APPENDIX H: TETRA TECH GIRDER AND SUBSTRUCTURE CONDITION ASSESSMENT

TETRA TECH

ISSUED FOR USE

To:	Cam Ward, P.Eng., Bridge Projects Engineer	**Date:**	March 1, 2024
From:	Rhys Laffin, B.Sc. Mike Lyseyko, P.Eng.	**File:**	734-2200070600-MEMO-S0001-00
Copy To:	Emile Shehata, Ph.D., P.Eng. File	**Memo No.:**	734-2200070600-MEMO-S0001-00
Project:	Professional Consulting Services for Lagimodiere Blvd. Twin Overpasses Rehabilitation (Over Concordia Ave. and CPR Keewatin)		
Subject:	Bridge Condition Assessment Report		
Attachments:	Appendix A – Lagimodiere Blvd Twin Overpasses Condition Assessment Drawings Appendix B – Stantec – Investigation of the Lagimodiere Boulevard Twin Overpasses over Concordia Avenue and CPR Keewatin – Winnipeg, Manitoba Appendix C – Limitations on the Use of this Document		

This 'Issued for Review' document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an 'Issued for Use' document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the 'Issued for Review' document should be either returned to Tetra Tech Canada Inc. (Tetra Tech) or destroyed.

1.0 INTRODUCTION

1.1 Report Objective

The overall scope of the engineering assignment is to provide comprehensive project services that includes PD of major structure rehabilitation to the Concordia Overpass, Functional Design (FD) for future widening of Lagimodiere Boulevard (Lagimodiere), an AT (AT) network study, future phases, stakeholder relations and a targeted stakeholder consultation program.

The PD phase will consist of a site topographical survey, condition assessment and load rating of existing girders, bearings, and substructures. Upon completion of these assessments, the PD services will include design of bridge rehabilitation and modifications.

The scope of this report is to summarize the bridge condition assessment that was undertaken by Tetra Tech (Tt) in September 2022. This report will document the results of the investigations and provide interpretation of the results. Any decisions for rehabilitation strategies or methodologies will not be included in this report but will follow later in the project.

1.2 Project Background

Located at the center of Winnipeg's northeast quadrant, the Concordia Overpass crosses over Concordia Avenue (Concordia) and the Canadian Pacific Railway (CPR) Keewatin railway tracks where they intersect with Lagimodiere. On and Off ramps north of the overpass allow for traffic movements in all directions between Lagimodiere and Concordia. The cityscape surrounding the site is primarily residential, with River East and Transcona neighborhoods on the west and east sides. There is also commercial space with shopping centers to the south along Lagimodiere. To the west of the site along Concordia are significant healthcare facilities which include the Concordia Hospital as well as multiple elderly and special care housing facilities. As a result, traffic entering and exiting the area is a mix of commercial traffic, emergency vehicles, and residential traffic. Lagimodiere, which is part of Provincial Trunk Highway 59, is a major artery for mixed traffic travelling across or in and out of Winnipeg. Classified as a 4-lane Expressway, it stretches North of the city to the Chief Peguis Trail as part of the inner ring road, the Perimeter highway, and beyond to the Northeast extents of Southern Manitoba where it is an RTAC route.

The Concordia Overpass was built in 1967 and designed to AASHTO HS20-S16-44 Live Loading. The twin structures each consist of five 24-meter-long spans, which have five lines of precast prestressed concrete I-girders. The superstructure consists of a cast-in-place (CIP) concrete deck reinforced with black steel, originally 190 mm thick, which was increased to 230 mm in 1978 with a partial depth rehab. The current structures each have two 3.7-meter lanes with 0.75-meter shy distance on either side. The skew angle between the substructure and the superstructure is 35 degrees. Diaphragms are cast-in-place concrete, with three intermediate diaphragms and two end diaphragms for each girder span. The expansion joints are located directly above the substructure units and are either sliding steel plate or seal joints. The reinforced concrete substructure units consist of four hammerhead piers and two abutments which are all supported by cast in place concrete footings on driven precast prestressed concrete hexagonal (PPCH) piles.

A bridge deck investigation was performed by AECOM in 2017 and 2018, and biennial inspections continue to be performed by the City of Winnipeg (City), with the most recent in 2020. The concrete deck, which was entirely refinished in 1978 and locally refinished in 1987 is considered by the City to be in poor condition. Results from chloride testing performed by AECOM paired with a reinforcing cover survey show that chlorides have significantly penetrated the deck to the depth of the black steel reinforcing, and it is very likely that corrosion and deterioration of the deck will accelerate. Corrosion Potential Survey and Water-Soluble Chloride Ion Content testing show results that are consistent and indicated that corrosion of the reinforcing steel is a concern for the remainder of the life of the concrete deck. In addition, the epoxy-aggregate polymer deck sealant applied several times to the deck surface between 1993 and 2010 is failing. Due to overall condition, the scope of the project includes a replacement of the concrete bridge deck and railings. Therefore, an inspection of the bridge deck or barriers was not included in the scope for this assignment.

1.3 Construction and Maintenance

Routine inspections of the twin-bridges over their lifespan have noted continual deterioration of some of the concrete girder ends and pier concrete cantilever hammerheads caused by the leaking expansion joints at pier locations.

Repairs to the girder ends were undertaken in 2010 including concrete repairs and the installation of a metallized coating to all exterior girders ends to help mitigate corrosion of the girder strands/reinforcing. There was visual evidence that concrete patching of the girder top flanges, mostly on the exterior girders, have also occurred in the past.

In 2012, several of the pier hammerhead ends received the same metalized coating along with containment meshing as shown below. This meshing is to help contain the concrete in these areas from further delamination leading to the concrete spalling off. Steel meshing can be found on:

- NB Pier 1 – East Hammerhead on South Face, and partial East Hammerhead on North Face
- SB Pier 1 – East and West Hammerheads on South Face, and West Hammerhead on North Face
- SB Pier 2 – West Hammerhead on both the North and South Faces
- SB Pier 4 – West Hammerhead on South Face, and East Hammerhead/partial West Hammerhead on North Face

Figure 1 – Metalized Coating on Exterior Girder Ends

Figure 2 – Metalized Coating on Exterior Girder Ends

Figure 3 – Containment Meshing on Pier Hammerheads

Figure 4 – Containment Meshing on Pier Hammerheads

2.0 CONDITION ASSESSMENT & INSPECTION FINDINGS

2.1 Bridge Condition Assessment Summary

Tt performed the bridge condition assessment over three (3) weeks in September, 2022. Tt performed the visual inspection of all bridge elements, as well as being responsible for coordinating all activities including traffic control on both Concordia Avenue and Lagimodiere Blvd, and flagging operations on the CPR. Tt retained Stantec Consulting Ltd. for all concrete testing, and ATS Traffic Services for installing, maintaining, and removing all traffic control signage.

Access for the bridge condition assessment was obtained using Manual Elevated Work Platforms (MEWP), operated from below. Traffic control was arranged for lane closures on Concordia Avenue in stages to provide access for inspection of the entire bridge.

As per the Request for Proposed (RFP), the City provided the underbridge crane for two (2) days of inspection. Lane closures on Lagimodiere Blvd. were arranged in accordance with the City's requirements, and only occurred between non-peak hours.

Tt coordinated with CPR and a CPR flag-person was on-site for five days. All inspection work that took place within CP's right-of-way was performed under their supervision.

2.2 Inspection Methodology

Tt performed the condition assessment that consisted of a visual inspection of the substructure elements including, delamination survey, crack mapping survey, reinforcing cover survey, and bridge coring program. Condition assessment inspections took place in accordance with the Ontario Standards Inspection Manual (OSIM) and considered Ontario Structure Rehabilitation Manual (OSRM) methodology. RCT was completed in general compliance with Alberta Transportation's standard test methods. The full results of all testing performed can be found in *Appendix B – Stantec-Investigation of the Lagimodiere Boulevard Twin Overpasses Over Concordia Avenue and CPR Keewatin – Winnipeg, Manitoba.* Testing frequency is summarized in Table 2-1 and Table 2-2 below:

Table 2-1: Frequency of Testing for Lagimodiere Overpass Condition Assessment - NB

Testing Frequency	Compressive Strength	Hardened Air Void Analysis	Petrographic Analysis	Water Soluble Chloride	Rapid Chloride Testing
Piers – 4 Total	4	4	4	8	4
Abutments – 2 Total	2	2	2	4	
Girders	2	2		2	5

#

Table 2-2: Frequency of Testing for Lagimodiere Overpass Condition Assessment - SB

Testing Frequency	Compressive Strength	Hardened Air Void Analysis	Petrographic Analysis	Water Soluble Chloride	Rapid Chloride Testing
Piers – 4 Total	4	4	4	8	6
Abutments – 2 Total	2	2	2	4	
Girders	2	2		4	10

2.3 Substructure Delamination Survey

A delamination survey was conducted on all substructure elements by means of sounding hammers. Locations of delamination were marked on the substructure surface, and have been plotted on the *Lagimodiere Blvd Twin Overpasses Condition Assessment Drawings* in Appendix A. Overall observations from the sounding survey have been summarized below:

- Pier delamination's were primarily observed in the hammerhead portions of the pier and the east and west ends throughout the height of the pier
- Little to no delamination's were observed in the lower shaft of the piers
- Delamination was observed throughout both north and south abutments for each structure.
- If girder delamination's were found, they were primarily located at the girder ends
  - A full summary of the visual girder inspection can be found below in Section 2.8

Figure 1 – Delamination in NB Pier 3 Hammerhead

Figure 2 – Delamination in SB Pier 2 Ends

Figure 3 – Delamination in SB Pier 3 Hammerhead

Figure 4 – Delamination in NB North Abutment

2.4 Bridge Crack Mapping

TT inspected the substructures and girders for any significant cracking. Only medium and wide cracks (>0.3mm) were documented and recorded on the *Lagimodiere Blvd Twin Overpasses Condition Assessment Drawings* in Appendix A.

In general, there appeared to be no pattern to any observed cracking that would suggest any structural deficiencies. Several wide cracks (>1.0mm) were observed in the piers, but these cracks were associated with areas of delamination. The ends of the girders were observed closely for any indication of shear cracking, specifically near bearings, and none was observed.

2.5 Substructure Cover Meter Survey

The cover meter survey took place for various substructure elements including the piers, abutments and wingwalls. The cover meter survey was completed on a 1m-by-1m grid pattern for all structural elements.

Table 2-3: Summary of Substructure Cover Meter Survey Data – NB Structure

Structure ID	Test Location		Number of Readings	Concrete Cover (mm)	
				Range	Average
South Abutment (N-0)	Abutment Face		15	38 – 73	54
	East Wingwall		24	36 – 108	63
	West Wingwall		24	36 – 110	61
Pier 1 (N-1)	Pier 1 - North Face	Upper Hammerhead	16*	28 – 62	47
		Lower Shaft	20	35 – 60	47
	Pier 1 – South Face	Upper Hammerhead	22*	33 – 74	48
		Lower Shaft	20	36 – 75	52
Pier 2 (N-2)	Pier 2 - North Face	Upper Hammerhead	29	19 – 75	51
		Lower Shaft	25	39 – 79	53
	Pier 2 – South Face	Upper Hammerhead	29	35 – 72	48
		Lower Shaft	25	36 – 55	45
Pier 3 (N-3)	Pier 3 - North Face	Upper Hammerhead	29	39 – 85	60
		Lower Shaft	25	40 – 76	53
	Pier 3 – South Face	Upper Hammerhead	29	34 – 79	50
		Lower Shaft	25	33 – 61	49
Pier 4 (N-4)	Pier 4 - North Face	Upper Hammerhead	29	31 – 85	48
		Lower Shaft	20	35 – 71	49
	Pier 4 – South Face	Upper Hammerhead	29	25 – 61	47
		Lower Shaft	20	32 – 68	45
North Abutment (N-5)	Abutment Face		13	33 – 82	52
	East Wingwall		20	27 – 79	56
	West Wingwall		21	39 – 95	66

**Steel mesh installed on pier ends prevented the ability to obtain all readings on pier face*

Table 2-5: Summary of Substructure Cover Meter Survey Data – SB Structure

Structure ID	Test Location		Number of Readings	Concrete Cover (mm)	
				Range	Average
South Abutment (S-0)	Abutment Face		15	43 – 98	67
	East Wingwall		24	50 – 161	90
	West Wingwall		24	56 – 114	79
Pier 1 (S-1)	Pier 1 – North Face	Upper Hammerhead	22*	42 – 73	53
		Lower Shaft	20	32 – 74	47
	Pier 1 – South Face	Upper Hammerhead	28*	20 – 81	56
		Lower Shaft	20	38 – 64	48
Pier 2 (S-2)	Pier 2 – North Face	Upper Hammerhead	27*	27 – 83	46
		Lower Shaft	25	29 – 59	47
	Pier 2 – South Face	Upper Hammerhead	27*	36 – 73	50
		Lower Shaft	25	26 – 59	39
Pier 3 (S-3)	Pier 3 – North Face	Upper Hammerhead	29	37 – 77	56
		Lower Shaft	25	41 – 70	51
	Pier 3 – South Face	Upper Hammerhead	29	25 – 71	43
		Lower Shaft	25	40 – 63	53
Pier 4 (S-4)	Pier 4 – North Face	Upper Hammerhead	25*	24 – 74	53
		Lower Shaft	20	39 – 61	51
	Pier 4 – South Face	Upper Hammerhead	25*	36 – 73	51
		Lower Shaft	20	18 – 68	49
North Abutment (S-5)	Abutment Face		13	33 – 82	52
	East Wingwall		20	27 – 79	56
	West Wingwall		21	39 – 95	66

Structure ID | **Test Location** | **Number of Readings** | **Concrete Cover (mm)**

**Steel mesh installed on pier ends prevented the ability to obtain all readings on pier face*

2.6 Substructure Corrosion Potential Survey

The corrosion potential survey took place on the substructure elements including the piers, abutments and wingwalls. The corrosion potential survey was conducted on a 1m-by-1m grid pattern, as outlined in the OSRM in accordance with ASTM C876, *Standard Test Method for Half Cell Potentials of Uncoated Reinforcing Steel in Concrete.* The complete corrosion potential survey data can be found in *Appendix B – Stantec-Investigation of the Lagimodiere Boulevard Twin Overpasses Over Concordia Avenue and CPR Keewatin – Winnipeg, Manitoba*. A summary of the results is shown in Table 2-5 below:

Table 2-4: Summary of Substructure Corrosion Potential Survey Data – NB Structure

Test Location	Corrosion Activity (% of area tested)		
	90% Probability of Corrosion	Corrosion Activity is Uncertain	90% Probability of No Corrosion
South Abutment (N-0) – Including Wingwalls	82%	16%	2%
Pier 1 (N-1)	23%	27%	50%
Pier 2 (N-2)	1%	19%	80%
Pier 3 (N-3)	12%	30%	58%
Pier 4 (N-4)	0%	19%	81%
North Abutment (N-5) – Including Wingwalls	79%	21%	0%

Table 2-6: Summary of Substructure Corrosion Potential Survey Data – SB Structure

Test Location	Corrosion Activity (% of area tested)		
	90% Probability of Corrosion	Corrosion Activity is Uncertain	90% Probability of No Corrosion
South Abutment (S-0) – Including Wingwalls	97%	3%	0%
Pier 1 (S-1)	48%	14%	38%
Pier 2 (S-2)	11%	16%	73%
Pier 3 (S-3)	35%	21%	44%
Pier 4 (S-4)	34%	24%	42%
North Abutment (S-5) – Including Wingwalls	98%	32%	0%

2.7 Rapid Chloride Testing (RCT) Program

The RCT program took place in accordance with Alberta Transportation standard test method and was performed by Stantec. Frequency of test locations for each of the NB and SB structures are noted in Table 2-1 and Table 2-2 with locations plotted on the *Lagimodiere Blvd Twin Overpasses Condition Assessment Drawings* in Appendix A. A summary of the RCT results is shown below in Table 2-6 where complete results can be found in Appendix B – *Stantec-Investigation of the Lagimodiere Boulevard Twin Overpasses Over Concordia Avenue and CPR Keewatin – Winnipeg, Manitoba*.

Table 2-5: Summary of Rapid Chloride Test Results

Sample ID No.	Bridge Structure	Structure Element	Powder Sample Recovery Location	Sample Depth (mm)	Acid-Soluble Rapid Chloride Ion Content (% by mass of concrete)
			Girders		
5539	Southbound	Girder 2	Span 3, southbound, girder 2, end block at pier 3	50	0.014
5540	Southbound	Girder 4	Span 3, southbound, girder 4, end block at pier 3	50	0.016
5541	Northbound	Girder 4	Span 3, northbound, girder 4, end block at pier 3	50	0.005
5542	Northbound	Girder 3	Span 3, northbound, girder 3, end block at pier 3	50	0.006
5543	Northbound	Girder 5	Span3, northbound, girder 5, good area of lower flange	50	0.013
5546	Southbound	Girder 4	Span 3, southbound, girder 4, bad area of upper flange	50	**0.151**
5547	Southbound	Girder 4	Span 3, southbound, girder 4, bad area of lower flange	100	**0.154**
5548	Southbound	Girder 3	Span 3, southbound, girder 3, bad area of upper flange, 2.5 m from south diaphragm	50	**0.166**
5549	Southbound	Girder 3	Span 3, southbound, girder 3, bad area of lower flange, 2.5 m from south diaphragm	100	0.006
5550	Southbound	Girder 2	Span 3, southbound, girder 2, good area of upper flange, 2.5 m from south diaphragm	50	0.014
5551	Southbound	Girder 2	Span 3, southbound, girder 2, good area of lower flange, 2.5 m from south diaphragm	50	0.005
5554	Southbound	Girder 1	Span 4, southbound, girder 1, bad area of upper flange, 1.42 m from diaphragm	50	**0.402**
5555	Southbound	Girder 1	Span 4, southbound, girder 4, extremely bad area of upper flange, 1.42 m from diaphragm	50	**0.142**
5560	Northbound	Girder 1	Span 4, northbound, girder 1, extremely bad area of upper flange	50	**0.398**
5561	Northbound	Girder 5	Span 4, northbound, girder 5, bad area of upper flange	50	**0.057**
			Piers		
5544	Southbound	Pier 3	Pier 3, southbound, south face, west end	50	**0.212**
5545	Southbound	Pier 3	Pier 3, southbound, south face, west end	100	**0.087**
5552	Northbound	Pier 2	Pier 2, northbound, northwest face	50	**0.224**

Sample ID No.	Bridge Structure	Structure Element	Powder Sample Recovery Location	Sample Depth (mm)	Acid-Soluble Rapid Chloride Ion Content (% by mass of concrete)
5553	Northbound	Pier 2	Pier 2, northbound, northwest face	100	**0.047**
5556	Southbound	Pier 4	Pier 4, southbound, south face, west end	50	**0.234**
5557	Southbound	Pier 4	Pier 4, southbound, south face, west end	100	**0.155**
5558	Northbound	Pier 4	Pier 4, northbound, south face, west end	50	**0.949**
5559	Northbound	Pier 4	Pier 4, northbound, south face, west end	100	**0.388**
5562	Southbound	Pier 4	Pier 4, southbound, south face, east end	50	**0.608**
5563	Southbound	Pier 4	Pier 4, southbound, south face, east end	100	**0.125**

#

41 Wkh#fkorulgh#wkuhvkrog#qhfhvvdu|#wr#shuplw#fruurvlrq#lq#wkh#uhlqirufloj#vwhho#zlwk#wkh#suhvhqfh#ri#r{|jhq#dqg#zdwhu#pxvw#eh#juhdwhu#wkdq#31358(#e|#pdvv#

51 Wkh#fkorulgh#uhvxow#h{fhhglqj#wklv#ydoxh#duh#kljkoljkwhg#lq#uhg1#

2.8 Bridge Coring/Testing Program

Cores were obtained from the piers, abutments and girders to complete compressive strength, hardened air void analysis, petrographic analysis, and water soluble chloride content testing. Samples were taken from various locations throughout each substructure element to generate a wide spread of data samples. All core locations have been plotted on the *Lagimodiere Blvd Twin Overpasses Condition Assessment Drawings* in Appendix A. Full results can be found in *Appendix B – Stantec-Investigation of the Lagimodiere Boulevard Twin Overpasses Over Concordia Avenue and CPR Keewatin – Winnipeg, Manitoba*. Below is a summary of the results:

Table 2-6: Summary of Compressive Strength Test Results

Core ID No.	Bridge Structure	Structure Element	Core Location	Compressive Strength (MPa)
Abutments				
5489	Northbound	Abutment N-0	2.6 m east from centerline of south abutment, 0.25 m below top of abutment, north face	60.2
5494	Northbound	Abutment N-5	2.57 m east from west end of north abutment, 0.35 m below top of abutment, south face	47.4
5495	Southbound	Abutment S-0	1.3 m west from east end of south abutment, 0.3 m below top of abutment, north face	54.5
5500	Southbound	Abutment S-5	1.35 m east from centerline of north abutment, 0.45 m below top of pier, south face	55.1
Piers				
5490	Northbound	Pier N-1	0.05 m east from centerline of pier, 0.85 m below top of pier, south face	51.3
5491	Northbound	Pier N-2	1.35 m west from centerline of pier, 0.6 m below top of pier, south face	44.5

TETRA TECH

Core ID No.	Bridge Structure	Structure Element	Core Location	Compressive Strength (MPa)
5492	Northbound	Pier N-3	1.8 m west from centerline of pier, 0.25 m below top of pier, north face	54.4
5493	Northbound	Pier N-4	0.3 m east from centerline of pier, 1.85 m below top of pier, south face	46.8
5496	Southbound	Pier S-1	0.65 m east from centerline of pier, 0.7 m below top of pier, south face	66.8
5497	Southbound	Pier S-2	0.6 m west from centerline of pier, 0.6 m below top of pier, south face	49.5
5498	Southbound	Pier S-3	0.9 m east from centerline of pier, 1.65 m below top of pier, north face	58.5
5499	Southbound	Pier S-4	0.99 m west from centerline of pier, 0.62 m below top of pier, south face	47.7
Girders				
5529	Southbound	Girder S-2	Centerline of girder 2 at pier 2	54.5
5530	Northbound	Girder N-3	Centerline of girder 3 at pier 1	67.6
5531	Southbound	Girder S-2	Centerline of girder 2 at pier 3	65.9
5532	Northbound	Girder N-2	Centerline of girder 2 at pier 3	78.3

Table 2-7: Summary of Hardened Air Void Analysis Results

Core ID No.	Bridge Structure	Structure Element	Core Location	Total Air Content (%)	Spacing Factor (μm)
Abutments					
5477	Northbound	Abutment N-0	2.3 m east from centerline of south abutment, 0.2 m below top of abutment, north face	**2.9**	**409**
5482	Northbound	Abutment N-5	2.75 m east from west end of north abutment, 0.3 m below top of abutment, south face	4.7	146
5483	Southbound	Abutment S-0	1.0 m west from east end of south abutment, 0.6 m below to of abutment, north face	3.6	179
5488	Southbound	Abutment S-5	1.95 m east from centerline of north abutment, 0.45 m below top of abutment, south face	**2.7**	214
Piers					
5478	Northbound	Pier N-1	Centerline of pier, 0.55 m below top of pier, south face	5.1	152
5479	Northbound	Pier N-2	1.35 m west from centerline of pier, 0.5 m below top of pier, south face	3.6	145
5480	Northbound	Pier N-3	2.0 m west from centerline of pier, 0.25 m below top of pier, north face	3.0	172

Core ID No.	Bridge Structure	Structure Element	Core Location	Total Air Content (%)	Spacing Factor (µm)
5481	Northbound	Pier N-4	0.3 m east from centerline of pier, 1.6 m below top of pier, south face	5.6	164
5484	Southbound	Pier S-1	0.7 m east from centerline of pier, 1.5 m up from bottom of pier, south face	3.9	216
5485	Southbound	Pier S-2	0.3 m east from centerline of pier, 0.6 m below top of pier, south face	5.1	188
5486	Southbound	Pier S-3	0.9 m east from centerline of pier, 1.65 m below top of pier, north face	4.6	219
5487	Southbound	Pier S-4	1.35 m west from centerline of pier, 0.6 m below top of pier, south face	4.8	122
Girders					
5525	Southbound	Girder S-3	Centerline of girder 3 at pier 1	3.0	228
5526	Northbound	Girder N-3	Centerline of girder 3 at pier 1	**1.5**	235
5527	Southbound	Girder S-5	Centerline of girder 5 at north abutment	**2.3**	**388**
5528	Northbound	Girder N-2	Centerline of girder 2 at south abutment	**2.8**	249
CSA A23.1 Specification Limits for Frost Resistant Concrete				**3.0 min.**	**260 max.**

Table 2-8: Summary of Water-Soluble Chloride Ion Content Test Results

Core ID No.	Bridge Structure	Structure Element	Core Recovery Location	Sample Depth (mm)	WSC Content (% by mass of concrete)
Abutments					
5501	Northbound	Abutment N-0	2.0 m east from centerline of south abutment, 0.45 m below top of abutment, north face	25 to 35	**0.146**
				60 to 70	**0.057**
				100 to 110	**0.028**
5502	Northbound	Abutment N-0	4.4 m east from centerline of south abutment, 0.25 m below top of abutment, north face	25 to 35	**0.069**
				60 to 70	0.017
				100 to 110	<0.010
5511	Northbound	Abutment N-5	0.3 m east from west face of north abutment, 0.35 m below top of abutment, south face	25 to 35	**0.204**
				60 to 70	**0.103**
				100 to 110	0.024
5512	Northbound	Abutment N-5	1.95 m east from centerline of north abutment, 0.45 m below top of abutment, south face	25 to 35	**0.168**
				60 to 70	**0.048**
				100 to 110	0.011
5513	Southbound	Abutment S-0	1.0 m west from centerline of south abutment, 0.3 m below top of abutment, north face	25 to 35	**0.248**
				60 to 70	**0.102**
				100 to 110	**0.033**
5514	Southbound	Abutment S-0	4.05 m east from centerline of south abutment, 0.3 m below top of abutment, north face	25 to 35	**0.410**
				60 to 70	**0.187**
				100 to 110	0.025

Core ID No.	Bridge Structure	Structure Element	Core Recovery Location	Sample Depth (mm)	WSC Content (% by mass of concrete)
5523	Southbound	Abutment S-4	1.25 m east from centerline of north abutment, 0.45 m below top of abutment, south face	25 to 35	**0.738**
				60 to 70	**0.239**
				100 to 110	**0.061**
5524	Southbound	Abutment S-4	0.6 m east from west end of north abutment, 0.45 m below top of abutment, south face	25 to 35	**0.166**
				60 to 70	0.022
				100 to 110	<0.010
Girders					
5503	Northbound	Pier N-1	Centerline of pier, 0.95 below top of pier, south face	25 to 35	**0.067**
				60 to 70	**0.038**
				100 to 110	0.016
5504	Northbound	Pier N-1	1.4 m west from centerline of pier, 1.55 m up from bottom of pier, south face	25 to 35	**0.094**
				60 to 70	0.023
				100 to 110	<0.010
5505	Northbound	Pier N-2	1.35 m west from centerline of pier, 0.75 m up from bottom of pier, south face	25 to 35	**0.034**
				60 to 70	<0.010
				100 to 110	<0.010
5506	Northbound	Pier N-2	0.1 m west from centerline of pier, 1.45 m up from bottom of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5507	Northbound	Pier N-3	1.75 m west from centerline of pier, 0.35 m below top of pier, north face	25 to 35	**0.033**
				60 to 70	<0.010
				100 to 110	<0.010
5508	Northbound	Pier N-3	0.45 m west from centerline of pier, 1.25 m up from bottom of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5509	Northbound	Pier N-4	Centerline of pier, 1.85 m below top of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5510	Northbound	Pier N-4	1.97 m east from west face of pier, 1.15 m up from bottom of pier, north face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5515	Southbound	Pier S-1	0.7 m east from centerline of pier, 1.1 m below top of pier, south face	25 to 35	**0.058**
				60 to 70	<0.010
				100 to 110	<0.010
5516	Southbound	Pier S-1	2.1 m east from centerline of pier, 1.5 m up from bottom of pier, south face	25 to 35	**0.448**
				60 to 70	**0.120**
				100 to 110	<0.010
5517	Southbound	Pier S-2		25 to 35	<0.010
				60 to 70	<0.010

Core ID No.	Bridge Structure	Structure Element	Core Recovery Location	Sample Depth (mm)	WSC Content (% by mass of concrete)
			0.35 m west from centerline of pier, 0.7 m below top of pier, south face	100 to 110	<0.010
5518	Southbound	Pier S-2	0.15 m west from centerline of pier, 1.5 m up from bottom of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5519	Southbound	Pier S-3	0.9 m east from centerline of pier, 1.75 m below top of pier, north face	25 to 35	**0.372**
				60 to 70	**0.149**
				100 to 110	0.01
5520	Southbound	Pier S-3	0.45 m west from centerline of pier, 1.4 m up from bottom of pier, south face	25 to 35	0.014
				60 to 70	<0.010
				100 to 110	<0.010
5521	Southbound	Pier S-4	1.33 m west from centerline of pier, 0.3 m below top of pier, south face	25 to 35	0.013
				60 to 70	<0.010
				100 to 110	<0.010
5522	Southbound	Pier S-4	1.96 m east from centerline of pier, 2.0 m up from bottom of pier, north face	25 to 35	0.012
				60 to 70	<0.010
				100 to 110	<0.010
Girders					
5533	Southbound	Girder S-1	Centerline of girder 1 at pier 2	25 to 35	0.016
				60 to 70	0.011
				100 to 110	0.013
5534	Southbound	Girder S-4	Centerline of girder 4 at pier 4	25 to 35	0.013
				60 to 70	0.014
				100 to 110	<0.010
5535	Southbound	Girder S-1	Centerline of girder 1 at north abutment	25 to 35	0.018
				60 to 70	0.011
				100 to 110	0.013
5536	Southbound	Girder S-3	Centerline of girder 3 at pier 3	25 to 35	0.018
				60 to 70	0.011
				100 to 110	<0.010
5537	Northbound	Girder N-3	Centerline of girder 3 at pier 3	25 to 35	0.012
				60 to 70	0.012
				100 to 110	0.012
5538	Northbound	Girder N-5	Centerline of girder 5 at south abutment	25 to 35	0.014
				60 to 70	0.013
				100 to 110	0.013

41 Wkh#fkorulgh#wkuhvkrog#qhfhvvdu|#wr#shup lw#fruurvlrq#lq#wkh#uhlqirufLqj#vwhho#z lwk#wkh#suhvhqfh#ri#r{|jhq#dqg#z dwhu#p xvw#eh# juhdwhu#wkdq#31358 (#e|#p dvv#
51 Wkh#fkorulgh#uhvxow#h{fhhglqj#wklv#ydoxh#duh#kljkoljkwhg#lq#uhg1#
61 Wkh#uhsruwlqj#ghwhfwdeoh,#lp lw#lv#31343 (1#

2.9 Petrographic Analysis

Concrete cores for petrographic analysis were taken at half the substructure units. Unfortunately, there is a nation-wide backlog at the only lab in Canada that provides the services of performing the thin-slice analysis. This means that the time for petrographic results are taking significantly longer than the usual 6-8 weeks that were anticipated at the beginning of the project.

Results from the petrographic analysis should be ready earlier 2023 and will be included in this report at that time.

2.10 Visual Inspection of Concrete Bridge Girders

A visual inspection of the existing concrete girders was performed to assess their condition. In general, the girders were found to be in fair to good condition overall. Patching of the exterior girders top flanges was found throughout both structures, with some of the girder ends patched as well. Metalized coatings have been applied to all exterior girder end blocks. Minimal cracking and or delamination was observed throughout both structures. The main defect found at various locations throughout both structures was surface scaling, mainly on the girder top flanges from leaks associated to the deck. Detailed markups and locations of girder defects can be found in Appendix A - *Lagimodiere Blvd Twin Overpasses Condition Assessment Drawings.* Notable observations and defects have been summarized below:

- Girder Delamination's:
  - G5 Top Flange - NB Structure, Span 3, near Pier 2
  - G5 Full Height (600mm wide) - NB Structure, Span 4, between Pier 3 and South Diaphragm
  - G5 Top Flange - SB Structure, Span 3, near Pier 2
- Vertical Hairline Cracking:
  - G3 End Block - NB Structure, Span 1, at Pier 1
  - G4 End Block - NB Structure, Span 2, at Pier 1
  - G2 End Block - NB Structure, Span 3, at Pier 3
- Patched Girder End's:
  - G2 - NB Structure, Span 1, at Pier 1
  - G3 - NB Structure, Span 1, at Pier 1
  - G4 - NB Structure, Span 1, at Pier 1
  - G2 - NB Structure, Span 2, at Pier 1
  - G3 - NB Structure, Span 2, at Pier 1
  - G2 - NB Structure, Span 2, at Pier 2
  - G3 - NB Structure, Span 2, at Pier 2
  - G3 - NB Structure, Span 3, at Pier 2

  - G4 - NB Structure, Span 3, at Pier 2
  - G3 - NB Structure, Span 3, at Pier 3
  - G4 - NB Structure, Span 3, at Pier 3
  - G3 - SB Structure, Span 3, at Pier 2
- Damaged Girder End's:
  - Cracked GE Bottom, G2 - NB Structure, Span 1, at Pier 1
  - Cracked GE Bottom, G2 - NB Structure, Span 2, at Pier 1
  - Cracked GE Bottom, G3 - NB Structure, Span 3, at Pier 3
  - Cracked GE Bottom, G4 - NB Structure, Span 3, at Pier 3
  - Cracked GE Bottom, G1 - SB Structure, Span 1, at Pier 1
  - Delaminated GE, G3 – SB Structure, Span 1, at Pier 1
  - Delaminated GE, G1 – SB Structure, Span 2, at Pier 2
  - Delaminated GE, G1 – SB Structure, Span 3, at Pier 2
  - Cracked GE Bottom, G4 - SB Structure, Span 3, at Pier 3
  - Cracked GE Bottom, G4 - SB Structure, Span 4, at Pier 3
  - Delaminated GE, G4 – SB Structure, Span 4, at Pier 4

Figure 12: Delaminated GE, G3 – SB Structure, Span 1, at Pier 1

Figure 12: G5 Full Height Delamination (600mm wide)
NB Structure, Span 4, between Pier 3 and South Diaphragm

Figure 12: Cracked GE Bottom, G4 - SB Structure, Span 3, at Pier 3

Figure 12: Surface Scaling Found at Various Locations

2.11 Visual Inspection of Bridge Bearings

Tetra Tech performed a visual inspection of all bearings and bearing seats during the investigation. Overall, the bearings were found to be in good condition, with slight bulging of the bearings observed in some locations. It was observed that the exterior girder bearings have overspray of the metalized coating that was applied to the girder ends. The bearings seats on the piers were found to be in good condition with little to no delamination/surface defects observed. The abutment bearing seats were found to be in poorer condition compared to the piers with higher quantities of delamination and cracking found.

3.0 SUMMARY AND INTERPRETATION OF RESULTS

3.1 Concrete Piers

3.1.1 Physical Condition

The concrete on the pier hammer heads is poor, with extensive delaminations and spalls. The remainder of the pier shaft is generally in good condition, with minor delaminations or defects. The exception is the pier ends, directly under the hammerheads, which are also delaminated in several locations.

3.1.2 Test Results

The results from the concrete testing indicate that the pier concrete is generally of good quality. The compressive strength results determined that that concrete is of moderate to high strength, well exceeding the original design strength of 26 MPa. The air void analysis does not indicate any concrete durability concerns. The preliminary petrographic results are favorable, but the final results, including the thin-slice analysis, are still forthcoming.

The results from the WSC and RCT chloride tests indicate that generally the chlorides in the hammer heads exceeds the threshold for corrosion of reinforcing. This is corroborated by the results from the corrosion potential test which shows a higher probability of reinforcing corrosion on the hammer heads compared to the main pier shaft.

3.1.3 Interpretation of Results

Concrete repairs will be required for a major rehabilitation of the concrete piers to increase their remaining service life. This will most likely include a partial depth concrete replacement for at least the pier hammer heads. Based on the test results from the half-cell testing, we anticipate that the reinforcing in the hammer heads is undergoing corrosion, and replacement of some, if not all, the reinforcing will be required. The results from the WSC tests at the 100-110mm, do not indicate that the chlorides have progressed past the depth of reinforcing in the concrete, and that there should be no concerns with the pier base concrete.

The quality of the concrete is sound, and any of the defects that were observed are to be accredited to the leaking expansion joints over the lifespan of the bridge. Addressing this issue with a deck replacement should reduce the risk of continual chloride ingress into the pier concrete and further deterioration of the piers.

3.2 Concrete Abutments

3.2.1 Physical Condition

The concrete on the abutments is generally in fair condition, with multiple delaminations and spalls noted throughout the entire area. Defects are not limited in location, and occur along both the bearing seat and the abutments wingwalls.

3.2.2 Test Results

The results from the concrete testing indicate that the abutment concrete is generally of good quality. The compressive strength results determined that that concrete is of moderate to high strength, well exceeding the original design strength of 26 MPa. The air void analysis indicates that the concrete may be susceptible to freeze-thaw damage, but no concrete deterioration attributed to this mode of failure was observed, ie excessive concrete scaling, failure of concrete paste and aggregate exposure. The preliminary petrographic results are favorable, but the final results, including the thin-slice analysis, is still forthcoming.

The results from the WSC and RCT chloride tests indicate that generally the chlorides in the abutments exceeds the threshold for corrosion of reinforcing. This is corroborated by the results from the corrosion potential test which shows a high probability of reinforcing corrosion throughout the abutment concrete, including the wingwalls.

3.2.3 Interpretation of Results

Concrete repairs will be required for a major rehabilitation of the concrete abutments to increase their remaining service life. This will most likely include a partial depth concrete replacement for the areas with concrete delaminations. Based on the test results from the half-cell testing, we anticipate that the reinforcing in the abutments is undergoing corrosion, and replacement of some, if not all, the reinforcing within concrete repair areas will be required. The results from the WSC tests at the 100-110mm, indicate that the chlorides have progressed past the depth of reinforcing in the concrete in a few locations. Repairs details may need to consider methods to address high chlorides in areas without concrete repairs, including cathodic protection.

The quality of the concrete is sound, and any of the defects that were observed are to be accredited to the leaking expansion joints over the lifespan of the bridge. Addressing this issue with a deck replacement should reduce the risk of continual chloride ingress into the concrete and further deterioration of the abutments.

3.3 Concrete Girders

3.3.1 Physical Condition

The concrete girders are generally in good condition, with a few isolated areas of deterioration. There is one location of delamination noted in the girder, and a few isolated areas of delaminations in the girder top flange. There was no indication of shear cracking at any girder location.

3.3.2 Test Results

The results from the concrete testing indicate that the girder concrete is generally of good quality. The compressive strength results determined that that concrete is of moderate to high strength, well exceeding the original design strength of 28 MPa. The air void analysis indicates that the concrete may be susceptible to freeze-thaw damage, but no concrete deterioration attributed to this mode of failure was observed, ie excessive concrete scaling, failure of concrete paste and aggregate exposure.

The results from the WCS indicates that the chloride levels in the girder end-blocks are low and do not exceed the threshhold for reinforcing corrosion. The results from the RCT indicates that the girder top flanges potentially have chloride issues, with tests in multiple locations exceeding the threshold for reinforcing corrosion. The samples were taken at varying location in the girder and bottom flanges, and were characterized by the quality of the deck soffit above the girder location. Areas where the concrete deck was showing signs of deterioration (water or rust staining, cracking, efflorescence, etc) were deemed as bad areas for the flanges.

3.3.3 Interpretation of Results

The concrete quality of the girders is sound and of high strength. Concrete repairs will be required in a few isolated areas, but partial depth concrete repairs should be possible without impact to the prestressing steel.

The high chlorides from the RCT results in the girder top flanges is concerning. The measured chloride levels indicates that the reinforcing in the top flanges, and possible into the girder webs, is undergoing corrosion. No visual effects of reinforcing corrosion were observed in these areas, including rust staining, delaminations, or spalls. However, the presence of past concrete patches in the girder top flanges indicates that this is not an isolated concern and has possibly caused issued in the past. The installation of a new bridge deck will reduce the ability of new chlorides to permeate into the girders and further increase the concentration. The main concern for corrosion of the reinforcing is not the prestressing strands, which generally have a larger concrete cover, but more the shear reinforcing stirrups. Consideration will need to be given and possible reduction of capacity of the girders may be needed in the load rating and design to account for possible corrosion of girder reinforcing.

4.0 CONCLUSION

With the exception of the petrographic analysis results, Tetra Tech has completed the substructure investigation for the Lagimodiere Blvd. Twin Overpass. Tetra Tech will coordinate with the City for a discussion on the results of the investigation to proceed with the development of the next phase in preliminary design.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the City of Winnipeg (the City) 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, 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 in the Contractual Terms and Conditions executed by both parties.

6.0 CLOSURE

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

Respectfully submitted,
Tetra Tech Canada Inc.

Prepared by:
Mike Lyseyko, P.Eng.
Structural Engineer
Direct Line: 204.298.3866
mike.lyseyko@tetratech.com

Reviewed by:
Rhys Laffin, EIT
Structural Designer
Direct Line: 204.954.6866
rhys.laffin@tetratech.com

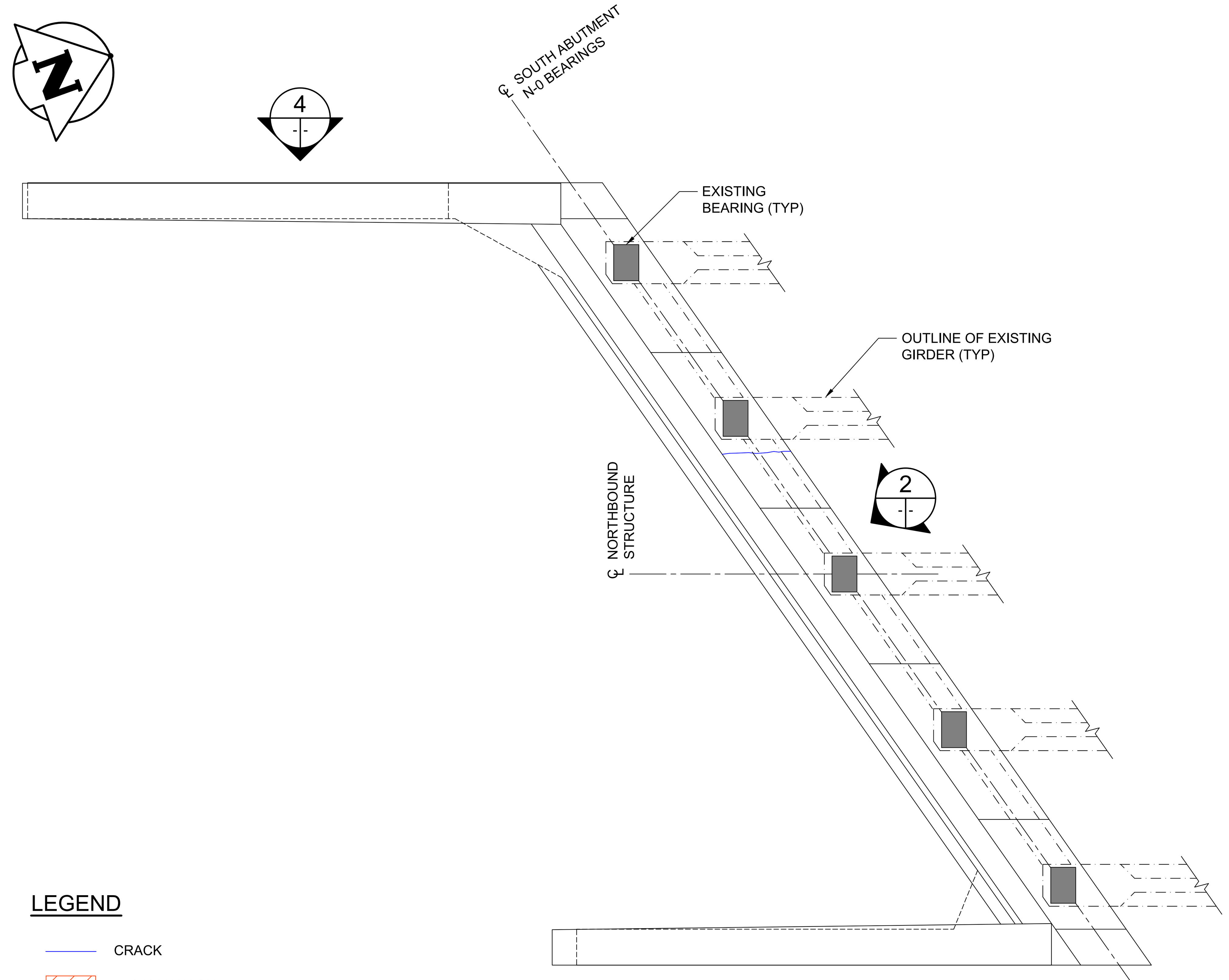
Prepared by:
Emile Shehata, Ph.D., P.Eng.
IAE Unit President
Direct Line: 204.954.6907
emile.Shehata@tetratech.com

ML/RL/ac

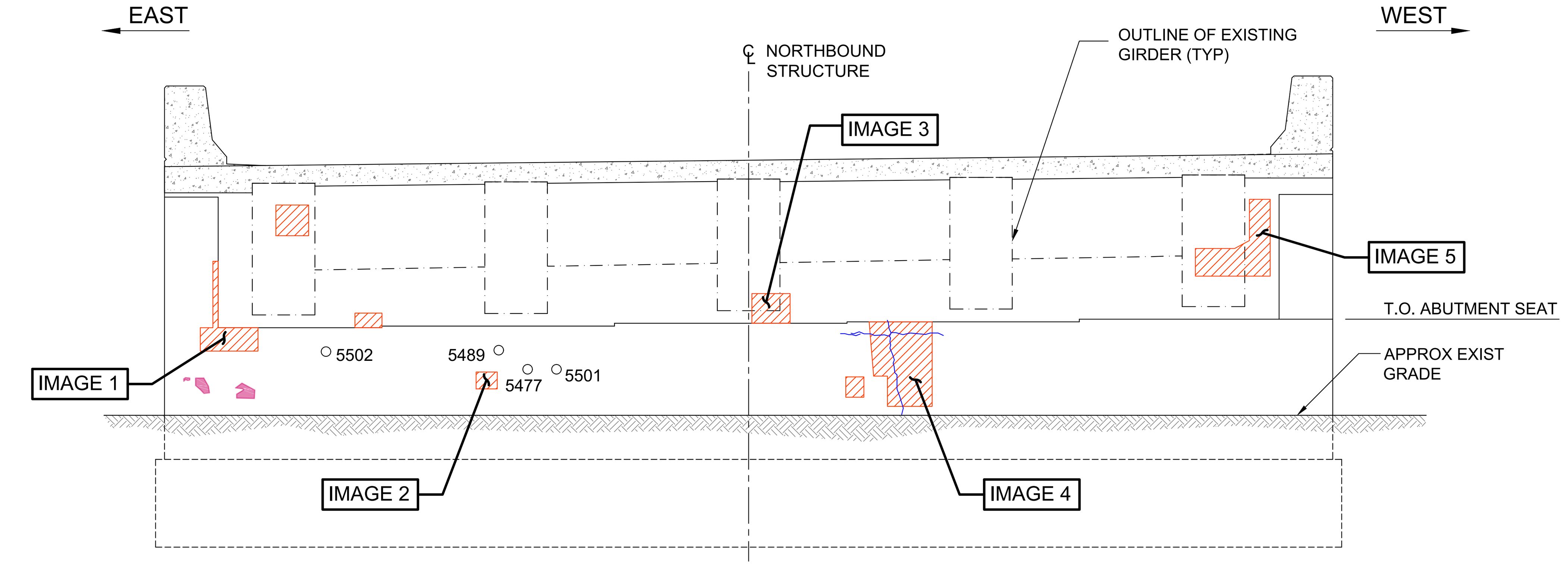
Enclosures: Lagimodiere Blvd Twin Overpasses Condition Assessment Drawings
STANTEC – Investigation of the Lagimodiere Boulevard Twin Overpasses over Concordia Avenue and CPR Keewatin – Winnipeg, Manitoba
Limitations on the Use of this Document

APPENDIX A

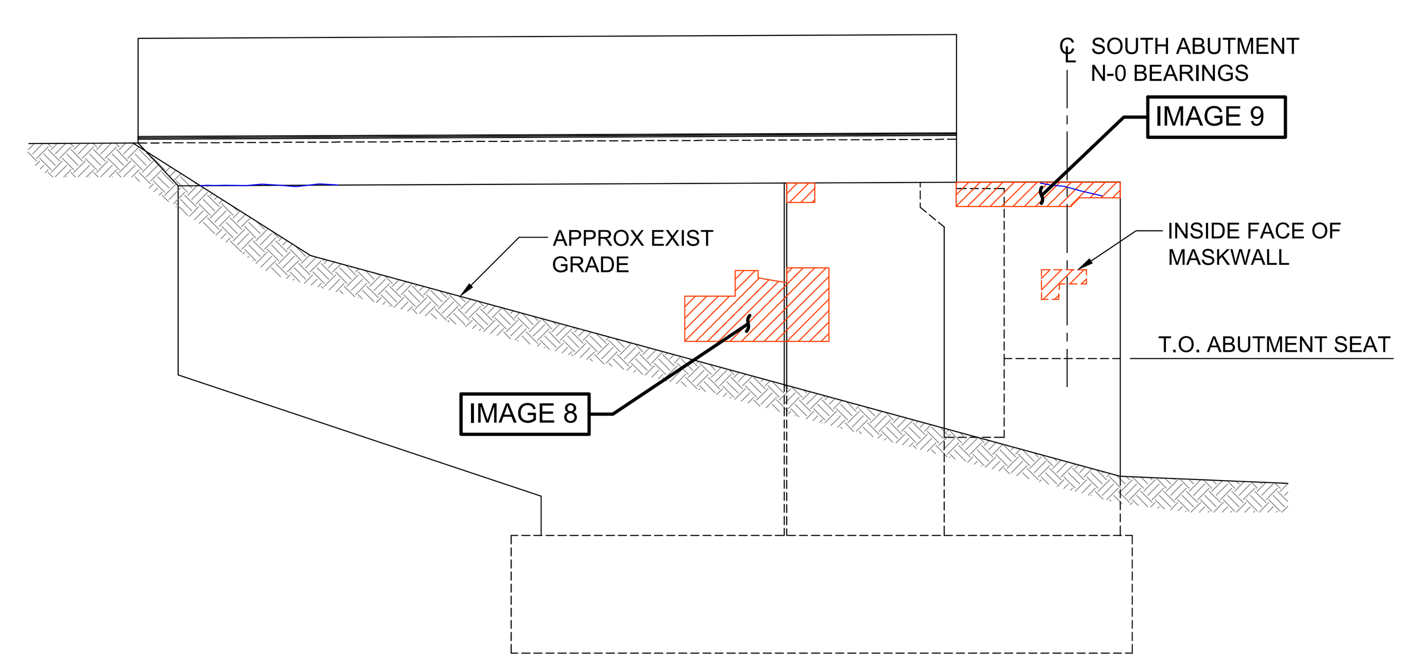
LAGIMODIERE BLVD TWIN OVERPASSES CONDITION ASSESSMENT DRAWINGS



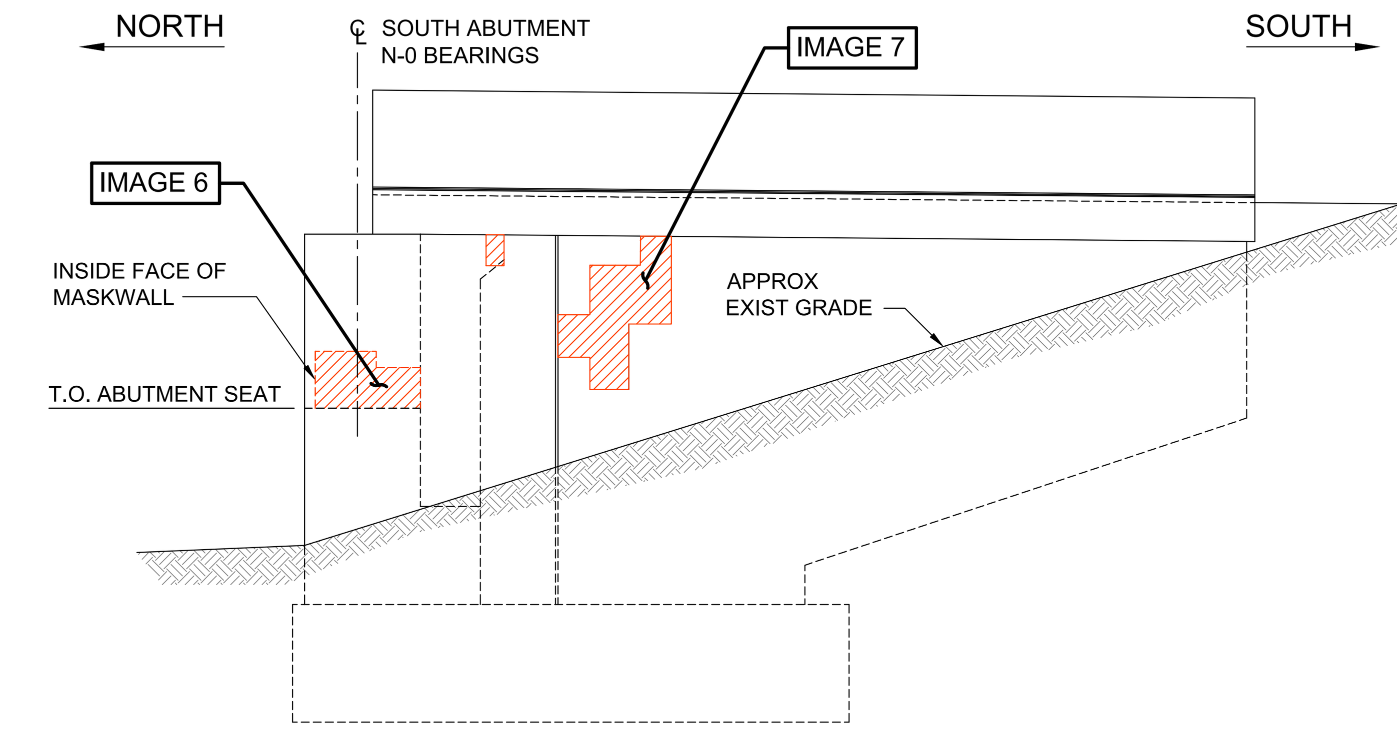
1 PLAN - ABUT N-0
1 : 50



2 ABUT N-0 - FRONT ELEVATION
1 : 50



3 ABUT N-0 - EAST ELEVATION
1 : 50



4 ABUT N-0 - WEST ELEVATION
1 : 50

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED.


IMAGE 1


IMAGE 2


IMAGE 3

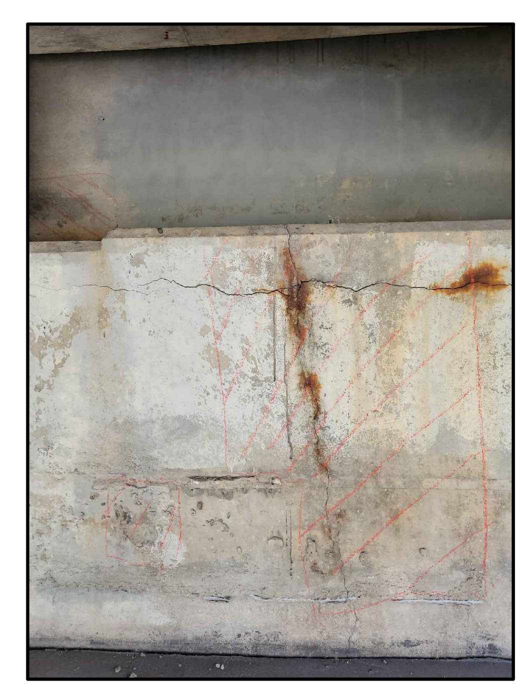


IMAGE 4


IMAGE 5


IMAGE 6


IMAGE 7


IMAGE 8


IMAGE 9

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

NO.	REVISIONS	DATE	BY

B.M. ELEV.

