APPENDIX 'B'

CONDITION ASSESSMENT REPORTS

REPORT

DETAILED BRIDGE CONDITION SURVEY

Pembina Highway Bridge Over Abinojii Mikanah (Bishop Grandin)

(Site No. B-215)

Prepared by:

Presented to:

Matthew Hildebrand, P.Eng.
Consulting Contract Administrator
Public Works Department
City of Winnipeg, Manitoba
T: 204 986 3508 | E: JonathanMHildebrand@winnipeg.ca

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TABLE OF CONTENTS

Page

1. STRUCTURE IDENTIFICATION SHEET

GENERAL INFORMATION

STRUCTURE NAME Pembina Highway Overpass

SITE NUMBER B215 **DISTRICT NUMBER** N/A

HIGHWAY **above** Route 42 **below** Route 165

TYPE OF STRUCTURE Four spans, continuous, CIP concrete box superstructure

NUMBER OF SPANS 4

SPAN LENGTH (m) 20.0 / 25.0 / 22.8 / 19.0

ROADWAY WIDTH 15.50 & 23.17 m **YEAR BUILT** 1990

DIRECTION OF STRUCTURE South-North

SEQUENCE NUMBER N/A **TOWNSHIP NUMBER** N/A

LHRS NUMBER N/A **BRIDGE NUMBER (MUNIC.)** N/A

LOCATION N/A **JURISDICTION** City of Winnipeg

INSPECTORS NAME Troy Hengen, P. Eng.

PARTY MEMBERS N. Vialoux, A. Lazcano Perez, S. Faraz, A. Gilarski, A. Scott

DATE OF INSPECTION October 24 – November 3, 2023, and June 11-13, 2024

TEMPERATURE -5 to 1 °C (2023), 7 to 15°C (2024)

WEATHER Generally sunny with light snow (2023) and overcast to sunny and clear (2024)

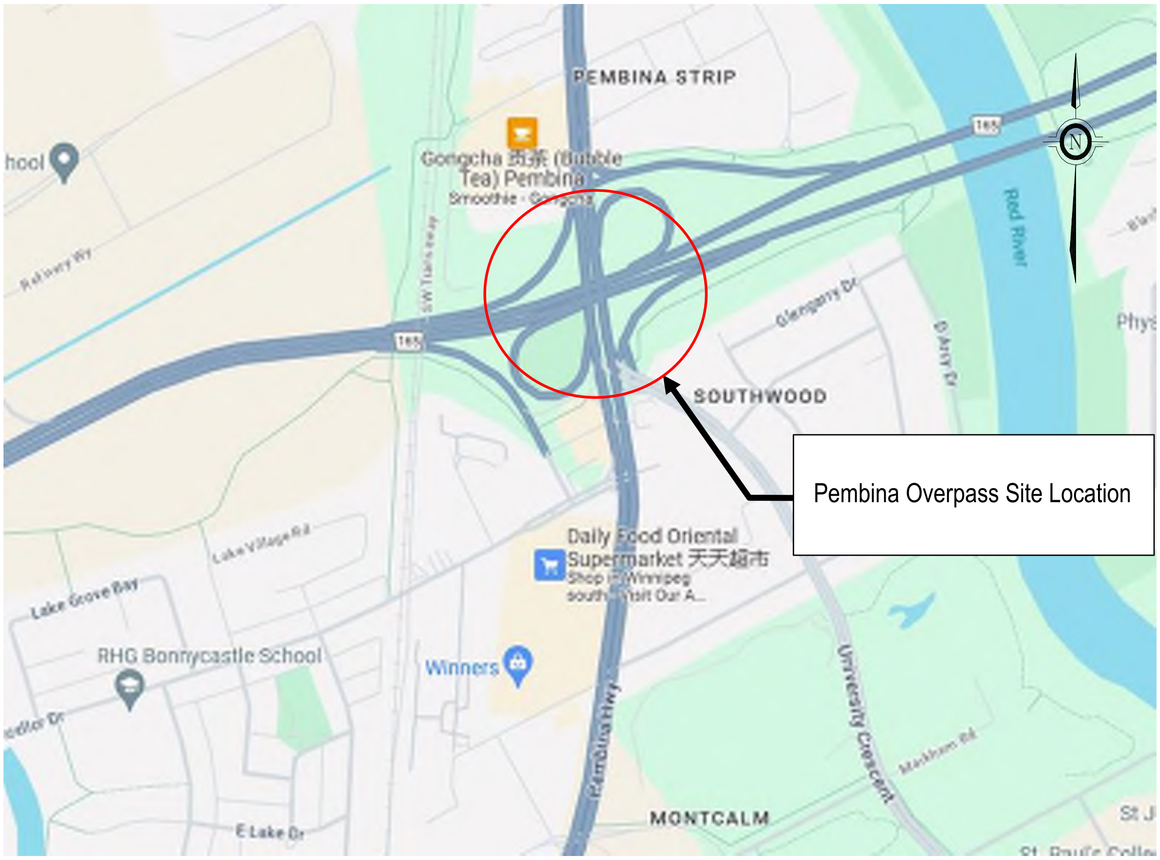
AADT 47900

DECK RIDING SURFACE Concrete

YEAR LAST REHABILITATED N/A

ENGINEER'S STAMP

2. KEY PLAN


PEMBINA STRIP
Gongcha 茶 (Bubble Tea) Pembina
165
SOUTHWOOD
Glengarry Dr
D'Arcy Dr
Red River
N
Pembina Overpass Site Location
Daily Food Oriental Supermarket 天天超市
Lake Village Rd
Lake Grove Bay
RHG Bonnycastle School
Winners
Pembina Hwy
University Crescent
Markham Rd
MONTCALM
E Lake Dr
Railway Wy
SW Transitway

3. SUMMARY OF SIGNIFICANT FINDINGS

3.1 Description of Structure

The Pembina Highway Overpass was originally constructed in 1990 and is 33 years old. The bridge carries the northbound and southbound lanes of Pembina Highway (Route 42) over Abinojii Mikanah, formerly known as Bishop Grandin Blvd. (Route 165). The intersection of Pembina Highway (Pembina) and Abinojii Mikanah (Abinojii), with University Crescent at the southeast corner of the interchange, is one of the busiest and most complex intersections in the City of Winnipeg, with an average of approximately 60,000 vehicles per weekday.

The existing concrete bridge is skewed ±12°, is approximately 47 m wide and 87 m long, and has 10 lanes of traffic (six in the southbound direction and four in the northbound direction), with a four metre wide concrete median curb. The bridge is a four-span continuous structure comprised of a cast-in-place concrete multi-cell box deck with a 140 mm high-density concrete overlay on the box girder top slab and is supported on concrete abutments and piers founded on precast prestressed concrete piles. The bridge currently has 1.53 m sidewalks on both the northbound and southbound sides of the bridge.

The maintenance history of the Pembina Highway Overpass includes an extensive maintenance program in 2014 to repair the delaminated concrete on the deck and median curb. Additionally, a bridge deck investigation was performed in 2017 / 2018 by others to determine the condition of the deck, and short-term repairs noted during this investigation were carried out in 2018. In 2020, slope stabilization works, including rockfill rib construction and trench drain construction, were completed in the intersection's southwest corner.

General views of the bridge deck are shown in **Appendix G** – OSIM Report and **Appendix H** – Condition Survey Photos.

3.2 Scope of Assessment

The current detailed condition survey was completed as part of a preliminary design assignment for rehabilitation of the structure. The scope of the assessment included:

- An OSIM inspection of the entire structure.
- Visual inspection of four overhead sign structures (OHSSs) in the vicinity of the bridge.
- Detailed Condition Assessment of the bridge deck, approach slabs, abutments and piers, including the following assessment work activities:
  - Surface defects / delamination survey – on the bridge deck / approach slabs, soffit, abutments, and piers.
  - Rebar cover survey – on the approach slabs, abutments, and piers.
  - Investigation of the condition inside the concrete box girder superstructure using a borescope camera and through deck coring.
  - Destructive testing program, including extraction of cores and rapid chloride testing (RCT).
    - Cores were extracted from the bridge deck, approach slabs, abutments, and piers for the following concrete tests:
      - Compressive strength, air void analysis, rapid chloride ion penetrability, acid soluble chloride content, petrographic analysis, and pH content
    - RCT samples were extracted from the bridge deck, approach slabs, abutments, piers, slope paving, and the exterior face of girder superstructure.

