By: Schmidtkunz #125 Date Received: 06/08/2020
Location: Anchorage Quantity Represented: 1/day Date Completed: 06/09/2020
Examined For: Conformance Date Reported: 06/09/2020

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.003**	
Lbs. per Gal. @ 60°F	**8.353**	
Viscosity, Saybolt 77°F	**22**	**20-100**
Sieve Test, % Retained	**0.05**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.3**	
Percent of Residue, (0.1)	**62.2**	**62 min**
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**157**	
Aged		
Aged/Original Ratio, %		

Remarks:

T-350 MSCR results : Creep Recovery - 95.1% (95%min)
3200Jnr - 0.14 (0.1 max)

DRAFT

Signature:

Mike Yerkes, P.E.
Regional Materials Engineer

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

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Acceptance

Laboratory Report

Laboratory No.: **2020A-0825**

Name: **Minnesotta Dr: Seward to Tudor Pavement Pres.** Project No.: **00106 / 0421098**
Sample: **Micro Surfacing Emulsion** Item/Spec No.: **413.2000.0000** Field No.: **MSE-5**
Sampled From: **Macropaver, distributor** Submitted By: **E. McMahon #128** Date Sampled: **06/11/2020**
Source: **Emulsion Products** Sampled By: **E. McMahon #128** Date Received: **06/11/2020**
Location: **Anchorage** Quantity Represented: **200 tons** Date Completed: **06/12/2020**
Examined For: **Conformance** Date Reported: **06/12/2020**

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.004**	
Lbs. per Gal. @ 60°F	**8.361**	
Viscosity, Saybolt 77°F	**23**	**20-100**
Sieve Test, % Retained	**0.09**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**63.2**	**62 min.**
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**216**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:

T-350 MSCR results : Creep Recovery - 96.6% (95%min)
3200Jnr - 0.09 (0.1 max)

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

Signature: Mike Yerkes, P.E.
Regional Materials Engineer

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Laboratory Report

Acceptance

Laboratory No.: **2020A-0826**

Name: **Minnesotta Dr: Seward to Tudor Pavement Pres.** Project No.: **00106 / 0421098**
Sample: **Micro Surfacing Emulsion** Item/Spec No.: **413.2000.0000** Field No.: **MSE-6**
Sampled From: **Plant Supply truck** Submitted By: **E. McMahon #128** Date Sampled: **06/11/2020**
Source: **Emulsion Products** Sampled By: **E. McMahon #128** Date Received: **06/11/2020**
Location: **Anchorage** Quantity Represented: **200 tons** Date Completed: **06/12/2020**
Examined For: **Conformance** Date Reported: **06/12/2020**

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**0.997**	
Lbs. per Gal. @ 60°F	**8.303**	
Viscosity, Saybolt 77°F	**22**	**20-100**
Sieve Test, % Retained	**0.13**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**64.7**	**62 min**
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**169**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:

T-350 MSCR results : Creep Recovery - 95.97% (95%min)
3200Jnr - 0.01 (0.1 max)
Sieve test may be waived if successful application is achieved in the field.

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

Signature:
Mike Yerkes, P.E.
Regional Materials Engineer

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Laboratory Report

Acceptance

Laboratory No.: 2020A-0852

Name: **Minnesotta Dr: Seward to Tudor Pavement Pres.** Project No.: **00106 / 0421098**
Sample: **Micro Surfacing Emulsion** Item/Spec No.: **413.2000.0000** Field No.: **MSE-7**
Sampled From: **Macro Paver On Grade Distributor** Submitted By: **E. McMahon #128** Date Sampled: **06/12/2020**
Source: **Emulsion Products** Sampled By: **E. McMahon #128** Date Received: **06/12/2020**
Location: **Anchorage** Quantity Represented: **200 tons** Date Completed: **06/15/2020**
Examined For: **Conformance** Date Reported: **06/15/2020**

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.003**	
Lbs. per Gal. @ 60°F	**8.353**	
Viscosity, Saybolt 77°F	**20**	**20-100**
Sieve Test, % Retained	**0.18**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**64.0**	**62 min**
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**186**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:

T-350 MSCR results : Creep Recovery - 95.8% (95%min)
3200Jnr - 0.011 (0.1 max)

Sieve test may be waived if successful application achieved in field.