TETRA TECH

DESIGNED BY	M.L.	CHECKED BY	
DRAWN BY	B.M.	APPROVED BY	
HOR. SCALE: VERTICAL:	AS NOTED	ACCEPTED BY	DATE
DATE	22.12.12	BRIDGE PROJECTS ENGINEER	

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0001

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

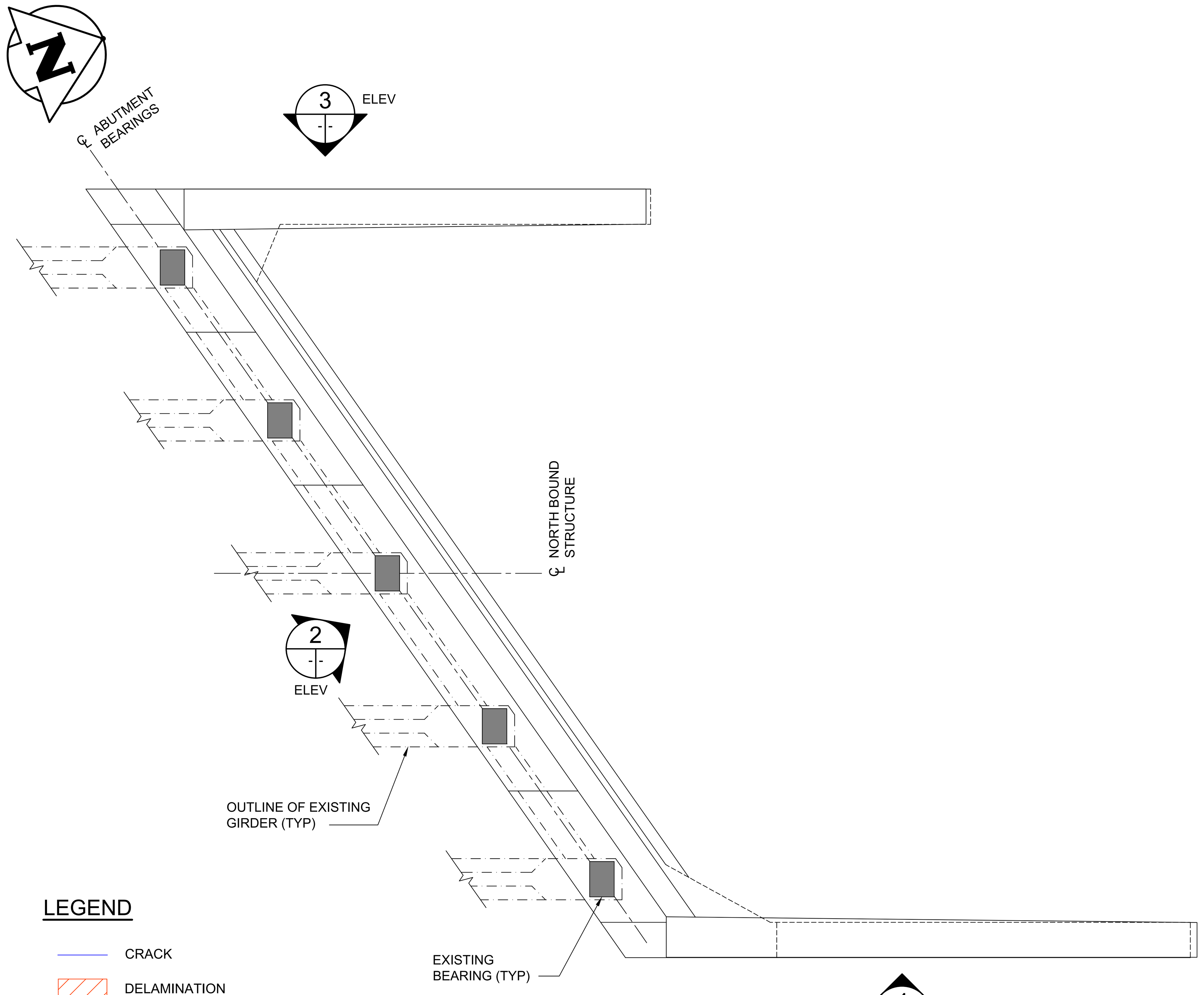
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTBOUND STRUCTURE
ABUTMENT N-0

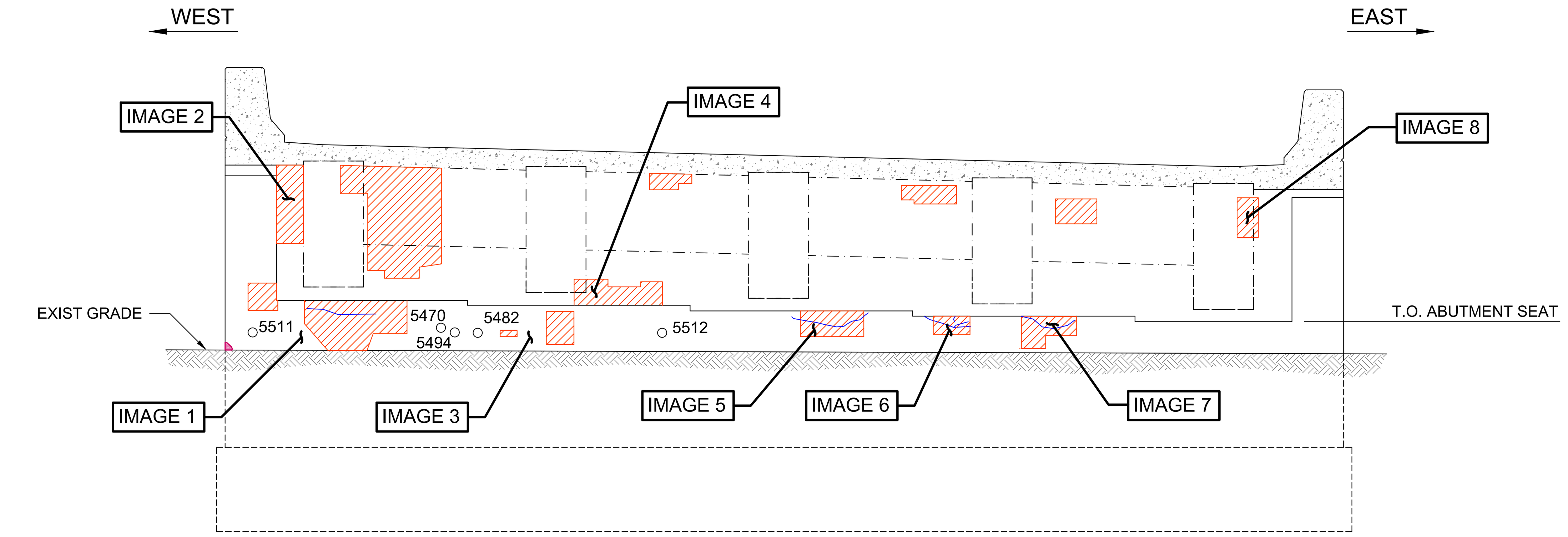
CITY DRAWING NUMBER

SHEET 1 OF 22

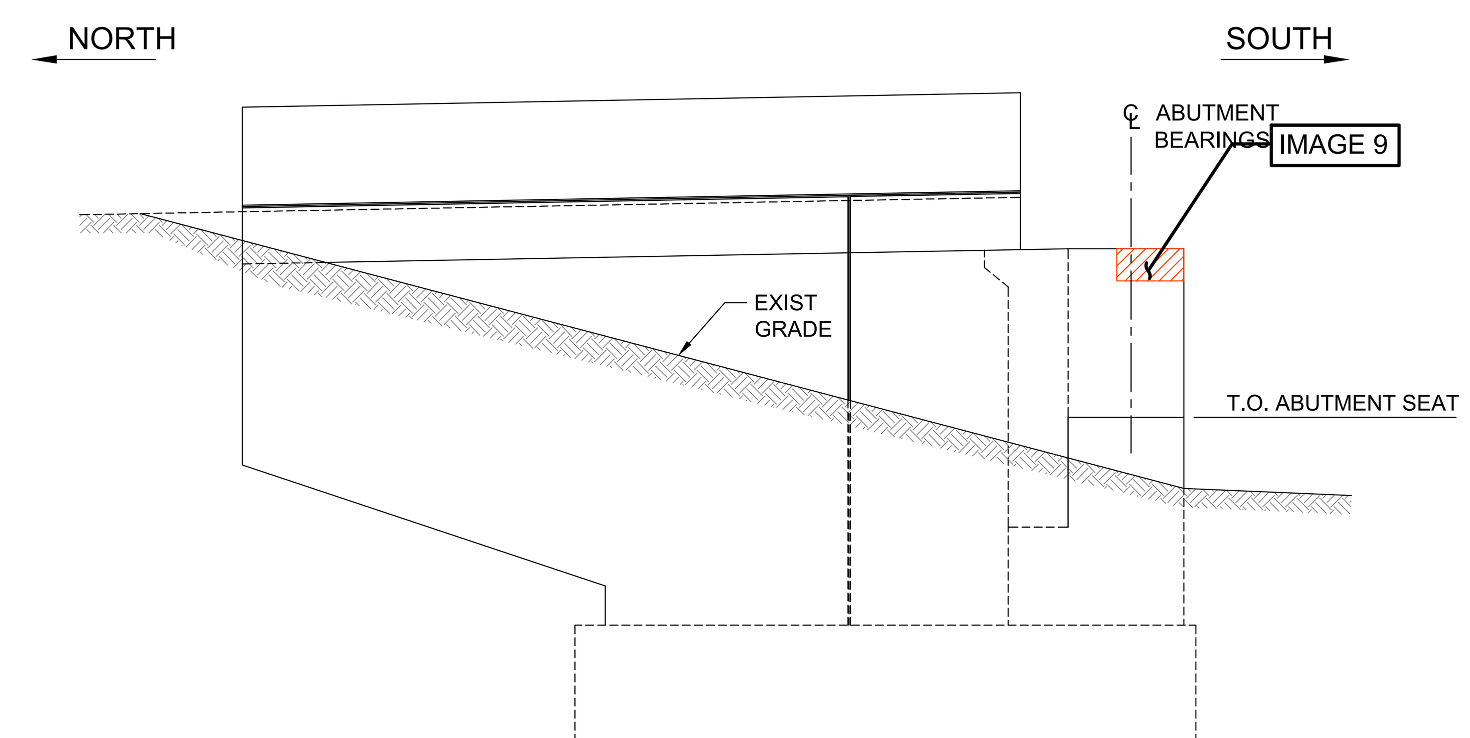
1



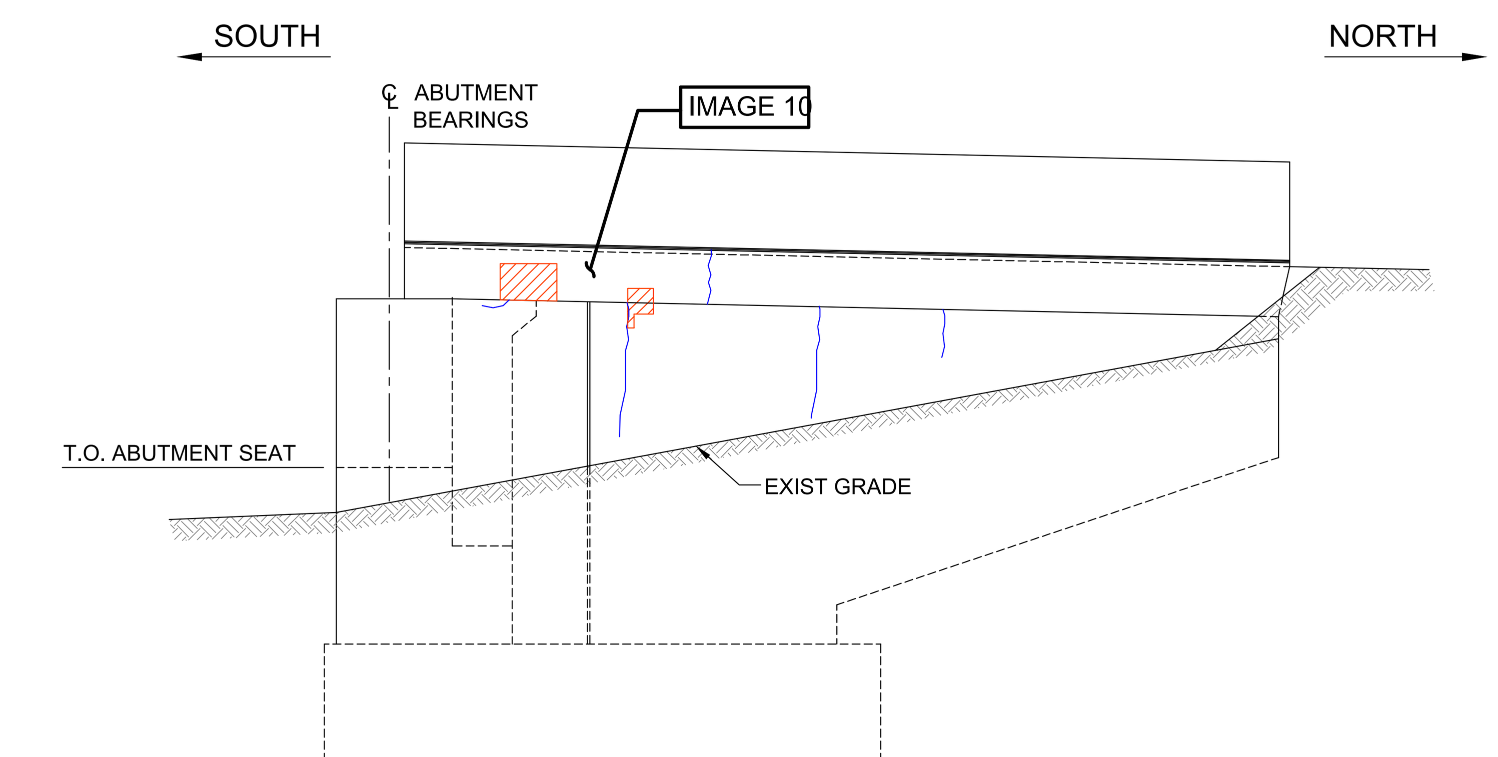
1 PLAN - ABUT N-5
1 : 50



2 FRONT ELEVATION - ABUT N-5
1 : 50



3 ABUT N-5 - WEST ELEVATION
1 : 50



4 ABUT N-5 - EAST ELEVATION
1 : 50

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED.

IMAGE 1

IMAGE 2

IMAGE 3

IMAGE 4

IMAGE 5

IMAGE 6

IMAGE 7

IMAGE 8

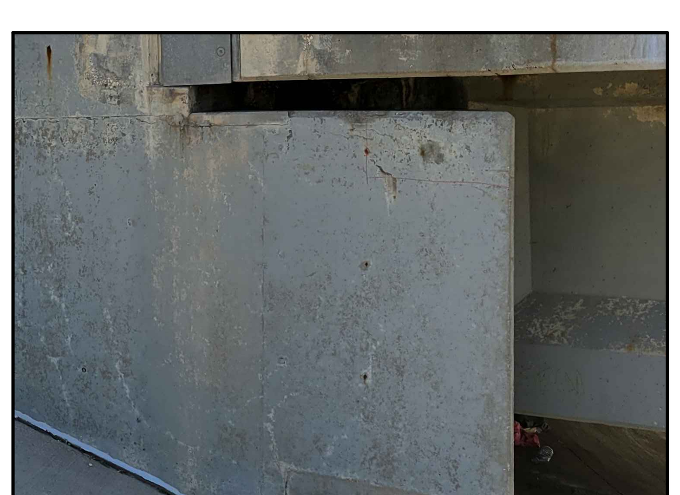


IMAGE 9

IMAGE 10

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M. ELEV.			
NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.	CHECKED BY	
DRAWN BY B.M.	APPROVED BY	
HOR. SCALE: AS NOTED VERTICAL:	ACCEPTED BY	DATE
DATE 12.12.22	BRIDGE PROJECTS ENGINEER	

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0002

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

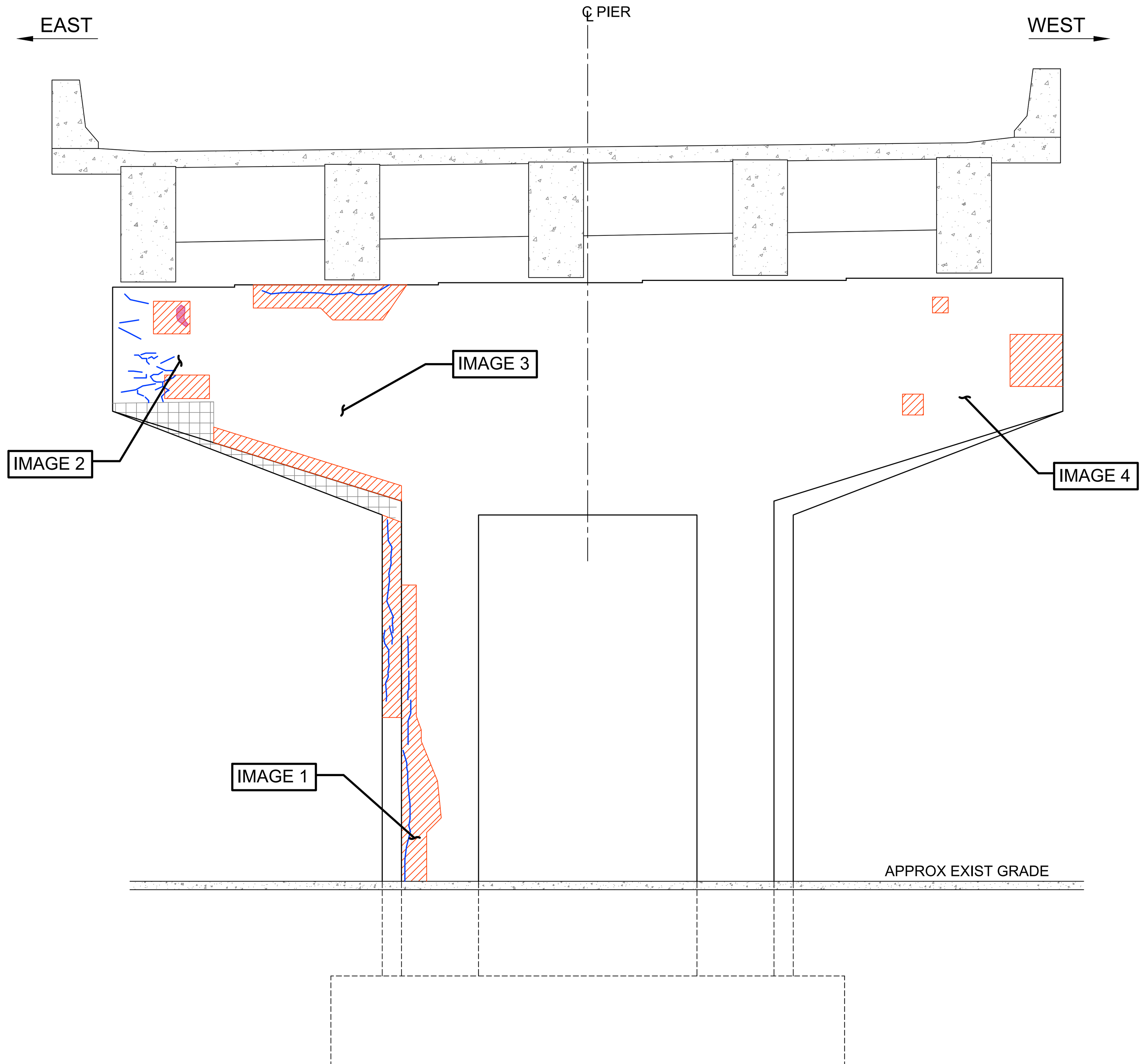
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTBOUND STRUCTURE
ABUTMENT N-5

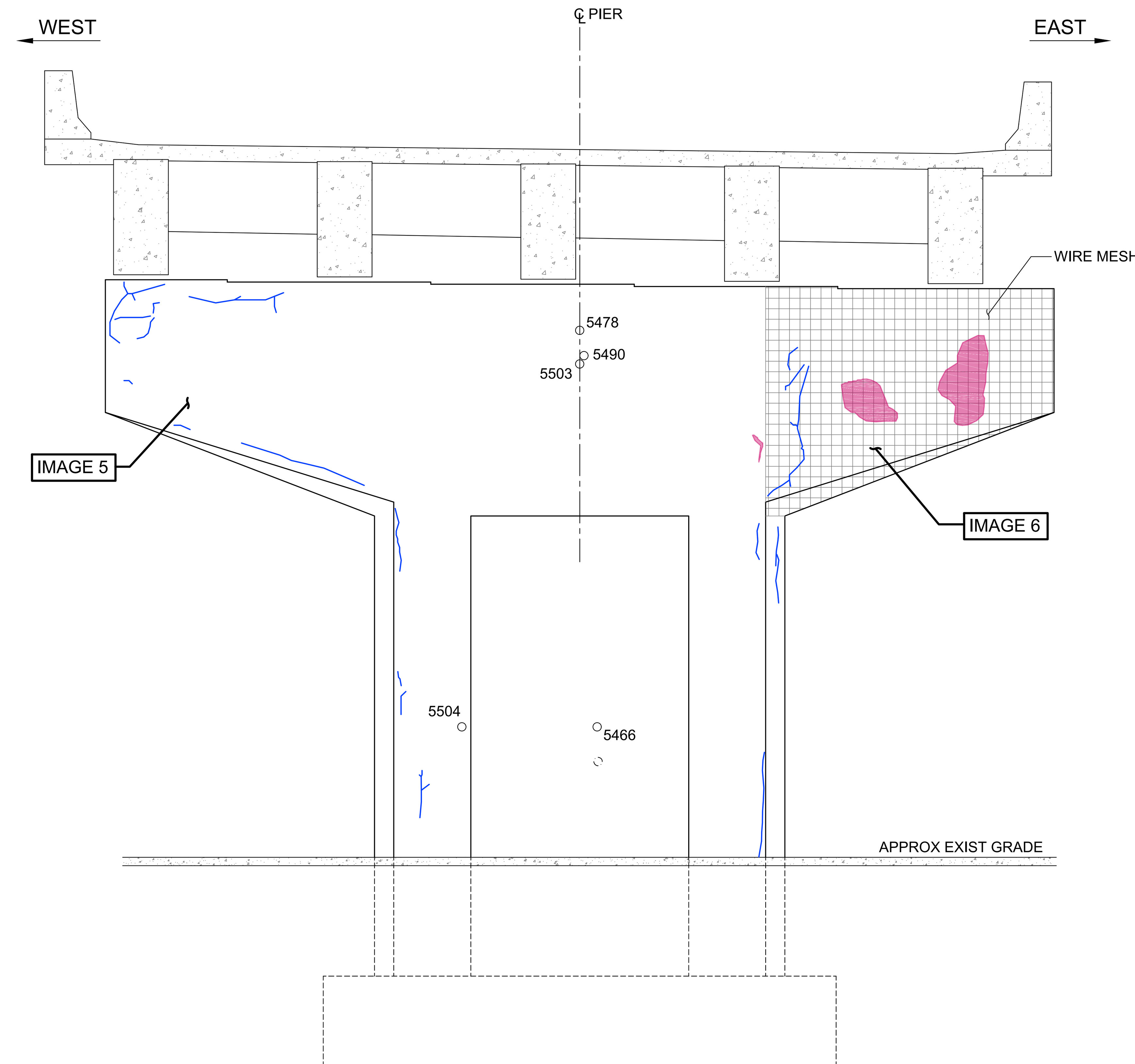
CITY DRAWING NUMBER

SHEET 2 OF 22

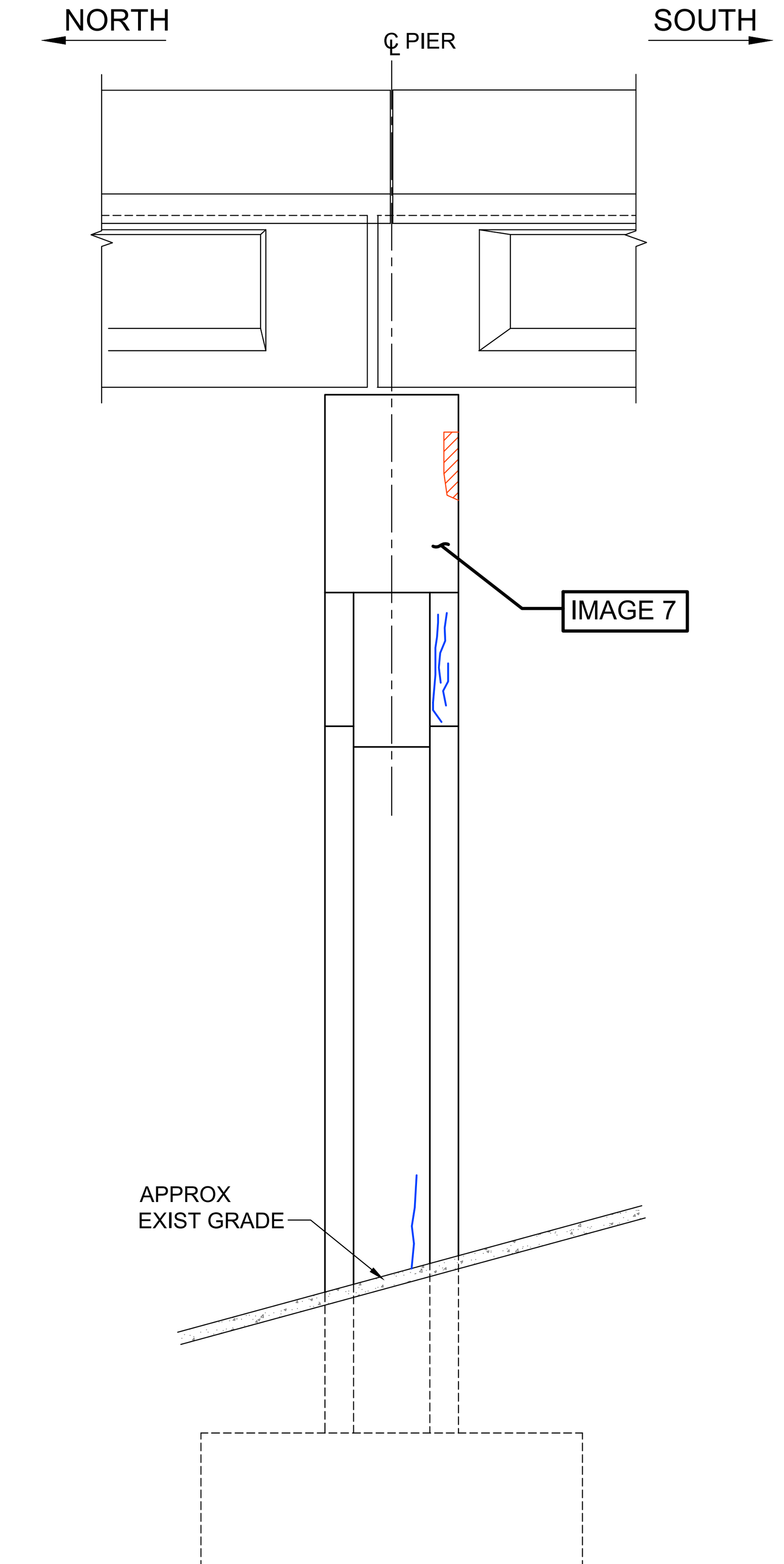
2



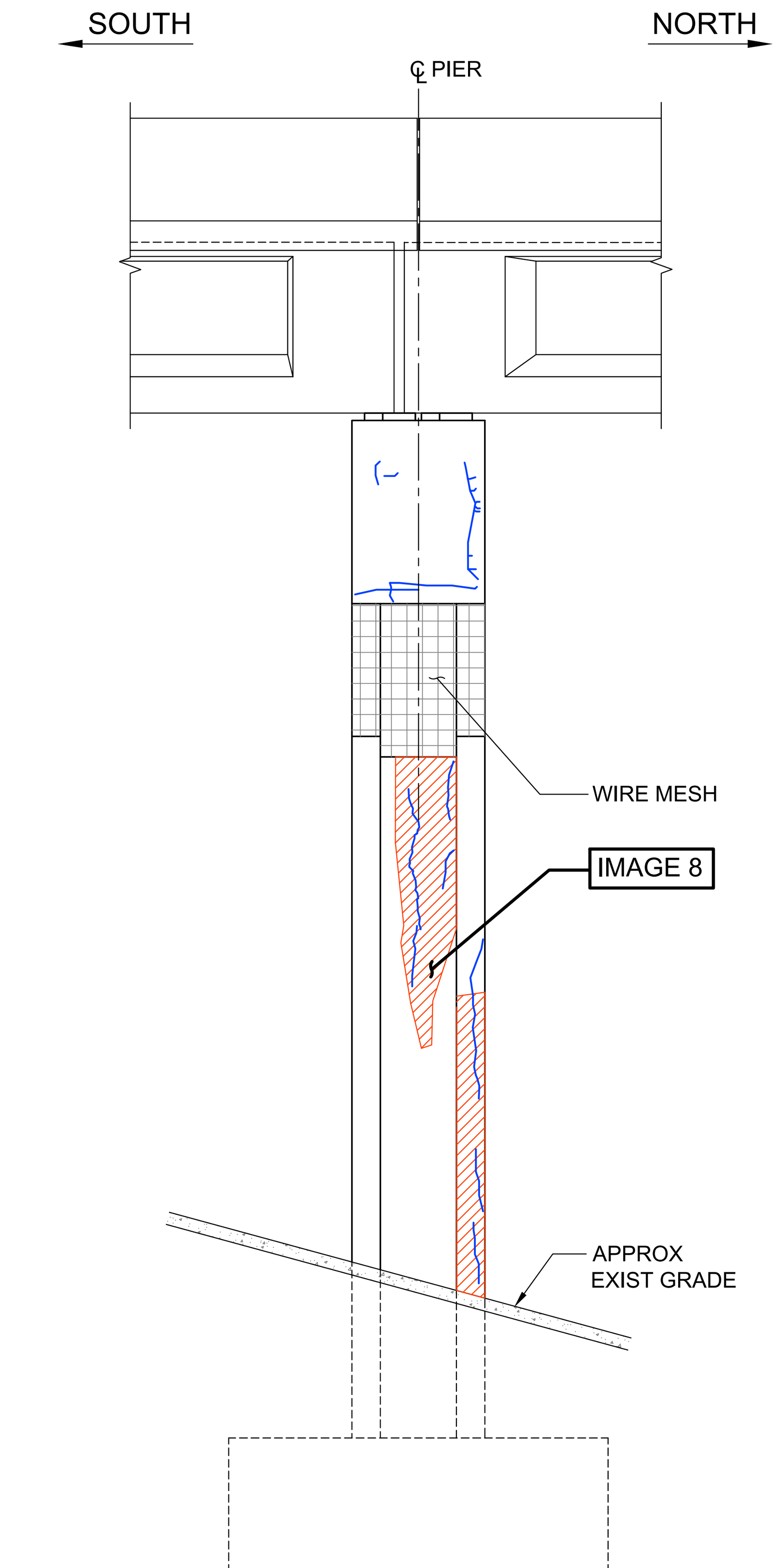
1 PIER N-1 - NORTH ELEVATION
1 : 50



2 PIER N-1 - SOUTH ELEVATION
1 : 50



4 WEST ELEVATION
1 : 50



3 EAST ELEVATION
1 : 50

IMAGE 1

IMAGE 2

IMAGE 3

IMAGE 4

IMAGE 5

IMAGE 6

IMAGE 7

IMAGE 8

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M. ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L. | CHECKED BY
DRAWN BY B.M. | APPROVED BY
HOR. SCALE: AS NOTED | ACCEPTED BY | DATE
VERTICAL:
DATE 12.12.22 | BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0003

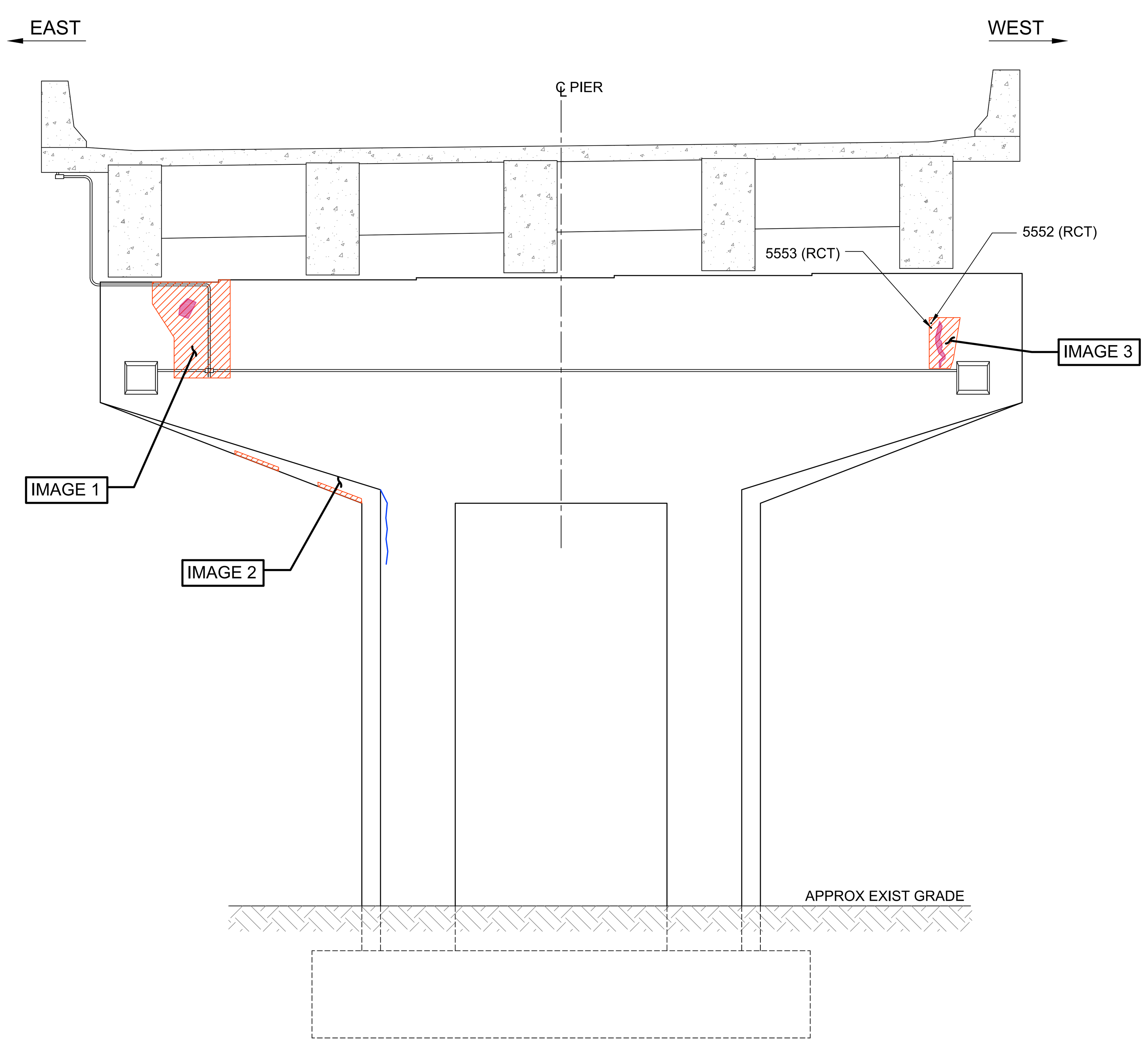
Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

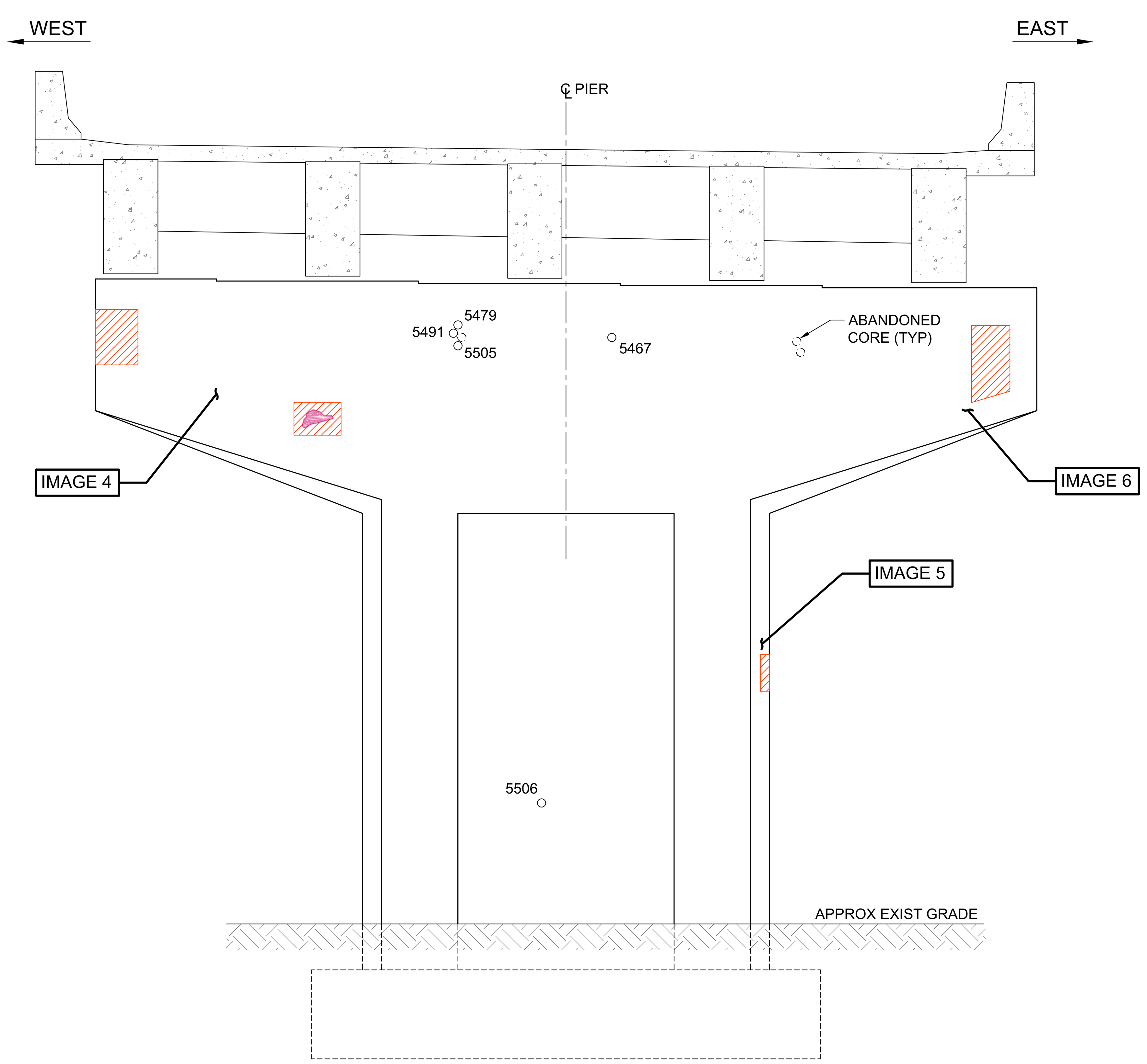
NORTHBOUND STRUCTURE
PIER N-1

CITY DRAWING NUMBER
SHEET 3 OF 22

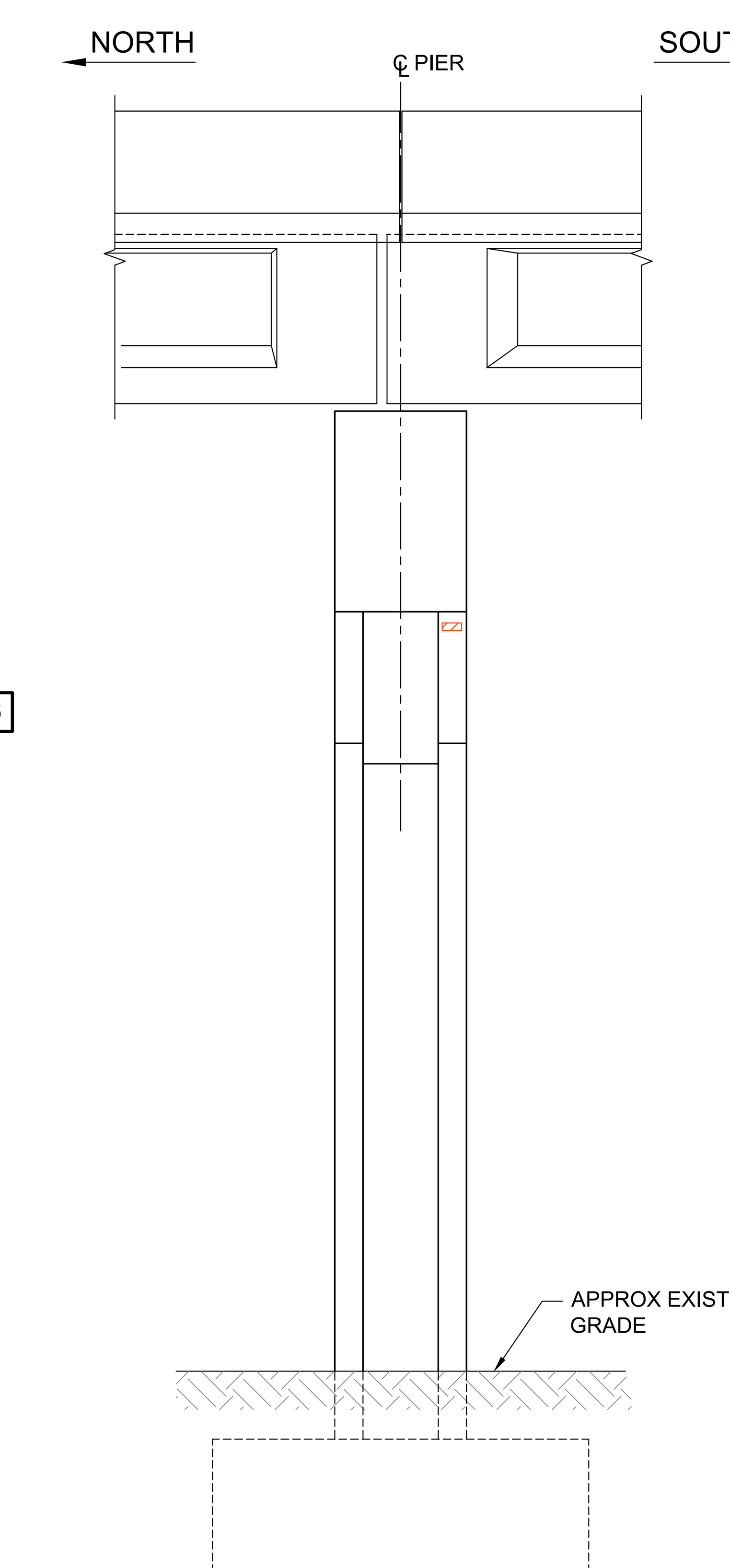
3



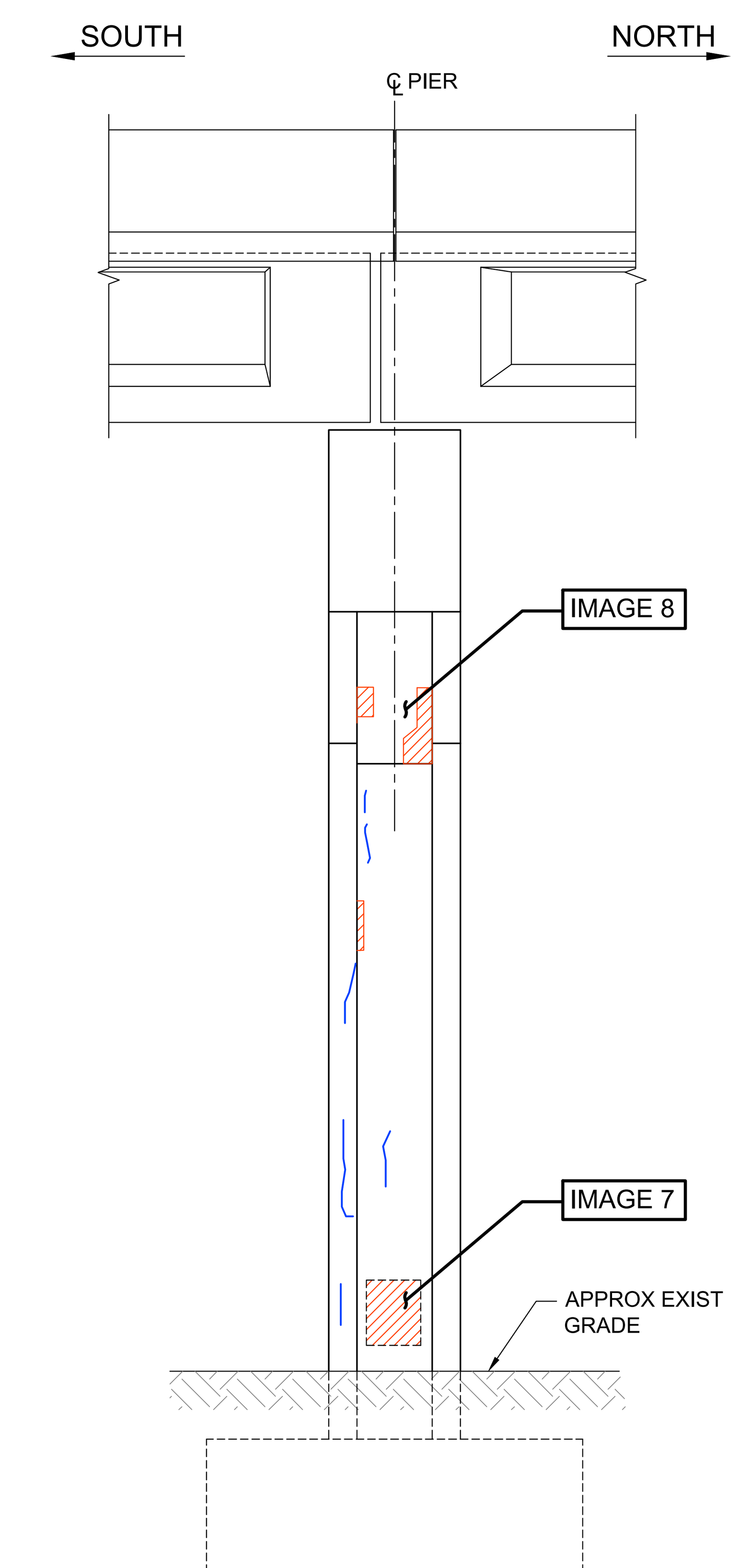
1 PIER N-2 - NORTH ELEVATION
1 : 50



2 PIER N-2 - SOUTH ELEVATION
1 : 50



4 WEST ELEVATION
1 : 50



3 EAST ELEVATION
1 : 50

IMAGE 1

IMAGE 2

IMAGE 3

IMAGE 4

IMAGE 5

IMAGE 6

IMAGE 7

IMAGE 8

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.
CHECKED BY
DRAWN BY B.M.
APPROVED BY
HOR. SCALE: AS NOTED
VERTICAL:
ACCEPTED BY
DATE
DATE 12.12.22
BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0004

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

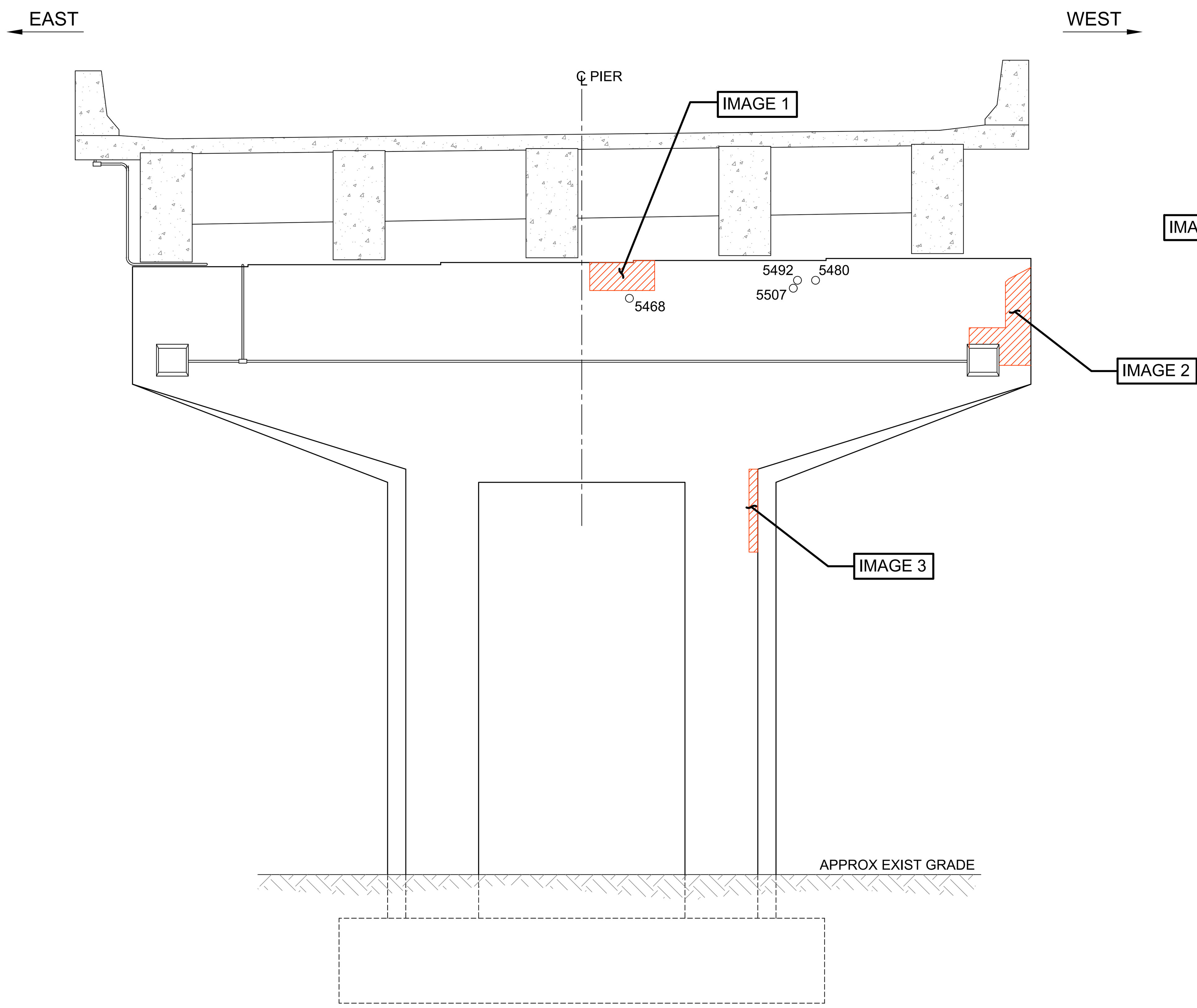
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTHBOUND STRUCTURE
PIER N-2

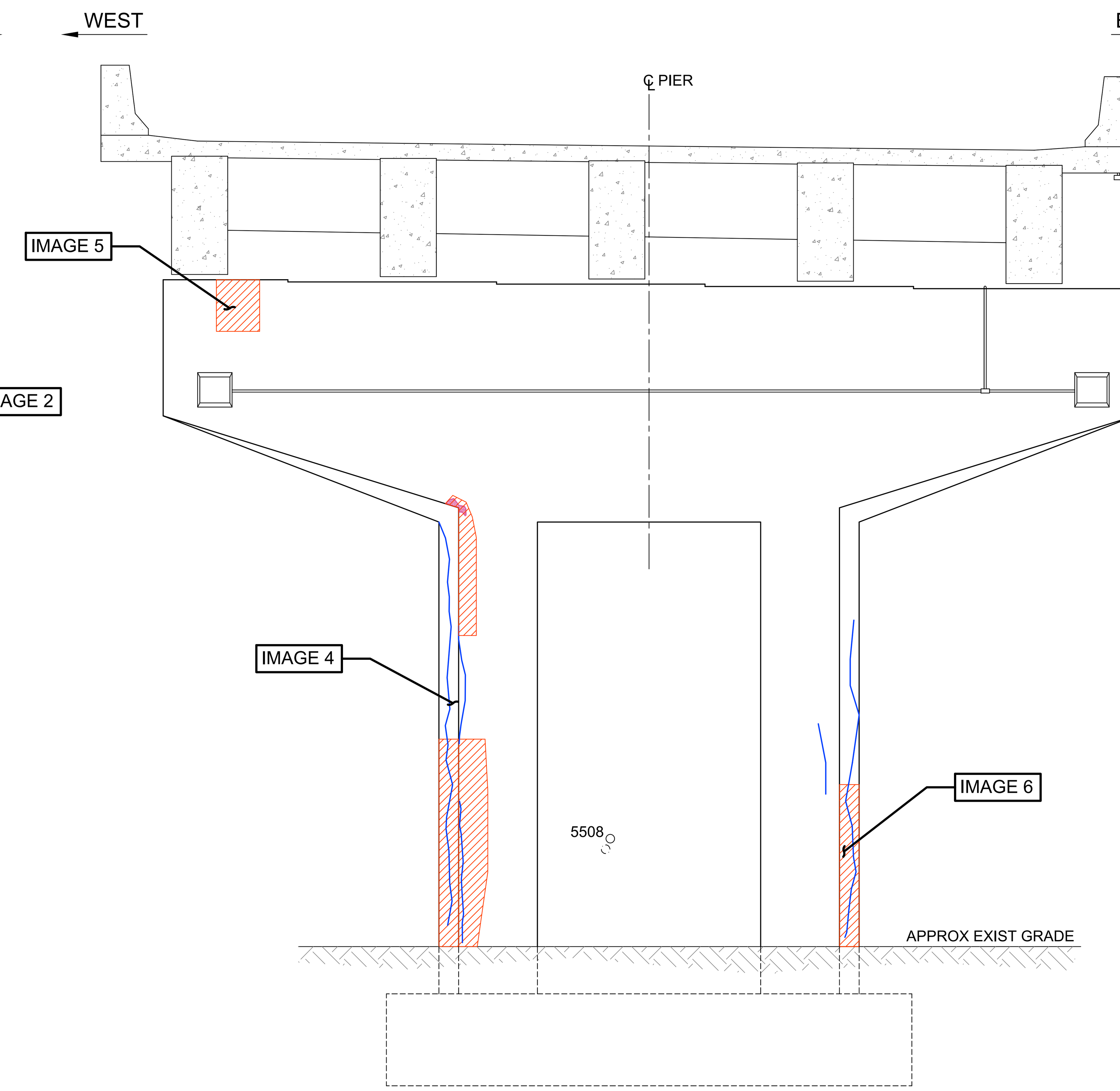
CITY DRAWING NUMBER

SHEET 4 OF 22

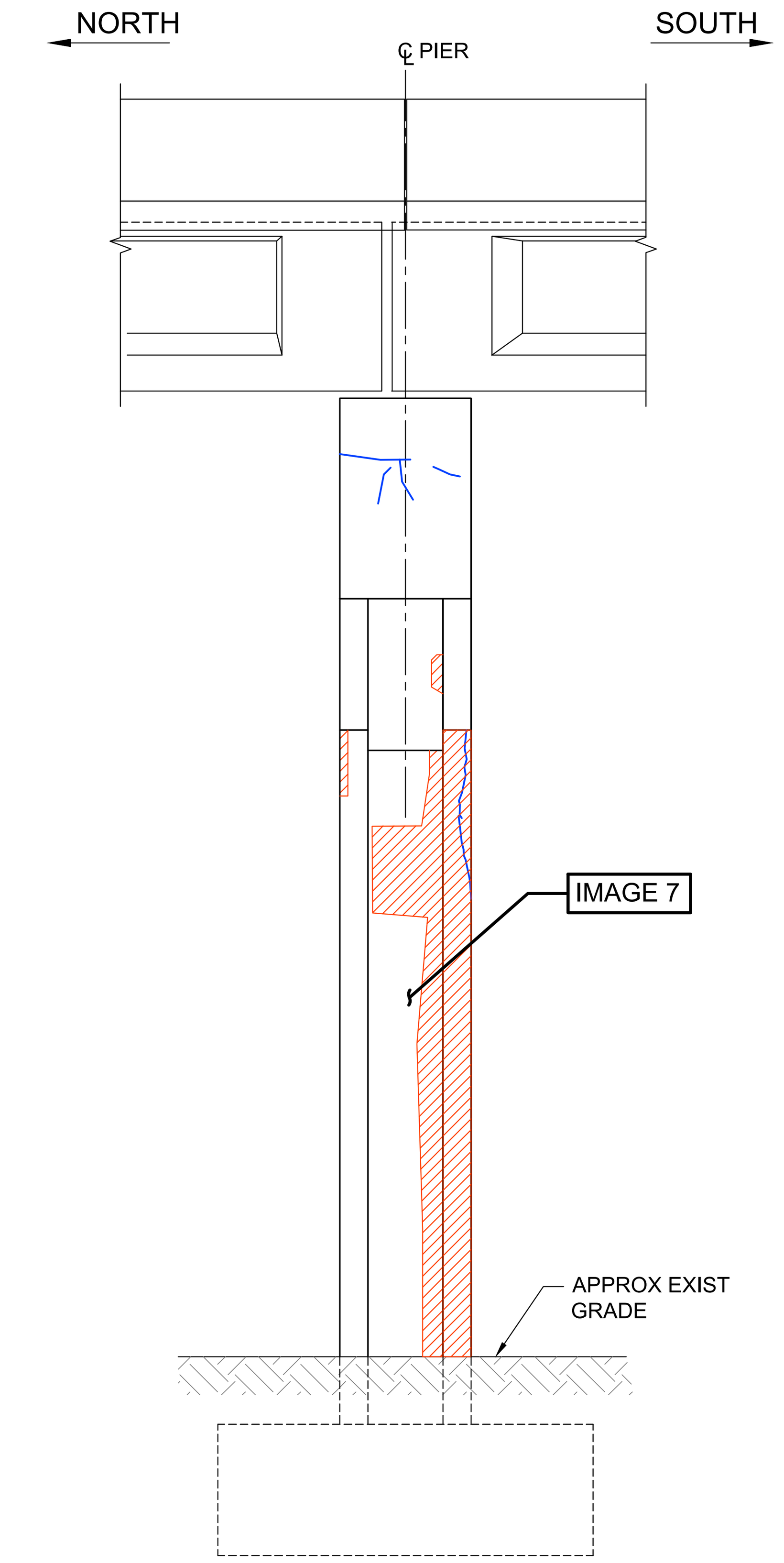
4



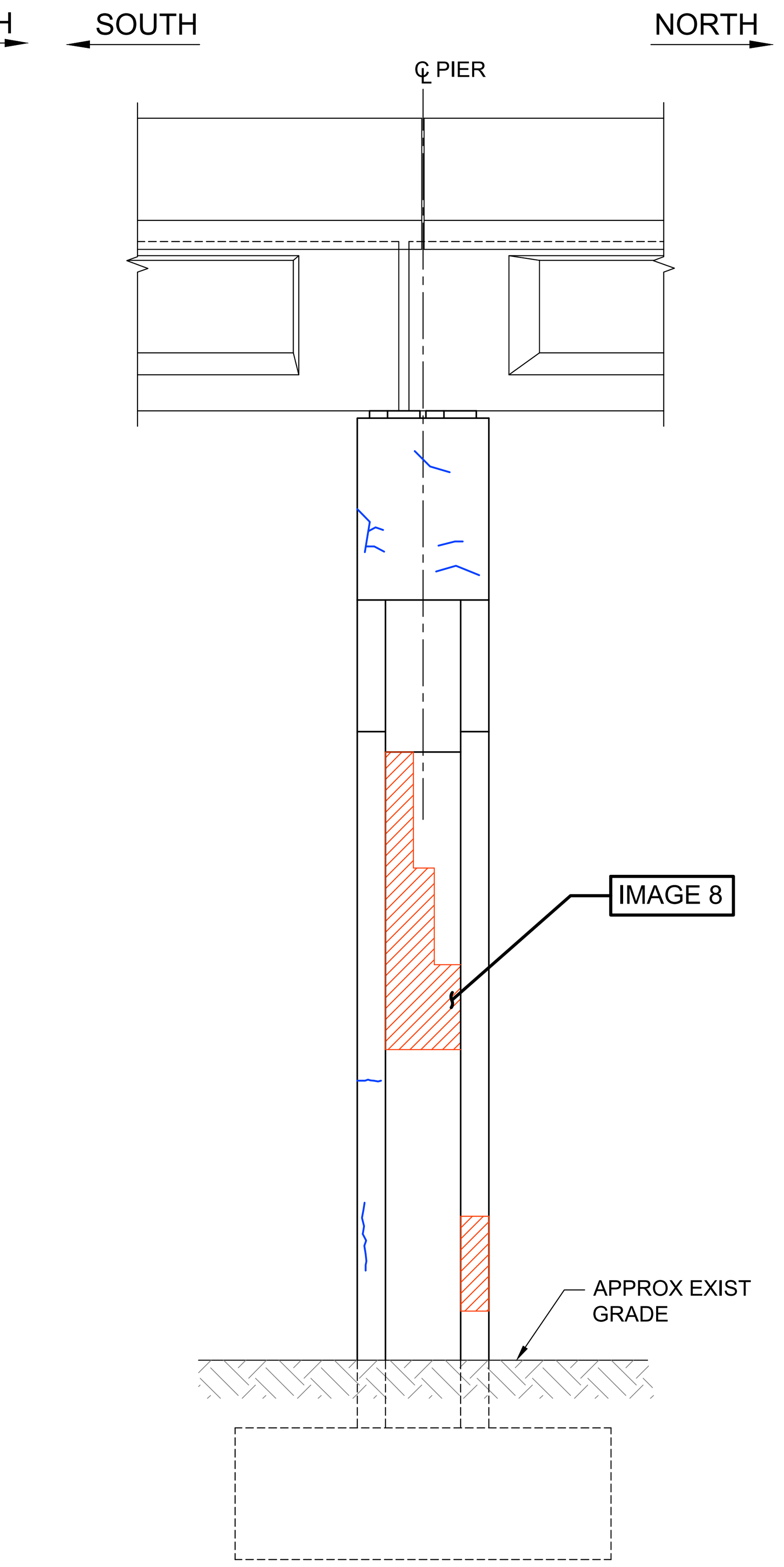
1 PIER N-3 - NORTH ELEVATION
1 : 50



2 PIER N-3 - SOUTH ELEVATION
1 : 50



4 WEST ELEVATION
1 : 50



3 EAST ELEVATION
1 : 50


IMAGE 1


IMAGE 2

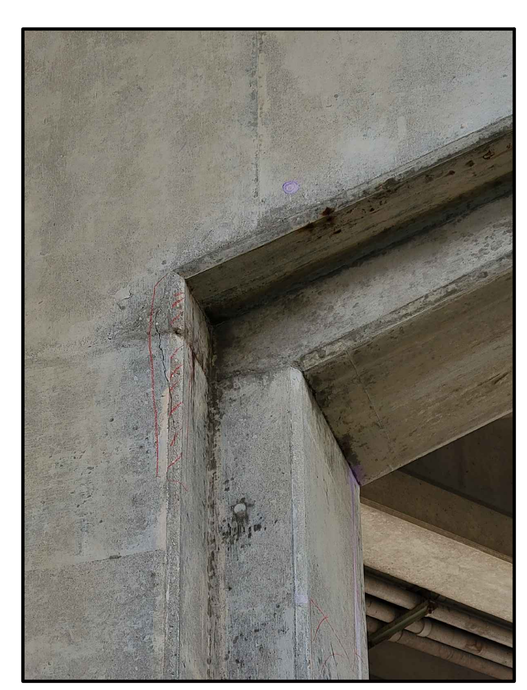


IMAGE 3


IMAGE 4


IMAGE 5

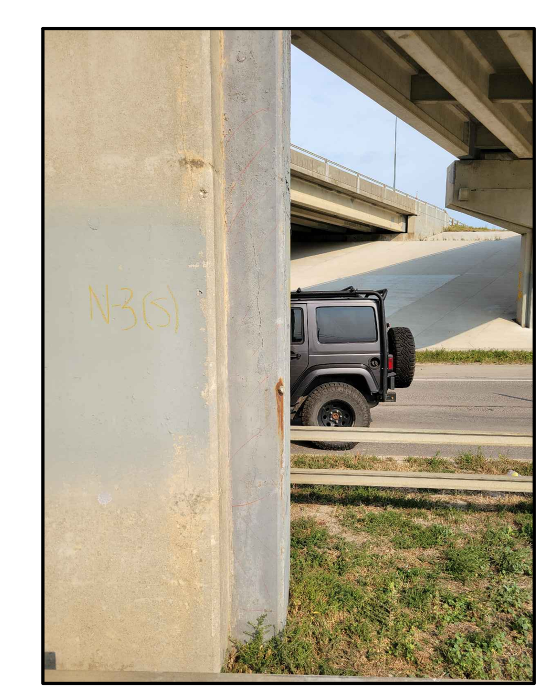


IMAGE 6


IMAGE 7


IMAGE 8

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.
CHECKED BY
DRAWN BY B.M.
APPROVED BY
HOR. SCALE: AS NOTED
VERTICAL:
ACCEPTED BY
DATE
DATE 12.12.22
BRIDGE PROJECTS ENGINEER

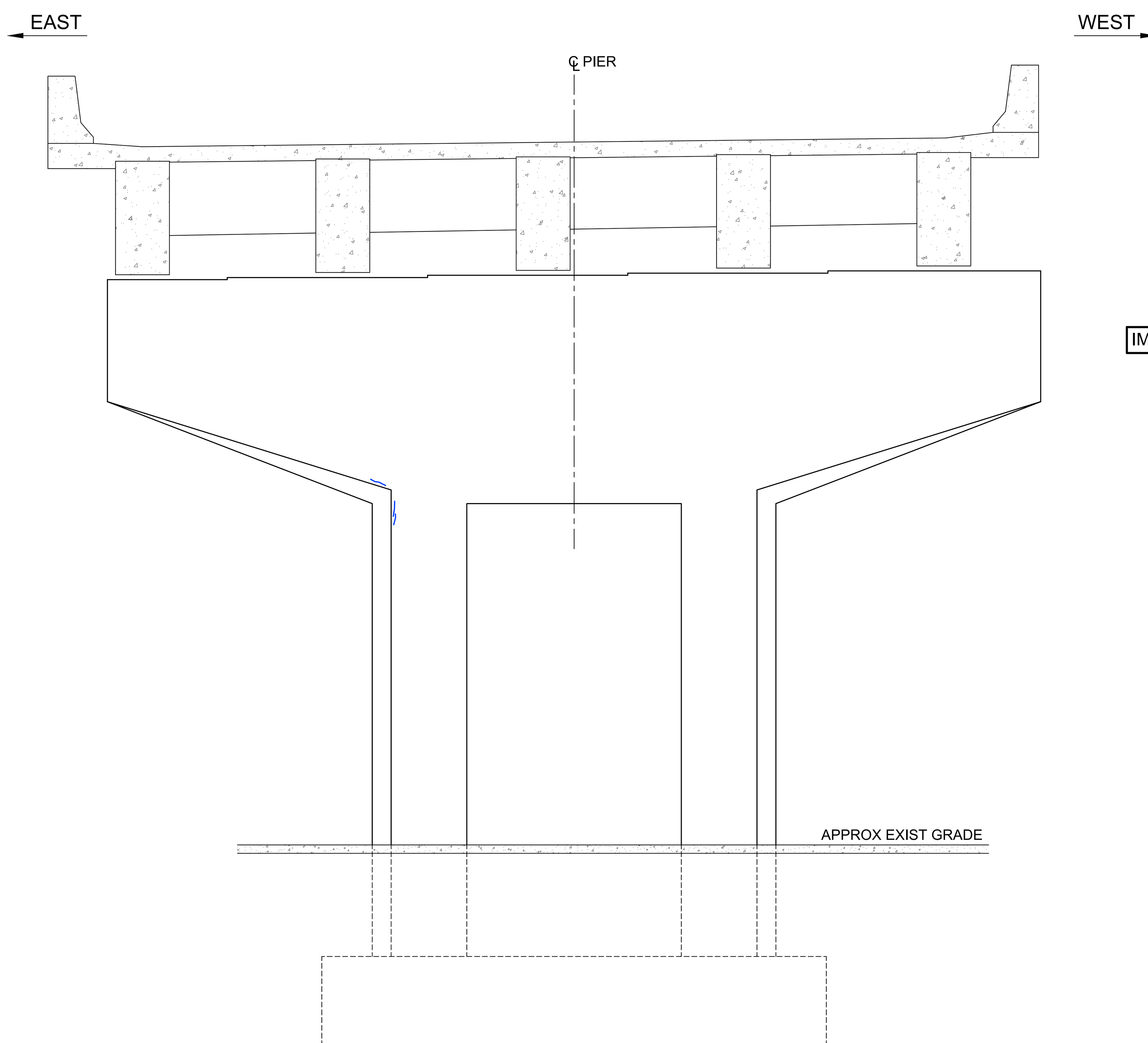
PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION
CONSULTANT DRAWING NO.
734-2200070600-SKT-S0005