Appendix I contains the Detailed Condition Survey Drawings, showing all key assessment findings, including surface defect mapping, delamination survey findings, cover survey measurements, core and RCT sample locations.

Photo documentation of the assessment and photos of the structure's condition are in **Appendix G** (OSIM Report) and **Appendix H** (Condition Assessment Photos).

3.3 Concrete Deck Slab

Refer to Drawing 1 in **Appendix I** for detailed condition survey observations on the deck surface and approach slabs. The thickness of the concrete deck shown on the drawings is 240 mm, comprised of 100 mm of the box girder top slab concrete (maximum dimension) and 140 mm of high-density overlay (HDO) concrete (minimum dimension) as per Sheet 3 of the rehabilitation drawings. No wearing surface was noted to be present on the bridge deck and the assessment was completed based on the bridge deck being exposed concrete construction.

Coring Program Observations Findings

A total of 29 cores were taken on the exposed concrete bridge deck (14 cores on the northbound lanes and 15 cores on the southbound lanes). The distribution of cores taken was three (3) x 50 mm diameter cores, 17 x 75 mm diameter cores, and nine (9) x 100 mm diameter cores. The cores were distributed evenly across the deck areas in both lane directions, with core locations distributed to represent all spans and the full width of both lane directions. The following table provides a summary of the depth at which the cores were taken, whether rebar was hit in the top or bottom mat, and the noted condition of the rebar and rebar epoxy coating.

Deck Core Summary Table

	HDO Layer Cores (<140 mm)	HDO and Girder Top Concrete (>140mm, <250mm)	Full Depth Deck Core (250 mm +/-)	Top Mat Rebar Hit in Core and Rebar Conditon		Bottom Mat Rebar Hit in Core and Rebar Condition	
	Core #	Core #	Core #	Core #	Rebar Cond.	Core #	Rebar Cond.
	D3	D1	D5	D5	Good	D1	Good
	D7	D2	D6	D7	Good	D5	Good
	D22	D4	D12	D10	Good	D8	Good w/ coating fail
		D8	D14	D14	Good	D9	Good
		D9	D15	D17	Good	D11	Good
		D10	D18	D19A	Good	D12	Good
		D11	D19A	D20	Good w/ coating fail	D13	Good
		D13	D26	D21	Good w/ coating fail	D16	Good
		D16	D28	D22	Good	D17	Good
		D17	D30			D18	Good
		D19				D19A	Good
		D20				D24	Good
		D21				D26	Good w/ coating fail
		D23				D27	Good w/ coating fail
		D24				D28	Good
		D27				D29	Good
		D29				D30	Good
Totals	3	17	10	9		17	

Note D15 core fell through deck.

17 of 29 cores extracted were noted to be unfractured through core depth; however, it is noted that not all unfractured cores were taken to full depth and/or to the level of the interface between the two deck layers (e.g., D3, D7, and D22). The following cores were noted to be not fractured upon retrieval:

- 50 mm diameter – D9
- 75 mm diameter – D1, 2, 6, 14, 17, 22, 27
- 100 mm diameter – D3, 4, 7, 12, 13, 18, 24, 28, 29
    - Note that the D24 core broke at the top of the core during retrieval.

12 of 29 cores extracted were noted to be fractured upon retrieval. Again, not all cores were taken full depth; however, the majority of the cores that were found to be fractured were taken below the HDO level and were fractured at the interface between the two concrete layers:

- 50 mm diameter – D10 and D11 (two of three total 50 mm cores extracted)

- D10 – broke 90 mm from top
- D11 – broke at 90 mm, 150 mm, 180 mm, and 200 from top.

- 75 mm diameter – D5, D8, D16, D19, D19A, D20, D21, D23, D26, and D30 (10 of 17 total 75 mm cores extracted). Note no rebar was found at the core break interfaces (which can cause cores to fracture on retrieval) except in core D20. The frequency of fracture occurrence versus depth of the fracture in the core are as follows:

Depth of Fracture from Top of Core	Number of Fractured Cores Noted
80 mm	1 of 10 cores
100–110 mm	2 of 10 cores
130-160 mm	7 of 10 cores

- No 100 mm diameter cores were fractured.

The majority of cores that fractured during coring were found to break at 80 mm – 110 mm and 130 mm – 160 mm from the deck top, which corresponds to the approximate level of the top mat of rebar and at the interface between the HDO and the girder top slab concrete layers. No cracks were observed in the core holes at the locations of the fractured cores as seen in cores taken through delaminated concrete locations. Cores D5, D26, and D30 were noted to have a striated / lined pattern at the fracture interface, which is the interface between the two deck concrete layers and is anticipated to be the rake finish placed on the top of the box girder top flange.

No cores were intentionally taken at visible cracks on the deck top so that extracted samples would be usable for testing. Test pits taken in the most recent previous condition assessment (by others) investigated at the crack location and showed the impacts of water / chloride ingress to rebar coating condition and shallow delaminations that occurred on the deck.

Cracking

Extensive narrow to wide transverse cracking was noted throughout the deck area, with the most notable cracking occurring over the piers in negative moment regions. Similar transverse cracking, although not as severe / extensive as noted at the piers' negative moment regions, was also noted in the girder positive moment areas. Localized longitudinal cracking in both lane directions was typically located in the two traffic lanes adjacent to the median in each lane direction. The deck cracking appears predominantly related to top mat reinforcing design with respect to serviceability limits.

Epoxy Rebar Coating Condition

The bridge deck has epoxy coated rebar in its top and bottom rebar mats; therefore, a standard corrosion potential survey could not be completed. MH and the City discussed prior to the condition assessment field work that the assessment of rebar corrosion would be completed by through a comprehensive RCT and concrete core testing program to determine chloride contents and review the rebar condition as noted during the coring program. Test pits were not completed as part of the current assessment, as test pit investigations were completed as part of the 2017 condition assessment (completed by others). The epoxy-coated rebar modified corrosion potential assessment method stated in OSRM was decided to not to be completed as the proposed chloride content and coring program would provide similar information for assessment of the epoxy rebar coating.

The top mat epoxy rebar coating condition varied and was noted to be in poor condition on select cores. It is anticipated to be deteriorating, particularly near crack locations, based on current and previous condition assessment findings (e.g., 2017 test pit results).

The top mat epoxy-coated rebar appears to be in varying degrees of condition, ranging from good to failed / debonded. As per the chloride content test results, it is noted that four of 16 of RCT samples and one of four acid soluble chloride core tests found that the chloride content was above 0.09% by mass of concrete at the deck rebar top mat level (e.g., the City's determined threshold for the corrosion in epoxy-coated rebar). Due to the variability of the condition of the epoxy coating rebar and the determined chloride content, it is anticipated that active corrosion is likely to be occurring in the top mat rebar, particularly in areas with noted deck cracking, due to the epoxy coating deterioration from water and chloride ingress. Epoxy coating on rebar is anticipated to be deteriorated or failing at deck concrete cracking locations, which are prevalent throughout the deck surface, indicating a significant portion of the deck area may have deteriorated top mat rebar epoxy coating condition.

Conversely, the epoxy coating on the bottom mat rebar encountered during full depth coring was found to be in generally good condition, with select cores (three of 17 cores) having epoxy coating deterioration noted, and the chloride contents in the bottom layer of the deck were found to indicate low to limited chlorides in the girder top concrete layer (e.g., bottom 100 mm of deck). The bottom layer concrete condition assessment is also supported by the findings from the assessment of the girder interiors / stay in place (SIP) formwork condition assessment (see Section 3.4 for expanded details).