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

Signature:
Mike Yerkes, P.E.
Regional Materials Engineer

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

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Laboratory Report

Acceptance

Laboratory No.: 2020A-0853

Name: Minnesotta Dr: Seward to Tudor Pavement Pres. Project No.: 00106 / 0421098

Sample: Micro Surfacing Emulsion Item/Spec No.: 413.2000.0000 Field No.: MSE-8

Sampled From: Supply Truck at Plant Submitted By: E. McMahon #128 Date Sampled: 06/12/2020

Source: Emulsion Products Sampled By: E. McMahon #128 Date Received: 06/12/2020

Location: Anchorage Quantity Represented: 200 tons Date Completed: 06/15/2020

Examined For: Conformance Date Reported: 06/15/2020

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.002**	
Lbs. per Gal. @ 60°F	**8.345**	
Viscosity, Saybolt 77°F	**24**	20-100
Sieve Test, % Retained	**0.06**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**64.2**	62 min.
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**161**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:

```
T-350 MSCR results : Creep Recovery - 96.1%  (95%min)
                     3200Jnr        - 0.10   (0.1 max)
```

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

Signature:

Mike Yerkes, P.E.
Regional Materials Engineer

State of Alaska
Department of Transportation & Public Facilities
Central Materials Lab
5750 East Tudor Road
Anchorage, AK 99507
Phone (907) 269-6200 FAX (907) 269-6201

Acceptance

Laboratory Report

Laboratory No.: **2020A-0874**

Name: **Minnesotta Dr: Seward to Tudor Pavement Pres.** Project No.: **00106 / 0421098**
Sample: **Micro Surfacing Emulsion** Item/Spec No.: **413.2000.0000** Field No.: **MSE-9**
Sampled From: **Plant Suppy Truck** Submitted By: **Schmidtkunz #125** Date Sampled: **06/13/2020**
Source: **Emulsion Products** Sampled By: **Schmidtkunz #125** Date Received: **06/15/2020**
Location: **Anchorage** Quantity Represented: **1/day** Date Completed: **06/18/2020**
Examined For: **Conformance** Date Reported: **06/18/2020**

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.001**	
Lbs. per Gal. @ 60°F	**8.336**	
Viscosity, Saybolt 77°F	**27**	20-100
Sieve Test, % Retained	**0.03**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**64.2**	62 ~~max~~ Min.
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**177**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:

```
T-350 MSCR results : Creep Recovery - 96.0%  (95%min)
                     3200Jnr        - 0.10   (0.1 max)
```

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

Signature:
Mike Yerkes, P.E.
Regional Materials Engineer

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

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Department of Transportation & Public Facilities
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Laboratory Report

Acceptance

Laboratory No.: 2020A-0875

Name: Minnesotta Dr: Seward to Tudor Pavement Pres. Project No.: 00106 / 0421098
Sample: Micro Surfacing Emulsion Item/Spec No.: 413.2000.0000 Field No.: MSE-10
Sampled From: Macropaver, distributor Submitted By: Schmidtkunz #125 Date Sampled: 06/13/2020
Source: Emulsion Products Sampled By: Schmidtkunz #125 Date Received: 06/15/2020
Location: Anchorage Quantity Represented: 1/day Date Completed: 06/18/2020
Examined For: Conformance Date Reported: 06/18/2020

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	1.003	
Lbs. per Gal. @ 60°F	8.353	
Viscosity, Saybolt 77°F	26	20-100
Sieve Test, % Retained	-0.06	0.10 max.
Particle Charge, at 8 mA	Positive	Positive
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	0.5	
Percent of Residue, (0.1)	64.3	62 min
Tests on Residue		
Penetration, 77°F, 100gm		
Original	169	100-250
Aged		
Aged/Original Ratio, %		

Remarks:
T-350 MSCR results : Creep Recovery - 96.3% (95%min)
3200Jnr - 0.10 (0.1 max)