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

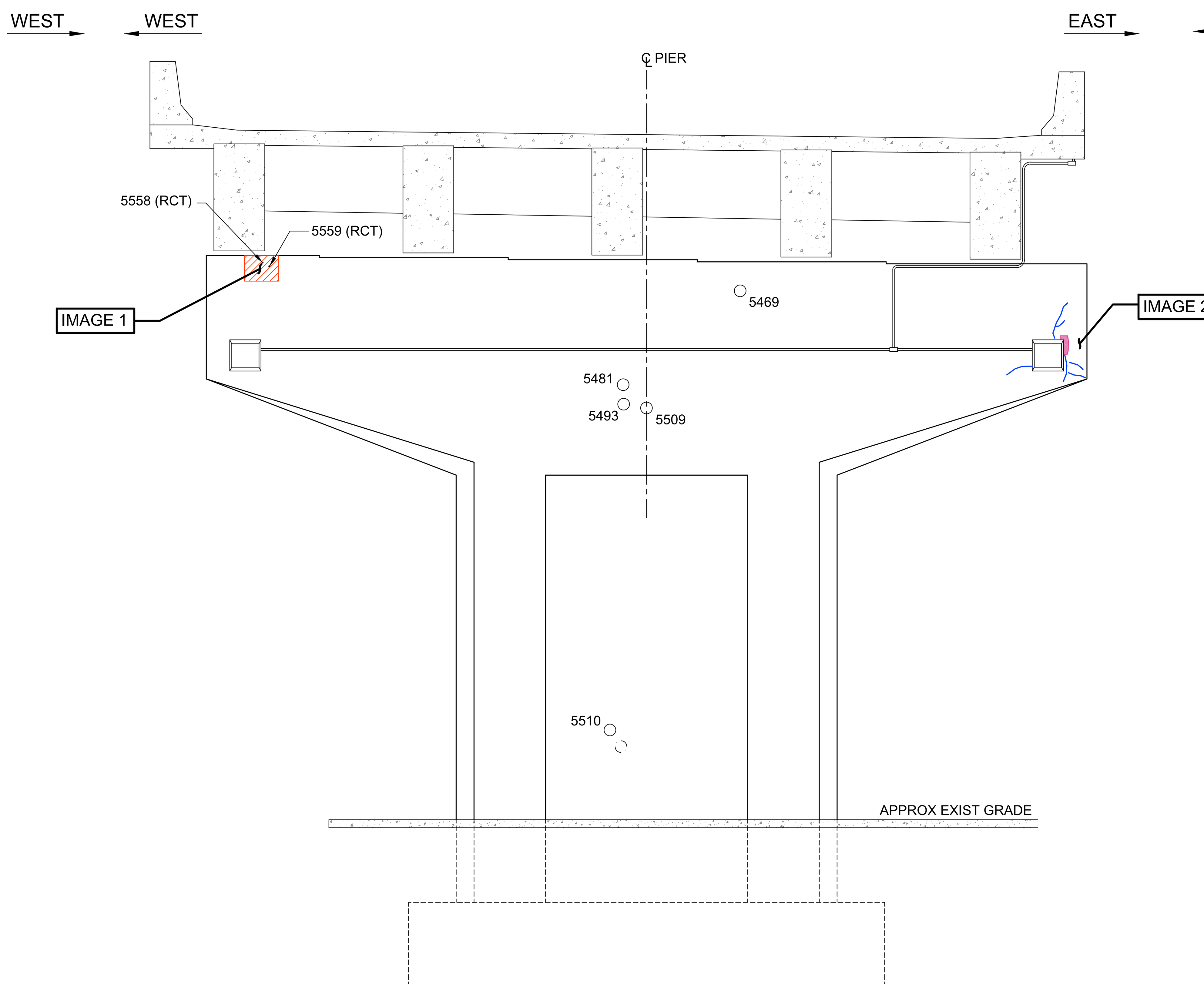
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTHBOUND STRUCTURE
PIER N-3

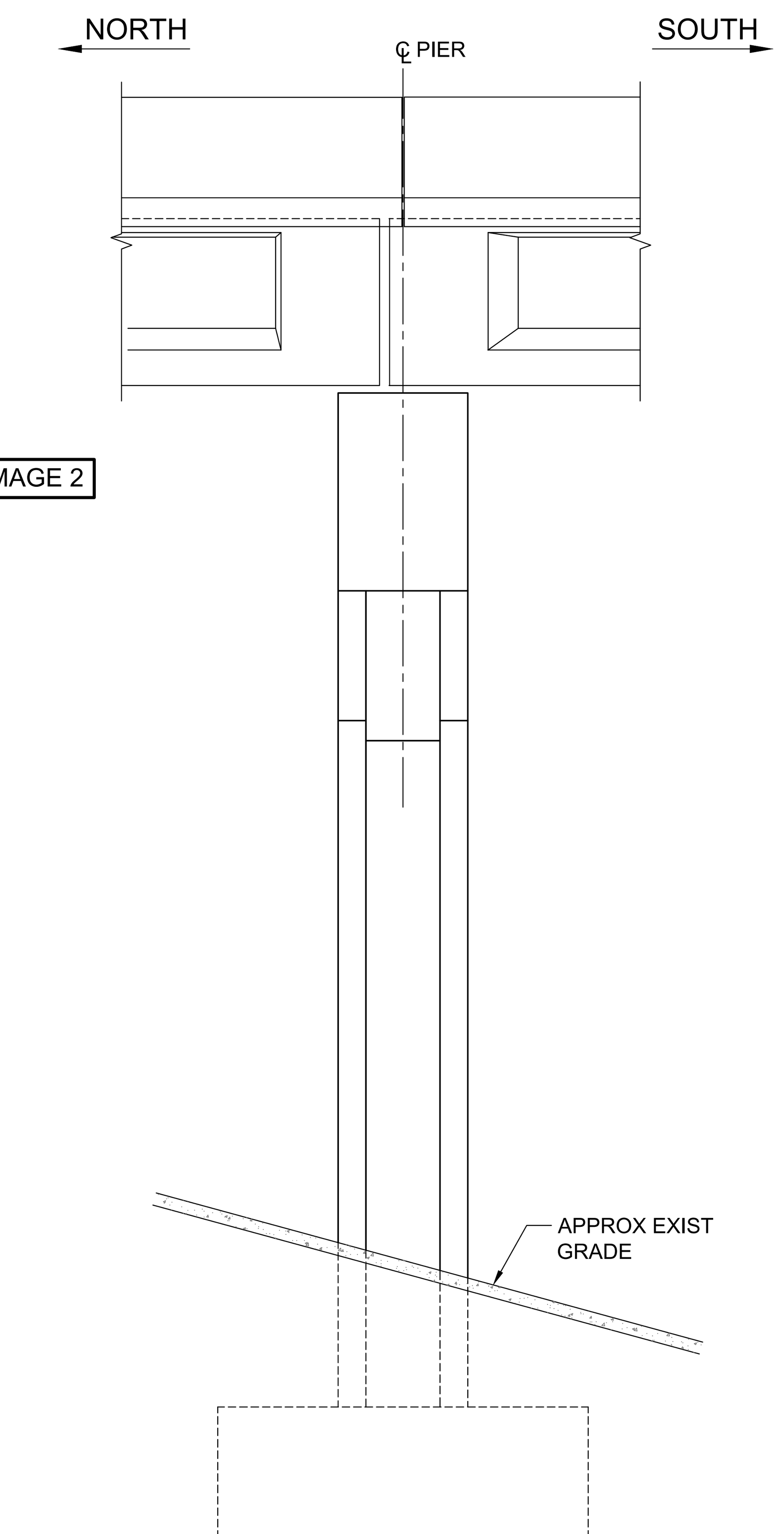
CITY DRAWING NUMBER
SHEET 5 OF 22
5



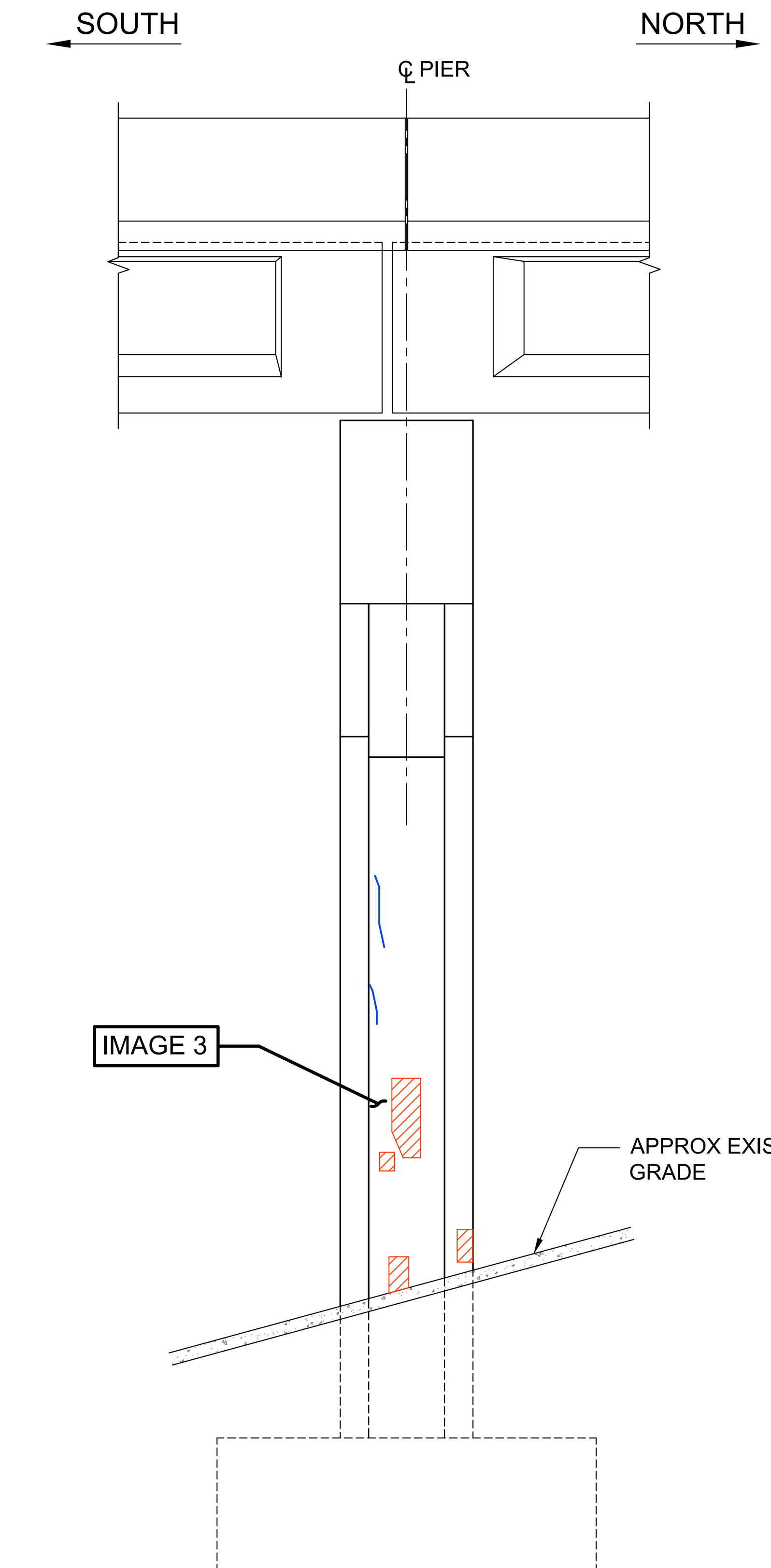
1 PIER N-4 - NORTH ELEVATION
1 : 50



2 PIER N-4 - SOUTH ELEVATION
1 : 50



4 PIER N-4 WEST ELEVATION
1 : 50



3 PIER N-4 EAST ELEVATION
1 : 50

IMAGE 1

IMAGE 2

IMAGE 3

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY	M.L.	CHECKED BY	
DRAWN BY	B.M.	APPROVED BY	
HOR. SCALE: VERTICAL:	AS NOTED	ACCEPTED BY	DATE
DATE	12.12.22	BRIDGE PROJECTS ENGINEER	

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

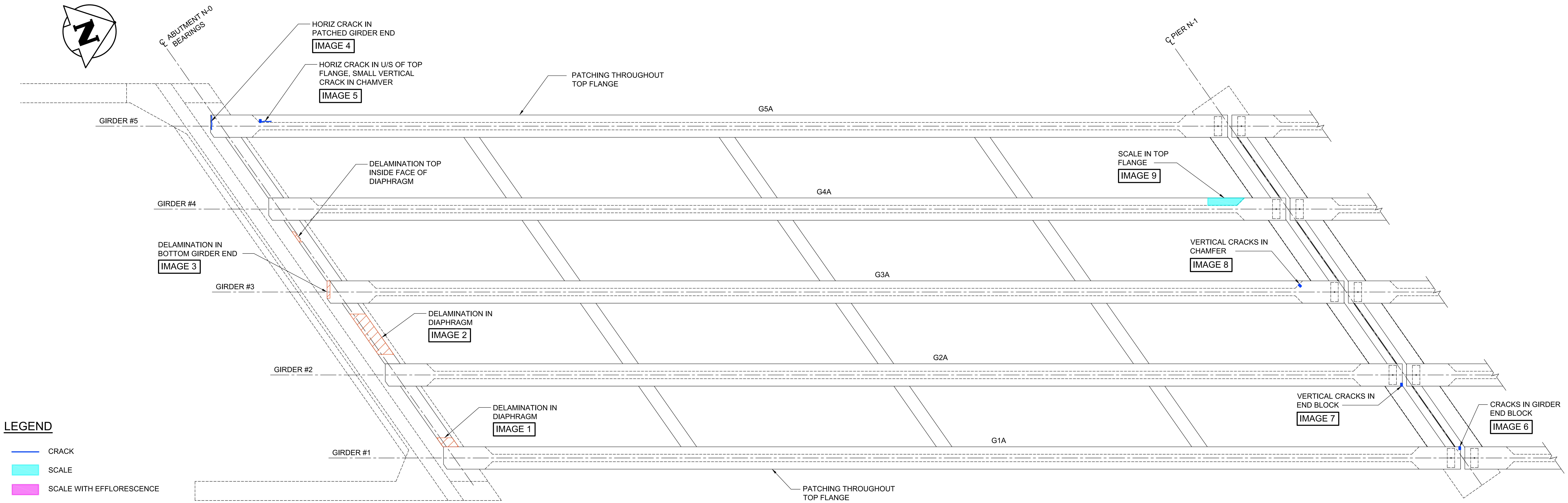
CONSULTANT DRAWING NO.
734-2200070600-SKT-S0006

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTHBOUND STRUCTURE
PIER N-4

CITY DRAWING NUMBER
SHEET 6 OF 22
6



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION

1
PLAN - SPAN 1 (NORTHBOUND)
1 : 50

IMAGE 1

IMAGE 2

IMAGE 3

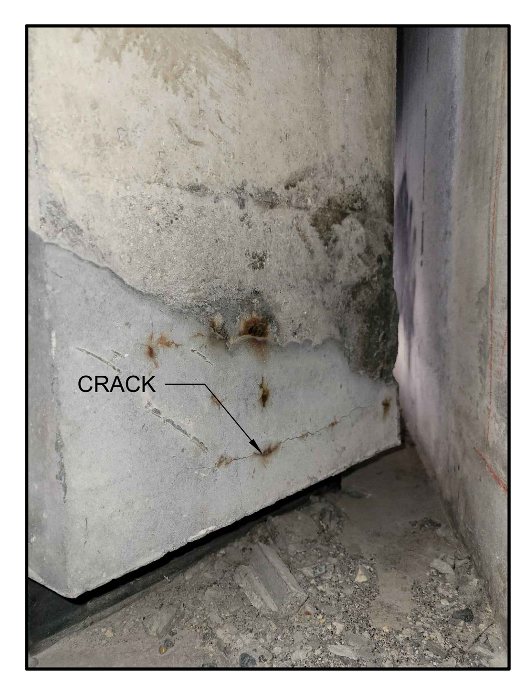


IMAGE 4

IMAGE 5

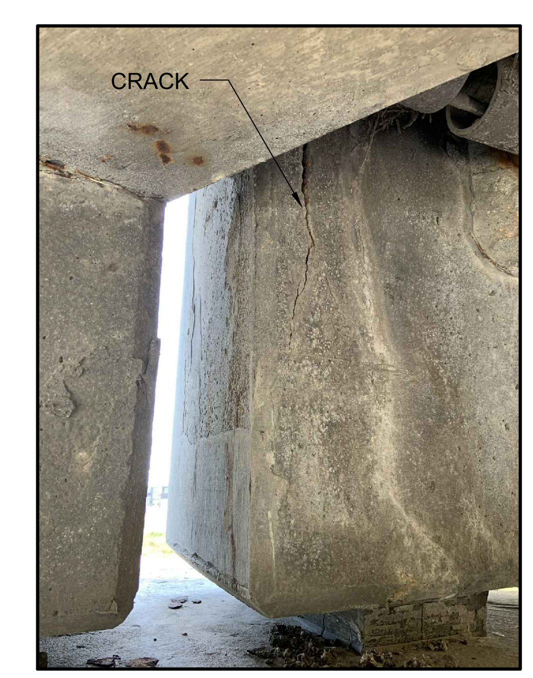


IMAGE 6

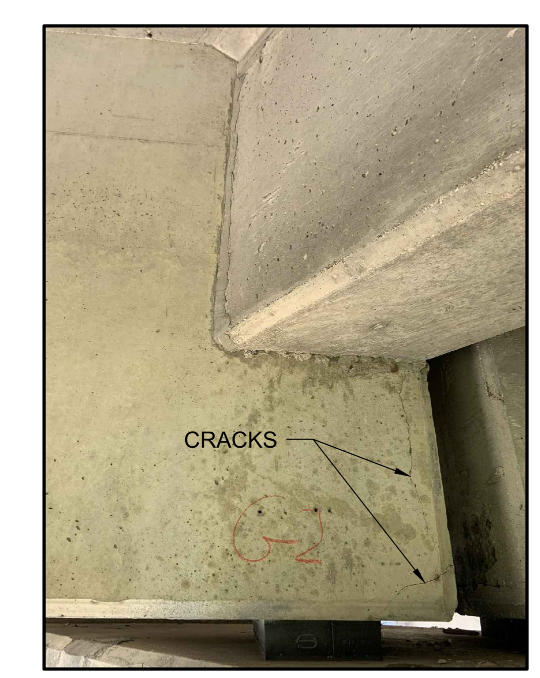


IMAGE 7

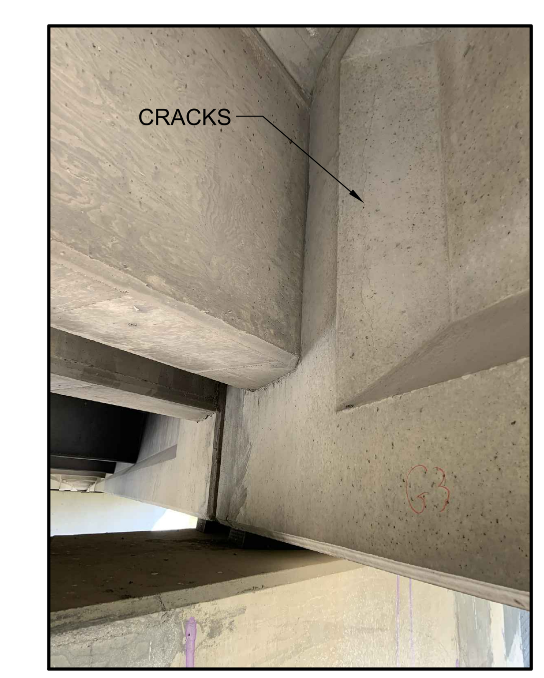


IMAGE 8

IMAGE 9

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.
CHECKED BY
DRAWN BY B.M.
APPROVED BY
HOR. SCALE: AS NOTED
VERTICAL:
ACCEPTED BY
DATE
DATE 12.12.22
BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

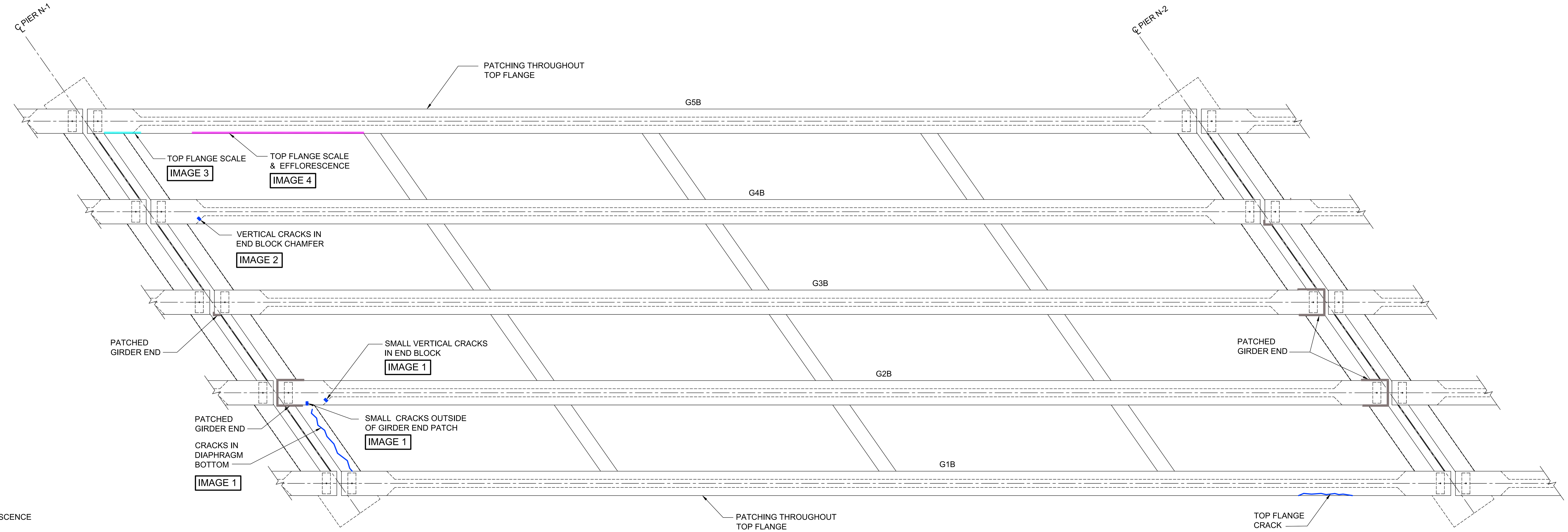
CONSULTANT DRAWING NO.
734-22000706000-SKT-S0007

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTHBOUND STRUCTURE
SPAN 1 GIRDERS

CITY DRAWING NUMBER
SHEET 7 OF 22
7



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION

1 PLAN - SPAN 2 (NORTHBOUND)

1 : 50

CRACKS

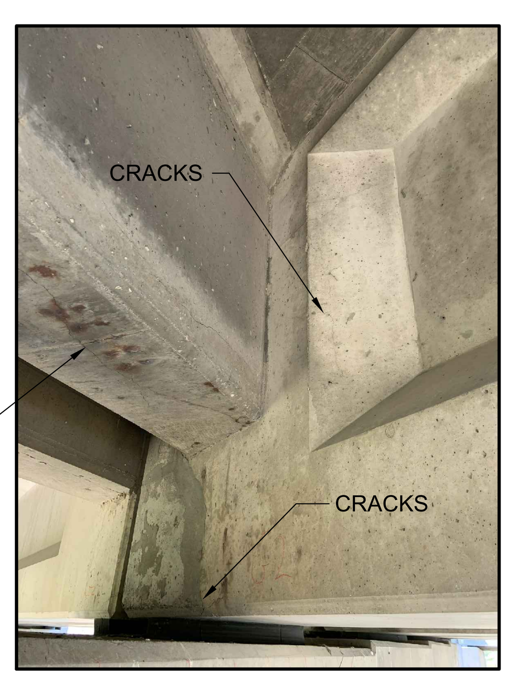


IMAGE 1

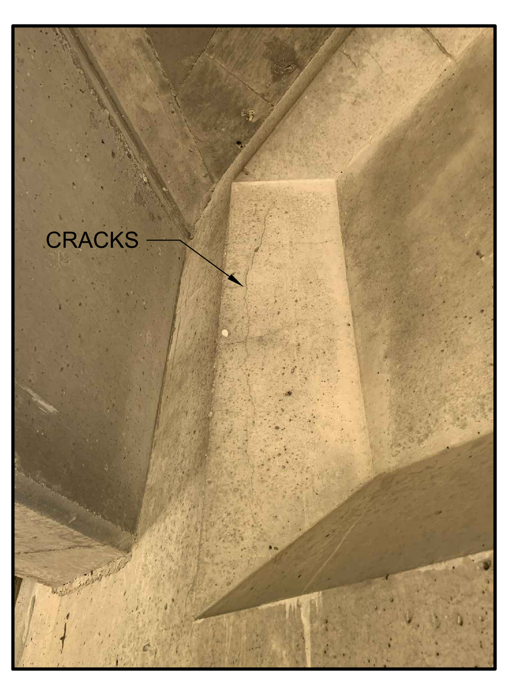


IMAGE 2

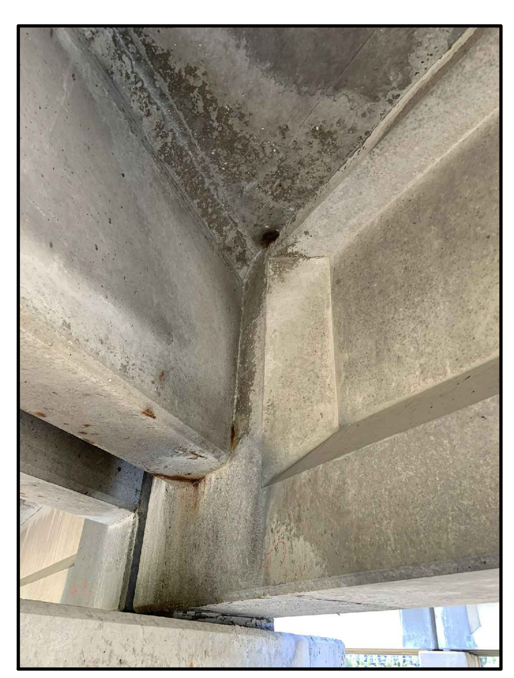


IMAGE 3

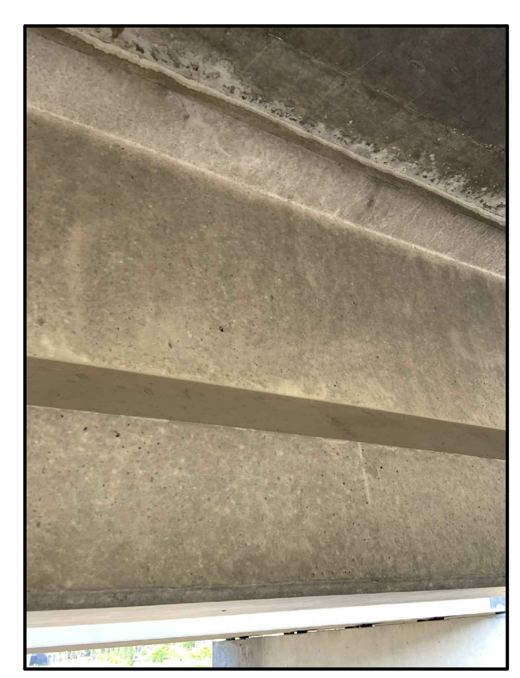


IMAGE 4

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

NO.	REVISIONS	DATE	BY

B.M.
ELEV.

TETRA TECH

DESIGNED BY M.L. | CHECKED BY
DRAWN BY B.M. | APPROVED BY
HOR. SCALE: AS NOTED | ACCEPTED BY | DATE
VERTICAL:
DATE 12.12.22 | BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0008

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

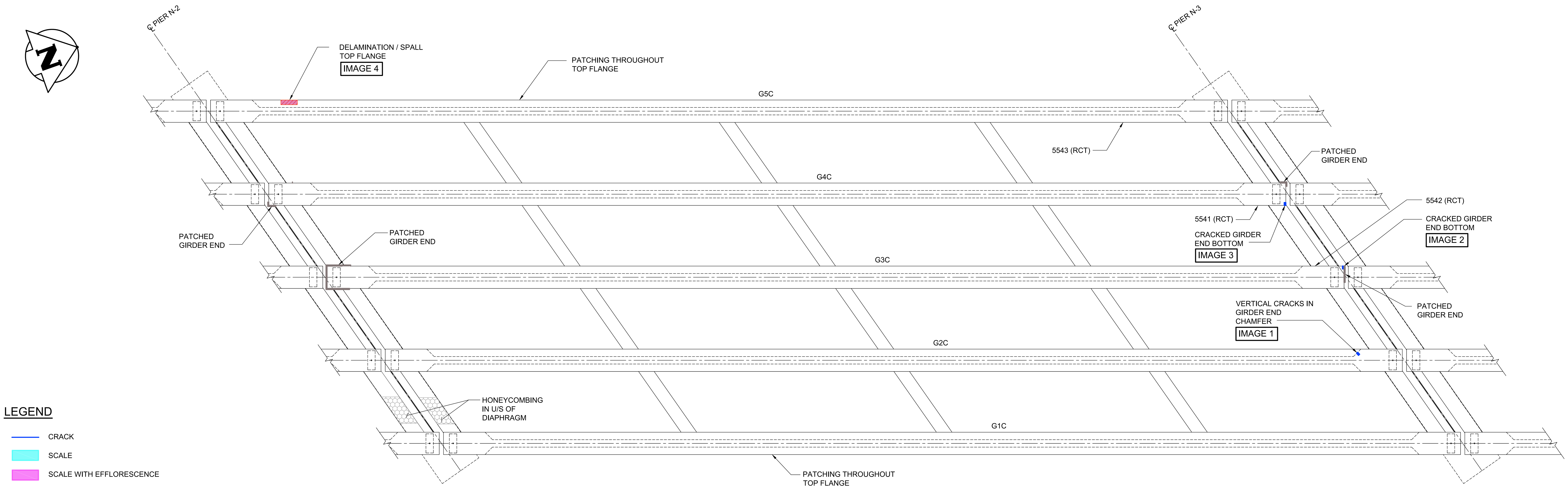
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTHBOUND STRUCTURE
SPAN 2 GIRDERS

CITY DRAWING NUMBER

SHEET 8 OF 22

8



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION
- HONEYCOMBING

1 PLAN - SPAN 3 (NORTHBOUND)

1 : 50

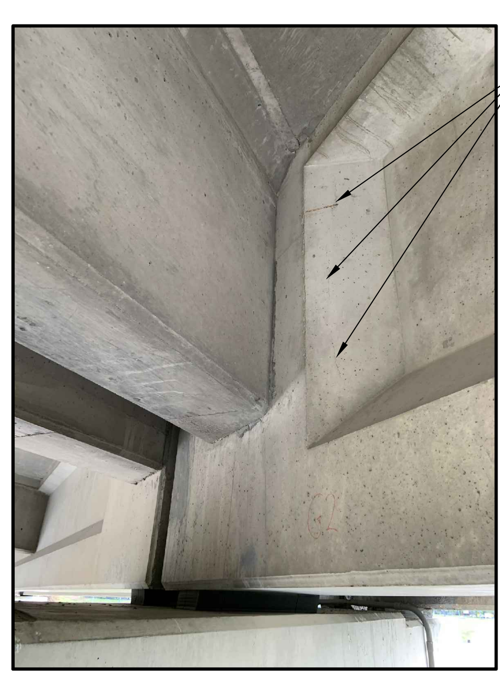


IMAGE 1

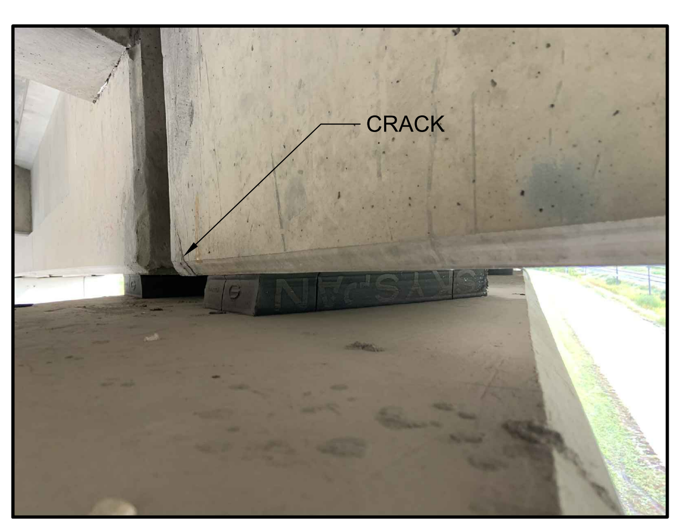


IMAGE 2

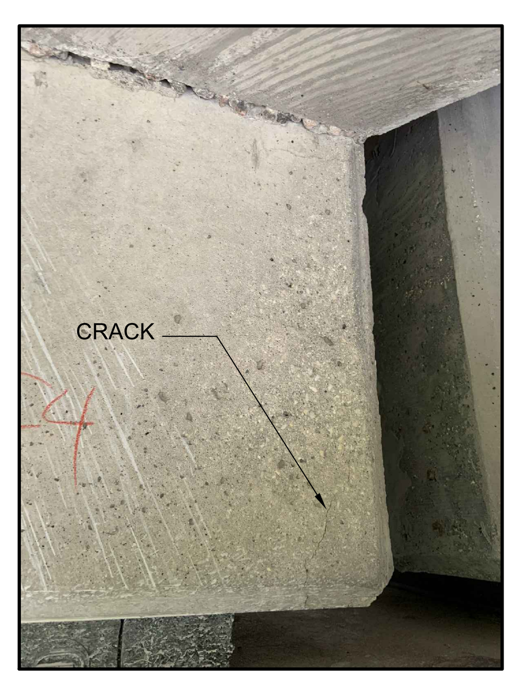


IMAGE 3

IMAGE 4

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.
CHECKED BY
DRAWN BY B.M.
APPROVED BY
HOR. SCALE: AS NOTED
VERTICAL:
ACCEPTED BY
DATE
DATE 12.12.22
BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0009

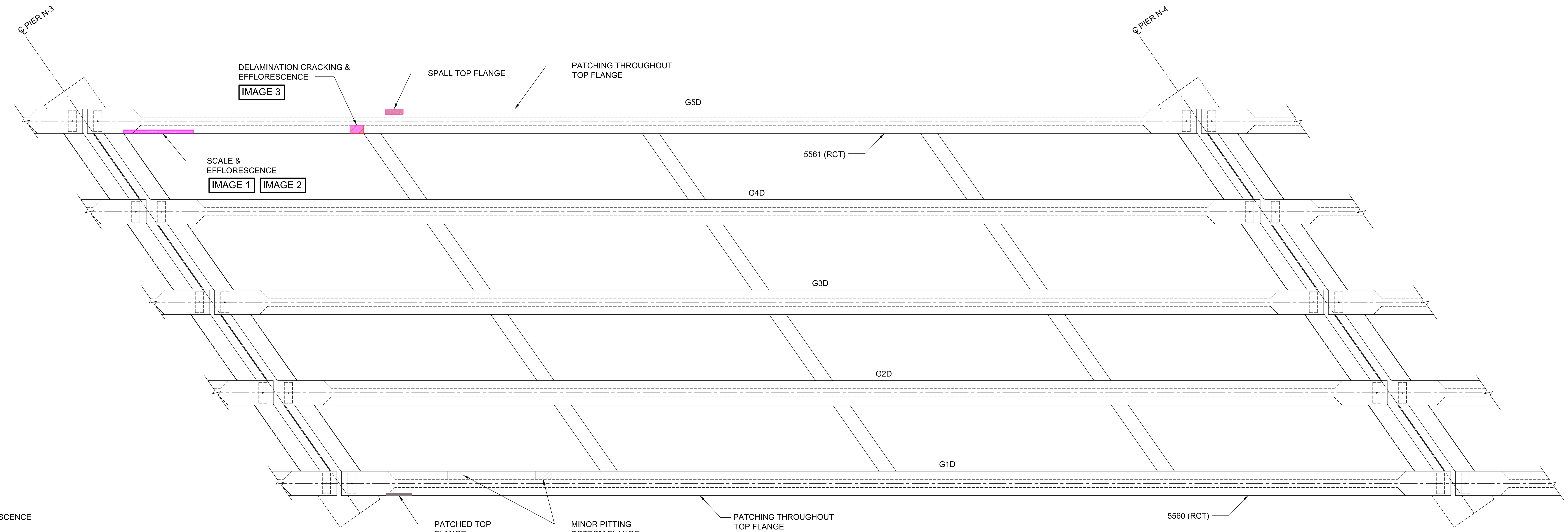
Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTHBOUND STRUCTURE
SPAN 3 GIRDERS

CITY DRAWING NUMBER
SHEET 9 OF 22

9



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION
- PITTING

1 PLAN - SPAN 4 (NORTHBOUND)
1 : 50

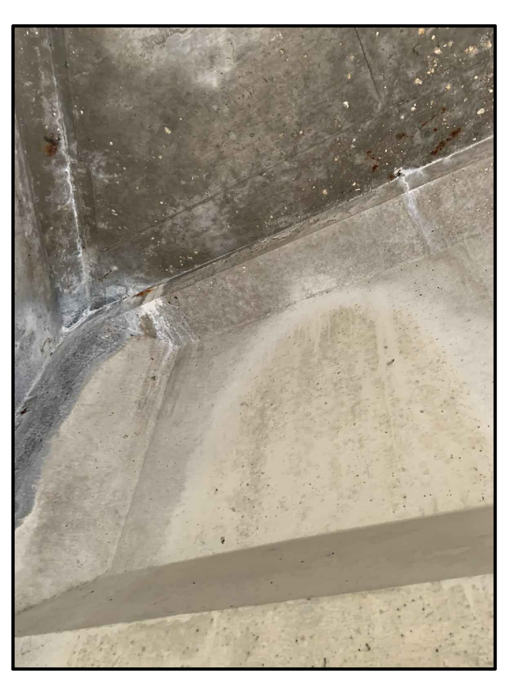


IMAGE 1

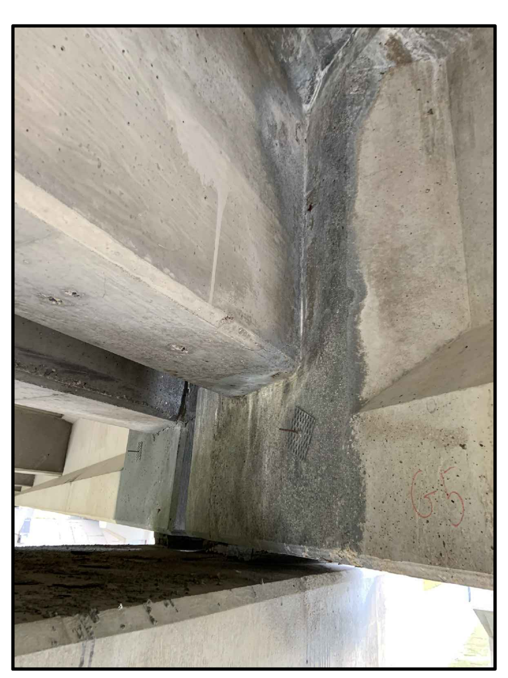


IMAGE 2

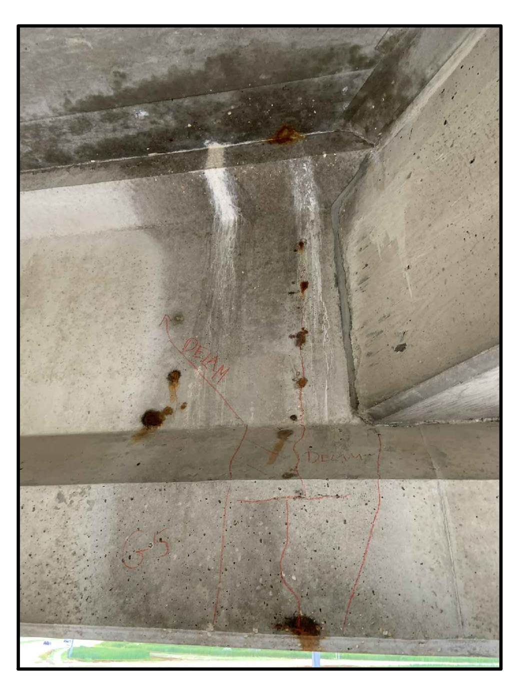


IMAGE 3

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.
CHECKED BY
DRAWN BY B.M.
APPROVED BY
HOR. SCALE: AS NOTED
VERTICAL:
ACCEPTED BY DATE
DATE 12.12.22
BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0010

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

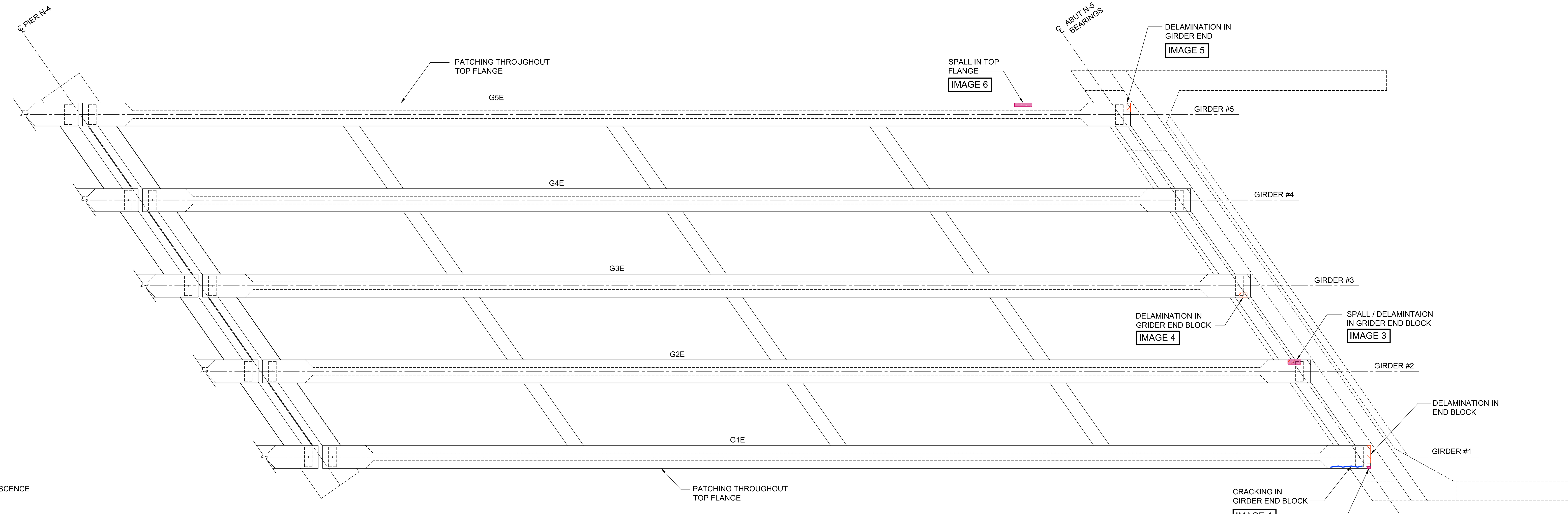
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

CITY DRAWING NUMBER

SHEET 10 OF 22

NORTHBOUND STRUCTURE
SPAN 4 GIRDERS

10



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION

1 — PLAN - SPAN 5 (NORTHBOUND)
1 : 50

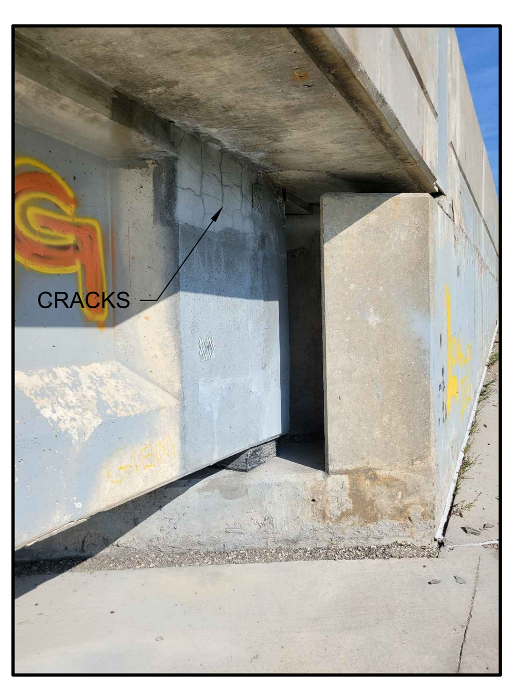


IMAGE 1

IMAGE 2

IMAGE 3

IMAGE 4

IMAGE 5

IMAGE 6

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M. ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY: M.L.	CHECKED BY
DRAWN BY: B.M.	APPROVED BY
HOR. SCALE: AS NOTED	ACCEPTED BY — DATE
VERTICAL:	
DATE: 12.12.22	BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

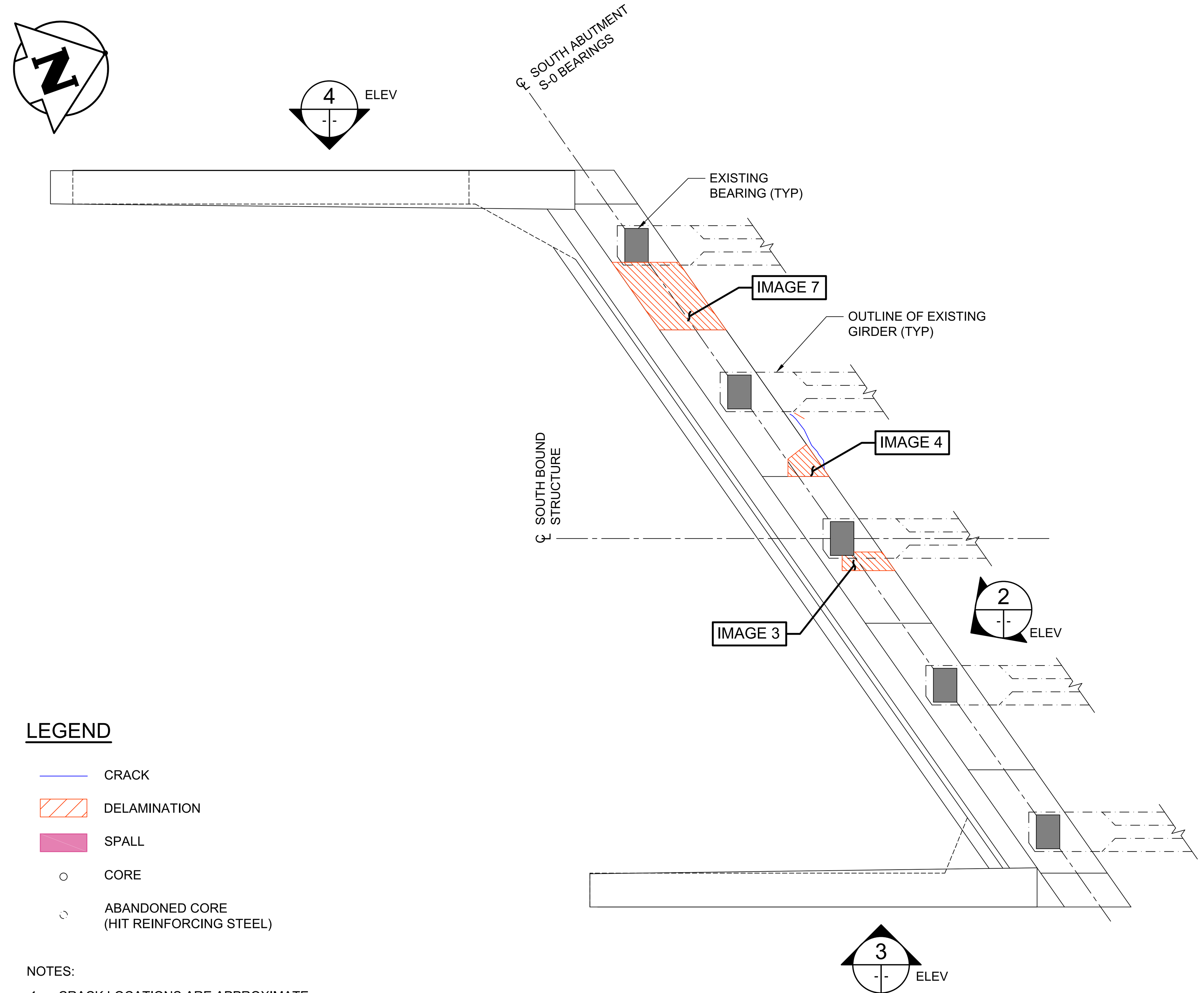
CONSULTANT DRAWING NO.
734-2200070600-SKT-S0011

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

NORTHBOUND STRUCTURE
SPAN 5 GIRDERS

CITY DRAWING NUMBER
SHEET 11 OF 22
11



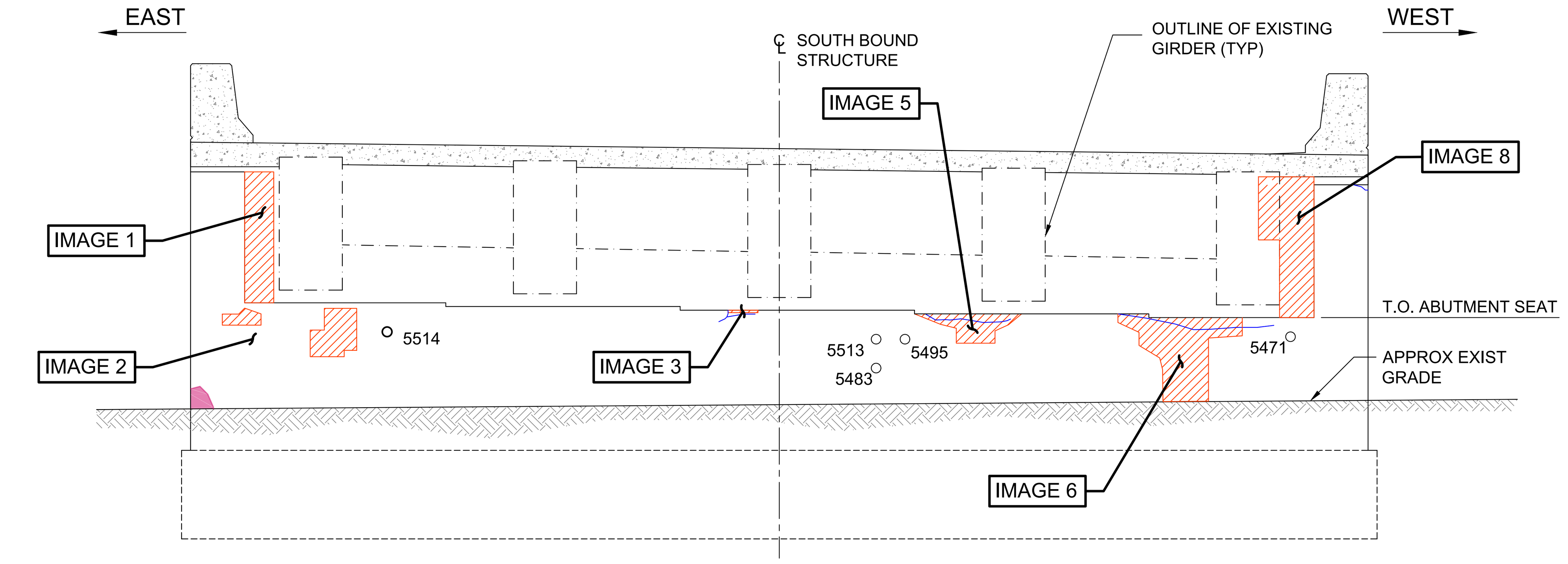
LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

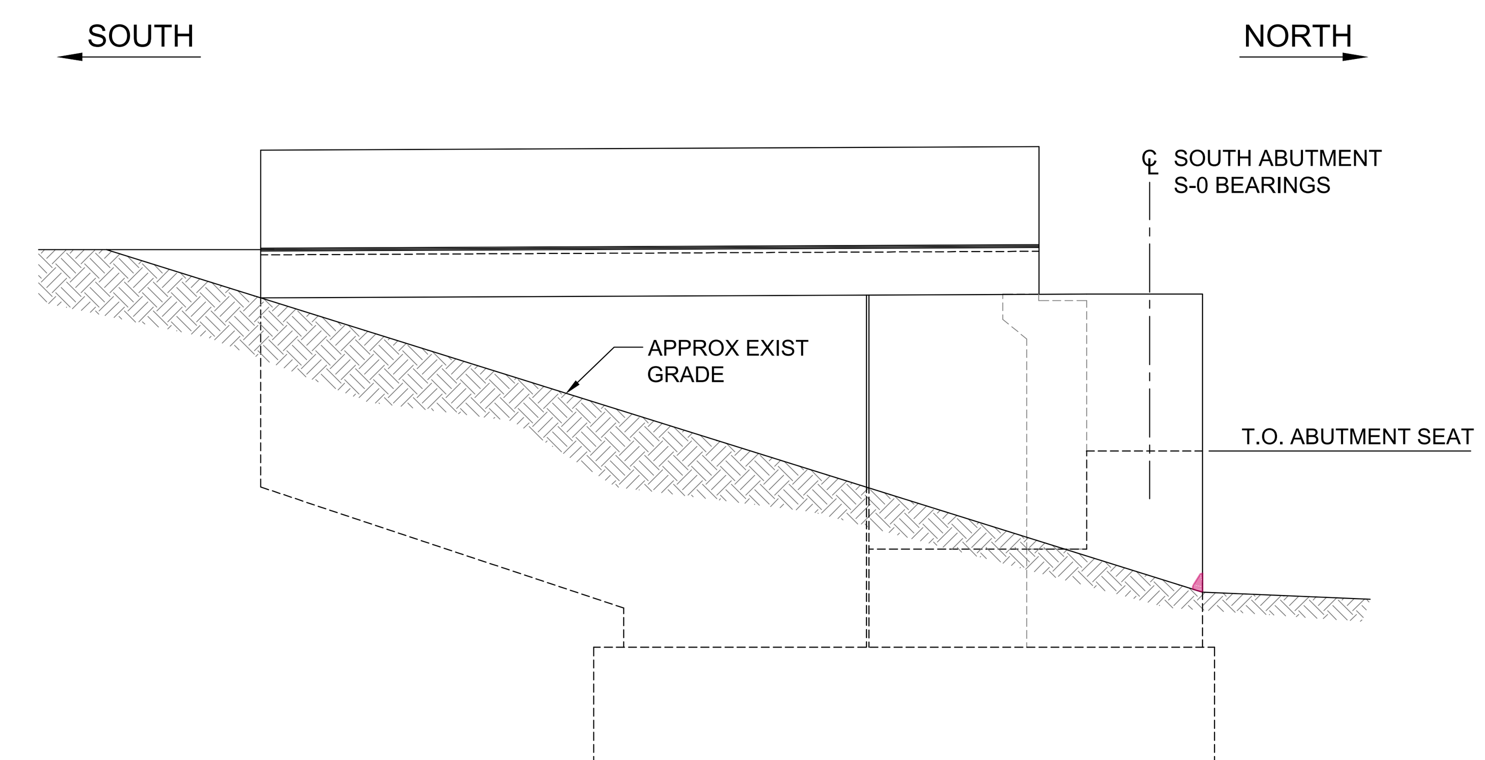
NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED.

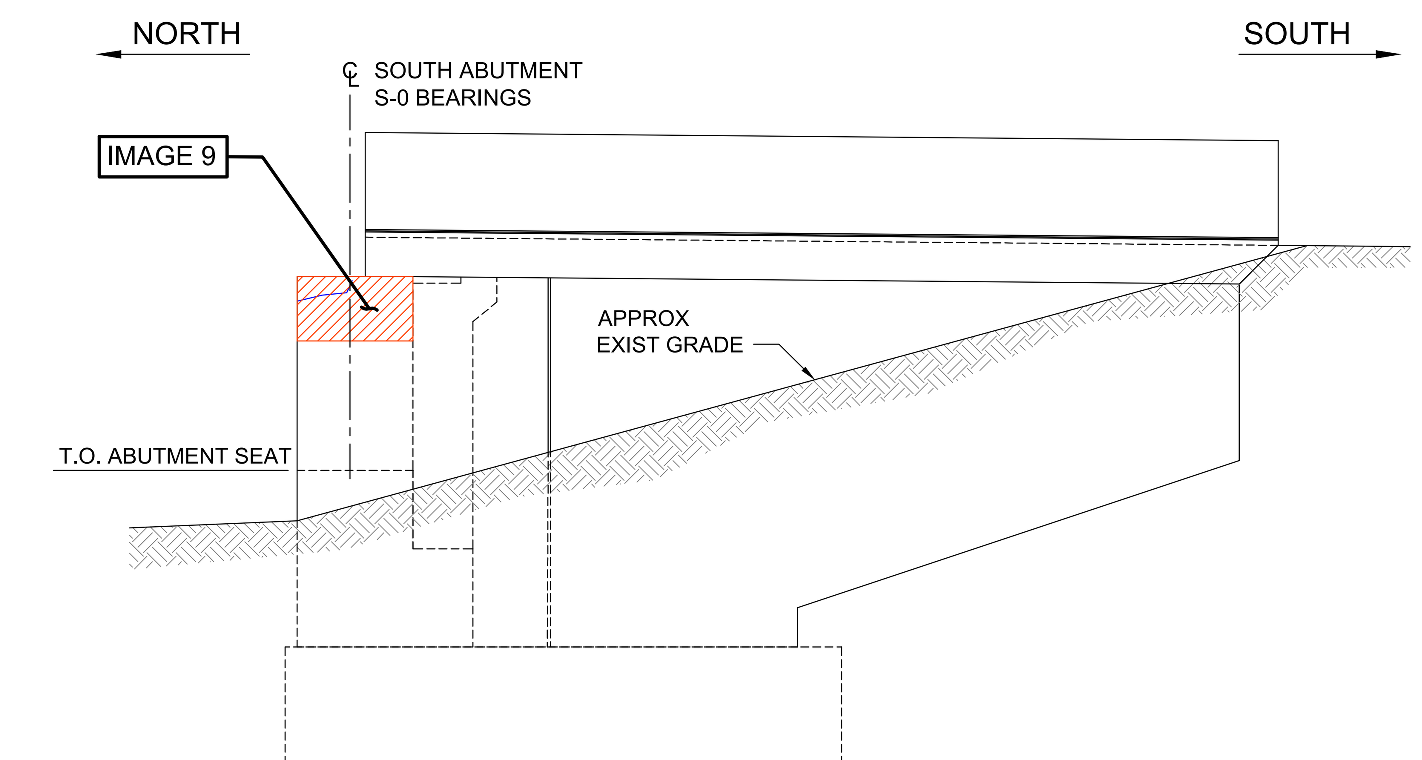
1 PLAN - ABUT S-0
1 : 50



2 ABUT S-0 - FRONT ELEVATION
1 : 50



3 ABUT S-0 - EAST ELEVATION
1 : 50



4 ABUT S-0 - WEST ELEVATION
1 : 50


IMAGE 1

IMAGE 2


IMAGE 3

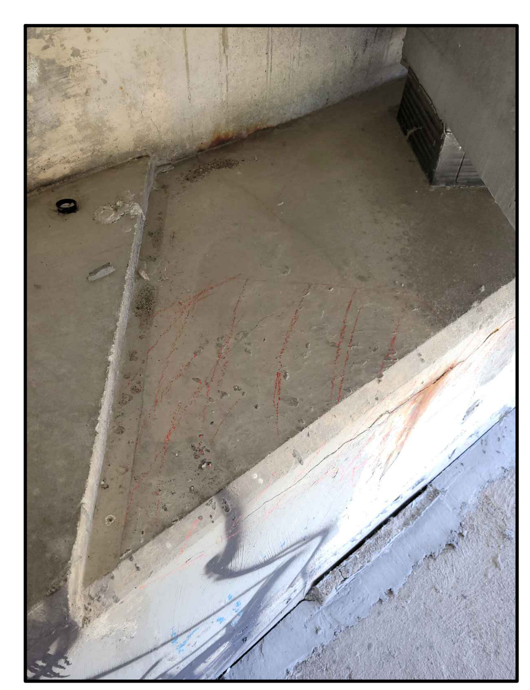


IMAGE 4


IMAGE 5


IMAGE 6


IMAGE 7


IMAGE 8


IMAGE 9

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M. ELEV.			
NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.	CHECKED BY
DRAWN BY B.M.	APPROVED BY
HOR. SCALE: AS NOTED VERTICAL:	ACCEPTED BY DATE
DATE 12.12.22	BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0012

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

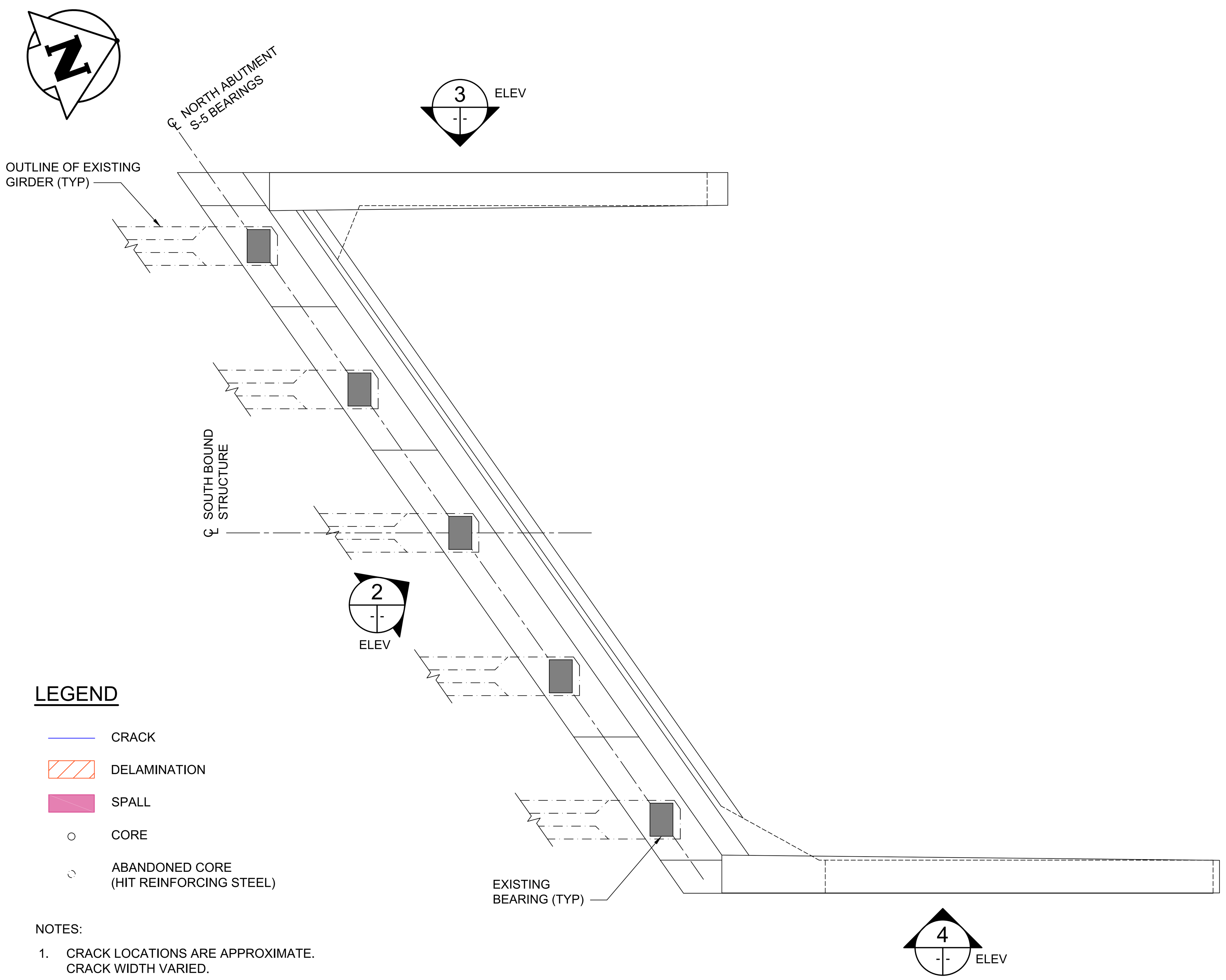
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
ABUTMENT S-0

CITY DRAWING NUMBER

SHEET 12 OF 22

12



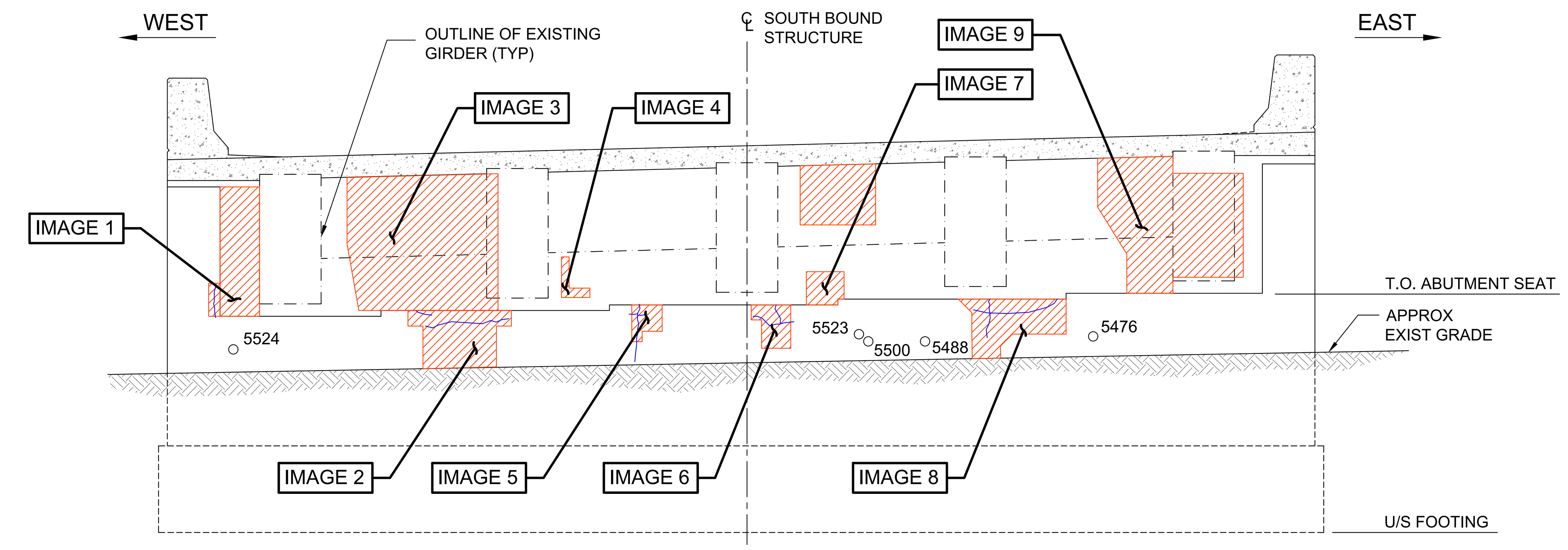
LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

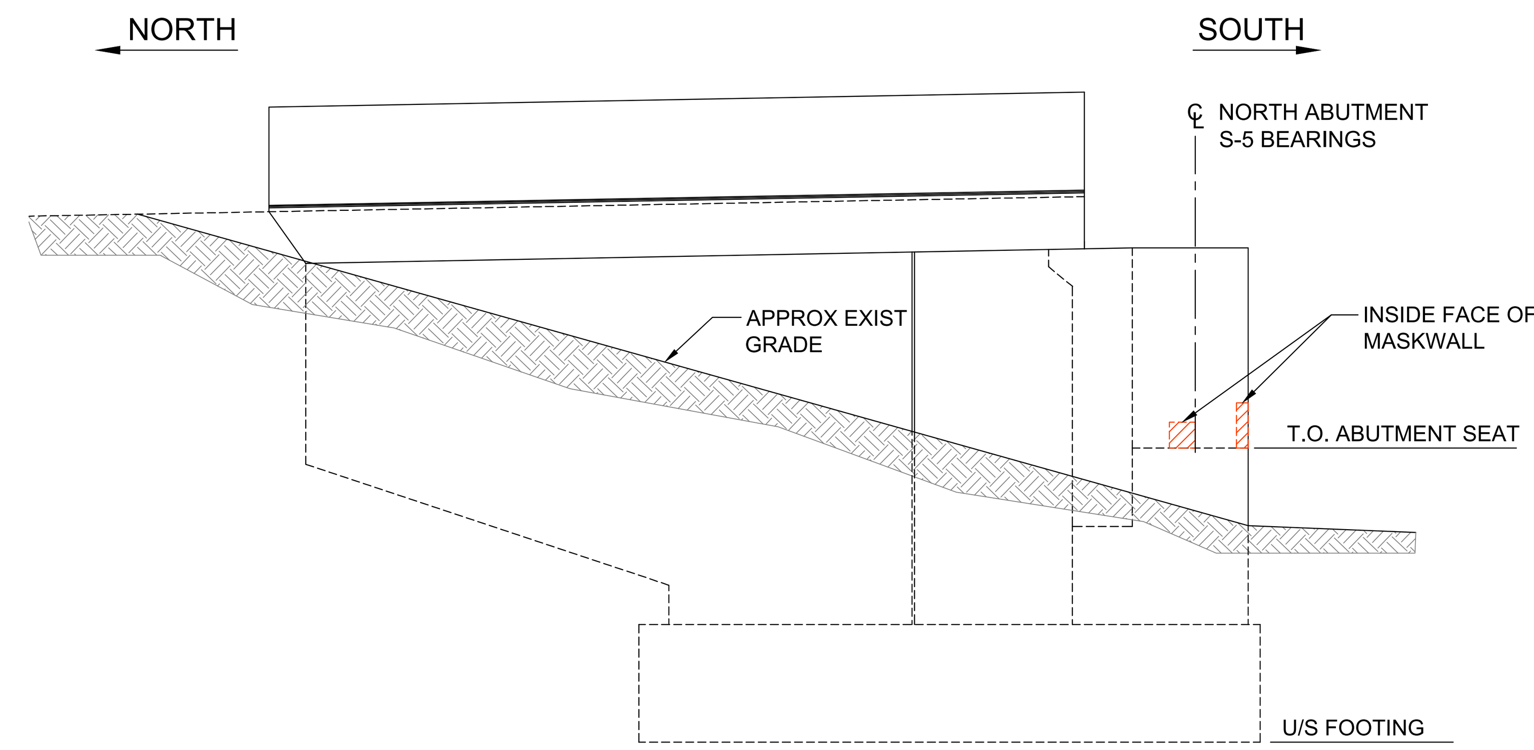
NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED.

