

Asphalt Concrete Pavement Arterial Roadway Salt and Brine Impact Study Edmonton, AB



PRESENTED TO
City of Edmonton

DECEMBER 3, 2020
ISSUED FOR USE
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EXECUTIVE SUMMARY

Introduction

This assessment has been completed as a follow-up to Tetra Tech's 2019 report, "Salt and Brine Impacts on Asphalt Concrete Pavement" (Tetra Tech File: 704-TRN.PAVE03571-01, dated July 31, 2020), which investigated the potential impacts of salt and brine on asphalt concrete. Part of the work completed in 2019 involved an assessment of the pavement condition of five City roadways following the 2019 winter season, which included the application of salt and brine chemicals as part of the City's anti-icing/de-icing program. This report is intended to provide an updated roadway condition assessment of roadway sections following an additional season of winter exposure.

NaCl and Sand De-icing Maintenance Routes

- 122nd Street: Between Whitemud Drive and Fox Drive – Northbound Direction only
- Groat Road: From 87th Avenue to Groat Road Bridge – Northbound and Southbound Directions

Anti-icing Routes (note: no anti-icing was completed in 2019)

- 178th Street: From 87th Avenue to and 95th Avenue
- 111th Avenue: From 124th Street to 132nd Street
- 97th Street: From 137th Avenue to 167th Avenue

Roadway Condition Review Process and Criteria

Tetra Tech's 2020 roadway condition review followed the general steps outlined below:

- Complete a field review and visual condition assessment of the five project roadways. Field review criteria included: general reavelling, coarse rock loss, hair-line cracking, segregated areas, and existing cracks. One or two stops were made for each roadway depending on the length of the section. The location of each stop was determined based on pavement condition and engineering judgement.
- Following the field review, complete a review of the 2020 pavement surface photolog, and confirm observations from the visual condition assessment completed on site. All five roadways sections were surveyed with Tetra Tech's GoPro Hero8 black wide screen (4k) mounted onto a standard vehicle in September 2020. This photographic survey provided a high-resolution visual log of the pavement surfaces.
- Compare the outcomes from the 2020 condition assessment to the October 2018 and May 2019 photologs and roadway condition summaries.

Summary of Pavement Condition Assessment

- 122nd Street: A slightly worse than expected rate of pavement deterioration was observed over the two winter maintenance seasons. The level of review completed at this time does not provide sufficient evidence that this observation is a direct result of the City's winter maintenance strategy.
- Groat Road: An expected or "typical" rate of pavement deterioration was observed over the two winter maintenance seasons.
- 178th Street: A similar pavement condition (poor or very poor) with extensive fatigue cracking was observed before and after the two winter maintenance seasons.
- 111th Avenue: An expected or "typical" rate of pavement deterioration was observed over the two winter maintenance seasons.
- 97th Street: An expected, or even better than expected, rate of pavement deterioration was observed over the two winter maintenance seasons.

From this assessment, it is Tetra Tech's opinion that there is no evidence that the City's winter maintenance strategy is adversely impacting pavement performance of these roadway sections.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	IV
1.0 INTRODUCTION	1
2.0 SUMMARY OF THE CITY OF EDMONTON'S ANTI/DE-ICING WINTER MAINTENANCE PRACTICES.....	1
3.0 ROADWAY CONDITION ASSESSMENT	2
3.1 Areas of Study	2
3.2 Photolog Data Collection Practices	3
3.3 2020 Roadway Condition Review Process.....	3
4.0 SUMMARY OF 2020 PAVEMENT CONDITION OBSERVATIONS.....	4
4.1 Field Review Criteria.....	4
5.0 PHOTOLOG REVIEW AND SUMMARY OF OBSERVATIONS	5
5.1 122 nd Street NB: From Whitemud Drive and Fox Drive	5
5.2 Groat Road NB and SB: From 87 th Avenue to Groat Road Bridge	5
5.3 178 th Street: From 87 th Avenue to and 95 th Avenue	6
5.4 111 th Avenue: From 124 th Street to 132 nd Street.	6
5.5 97 th Street: From 137 th Avenue to 167 th Avenue	7
6.0 CLOSURE.....	8

APPENDIX SECTIONS

APPENDICES

Appendix A	Tetra Tech's Limitations on the Use of this Document
Appendix B	Field Review Results
Appendix C	Photographs

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the City of Edmonton and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the City of Edmonton, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the City of Edmonton (the City) to provide an updated assessment of the potential impacts of sodium chloride (salt) and calcium chloride (brine) on a select number of Asphalt Concrete Pavement (ACP) surfaced roadways within the City's roadway network.