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

Signature: Mike Yerkes, P.E.
Regional Materials Engineer

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

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Acceptance

Laboratory Report

Laboratory No.: **2020A-0880**

Name: **Minnesotta Dr: Seward to Tudor Pavement Pres.** Project No.: **00106 / 0421098**
Sample: **Micro Surfacing Emulsion** Item/Spec No.: **413.2000.0000** Field No.: **MSE-11**
Sampled From: **Macropaver, distributor** Submitted By: **Schmidtkunz #125** Date Sampled: **06/14/2020**
Source: **Emulsion Products** Sampled By: **E. McMahon #128** Date Received: **06/15/2020**
Location: **Anchorage** Quantity Represented: **1/day** Date Completed: **06/19/2020**
Examined For: **Conformance** Date Reported: **06/19/2020**

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.004**	
Lbs. per Gal. @ 60°F	**8.361**	
Viscosity, Saybolt 77°F	**23**	**20-100**
Sieve Test, % Retained	**0.07**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**64.0**	**62 min**
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**187**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:

T-350 MSCR results : Creep Recovery - 96.2% (95%min)
3200Jnr - 0.10 (0.1 max)

Signature:

Mike Yerkes, P.E.
Regional Materials Engineer

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

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Acceptance

Laboratory Report

Laboratory No.: 2020A-0881

Name: Minnesotta Dr: Seward to Tudor Pavement Pres. Project No.: 00106 / 0421098
Sample: Micro Surfacing Emulsion Item/Spec No.: 413.2000.0000 Field No.: MSE-12
Sampled From: Delivery Truck at plant Submitted By: Schmidtkunz #125 Date Sampled: 06/14/2020
Source: Emulsion Products Sampled By: E. McMahon #128 Date Received: 06/15/2020
Location: Anchorage Quantity Represented: 1/day Date Completed: 06/19/2020
Examined For: Conformance Date Reported: 06/19/2020

AASHTO T59

TEST	RESULT	SPECIFICATION
Specific Gravity @ 60°F	**1.004**	
Lbs. per Gal. @ 60°F	**8.361**	
Viscosity, Saybolt 77°F	**25**	20-100
Sieve Test, % Retained	**0.09**	**0.10 max.**
Particle Charge, at 8 mA	**Positive**	**Positive**
Settlement, % @ 1 Day		
Settlement, % @ 5 Days		
Demulsibility %		
Percent of Oil Distillate, (0.1)	**0.5**	
Percent of Residue, (0.1)	**64.7**	62 min.
Tests on Residue		
Penetration, 77°F, 100gm		
Original	**179**	**100-250**
Aged		
Aged/Original Ratio, %		

Remarks:
T-350 MSCR results : Creep Recovery - 96.0% (95%min)
3200Jnr - 0.011 (0.1 max)

Signature: [signature]
Mike Yerkes, P.E.
Regional Materials Engineer

D1 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

Appendix E

Ramp Removal Photolog and Friction Tests

On August 10th construction determined there had been a loss of friction on Ramps 1, 2, 5, 10 and 13 and friction testing were performed to confirm this. The locations with flushing and loss of friction are shown on the following pages. Ramp 1 is below.

The flushing distress and pickup by traffic can be observed on Ramp 2

The deformation of the micro surfacing created a hump where the pen is placed in the photo below. This deformation was not observed on any other ramps where flushing was present, likely because Ramp 2 is the only ramp that has static loading on the micro surfacing.

Ramp 5 had some minor flushing on the portion closest to Minnesota shown in the first photo below that was placed over moderate to major severity longitudinal cracks.

More severe flushing was visible in the area closer to merging onto International.

Ramp 10 had been noted to be a part of a haul route, as Ramps 1 and 2 were, so it was investigated as well. There was minimal flushing over the initial part of the ramp that received rut fill.

This turned into more severe flushing after the rut-filled area going into the curve.

Ramp 13 had the least visible flushing and was placed over a rut filled area, but given the distresses on the other ramps and the shininess visible on the surface it was determined to pursue removal while out performing other milling operations.

Friction values measured on the distressed ramps removed in 2020 are below.