Delaminations

Extensive delaminated areas were noted throughout the deck area that ranged in size from 0.3 m x 0.3 m to 0.9 m x 0.9 m. Depth of delamination sounded as though delaminations were shallow; this may due to actual shallow delaminations being present and also cores partially becoming cracked or debonded deeper in deck section based on deck coring observations, e.g. at or approaching the HDO / box girder top concrete layers

interface. Shallow delaminations were noted during the 2017 condition assessment test pit investigations and several cores were noted to have broken at 100 mm and 130 mm – 150 mm from deck top as per the coring investigation, which support the previous assessment statements.

Delaminations were concentrated over pier locations but were also noted between piers (e.g. in positive bending moment superstructure areas). Delaminations were noted to be present between maintenance patches but not surrounding the patches themselves, which is an indication the patches are not causing “halo” corrosion effects.

No corrosion to light corrosion was noted in top mat rebar from cores extracted during the current assessment; however, crack locations were generally avoided as the condition below cracks was assessed in a previous condition assessment (by others). As per the 2017 condition assessment report (by others), the epoxy coating at crack locations was deteriorated due to water / chloride ingress, and corrosion was occurring. Main contributing factors to the delaminations are surmised to include:

1. Corrosion in areas of rebar epoxy coating deterioration, e.g. at or near deck top cracking.
2. Serviceability limits cracking due to design of deck top mat rebar, which are noted to not meet current bridge design code deck crack control criteria.

Delaminations at or below the top rebar mat may be too deep to detect delamination with standard acoustic sounding methods used during the condition assessment, e.g. chain drags and rotary delamination tools. The average deck rebar cover in the 2017 condition assessment was 75 mm – 80 mm.

The deck delamination survey on the southbound lanes gutter was unable to be completed in the westmost 1 m – 1.5 m of the deck due to snow cover at time of the assessment field work. The majority of the deck area was able to have a delamination survey completed.

Maintenance Patching

Extensive maintenance patching was noted throughout both lanes, with the higher amounts of patching located in the negative moment areas over the piers. The majority of maintenance patches were noted to be bonded well to the substrate concrete based on delamination survey findings. It is noted that core locations were selected to not go through maintenance patches to obtain samples of the original high density overlay concrete and the top of box girder concrete. Delaminations were noted to be present between maintenance patches but not surrounding the patches themselves, which is an indication the patches are not caused “halo” corrosion effects. MH understands that previous maintenance programs completed by the City used galvanic anodes to reduce / slow potential rebar corrosion at patching areas.

Deck Concrete Cover

A deck concrete cover survey was not completed during the current condition assessment. Deck concrete cover was noted to be an average of 78 mm depth with a standard deviation of 11 mm in the previous condition assessment completed in 2017 by others. The cover reading values are deemed to be in accordance with the specified design cover 75 mm ± 5 mm from the original construction drawings for the deck top construction.

Deck Material Testing Results

Compressive Strength

Concrete compressive strength was measured in ten cores with a testing distribution in the below stated deck concrete layers:

- Both deck concrete layers tested together - Cores D1 and D7. Note these cores were tested with concrete from both deck layers due to challenges obtaining cores from the bottom half of the deck that did not contain rebar.
- HDO Concrete Only – Cores D8, D19, D21, and D23.
- Girder Top Flange Concrete Only – D6, D14, D17, and D19.

A summary showing the breakdown of compressive strength test results by deck layer(s) tested is shown in the below table, including average, minimum, and maximum test result strengths.

The specified minimum concrete compressive strength of the HDO concrete and girder concrete is 30 MPa, as shown on Sheet No. 2 of the 1988 original construction drawings. The design's compressive strength appears to be met based on the cores tested as part of the assessment.

	Deck Compressive Strength Summary (MPa)			
	All Cores	Both Layers Tested	HDO Layer Tested	Girder Top Flange Layer Tested
Minimum	33.3	50.6	33.3	43.5
Maximum	63.5	57.3	63.5	61.8
Average	50.9	54.0	44.4	55.9
No. of Cores Tested	10	2	4	4

Air Void Analysis (AVA)

Three cores were tested in total for AVA (D5, D19A, and D29); all three cores tested were in the girder top flange layer concrete. A summary showing the breakdown of AVA test results is shown in the below table, including average, minimum, and maximum test results. The original design air concrete in the deck concrete is 5 – 7% for the girder top flange and 5.5 to 7.5% for the HDO based on the original construction

specifications (SP 16.3.2 and SP 17.4.4). The CSA limits for frost resistant concrete are included in the table below for reference and are met based on the deck core samples tested.

Air Void Analysis Summary Girder Top Flange Layer Tested Only				
	Total Air Content (%)	**Specific Surface (mm-1)**	**Paste Content (%)**	**Spacing Factor (um)**
Minimum	4.5	30.9	29.1	122.0
Maximum	6.3	44.1	36.2	154.0
Average	5.5	36.3	32.1	139.0
CSA Limits for Frost Resistant Concrete	3.0 min.	---	---	230 max average

Chloride Content

Chloride content was measured on four deck cores (D9, D11, D27, and D30) and 16 deck RCT sample locations (RCT Sample Nos. 3, 4, 5, 6, 9, 10, 11, 12, 24, 25, 26, 27, 30, 31, 32, and 33). Detailed chloride content information is presented in **Appendix J**. Excerpts of the deck RCT and concrete core chloride content testing summaries from **Appendix J** are shown below.

DECK TOP RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)							
RCT SAMPLE LOCATION		TEST DEPTH (mm)					
No.	Lane Dir.	5 - 20	40 - 60	70 - 90	120 - 140	150 - 170	190 - 210
3	NB	0.528	0.395	0.186	0.005	0.001	0.000
4	NB	0.560	0.144	0.014	0.000	0.000	0.034
5	NB	0.418	0.138	0.006	0.000	0.000	--
6	NB	0.383	0.070	0.000	0.000	0.000	0.000
9	NB	0.558	0.236	0.098	0.000	0.002	0.002
10	NB	0.442	0.138	0.014	0.004	0.000	0.051
11	NB	0.629	0.212	0.029	0.000	0.000	0.029
12	NB	0.385	0.053	0.000	0.000	0.000	0.000
24	SB	0.416	0.216	0.060	0.003	0.002	0.003
25	SB	0.596	0.197	0.043	0.005	0.002	0.004
26	SB	0.511	0.402	0.165	0.117	0.068	0.027
27	SB	0.503	0.182	0.097	0.007	0.006	0.004
30	SB	0.390	0.202	0.028	0.000	0.001	0.008
31	SB	0.630	0.274	0.087	0.000	0.004	--
32	SB	0.519	0.208	0.025	0.000	0.000	0.000
33	SB	0.558	0.367	0.135	0.001	0.000	--
Average Chloride Content		**0.502**	**0.215**	**0.062**	**0.009**	**0.005**	**0.010**

Core / RCT Sample Nos.	Sample Depth (mm)	Lab Test Chloride Content (% by mass of concrete)	RCT Test Chloride Content (% by mass of concrete)
D9 and RCT 10	5 to 20	0.730	0.442
	40 to 60	0.272	0.138
	70 to 90	0.067	0.014
	120 to 140	0.012	0.004
	150 to 170	0.012	0.000
D11 and RCT 12	5 to 20	0.572	0.385
	40 to 60	0.166	0.053
	70 to 90	0.013	0.000
	120 to 140	0.012	0.000
	150 to 170	0.013	0.000
	190 to 200	0.013	0.000
D27 and RCT 33	5 to 20	0.812	0.558
	40 to 60	0.422	0.367
	70 to 90	0.173	0.135
	120 to 140	0.012	0.001
	150 to 170	0.012	0.000
D30 and RCT 32	5 to 20	0.530	0.519
	40 to 60	0.229	0.208
	70 to 90	0.023	0.025
	120 to 140	0.012	0.000
	150 to 170	0.012	0.000

RCT chloride content testing was completed at the following test depth levels: 5 mm – 20 mm, 40 mm – 60 mm, 70 mm – 90 mm, 120 mm – 140 mm, 150 mm – 170 mm, and 190 mm – 210 mm. Deck concrete cores were tested at similar test depth levels to allow for cross comparison between the two test methods. Chloride testing depths were generally distributed over the deck area to test the chloride contents throughout the entire deck thickness for confirmation of chloride content data as it would pertain to the development of various deck rehabilitation treatments.