This assessment has been completed as a follow-up to Tetra Tech's 2019 report, "Salt and Brine Impacts on Asphalt Concrete Pavement" (Tetra Tech File: 704-TRN.PAVE03571-01, dated July 31, 2020), which investigated the potential impacts of salt and brine on asphalt concrete. Part of the work completed in 2019 involved an assessment of the pavement condition of five City roadways following the 2019 winter season, which included the application of salt and brine chemicals as part of the City's anti-icing/de-icing program. This 2020 assessment is intended to provide an updated roadway condition assessment of five roadway sections following an additional season of winter exposure.

The assessment and subsequent observations and discussion provided in this report are intended to address the asphalt surfaced arterial roadway sections outlined in Tetra Tech's proposal submitted in December 2019 (Tetra Tech File: 704-PTRN.PAVE03571-01, dated December 20, 2019). It is understood that the other scope items and deliverables presented in this proposal have been delivered to the City under separate cover.

2.0 SUMMARY OF THE CITY OF EDMONTON'S ANTI/DE-ICING WINTER MAINTENANCE PRACTICES

The following provides our understanding of the City's historical practice for the usage of anti-icing and de-icing material for the 2018 and 2019 winter seasons. For clarity of terminology, throughout this report "anti-icing" refers to the process of applying a chemical solution (typically brine) prior to a snow fall event, and "de-icing" refers to the process of applying a chemical (typically rock salt) during or after a snow fall event when snow and/or ice has begun to accumulate on the roadway surface.

Summary of the City's Anti-Icing / De-icing Practices in 2018

It is understood that the City's 2018 winter maintenance practices include the use of:

- Calcium Chloride (CaCl_2) brine as an anti-icing agent,
- Sodium Chloride (NaCl) as a de-icing agent, which is often rock salt mixed with sand (a traction aid), and distributed at various application rates dependent on ambient temperature, and
- A combined application of CaCl_2 brine anti-icing pre-treatment, followed by a NaCl treatment during the snow fall event.

In 2018, the City used Road Guard Plus (CaCl_2 brine with corrosion inhibitors) for anti-icing. This product, supplied by Tiger Calcium Services Inc., contains a chemical composition of 25% to 27% CaCl_2 , 2% to 4% Magnesium Chloride (MgCl_2), and 3% to 5% other chlorides. For this investigation, Road Guard Plus is referred to as CaCl_2 brine and/or anti-icing brine. Standard practice is to apply a thin film of anti-icer (to avoid pooling) prior to a snow fall event.

The anti-icing units were calibrated at 100L /per lane km (at 10 pounds per square inch and 30 km/hr), as per the City's Standard Operating Procedure (2018). The spray bars for the pre-wetting system on the sander/plow units are calibrated at 40L /per metric tonne. Streets that are anti-iced also receive standard snowstorm plowing, NaCl salt and sand applications.

In addition to CaCl_2 anti-icing, the City used a combination of NaCl rock salt and sand for roadway ice control. Salt and sand application rates are a function of ambient temperature, where warmer temperature (e.g., -1°C to -5°C) receive a higher ratio of salt to sand (typically 25%) than at colder temperatures. For ambient temperatures below -19°C , salt is no longer applied, and only sand is distributed as a traction aid. For the purpose of this investigation, NaCl rock salt is referred to salt, NaCl, and/or de-icing chemical.

Tetra Tech's Understanding of the City's Anti-Icing / De-icing Practices in 2019

It is understood that the City's 2019 winter maintenance practices were modified to include only salt de-icing without the direct application of brine anti-icing chemicals. However, it is understood that brine (consisting of the same CaCl_2 product) was used as an anti-icing agent on sidewalks, bike lanes and paths. Brine was also used as a pre-wetting agent for the City's sand and salt stockpiles to improve the adhesion of the sand and salt to the snow and ice accumulation on the road surface.