Ramp Number	Distressed Micro	Non-Distressed Micro	Hot Mix
1	0.31	0.54	0.54
2	0.28	0.45	0.47
5	0.28	0.47	0.48
10	0.35	0.53	0.55
13	0.45	0.52	0.57
Average:	0.33	0.50	0.52

Appendix F

Experimental Feature Workplan

Work Plan For

Minnesota Drive Ramps

Micro-surfacing Monitoring Project

Alaska Department of Transportation & Public Facilities

Andrew Pavey
Statewide Asset Management
Pavement Management Engineer

January 2019

Introduction

Central Region Alaska Department of Transportation and Public Facilities (DOT&PF) will be installing the first application of micro-surfacing in Central Region during the 2019 construction season. Micro-surfacing is a preservation treatment that can be applied in thin lifts (1/3" or less), offering significant cost savings over typical hot mix asphalt that requires between a 1" to 2" thick application. The micro-surfacing system proposed in this project is composed of fine aggregate and emulsion. The aggregate is ISSA (International Slurry Seal Association) Type II aggregate, which is 3/8" minus, with the aggregate primarily passing the #8 sieve. The emulsion used is highly polymer modified, coming from a base oil meeting PG64-40E.

Although this treatment has been widely used in the lower 48 states, it has not been used on roads in Central Region of Alaska to date due to poor historical prall testing (lab test to simulate studded tire wear) results on micro-surfacing samples. However, Central Region has tested a new micro-surfacing formulation that performed well on the prall test. This confirmation of performance has made Central Region comfortable with testing micro-surfacing on low to moderate volume roads using ISSA Type II aggregate and the highly polymer modified emulsion.

Background / History

Micro-surfacing is a pavement preservation treatment that has been used widely across the country. It offers the advantages of being a thin application that can be used to fill ruts and provide a new wearing course without requiring the milling and thicker pavement applications that come with Type II and Type V hot mix asphalts.
Micro-surfacing is an emulsion that is polymer modified, mixed with aggregate that creates a dense graded, cold mixed, quick setting asphalt surfacing material. It uses additives that changes it from a semi-liquid material to a dense material that can carry traffic loading within one hour of application.

Mill/fill treatments have been used on Anchorage roads for decades due to more economical preservation solutions not being able to handle the high traffic volumes with studded tire use in the Anchorage area. Prall testing was performed on micro-surfacing samples at multiple times in the past decade, but in all cases the samples were destroyed prior to the completion of the test, and based on those results micro-surfacing was never applied on Anchorage roads.

Central Region Materials has experimented with multiple methods of combating studded tire wear. The first method was the use of hard aggregate, which is typically imported by train from Cantwell in Northern Region. While the use of hard aggregate has slowed the rate of rutting, Central Region Materials felt the rate of rutting may be slowed through the use of different asphalt binders. After experimenting with different grades of oil it was observed that lowering the bottom end of the oil to a minus 40 significantly improved prall results.

Upon these findings micro-surfacing specimens were made using emulsion from a

PG 64-40E base oil, and submitted to the materials lab in Southcoast Region for prall testing. These specimens passed the prall testing with results similar to hot mix asphalt using local aggregate and Central Region was comfortable with applying micro-surfacing on low to moderate volume roads based on the results using the highly polymer modified emulsion.

Objectives and Scope

Micro-surfacing will be applied at 16 locations on Minnesota Drive Ramps for a total area of 26,300 square yards.

The primary objectives of the Micro-surfacing Monitoring project are the following:

1. Assess existing asphalt surface conditions prior to construction

For this project, DOT&PF is proposing to assess the existing asphalt conditions by performing the following:

- Collect pavement condition data on the ramps using an inertial profiler and laser crack measurement system (LCMS). Prior to construction this system will collect rut depths (inches), roughness (IRI), pattern cracking (square feet), transverse cracking (liner feet) and longitudinal cracking (liner feet) on each ramp. Cracking data will also contain the average crack width for each category, being pattern, longitudinal and transverse. Photos will also be taken at each ramp prior to the application.

- Perform a visual inspection prior to construction to take photos of existing conditions and locate high severity cracks or other distresses that may reflect through the micro-surfacing application.

2. Access Micro-surfacing as constructed condition

Micro-surfacing conditions will be documented as constructed with photographs. The resulting surface texture should be consistently 1/3" in thickness, with no drag marks, washboarding, uneven surfaces or raveling.

Construction methods will be documented as well as mix design properties. Cores will be taken after construction for prall testing for testing of projected studded tire wear and Haumberg testing for plastic deformation resistance.

3. Long-term performance monitoring under Alaska Conditions

For the long-term we are proposing that these micro-surfacing sites be monitored for a period of three years. Within the three-year period from construction DOT&PF anticipates all testing and analysis be completed for inclusion in a final report.