Key findings from the deck chloride content testing are as follows:

1. The chloride test results predominantly indicate that chlorides have not permeated into the lower concrete layer (e.g., the girder top concrete). No measured chloride test results from both concrete core testing or RCT testing show any chloride test results above the 0.09% chloride content in the bottom 100 mm of the deck (girder top slab concrete).
2. RCT Sample No. 26 shows chloride content by mass of concrete above 0.05% at the 120 mm – 140 mm test depth, which is the corrosion threshold used by OSRM for initiation of corrosion in black reinforcing.
3. Fourteen of 16 RCT samples and four of four concrete cores samples show the 0.09% chloride content threshold is exceeded at the 40 mm – 60 mm test depth.

4. Four of 16 and one of four concrete cores samples show the 0.09% chloride content threshold is exceeded at the 70 mm – 90 mm test depth (e.g. the top mat rebar level).
5. With respect to black rebar corrosion threshold levels, which may be considered applicable based on the deteriorated condition of the rebar's epoxy coating, seven of 16 RCT samples and two of four concrete cores samples show the 0.05% chloride content threshold (e.g. OSRM black rebar chloride content corrosion initiation threshold) are exceeded at the 70 mm – 90 mm test depth.
6. Light rebar corrosion noted during coring showed generally that corrosion may be beginning based on the measured chloride content test results and rebar condition in the extracted cores. The test pit photos from the 2017 assessment below cracked locations indicate that rebar corrosion may be occurring at deck crack locations. It is anticipated that epoxy coating failure and rebar corrosion are occurring at deck cracking locations, which are prevalent throughout the deck, based on the measured chloride contents and observations from the condition assessment.

Photo 2.4 – Test Patch at Wide Crack with Failed Epoxy Coating and Corroded Reinforcing Directly Below Crack

Photo 2.5 – Test Patch with Shallow Delamination

Reference photos from the B-215 Pembina Highway Overpass over Bishop Grandin Boulevard Bridge Deck Investigation Report – Final, prepared by AECOM.

Rapid Chloride Ion Penetrability

Rapid Chloride Ion Penetrability testing was completed on two cores: Cores D12 and D18. The results of the testing are as follows:

Chloride Permeability*	D12	D18	Average By Concrete Type
HDO / Girder Concrete Combined	1113	1669	1391 (low)
Girder Concrete Only	1330	1421	2751 (low)
Average By Core	1222 (low)	1545 (low)	--
*CSA A23.2-23C – Chloride Penetrability Rating Based on Charge Passed (Charge passed in 6 hours – Coulombs)			

Two Rapid Chloride Ion Penetrability tests were completed on each core: one in a combined layer of HDO and girder top flange concrete and one in the girder top flange concrete only. The results from the laboratory test results in **Appendix K** show the results as an average by core, which is applicable considering chloride ion penetrability in the current bridge deck. The average results by concrete type are shown in the above table to provide an average of the test results by concrete type. As stated above, chloride ion penetrability was found to be low in both the HDO and girder top slab concrete.

pH Content Testing

Two cores were tested for pH content to identify any potential for concrete carbonation. The test results for cores D10 and D20 on the deck concrete indicated pH values ranging from 11.82 to 11.99. pH values range depending on the mix designs used; however, typical good-performing concrete pH ranges from 12 – 13.3, and the test results found that the measured pH in the concrete is in line with these values.

Petrographic Analysis

Petrographic analysis of two deck cores (D13 and D28) was completed. The deck cores were selected as they both contained HDO and original concrete. Key findings from the petrographic report are as follows:

- Both the base concrete and overlay concrete layers on the deck cores were found to be in overall good condition and had no noted issues with the concrete mix components.
- Core D28 has a notable layer of very soft cementitious slurry, presumably the bonding agent material used between layers. The upper and lower layers did not separate during saw cutting and sample preparation, however the slurry layer represents a plane of weakness between the two layers. Furthermore, when the core was struck with a rock hammer at the bond level, it fractured mostly along the bond plane.

- At the top surface of the base layer concrete, the petrographers noted lines / striations between the base and upper concrete giving the appearance of a raked finish (which is supported by the visual observations made during the core reviews prior to lab testing and information found in the original construction specifications).
- No comments were made about core D13 having the same slurry layer as core D28, however the bonding agent layers were noted during the visual review of cores prior to testing. It appears that the placement of the slurry bonding agent may have been thicker in some areas than others and this may be a contributing factor in bond performance between the two deck layers.

3.4 Approach Slabs

Approach Slab Surface Defect and Delamination Survey Findings

The approach slabs were noted to be in overall fair condition. The approach slabs were visually inspected, and chain drag sounded to determine delamination locations. Key inspection findings were:

- The approach slabs are noted to be monolithically poured with a single mix design that was specified to be similar to the box girder superstructure top flange (e.g. bottom 100 mm of deck) and are reinforced with epoxy coated rebar.
- Medium to wide cracking was noted on approach slabs (Medium: 70.2 m, Wide: 209.1 m), which was predominantly longitudinal cracking.
- Delaminations were noted at both the north and south approach slabs (Total: 16.9 sq.m). Delamination locations generally coincided with longitudinal crack locations and adjacent to the expansion joint blockouts.

Approach Slab Cover Survey Measurements

A concrete cover survey was completed on the approach slabs as no cover survey data was collected on the approach slabs as part of the most recent previous condition assessment (by others). See Drawing 2 in **Appendix I** for an illustration of the cover measurement values.

The approach slab concrete cover was noted to be an average of 89 mm, with minimum and maximum cover measurements of 55 mm and 122 mm recorded, respectively. The average measured cover generally meets and exceeds the specified design cover 70 mm ± 5 mm from the original construction drawings.

Coring Program Observations Findings

The extracted approach slab cores were noted to be in overall good condition with the exceptions of the following noted findings:

- APP7 – Core drilled at the longitudinal crack location, and the crack extended to 125 mm ± into the core. Rebar epoxy coating failure and severe corrosion on rebar were noted.
- APP9 – Core broke at 70 mm deep and 130 mm deep during extraction.
- APP10 – Core broke at 130 mm deep during extraction.

Approach Slab Material Testing Results

Compressive Strength

The approach slab concrete compressive strength was measured on six cores: APP1, APP3, APP4, APP5, APP8, and APP10.

A summary of the compressive strength test results is shown in the below table, including average, minimum, and maximum test result strengths. The specified minimum concrete compressive strength of the approach slab concrete is 30 MPa, as shown on Sheet No. 2 of the 1988 original construction drawings; the compressive strength test results show that the approach slab concrete meets and exceeds the design compressive strength based on the cores tested.

	Approach Slab Compressive Strength Summary (MPa)
Minimum	60.0
Maximum	83.9
Average	72.2
Cores Tested	6

Air Void Analysis (AVA)

Two approach slab cores were tested in total for AVA. A summary showing the AVA test results is shown in the below table, including average, minimum, and maximum test results. The original design air concrete in the deck concrete is understood to be 5 – 8%. The CSA limits for frost resistant concrete are included in the table below for reference and are met based on the approach slab core samples tested.

Approach Slab Concrete Air Void Analysis Summary				
	Total Air Content (%)	Specific Surface (mm-1)	Paste Content (%)	Spacing Factor (um)
Minimum	5.3	25.8	27.2	154
Maximum	5.7	30.8	30.2	181
Average	5.5	28.3	28.7	168
CSA Limits for Frost Resistant Concrete	3.0 min.	---	---	230 max average

Chloride Content

Approach slab chloride content was measured on eight RCT sample locations (RCT Sample Nos. 1, 2, 7, 8, 22, 23, 28, and 29). Detailed chloride content information is presented in **Appendix J**. An excerpt of the RCT testing summary from **Appendix J** is as follows. Note no concrete core chloride tests were completed for the approach slabs.