3.0 ROADWAY CONDITION ASSESSMENT

3.1 Areas of Study

During initial discussions with the City in the Fall of 2018, five roadway segments were selected as candidates for the 2019 and 2020 roadway condition assessments. The purpose of these condition assessments was to evaluate the potential in-situ impact anti-icing and de-icing chemicals have under Edmonton winter conditions. The general approach followed in the selection of the candidate roadway sections included:

- The selection of a roadway, or roadways that have been recently paved and ideally have not experienced a winter season.
- The selected roadway, or roadways would have been constructed of similar asphalt mix type used for the laboratory testing program completed in 2019.
- The roadway, or roadways will be in service and be exposed to a reasonable amount of traffic loading (residential or local road at minimum, bus route preferred).
- The roadway, or roadways would be subjected to both anti-icing and de-icing operations.

Based on the above, and through consultation with the City, the following roadways were selected for the field review:

NaCl and Sand De-icing Maintenance Routes

- 122nd Street: Between Whitemud Drive and Fox Drive – Northbound Direction only
- Groat Road: From 87th Avenue to Groat Road Bridge – Northbound and Southbound Directions

Anti-icing Routes (note: no Anti-icing was completed in 2019)

- 178th Street: From 87th Avenue to and 95th Avenue
- 111th Avenue: From 124th Street to 132nd Street
- 97th Street: From 137th Avenue to 167th Avenue

These five roadway sections formed the network used for the 2019 and 2020 condition assessments.

As noted, the selected anti-icing routes were only subjected to direct application of anti-icing over the 2018/2019 winter season. De-icing practices were completed on all roadway segments over the 2019/2020 winter season. The extent to which any pre-wetted sand/salt de-icing materials were applied to all five roadway sections is not known.

3.2 Photolog Data Collection Practices

2018 and 2019 Photolog Data Collection Practices

All five roadway sections were surveyed with Tetra Tech's Pavement Surface Profiler (PSP-7000) pre-winter season in October 2018, and post-winter season in May 2019. The PSP surveys provided high resolution right-of-way (ROW) images, as well as Laser Crack Mapping System (LCMS) pavement surface images along each travel lane for each roadway. Both the ROW and LCMS photologs collected pre and post 2018/2019 winter maintenance season were included as part of this field review.

The reduced lane widths on Groat Road during the 2019 to 2020 construction precluded the use of the PSP-7000 vehicle. The 2019 Groat Road images were captured with a GoPro Hero7 Black wide screen mounted on a passenger vehicle.

2020 Photolog Data Collection Practices

All the September 2020 images were collected utilizing the upgraded GoPro Hero8 model which was similarly mounted to a passenger vehicle. This change in equipment/method was used to obtain improved image quality from a vantage point closer to the concrete infrastructure. Once the images were collected, they were similarly labeled to the previous years. The decision to change equipment type and method of obtaining images was at Tetra Tech's discretion.

3.3 2020 Roadway Condition Review Process

Tetra Tech's 2020 roadway condition review followed the general steps outlined below:

- Complete a field review and visual condition assessment of the five project roadways.
- Following the field review, complete a review of the 2020 pavement surface photolog, and confirm observations from the visual condition assessment completed on site.
- Compare the outcomes from the 2020 condition assessment to the 2018 photologs and roadway condition summaries.

As part of the 2020 roadway condition assessment, specific attention was focused on potential changes in asphalt concrete weathering and ravelling (pavement durability and/or moisture susceptibility) and surfacing cracking (pavement strength and/or asphalt binder stiffness). Where possible, changes in surface rutting were also reviewed.

When comparing the 2020 dataset to previous years, differences and/or changes in roadway surface condition were noted. Additional details pertaining to Tetra Tech's observations are provided in the following sections of this report.