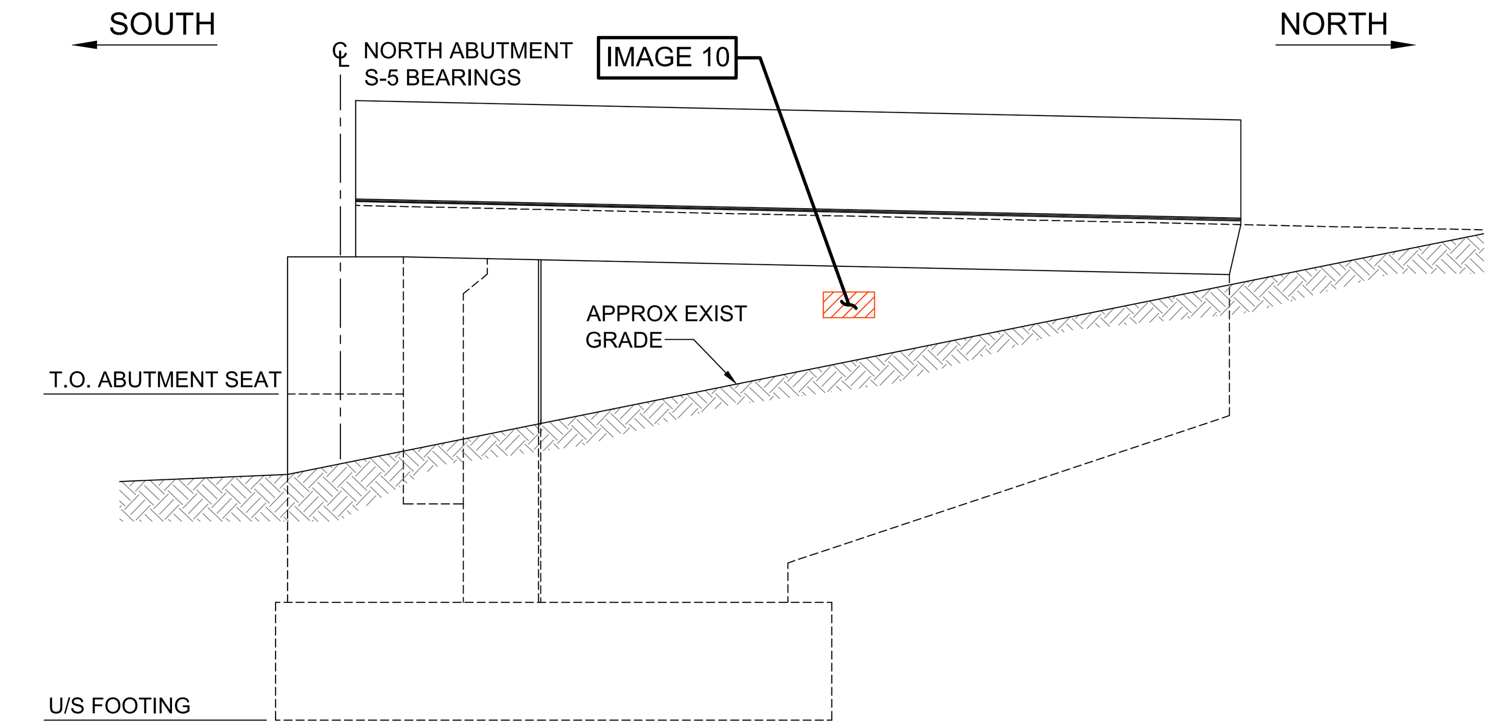
1 PLAN - ABUT S-5
1 : 50



2 ABUT S-5 - FRONT ELEVATION
1 : 50



3 ABUT S-5 - WEST ELEVATION
1 : 50



4 ABUT S-5 - EAST ELEVATION
1 : 50


IMAGE 1


IMAGE 2


IMAGE 3


IMAGE 4


IMAGE 5


IMAGE 6


IMAGE 7


IMAGE 8

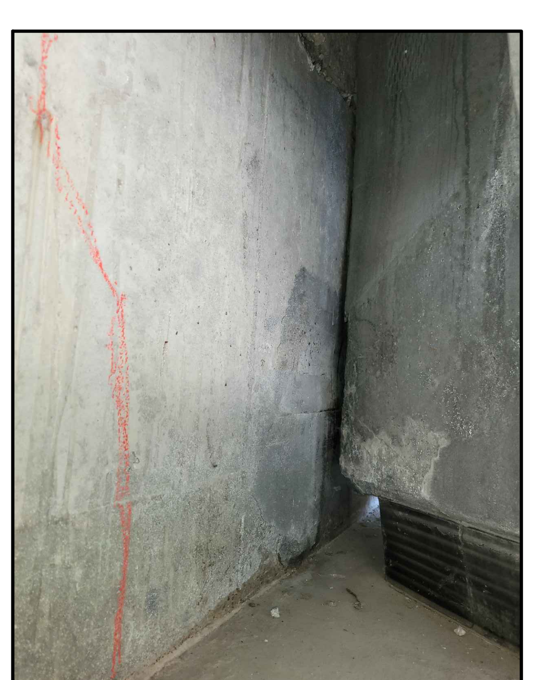


IMAGE 9

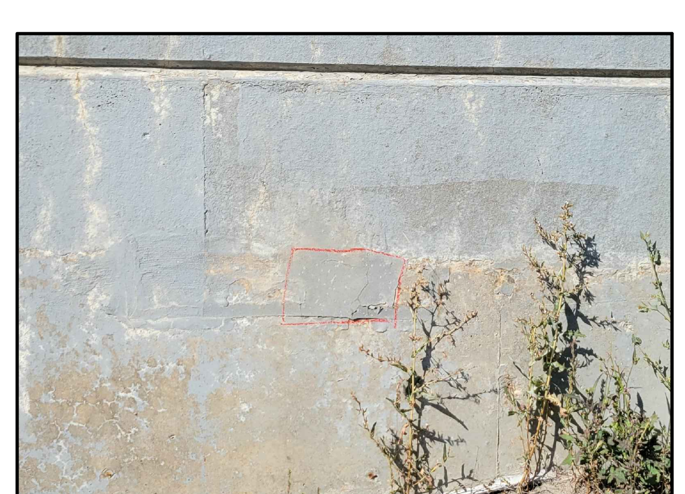


IMAGE 10

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M. ELEV.			
NO. REVISIONS		DATE	BY

TETRA TECH

DESIGNED BY	M.L.	CHECKED BY	
DRAWN BY	B.M.	APPROVED BY	
HOR. SCALE: VERTICAL:	AS NOTED	ACCEPTED BY	DATE
DATE	12.12.22	BRIDGE PROJECTS ENGINEER	

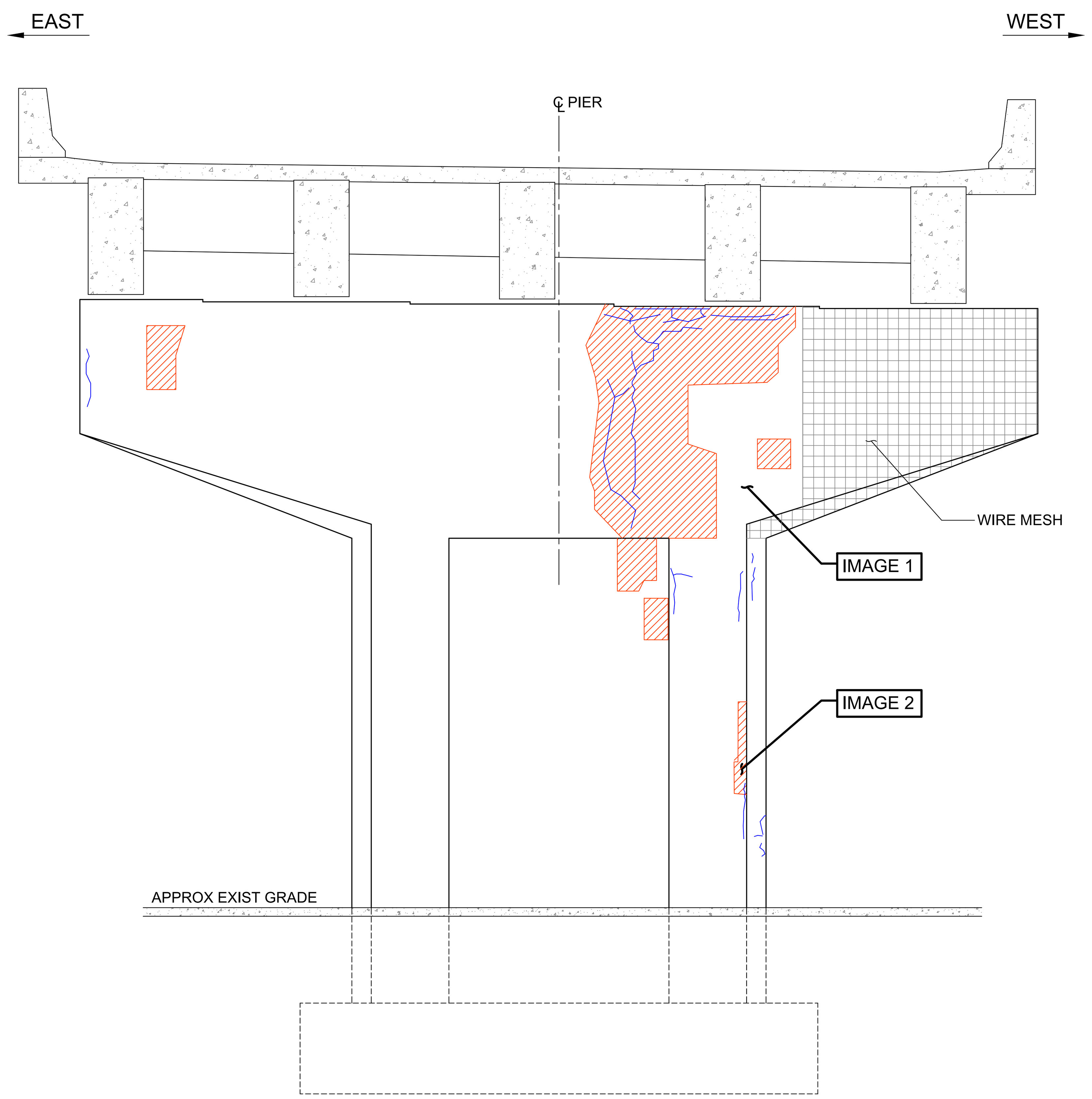
PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION
CONSULTANT DRAWING NO.
734-2200070600-SKT-S0022

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

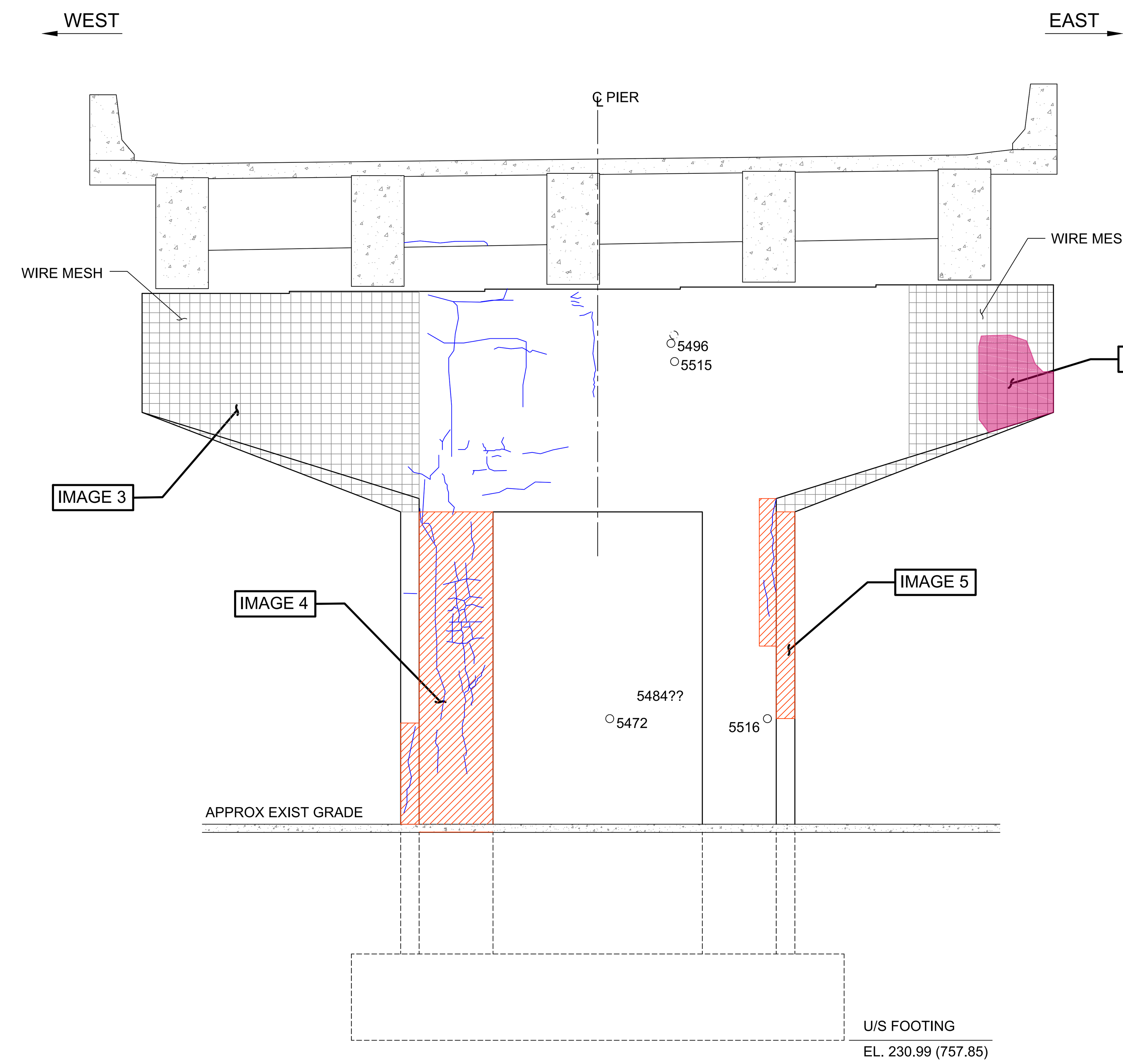
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
ABUTMENT S-5

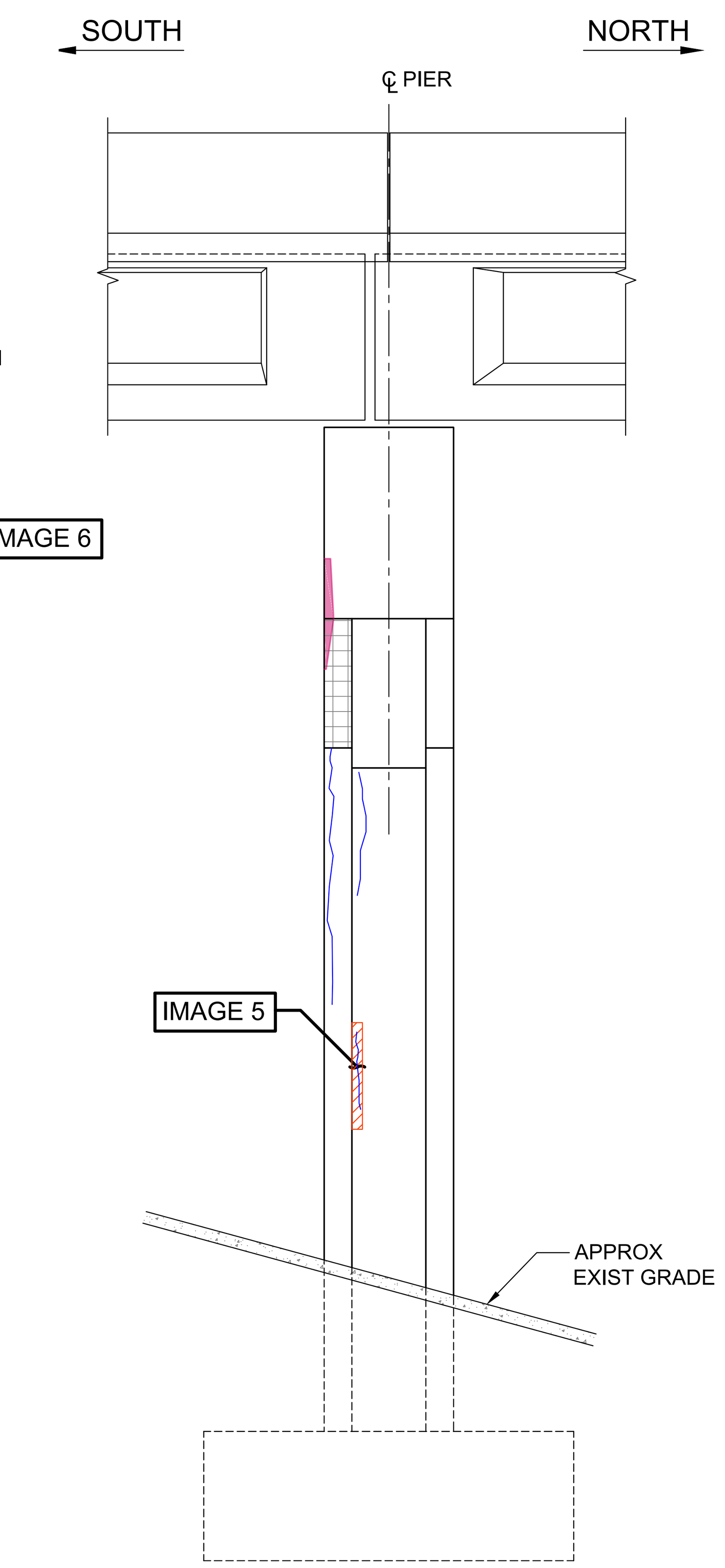
CITY DRAWING NUMBER
SHEET 13 OF 22
13



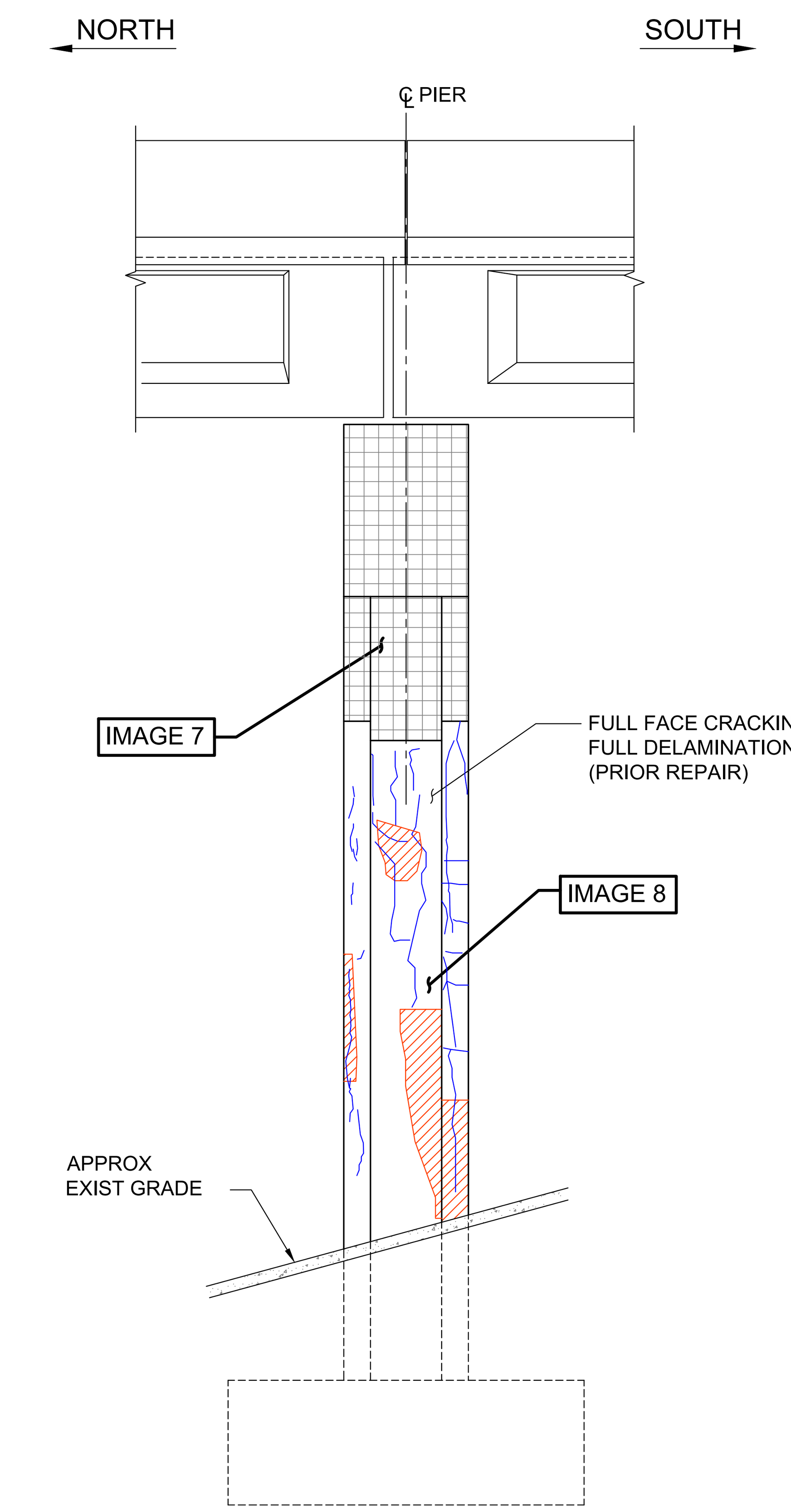
1 PIER S-1 - NORTH ELEVATION
1 : 50



2 PIER S-1 - SOUTH ELEVATION
1 : 50



3 EAST ELEVATION
1 : 50



4 WEST ELEVATION
1 : 50

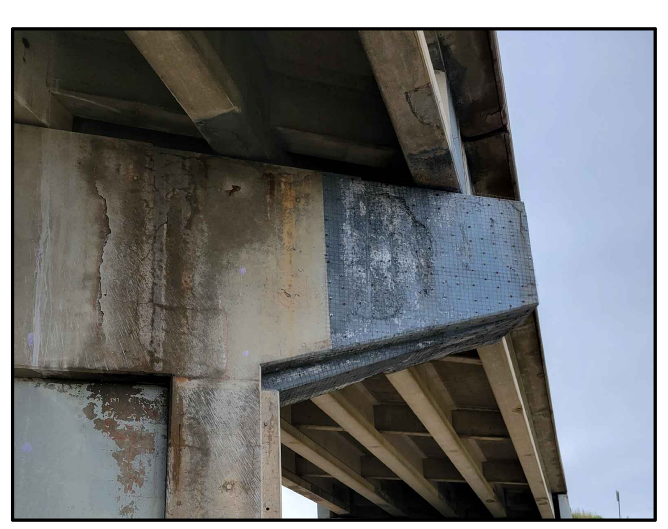


IMAGE 1

IMAGE 2

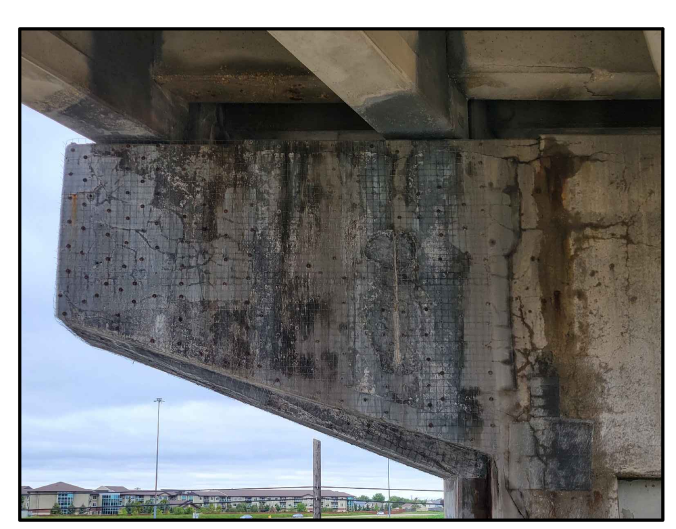


IMAGE 3

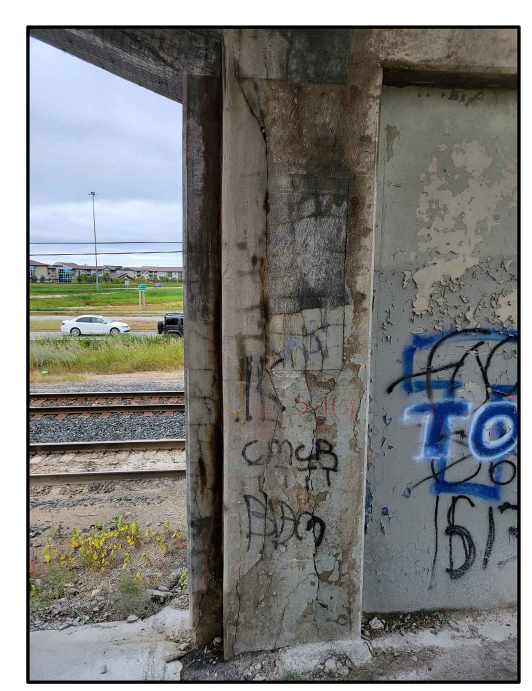


IMAGE 4

IMAGE 5

IMAGE 6

IMAGE 7

IMAGE 8

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M. ELEV.			
NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.	CHECKED BY
DRAWN BY B.M.	APPROVED BY
HOR. SCALE: AS NOTED VERTICAL:	ACCEPTED BY DATE
DATE 12.12.22	BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0014

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

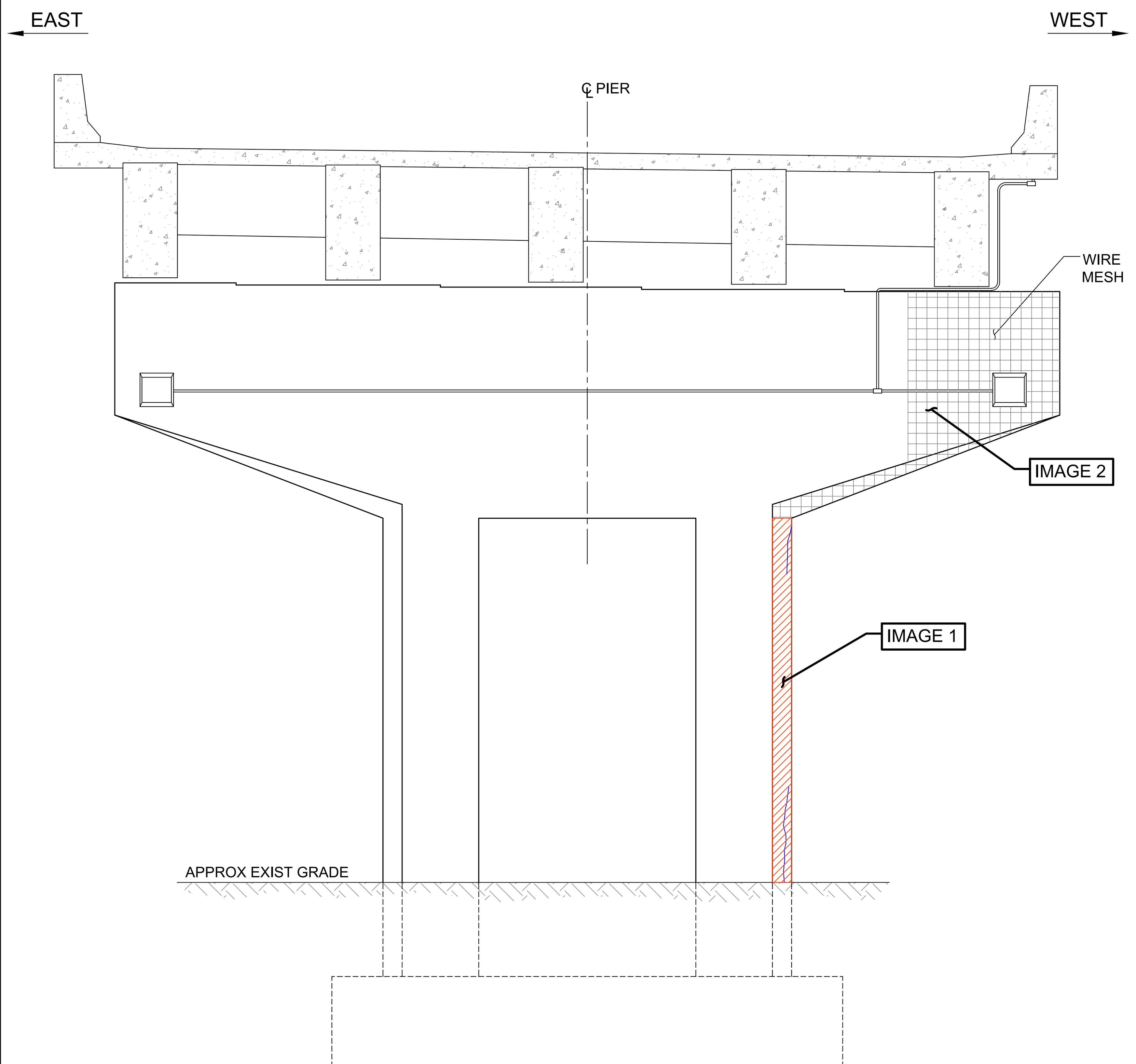
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUD STRUCTURE
PIER S-1

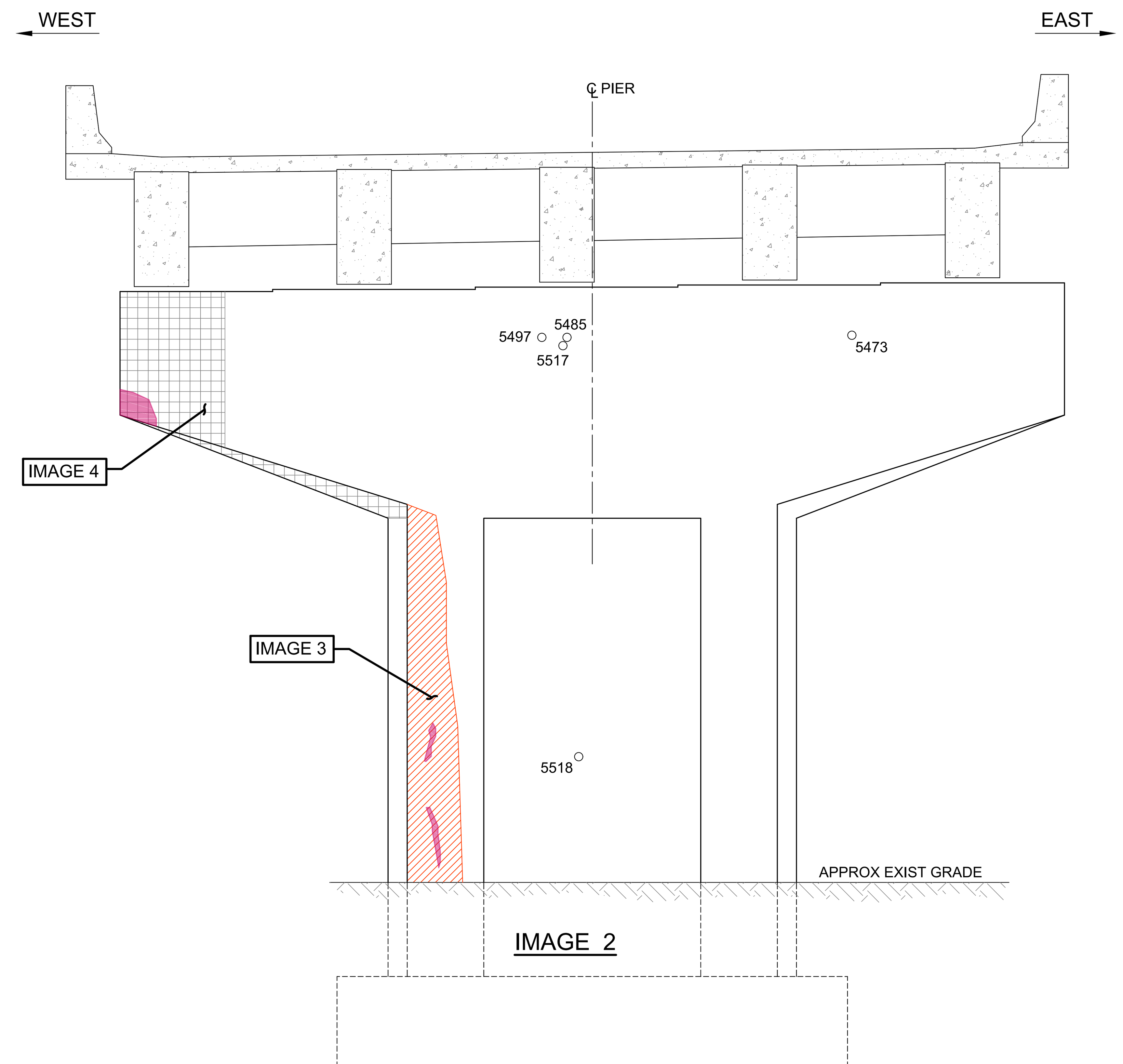
CITY DRAWING NUMBER

SHEET 14 OF 22

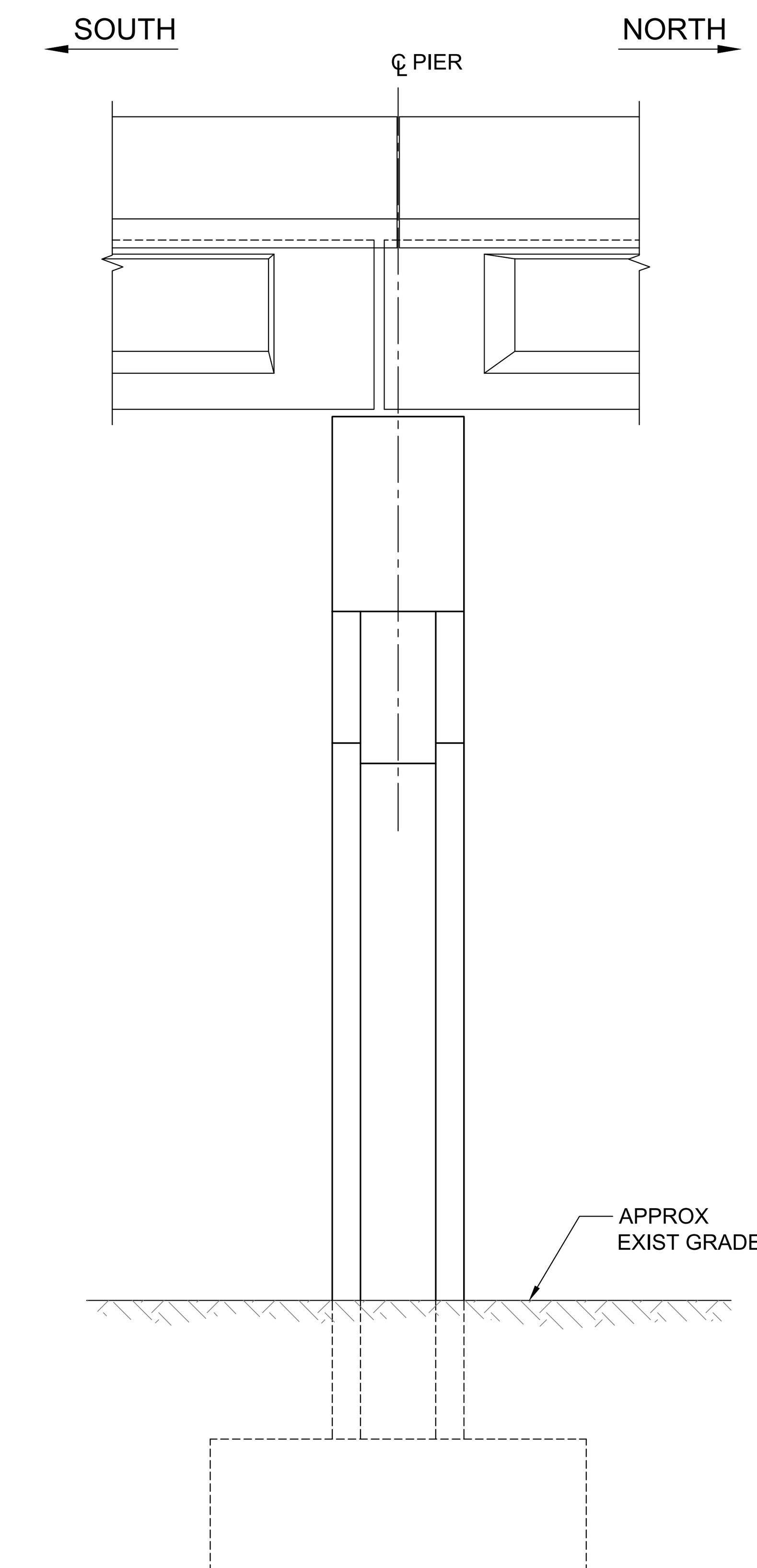
14



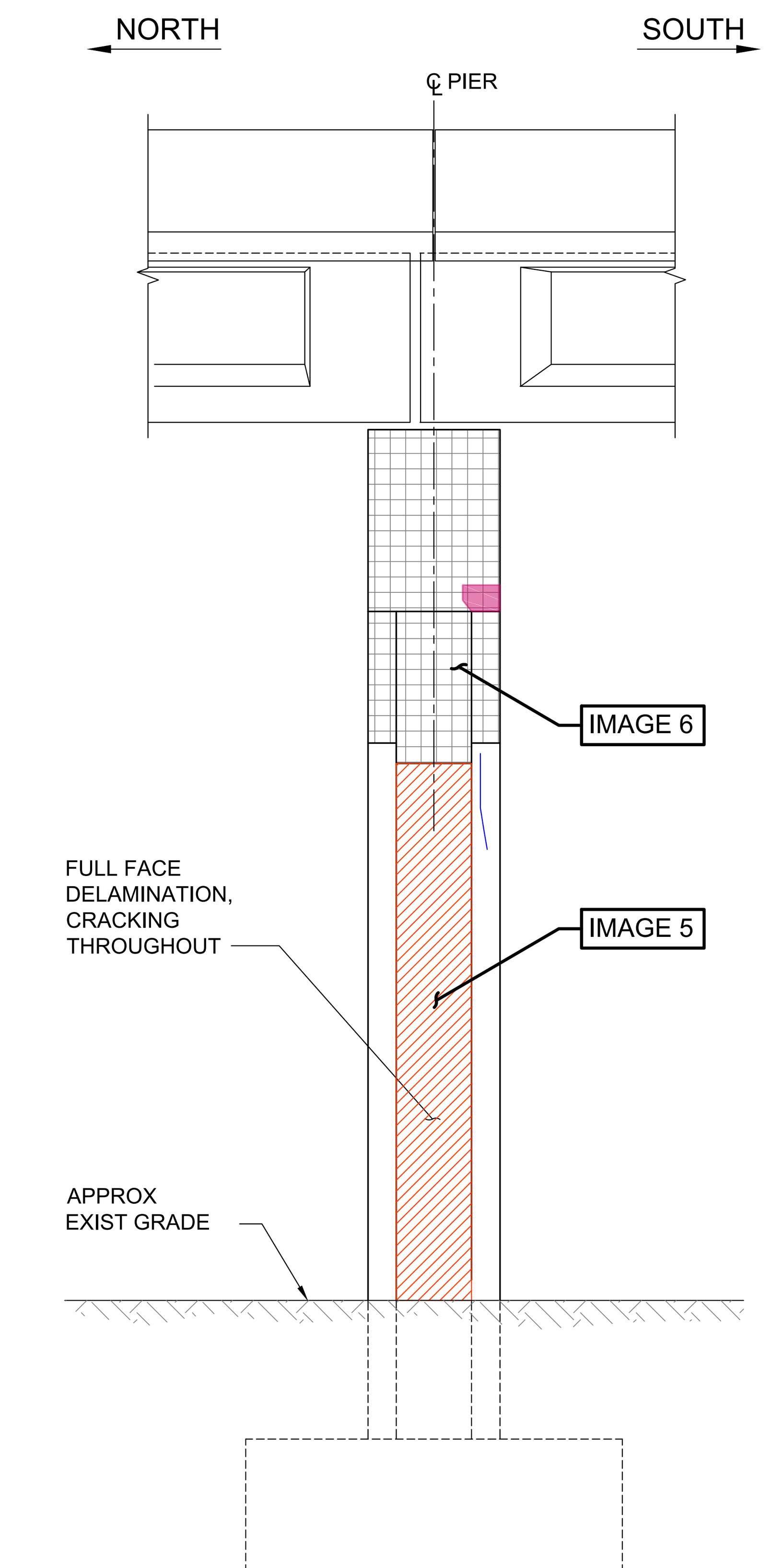
1 PIER S-2 - NORTH ELEVATION
1 : 50



2 PIER S-2 - SOUTH ELEVATION
1 : 50



3 EAST ELEVATION
1 : 50



4 WEST ELEVATION
1 : 50

IMAGE 1

IMAGE 2

IMAGE 3

IMAGE 4

IMAGE 5

IMAGE 6

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L. | CHECKED BY
DRAWN BY B.M. | APPROVED BY
HOR. SCALE: AS NOTED | ACCEPTED BY | DATE
VERTICAL:
DATE 12.12.22 | BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0015

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

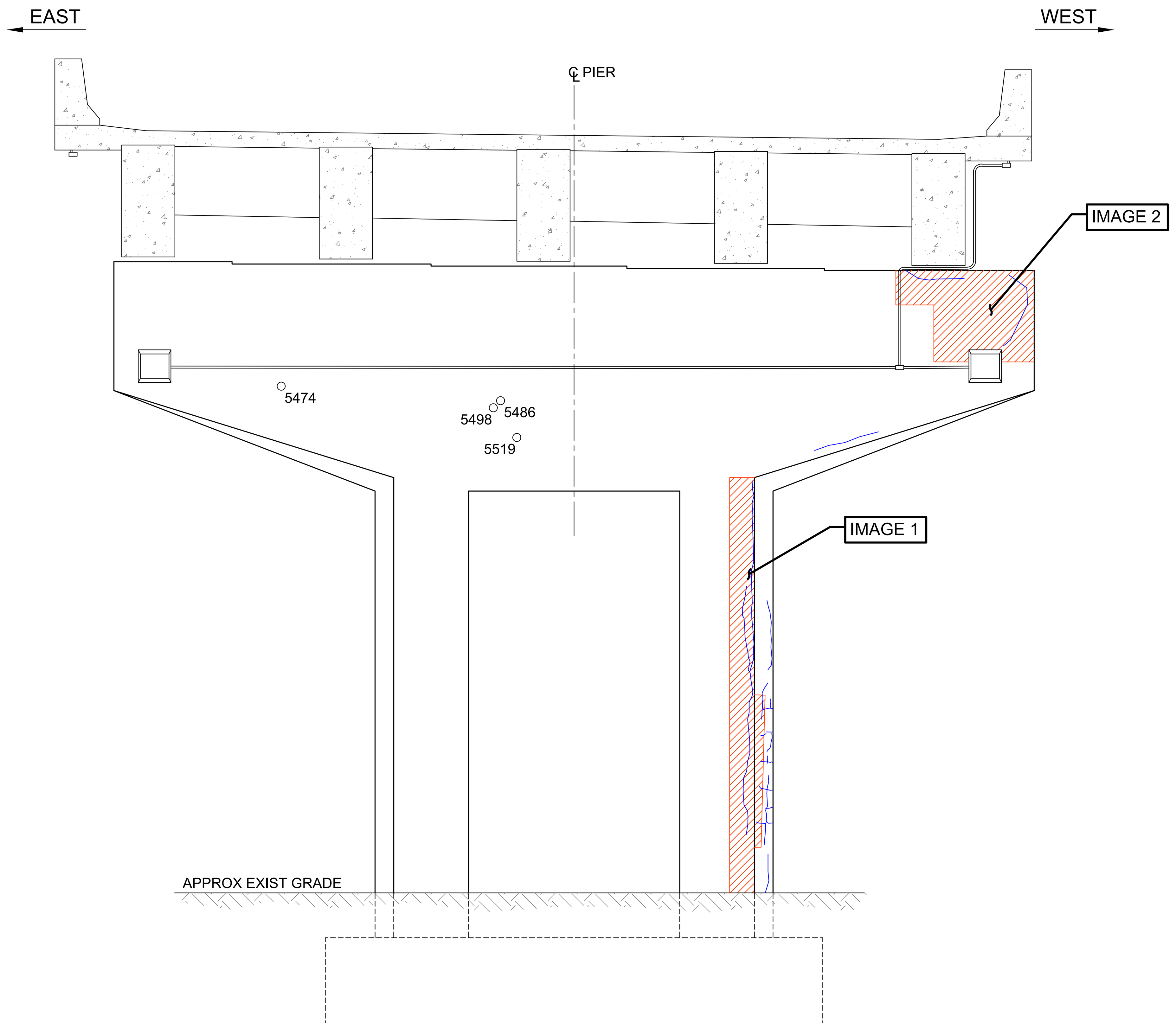
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
PIER S-2

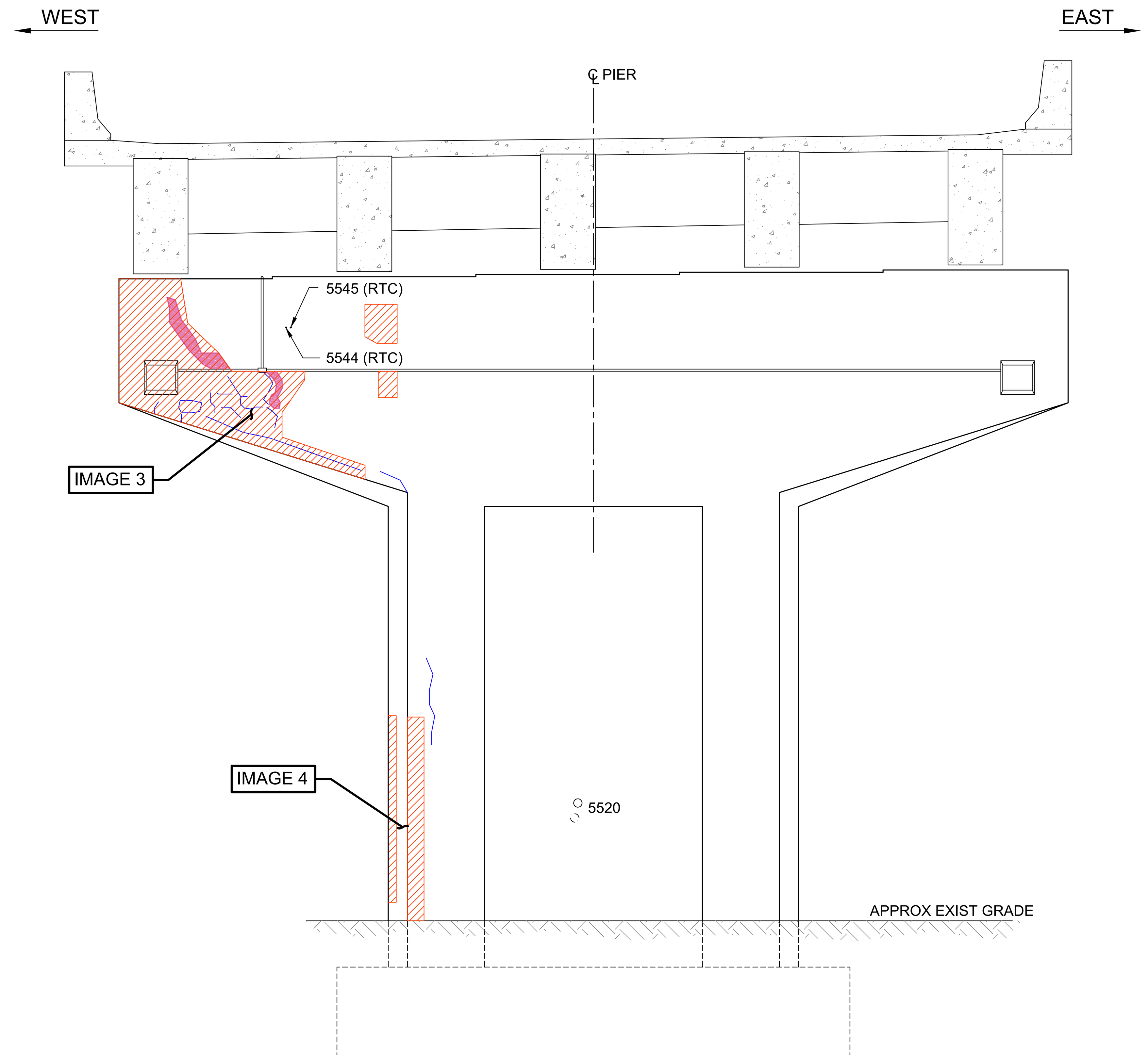
CITY DRAWING NUMBER

SHEET 15 OF 22

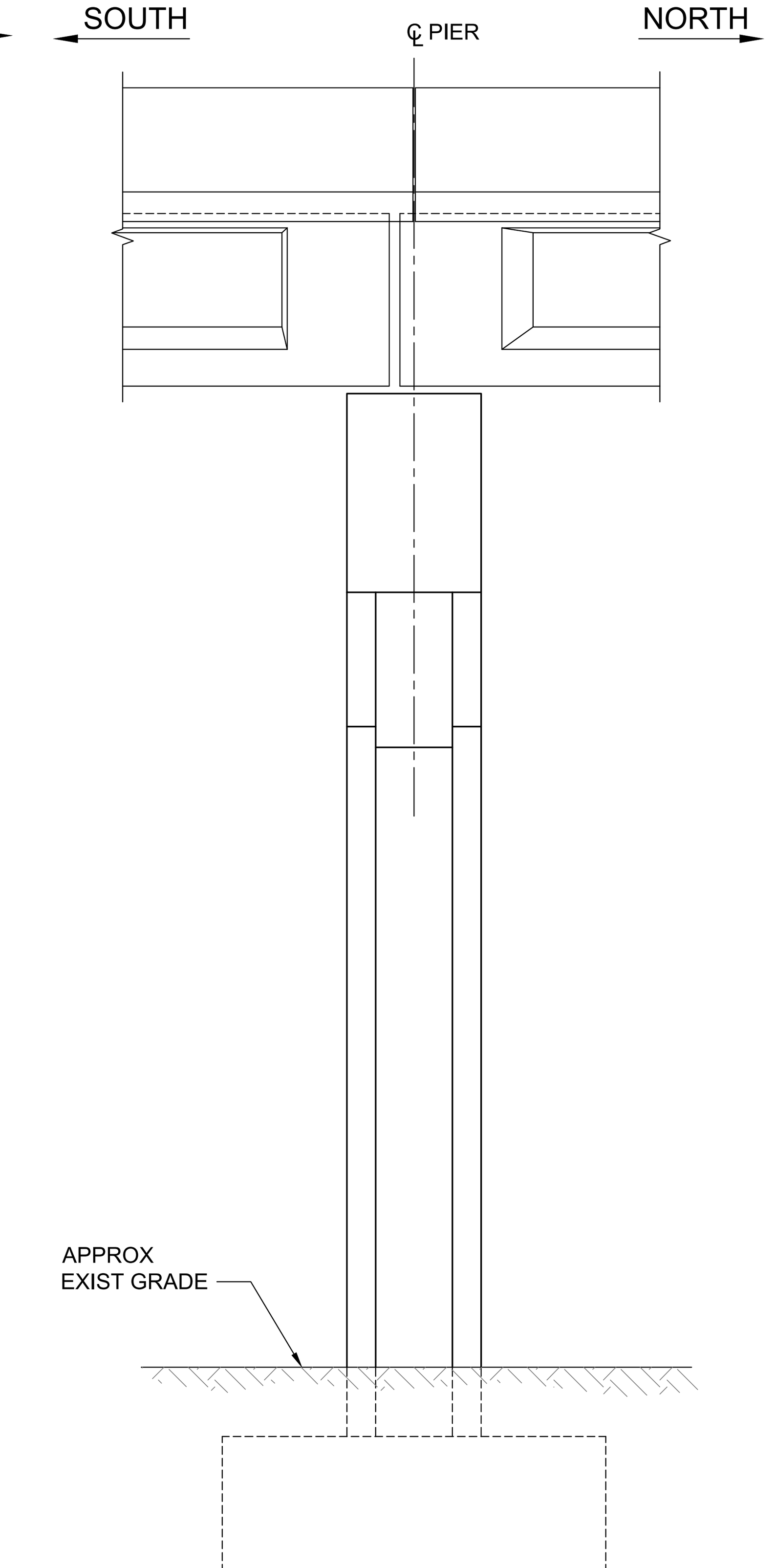
15



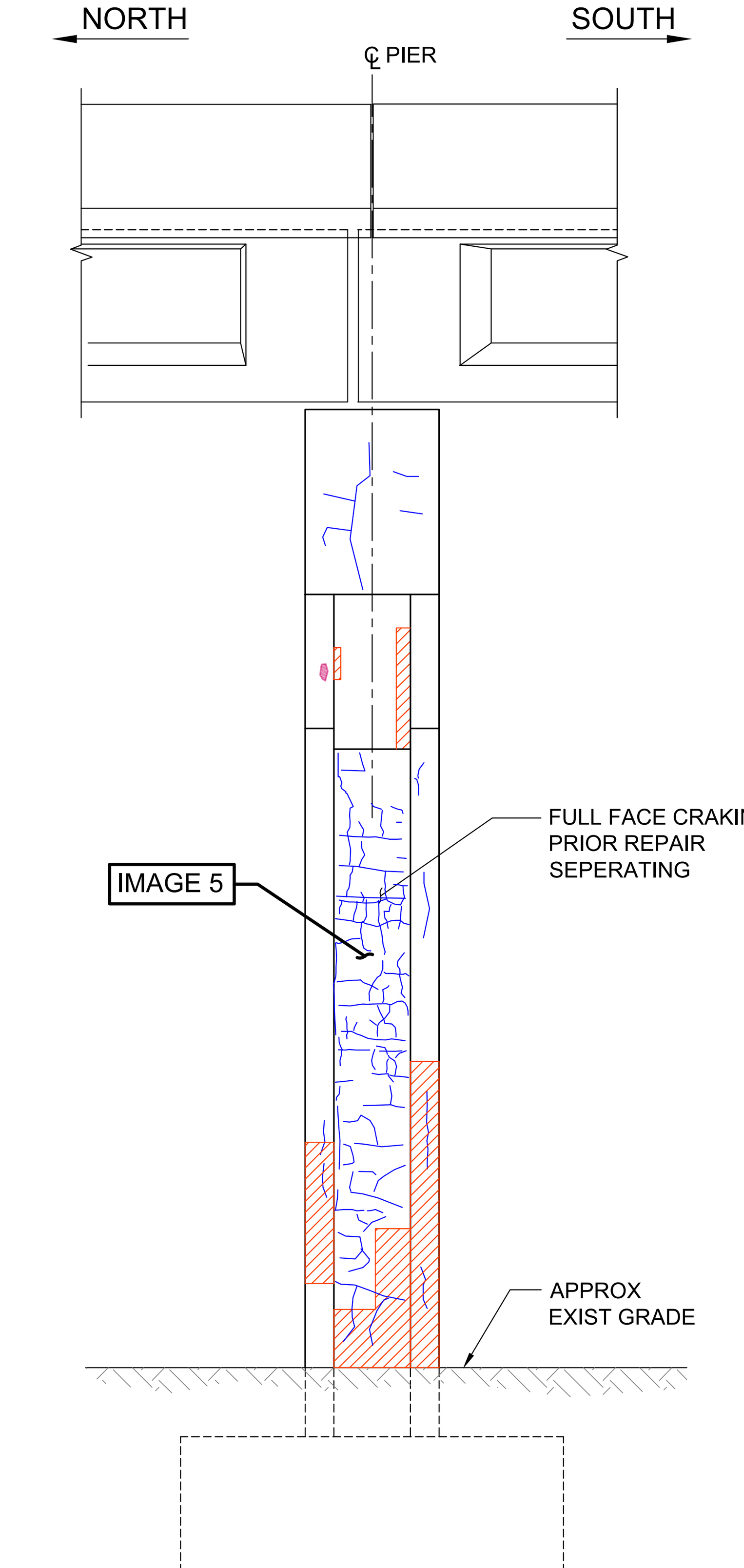
1 PIER S-3 - NORTH ELEVATION
1 : 50



2 PIER S-3 - SOUTH ELEVATION
1 : 50



2 EAST ELEVATION
1 : 50



3 WEST ELEVATION
1 : 50

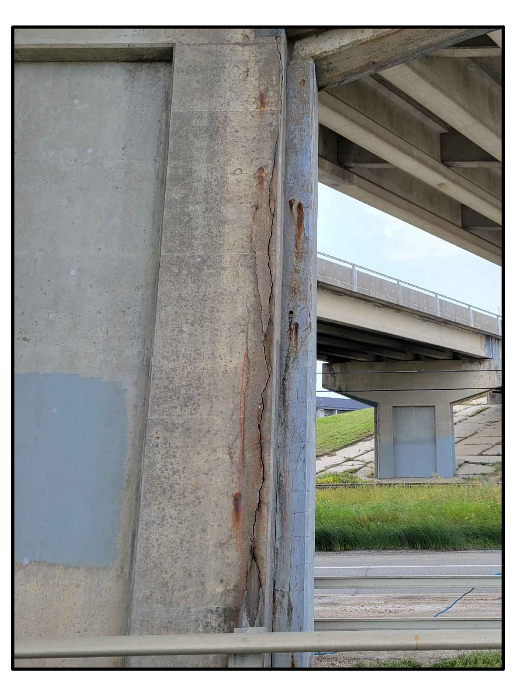


IMAGE 1

IMAGE 2

IMAGE 3

IMAGE 4

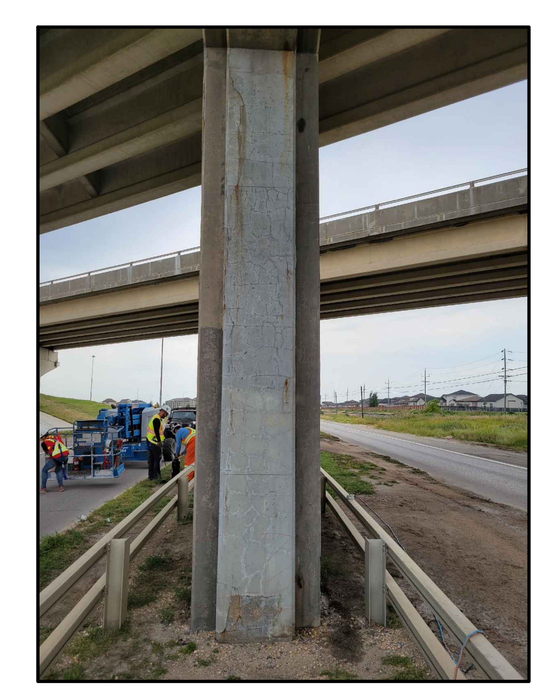


IMAGE 5

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.	CHECKED BY
DRAWN BY B.M.	APPROVED BY
HOR. SCALE: AS NOTED	ACCEPTED BY DATE
VERTICAL:	
DATE 12.12.22	BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0016