APPROACH SLAB RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)							
RCT SAMPLE LOCATION		TEST DEPTH (mm)					
No.	Lane Dir.	5 - 20	40 - 60	70 - 90	120 - 140	150 - 170	190 - 210
1	NB	0.518	0.110	0.000	0.000	0.000	0.000
2	NB	0.602	0.125	0.029	0.000	0.002	0.000
7	NB	0.442	0.077	0.008	0.000	0.000	0.000
8	NB	0.322	0.117	0.028	0.000	0.000	0.000
22	SB	0.301	0.040	0.005	0.000	0.000	0.000
23	SB	0.435	0.145	0.074	0.003	0.005	0.001
28	SB	0.641	0.145	0.021	0.007	0.004	0.005
29	SB	0.552	0.221	0.077	0.008	0.016	0.015
Average Chloride Content		**0.477**	**0.123**	**0.030**	**0.002**	**0.003**	**0.003**

Approach slab RCT chloride content testing was completed at the following test depth levels: 5 mm – 20 mm, 40 mm – 60 mm, 70 mm – 90 mm, 120 mm – 140 mm, 150 mm – 170 mm, and 190 mm – 210 mm. Chloride testing sample locations were distributed to gather representative data from all four approach slab quadrants, including data from the higher and lower sides of the approach slabs with respect to the approach slabs transverse cross fall, to determine the depth of chloride ingress into the concrete to provide information for rehabilitation treatment options assessment.

Key findings from the approach slab chloride content testing are as follows:

1. The approach slab chloride test results predominantly indicate that chlorides have generally ingressed to the 40 mm – 60 mm test depth above the corrosion threshold amount of 0.09%. Six of eight RCT locations (75%) had chloride contents above 0.09% at the 40 mm – 60 mm test level.

2. No RCT test results were above 0.09% chloride content deeper than the 40 mm – 60 mm test depth level.

3. RCT Sample Nos. 23 and 29 have chloride contents above 0.05% at the 70 mm – 90 mm test level, which is the OSRM threshold for chloride content initiating corrosion on black rebar. Epoxy coating is anticipated to be deteriorated at top mat level particularly at or near crack locations.

Rapid Chloride Ion Penetrability

No Rapid Chloride Ion Penetrability testing was completed for the approach slab concrete.

pH Content Testing

No pH content testing was completed for the approach slab concrete.

Petrographic Analysis

No petrographic analysis was completed for the approach slab concrete.

3.5 Deck Underside

The soffit / underside of the deck inspection was divided into two main portions:

1. The stay in place formwork face inside the superstructure, which was inspected using a combination of borescope inspection and coring through the deck to take inspection photographs.

2. The bottom face of the of the concrete superstructure (e.g. soffit face of superstructure closest to Abinojii Mikanah).

Inspection of these elements was completed using a combination of ground access and a rolling scaffold. The rolling scaffold was used primarily to gain access for the borescope inspection at the SU2 and SU4 pier locations.

General views of the bottom face of the of the concrete superstructure and the stay-in-place formwork are shown in **Appendix G** (OSIM Report), **Appendix H** (Condition Survey Photos), and **Appendix L** (Borescope Inspection).

Drawing 3 in **Appendix J** illustrates the condition of the bottom face of the concrete superstructure.

Stay In Place (SIP) Formwork

The SIP formwork condition was assessed using two methods:

1. Borescope inspection through the girder weep holes, completed by VCS Engineering Ltd., and
2. Through-deck coring completed by MH at two locations for taking inspection photos of the insides of the girder superstructure and SIP formwork (one core was taken in the northbound lanes (D12) and one core was taken in the southbound lanes (D29)).

Borescope Inspection

Borescope inspection of the interior of the superstructure was completed on November 1 and 2, 2023. MH provided a rolling scaffold for VCS's use for the inspection access. All abutment and pier weep holes were attempted to be inspected; however, several weep drain holes were noted to be blocked or inaccessible as follows:

- South Abutment – Girders 12 and 14 (blocked);
- Pier 1 (South Pier) – Girder 10 (blocked), Girders 14 - 20 (inaccessible due to sidewalk width);
- Pier 3 (North Pier) – Girders 1 – 8 (inaccessible due to sidewalk width), Girder 12 (blocked); and
- North Abutment – Girder 8 (inaccessible).

Over 90% of the abutment weep holes and 60% ± of the pier weep holes were inspected as part of the borescope inspection.

Key Inspection Findings:

Overall, the SIP forms on the deck underside appear to be in generally good condition. White zinc corrosion product / oxidation was commonly observed. Photos in **Appendix H** and Figures 6 and 7 in **Appendix L** photos show typical corrosion of the zinc galvanizing. The bridge was constructed in 1988, and corrosion / oxidation of the zinc galvanizing deck forms is to be expected to be present due to the minor noted moisture infiltration noted inside the girder. There were no indications of steel corrosion at the time of the inspection. None of the borescope videos showed the presence of brown corrosion byproduct which is indicative of steel corrosion.

As requested by the City, VCS also attempted to image the back of the girders at the north and south abutments. However, it was not possible to adequately articulate the borescope head due to the small gap between the end of the girder and the abutment wall, and therefore the videos were very dark, and it was not possible to analyze the condition of the girder ends. During the imaging of the girder ends, VCS noticed that there was some corrosion present at the bearing plate at the North Abutment G15 location, as shown in Figure 64 of **Appendix L**.

Through Deck Coring Inspection

MH completed two through deck cores (through the deck concrete and the SIP formwork) to investigate the condition of the interior portion of the superstructure. MH took core D12 on October 26 in Span 2 (second from south) and D29 on October 29 in Span 1 (southmost span) through the deck / SIP formwork. A camera on an extension pole was lowered through the core holes and the camera was operated using a Bluetooth shutter control to take the inspection photos.

Key Inspection Findings:

Similar to the borescope inspection findings, the galvanizing on the SIP formwork was noted to have white corrosion / oxidation product present throughout to varying degrees however, no steel corrosion was noted.

Both core locations D12 and D24 had a small amount of water noted on the bottom slab along one of the walls in the photos (anticipated to be from coring), and the walls appeared damp to varying degrees. See photos in **Appendix H** for illustrations.

Exterior Soffits (Fascia and Deck Overhangs)

The exterior soffits had narrow to medium cracks with efflorescence noted on both East and West exterior soffits.

Chloride Content

Exterior girder chloride content was assessed at four RCT sample locations (RCT Sample No. 64, 65, 66, and 67). The four samples were taken on the east exterior girder face near Pier 3 (middle pier) and Pier 4 (north pier). The RCT samples were located as follows (RCT 64-67):

- RCT 64 (also labeled Girder RCT 1 in testing documentation)
  - 0.4 m above bottom of girder, 0.7m south of Pier 2 (SU3 – median pier) centre line
- RCT 65 (also labeled Girder RCT 2 in testing documentation)
  - 0.6 m above bottom of girder, 1.6 m north of Pier 2 (SU3 – median pier) centre line
- RCT 66 (also labeled Girder RCT 3 in testing documentation)
  - 0.6 m above bottom of girder, 0.9 m north of Pier 3 (SU4 – north pier) centre line
- RCT 67 (also labeled Girder RCT 4 in testing documentation)
  - 0.7 m above bottom of girder, 0.6 m south of Pier 3 (SU4 – north pier) centre line

Detailed chloride content information is presented in **Appendix J**. An excerpt of the RCT testing summary from **Appendix J** is as follows. Note no concrete core chloride tests were completed for the girders.

EXTERIOR GIRDER RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	Location	5 - 20	40 - 60	70 - 90
64*		0.004	0.001	0.011
65*		0.006	0.000	0.002
66*		0.104	0.066	0.034
67*		0.004	0.008	0.012
Average Chloride Content		0.030	0.019	0.015

Notes:
1. Red cells equal chloride content greater than 0.090% by mass of concrete.
2. City of Winnipeg chloride content corrosion threshold for epoxy coated rebar is 0.09% by mass of concrete.
3. Background chlorides of 0.008% chlorides by mass of concrete subtracted from raw measured chloride values.
4. Samples marked with (*) were extracted during the Spring portion of the condition assessment.