4.0 SUMMARY OF 2020 PAVEMENT CONDITION OBSERVATIONS

As noted previously, Tetra Tech's 2020 pavement condition assessment included a combined field and 2020 photolog review of the following roadways:

- 122nd Street: Between Whitemud Drive and Fox Drive – Northbound Direction only
- Groat Road: From 87th Avenue to Groat Road Bridge – Northbound and Southbound Directions
- 178th Street: From 87th Avenue to and 95th Avenue
- 111th Avenue: From 124th Street to 132nd Street
- 97th Street: From 137th Avenue to 167th Avenue

As part of the field review, one or two stops were made for each roadway depending on the length of the section. The location of each stop was determined based on pavement condition, traffic condition, parking availability, and engineering judgement. The details of each stop location are included in Table 1 in Appendix B of this report. At each stop location, approximately 100 m of pavement was evaluated by walking on the adjacent sidewalk. The pavement condition assessment was completed by two Tetra Tech pavement engineers. The outer lane was typically selected for the pavement condition assessment. Representative photos were taken and included in Appendix C of this report.

4.1 Field Review Criteria

The general guideline for completing the pavement condition assessment followed the Alberta Transportation Guidelines for the Assessment, Rating and Prioritization of Pavements for Seal Coat. This guideline was selected based on the premise that it investigated pavement distress types similar to those that might be expected to manifest as a result of salt and/or brine applications. The following factors were adopted to evaluate the impact of salt and brine on asphalt pavement preference during field assessment:

- **General Ravelling**

The pavement surface is wearing away as a result of the dislodging of the aggregate particles and loss of asphalt binder. General ravelling is assessed as how many millimetres of top aggregate are exposed.

- **Coarse Rock Loss**

The pavement surface is losing coarse rock and leaving voids conforming to the shape of the coarse rock particles that have disappeared. These voids have dimensions approximating the aggregate top size (i.e., 10 mm for 10 mm HT). The coarse rock loss was counted at random chosen area of 0.1 m² at each stop location.

- **Hair-Line Cracking**

Hair-line cracks are often seen as a network of fine cracks distributed over many small discrete areas of pavement throughout the roadway length. At each stop location, the length of roadway affected by hairline cracking was estimated over a randomly chosen 100 m section which was considered as representative to assess the extent of roadway hair-line cracking.

■ Segregated Areas

Segregation is a condition where the surface to the asphalt matrix and fine aggregate lacks homogeneity. Segregated areas were observed to have fine aggregate particles dislodged and/or are disappearing, along with some asphalt binder.

There is a concern that segregated areas might potentially be more prone to salt and brine application. Firstly, segregated areas, if any, were visually assessed on site; secondly, special attention was paid during review the 2018 photo logs for any significant changes.

■ Existing Cracks

Similar to segregated areas, pavement conditions at longitudinal/transverse cracks, or construction joints were closely reviewed on site. Special attention was paid during review the 2018 photo logs for any significant changes.

A summary of the field review results is included in Table 1 in Appendix B of this report. This summary was used in the preparation of the Summary of Observations presented in the following section of this report.

5.0 PHOTOLOG REVIEW AND SUMMARY OF OBSERVATIONS

5.1 122nd Street NB: From Whitemud Drive and Fox Drive

The section of 122nd Street was treated with NaCl and sand de-icing maintenance activities during both the 2018/2019 and 2019/2020 winter seasons.

Based on review of the 2018 photologs, this section of 122nd Street appears to have been recently paved. This observation was confirmed by the City as mentioned in a previous report, indicating that the roadway was paved in 2018 with an HT asphalt concrete mix.

Observations from the 2020 field review and pavement condition assessment indicated an overall good to fair roadway condition. In general, the pavement condition was observed to be worse (i.e., more ravelling) from the field review compared to the 2020 photologs. The primary distress types included coarse aggregate loss, and localized ravelling.

Field photos are presented in Appendix C as Photographs 1 and 2.

By comparing the 2018, 2019 and 2020 photologs and pavement condition summaries, a slightly worse than expected rate of pavement deterioration was observed over the two winter maintenance seasons, given the age of the asphalt surface (~2 years). The level of review completed at this time does not provide sufficient evidence that this observed durability issue is a direct result of the City's winter maintenance strategy.