This project's 16 locations are located in urban Anchorage area on ramps off of

Minnesota Drive ramps are subject to the following cold climate conditions:

- Seasonal studded tire wear between September and May;
- Winter plowing operations;
- Anti-icing and de-icing applications, and;
- A freeze-thaw pavement cycle.

If the micro-surfacing shoves from plastic deformation, or erodes from studded tire wear to where the underlying pavement is visible prior to the three year monitoring period the micro-surfacing will be considered a failure at that location. It will be determined if the failure was specific to that location due to abrasion from high speed studded tire wear, or plastic deformation caused by shoving action in curves, which will help determine what conditions micro-surfacing can survive in Alaska. It is expected that existing cracks will reflect through the micro-surfacing within two or three years, and reflective cracking will not be considered failure. If failures are widespread from studded tire wear or deformation then this micro-surfacing formulation will not be suited for Alaska's climactic conditions.

Micro-surfacing will be considered successful if there is minimal raveling and no underlying pavement is visible (less than 0.3" rutting) after the three years of post-construction monitoring. The micro-surfacing is being applied to ramps of varying traffic volumes, speeds and curves. The degree of success, or failure, may vary between the ramps which will be documented in the final report.

Work Plan

1. Micro-Surfacing Site Description and Construction Procedure

Location maps, a summary table, and as-advertised plans showing the proposed Micro-surfacing locations are included in Appendix A. The project title is: Minnesota Drive: Seward to Tudor Pavement Preservation Project No. 0421098/CFHWY00106.

Construction, materials, and methods used will conform to Section 413 of the "Special Provisions" of the project "Contract Documents and Specifications". The project calls for the placement of approximately 26,300 square yards of Micro-surfacing on the 16 ramps.

2. Method of Evaluation

A) Prior to and during construction, DOT&PF staff will document ramp surface conditions, including:

- The pavement condition at the time of Micro-surfacing application including ruts, cracks, etc. and whether the application was on existing aged pavement or new pavement;

- Weather and temperature conditions at the time of Micro-surfacing application;
- The production rates for the automated lay down equipment and equipment model information, and;
- Amount of time before roadway is opened to traffic.

B) Post-construction evaluation will consist of monitoring the condition and friction of the Micro-surfacing treated areas over a three-year period. Monitoring will include summer evaluation of:

- Overall pavement condition;
- Pavement rut depths, cracking, IRI (from annual Pavement Management System survey);
- Extent of micro-surfacing raveling, shoving (from visual inspections) and;
- Micro-surfacing friction compared to time of application and control points on ramps;
- Performance of micro-surfacing placed over existing pavement to that placed over new pavement.

Reporting

Construction of Micro-surfacing will be completed by September 30th, 2019 and a post construction report will be submitted by December 30th, 2019.

Interim reports will be submitted at the end of each of the three evaluation years. A final report, summarizing previous reports will be submitted by the end of 2022. At the end of the evaluation period, a synopsis will be provided that will provide a recommendation whether the use of Micro-surfacing should continue in Alaska. If studded tires wear through the micro-surfacing within the three year monitoring (rut greater than 0.3 inches), or the micro-surfacing suffers from widespread raveling or delamination's it will not be recommended for continued use. It will also contain information concerning what pitfalls or construction/maintenance issues could have been avoided through improved specifications, construction plans and practices.

Schedule

- Construction completion of all Micro-surfacing sites: Fall 2019
- Post construction report submitted to FHWA: December 2019
- First year survey and report submitted to FHWA: December 2020
- Second year survey and report submitted to FHWA: December 2021
- Third year survey and final report submitted to FHWA: December 2022

Budget

No additional cost will be incurred for pavement rutting, cracking, or IRI data collection, as the annual Pavement Management System (PMS) survey will document pavement performance after initial construction testing is complete.

There will be a cost associated with the initial friction testing and post construction friction testing, coring and lab testing and Micro-surfacing evaluation. DOT&PF Materials staff will perform the pavement coring, lab testing and friction testing. A budget of $100,000 is requested which includes traffic control operations, ICAP, equipment use, reporting, and staff time. See Appendix B for detailed cost estimate.