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

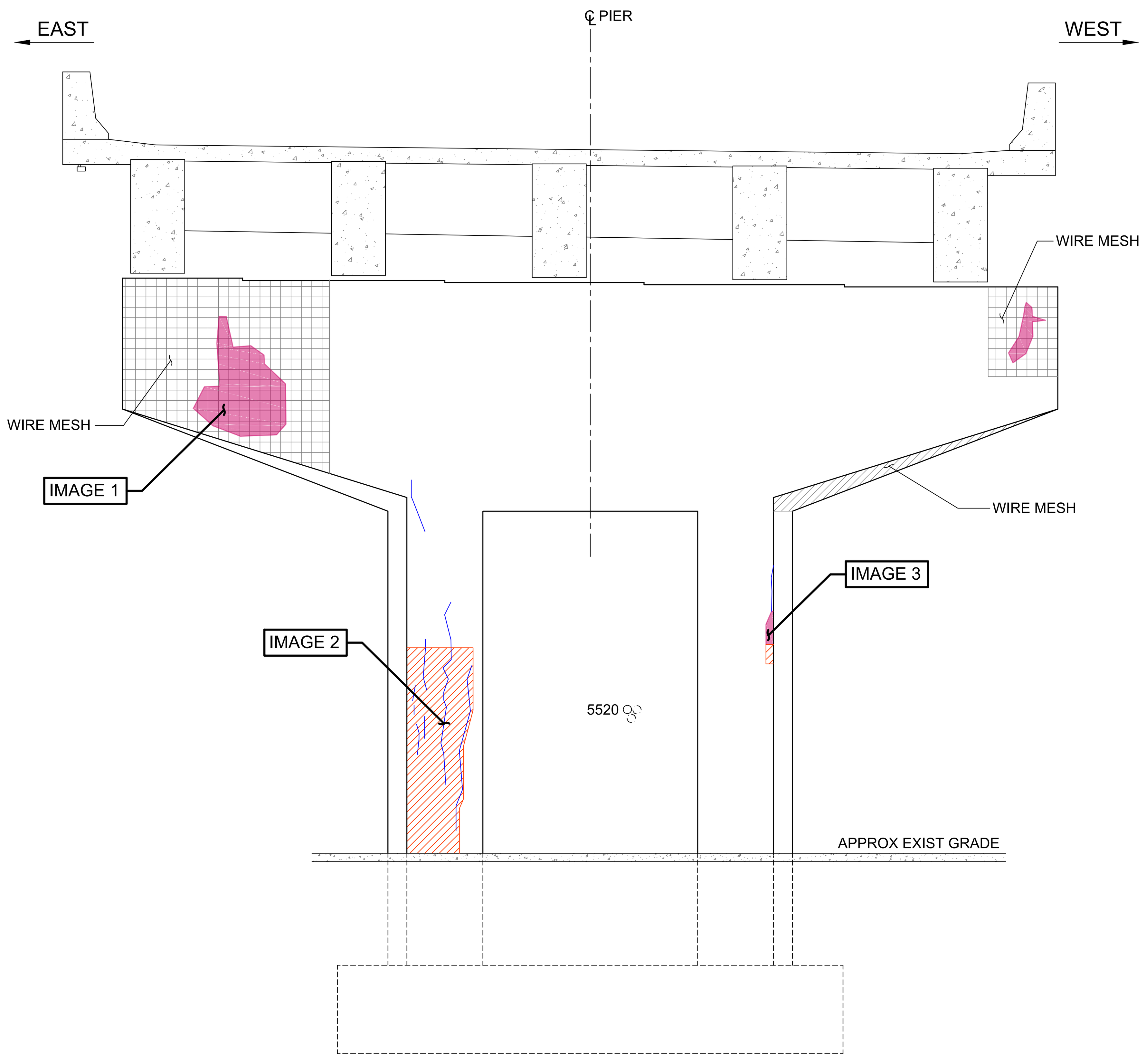
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTBOUND STRUCTURE
PIER S-3

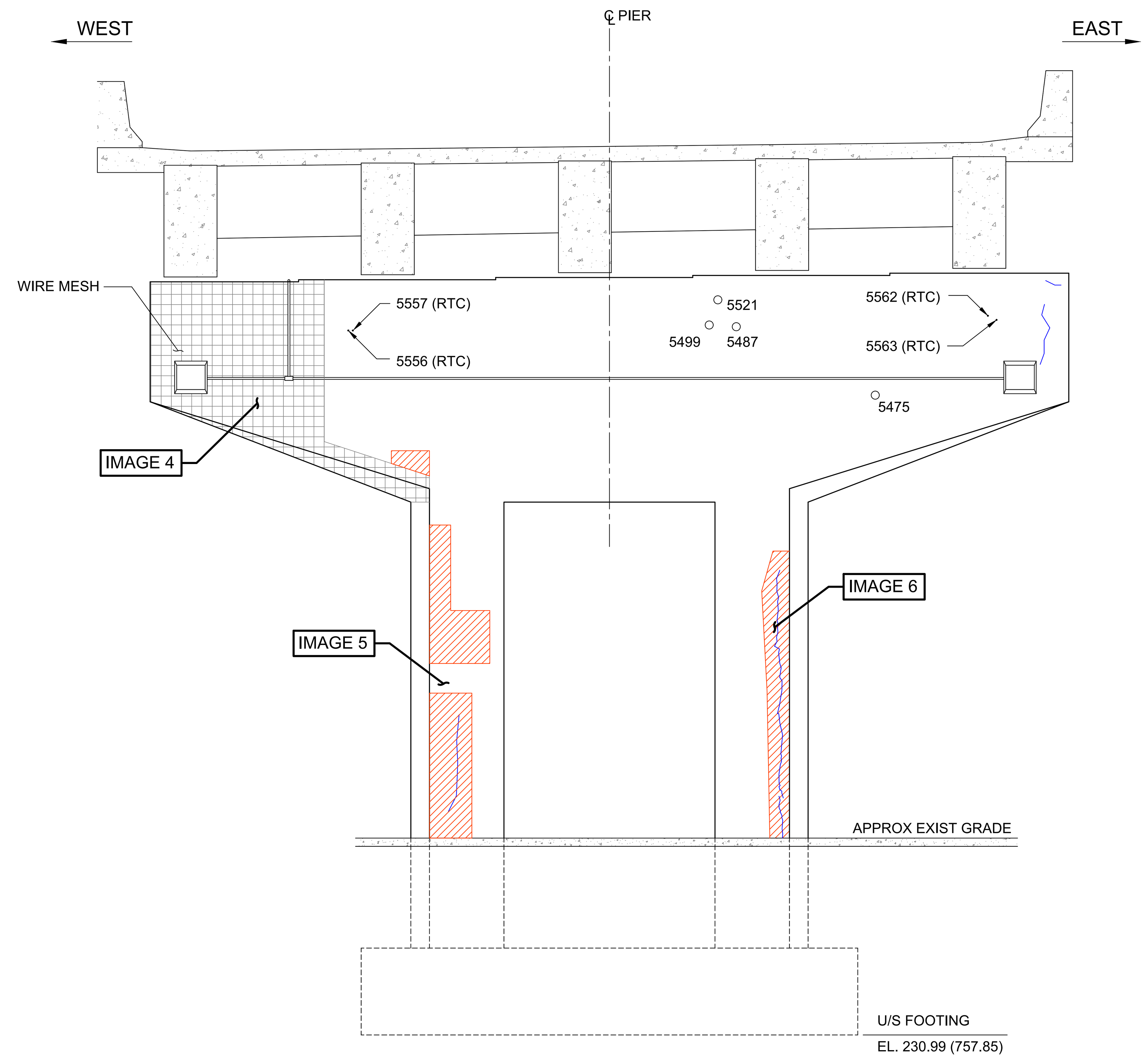
CITY DRAWING NUMBER

SHEET 16 OF 22

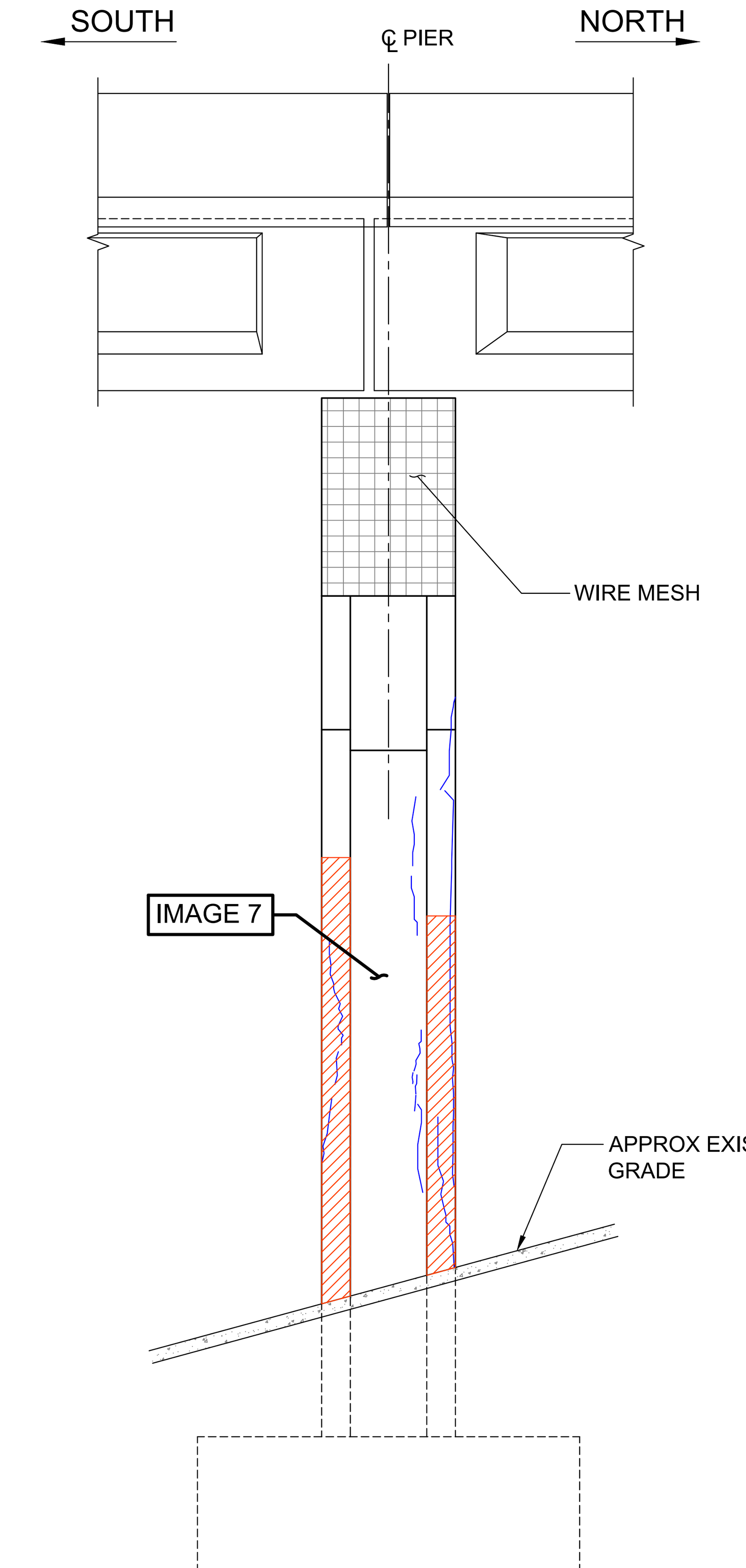
16



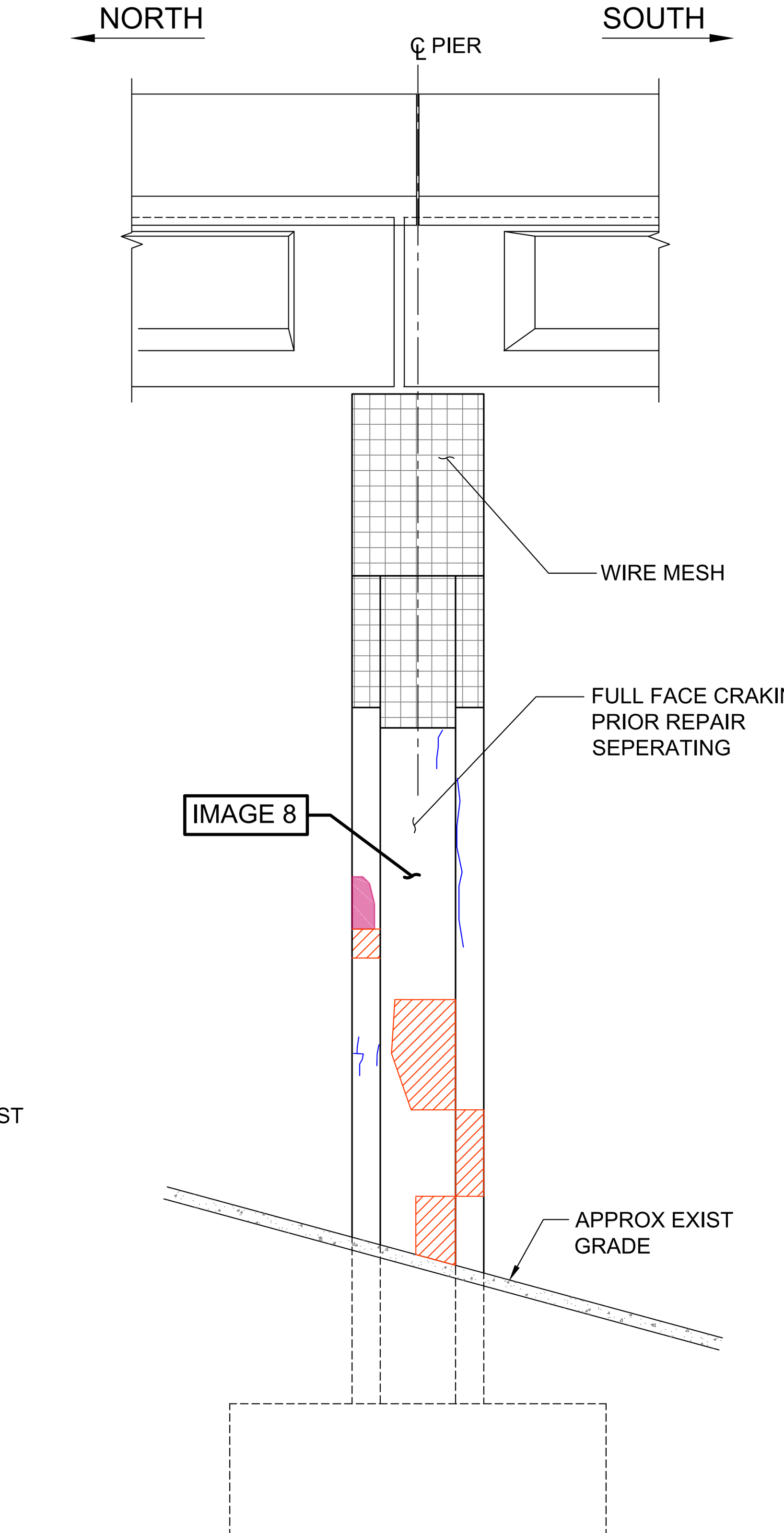
1 PIER S-4 - NORTH ELEVATION
1 : 50



2 PIER S-4 - SOUTH ELEVATION
1 : 50



3 EAST ELEVATION
1 : 50



4 WEST ELEVATION
1 : 50

IMAGE 1

IMAGE 2

IMAGE 3

IMAGE 4

IMAGE 5

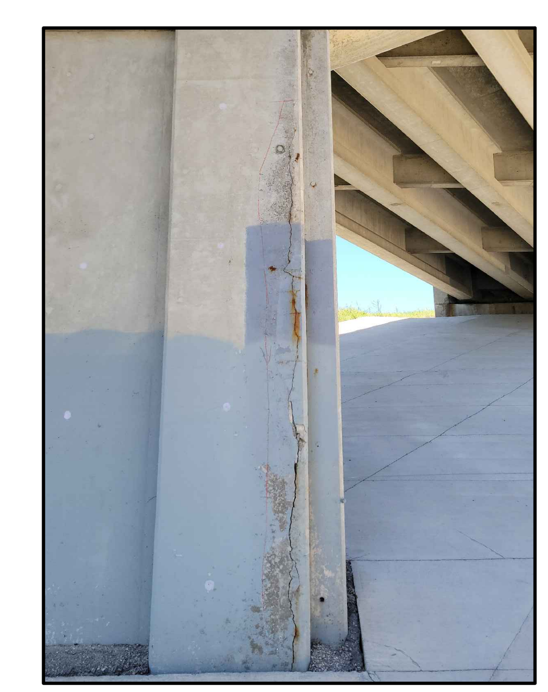


IMAGE 6

IMAGE 7

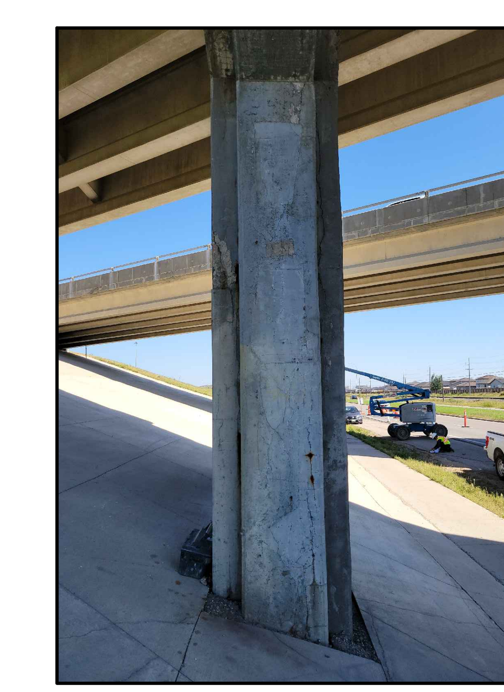


IMAGE 8

LEGEND

- CRACK
- DELAMINATION
- SPALL
- CORE
- ABANDONED CORE (HIT REINFORCING STEEL)

NOTES:

1. CRACK LOCATIONS ARE APPROXIMATE. CRACK WIDTH VARIED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY	M.L.	CHECKED BY	
DRAWN BY	B.M.	APPROVED BY	
HOR. SCALE:	AS NOTED	ACCEPTED BY	DATE
VERTICAL:			
DATE	12.12.22	BRIDGE PROJECTS ENGINEER	

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0017

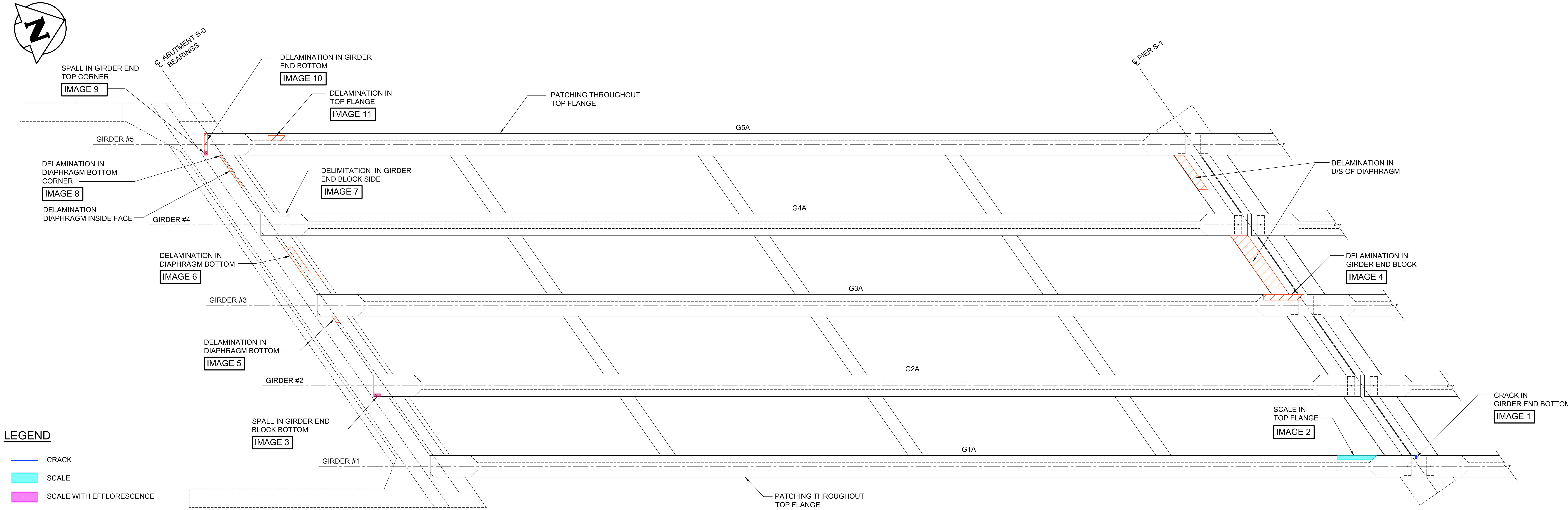
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
PIER S-4

CITY DRAWING NUMBER
SHEET 17 OF 22

17



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION

1 PLAN - SOUTHBOUND SPAN 1
1 : 50

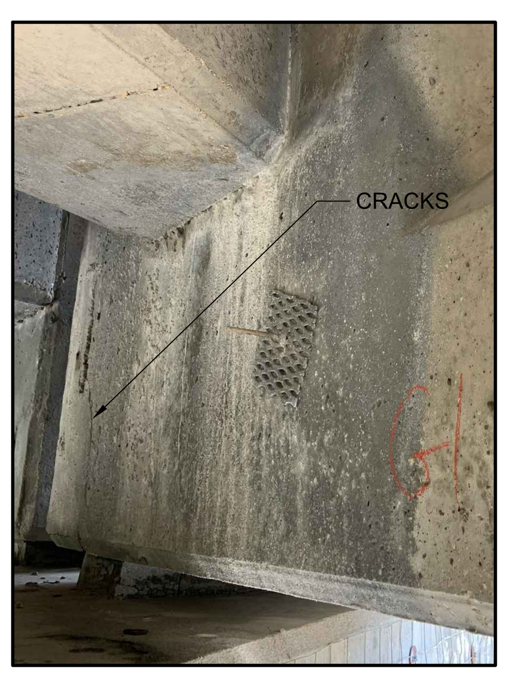


IMAGE 1

IMAGE 2

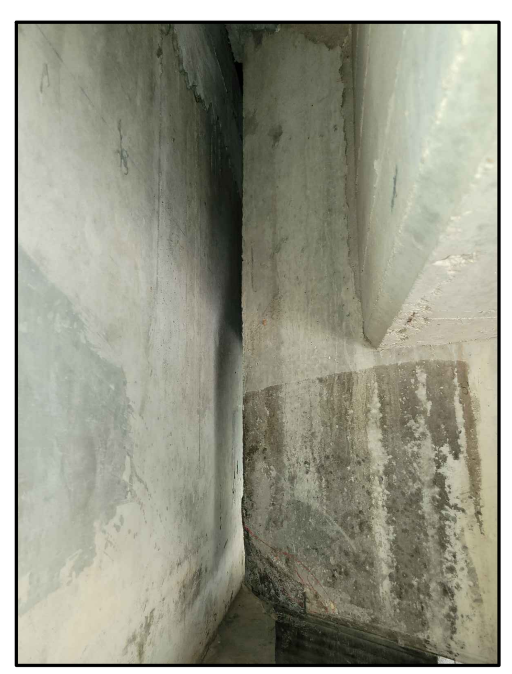


IMAGE 3

IMAGE 4

IMAGE 5

IMAGE 6

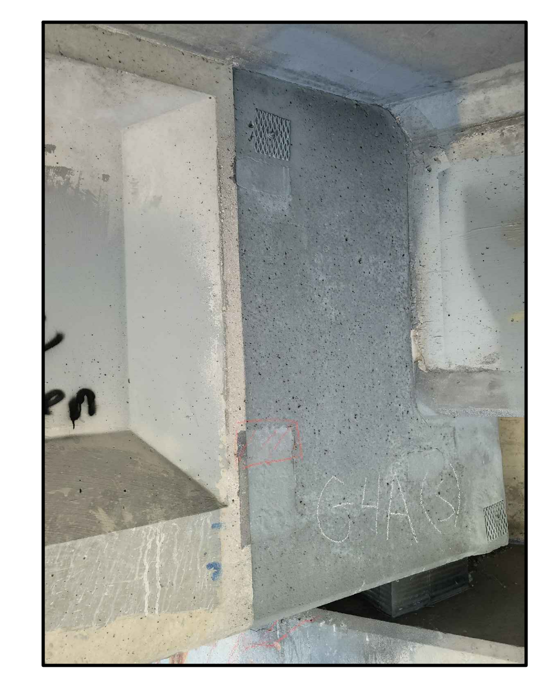


IMAGE 7

IMAGE 8

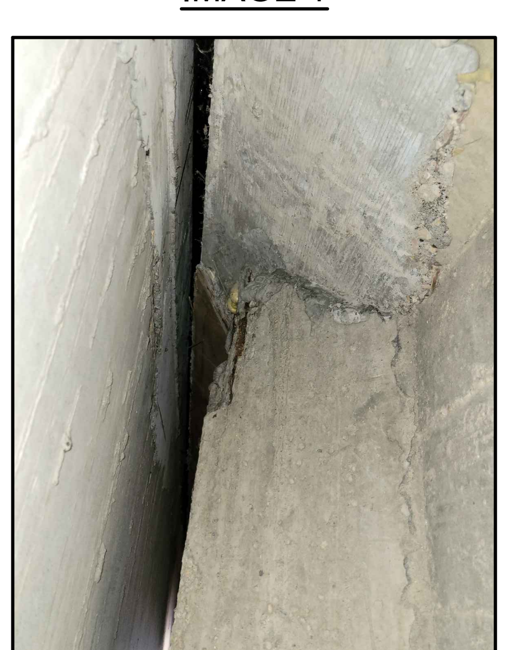


IMAGE 9

IMAGE 10

IMAGE 11

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY	M.L.	CHECKED BY	
DRAWN BY	B.M.	APPROVED BY	
HOR. SCALE: AS NOTED	VERTICAL:	ACCEPTED BY	DATE
DATE	12.12.22	BRIDGE PROJECTS ENGINEER	

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0018

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

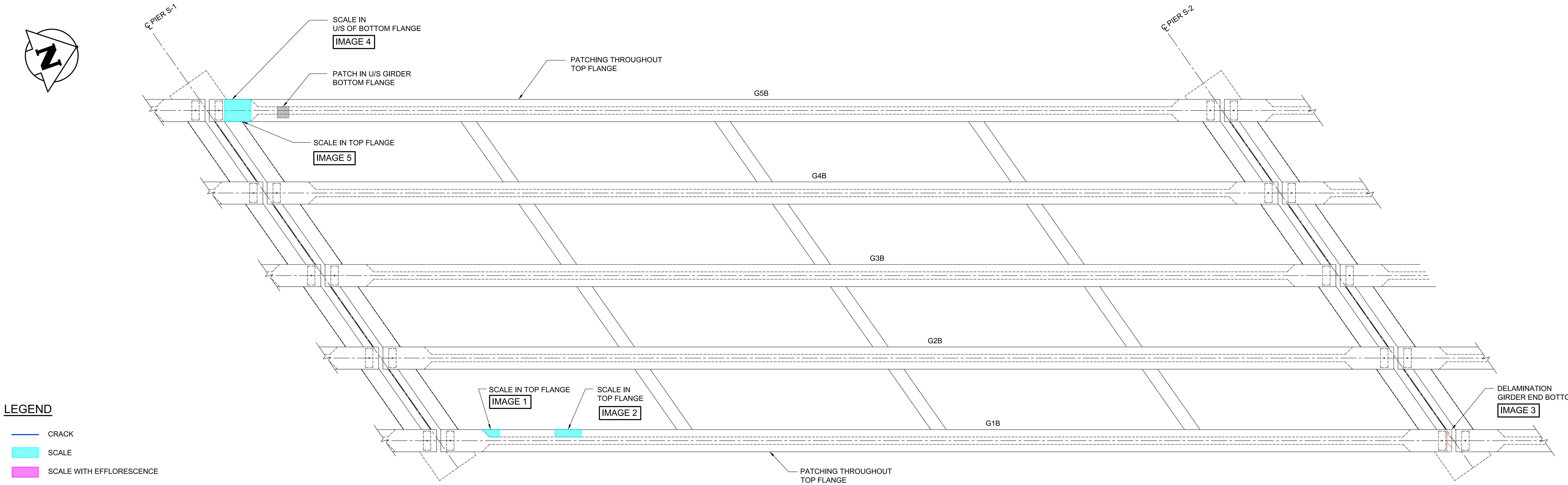
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
SPAN 1 GIRDERS

CITY DRAWING NUMBER

SHEET 18 OF 22

18



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION

1 — PLAN - SOUTHBOUND SPAN 2
1 : 50


IMAGE 1

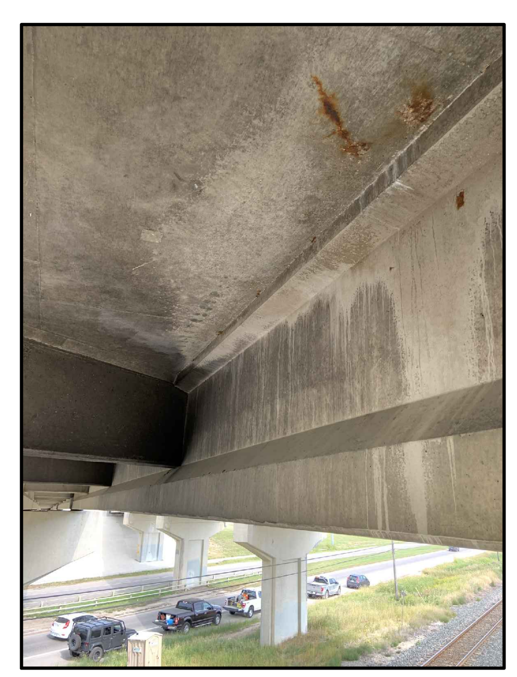


IMAGE 2


IMAGE 3


IMAGE 4

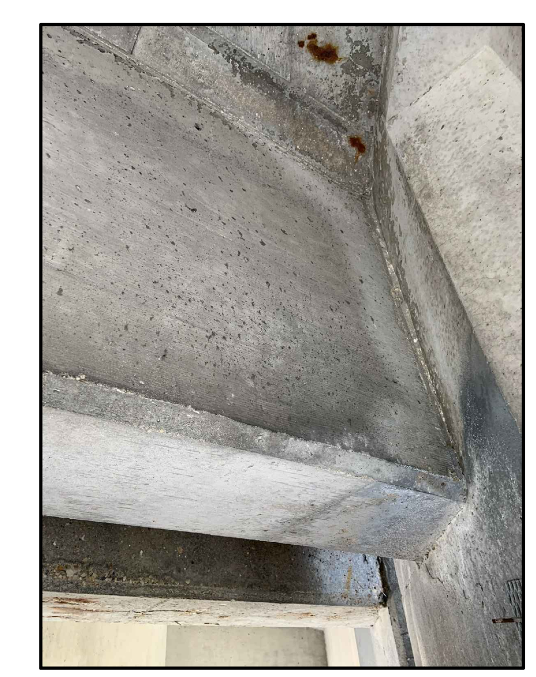


IMAGE 5

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.	CHECKED BY
DRAWN BY B.M.	APPROVED BY
HOR. SCALE: AS NOTED VERTICAL:	ACCEPTED BY DATE
DATE 12.12.22	BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0019

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

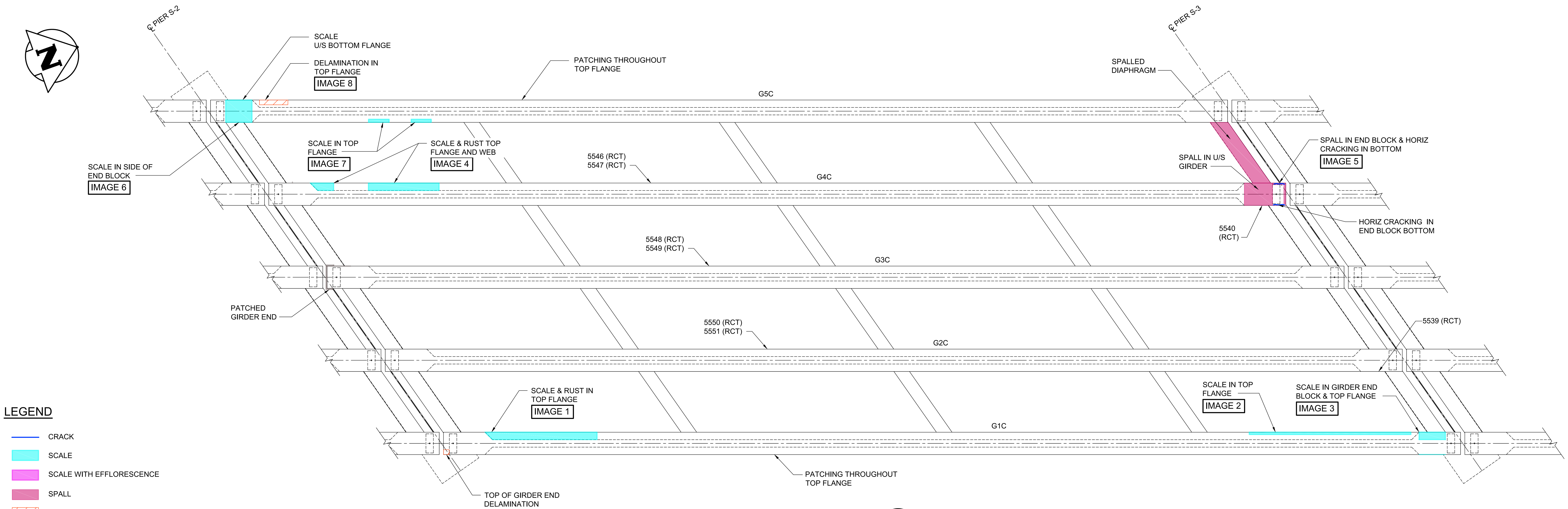
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
SPAN 2 GIRDERS

CITY DRAWING NUMBER

SHEET 19 OF 22

19



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION

1 PLAN - SOUTHBOUND SPAN 3
1 : 50

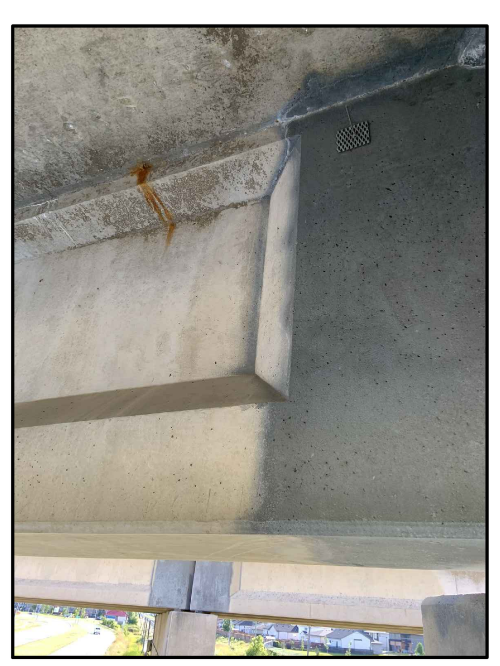


IMAGE 1

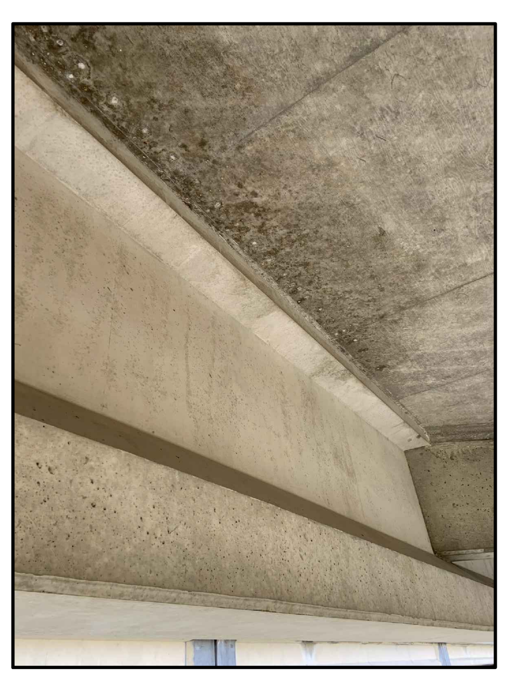


IMAGE 2

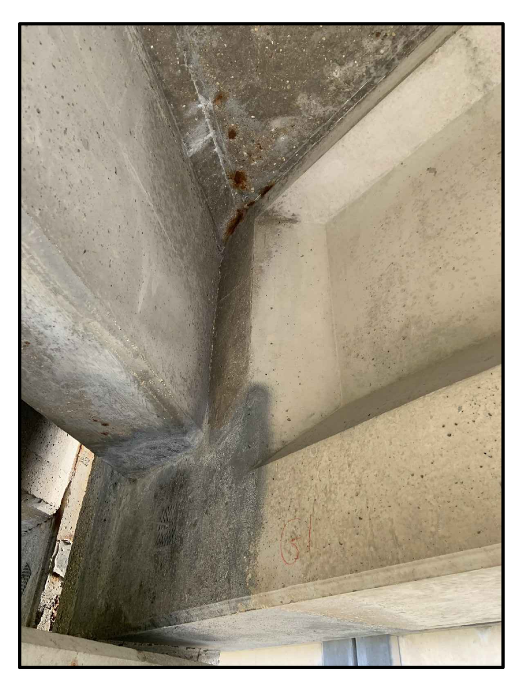


IMAGE 3

IMAGE 4

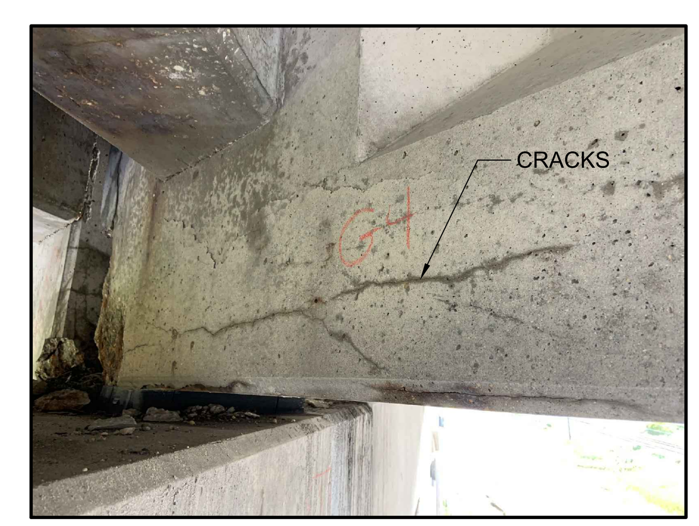


IMAGE 5

IMAGE 6

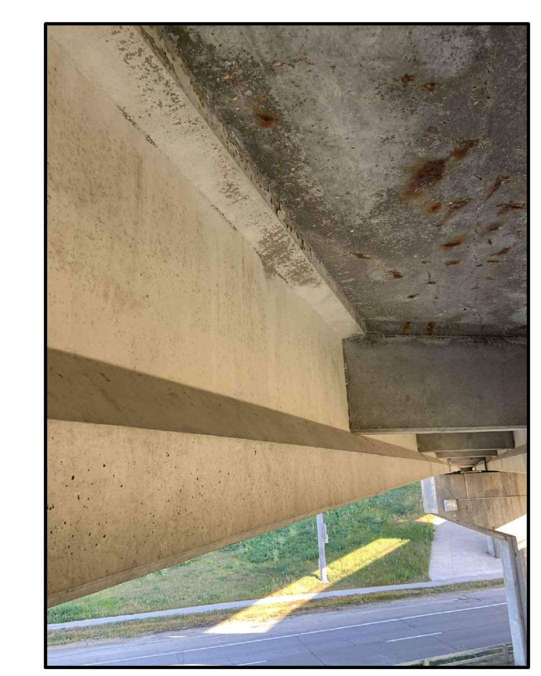


IMAGE 7

IMAGE 8

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M. ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY M.L.
DRAWN BY B.M.
HOR. SCALE: AS NOTED
VERTICAL:
DATE 12.12.22
CHECKED BY
APPROVED BY
ACCEPTED BY DATE
BRIDGE PROJECTS ENGINEER

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0020

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

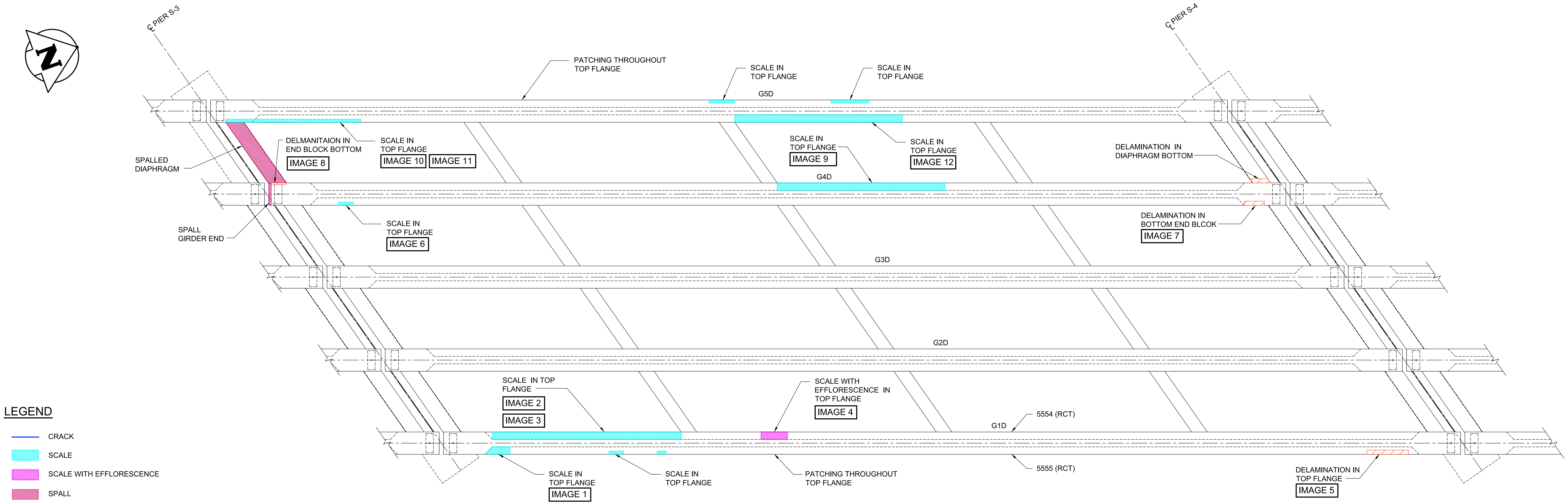
LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
SPAN 3 GIRDERS

CITY DRAWING NUMBER

SHEET 20 OF 22

20



LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION

1 — PLAN - SOUTHBOUND SPAN 4
1 : 50

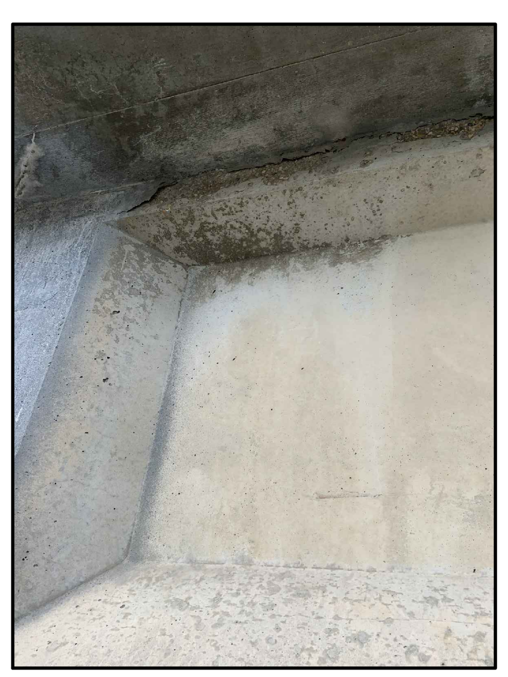


IMAGE 1

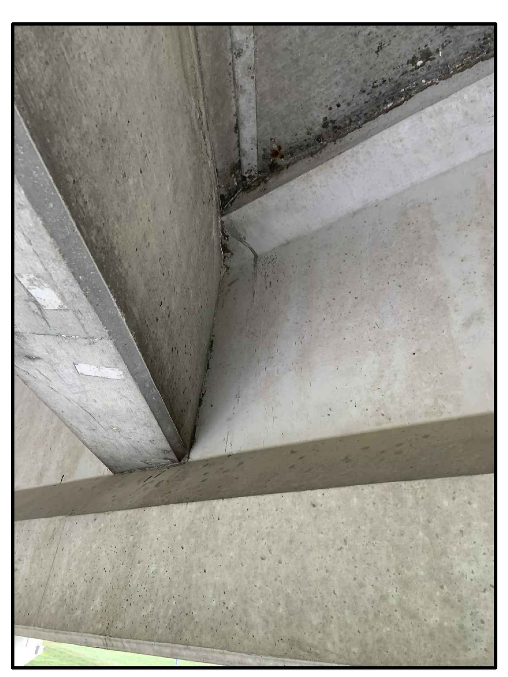


IMAGE 2

IMAGE 3

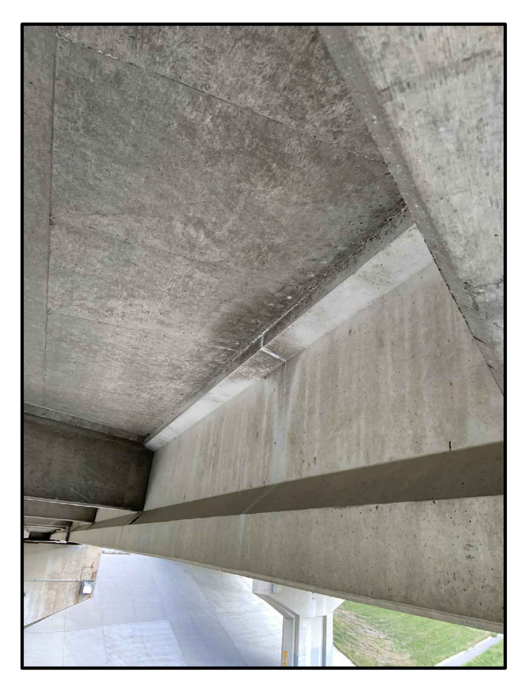


IMAGE 4

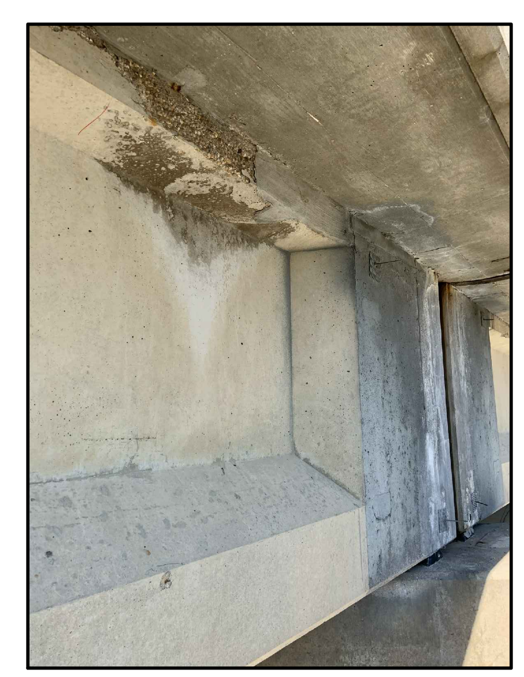


IMAGE 5

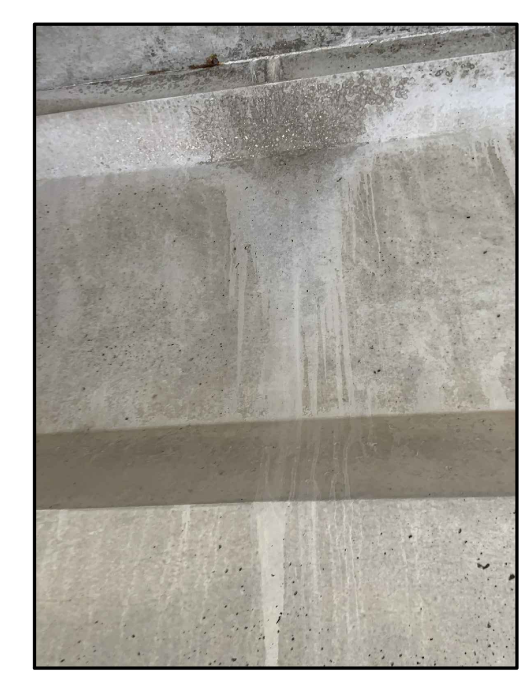


IMAGE 6

IMAGE 7

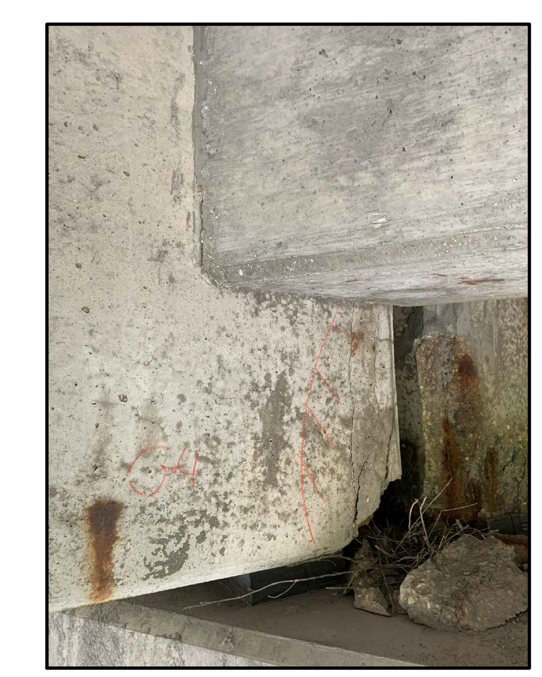


IMAGE 8

IMAGE 9

IMAGE 10

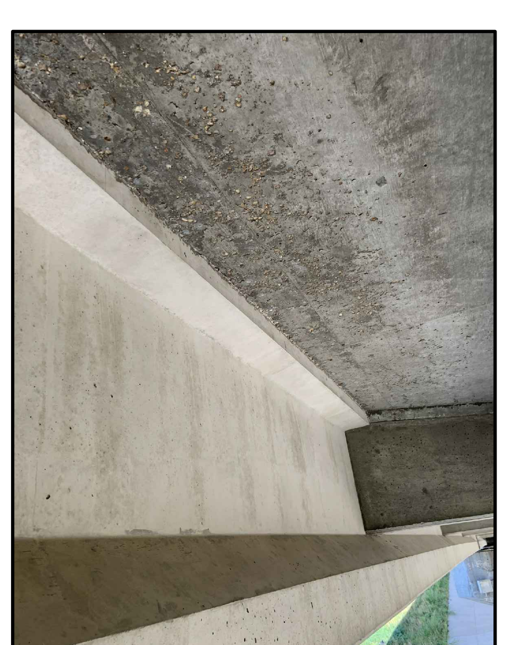


IMAGE 11

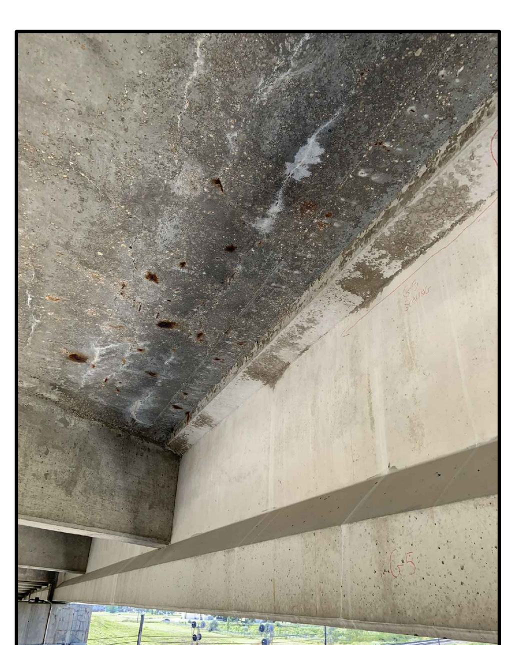


IMAGE 12

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

TETRA TECH

DESIGNED BY	M.L.	CHECKED BY	
DRAWN BY	B.M.	APPROVED BY	
HOR. SCALE: VERTICAL:	AS NOTED	ACCEPTED BY	DATE
DATE	12.12.22	BRIDGE PROJECTS ENGINEER	

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0021

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
SPAN 4 GIRDERS

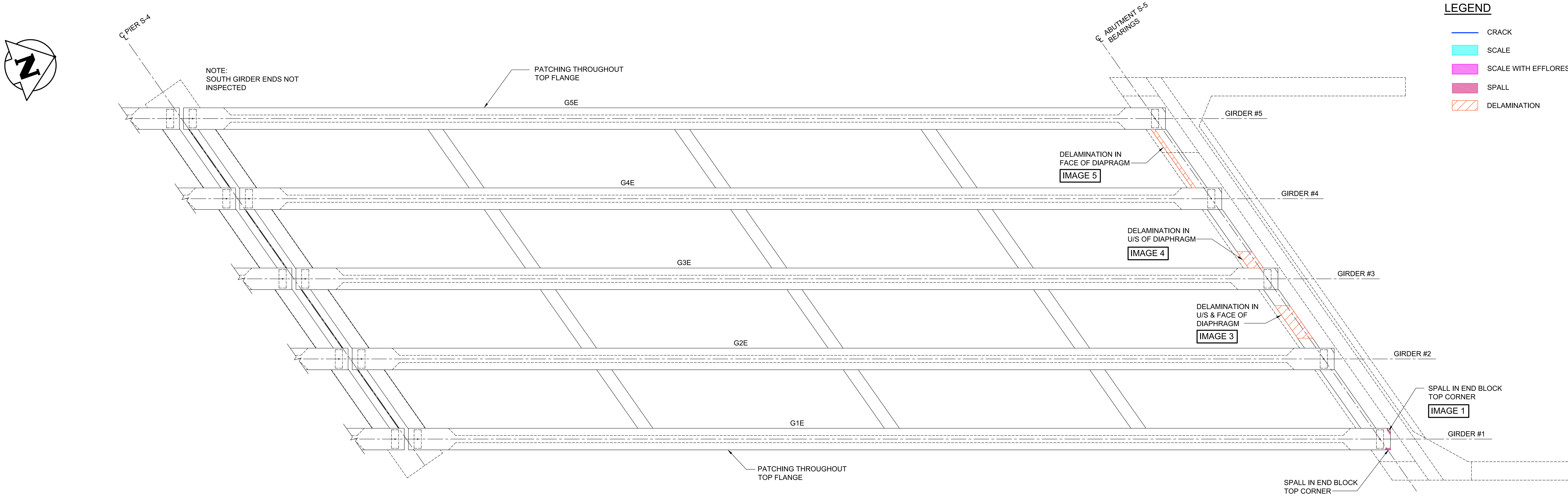
CITY DRAWING NUMBER

SHEET 21 OF 22

21

LEGEND

- CRACK
- SCALE
- SCALE WITH EFFLORESCENCE
- SPALL
- DELAMINATION



1 PLAN - SPAN 5 (SOUTH BOUND)
1 : 50

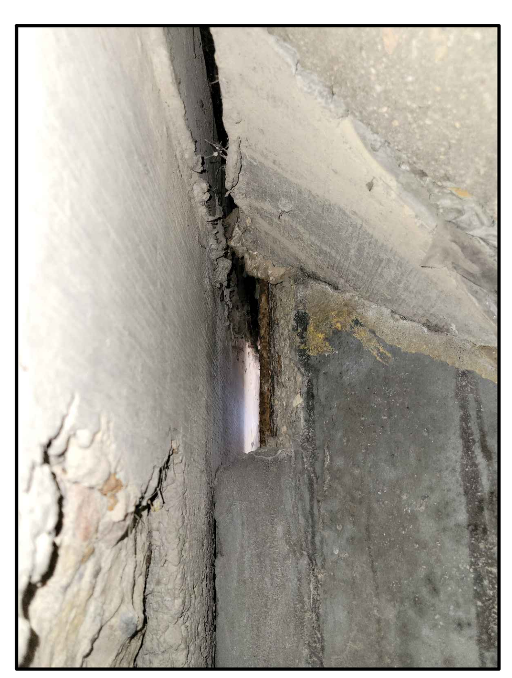


IMAGE 1

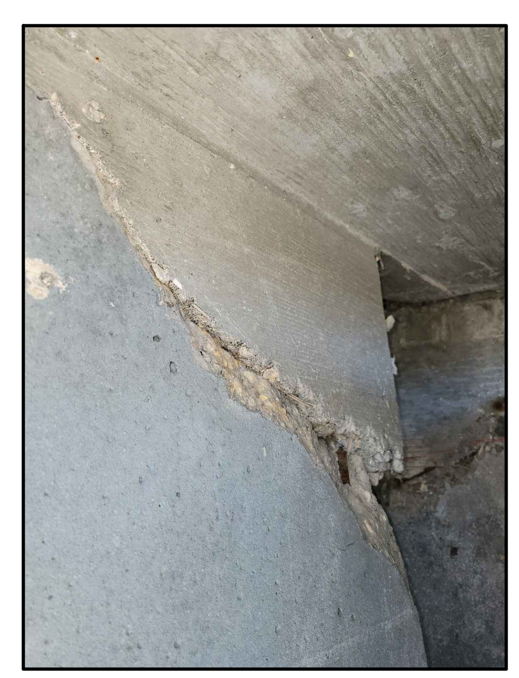


IMAGE 2

IMAGE 3

IMAGE 4

IMAGE 5

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Tetra Tech Canada Inc.
No. 6499

NO.	REVISIONS	DATE	BY

B.M.
ELEV.

TETRA TECH

DESIGNED BY	M.L.	CHECKED BY	
DRAWN BY	B.M.	APPROVED BY	
HOR. SCALE: VERTICAL:	AS NOTED	ACCEPTED BY	DATE
DATE	12.12.22	BRIDGE PROJECTS ENGINEER	

PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

CONSULTANT DRAWING NO.
734-2200070600-SKT-S0022

Winnipeg
THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

LAGIMODIERE BLVD TWIN OVERPASSES
CONDITION ASSESSMENT

SOUTHBOUND STRUCTURE
SPAN 5 GIRDERS

CITY DRAWING NUMBER

SHEET 22 OF 22

22

APPENDIX B

STANTEC – INVESTIGATION OF THE LAGIMODIERE BOULEVARD TWIN OVERPASSES OVER CONCORDIA AVENUE AND CPR KEEWATIN – WINNIPEG, MANITOBA

Investigation of the Lagimodiere Boulevard Twin Overpasses Over Concordia Avenue and CPR Keewatin – Winnipeg, Manitoba

Project No. 123316064

February 19, 2023

Prepared for:

Mr. Rhys Laffin
Tetra Tech Canada
400-161 Portage Avenue East
Winnipeg, MB R3B 0Y4

Prepared by:

Jason Thompson, C.E.T.
Stantec Consulting Ltd.
199 Henlow Bay
Winnipeg, MB R3Y 1G4

Table of Contents

LIST OF APPENDICES

1.0 INTRODUCTION

Stantec Consulting Ltd. was retained to undertake a bridge investigation and laboratory testing program for the substructure and girder elements of the Lagimodiere Twin Overpasses (northbound and southbound) over the Concordia Avenue and CPR Keewatin in Winnipeg, Manitoba. The purpose of the investigation was to provide information on the condition of the concrete which included the following:

- Corrosion potential survey
- Concrete cover survey
- Laboratory testing and evaluation of the insitu concrete

The field investigation was carried out between September 6 and 23, 2022. The results of our investigation are discussed in the following sections.