5.2 Groat Road NB and SB: From 87th Avenue to Groat Road Bridge

The section of Groat Road was treated with NaCl and sand de-icing maintenance activities during the 2018/2019 winter season.

Based on review of the 2018 and 2020 photologs, this section of Groat Road appears to have been recently paved.

Observations from the 2020 field review and pavement condition assessment indicated an overall good roadway condition. The primary distress type included medium to high density (~5 m) transverse cracking – assumed to be reflective cracking. No significant areas of ravelling, segregation, or hairline cracking were observed.

Field photos are presented in Appendix C as Photographs 3 and 4.

By comparing the 2018, 2019, and 2020 photologs and pavement condition summaries, an expected or “typical” rate of pavement deterioration was observed over the two winter maintenance seasons. Therefore, there is no indication that the City’s winter maintenance strategy for this roadway section is adversely impacting pavement performance.

5.3 178th Street: From 87th Avenue to and 95th Avenue

The section of 178th Street was treated with anti-icing and de-icing maintenance activities during the 2018/2019 winter season. As noted, it is understood that only de-icing maintenance activities were completed during the 2019/2020 winter season.

Based on review of the 2018 and 2019 photologs, severe distresses (weathering, fatigue cracking, longitudinal cracking, and transverse cracking) were observed along this section.

Observations from the 2020 field review and pavement condition assessment indicated an overall poor or very poor roadway condition. The primary distress type included medium to high density (~5 m) longitudinal and transverse cracking. Frequent instances of potholes were also observed. This section of roadway presented the highest rate of general ravelling of all the five roadway sections. The presence of ongoing spray patching was evident in both the photo logs and field review.

Field photos are presented in Appendix C as Photographs 5 and 6.

By comparing the 2018, 2019 and 2020 photologs and pavement condition summaries, a similar pavement condition (poor or very poor) was observed before and after the two winter maintenance seasons. The overall pavement condition makes it difficult to determine if there is any direct evidence that the City’s winter maintenance strategy for this roadway section is adversely impacting pavement performance.

5.4 111th Avenue: From 124th Street to 132nd Street.

The section of 111th Avenue was treated with anti-icing and de-icing maintenance activities during the 2018/2019 winter season. As noted, it is understood that only de-icing maintenance activities were completed during the 2019/2020 winter season.

Based on review of the 2018 and 2019 photologs, this section of 111th Avenue appears to have been recently paved.

Observations from the 2020 field review and pavement condition assessment indicated an overall good pavement condition. The primary distress type included low density (~15 m) transverse cracking – assumed to be reflective cracking. Only localized areas of ravelling, segregation or hairline cracking were observed. In most cases, these distresses were observed to be of low severity.

Field photos are presented in Appendix C as Photographs 7 to 10.

By comparing the 2018, 2019, and 2020 photologs and pavement condition summaries, a reasonable or “typical” rate of pavement deterioration was observed over the two winter maintenance seasons. Therefore, there is no indication that the City’s winter maintenance strategy for this roadway section is adversely impacting pavement performance.

5.5 97th Street: From 137th Avenue to 167th Avenue

The section of 97th Street was treated with anti-icing and de-icing maintenance activities during the 2018/2019 winter season. As noted, it is understood that only de-icing maintenance activities were completed during the 2019/2020 winter season.

Based on review of the 2018 and 2019 photologs, this section of 97th Street appears to have been recently paved.

Observations from the 2020 field review and pavement condition assessment indicated an overall good roadway condition. The primary distress type included infrequent (~30 m) transverse cracking – assumed to be reflective cracking. No significant areas of ravelling, segregation or hairline cracking were observed.

Field photos are presented in Appendix C as Photographs 11 to 15.

By comparing the 2018, 2019 and 2020 photologs and pavement condition summaries, an expected, or even better than expected, rate of pavement deterioration was observed over the two winter maintenance seasons. Therefore, there is no indication that the City's winter maintenance strategy for this roadway section is adversely impacting pavement performance.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Tetra Tech Canada Inc.