Only one RCT test (RCT 66 at 5-20 mm test level) had chloride content exceeding the 0.09% mass of concrete epoxy rebar chloride threshold, and the RCT 66 test at 40-60 mm test level had chloride content exceeding 0.05 % mass of concrete for typical black rebar chloride threshold level.

Interior Soffit

The interior soffit was noted to have hairline to narrow cracking noted throughout, with cracking predominantly located at plastic rebar chair locations. Signs of leakage / interior girder drainage were noted from the weep holes on all spans. Longitudinal cracks were mostly located over Columns 3 and 4 (centremost column and first column to east of centre) over the piers.

Specific inspection findings recorded by span are as follows:

- **Span 1:** Longitudinal cracking with efflorescence near pier with signs of leakage. Rust staining near SU2 pier, appears to come from minor spall with exposed rebar.
- **Span 2:** Longitudinal cracking with efflorescence near piers.
- **Span 3:** Longitudinal cracking with efflorescence near piers. Small area of rust staining noted.
- **Span 4:** Longitudinal cracking with efflorescence noted mostly near SU4 pier. Small isolated areas of rust staining.

3.6 Abutments

Surface Defect and Delamination Survey Findings

Abutment Walls

The abutment walls are in overall fair condition. The abutment walls were visually inspected, and hammer sounded to determine delamination locations. Key inspection findings were:

- The abutment walls are reinforced with epoxy coated rebar.
- Evidence of leakage occurring at intermittent locations across the width of both abutments.
- Localized delaminations were noted near the centreline and the west edge of the south abutment.
- Localized spall near the west edge of the north abutment.
- 18 x full height (FH) narrow to medium vertical cracks on the south abutment (three medium and 15 narrow).
- 25 x FH narrow to medium vertical cracks on north abutment (eight medium, 17 narrow).
- Several cracks have been previously repaired, and select cracks have efflorescence.

Ballast Walls

The ballast walls are in overall fair to poor condition. The ballast walls were visually inspected and hammer sounded at exposed locations at ends to determine delamination locations. Key inspection findings were:

- The ballast walls are reinforced with epoxy coated rebar.
- Delamination was noted at the east side of the north ballast wall.
- Evidence of leakage coming from expansion joints on both the north and south ballast walls.
- 23 x FH medium vertical cracks with efflorescence on the south abutment.
- 31 x FH medium vertical cracks with efflorescence on the north abutment.

Abutment Wall Cover Survey Measurements

A concrete cover survey was completed on both abutments, with one measurement taken at mid-height of each abutment wall due to their shallow height (ranging from 550 mm to 800 mm high measured from the top of slope paving to the top of bearing seat). The abutment concrete cover was noted to be an average of 49 mm, with minimum and maximum cover measurements of 25 mm and 68 mm recorded, respectively. The measured cover is generally well below the specified design cover 80 mm ± 5 mm from the original construction drawings.

Coring Program Observations Findings

The extracted abutment cores were noted to be in overall good condition with the following findings noted:

- A1 – Core broke at 150 mm due to hitting a 15M rebar. Narrow to medium crack to 150 mm depth.
- A9 – Narrow crack on the east side of core, which extended 5 mm – 10 mm from the core surface.

Abutment Material Testing Results

Compressive Strength

The abutment concrete compressive strength was tested on three cores: A6, A7, and A11.

A summary showing the compressive strength test results is in the below table, including average, minimum, and maximum test result strengths. The specified minimum concrete compressive strength of the substructure concrete is 30 MPa, as shown on Sheet No. 2 of the 1988 original construction drawings; the compressive strength test results show that the abutments meet and exceed the design compressive strength.

	Abutment Compressive Strength Summary (MPa)
Minimum	49.1
Maximum	59.5
Average	55.5
Cores Tested	3

Air Void Analysis (AVA)

Two abutment cores were tested in total for AVA, cores A4 and A9. A summary of the AVA test results is shown in the below table, including average, minimum, and maximum test results. The original design air content in the substructure was noted to be 5-7 % as per the original construction specifications (SP 16.3.2) for 30 MPa design strength concrete with 20 mm nominal size aggregate. The abutment concrete has higher concrete than the original specifications however it is generally in line with current design standards for air content of 5-8%. The CSA limits for frost resistant concrete are included in the table below for reference and are met based on the abutment core samples tested.

Abutment Concrete Air Void Analysis Summary				
	Total Air Content (%)	Specific Surface (mm-1)	Paste Content (%)	Spacing Factor (um)
Minimum	8.0	16.8	25.0	154
Maximum	8.3	19.6	25.6	191
Average	8.2	18.2	25.3	173
CSA Limits for Frost Resistant Concrete	3.0 min.	---	---	230 max average

Chloride Content

Chloride content was measured on two abutment cores (A2 and A8) and 16 abutment wall RCT sample locations (RCT Sample Nos. 13, 14, 15, 16, 17, 18, 19, 34, 35, 36, 37, 38, 39, and 42), and four ballast wall RCT sample locations (RCT 20, 21, 40, and 41). Detailed chloride content information is in **Appendix J.** An excerpt of the RCT testing summary from **Appendix J** is as follows (concrete core testing results are similar to the RCT results).

ABUTMENT RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	ABUTMENT	5 - 20	40 - 60	90-110
13	NORTH	0.017	0.008	0.001
14	NORTH	0.289	0.164	0.044
15	NORTH	0.070	0.077	--
16	NORTH	0.064	0.035	--
17	NORTH	0.115	0.090	0.028
18	NORTH	0.055	0.000	0.014
19	NORTH	0.063	0.004	0.005
20	NORTH	0.164	0.078	0.149
21	NORTH	0.077	0.038	0.027
34	SOUTH	0.050	0.000	0.016
35	SOUTH	0.039	0.006	0.001
36	SOUTH	0.012	0.003	0.001
37	SOUTH	0.081	0.000	0.003
38	SOUTH	0.035	0.027	0.031
39	SOUTH	0.008	0.000	0.004
40	SOUTH	0.157	0.048	0.010
41	SOUTH	0.030	0.007	0.003
42	SOUTH	0.073	0.047	0.027
Average Chloride Content (Overall)		0.078	0.035	0.020
Average Chloride Content (Abutment Wall)		0.069	0.033	0.013
Average Chloride Content (Ballast Wall)		0.107	0.043	0.047

RCT chloride content testing was completed at the following test depth levels: 5 mm – 20 mm, 40 mm – 60 mm, and 90 mm – 110 mm. Abutment concrete cores were tested at similar test depth levels to allow for cross comparison between the lab chloride content testing on cores and RCT chloride testing. Chloride testing sample locations were positioned on the abutments to determine the impacts of location on the abutment wall with respect to joint leakage and to determine the depth of chloride ingress into the concrete to provide information for rehabilitation treatment option assessment.

Key findings from the abutment and ballast wall chloride content testing are as follows:

1. The abutment wall chloride test results predominantly indicate that chlorides have generally only ingressed to the 5 mm – 20 mm test depth to be above the corrosion threshold amount of 0.09%. The 0.09% chloride content threshold was exceeded at the 5 mm – 20 mm test level in four of 18 total combined abutment and ballast RCT sample locations (two of 14 abutment RCT test locations and two of four ballast wall RCT test locations).

2. Except for RCT Sample No. 14, no concrete core or RCT test results are above the 0.09% chloride content threshold at the 40 mm – 60 mm test depth or deeper test depths in the abutment concrete.
3. RCT 20 (northeast ballast wall sample location has an outlier chloride test value of being lower at the 40 mm – 60 mm test depth than the 90 mm – 110 mm test depth; however, this sample location is below cracked / delaminated areas of the ballast which may be causing atypical ingress pathways into the concrete.
4. Based on average test depth values, only the ballast wall 5 mm – 20 mm test depth is above the 0.09% chloride corrosion threshold.