2.0 FIELD INVESTIGATION

2.1 CORING & SAMPLE RECOVERY PROGRAM

A total of seventy-four (74) concrete core samples (36 northbound and 38 southbound) were recovered from the bridge abutments, piers, and girders for laboratory testing and evaluation. In addition, a total of 25 concrete powder samples were recovered from the girders (16 northbound and 9 southbound) A covermeter was utilized to locate reinforcing steel prior to coring to reduce the risk of cutting steel at the core locations. All core holes were backfilled with MasterEmaco T 1060 rapid set mortar. A summary of the core samples obtained and relative information for each is provided in **Appendix A**.

2.2 CORROSION POTENTIAL SURVEY

The corrosion potential survey was conducted in accordance with *ASTM C876; Standard Test Method for Corrosion (Half Cell) Potentials of Uncoated Reinforcing Steel in Concrete*. The corrosion potential readings were obtained on a 1 m x 1 m grid on all exposed faces of the bridge abutments and piers for both northbound and southbound structures. The test data obtained from the survey is provided in **Appendix B**. A summary of the corrosion potential survey data is shown in the following **Table 1**.

Table 1 - Summary of Corrosion Potential Survey Data

Area	Corrosion Activity (% of area tested)		
	90% Probability of Corrosion	Corrosion Activity is Uncertain	90% Probability of No Corrosion
Northbound Abutment N-0	82	16	2
Northbound Pier N-1	23	27	50
Northbound Pier N-2	1	19	80
Northbound Pier N-3	12	30	58
Northbound Pier N-4	0	19	81
Northbound Abutment N-5	79	21	0
Northbound Overall	**24**	**23**	**53**
Southbound Abutment S-0	97	3	0
Southbound Pier S-1	48	14	38
Southbound Pier S-2	11	16	73
Southbound Pier S-3	35	21	44
Southbound Pier S-4	34	24	32
Southbound Abutment S-5	68	32	0
Southbound Overall	**42**	**18**	**39**

It is recommended that the corrosion potential data be evaluated along with the results of the chloride content tests, in addition to visual and delamination survey findings. Evaluation of reinforcing steel corrosion from half-cell data alone may be misleading. It should be noted that the half-cell potential measurements only reveal the corrosion probability at a given time and location. Long term monitoring of the half-cell potential readings is recommended.

2.3 CONCRETE COVER

The concrete cover over the reinforcing steel was determined by use of a Model BH Elcometer 331 covermeter. A covermeter measures the disturbance in the magnetic field and the magnitude of the disturbance is proportional to the size of the bar and the distance from the probe. The covermeter survey was conducted on a 1 m x 1 m grid on all exposed faces of the bridge abutments and piers for both northbound and southbound structures.

A total of 1865 observations were conducted on thought the eastbound and westbound bridge superstructure. The test data obtained is also documented in **Appendix C** with a summary of the test data shown in the following **Table 2**.

Table 2 - Summary of Covermeter Survey Data

Test Location	Number of Readings	Concrete Cover (mm)	
		Range	Average
Northbound Abutment N-0	63	36 to 110	60
Northbound Pier N-1	110	28 to 75	49
Northbound Pier N-2	122	19 to 79	50
Northbound Pier N-3	122	33 to 85	50
Northbound Pier N-4	110	25 to 85	48
Northbound Abutment N-5	54	27 to 95	59
Northbound Overall	**581**	**19 to 110**	**53**
Southbound Abutment S-0	62	43 to 161	80
Southbound Pier S-1	110	20 to 81	51
Southbound Pier S-2	122	26 to 83	47
Southbound Pier S-3	122	25 to 93	51
Southbound Pier S-4	110	18 to 74	51
Southbound Abutment S-5	61	36 to 95	60
Southbound Overall	**587**	**18 to 161**	**57**

3.0 LABORATORY TESTING

3.1 COMPRESSIVE STRENGTH CONCRETE

A total of sixteen (16) core samples were recovered from the bridge abutments, piers, and girders to determine the compressive strength of the concrete. The tests were conducted in accordance with *CSA A23.2-14C, Obtaining and Testing Drilled Cores for Compressive Strength*. The core samples were conditioned in water at room temperature for 48 hours prior to testing.

The compressive strength results ranged from 44.5 to 78.3 MPa with an average of 56.4 MPa. The test results for compressive strength are summarized in **Appendix D**.

3.2 AIR VOID PARAMETERS IN HARDENED CONCRETE

A total of sixteen (16) core samples were recovered from the bridge abutments, piers, and girders to determine the air void parameters of concrete. The tests were conducted in accordance with the modified linear point count method outline in *ASTM C457, Test Method for Microscopical Determination of Parameters of the Air Void System in Hardened Concrete*.

The total air content results ranged from 1.5 to 5.6% with an average of 3.7%. The spacing factor ranged from 122 to 409 µm with an average of 214 µm. The test results five (5) of the core samples do not comply with CSA A23.1-19 specification for frost resistant concrete. The test results for the air void parameters are summarized in **Appendix E**.

3.3 WATER-SOLUBLE CHLORIDE CONTENT OF CONCRETE

A total of thirty (30) core samples were recovered from the bridge abutments, piers, and girders to determine the chloride content of the concrete. The core samples were prepared for chloride ion content determination by trimming test specimens at prescribed depths from top of core. Testing of the specimens was performed by CARO Analytical Services in accordance with *CSA A23.2-4B; Sampling and Determination of Water-Soluble Chloride Ion Content in Hardened Grout or Concrete*.

The chloride content value necessary to depassivate embedded steel and permit corrosion in the presence of oxygen and moisture must be greater than 0.025% by mass of concrete, in accordance with the Ontario Structure Rehabilitation Manual (OSRM) dated April 2007.

The chloride content results ranged from <0.010 to 0.738%, with the bulk of the high chloride results within the top 30 mm of the core sample. The test results for the chloride ion content are summarized in **Appendix F**.

3.4 RAPID CHLORIDE TEST (RCT)

A total of thirty (25) concrete powder samples were recovered from the bridge piers and girders to determine the chloride content of the concrete by rapid test method. The powder samples were obtained at prescribed depths from the concrete directly on site. The powder samples were bagged and transported to the laboratory for analysis. Testing of the specimens was performed using Germann Instruments RCT test kit in accordance with *ASTM C1152; Standard Test Method for Acid-Soluble Chloride in Mortar or Concrete.*

Again, the chloride content value necessary to depassivate embedded steel and permit corrosion in the presence of oxygen and moisture must be greater than 0.025% by mass of concrete, in accordance with the Ontario Structure Rehabilitation Manual (OSRM) dated April 2007.

The chloride content results ranged from 0.005 to 0.949% with an average of 0.183%. The test results for the chloride ion content are summarized in **Appendix G**.

3.5 PETROGRAPHIC EVALUATION

A total of twelve (12) core samples were recovered from bridge abutments and piers for qualitative evaluation of the concrete. The core samples were submitted to Golder Associates in Vancouver, British Columbia where it was examined in accordance with *ASTM C856, Standard Practice for Petrographic Examination of Hardened Concrete*. The petrographic evaluation reports found in **Appendix H**, provide detailed information on the concrete matrix of the core samples.

4.0 PHOTOGRAPHS

Photographs of the seventy-four (74) core samples recovered are provided in **Appendix I**.

5.0 CLOSING

Reporting of these test results constitutes a testing service only. Engineering and interpretation of the test results can be provided upon written request. The data presented is for the sole use of the Client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.

We trust the information provided herein meets your requirements. Should you have any questions or require clarification on the contents of this report, please do not hesitate to contact the undersigned.

We appreciate the opportunity to assist you with this assignment.

Regards,

Stantec Consulting Ltd.

Jason Thompson C.E.T.
Principal – Manager, Materials Testing Services

Phone: 204-928-4004
Mobile: 204-981-8445
jason.thompson@stantec.com

Guillaume Beauce P.Eng.
Associate – Field Supervisor, Materials Testing Services

Phone: 204-928-7618
Mobile: 204-898-8920
guillaume.beauce@stantec.com

APPENDIX A

Summary of Concrete Core & Powder Sample Recovery

Stantec

Table 3 - Summary of Core & Powder Sample Recovery

Sample ID No.	Bridge Structure	Structure Element	Testing Conducted	Core Recovery Location	Core Length (mm)
5464	Northbound	Abutment N-0	Petro	0.5 m east from west end of south abutment, 0.2 m below top of abutment, north face	150
5466	Northbound	Pier N-1	Petro	0.2 m east from centerline of pier, 1.55 m up from bottom of pier, south face	160
5467	Northbound	Pier N-2	Petro	0.55 m east from centerline of pier, 0.65 m below top of pier, south face	167
5468	Northbound	Pier N-3	Petro	0.6 m west from centerline of pier, 0.35 m below top of pier, north face	227
5469	Northbound	Pier N-4	Petro	1.2 m west from centerline of pier, 0.4 m below top of pier, south face	205
5470	Northbound	Abutment N-5	Petro	2.45 m east from west end of north abutment, 0.3 m below top of abutment, south face	170
5471	Southbound	Abutment S-0	Petro	0.85 m east from west end of south abutment, 0.2 m below top of abutment, north face	198
5472	Southbound	Pier S-1	Petro	0.15 m east from centerline of pier, 1.5 m up from bottom of pier, south face	160
5473	Southbound	Pier S-2	Petro	3.1 m east from centerline of pier, 0.6 m below top of pier, south face	200
5474	Southbound	Pier S-3	Petro	3.1 m east from centerline of pier, 1.5 m below top of pier, north face	220
5475	Southbound	Pier S-4	Petro	1.05 m east from centerline of pier, 1.4 m below top of pier, north face	201
5476	Southbound	Abutment S-5	Petro	2.35 m east from west end of north abutment, 0.45 m below top of abutment, south face	148
5477	Northbound	Abutment N-0	AV	2.3 m east from centerline of south abutment, 0.2 m below top of abutment, north face	140
5478	Northbound	Pier N-1	AV	Centerline of pier, 0.55 m below top of pier, south face	150
5479	Northbound	Pier N-2	AV	1.35 m west from centerline of pier, 0.5 m below top of pier, south face	127
5480	Northbound	Pier N-3	AV	2.0 m west from centerline of pier, 0.25 m below top of pier, north face	137
5481	Northbound	Pier N-4	AV	0.3 m east from centerline of pier, 1.6 m below top of pier, south face	145
5482	Northbound	Abutment N-5	AV	2.75 m east from west end of north abutment, 0.3 m below top of abutment, south face	145
5483	Southbound	Abutment S-0	AV	1.0 m west from east end of south abutment, 0.6 m below to of abutment, north face	165
5484	Southbound	Pier S-1	AV	0.7 m east from centerline of pier, 1.5 m up from bottom of pier, south face	110
5485	Southbound	Pier S-2	AV	0.3 m east from centerline of pier, 0.6 m below top of pier, south face	112
5486	Southbound	Pier S-3	AV	0.9 m east from centerline of pier, 1.65 m below top of pier, north face	140
5487	Southbound	Pier S-4	AV	1.35 m west from centerline of pier, 0.6 m below top of pier, south face	142
5488	Southbound	Abutment S-5	AV	1.95 m east from centerline of north abutment, 0.45 m below top of abutment, south face	140
5489	Northbound	Abutment N-0	CS	2.6 m east from centerline of south abutment, 0.25 m below top of abutment, north face	100
5490	Northbound	Pier N-1	CS	0.05 m east from centerline of pier, 0.85 m below top of pier, south face	120
5491	Northbound	Pier N-2	CS	1.35 m west from centerline of pier, 0.6 m below top of pier, south face	90
5492	Northbound	Pier N-3	CS	1.8 m west from centerline of pier, 0.25 m below top of pier, north face	140
5493	Northbound	Pier N-4	CS	0.3 m east from centerline of pier, 1.85 m below top of pier, south face	135
5494	Northbound	Abutment N-5	CS	2.57 m east from west end of north abutment, 0.35 m below top of abutment, south face	115
5495	Southbound	Abutment S-0	CS	1.3 m west from east end of south abutment, 0.3 m below top of abutment, north face	90
5496	Southbound	Pier S-1	CS	0.65 m east from centerline of pier, 0.7 m below top of pier, south face	110
5497	Southbound	Pier S-2	CS	0.6 m west from centerline of pier, 0.6 m below top of pier, south face	90
5498	Southbound	Pier S-3	CS	0.9 m east from centerline of pier, 1.65 m below top of pier, north face	96
5499	Southbound	Pier S-4	CS	0.99 m west from centerline of pier, 0.62 m below top of pier, south face	144
5500	Southbound	Abutment S-5	CS	1.35 m east from centerline of north abutment, 0.45 m below top of abutment, south face	140
5501	Northbound	Abutment N-0	WSC	2.0 m east from centerline of south abutment, 0.45 m below top of abutment, north face	115
5502	Northbound	Abutment N-0	WSC	4.4 m east from centerline of south abutment, 0.25 m below top of abutment, north face	125
5503	Northbound	Pier N-1	WSC	Centerline of pier, 0.95 below top of pier, south face	120
5504	Northbound	Pier N-1	WSC	1.4 m west from centerline of pier, 1.55 m up from bottom of pier, south face	130
5505	Northbound	Pier N-2	WSC	1.35 m west from centerline of pier, 0.75 m up from bottom of pier, south face	130
5506	Northbound	Pier N-2	WSC	0.1 m west from centerline of pier, 1.45 m up from bottom of pier, south face	155
5507	Northbound	Pier N-3	WSC	1.75 m west from centerline of pier, 0.35 m below top of pier, north face	125
5508	Northbound	Pier N-3	WSC	0.45 m west from centerline of pier, 1.25 m up from bottom of pier, south face	140
5509	Northbound	Pier N-4	WSC	Centerline of pier, 1.85 m below top of pier, south face	140
5510	Northbound	Pier N-4	WSC	1.97 m east from west face of pier, 1.15 m up from bottom of pier, north face	140
5511	Northbound	Abutment N-5	WSC	0.3 m east from west face of north abutment, 0.35 m below top of abutmment, south face	120
5512	Northbound	Abutment N-5	WSC	1.95 m east from centerline of north abutment, 0.45 m below top of abutment, south face	115
5513	Southbound	Abutment S-0	WSC	1.0 m west from centerline of south abutment, 0.3 m below top of abutment, north face	120
5514	Southbound	Abutment S-0	WSC	4.05 m east from centerline of south abutment, 0.3 m below top of abutment, north face	125
5515	Southbound	Pier S-1	WSC	0.7 m east from centerline of pier, 1.1 m below top of pier, south face	125
5516	Southbound	Pier S-1	WSC	2.1 m east from centerline of pier, 1.5 m up from bottom of pier, south face	120
5517	Southbound	Pier S-2	WSC	0.35 m west from centerline of pier, 0.7 m below top of pier, south face	110
5518	Southbound	Pier S-2	WSC	0.15 m west from centerline of pier, 1.5 m up from bottom of pier, south face	140
5519	Southbound	Pier S-3	WSC	0.9 m east from centerline of pier, 1.75 m below top of pier, north face	115

Stantec

Table 3 - Summary of Core & Powder Sample Recovery

Sample ID No.	Bridge Structure	Structure Element	Testing Conducted	Core Recovery Location	Core Length (mm)
5520	Southbound	Pier S-3	WSC	0.45 m west from centerline of pier, 1.4 m up from bottom of pier, south face	135
5521	Southbound	Pier S-4	WSC	1.33 m west from centerline of pier, 0.3 m below top of pier, south face	120
5522	Southbound	Pier S-4	WSC	1.96 m east from centerline of pier, 2.0 m up from bottom of pier, north face	130
5523	Southbound	Abutment S-4	WSC	1.25 m east from centerline of north abutment, 0.45 m below top of abutment, south face	140
5524	Southbound	Abutment S-4	WSC	0.6 m east from wes end of north abutment, 0.45 m below top of abutment, south face	140
5525	Southbound	Girder 3	AV	Centerline of girder 3 at pier 1	140
5526	Northbound	Girder 3	AV	Centerline of girder 3 at pier 1	135
5527	Southbound	Girder 5	AV	Centerline of girder 5 at north abutment	145
5528	Northbound	Girder 2	AV	Centerline of girder 2 at south abutment	145
5529	Southbound	Girder 2	CS	Centerline of girder 2 at pier 2	152
5530	Northbound	Girder 3	CS	Centerline of girder 3 at pier 1	125
5531	Southbound	Girder 2	CS	Centerline of girder 2 at pier 3	170
5532	Northbound	Girder 2	CS	Centerline of girder 2 at pier 3	165
5533	Southbound	Girder 1	WSC	Centerline of girder 1 at pier 2	129
5534	Southbound	Girder 4	WSC	Centerline of girder 4 at pier 4	134
5535	Southbound	Girder 1	WSC	Centerline of girder 1 at north abutment	144
5536	Southbound	Girder 3	WSC	Centerline of girder 3 at pier 3	150
5537	Northbound	Girder 3	WSC	Centerline of girder 3 at pier 3	176
5538	Northbound	Girder 5	WSC	Centerline of girder 5 at south abutment	170
Sample ID No.	**Bridge Structure**	**Structure Element**	**Testing Conducted**	**Powder Sample Recovery Location**	**Sample Depth (mm)**
5539	Southbound	Girder 2	RCT	Span 3, southbound, girder 2, end block at pier 3	50
5540	Southbound	Girder 4	RCT	Span 3, southbound, girder 4, end block at pier 3	50
5541	Northbound	Girder 4	RCT	Span 3, northbound, girder 4, end block at pier 3	50
5542	Northbound	Girder 3	RCT	Span 3, northbound, girder 3, end block at pier 3	50
5543	Northbound	Girder 5	RCT	Span 3, northbound, girder 5, good area of lower flange	50
5544	Southbound	Pier 3	RCT	Pier 3, southbound, south face, west end	50
5545	Southbound	Pier 3	RCT	Pier 3, southbound, south face, west end	100
5546	Southbound	Girder 4	RCT	Span 3, southbound, girder 4, bad area of upper flange	50
5547	Southbound	Girder 4	RCT	Span 3, southbound, girder 4, bad area of lower flange	100
5548	Southbound	Girder 3	RCT	Span 3, southbound, girder 3, bad area of upper flange, 2.5 m from south diaphragm	50
5549	Southbound	Girder 3	RCT	Span 3, southbound, girder 3, bad area of lower flange, 2.5 m from south diaphragm	100
5550	Southbound	Girder 2	RCT	Span 3, southbound, girder 2, good area of upper flange, 2.5 m from south diaphragm	50
5551	Southbound	Girder 2	RCT	Span 3, southbound, girder 2, good area of lower flange, 2.5 m from south diaphragm	50
5552	Northbound	Pier 2	RCT	Pier 2, northbound, northwest face	50
5553	Northbound	Pier 2	RCT	Pier 2, northbound, northwest face	100
5554	Southbound	Girder 1	RCT	Span 4, southbound, girder 1, bad area of upper flange, 1.42 m from diaphragm	50
5555	Southbound	Girder 1	RCT	Span 4, southbound, girder 1, extremely bad area of upper flange, 1.42 m from diaphragm	50
5556	Southbound	Pier 4	RCT	Pier 4, southbound, south face, west end	50
5557	Southbound	Pier 4	RCT	Pier 4, southbound, south face, west end	100
5558	Northbound	Pier 4	RCT	Pier 4, northbound, south face, west end	50
5559	Northbound	Pier 4	RCT	Pier 4, northbound, south face, west end	100
5560	Northbound	Girder 1	RCT	Span 4, northbound, girder 1, extremely bad area of upper flange	50
5561	Northbound	Girder 5	RCT	Span 4, northbound, girder 5, bad aread of upper flange	50
5562	Southbound	Pier 4	RCT	Pier 4, southbound, south face, east end	50
5563	Southbound	Pier 4	RCT	Pier 4, southbound, south face, east end	100

Notes:

1. Testing Abbreviations: Petro (Petrograpchic Evaluation); AV (Air Voids); CS (Compressive Strength); WSC (Water-Soluble Chloride); RCT (Acid-Soluble Rapid Chloride)

APPENDIX B

Corrosion Potential Survey Data

Stantec

Table 4(a) - Corrosion Potential Survey Test Data (mV) - Northbound Bridge - Abutment N-0

Elevation	Abutment N-0 - Front Elevation (N. Face) Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
2.5m above grade	472	Girders									289
1.5 m above grade	285										411
0.5 m above grade	332	386	358	344	301	298	421	324	317	291	456

Elevation	Abutment N-0 - East Elevation Readings (mV) - Distance from North End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	460	533	517	490	446	524	Girders	
0.5 m below deck	521	564	486	457	461	491	467	491
1.5 m below deck			415	392	440	434	454	479
2.5 m below deck						368	411	176

Elevation	Abutment N-0 - West Elevation Readings (mV) - Distance from North End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	580	577	591	623	578	574	659
0.5 m beow deck	400	566	616	534	579	512	583	643
1.5 m below deck	430	520	576	560	487	486		
2.5 m below deck	303	407	485					

Notes:

1. Corrosion potential survey conducted on a 3 m x 3 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

	Colour	
2%	Green	90 % probability that no reinforcing steel corrosion is occurring
16%	Yellow	Corrosion activity of the reinforcing steel is uncertain
82%	Orange	90% probability that reinforcing steel corrosion is occurring

Table 4(b) - Corrosion Potential Survey Test Data (mV) - Northbound Bridge - Pier N-1

Elevation, m (below top of pier)	Pier N-1 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	215	319	247	250	27	10	33	41	93	360	282
1.5	318	370	273	226	39	14	47	54	136	404	338
2.5			370	489	16	21	31	33	246		
3.5				228	6	18	44	55			
4.5				309	59	27	24	54			
5.5				271	8	45	18	16			
6.5				293	174	240	265	134			

Elevation, m (below top of pier)	Pier N-1 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	534	405	407	410	70	27	44	34	157	928	928
1.5	531	454	445	483	67	101	64	34	168	963	928
2.5			400	307	108	42	27	148	210		
3.5				304	97	33	72	120			
4.5				359	102	81	47	33			
5.5				519	82	44	4	83			
6.5				415	208	265	228	289			

Elevation, m (below top of pier)	Pier N-1 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						346					
1.5						380					
2.5											
3.5						290					
4.5						224					
5.5						233					
6.5						295					

Elevation, m (below top of pier)	Pier N-1 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						496					
1.5						369					
2.5											
3.5						260					
4.5						3					
5.5						219					
6.5						388					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

50%	(green)	90 % probability that no reinforcing steel corrosion is occurring
27%	(yellow)	Corrosion activity of the reinforcing steel is uncertain
23%	(orange)	90% probability that reinforcing steel corrosion is occurring

Table 4(c) - Corrosion Potential Survey Test Data (mV) - Northbound Bridge - Pier N-2

Elevation, m (below top of pier)	Pier N-2 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	38	276	10	42	78	33	63	13	51	205	179
1.5	248	225	4	36	23	31	12	6	95	176	155
2.5			39	165	41	6	10	81	55		
3.5				189	55	77	25	56			
4.5				149	30	30	10	40			
5.5				176	28	21	5	65			
6.5				169	73	100	107	146			
7.5				229	217	243	151	248			

Elevation, m (below top of pier)	Pier N-2 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	304	171	10	35	17	53	31	29	29	39	297
1.5	211	165	15	18	2	15	30	38	6	51	284
2.5			80	51	37	45	43	5	12		
3.5				12	62	84	72	51			
4.5				18	45	78	31	36			
5.5				19	42	52	37	61			
6.5				36	18	1	0	62			
7.5				258	245	244	209	179			

Elevation, m (below top of pier)	Pier N-2 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						147					
1.5						316					
2.5											
3.5						301					
4.5						280					
5.5						249					
6.5						146					
7.5						301					

Elevation, m (below top of pier)	Pier N-2 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						235					
1.5						207					
2.5											
3.5						401					
4.5						294					
5.5						57					
6.5						137					
7.5						259					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

80%	(green)	90 % probability that no reinforcing steel corrosion is occurring
19%	(yellow)	Corrosion activity of the reinforcing steel is uncertain
1%	(orange)	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(d) - Corrosion Potential Survey Test Data (mV) - Northbound Bridge - Pier N-3

Elevation, m (below top of pier)	Pier N-3 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	445	217	48	21	2	49	181	162	199	382	442
1.5	305	211	28	6	15	26	17	80	161	315	336
2.5			216	211	1	6	7	2	198		
3.5				340	33	49	49	3			
4.5				366	93	5	17	34			
5.5				333	126	35	63	139			
6.5				236	179	145	170	168			
7.5				400	345	390	388	346			

Elevation, m (below top of pier)	Pier N-3 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	386	340	149	25	243	31	6	8	2	411	487
1.5	257	242	63	34	22	13	13	16	15	294	310
2.5			180	231	19	11	46	11	187		
3.5				300	30	33	57	56			
4.5				335	33	39	3	104			
5.5				401	33	63	56	35			
6.5				329	16	31	22	87			
7.5				402	303	332	314	261			

Elevation, m (below top of pier)	Pier N-3 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						473					
1.5						330					
2.5											
3.5						466					
4.5						298					
5.5						266					
6.5						224					
7.5						312					

Elevation, m (below top of pier)	Pier N-3 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						312					
1.5						292					
2.5											
3.5						404					
4.5						266					
5.5						243					
6.5						228					
7.5						320					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

58%	90 % probability that no reinforcing steel corrosion is occurring
30%	Corrosion activity of the reinforcing steel is uncertain
12%	90% probability that reinforcing steel corrosion is occurring

Table 4(e) - Corrosion Potential Survey Test Data (mV) - Northbound Bridge - Pier N-4

Elevation, m (below top of pier)	Pier N-4 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	262	293	17	28	36	46	36	7	93	230	335
1.5	330	103	22	38	31	46	20	50	114	218	294
2.5			313	19	28	48	18	18	172		
3.5				25	60	56	40	56			
4.5				71	32	65	50	35			
5.5				300	16	12	70	48			
6.5				250	223	148	152	181			

Elevation, m (below top of pier)	Pier N-4 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	187	53	14	51	30	67	55	54	36	63	252
1.5	190	31	6	45	29	88	55	51	21	75	214
2.5			65	56	65	76	74	64	162		
3.5				31	96	105	86	54			
4.5				81	51	108	117	48			
5.5				100	21	91	49	129			
6.5				22	94	65	40	97			

Elevation, m (below top of pier)	Pier N-4 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						300					
1.5						274					
2.5											
3.5						239					
4.5						231					
5.5						237					
6.5						254					

Elevation, m (below top of pier)	Pier N-4 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						244					
1.5						198					
2.5											
3.5						65					
4.5						86					
5.5						111					
6.5						296					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

81%	(green)	90 % probability that no reinforcing steel corrosion is occurring
19%	(yellow)	Corrosion activity of the reinforcing steel is uncertain
0%	(orange)	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(f) - Corrosion Potential Survey Test Data (mV) - Northbound Bridge - Abutment N-5

Elevation	Abutment N-5 - Front Elevation (S. Face) Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
2.5m above grade	422	Girders									318
1.5 m above grade	254										293
0.5 m above grade	387	356	309	427	311	378	334	357	339	396	351

Elevation	Abutment N-5 - East Elevation Readings (mV) - Distance from South End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	516	461	479	490	488	450	Girders	
0.5 m below deck	585	537	430	428	408	343	406	460
1.5 m below deck			483	293	322	367	415	400
2.5 m below deck							338	384

Elevation	Abutment N-5 - West Elevation Readings (mV) - Distance from South End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	476	478	568	522	491	482	550
0.5 m below deck	371	386	432	489	457	464	497	591
1.5 m below deck	211	380	427	385	455	431		
2.5 m below deck	338	369	456					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

	Colour	Description
0%	Green	90 % probability that no reinforcing steel corrosion is occurring
21%	Yellow	Corrosion activity of the reinforcing steel is uncertain
79%	Orange	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(g) - Corrosion Potential Survey Test Data (mV) - Southbound Bridge - Abutment S-0

Elevation	Abutment S-0 - Front Elevation (N. Face) Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
2.5m above grade	288	Girders									472
1.5 m above grade	379										355
0.5 m above grade	480	379	489	406	454	432	468	469	420	460	477

Elevation	Abutment S-0 - East Elevation Readings (mV) - Distance from North End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	610	520	504	480	446	415	Girders	
0.5 m below deck	590	496	371	434	421	448	446	389
1.5 m below deck			490	420	410	377	365	290
2.5 m below deck						380	391	396

Elevation	Abutment S-0 - West Elevation Readings (mV) - Distance from North End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	518	570	570	553	521	520	524
0.5 m below deck	576	523	493	470	472	473	491	491
1.5 m below deck	377	404	440	384	471	399		
2.5 m below deck	430	396	389					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

	Colour	
0%	Green	90 % probability that no reinforcing steel corrosion is occurring
3%	Yellow	Corrosion activity of the reinforcing steel is uncertain
97%	Orange	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(h) - Corrosion Potential Survey Test Data (mV) - Southbound Bridge - Pier S-1

Elevation, m (below top of pier)	Pier S-1 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	319	138	57	7	48	198	441	456	816	917	921
1.5	299	167	23	50	72	181	380	407	942	904	942
2.5			219	12	18	139	489	298	924		
3.5				48	41	3	353	399			
4.5				93	4	36	311	399			
5.5				65	41	140	282	397			
6.5				123	110	280	385	351			

Elevation, m (below top of pier)	Pier S-1 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	757	812	840	899	588	460	200	161	158	502	908
1.5	830	820	600	450	522	344	191	121	121	264	888
2.5			500	512	368	72	54	54	61		
3.5				410	433	77	38	356			
4.5				443	365	68	44	383			
5.5				433	399	60	42	337			
6.5				460	358	276	234	194			

Elevation, m (below top of pier)	Pier S-1 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						407					
1.5						432					
2.5											
3.5						229					
4.5						272					
5.5						160					
6.5						322					

Elevation, m (below top of pier)	Pier S-1 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						913					
1.5						874					
2.5											
3.5						359					
4.5						373					
5.5						436					
6.5						450					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

38%	(green)	90 % probability that no reinforcing steel corrosion is occurring
14%	(yellow)	Corrosion activity of the reinforcing steel is uncertain
48%	(orange)	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(i) - Corrosion Potential Survey Test Data (mV) - Southbound Bridge - Pier S-2

Elevation, m (below top of pier)	Pier S-2 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	263	176	15	39	65	44	36	28	45	510	Mesh
1.5	165	107	8	12	58	26	40	38	185	468	
2.5			70	67	64	41	60	60	210		
3.5				20	43	16	116	509			
4.5				26	21	8	250	494			
5.5				54	5	28	205	510			
6.5				24	26	42	266	497			
7.5				138	276	225	282	518			

Elevation, m (below top of pier)	Pier S-2 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	Mesh	349	36	2	1	20	38	5	40	25	291
1.5		820	90	26	18	17	24	22	30	34	201
2.5			170	7	9	32	34	171	90		
3.5				44	61	28	47	108			
4.5				34	24	44	34	198			
5.5				59	6	18	43	93			
6.5				130	80	54	26	138			
7.5				126	25	203	149	249			

Elevation, m (below top of pier)	Pier S-2 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						206					
1.5						256					
2.5											
3.5						120					
4.5						94					
5.5						63					
6.5						117					
7.5						208					

Elevation, m (below top of pier)	Pier S-2 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						400					
1.5						484					
2.5											
3.5						400					
4.5						441					
5.5						312					
6.5						496					
7.5						485					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

73%	(green)	90 % probability that no reinforcing steel corrosion is occurring
16%	(yellow)	Corrosion activity of the reinforcing steel is uncertain
11%	(orange)	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(j) - Corrosion Potential Survey Test Data (mV) - Southbound Bridge - Pier S-3

Elevation, m (below top of pier)	Pier S-3 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	396	322	356	4	31	34	109	371	524	549	410
1.5	280	368	182	9	7	4	175	382	317	501	482
2.5			323	232	21	11	144	426	372		
3.5				173	20	31	99	381			
4.5				161	46	12	138	382			
5.5				181	121	40	134	456			
6.5				190	153	126	238	446			
7.5				230	125	391	389	369			

Elevation, m (below top of pier)	Pier S-3 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	542	490	581	526	254	61	31	11	61	372	267
1.5	463	501	584	518	269	93	41	22	73	253	309
2.5			500	503	243	72	20	11	296		
3.5				524	331	63	4	42			
4.5				523	345	60	13	32			
5.5				518	302	54	9	15			
6.5				499	326	103	58	86			
7.5				514	287	317	341	266			

Elevation, m (below top of pier)	Pier S-3 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						438					
1.5						437					
2.5											
3.5						185					
4.5						200					
5.5						204					
6.5						280					
7.5						277					

Elevation, m (below top of pier)	Pier S-3 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						476					
1.5						368					
2.5											
3.5						398					
4.5						394					
5.5						333					
6.5						367					
7.5						483					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

44% (green)	90 % probability that no reinforcing steel corrosion is occurring
21% (yellow)	Corrosion activity of the reinforcing steel is uncertain
35% (orange)	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(k) - Corrosion Potential Survey Test Data (mV) - Southbound Bridge - Pier S-4

Elevation, m (below top of pier)	Pier S-4 - North Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	867	386	200	165	138	38	81	370	518	555	532
1.5	888	247	180	65	122	56	83	320	370	426	384
2.5			294	363	102	60	73	285			
3.5				437	152	60	68	335			
4.5				354	88	67	371	466			
5.5				350	111	134	370	444			
6.5				421	296	318	433	419			

Elevation, m (below top of pier)	Pier S-4 - South Elevation Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	608	422	354	258	142	127	54	114	249	240	352
1.5	561	454	341	139	98	70	59	93	357	226	306
2.5			811	121	39	51	62	224	380		
3.5				290	1	5	84	282			
4.5				300	39	42	56	239			
5.5				235	26	32	187	308			
6.5				319	121	86	115	323			

Elevation, m (below top of pier)	Pier S-4 - East Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						349					
1.5						381					
2.5											
3.5						282					
4.5						249					
5.5						357					
6.5						338					

Elevation, m (below top of pier)	Pier S-4 - West Elevation Readings (mV) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						578					
1.5						601					
2.5											
3.5						466					
4.5						348					
5.5						358					
6.5						393					

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

42%	(green)	90 % probability that no reinforcing steel corrosion is occurring
24%	(yellow)	Corrosion activity of the reinforcing steel is uncertain
34%	(orange)	90% probability that reinforcing steel corrosion is occurring

Stantec

Table 4(l) - Corrosion Potential Survey Test Data (mV) - Southbound Bridge - Abutment S-5

Elevation	Abutment S-5 - Front Elevation (S. Face) Readings (mV) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
2.5m above grade	236	Girders									212
1.5 m above grade	251										436
0.5 m above grade	356	411	343	334	353	357	364	338	306	347	385

Elevation	Abutment S-5 - West Elevation Readings (mV) - Distance from South End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	479	446	508	366	395	454	Girders	
0.5 m below deck	471	410	364	368	391	384	409	247
1.5 m below deck			332	388	322	262	320	340
2.5 m below deck							381	388

Elevation	Abutment S-5 - East Elevation Readings (mV) - Distance from South End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	353	516	472	425	429	447	523
0.5 m below deck	347	406	382	378	332	327	385	481
1.5 m below deck	417	326	357	330	384	364		
2.5 m below deck	412	411						

Notes:

1. Corrosion potential survey conducted on a 1 m x 1 m grid
2. Corrosion potential at grid points shown in millivolts (negative sign omitted)
3. Colour Legend:

0%	90 % probability that no reinforcing steel corrosion is occurring
32%	Corrosion activity of the reinforcing steel is uncertain
68%	90% probability that reinforcing steel corrosion is occurring

APPENDIX C

Concrete Cover Survey

Stantec

Table 5(a) - Covermeter Survey Test Data (mm) - Northbound Bridge - Abutment N-0

Elevation	Abutment N-0 - Front Elevation (N. Face) Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
2.5m above grade	53	Girders									43
1.5 m above grade	56										59
0.5 m above grade	73	71	50	38	55	49	46	47	49	47	68

Elevation	Abutment N-0 - East Elevation Readings (mm) - Distance from North End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	62	71	106	108	101	83	Girders	
0.5 m below deck	77	50	55	53	45	48	48	41
1.5 m below deck			43	36	41	41	66	93
2.5 m below deck					46	65	74	57

Elevation	Abutment N-0 - West Elevation Readings (mm) - Distance from North End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	58	53	81	108	110	90	81
0.5 m beow deck	49	52	50	48	57	59	50	58
1.5 m below deck	54	48	36	38	57	59		
2.5 m below deck	52	58	49					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 110 mm
   - b) minimum = 36 mm
   - c) average = 60 mm

Stantec

Table 5(b) - Covermeter Survey Test Data (mm) - Northbound Bridge - Pier N-1

Elevation, m (below top of pier)	Pier N-1 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	Mesh				54	48	39	43	44	56	Mesh
1.5					62	53	46	41	31	28	
2.5					58	56	51	45	Mesh		
3.5				51	49	43	35	38			
4.5				51	50	41	47	46			
5.5				51	45	39	47	46			
6.5				53	58	60	41	41			

Elevation, m (below top of pier)	Pier N-1 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	50	51	47	45	51	38	33	35	Mesh		
1.5	50	40	39	36	52	40	38	64			
2.5			74	61	59	53	51	46			
3.5				51	48	54	54	43			
4.5				57	45	42	36	47			
5.5				42	51	51	54	70			
6.5				44	50	62	56	75			

Elevation, m (below top of pier)	Pier N-1 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						48					
1.5						53					
2.5											
3.5						35					
4.5						39					
5.5						37					
6.5						53					

Elevation, m (below top of pier)	Pier N-1 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						Mesh					
1.5											
2.5											
3.5						61					
4.5						64					
5.5						71					
6.5						70					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 75 mm
   - b) minimum = 28 mm
   - c) average = 49 mm

Stantec

Table 5(c) - Covermeter Survey Test Data (mm) - Northbound Bridge - Pier N-2

Elevation, m (below top of pier)	Pier N-2 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	27	48	55	52	47	44	51	50	53	54	19
1.5	32	41	37	35	49	53	70	51	59	59	66
2.5			75	50	56	56	64	74	61		
3.5				49	50	52	49	56			
4.5				48	49	50	42	61			
5.5				47	53	67	46	74			
6.5				45	57	55	79	52			
7.5				49	57	56	54	39			

Elevation, m (below top of pier)	Pier N-2 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	40	56	53	39	38	42	42	39	46	60	52
1.5	51	38	38	48	36	43	38	35	44	72	71
2.5			58	41	41	65	42	56	57		
3.5				43	45	43	46	39			
4.5				36	46	41	45	39			
5.5				36	47	44	42	48			
6.5				39	52	48	48	40			
7.5				46	49	54	55	46			

Elevation, m (below top of pier)	Pier N-2 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						38					
1.5						65					
2.5											
3.5						65					
4.5						55					
5.5						56					
6.5						60					
7.5						58					

Elevation, m (below top of pier)	Pier N-2 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						70					
1.5						76					
2.5											
3.5						46					
4.5						50					
5.5						26					
6.5						49					
7.5						43					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 79 mm
   - b) minimum = 19 mm
   - c) average = 50 mm

Stantec

Table 5(d) - Covermeter Survey Test Data (mm) - Northbound Bridge - Pier N-3

Elevation, m (below top of pier)	Pier N-3 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	73	48	46	58	58	49	50	67	64	66	39
1.5	65	53	53	55	57	51	57	65	74	63	39
2.5			85	51	76	72	47	73	84		
3.5				47	54	51	50	58			
4.5				45	49	46	53	48			
5.5				47	45	41	72	54			
6.5				46	47	40	55	74			
7.5				46	76	46	70	73			

Elevation, m (below top of pier)	Pier N-3 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	42	51	46	34	44	43	49	49	55	47	43
1.5	61	57	56	51	42	50	47	60	42	45	48
2.5			55	55	62	79	48	45	52		
3.5				44	43	46	45	51			
4.5				44	47	51	54	33			
5.5				47	51	52	61	51			
6.5				47	49	53	57	54			
7.5				42	49	52	54	48			

Elevation, m (below top of pier)	Pier N-3 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						56					
1.5						79					
2.5											
3.5						52					
4.5						58					
5.5						56					
6.5						52					
7.5						44					

Elevation, m (below top of pier)	Pier N-3 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						39					
1.5						49					
2.5											
3.5						54					
4.5						49					
5.5						46					
6.5						44					
7.5						60					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 85 mm
   - b) minimum = 33 mm
   - c) average = 50 mm

Stantec

Table 5(e) - Covermeter Survey Test Data (mm) - Northbound Bridge - Pier N-4

Elevation, m (below top of pier)	Pier N-4 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	54	47	41	40	38	41	47	47	52	54	34
1.5	85	39	37	31	57	39	64	50	50	57	43
2.5			70	52	38	42	41	47	63		
3.5				40	41	47	45	53			
4.5				36	46	54	53	62			
5.5				35	40	47	51	71			
6.5				42	41	48	52	71			

Elevation, m (below top of pier)	Pier N-4 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	42	43	50	41	25	42	52	60	53	56	52
1.5	56	32	33	34	47	48	41	61	52	59	44
2.5			60	56	46	49	31	55	51		
3.5				38	41	43	46	54			
4.5				34	46	46	51	68			
5.5				32	39	45	42	64			
6.5				33	39	38	46	63			

Elevation, m (below top of pier)	Pier N-4 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						60					
1.5						69					
2.5											
3.5						44					
4.5						50					
5.5						47					
6.5						45					

Elevation, m (below top of pier)	Pier N-4 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						32					
1.5						47					
2.5											
3.5						63					
4.5						64					
5.5						57					
6.5						54					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 85 mm
   - b) minimum = 25 mm
   - c) average = 48 mm

Stantec

Table 5(f) - Covermeter Survey Test Data (mm) - Northbound Bridge - Abutment N-5

Elevation	Abutment N-5 - Front Elevation (N. Face) Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
1.5 m above grade	82	Girders									82
0.5 m above grade	36	41	50	33	57	48	40	35	57	46	63

Elevation	Abutment N-5 - East Elevation Readings (mm) - Distance from South End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	70	70	79	73	69	61	Girders	
0.5 m below deck	74	73	48	64	27	40	51	40
1.5 m below deck			39	67	41	36	53	53

Elevation	Abutment N-5 - West Elevation Readings (mm) - Distance from South End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	93	88	95	95	84	74	58
0.5 m beow deck	65	51	39	41	54	53	67	55
1.5 m below deck	79	67	55	53	59	62		

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   a) maximum = 95 mm
   b) minimum = 27 mm
   c) average = 59 mm

Stantec

Table 5(g) - Covermeter Survey Test Data (mm) - Southbound Bridge - Abutment S-0

Elevation	Abutment S-0 - Front Elevation (N. Face) Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
2.5m above grade	43	Girders									91
1.5 m above grade	70										65
0.5 m above grade	83	61	70	54	47	65	69	68	63	59	98

Elevation	Abutment S-0 - East Elevation Readings (mm) - Distance from North End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	87	89	105	98	80	91	Girders	
0.5 m below deck	50	65	54	55	91	66	116	161
1.5 m below deck			60	80	72	61	87	145
2.5 m below deck						90	114	155

Elevation	Abutment S-0 - West Elevation Readings (mm) - Distance from North End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	64	94	114	99	102	91	68
0.5 m beow deck	70	65	65	62	77	60	79	68
1.5 m below deck	64	84	90	93	61	56		
2.5 m below deck	93	85	100					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 161 mm
   - b) minimum = 43 mm
   - c) average = 80 mm

Table 5(h) - Covermeter Survey Test Data (mm) - Southbound Bridge - Pier S-1

Elevation, m (below top of pier)	Pier S-1 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	42	61	59	42	45	55	59	54		Mesh	
1.5	48	54	66	54	46	46	55	45			
2.5			73	72	45	61	51	42			
3.5				54	53	39	44	54			
4.5				54	42	33	42	74			
5.5				50	37	32	39	72			
6.5				44	44	40	46	42			

Elevation, m (below top of pier)	Pier S-1 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	20	64	65	61	81	64	53	40	54	41	78
1.5	31	34	77	53	60	51	54	67	53	60	64
2.5			Mesh	42	60	60	51	50	74		
3.5				46	45	38	44	49			
4.5				44	46	40	51	52			
5.5				49	43	43	51	52			
6.5				43	43	53	55	64			

Elevation, m (below top of pier)	Pier S-1 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						42					
1.5						48					
2.5											
3.5						44					
4.5						66					
5.5						53					
6.5						52					

Elevation, m (below top of pier)	Pier S-1 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						52					
1.5						62					
2.5											
3.5						39					
4.5						37					
5.5						29					
6.5						33					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 81 mm
   - b) minimum = 20 mm
   - c) average = 51 mm

Table 5(i) - Covermeter Survey Test Data (mm) - Southbound Bridge - Pier S-2

Elevation, m (below top of pier)	Pier S-2 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	32	49	45	41	43	49	38	33	38	56	Mesh
1.5	31	41	83	27	71	47	35	44	46	45	
2.5			67	67	62	44	32	51	30		
3.5				43	57	39	37	51			
4.5				49	56	32	29	53			
5.5				34	52	44	35	56			
6.5				54	49	52	49	56			
7.5				44	44	57	59	50			

Elevation, m (below top of pier)	Pier S-2 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	Mesh	44	49	56	44	47	68	47	36	59	52
1.5		44	40	66	49	44	61	45	41	59	60
2.5			51	44	46	41	37	56	73		
3.5				38	44	47	38	53			
4.5				33	37	44	59	33			
5.5				29	33	40	52	40			
6.5				32	35	38	44	34			
7.5				36	38	34	45	26			

Elevation, m (below top of pier)	Pier S-2 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						81					
1.5						56					
2.5											
3.5						70					
4.5						73					
5.5						58					
6.5						51					
7.5						48					

Elevation, m (below top of pier)	Pier S-2 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						Mesh					
1.5											
2.5											
3.5						39					
4.5						40					
5.5						54					
6.5						68					
7.5						74					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 83 mm
   - b) minimum = 26 mm
   - c) average = 47 mm

Stantec

Table 5(j) - Covermeter Survey Test Data (mm) - Southbound Bridge - Pier S-3

Elevation, m (below top of pier)	Pier S-3 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	39	77	69	53	57	56	67	56	65	55	38
1.5	57	70	69	43	50	60	49	49	48	70	38
2.5			62	60	54	55	57	37	77		
3.5				70	50	47	48	46			
4.5				54	49	45	46	46			
5.5				60	64	44	48	44			
6.5				58	50	48	52	41			
7.5				57	50	47	49	50			

Elevation, m (below top of pier)	Pier S-3 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	38	54	46	38	31	30	25	37	39	39	49
1.5	39	49	36	30	47	29	46	59	33	36	71
2.5			44	46	63	52	46	56	51		
3.5				40	62	48	52	53			
4.5				51	63	46	48	51			
5.5				61	57	48	51	52			
6.5				62	61	47	57	52			
7.5				54	57	48	42	52			

Elevation, m (below top of pier)	Pier S-3 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						53					
1.5						93					
2.5											
3.5						50					
4.5						54					
5.5						55					
6.5						67					
7.5						39					

Elevation, m (below top of pier)	Pier S-3 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						36					
1.5						34					
2.5											
3.5						48					
4.5						40					
5.5						48					
6.5						64					
7.5						49					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
    - a) maximum = 93 mm
    - b) minimum = 25 mm
    - c) average = 51 mm

Table 5(k) - Covermeter Survey Test Data (mm) - Southbound Bridge - Pier S-4

Elevation, m (below top of pier)	Pier S-4 - North Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5	Mesh	42	44	57	71	51	52	74	63	59	Mesh
1.5		25	35	45	45	55	51	47	69	68	
2.5			68	68	24	41	68	47	63		
3.5				50	41	46	51	47			
4.5				50	47	60	57	42			
5.5				59	40	45	54	61			
6.5				61	39	61	53	52			

Elevation, m (below top of pier)	Pier S-4 - South Elevation Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0 (CL)	1m E	2m E	3m E	4m E	5m E
0.5	Mesh		59	61	36	38	39	42	56	53	52
1.5			46	43	70	40	41	62	44	52	53
2.5			54	54	73	44	37	52	62		
3.5				51	18	51	57	49			
4.5				53	68	48	48	51			
5.5				47	46	37	39	47			
6.5				63	49	62	46	58			

Elevation, m (below top of pier)	Pier S-4 - East Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						Mesh					
1.5											
2.5											
3.5						44					
4.5						50					
5.5						47					
6.5						45					

Elevation, m (below top of pier)	Pier S-4 - West Elevation Readings (mm) - Distance from Centerline, m										
	5m E	4m E	3m E	2m E	1m E	0 (CL)	1m W	2m W	3m W	4m W	5m W
0.5						Mesh					
1.5											
2.5											
3.5						63					
4.5						64					
5.5						57					
6.5						54					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 74 mm
   - b) minimum = 18 mm
   - c) average = 51 mm

Stantec

Table 5(l) - Covermeter Survey Test Data (mm) - Southbound Bridge - Abutment S-5

Elevation	Abutment S-5 - Front Elevation (N. Face) Readings (mm) - Distance from Centerline, m										
	5m W	4m W	3m W	2m W	1m W	0m (CL)	1m E	2m E	3m E	4m E	5m E
2.5m above grade	Girders										62
1.5 m above grade	55	Girders									47
0.5 m above grade	48	40	41	44	43	43	39	40	43	43	56

Elevation	Abutment S-5 - West Elevation Readings (mm) - Distance from South End, m							
	7.5m	6.5m	5.5m	4.5m	3.5m	2.5m	1.5m	0.5 m
0.5 m above deck	68	71	85	93	85	60	Girders	
0.5 m below deck	36	42	53	65	74	66	53	55
1.5 m below deck			48	48	48	50	65	74
2.5 m below deck						40	59	95

Elevation	Abutment S-5 - East Elevation Readings (mm) - Distance from South End, m							
	0.5m	1.5m	2.5m	3.5m	4.5m	5.5m	6.5m	7.5m
0.5 m above deck	Girders	62	76	89	94	86	94	59
0.5 m beow deck	75	52	67	69	63	60	40	58
1.5 m below deck	62	64	64	67	63	70		
2.5 m below deck	51	74	51					

Notes:

1. Covermeter survey conducted on a 1 m x 1 m grid
2. Concrete Cover Summary:
   - a) maximum = 95 mm
   - b) minimum = 36 mm
   - c) average = 60 mm

APPENDIX D

Compressive Strength Test Data

Table 6 - Compressive Strength Test Data

Core ID No.	Bridge Structure	Structure Element	Core Location	Compressive Strength (MPa)
5489	Northbound	Abutment N-0	2.6 m east from centerline of south abutment, 0.25 m below top of abutment, north face	60.2
5490	Northbound	Pier N-1	0.05 m east from centerline of pier, 0.85 m below top of pier, south face	51.3
5491	Northbound	Pier N-2	1.35 m west from centerline of pier, 0.6 m below top of pier, south face	44.5
5492	Northbound	Pier N-3	1.8 m west from centerline of pier, 0.25 m below top of pier, north face	54.4
5493	Northbound	Pier N-4	0.3 m east from centerline of pier, 1.85 m below top of pier, south face	46.8
5494	Northbound	Abutment N-5	2.57 m east from west end of north abutment, 0.35 m below top of abutment, south face	47.4
5495	Southbound	Abutment S-0	1.3 m west from east end of south abutment, 0.3 m below top of abutment, north face	54.5
5496	Southbound	Pier S-1	0.65 m east from centerline of pier, 0.7 m below top of pier, south face	66.8
5497	Southbound	Pier S-2	0.6 m west from centerline of pier, 0.6 m below top of pier, south face	49.5
5498	Southbound	Pier S-3	0.9 m east from centerline of pier, 1.65 m below top of pier, north face	58.5
5499	Southbound	Pier S-4	0.99 m west from centerline of pier, 0.62 m below top of pier, south face	47.7
5500	Southbound	Abutment S-5	1.35 m east from centerline of north abutment, 0.45 m below top of pier, south face	55.1
5529	Southbound	Girder S-2	Centerline of girder 2 at pier 2	54.5
5530	Northbound	Girder N-3	Centerline of girder 3 at pier 1	67.6
5531	Southbound	Girder S-2	Centerline of girder 2 at pier 3	65.9
5532	Northbound	Girder N-2	Centerline of girder 2 at pier 3	78.3

APPENDIX E

Air Void Parameters Test Data

Stantec

Table 7 - Air Void Parameters Test Data

Core ID No.	Bridge Structure	Structure Element	Core Recovery Location	Total Air Content (%)	Spacing Factor (µm)
5477	Northbound	Abutment N-0	2.3 m east from centerline of south abutment, 0.2 m below top of abutment, north face	**2.9**	**409**
5478	Northbound	Pier N-1	Centerline of pier, 0.55 m below top of pier, south face	5.1	152
5479	Northbound	Pier N-2	1.35 m west from centerline of pier, 0.5 m below top of pier, south face	3.6	145
5480	Northbound	Pier N-3	2.0 m west from centerline of pier, 0.25 m below top of pier, north face	3.0	172
5481	Northbound	Pier N-4	0.3 m east from centerline of pier, 1.6 m below top of pier, south face	5.6	164
5482	Northbound	Abutment N-5	2.75 m east from west end of north abutment, 0.3 m below top of abutment, south face	4.7	146
5483	Southbound	Abutment S-0	1.0 m west from east end of south abutment, 0.6 m below to of abutment, north face	3.6	179
5484	Southbound	Pier S-1	0.7 m east from centerline of pier, 1.5 m up from bottom of pier, south face	3.9	216
5485	Southbound	Pier S-2	0.3 m east from centerline of pier, 0.6 m below top of pier, south face	5.1	188
5486	Southbound	Pier S-3	0.9 m east from centerline of pier, 1.65 m below top of pier, north face	4.6	219
5487	Southbound	Pier S-4	1.35 m west from centerline of pier, 0.6 m below top of pier, south face	4.8	122
5488	Southbound	Abutment S-5	1.95 m east from centerline of north abutment, 0.45 m below top of abutment, south face	**2.7**	214
5525	Southbound	Girder S-3	Centerline of girder 3 at pier 1	3.0	228
5526	Northbound	Girder N-3	Centerline of girder 3 at pier 1	**1.5**	235
5527	Southbound	Girder S-5	Centerline of girder 5 at north abutment	**2.3**	**388**
5528	Northbound	Girder N-2	Centerline of girder 2 at south abutment	**2.8**	249
CSA A23.1 Specification Limits for Frost Resistant Concrete				**3.0 min.**	**260 max.**

Notes:

1. Tests conducted in accorance with ASTM C457 using Modified Point Count Method (Procedure B).
2. The test samples were prepared and traversed along the vertical face.

Notes:

For the category of concrete defined in CSA A23.1, Clause 4.3.3.2, the air void system shall meet the following:

a) The average of all tests shall have a spacing factor not exceeding 230 µm, with no single value greater than 260 µm; and

b) Air content shall be greater than or equal to 3.0% in the hardened concrete.

For concrete with water-to-cementing materials ratio of 0.36 or less, the average spacing factor shall not exceed 250 µm, with no single value greater than 300 µm.

APPENDIX F

Water-Soluble Chloride Ion Content Test Data

Stantec

Table 8 - Water-Soluble Chloride Ion Content Test Data

Core ID No.	Bridge Structure	Structure Element	Core Recovery Location	Sample Depth (mm)	WSC Content (% by mass of concrete)
5501	Northbound	Abutment N-0	2.0 m east from centerline of south abutment, 0.45 m below top of abutment, north face	25 to 35	**0.146**
				60 to 70	**0.057**
				100 to 110	**0.028**
5502	Northbound	Abutment N-0	4.4 m east from centerline of south abutment, 0.25 m below top of abutment, north face	25 to 35	**0.069**
				60 to 70	0.017
				100 to 110	<0.010
5503	Northbound	Pier N-1	Centerline of pier, 0.95 below top of pier, south face	25 to 35	**0.067**
				60 to 70	**0.038**
				100 to 110	0.016
5504	Northbound	Pier N-1	1.4 m west from centerline of pier, 1.55 m up from bottom of pier, south face	25 to 35	**0.094**
				60 to 70	0.023
				100 to 110	<0.010
5505	Northbound	Pier N-2	1.35 m west from centerline of pier, 0.75 m up from bottom of pier, south face	25 to 35	**0.034**
				60 to 70	<0.010
				100 to 110	<0.010
5506	Northbound	Pier N-2	0.1 m west from centerline of pier, 1.45 m up from bottom of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5507	Northbound	Pier N-3	1.75 m west from centerline of pier, 0.35 m below top of pier, north face	25 to 35	**0.033**
				60 to 70	<0.010
				100 to 110	<0.010
5508	Northbound	Pier N-3	0.45 m west from centerline of pier, 1.25 m up from bottom of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5509	Northbound	Pier N-4	Centerline of pier, 1.85 m below top of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5510	Northbound	Pier N-4	1.97 m east from west face of pier, 1.15 m up from bottom of pier, north face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5511	Northbound	Abutment N-5	0.3 m east from west face of north abutment, 0.35 m below top of abutmment, south face	25 to 35	**0.204**
				60 to 70	**0.103**
				100 to 110	0.024
5512	Northbound	Abutment N-5	1.95 m east from centerline of north abutment, 0.45 m below top of abutment, south face	25 to 35	**0.168**
				60 to 70	**0.048**
				100 to 110	0.011
5513	Southbound	Abutment S-0	1.0 m west from centerline of south abutment, 0.3 m below top of abutment, north face	25 to 35	**0.248**
				60 to 70	**0.102**
				100 to 110	**0.033**
5514	Southbound	Abutment S-0	4.05 m east from centerline of south abutment, 0.3 m below top of abutment, north face	25 to 35	**0.410**
				60 to 70	**0.187**
				100 to 110	0.025

Stantec

Table 8 - Water-Soluble Chloride Ion Content Test Data

Core ID No.	Bridge Structure	Structure Element	Core Recovery Location	Sample Depth (mm)	WSC Content (% by mass of concrete)
5515	Southbound	Pier S-1	0.7 m east from centerline of pier, 1.1 m below top of pier, south face	25 to 35	**0.058**
				60 to 70	<0.010
				100 to 110	<0.010
5516	Southbound	Pier S-1	2.1 m east from centerline of pier, 1.5 m up from bottom of pier, south face	25 to 35	**0.448**
				60 to 70	**0.120**
				100 to 110	<0.010
5517	Southbound	Pier S-2	0.35 m west from centerline of pier, 0.7 m below top of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5518	Southbound	Pier S-2	0.15 m west from centerline of pier, 1.5 m up from bottom of pier, south face	25 to 35	<0.010
				60 to 70	<0.010
				100 to 110	<0.010
5519	Southbound	Pier S-3	0.9 m east from centerline of pier, 1.75 m below top of pier, north face	25 to 35	**0.372**
				60 to 70	**0.149**
				100 to 110	0.01
5520	Southbound	Pier S-3	0.45 m west from centerline of pier, 1.4 m up from bottom of pier, south face	25 to 35	0.014
				60 to 70	<0.010
				100 to 110	<0.010
5521	Southbound	Pier S-4	1.33 m west from centerline of pier, 0.3 m below top of pier, south face	25 to 35	0.013
				60 to 70	<0.010
				100 to 110	<0.010
5522	Southbound	Pier S-4	1.96 m east from centerline of pier, 2.0 m up from bottom of pier, north face	25 to 35	0.012
				60 to 70	<0.010
				100 to 110	<0.010
5523	Southbound	Aubutment S-4	1.25 m east from centerline of north abutment, 0.45 m below top of abutment, south face	25 to 35	**0.738**
				60 to 70	**0.239**
				100 to 110	**0.061**
5524	Southbound	Aubutment S-4	0.6 m east from wes end of north abutment, 0.45 m below top of abutment, south face	25 to 35	**0.166**
				60 to 70	0.022
				100 to 110	<0.010
5533	Southbound	Girder S-1	Centerline of girder 1 at pier 2	25 to 35	0.016
				60 to 70	0.011
				100 to 110	0.013
5534	Southbound	Girder S-4	Centerline of girder 4 at pier 4	25 to 35	0.013
				60 to 70	0.014
				100 to 110	<0.010
5535	Southbound	Girder S-1	Centerline of girder 1 at north abutment	25 to 35	0.018
				60 to 70	0.011
				100 to 110	0.013
5536	Southbound	Girder S-3	Centerline of girder 3 at pier 3	25 to 35	0.018
				60 to 70	0.011
				100 to 110	<0.010

Table 8 - Water-Soluble Chloride Ion Content Test Data

Core ID No.	Bridge Structure	Structure Element	Core Recovery Location	Sample Depth (mm)	WSC Content (% by mass of concrete)
5537	Northbound	Girder N-3	Centerline of girder 3 at pier 3	25 to 35	0.012
				60 to 70	0.012
				100 to 110	0.012
5538	Northbound	Girder N-5	Centerline of girder 5 at south abutment	25 to 35	0.014
				60 to 70	0.013
				100 to 110	0.013

Notes:

1. The chloride threshold necessary to permit corrosion in the reinforcing steel with the presence of oxygen and water must be greater than 0.025% by mass of concrete (in accordance with OSRM manual, April 2007)
2. The chloride results that exceeded this threshold are highlighted in the table above.
3. The reporting (detectable) limit is 0.010%.