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APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

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Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

APPENDIX B

FIELD REVIEW RESULTS

Table 1 - Summary of Field Assessment and Comparison with 2018 Photo Logs											
Street	Stop Location	General Raveling (mm)	Coarse Rock Loss (Count/0.1 m ²)	Hairline Cracking (m/100m)	Segregation	Field Photo #	Assessment from field visit 2020	Assessment from 2020 Photologs	Review photo logs 2018	Change in pavement condition from 2018 to 2020	Salt and Brine Impacts
122 St (NB only)	122 St at 62 Ave	1.5	12	NO	Few	1	Pavement is in fair to poor condition with segregations (note: observed condition conflicts with photolog observations)	Good to fair condition	Newly paved, no visible distress	Noticeable change in the overall pavement condition in terms of aggregate loss especially at segregated areas. The change is considered worse than what is typically expected for a roadway ~ 2 years old.	No significant impact to overall pavement condition.
	122 St at 48 Ave-51 Ave	<1.0	1	NO	NO	2	Pavement is in good condition, no significant distress	Consistent with the field visit 2020		No significant change in the pavement condition.	No significant impact noted.
Groat Road	Groat Road at 87 Ave-89 Ave	<1.0	2	NO	NO	3,4	Pavement is in good condition with reflective Cracks	Consistent with the field visit 2020	Newly paved, no visible distress	Changes in the pavement condition are as expected.	No significant impact noted.
178 St	178 St at 93 Ave-95 Ave	3.0 - 3.5	17	100 m	Few	5,6	Pavement is in very poor condition; Extreme severity transverse cracking and longitudinal cracking; potholes and spray patches	Consistent with the field visit 2020	Pavement was in very poor condition; Longitudinal and transverse cracking; potholes and fatigue cracking	Changes in the overall pavement condition is as expected; more significant changes in transvers crack severity.	No significant impact to overall pavement condition.
111 Ave	111 Ave at 130 St-129 St	1.0 - 1.25	4	2	Few	7,8	Pavement is in good condition; Reflective cracks; Edge cracking observed throughout at outside gutter.	Consistent with the field visit 2020	Newly paved, no visible distress	The changes in the pavement condition is as expected; A few segregated areas noted.	No significant impact to overall pavement condition.
	111 Ave and 126 St	1.0	1	NO	Few	9,10					
97 St	97 St at 153 Ave (NB)	NO	NO	NO	NO	11	Pavement is in good condition with reflective Cracks	Consistent with the field visit 2020	Newly paved, no visible distress	Changes in the pavement condition are as, or are slightly better, than expected.	No significant impact noted.
	97 St at 165 Ave (NB)	NO	2	NO	NO	12					
	97 St at 160 Ave (SB)	NO	NO	NO	NO	13					
	97 St at Griesbach (SB)	NO	NO	NO	NO	14,15					

Notes: "NO" - Not observed at stop location; NB - Northbound lane; SB - Southbound lane; IWP - Inner wheel path; OWP - Outer wheel path

APPENDIX C

PHOTOGRAPHS



Photo 1: 122 St NW at 62 Ave–Pavement condition at segregated area, close-up



Photo 2: 122 St NW at 51 Ave–General pavement condition, close-up



Photo 3: Groat Road at 89 Ave, General pavement condition, close-up



Photo 4: Groat Road at 89 Ave, Transverse crack, looking south



Photo 5: 178 St NW at 93 Ave—Transverse crack, looking east



Photo 6: 178 St NW at 93 Ave—General pavement condition, looking east



Photo 7: 111 Ave NW at 130 St, General pavement condition, close-up



Photo 8: 111 Ave NW at 129 St, Pavement condition at segregated area, close-up



Photo 9: 111 Ave NW at 126 St, Transverse crack, looking north



Photo 10: 111 Ave NW at 125 St, Pavement condition at segregated area, close-up



Photo 11: 97 St NW (NB) at 153 Ave, Transverse crack, looking west



Photo 12: 97 St NW (NB) at 165 Ave, General pavement condition, close-up



Photo 13: 97 St NW (NB) at 160 Ave, Transverse crack, looking east



Photo 14: 97 St NW (NB) at Griesbach Rd, Transverse crack, looking east



Photo 15: 97 St NW (NB) at Griesbach Rd, General pavement condition, close-up