Rapid Chloride Ion Penetrability

Rapid Chloride Ion Penetrability testing was completed on one abutment core, A3, and the test results are as follows:
Two rapid chloride ion penetrability tests were completed on the core. As stated above, rapid chloride ion penetrability was found to be very low to low in the abutment concrete core tested.

Chloride Permeability*	A3
14 to 64 mm Test Depth	874 (very low)
67 to 117 mm Test Depth	1281 (low)
Average	1078 (low)
*CSA A23.2-23C – Chloride Penetrability Rating Based on Charge Passed (Charge passed in 6 hours – Coulombs)	

pH Content Testing

One core, A5, was tested for pH content to identify any potential for concrete carbonation. The test results for Core A5 on the abutment concrete indicated pH values ranging from 11.88 to 11.89. pH values range depending on the mix designs used; however, typical good-performing concrete pH ranges from 12 – 13.3, and the test results found that the measured pH in the concrete is generally in line with these values.

Petrographic Analysis

Petrographic analysis was completed on core A10. Key findings from the petrographic report are as follows:

- The substructure concrete from core A10 appears to be in overall good condition based on the petrographic assessment.

- Core A10 exhibited a surface-parallel zone of concrete up to 25 mm (1") thick located between 76 mm (3") and 102 mm (4") depth which exhibited greatly reduced air void content.

In general, the substructure appears to be performing satisfactorily to date based on in-situ air content with respect to freeze thaw performance.

3.7 Piers

The piers were noted to be in overall good condition. The structure articulation is continuous between the abutments and pier exposure is limited to salt spray from the roadway under passing the overpass bridge. The piers are noted to be setback from the roadway a significant distance from the closest lane shoulder line (e.g. 3.0 m ±).

Surface Defect and Delamination Survey Findings

The piers were noted to be in overall good condition. The piers were visually inspected and hammer sounding / rotary delamination tools were used to sound the concrete to determine delamination locations. The delamination survey was completed on the bottom 3.5 m± of the piers and spot checks on the remaining height of the piers due to limited exposure. Key inspection findings were:

- The piers are reinforced with epoxy coated rebar.
- No delaminations / spalling, cracking greater than narrow severity or other notable defects were identified during the inspections.
- Pier Caps – Signs of leakage on caps is suspected to be coming from weep drainage holes from superstructure. Pier caps are in generally good condition.
- Pier Shafts (below pier caps) – Light honeycombing noted, generally good condition.
- Pier Shafts – Base Pedestal at Ground Level – Narrow vertical cracking noted with select cracks previously patched.

Pier Cover Survey Measurements

Cover measurements were recorded for the bottom 3.0 m of the pier shaft / barrier wall on SU2, 3, and 4. See Drawings 5, 6, and 7 in **Appendix I** for illustration of the cover measurement values.

The pier concrete cover for SU2 and 4 was noted to be an average of 55 mm, with minimum and maximum cover measurements of 31 mm and 80 mm recorded, respectively. The concrete cover for SU3 was noted to be an average of 67 mm, with minimum and maximum cover measurements of 45 mm and 90 mm

respectively. The average measured cover is generally well below the specified design cover 80 mm ± 5 mm from the original construction drawings.

Coring Program Observations Findings

The extracted pier cores were noted to be in overall good condition with the exceptions of the following noted findings:

- P3 – Core broke at 110 mm during coring / retrieval.
- P11 – Core broke at 140 mm during coring / retrieval.
- P15 – Core broke at 140 mm during coring / retrieval.

Pier Material Testing Results

Compressive Strength

The pier concrete compressive strength was measured on seven cores: P1, P2, P5, P10, P13, P16, and P17.

A summary showing the compressive strength test results is shown in the below table, including average, minimum, and maximum test result strengths. The specified minimum concrete compressive strength of the substructure concrete is 30 MPa, as shown on Sheet No. 2 of the 1988 original construction drawings; the compressive strength test results show that the pier concrete meets and exceeds the design compressive strength based on the cores tested.

	Pier Compressive Strength Summary (MPa)
Minimum	56.3
Maximum	69.5
Average	61.8
Cores Tested	7

Air Void Analysis (AVA)

Three pier cores were tested in total for AVA, cores P4, P12, and P18. A summary showing the AVA test results is shown in the below table, including average, minimum, and maximum test results. The original design air content in the substructure was noted to be 5-7 % as per the original construction specifications (SP 16.3.2) for 30 MPa design strength concrete with 20 mm nominal size aggregate. The pier concrete test results appear to be notably lower than the abutment concrete test results. The CSA limits for frost-resistant concrete are shown included in the table below for reference and are marginally met based on the pier core

samples tested (spacing factor criteria are not met by CSA standards however, test results are based on a limited sample data set).

Pier Concrete Air Void Analysis Summary				
	Total Air Content (%)	Specific Surface (mm-1)	Paste Content (%)	Spacing Factor (um)
Minimum	3.1	18	21	206
Maximum	4.2	27.1	24.4	**292**
Average	3.5	23.1	23.3	236
CSA Limits for Frost Resistant Concrete	3.0 min.	---	---	230 max average

Chloride Content

Chloride content was measured on one pier core (P20) and 14 pier RCT sample locations (RCT Sample Nos. 43 to 59). Detailed chloride content information is presented in **Appendix J**. An excerpt of the RCT testing summary from **Appendix J** is as follows (concrete core testing results are generally similar to the RCT results). Additional pier RCT samples (RCT No. 57-59) were obtained for pier SU3 during the follow up portion of the condition assessment completed in June 2024.

PIER RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	SU# / COL.	5 - 20	40 - 60	70 - 90
43	SU2 - BASE	0.136	0.057	0.016
44	SU2 - P1	0.075	0.008	0.000
45	SU2 - P2	0.159	0.022	0.001
46	SU2 - P3	0.124	0.016	0.001
47	SU2 - P4	0.044	0.000	0.000
48	SU2 - P5	0.055	0.000	0.000
49	SU2 - P5	0.075	0.004	0.002
50	SU4 - BASE E	0.093	0.011	0.007
51	SU4 - P5	0.188	0.025	0.001
52	SU4 - P4	0.149	0.020	0.002
53	SU4 - P3	0.081	0.014	0.000
54	SU4 - P2	0.071	0.006	0.018
55	SU4 - P1	0.099	0.002	0.001
56	SU4 - BASE W	0.028	0.005	0.000
57*	SU3 - BASE E	0.091	0.012	0.001
58*	SU3 - BASE CL	0.065	0.017	0.000
59*	SU3 - P3	0.051	0.006	0.000
Average Chloride Content		**0.093**	**0.013**	**0.003**

RCT chloride content testing was completed at the following test depth levels: 5 mm – 20 mm, 40 mm – 60 mm, and 90 mm – 110 mm. The pier concrete core was tested at similar test depth levels to allow for cross comparison between the lab chloride content testing on cores and RCT chloride testing. Chloride testing sample locations were positioned in the pier splash zones (e.g. the lower 2 m – 3 m of the pier shafts / barrier wall at the bottom of the piers) to determine the depth of chloride ingress into the concrete to provide information for rehabilitation treatment options assessment.

Key findings from the pier chloride content testing are as follows:

1. The pier chloride test results predominantly indicate that chlorides have generally only ingressed to the 5 mm – 20 mm test depth above the chloride content threshold amount of 0.09%. Eight of 17 RCT locations (47%) had chloride contents above 0.09% at the 5 mm – 20 mm test level.
2. Except for Core P20 test depth 40 mm – 60 mm, no concrete core or RCT test results are above the 0.09% chloride content by mass of concrete threshold at the 40 mm – 60 mm test depth or deeper in the pier concrete.
3. Core P20 and RCT 52 were taken in similar locations; however, there was a variance in chloride contents between the lab chloride content and RCT test results. The concrete core test results above 0.09% at the 40 mm – 60 mm test depth but the RCT results are well below the 0.09% threshold. The 90 mm – 110 mm test depth results generally are in agreement for both test methods. An excerpt of the chloride content comparison table between lab and RCT test results from **Appendix J** is shown below.