APPENDIX G

Rapid Chloride Test (RCT) Data

Table 9 - Acid-Soluble Rapid Chloride Ion Content Test Data

Sample ID No.	Bridge Structure	Structure Element	Powder Sample Recovery Location	Sample Depth (mm)	Acid-Soluble Rapid Chloride Ion Content (% by mass of concrete)
5539	Southbound	Girder 2	Span 3, southbound, girder 2, end block at pier 3	50	0.014
5540	Southbound	Girder 4	Span 3, southbound, girder 4, end block at pier 3	50	0.016
5541	Northbound	Girder 4	Span 3, northbound, girder 4, end block at pier 3	50	0.005
5542	Northbound	Girder 3	Span 3, northbound, girder 3, end block at pier 3	50	0.006
5543	Northbound	Girder 5	Span3, northbound, girder 5, good area of lower flange	50	0.013
5544	Southbound	Pier 3	Pier 3, southbound, south face, west end	50	**0.212**
5545	Southbound	Pier 3	Pier 3, southbound, south face, west end	100	**0.087**
5546	Southbound	Girder 4	Span 3, southbound, girder 4, bad area of upper flange	50	**0.151**
5547	Southbound	Girder 4	Span 3, southbound,girder 4, bad area of lower flange	100	**0.154**
5548	Southbound	Girder 3	Span 3, southbound, girder 3, bad area of upper flange, 2.5 m from south diaphragm	50	**0.166**
5549	Southbound	Girder 3	Span 3, southbound, girder 3, bad area of lower flange, 2.5 m from south diaphragm	100	0.006
5550	Southbound	Girder 2	Span 3, southbound, girder 2, good area of upper flange, 2.5 m from south diaphragm	50	0.014
5551	Southbound	Girder 2	Span 3, southbound, girder 2, good area of lower flange, 2.5 m from south diaphragm	50	0.005
5552	Northbound	Pier 2	Pier 2, northbound, northwest face	50	**0.224**
5553	Northbound	Pier 2	Pier 2, northbound, northwest face	100	**0.047**
5554	Southbound	Girder 1	Span 4, southbound, girder 1, bad area of upper flange, 1.42 m from diaphragm	50	**0.402**
5555	Southbound	Girder 1	Span 4, southbound, girder 4, extremely bad area of upper flange, 1.42 m from diaphragm	50	**0.142**
5556	Southbound	Pier 4	Pier 4, southbound, south face, west end	50	**0.234**
5557	Southbound	Pier 4	Pier 4, southbound, south face, west end	100	**0.155**
5558	Northbound	Pier 4	Pier 4, northbound, south face, west end	50	**0.949**

Stantec

Table 9 - Acid-Soluble Rapid Chloride Ion Content Test Data

Sample ID No.	Bridge Structure	Structure Element	Powder Sample Recovery Location	Sample Depth (mm)	Acid-Soluble Rapid Chloride Ion Content (% by mass of concrete)
5559	Northbound	Pier 4	Pier 4, northbound, south face, west end	100	**0.388**
5560	Northbound	Girder 1	Span 4, northbound, girder 1, extremely bad area of upper flange	50	**0.398**
5561	Northbound	Girder 5	Span 4, northbound, girder 5, bad area of upper flange	50	**0.057**
5562	Southbound	Pier 4	Pier 4, southbound, south face, east end	50	**0.608**
5563	Southbound	Pier 4	Pier 4, southbound, south face, east end	100	**0.125**

Notes:

1. The chloride threshold necessary to permit corrosion in the reinforcing steel with the presence of oxygen and water must be greater than 0.025% by mass of concrete (in accordance with OSRM manual, April 2007)
2. The chloride results that exceeded this threshold are highlighted in the table above.

APPENDIX H

Petrographic Evaluation Reports

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE
ASTM C856-20

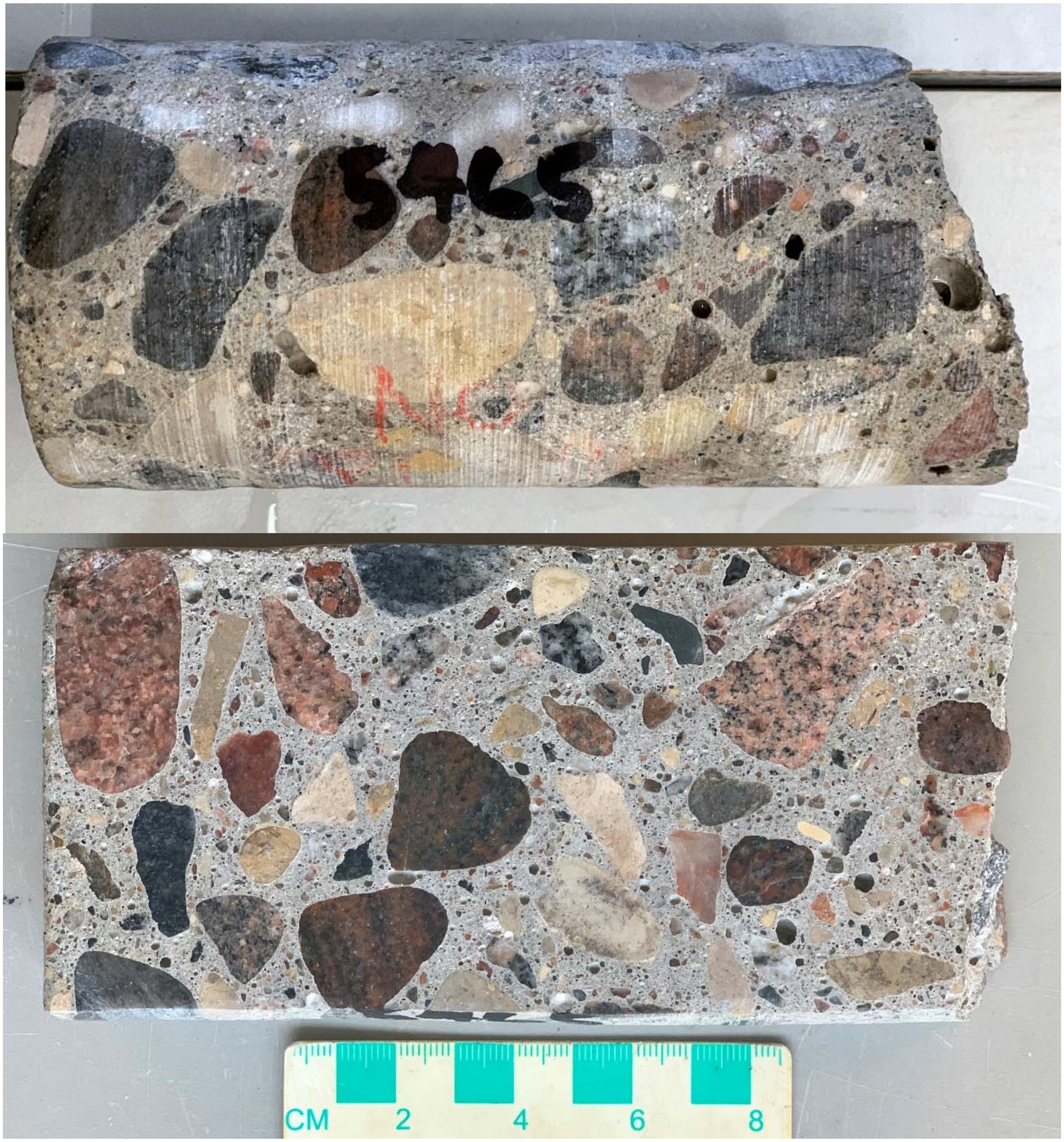
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 15, 2023

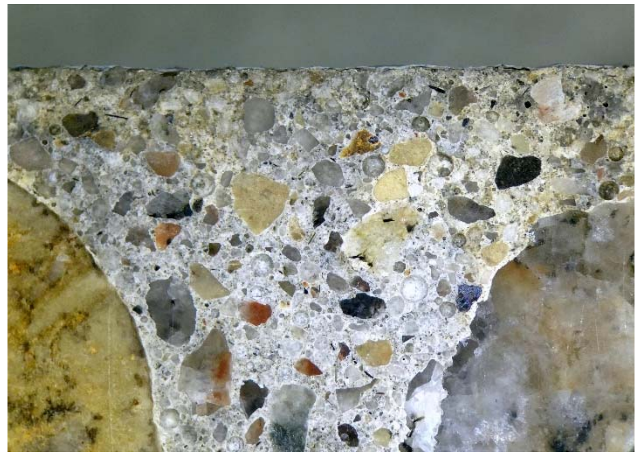
Attention: Mr. Kevin Hiraoka, CTech

PROJECT:	Lagimodiere Twin Overpasses	Sample	5465

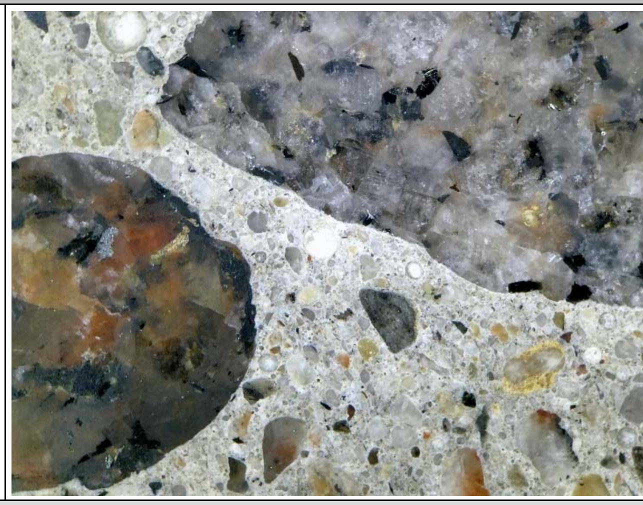
SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 143/156 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	22 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and moderately hard to firm
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor carbonation observed in paste phase.



Core prior to and after cutting and polishing.

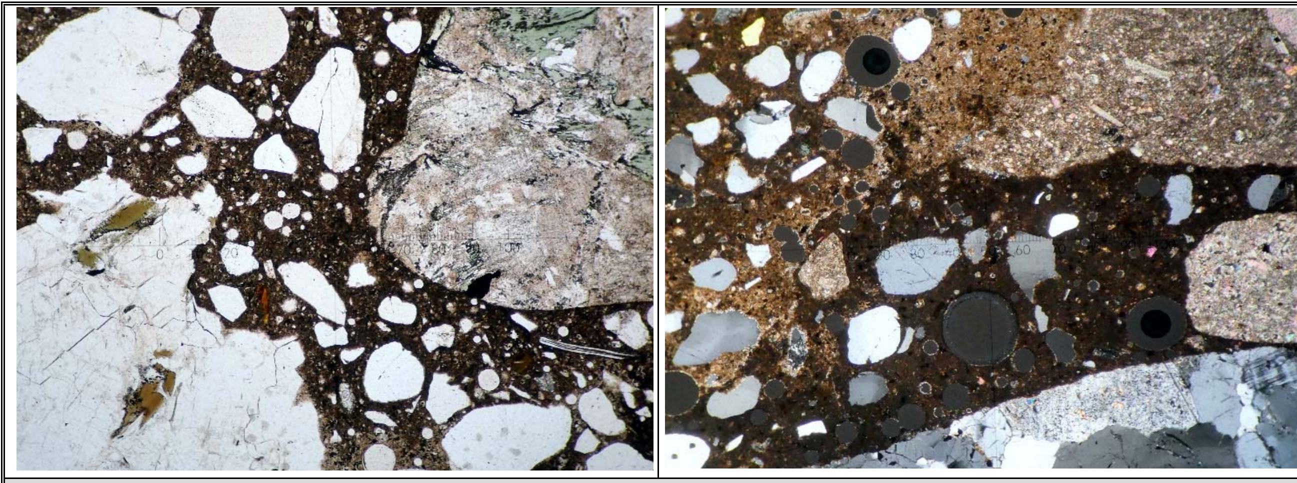



Views at upper/outer face of core, in profile. Sligtly discoloured paste at surface. Magn. 10x, fov = 13 mm

Views at 10x magnification illustrating general condition of paste and aggregates. Field of view is about 13 mm across.


Views at 20x magnification showing dense paste and good encapsulation of aggregates. Fields of view 8 mm across.



Thin-section views depict (left) cement paste that is generally dense and encapsulates aggregates, and (right) shows patchy carbonation in some areas (lighter brown in upper left area of image). Magnification 50x, field of view 3 mm.

SUMMARY	Concrete is dense and well-consolidated mix. Paste encapsulation of fine and coarse aggregates is satisfactory. Minor discoluration of paste is observed at the surface of the core.

Petrographer: ______________________ DATE: February 16, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 16, 2023

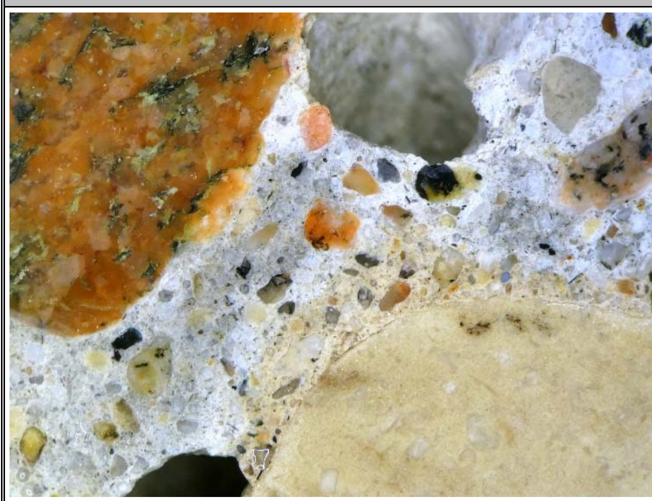
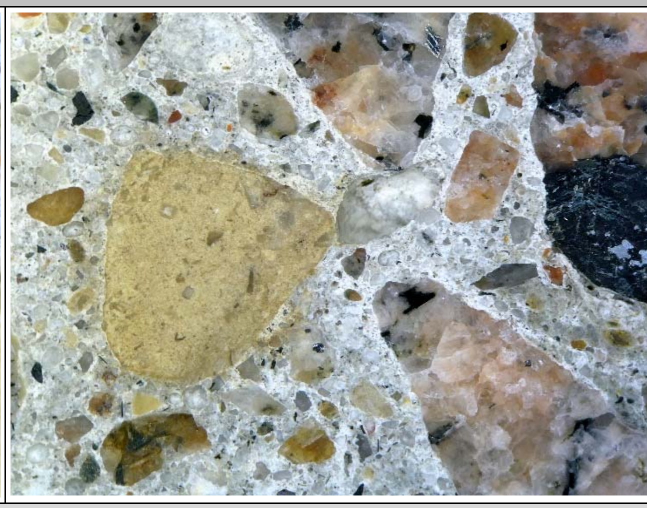
Attention: Mr. Kevin Hiraoka, CTech

PROJECT:	Lagimodiere Twin Overpasses	Sample	5466

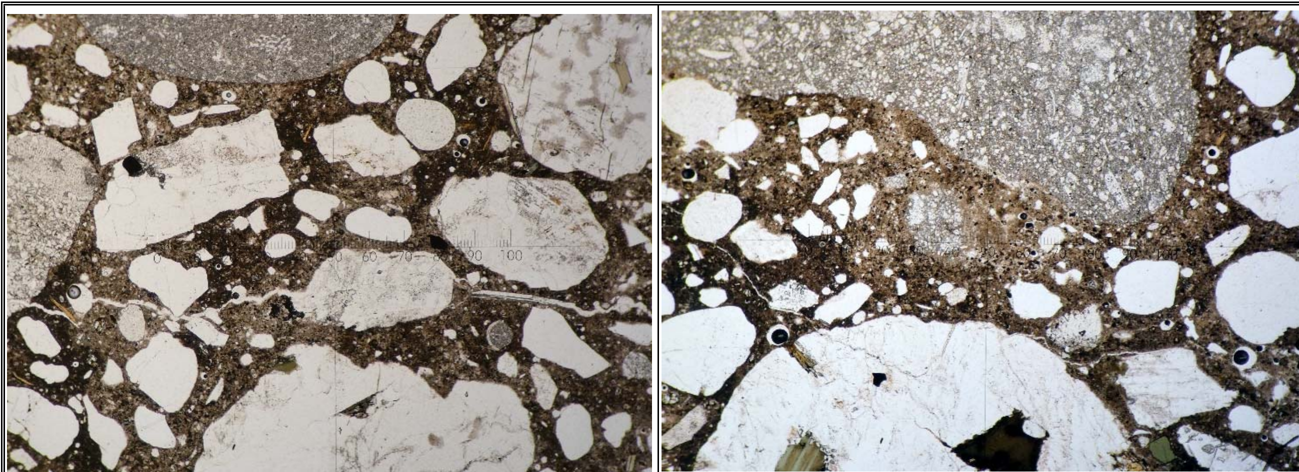
SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 143/156 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	22 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and moderately hard to firm
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor parallel-to-surface cracking observed at outer edge of core. Some of the applied finishes (paint) have delaminated while in other zones are still intact and well-adhering to the surface. Minor discolouration of the paste in the outer 5 mm was noted. A few entrapped air voids were observed adjacent coarse aggregate particles. Rare patches of carbonated paste are observed in thin-section, and rare fine cracks are observed in thin-section at magnification.

Core prior to (above) after cutting and polishing (below).

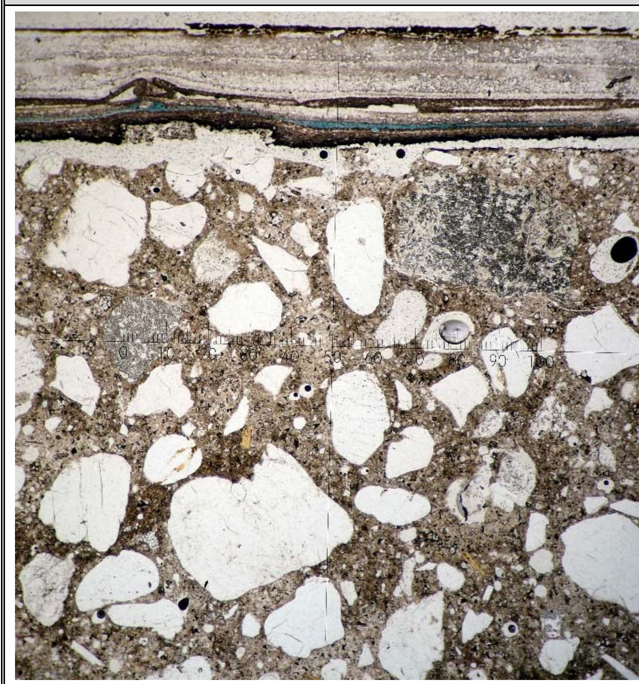

Views at upper/outer face of core, in profile, showing cracks in paste, delamination of paint coatings (left view), and discoloured paste at surface. Magn. 10x, fov = 13 mm

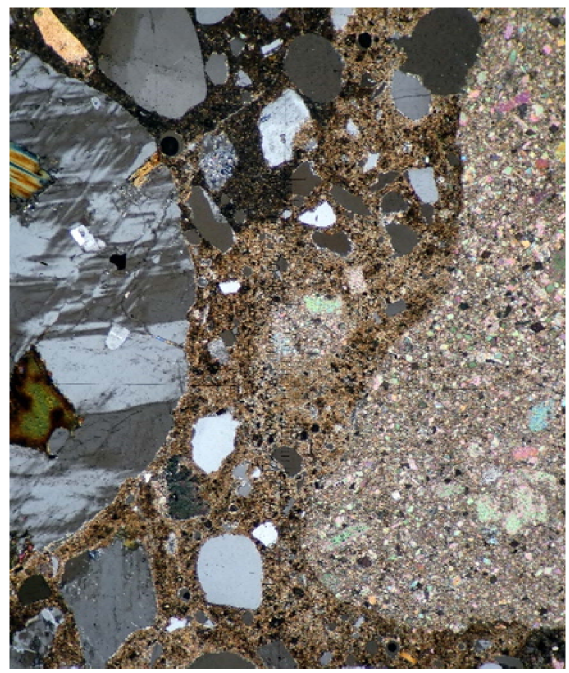
Views at 10x magnification illustrating (left) discoloured paste surrounding a limestone coarse aggregate, with a slight debond observed along its periphery, and a n entrapped air void next to the granite aggregates at the upper left; and (right) general condition of paste that encloses granite, gneiss, and limestone aggregates. Fields of view about 13 mm.



Cracks are observed in the paste, in thin-section. These are generally devoid of deposits of secondary materials, are fine, and are overall uncommon. 50x magnification, field of view 3 mm.



Outer surface of core showing applied layers of paint, etc., at top of image. 50x.



Slightly carbonated paste is seen in this image; 50x magnification.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Minor cracking is noted in the outermost 5 mm of the core. Fine cracks are observed in thin-section at magnification, in modest amounts. Minor entrapped air voids are observed.

Petrographer: ______________________ DATE: February 16, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 16, 2023

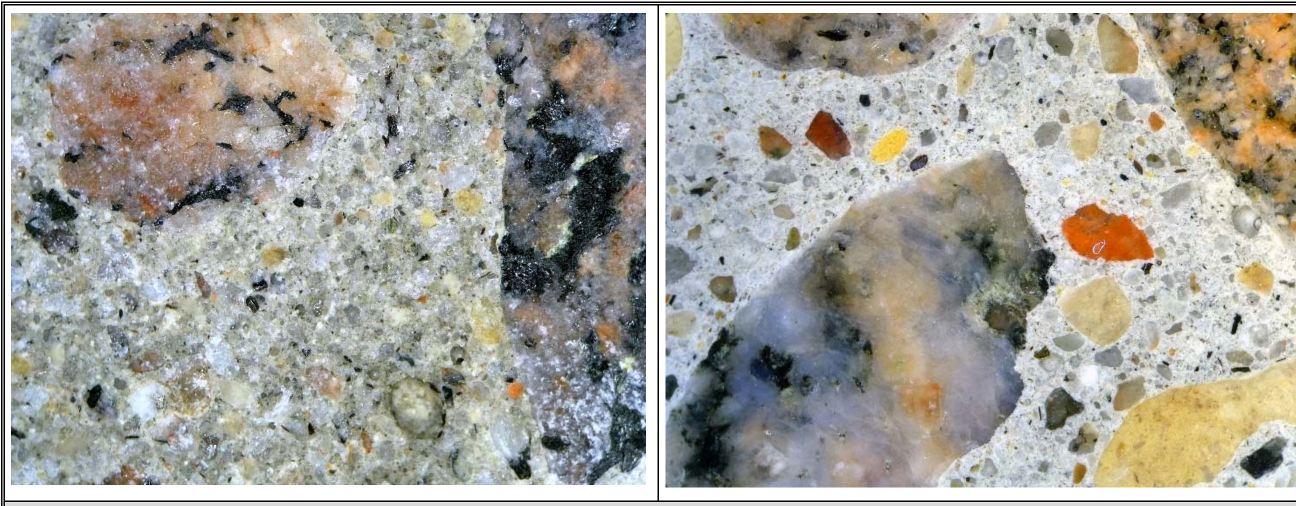
Attention: Mr. Kevin Hiraoka, CTech

PROJECT:	Lagimodiere Twin Overpasses	Sample	5467

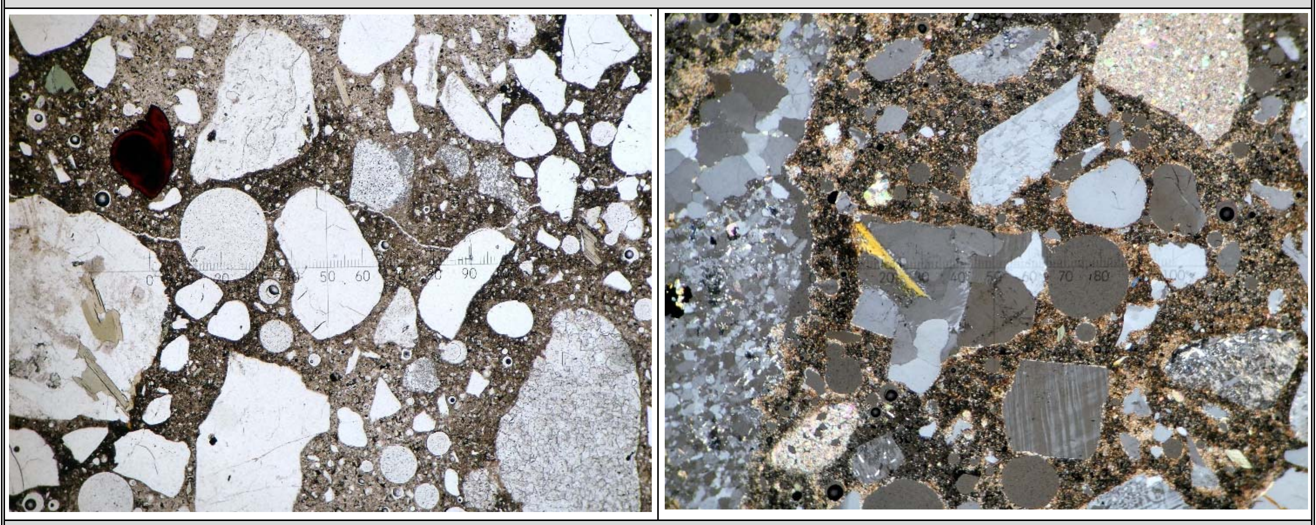
SAMPLE TYPE – GENERAL	The core is 82 mm in diameter by 158/175 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	25 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and moderately hard to firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor discolouration of the paste in the outer 3 mm was noted. Minor flaking of the paste at the surface is observed. A few entrapped air voids were observed adjacent coarse aggregate particles.

Core after cutting and polishing. Note slight discolouration of paste at outer end.

Views at upper/outer face of core, in profile, showing slight attrition of paste on surface and slight discolouration of paste at surface. Magn. 10x, fov = 13 mm



Views at 10x magnification illustrating dense paste containing two granitic aggregate particles, (right) polished surface showing paste that encloses aggregates. Fields of view about 13 mm.



Thin-section views showing (left) microcrack extending through paste and (right) generally dense but slightly carbonated paste that encapsulates aggregates. Magnification 50x, fields of view 3 mm across.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Slight discolouration of paste is seen in the outermost 5 mm of the core. Rare fine microcracking observed in paste. Some patchy carbonated paste.

Petrographer: ______________________
F. Shrimer, P. Geo.

DATE: February 16, 2023

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

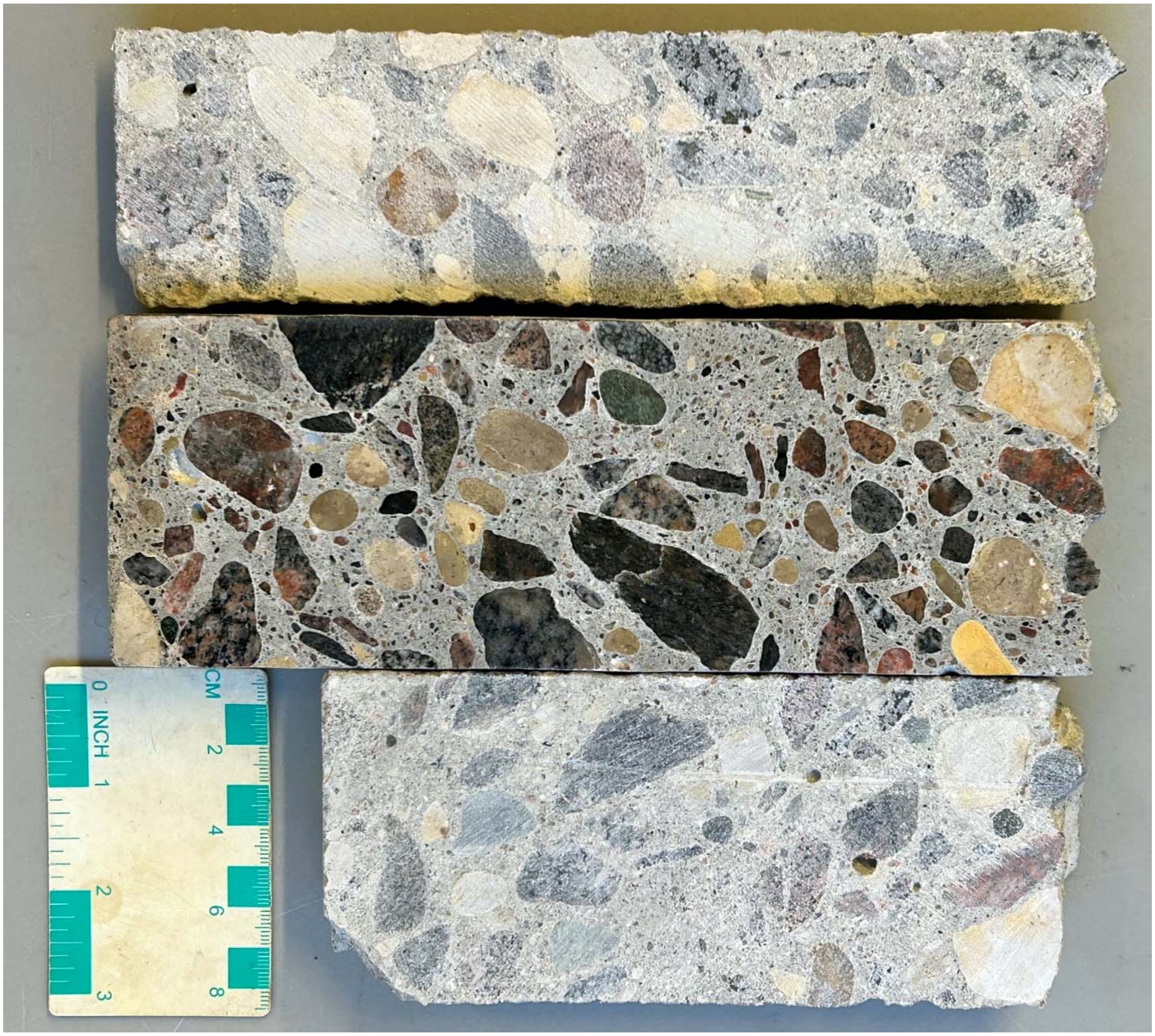
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 16, 2023

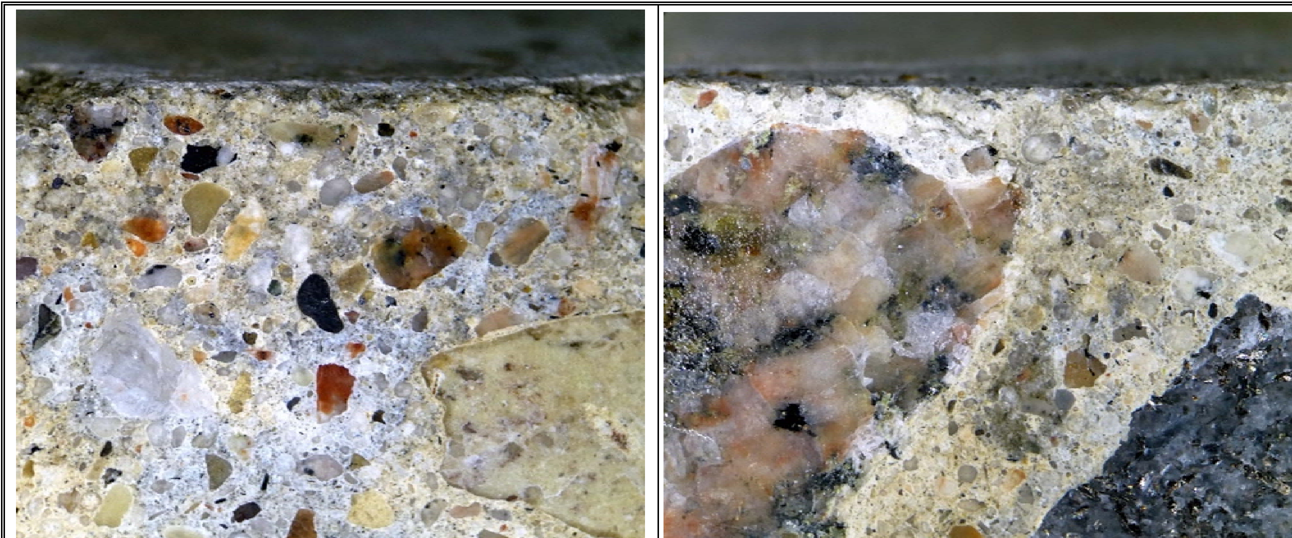
Attention: Mr. Kevin Hiraoka, CTech

PROJECT:	Lagimodiere Twin Overpasses	Sample	5468

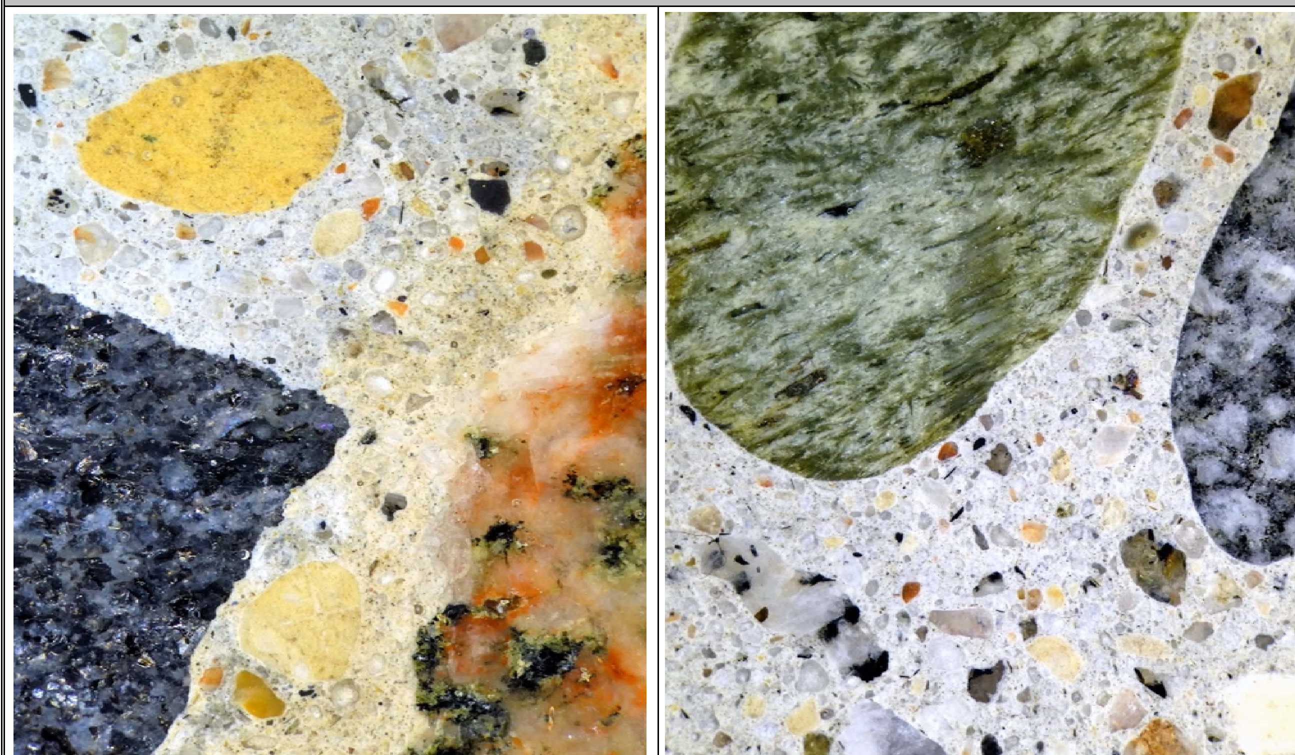
SAMPLE TYPE – GENERAL	The core is 82 mm in diameter by 225/235 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	30 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and moderately hard to firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor discolouration of the paste in the outer 15 mm was noted. Minor flaking of the paste at the surface is observed.



Core after cutting and polishing. Outer end is discoloured to a depth of about 15 mm.

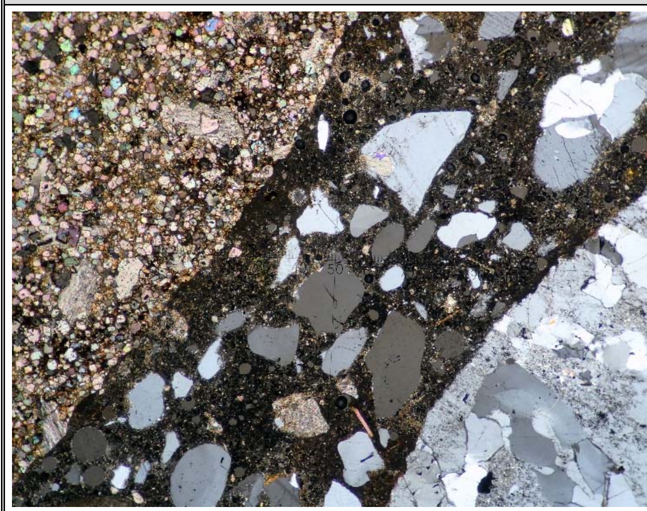


Views at upper/outer face of core, in profile, showing uneven discoloured paste at surface. Magn. 10x, fov = 13 mm

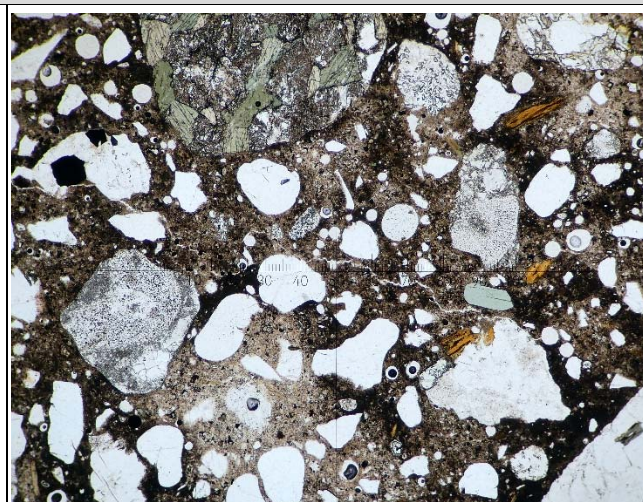


Discoloured, likely carbonated, cement paste at top of sample in left view contrasts with light grey paste seen in the right image, both at 10x magnification. Fields of view about 13 mm.


Additional images showing dense paste enclosing sound aggregates; mag. 10x.



Sound paste is seen between dolomite particle on left and granite on right in this thin-section image; 50x magnification, field of view 3 mm across.



A microcrack is seen in this thin-section view extending through paste that exhibits variable carbonation. 50x.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Minor discolouration/carbonation of paste is noted in the outermost 15 mm of the core and in other locations within the core. Minor microcracking is observed in the paste.

Petrographer: ______________________ DATE: February 16, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

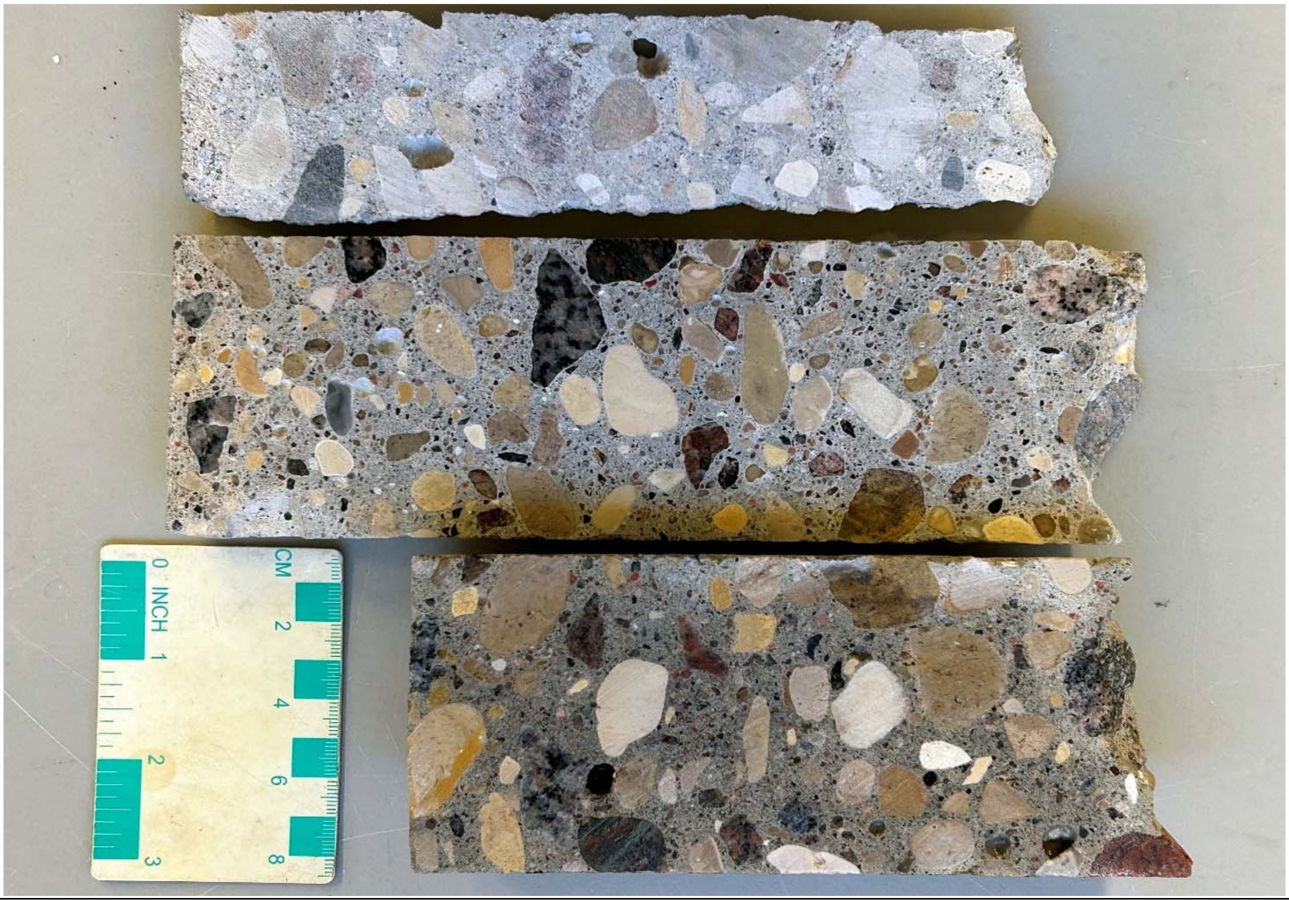
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 17, 2023

Attention: Mr. Kevin Hiraoka, CTech

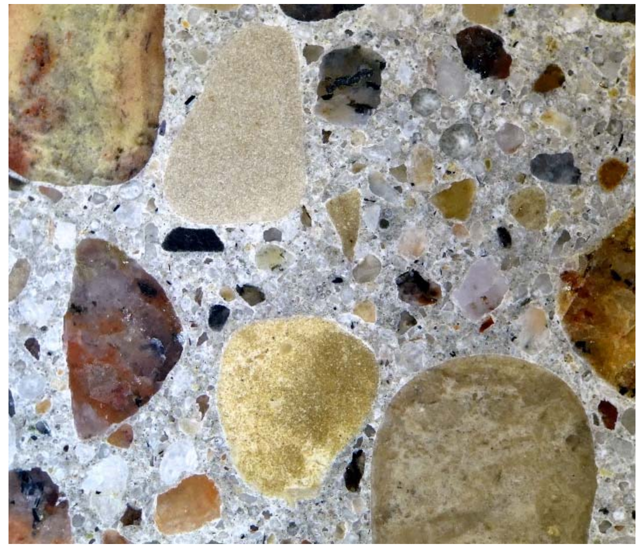
PROJECT:	Lagimodiere Twin Overpasses	Sample	5469

SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 199/215 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	30 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and moderately hard to firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor discolouration of the paste in the outer 3 mm was noted. Minor flaking of the paste at the surface is observed. A few entrapped air voids were observed adjacent coarse aggregate particles. Minor microcracking observed in the paste. Patchy carbonated paste is seen in localized areas.

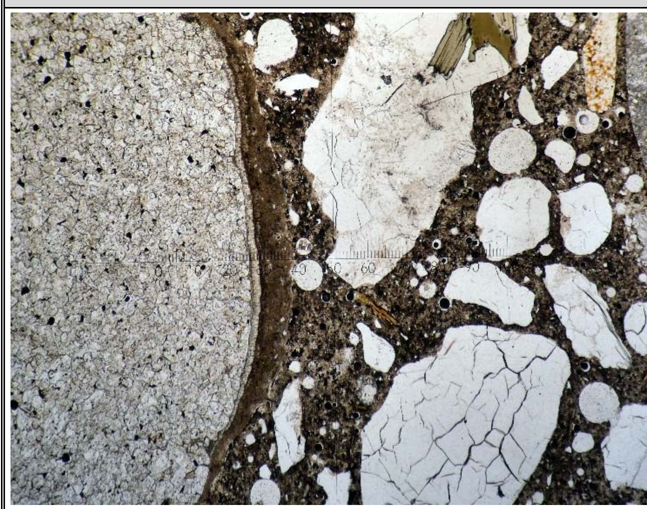


Core after cutting and polishing.

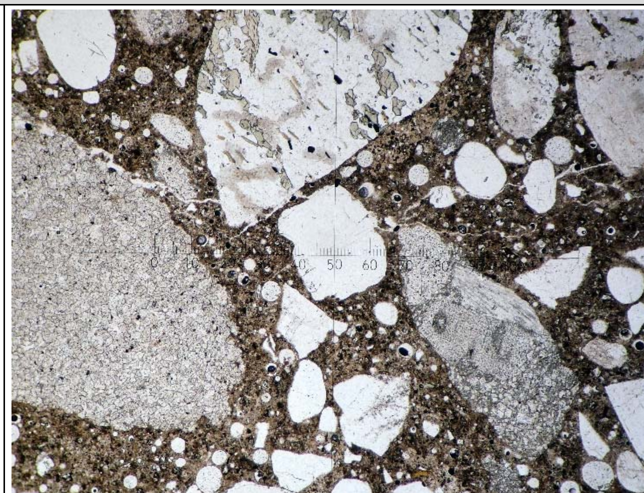
Views at upper/outer face of core, in profile, showing generally sound paste, with only minor discolouration and no cracking. Magn. 10x, fov = 13 mm

Views at 10x magnification illustrating paste that encloses granite, gneiss, dolomite and limestone aggregates. Fields of view about 13 mm.



An encrustation of layered calcite is observed on the dolomite coarse aggregate seen at left in this thin-section view, set in dense paste. 50x magn. FOV – 3 mm.



A thin microcrack is observed passing through the paste in this view. 50x magnification.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory.

Petrographer: ______________________ DATE: February 17, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

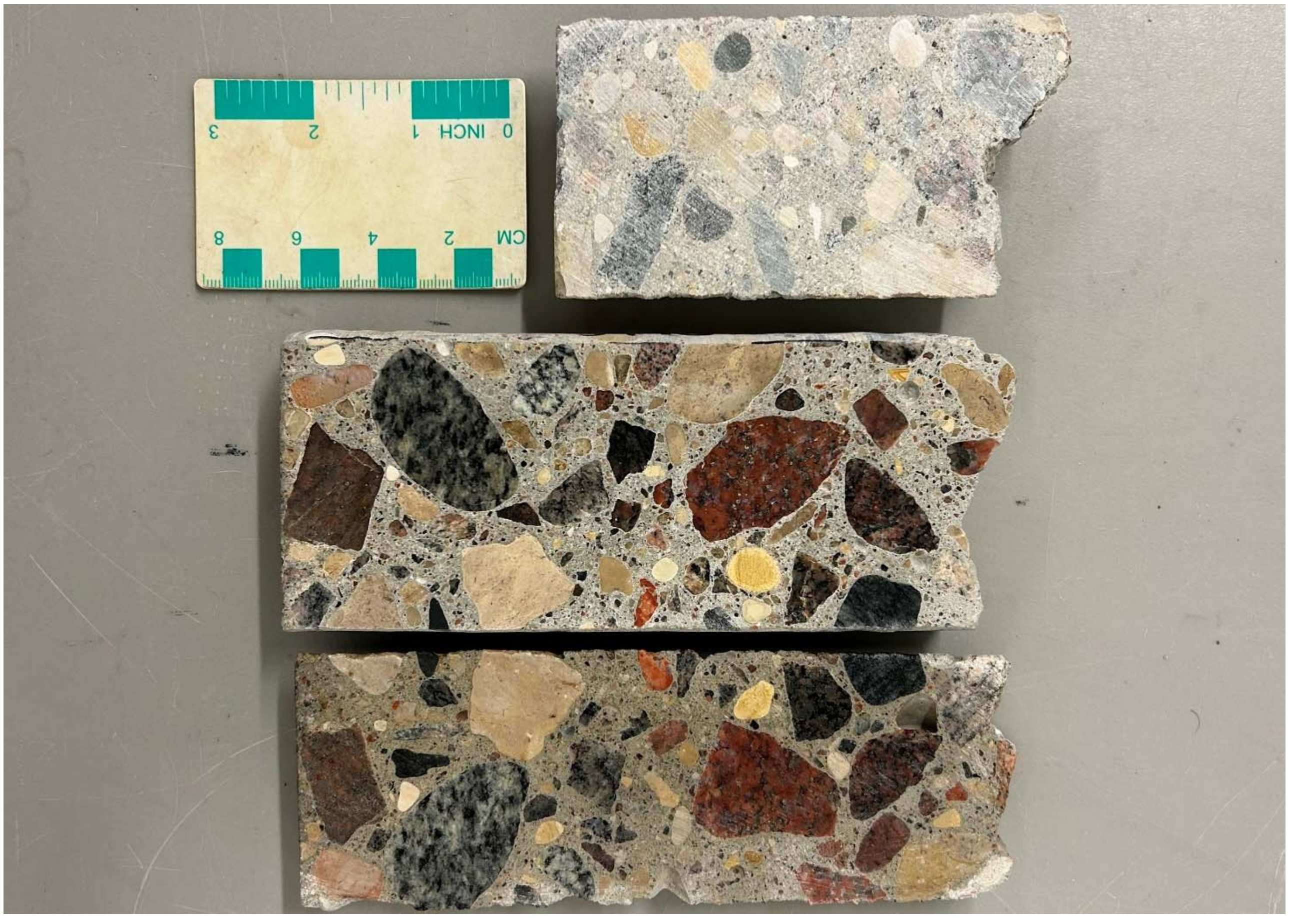
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 17, 2023

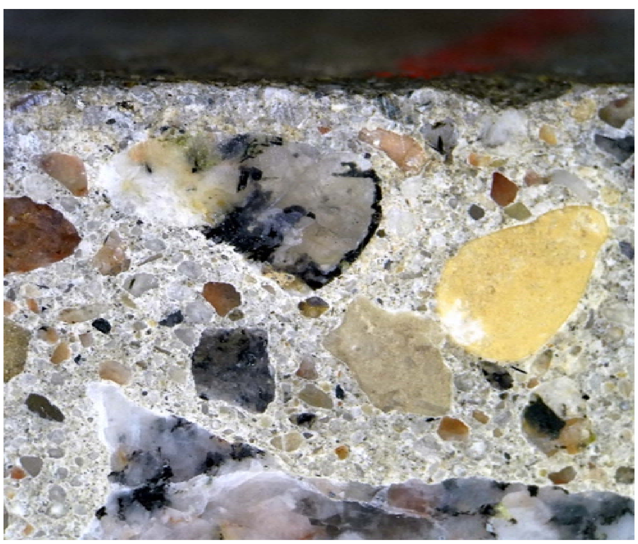
Attention: Mr. Kevin Hiraoka, CTech

PROJECT:	Lagimodiere Twin Overpasses	Sample	5470

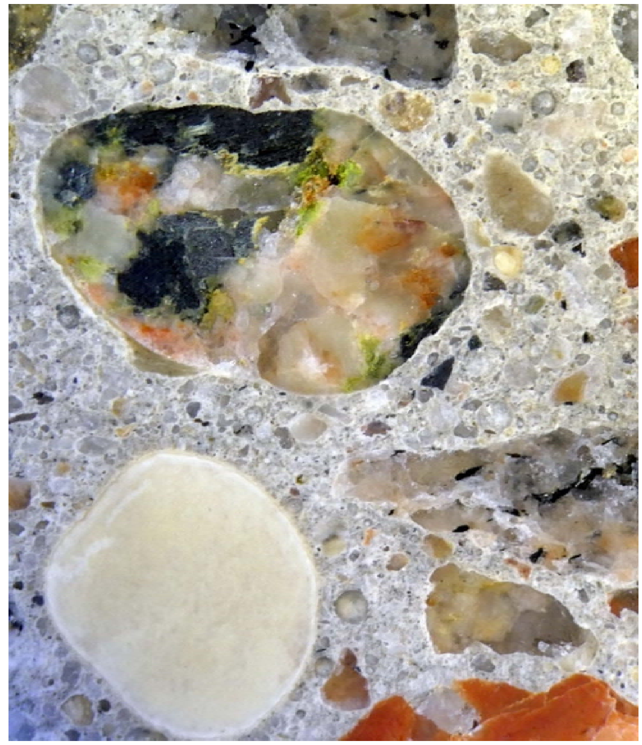
SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 163/194 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	30 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and hard / firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor microcracking and minor carbonation of paste.



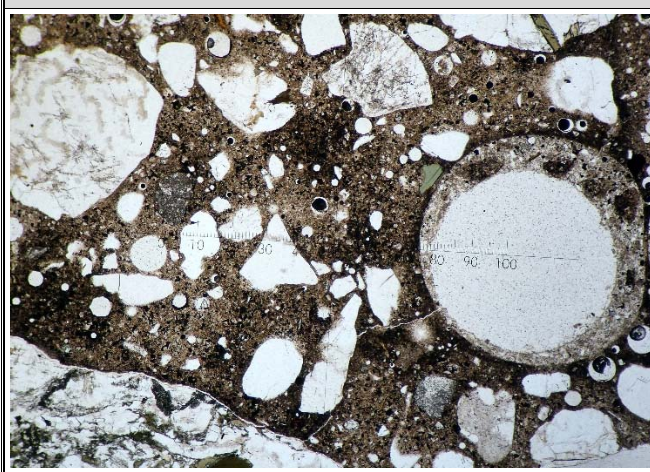
Core after cutting and polishing.



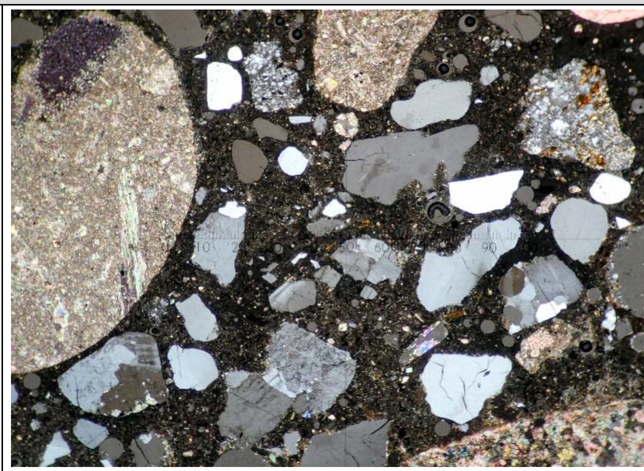
Views at upper/outer face of core, in profile, showing slight attrition paste. Magn. 10x, fov = 13 mm



Views at 10x magnification illustrating (left) slight patches of discoloured paste, and (right) general condition of paste that encloses granite, gneiss, and limestone aggregates. Fields of view about 13 mm.



A thin microcrack extends through paste in this thin-section image; 50x magnification.



A cross-polarized view showing dense paste; 50 magnification, 3 mm FOV.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Minor microcracking observed at magnification.

Petrographer: ______________________ DATE: February 17, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

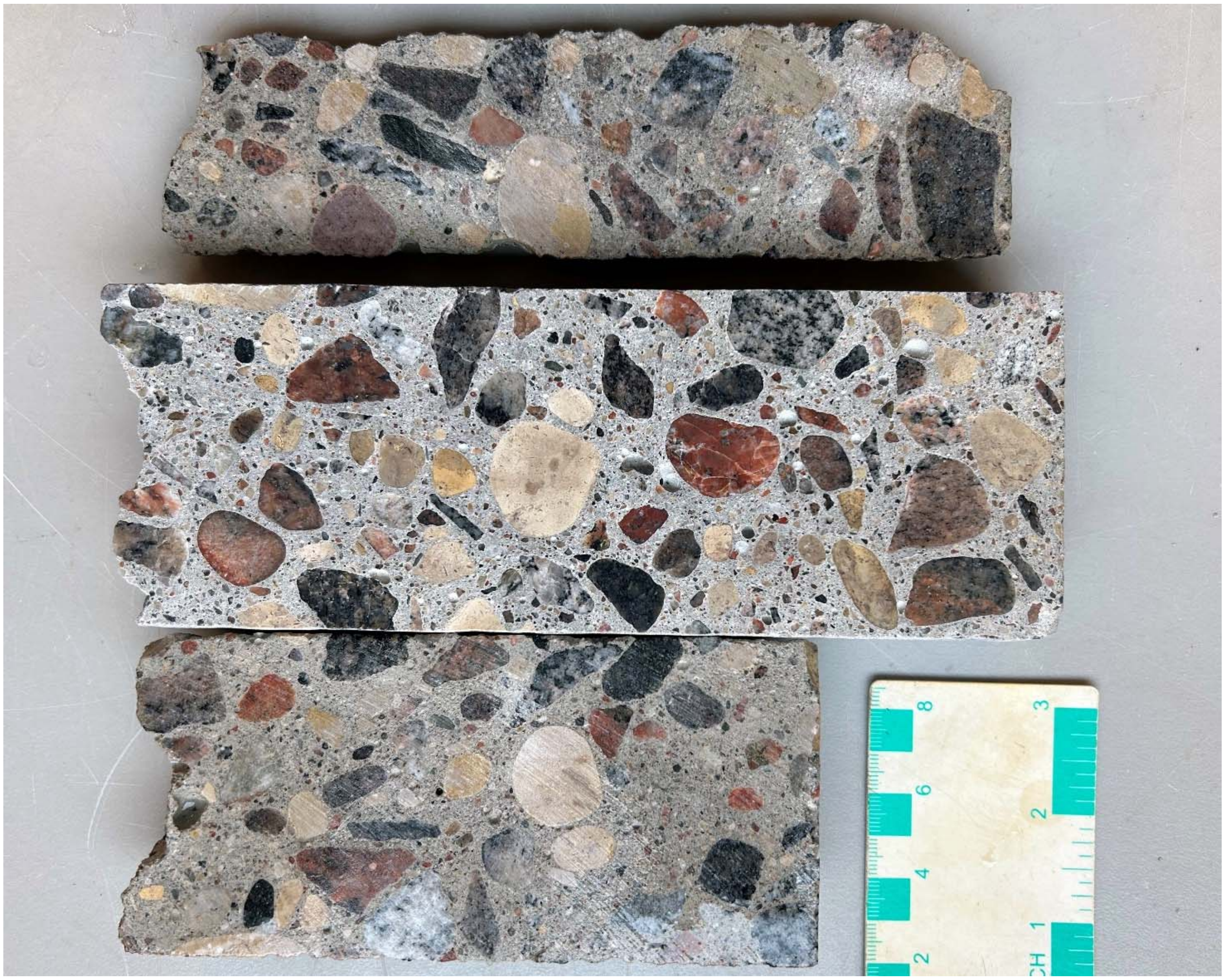
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 17, 2023

Attention: Mr. Kevin Hiraoka, CTech

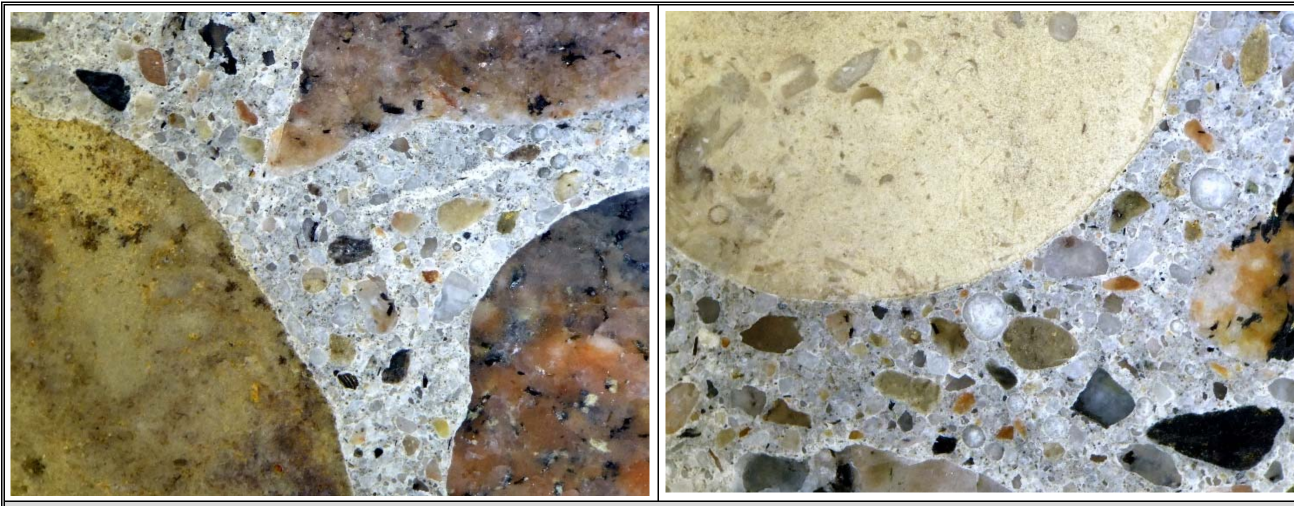
PROJECT:	**Lagimodiere Twin Overpasses**	**Sample**	**5471**

SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 193/207 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	28 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and hard / firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite. A small amount of crushed granitic rock is present.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor microcracking in paste; minor carbonation.

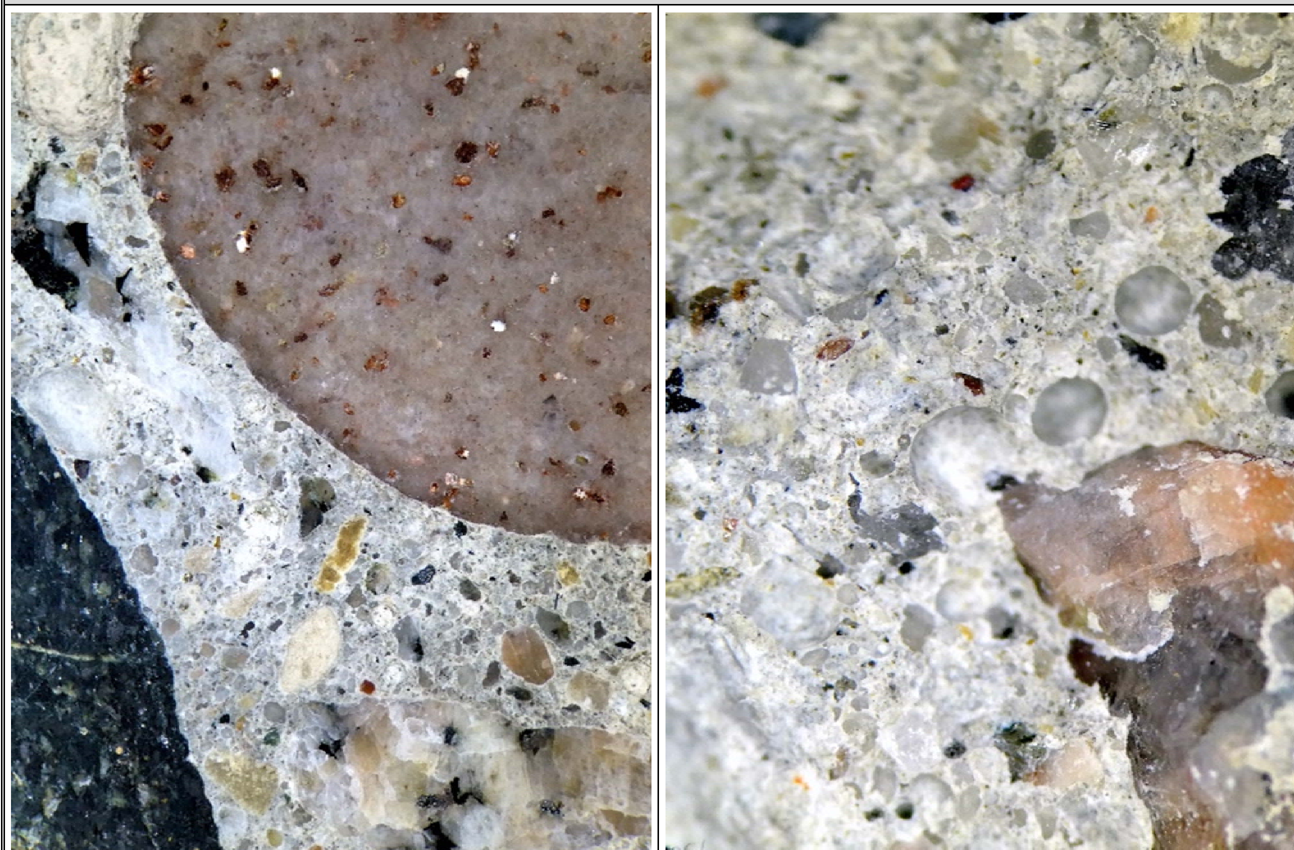


Core after cutting and polishing.

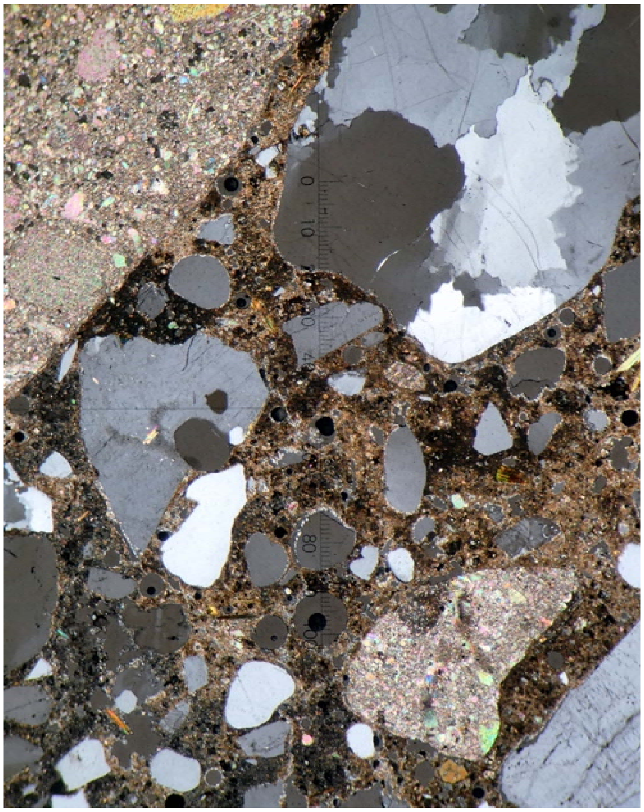
Views at upper/outer face of core, in profile, showing condition of paste. Magn. 10x, fov = 13 mm



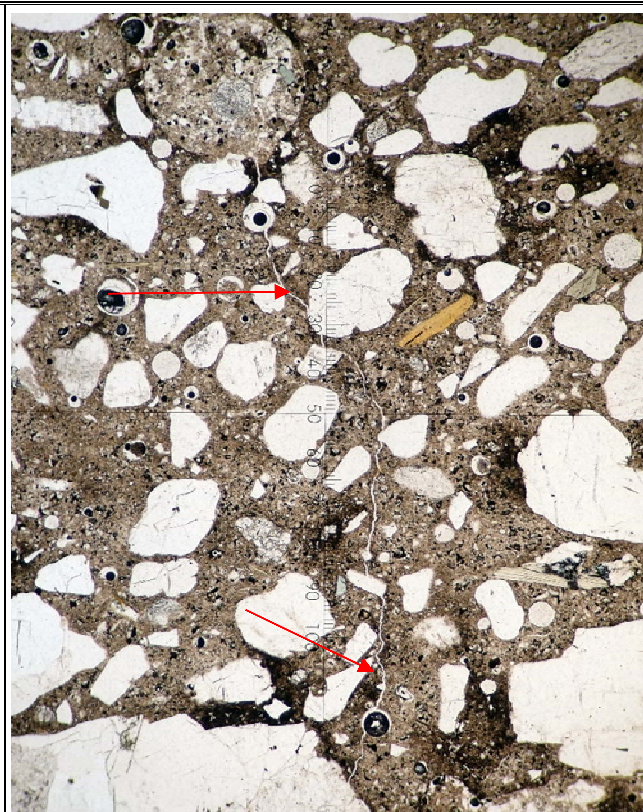
Views at 10x magnification illustrating granitic, carbonate and siliceous coarse aggregate enclosed in a dense paste matrix. Fields of view about 13 mm.



Sandstone coarse aggregate with a vague rim (left image) and view of a rough fractured surface (right image). 10x mag.



Thin-section, viewed in cross-polarized light illustrating generally dense paste containing a variety of lithologies as fine and coarse aggregates. 50x magnification, field of view 3 mm length.



Thin-section view in plane polarized light showing a very fine microcrack (red arrows) passing through the paste; 50x magnification, FOV 3 mm length.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Minor carbonation of paste and minor microcracking observed in paste.

Petrographer: ______________________ DATE: February 17, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

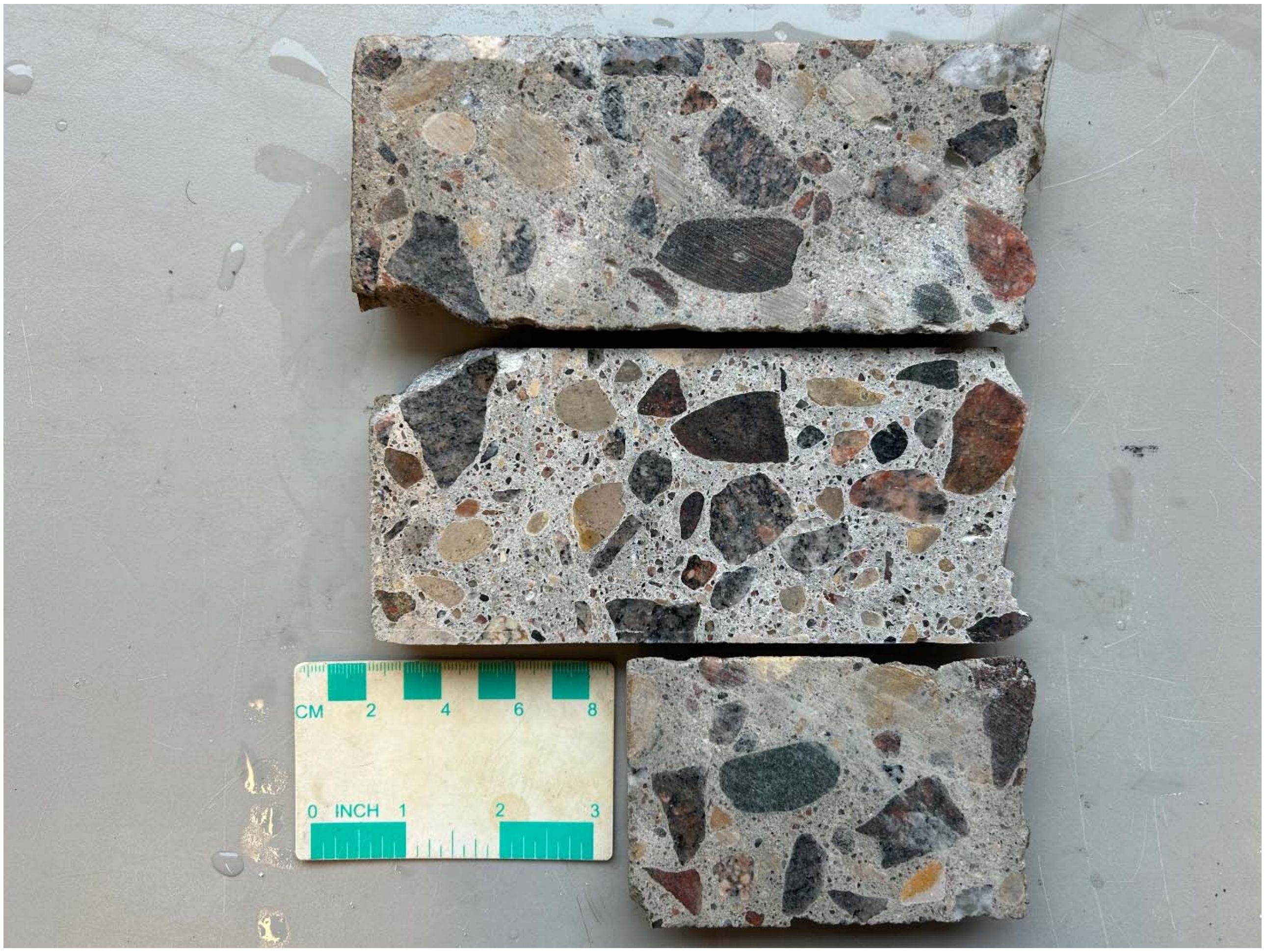
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 17, 2023

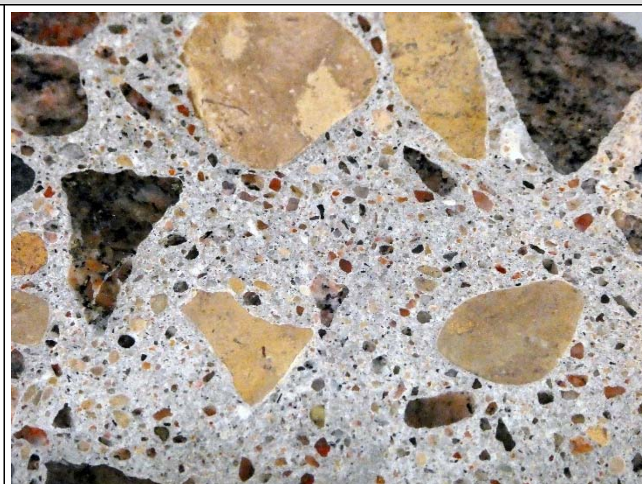
Attention: Mr. Kevin Hiraoka, CTech

PROJECT:	Lagimodiere Twin Overpasses	Sample	5472

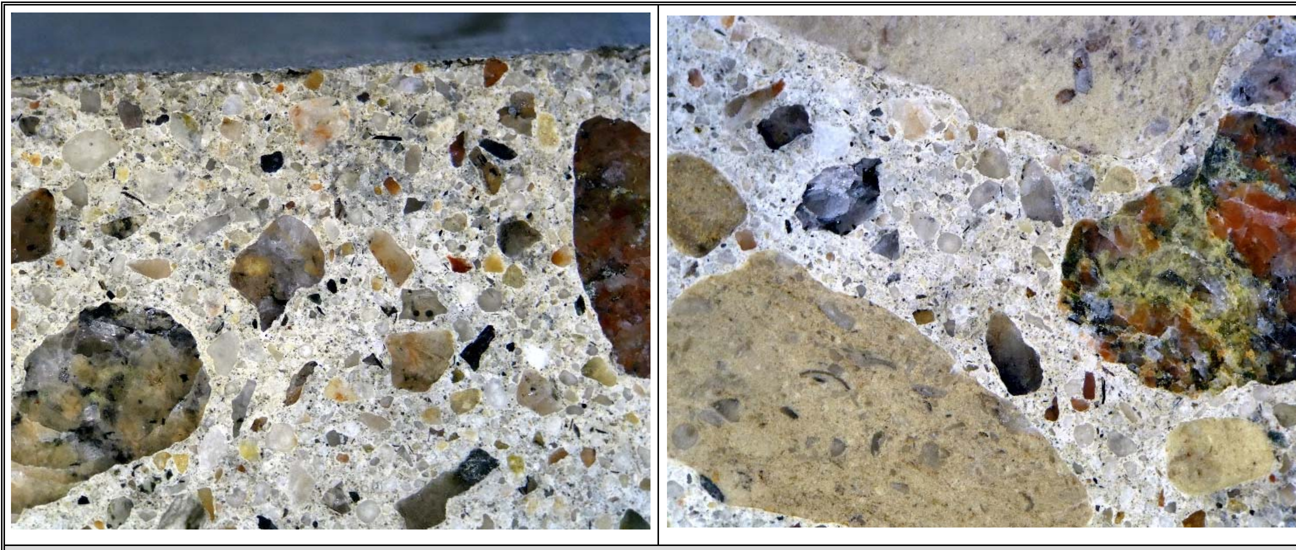
SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 157/172 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	28 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and hard / firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite. Minor crushed granitic rock is observed.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate. A few instances of coarse aggregate debonding from the paste were noted, and a few water bleed cavities adjacent aggregates.
Defects	A few water bleed cavities were observed adjacent aggregate particles. Instances of partial debonding of coarse aggregate from paste were also noted. Rare fine microcracks in paste; patches of carbonated paste.



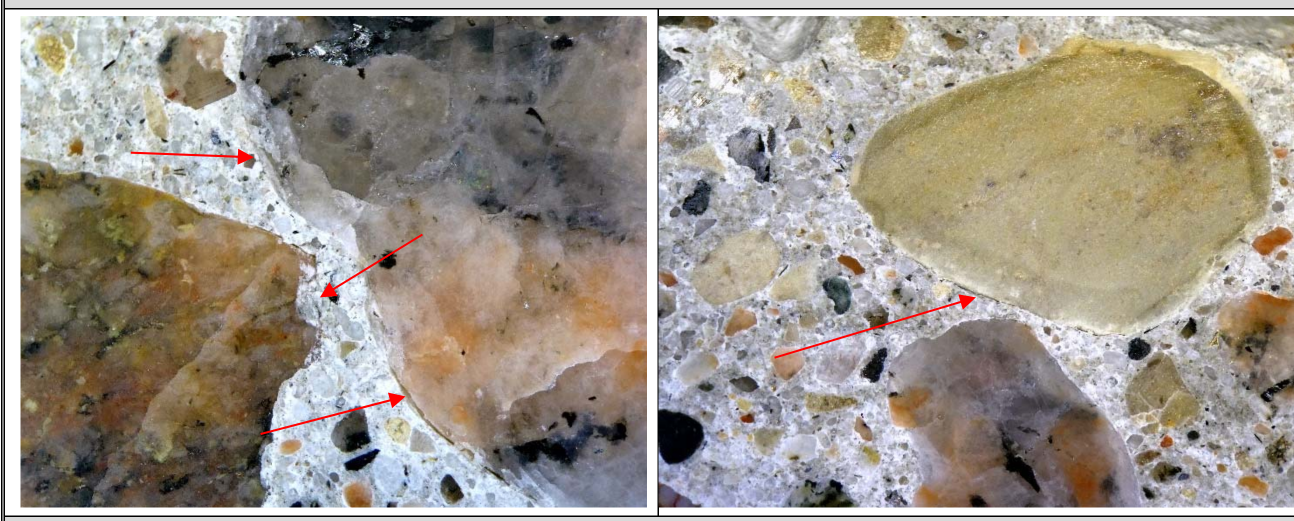
Core after cutting and polishing.



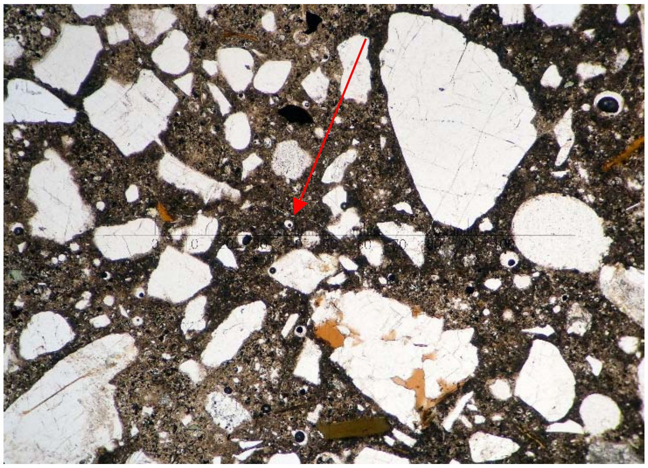
Detail views of the polished core surface, showing an array of granitic, gneissic, quartzite and carbonate coarse aggregates in paste. Fields of view about 90 mm.

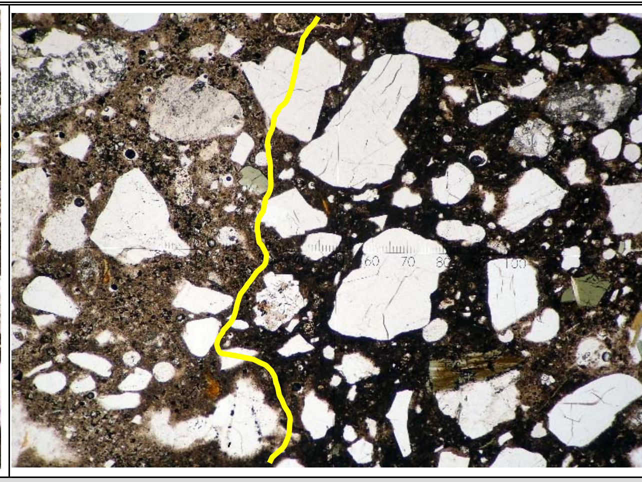


Views at 10x magnification showing profile at outer surface of core (left) and general view of paste and aggregates.. Fields of view about 13 mm.



Coarse aggregate particles are partly debonded (arrows) from the paste. 10x mag.





Thin section views, both in plane polarized light showing (left image) tiny microcrack (arrow) in paste and (right image) variegated paste represented by darker brown on right portion of image and contrasting light-medium brown paste in left portion of image. Both views at 50x magnification with fields of view of 3 mm in length.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. A few instances of water bleed cavities and of aggregate debonding were noted. Very minor microcracks in paste and patches of carbonate paste.

Petrographer: ______________________ DATE: February 17, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

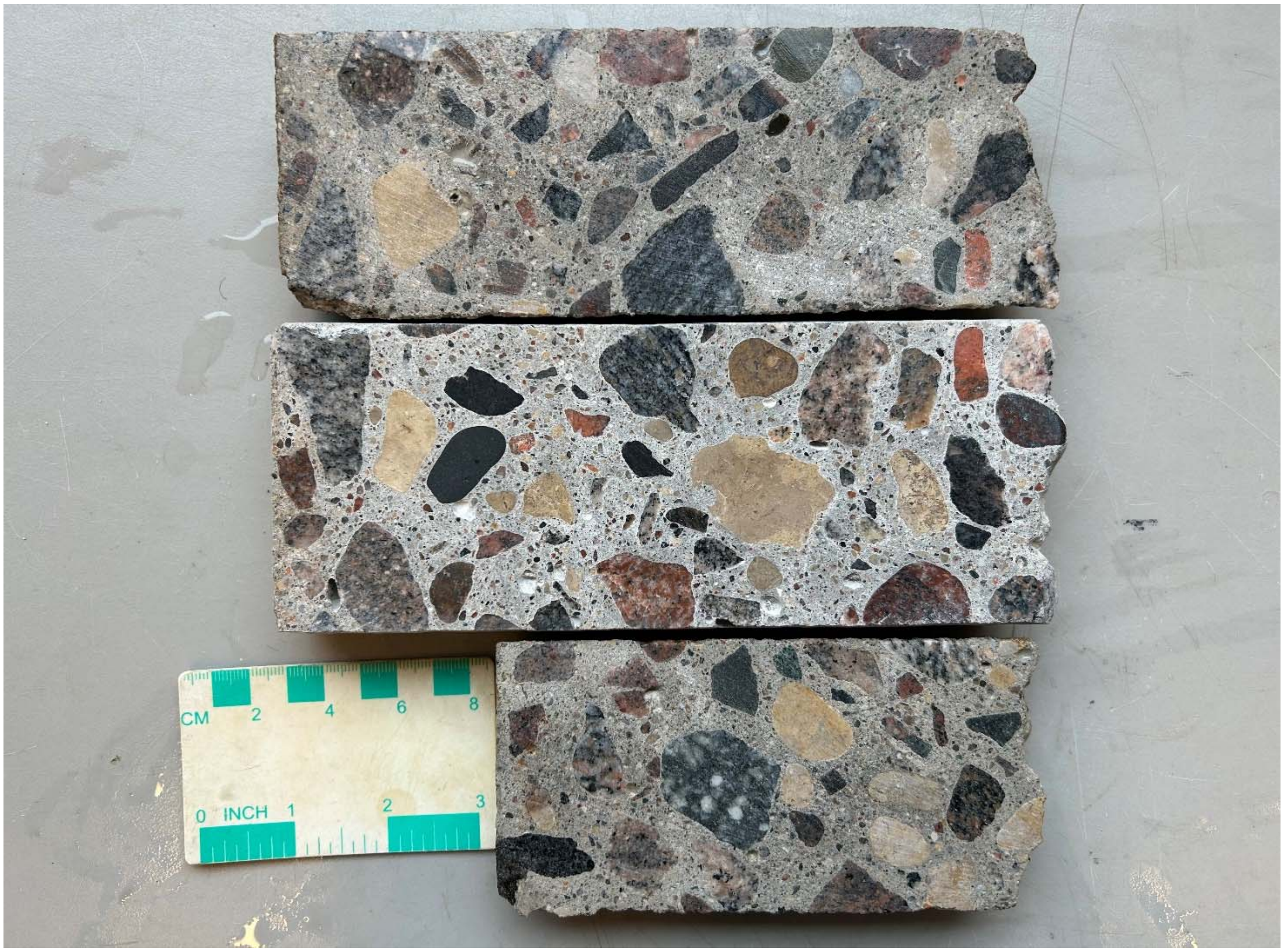
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 17, 2023

Attention: Mr. Kevin Hiraoka, CTech

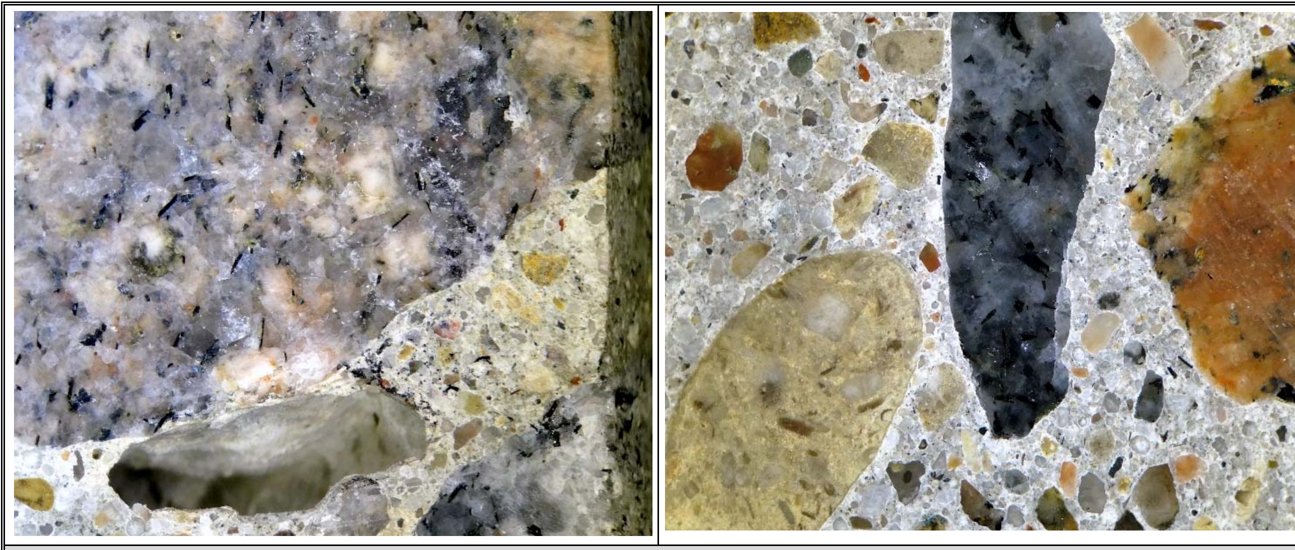
PROJECT:	**Lagimodiere Twin Overpasses, Pier S-2**	**Sample**	**5473**

SAMPLE TYPE – GENERAL	The core is 82 mm in diameter by 192/200 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	30 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and hard / firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite. Minor crushed granitic rock is observed.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	A few entrapped air voids were observed adjacent aggregate particles.

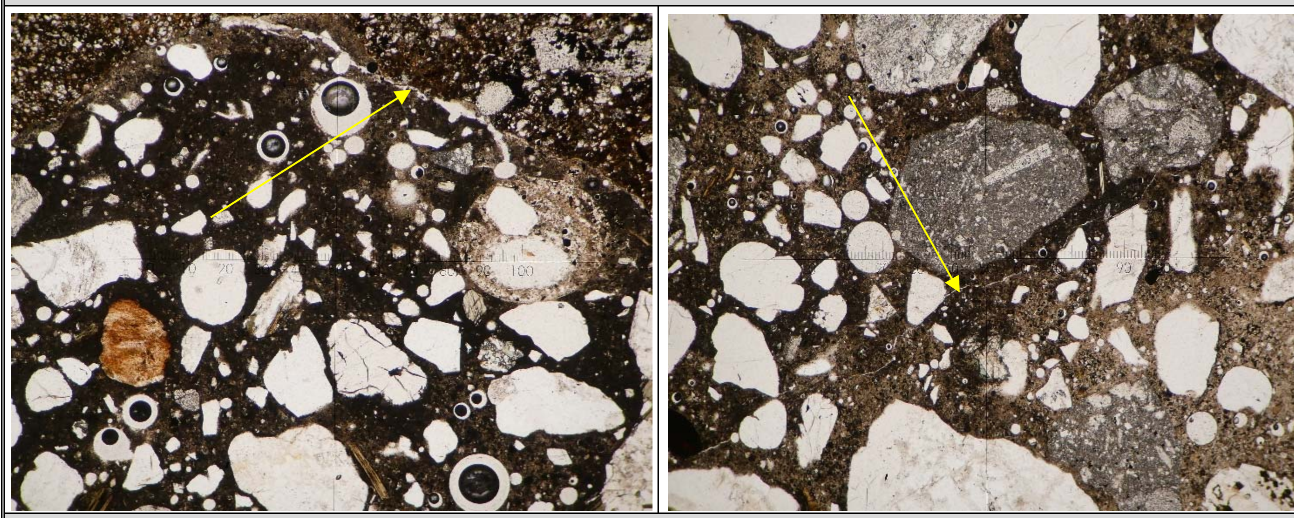


Core after cutting and polishing.

Left: Detail view of the polished core surface, showing granitic, gneissic, quartzite and carbonate coarse aggregates in paste. Right: Profile view at top of core, mag. 10x, field of view about 13 mm.



Views at 10x magnification showing entrapped air void adjacent gneiss coarse aggregate (left image) and general view of paste and aggregates. Fields of view about 13 mm.



Thin-section images showing fine and very fine microcracks in cement paste; 50x magnification.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. A few entrapped air cavities were observed. Rare fine microcracks in paste.

Petrographer: ______________________ DATE: February 17, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

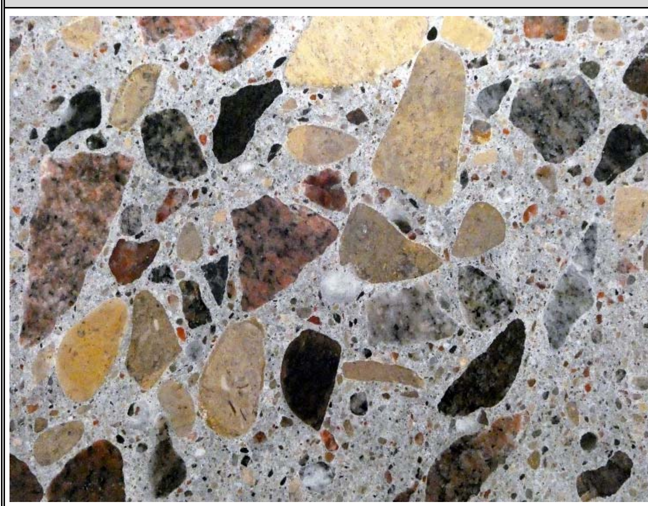
Project number: 20138844.13000
February 17, 2023

Attention: Mr. Kevin Hiraoka, CTech

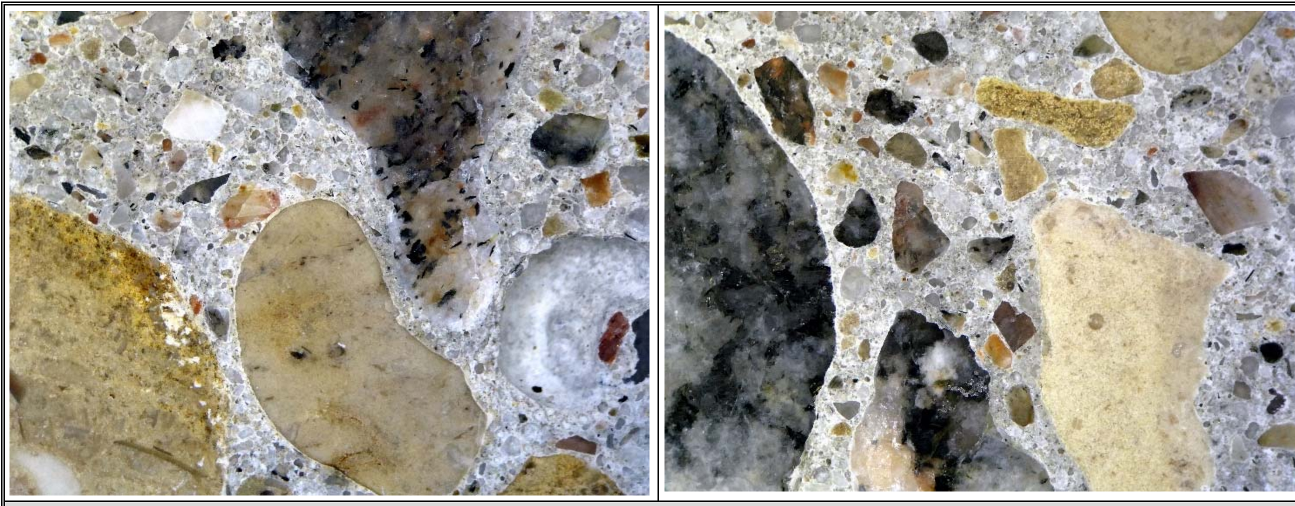
PROJECT:	**Lagimodiere Twin Overpasses, Pier S-3**	**Sample**	**5474**

SAMPLE TYPE – GENERAL	The core is 89 mm in diameter by 205/216 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	32 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and hard / firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite. Minor crushed granitic rock is observed.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	A few entrapped air voids were observed adjacent aggregate particles. Minor microcracks in paste.

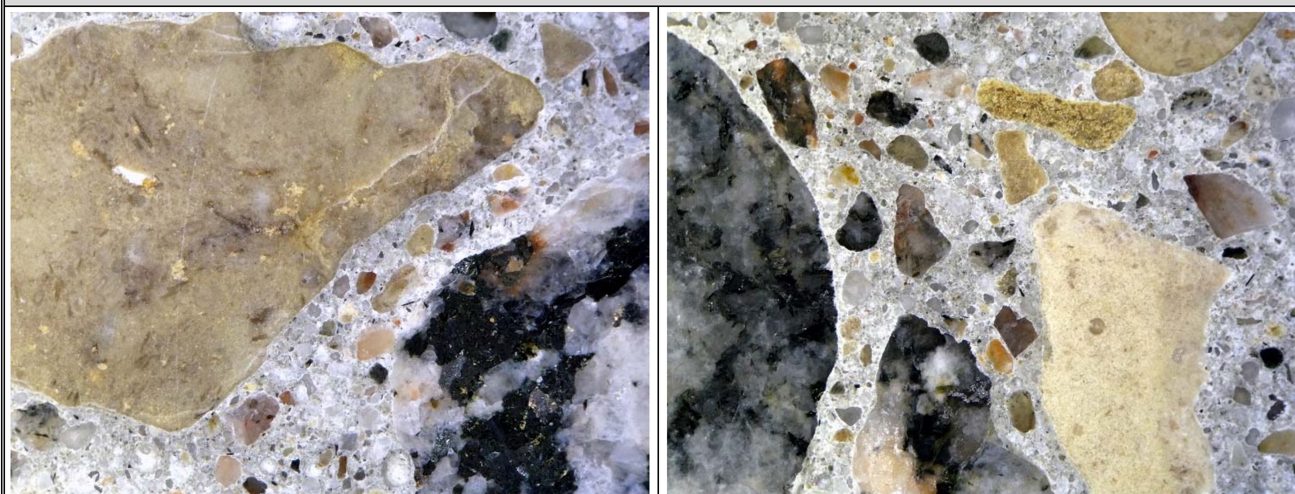
Core after cutting and polishing.



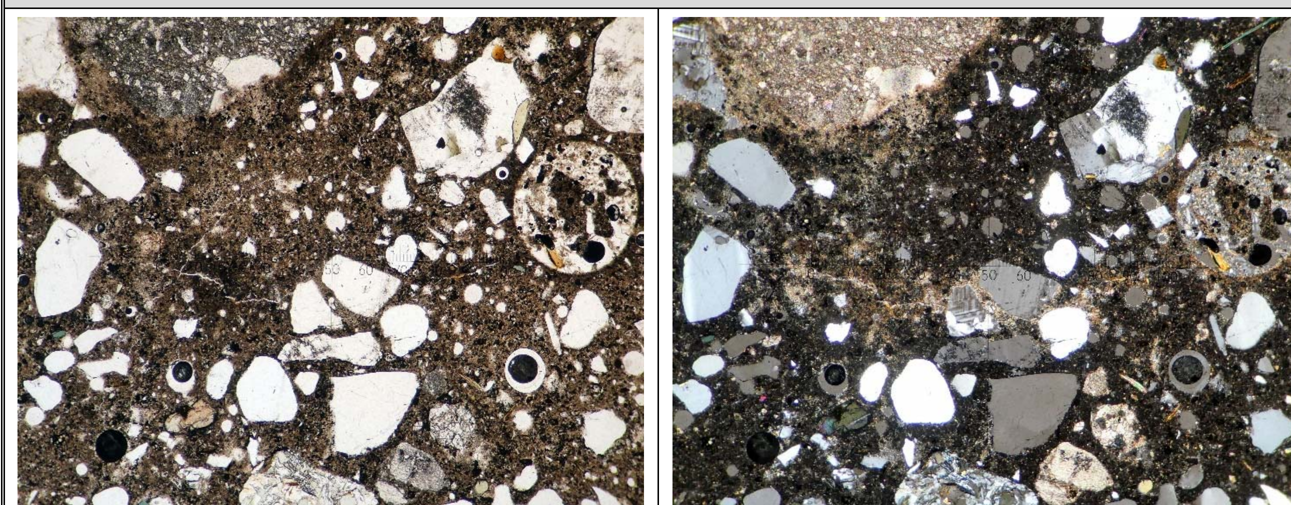
Left: Detail view of the polished core surface, showing granitic, gneissic, quartzite and carbonate coarse aggregates in paste. Right: Profile view at top of core, mag. 10x, field of view about 13 mm.



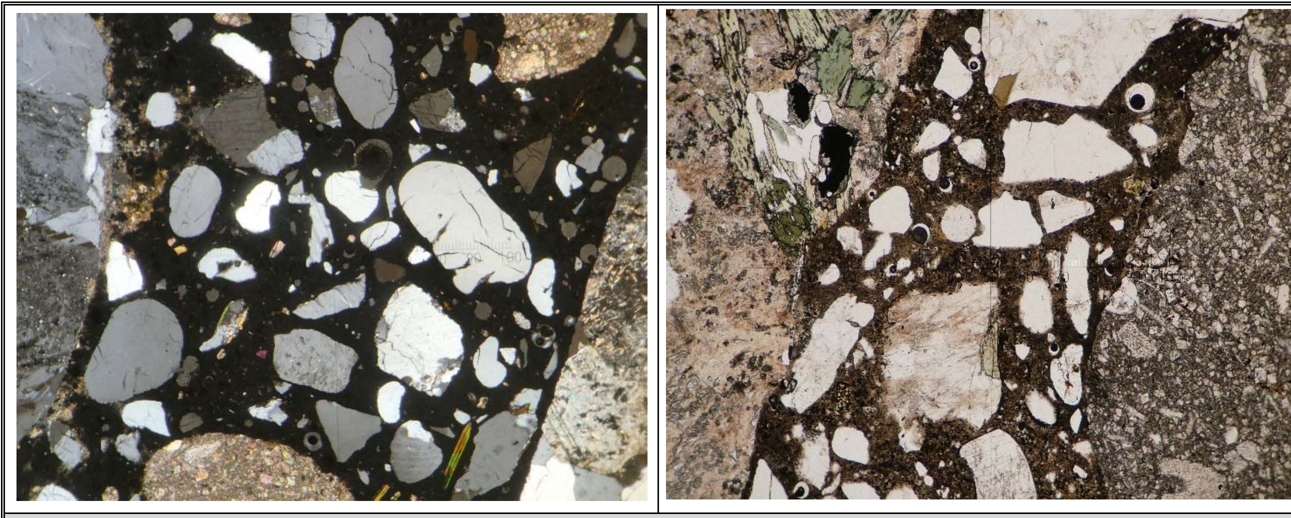
Views at 10x magnification showing entrapped air void at right end of left image, and a general view of paste and aggregates in the right image. Fields of view about 13 mm.



General views of the sample at 10x magnification.



‘Matched-pair’ images in thin section, viewed in plane- (left) and cross-polarized light (right) illustrating microcracks in the paste; 50x magnification FOV of 3 mm.



Thin-section images illustrate overall dense, good quality paste. 50x mag.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Paste density and quality are satisfactory. A few entrapped air voids were observed. Very minor microcracks observed in paste.

Petrographer: ______________________ DATE: February 17, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

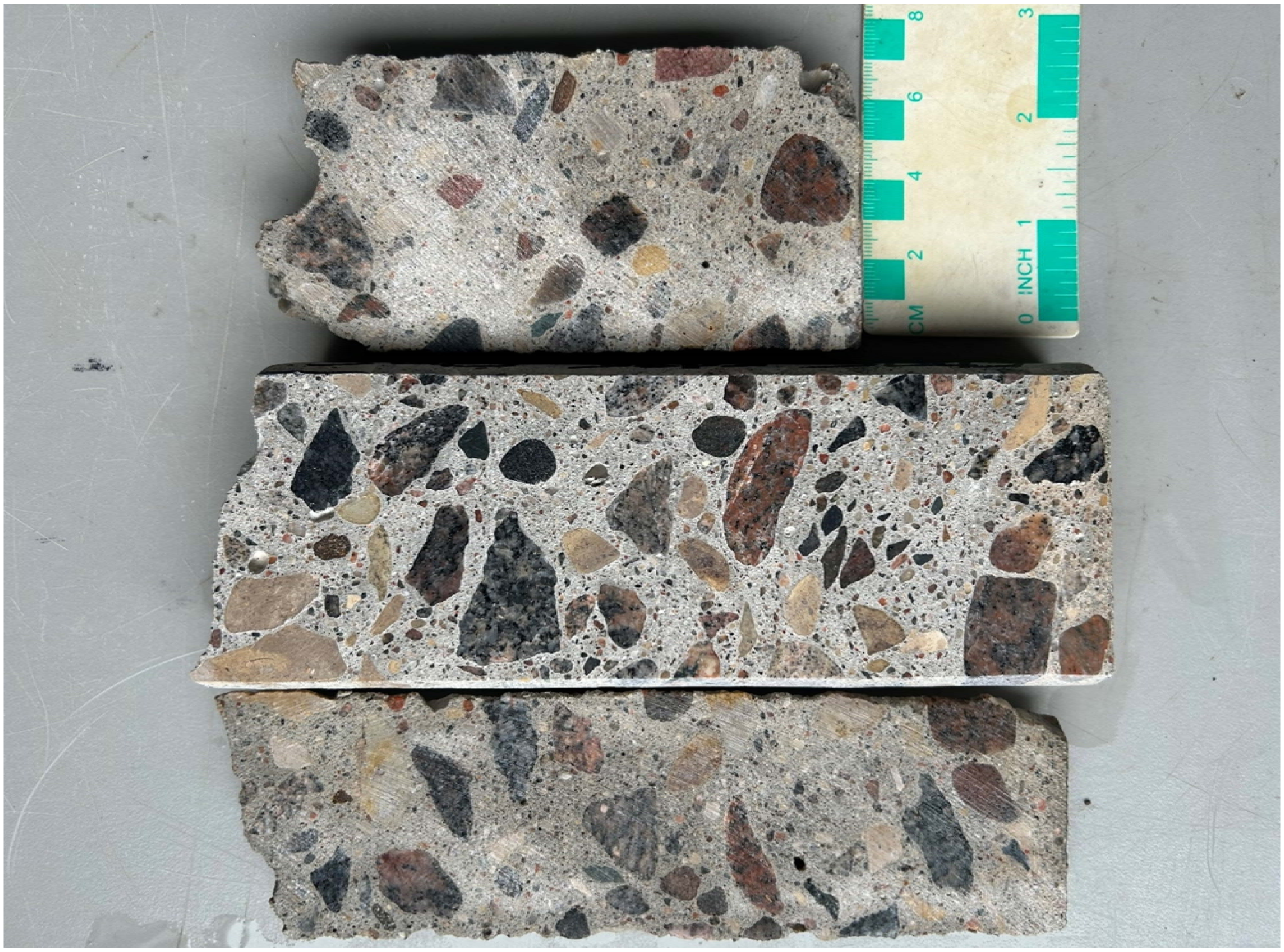
Stantec
199 Henlow Bay
Winnipeg, Manitoba
R3Y 1G4

Project number: 20138844.13000
February 17, 2023

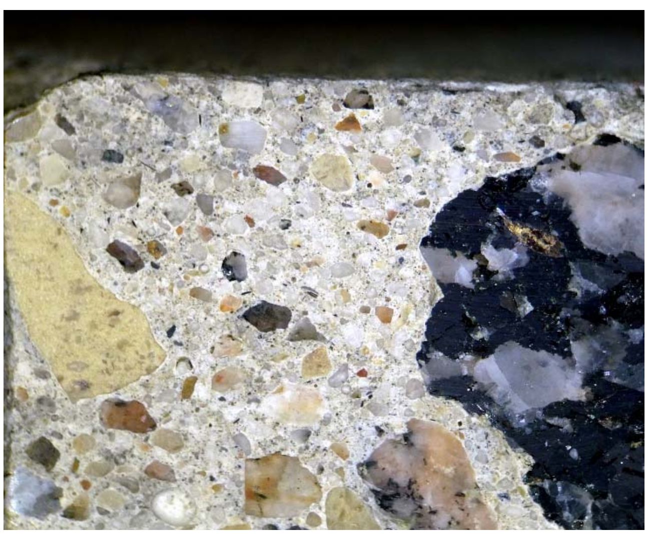
Attention: Mr. Kevin Hiraoka, CTech

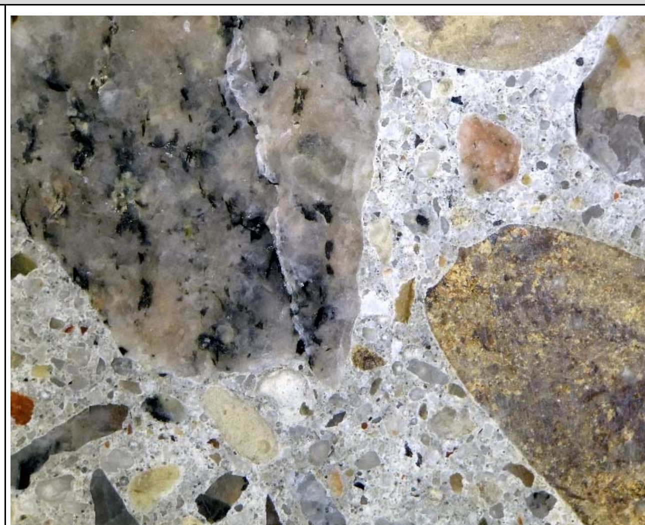
PROJECT:	Lagimodiere Twin Overpasses, Pier S-4	Sample	5475

SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 184/206 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	32 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and hard / firm.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite. Minor crushed granitic rock is observed.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	Minor discoloured paste (carbonated) at outer 10 mm of core. Minor microcracking and carbonation in localized zones.

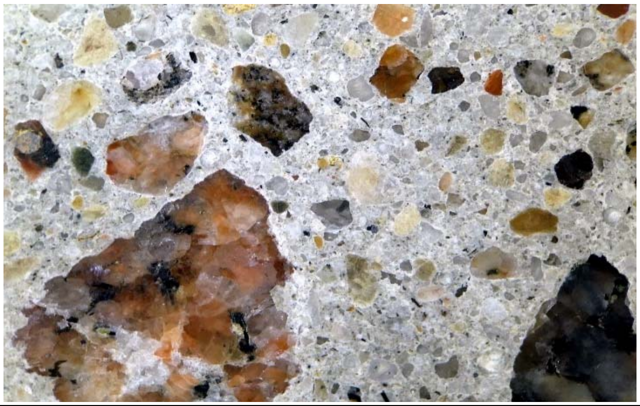


Core after cutting and polishing. Note slightly discoloured paste zone at far right in polished (centre) slab.



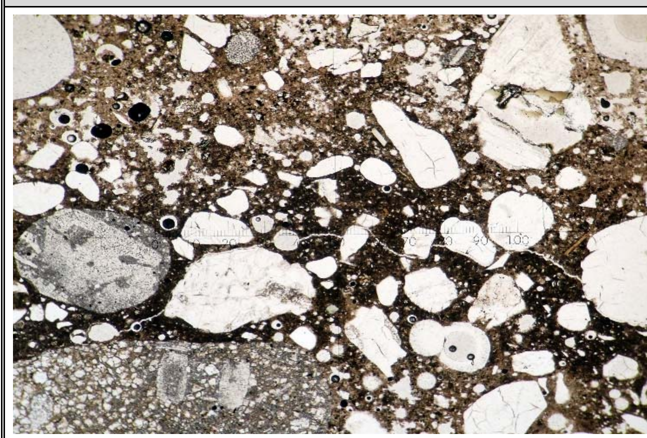
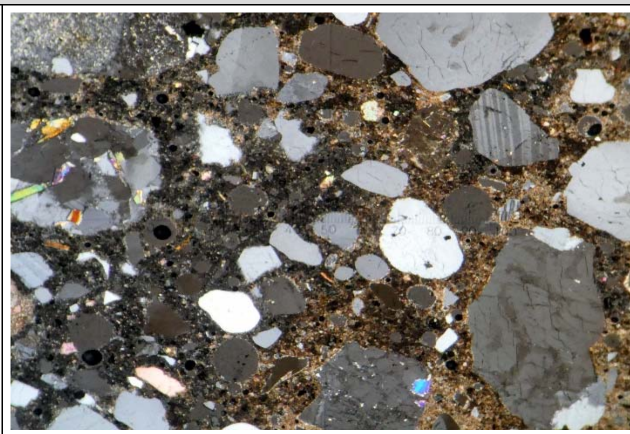


Left: Detail view of the polished core surface in profile. Right: gneiss and carbonate aggregate surrounded by dense paste. Both views at 10x magnification, field of view about 13 mm.




Views at 10x magnification illustrating general views of paste and aggregates. Fields of view about 13 mm.


General views of the sample at 10x magnification.

Crack in paste (left) and carbonated paste at right in right image, in thin-section. 50x magn., fov 3 mm

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Paste density and quality are satisfactory. Minor microcracking and carbonation observed in the paste.

Petrographer: ______________________ DATE: February 17, 2023
F. Shrimer, P. Geo.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE

ASTM C856-20

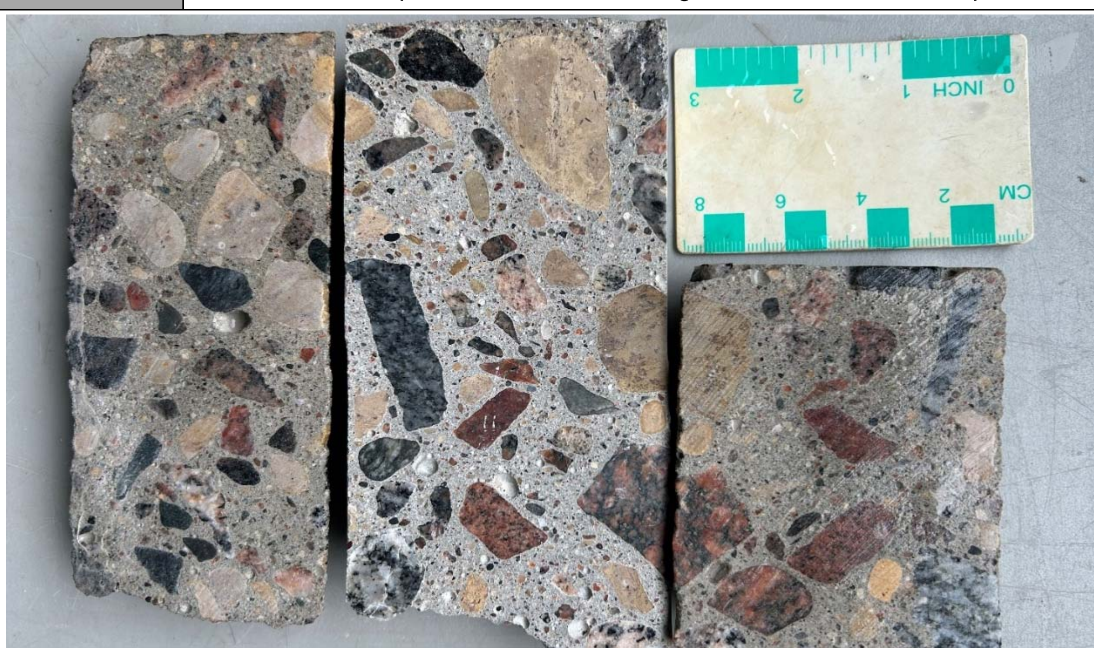
Stantec
199 Henlow Bay
Winnipeg, Manitoba R3Y 1G4

Project number: 20138844.13000
February 17, 2023

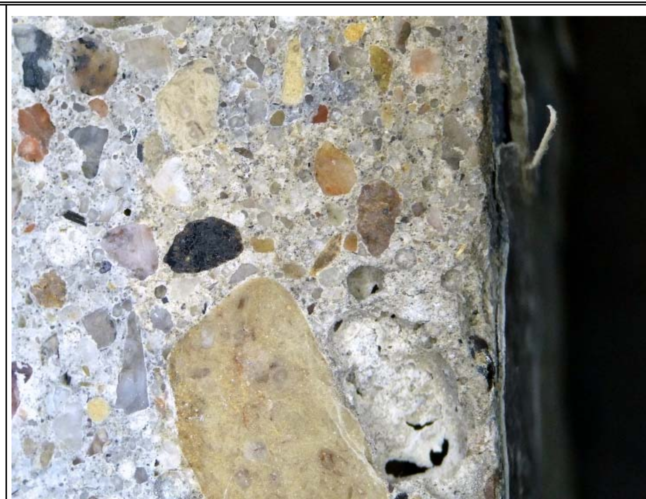
Attention: Mr. Kevin Hiraoka, CTech

PROJECT:	**Lagimodiere Twin Overpasses, Abutment S-5**	**Sample**	**5476**

SAMPLE TYPE – GENERAL	The core is 76 mm in diameter by 143/155 mm long. No reinforcing steel was observed. Paint coats the outer surface.
Aggregate maximum size	32 mm
Aggregate grading	Satisfactory
Concrete consolidation	Concrete is generally dense.
Cement paste	The paste is light cream/beige and hard / firm. Outer~12 mm of paste is discoloured to a brownish colour.
Coarse Aggregate	The coarse aggregate is composed of a fluvial (rounded) gravel of multiple lithologies, including limestone, dolomite, granite, gneiss and quartzite. Minor crushed granitic rock is observed.
Fine Aggregate	Fine aggregate is a natural sand composed of carbonates, granite, gneiss, quartzite, quartz, feldspar, biotite, garnet and other minerals.
Description	The concrete is well consolidated and generally exhibits good contact between paste and aggregate.
Defects	A few entrapped air voids were observed adjacent aggregate particles. Slight discolouration of paste at core's outer edge. Rare microcracks in paste.

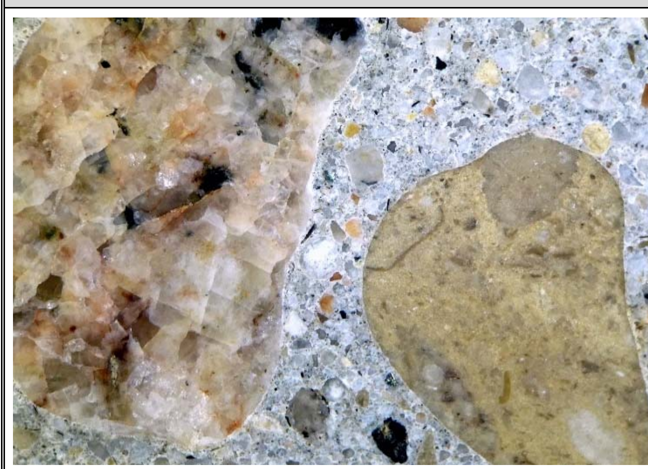


Core after cutting and polishing. Slightly discoloured paste is evident at outer surface, and appears as a slightly brownish layer.

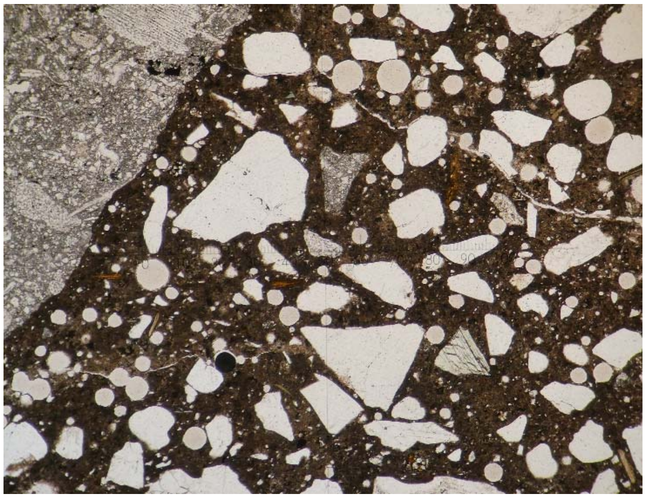


Left: Detail view of the polished core surface, showing granitic, gneissic, quartzite and carbonate coarse aggregates in paste. Field of view about 90 mm.
Right: Profile view at top of core showing paint debonded slightly and brownish discolouration of paste to about 8 mm in this view. Mag. 10x, field of view about 13 mm.

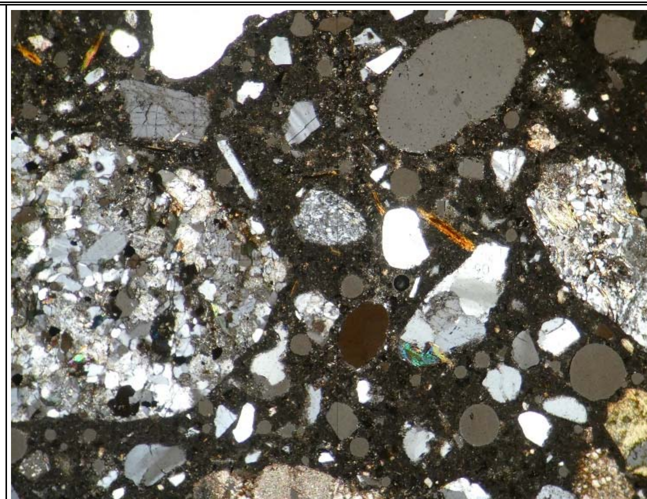
Views at 10x magnification showing entrapped air void; right image provides a general view of paste and aggregates. Fields of view about 13 mm.



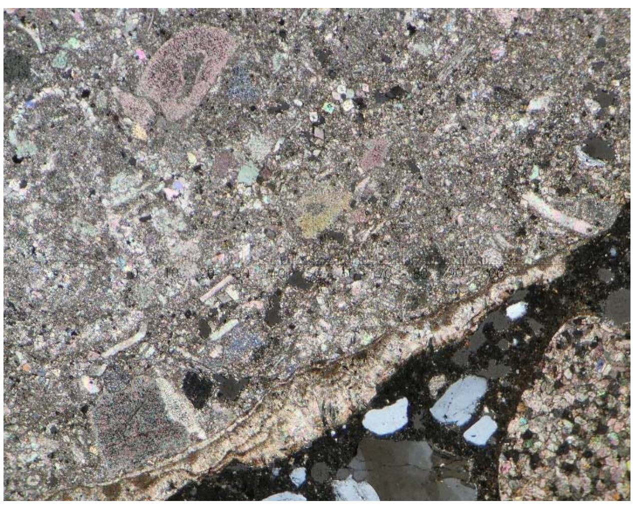
General views of the sample at 10x magnification.

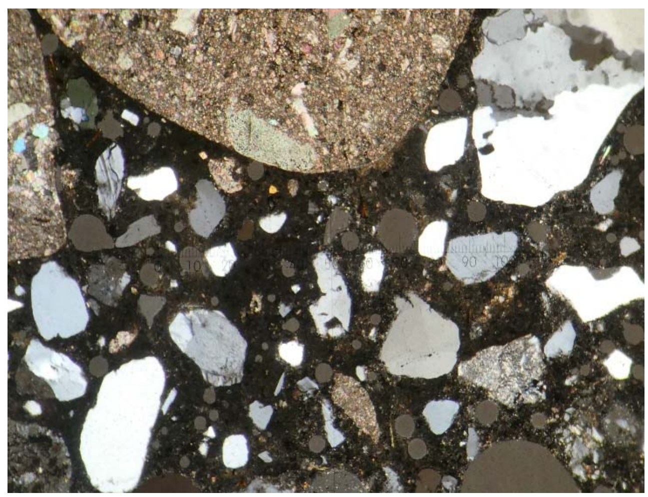


Microcrack in paste passes through the view, seen in thin-section. 50x magn.



Dense paste seen in this view in cross-polarized light. Note blade-like mica grains. 50x magn.





Two images in thin-section, viewed in cross-polarized light. Left image shows limestone coarse aggregate with encrusted layered calcite deposit, and right image illustrates dense paste. Both images at 50x magnification.

SUMMARY	Concrete is dense and well-consolidated. Paste encapsulation of fine and coarse aggregates is satisfactory. Paste density and quality are satisfactory. A few entrapped air voids were observed. Slight zone of discolouration is observed at the core's outer edge, about 10 – 14 mm deep. Rare microcracking observed in paste.

Petrographer: ______________________
F. Shrimer, P. Geo.

DATE: February 17, 2023

APPENDIX I

Photographs of Core Samples


Figure 1 – Sample No. 5465 - Petro


Figure 2 – Sample No. 5466 - Petro


Figure 3 – Sample No. 5467 - Petro


Figure 4 – Sample No. 5468 – Petro

Stantec


Figure 5 – Sample No. 5469 - Petro


Figure 6 – Sample No. 5470 - Petro


Figure 7 – Sample No. 5471 - Petro


Figure 8 - Sample No. 5472 - Petro


Figure 9 - Sample No. 5473 - Petro


Figure 10 - Sample No. 5474 - Petro


Figure 11 - Sample No. 5475 - Petro


Figure 12 - Sample No. 5476 - Petro

Figure 13 - Sample No. 5477 – Air Void

Figure 14 - Sample No. 5478 – Air Void

Figure 15 - Sample No. 5479 – Air Void

Figure 16 - Sample No. 5480 – Air Void


Figure 17 - Sample No. 5481 – Air Void


Figure 18 - Sample No. 5482 – Air Void


Figure 19 - Sample No. 5483 – Air Void


Figure 20 - Sample No. 5484 – Air Void

Figure 21 - Sample No. 5485 – Air Void

Figure 22 - Sample No. 5486 – Air Void

Figure 23 - Sample No. 5487 – Air Void

Figure 24 - Sample No. 5488 – Air Void

Figure 25 - Sample No. 5489 – Compressive Strength

Figure 26 - Sample No. 5490 – Compressive Strength

Figure 27 - Sample No. 5491 – Compressive Strength

Figure 28 - Sample No. 5492 – Compressive Strength


Figure 29 - Sample No. 5493 – Compressive Strength


Figure 30 - Sample No. 5494 – Compressive Strength


Figure 31 - Sample No. 5495 – Compressive Strength


Figure 32 - Sample No. 5496 – Compressive Strength

Figure 33 - Sample No. 5497 – Compressive Strength

Figure 34 - Sample No. 5498 – Compressive Strength

Figure 35 - Sample No. 5499 – Compressive Strength

Figure 36 - Sample No. 5500 – Compressive Strength

Figure 37 - Sample No. 5501 – Chloride Content

Figure 38 - Sample No. 5502 – Chloride Content

Figure 39 - Sample No. 5503 – Chloride Content

Figure 40 - Sample No. 5504 – Chloride Content


Figure 41 - Sample No. 5505 – Chloride Content


Figure 42 - Sample No. 5506 – Chloride Content


Figure 43 - Sample No. 5507 – Chloride Content


Figure 44 - Sample No. 5508 – Chloride Content

Figure 45 - Sample No. 5509 – Chloride Content

Figure 46 - Sample No. 5510 – Chloride Content

Figure 47 - Sample No. 5511 – Chloride Content

Figure 48 - Sample No. 5512 – Chloride Content


Figure 49 - Sample No. 5513 – Chloride Content


Figure 50 - Sample No. 5514 – Chloride Content


Figure 51 - Sample No. 5515 – Chloride Content


Figure 52 - Sample No. 5516 – Chloride Content

Figure 53 - Sample No. 5517 – Chloride Content

Figure 54 - Sample No. 5518 – Chloride Content

Figure 55 - Sample No. 5519 – Chloride Content

Figure 56 - Sample No. 5520 – Chloride Content


Figure 57 - Sample No. 5521 – Chloride Content


Figure 58 - Sample No. 5522 – Chloride Content


Figure 59 - Sample No. 5523 – Chloride Content


Figure 60 - Sample No. 5524 – Chloride Content

Figure 61 - Sample No. 5525 – Air Void

Figure 62 - Sample No. 5526 – Air Void

Figure 63 - Sample No. 5527 – Air Void

Figure 64 - Sample No. 5528 – Air Void

Figure 65 - Sample No. 5529 – Compressive Strength

Figure 66 - Sample No. 5530 – Compressive Strength

Figure 67 - Sample No. 5531 – Compressive Strength

Figure 68 - Sample No. 5532 – Compressive Strength

Figure 69 - Sample No. 5533 – Chloride Content

Figure 70 - Sample No. 5534 – Chloride Content

Figure 71 - Sample No. 5535 – Chloride Content

Figure 72 - Sample No. 5536 – Chloride Content

Figure 73 - Sample No. 5537 – Chloride Content

Figure 74 - Sample No. 5538 – Chloride Content

APPENDIX C

LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

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.

1.3 STANDARD OF CARE

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.