Core / RCT Sample Nos.	Sample Depth (mm)	Lab Test Chloride Content (% by mass of concrete)	RCT Test Chloride Content (% by mass of concrete)
P20 and RCT 52	50 to 20	0.248	0.149
	40 to 60	0.096	0.020
	90 to 110	0.017	0.002
	120 to 140	0.013	No test at depth
	150 to 170	0.012	No test at depth
	190 to 210	0.012	No test at depth

Rapid Chloride Ion Penetrability

Rapid Chloride Ion Penetrability testing was completed on one pier core, P8, and the results are as follows:

Chloride Permeability*	P8
16 to 66 mm Test Depth	943 (very low)
69 to 118 mm Test Depth	1501 (low)
Average	1222 (low)
*CSA A23.2-23C – Chloride Penetrability Rating Based on Charge Passed (Charge passed in 6 hours – Coulombs)	

Two rapid chloride ion penetrability tests were completed on the core. As stated above, rapid chloride ion penetrability was found to be very low to low in the pier concrete core tested.

pH Content Testing

One pier core, P19, was tested for pH content to identify any potential for concrete carbonation. The test results for Core P19 on the pier concrete indicated pH values ranging from 11.90 to 11.92. pH values range depending on mix designs used; however, typical good performing concrete pH ranges from 12 - 13.3, and the test results found that the measured pH in the concrete is generally in line with these values.

Petrographic Analysis

Petrographic analysis of one pier core P7 was completed. Key findings from the petrography report are as follows:

- The substructure concrete from core P7 appears to be in overall good condition based on the petrographic assessment. Select issues with air content were noted in this analysis which are in alignment with the air void analysis completed by Stantec. The anticipated freeze thaw durability during service will be of consideration during the substructure rehabilitation planning. In general, the substructure appears to be performing satisfactorily to date based on in-situ air content with respect to freeze thaw performance.

3.8 Other Structure Elements

General

The structure elements in the following sections were not included in the detailed condition assessment scope but were assessed as part of the OSIM inspection and onsite observations made during the condition

assessment. The findings stated below were developed based on observations and key findings made from visual inspections for the OSIM inspection and visual observations made during the condition assessment field work.

Concrete Barriers

As per pre-inspection discussion between the City and MH, it was agreed that the barriers would not be inspected or have destructive testing completed as part of the condition survey as the barriers are assumed to be required to be replaced to modify / widen the bridge deck cross section. Commentary on the barrier condition is as follows and detailed inspection findings are provided in the OSIM report, located in **Appendix G.**

Exterior Barrier Faces

- Seals falling between barrier joints, are typical.
- Full height (FH) narrow to medium cracks typical with select wide cracks noted.

Interior Barrier Faces

- Spall on traffic barrier interior face with exposed rebar over Span 4 northbound lanes (1.2 m x 0.3 m).
- Spalls on traffic barrier top face with exposed rebar over Span 4 southbound lanes (0.1 m x 0.15 m and 0.15 m x 0.1 m) and over Span 3 southbound lanes (2.4 m x 0.3 m).
- Seals falling between barrier joints, and typical.
- Limited inspection on southbound lanes traffic barrier inside face due to snow cover.
- FH narrow to medium cracks typical with some wide cracking noted.

Expansion Joints

The deck expansion joints are single strip seal type joints located at both abutments and are in overall poor condition. The expansion joint armouring is noted to be deformed across the full width of all joint locations in a “wave” pattern, with expansion joint measurements varying along the width of the bridge from 20 mm – 40 mm ±. Extensive leakage at intermittent locations was noted on the abutment and ballast walls, anticipated to be due to the armouring damage, partial joint seal unseating, and uneven joint movement. Seating of the joint seals was difficult to assess based on the small expansion joint gap measurements where the joint was more tightly closed. The joint end dams have several locations of delamination, cracking, and previous maintenance patching noted.

Deck Drains

Surface drainage on the bridge deck is provided by transverse and longitudinal crossfalls, which drain to four double drain scuppers located at each corner of the deck. The deck drain grates are 980 mm x 430 mm on

the roadway and 280 mm x 280 mm on the sidewalk. The deck drains were noted to be in generally good condition and were noted to be clear during the inspection.

Bearings

The bearings are noted to be Goodco pot bearings with the following model numbers as specified on the original construction drawings:

- Abutments (SU1 and SU5) – 50 mm of longitudinal movement range:
    - PMG-68 unidirectional bearings
    - PM-68 multidirectional bearings
- Pier 1 and 3 (SU2 and SU4) – 30 mm of longitudinal movement range:
    - PMG-142 unidirectional bearings
    - PM–142 multidirectional bearings
- Pier 2 (SU3)
    - PF-142 fixed bearings

Abutment Bearings

The abutment bearings were noted to be in overall good to fair condition. The following key inspection findings were found during the inspection:

- Bearing on south abutment (11th from west end) has a cracked bearing guiderail on one side of the bearing.
- Bearing on north abutment (3rd from east end) has medium corrosion.

Piers Bearings

The pier bearings were inspected using lane closures and an aerial work platform in June 2024. Confirmatory dimensional measurements were taken on select bearings in case of potential bearing repair / rehabilitation works. Movement measurements were also taken on exterior pier bearings during the inspections which generally agreed with City of Winnipeg routine inspection measurements.

The following is a summary of inspection findings noted during the within arms reach inspection of the pier bearings:

- SU2 (South Pier)
    - Line N - coating spatter on sliding plate
- SU3 (Middle Pier)
    - Line D – coating failure on west side of bearing
    - Line H and I – loose Teflon strips on south side of bearing
    - The following bearings were noted to have loose Teflon strips on the north side of the bearings: Lines G, H, M, N, Q, R, and S.
- SU4 (North Pier)
    - Line B, D, and H – minor coating failure

Wingwalls

The abutment wingwalls are overall in good to fair condition. Key inspection findings are as follows:

- **SE wingwall:** Narrow to medium FH crack.
- **NE wingwall:** Several hairline to narrow FH cracks. Spall at wingwall corner (0.1 m x 0.15 m).
- **NW wingwall:** Medium vertical crack 0.6 m long. Several spalls on wingwall (0.1 m x 0.1 m and 0.2 m x 0.15 m).
- **SW wingwall**: Narrow to medium cracks.

Slope Paving

The embankment slope paving is in overall good to fair condition. Key inspection findings are as follows:

- Transverse and longitudinal cracking throughout, with previous caulking sealant wearing off / failing in exposed areas at ends.
- Wide cracks and localized delaminations / spalls noted in drainage troughs.
- Slope paving at both abutments appears to be settled approximately 50 mm.
- Cracking totals: narrow - 178 m, medium - 44 m, wide - 39 m
- Delamination and Spalling total 2.71 sq.m.

Chloride Content

Slope paving chloride content was measured on four RCT sample locations (RCT Sample No. 60, 61, 62, and 63). All samples were obtained from the slope paving on the North end of the bridge. Detailed chloride content information is presented in **Appendix J**. An excerpt of the slope paving RCT testing summary from Appendix J is as follows. Note no concrete core chloride tests were completed for the slope paving.

SLOPE PAVING CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	LOCATION	5 - 20	40 - 60	70 - 90
60*	NORTH	0.354	0.129	0.039
61*	NORTH	0.307	0.001	0.000
62*	NORTH	0.184	0.002	0.000
63*	NORTH	0.245	0.089	0.031
Average Chloride Content		**0.273**	**0.055**	**0.018**

Locations on the north slope paving where the RCT samples were taken are as follows:

RCT 60 (labelled SP RCT 1 in the field)
- West Drain Trough
- 5.6m South of North Abutment Face
- 2.15m East of West End of North Abutment

RCT 61 (labelled SP RCT 2 in the field)
- Flat Middle Apron
- 10.7m South of North Bearing E (5th bearing from west) of the Abutment Face

RCT 62 (labelled SP RCT 3 in the field)
- Upper Apron at North Abutment
- 1.0m South of Abutment Face
- 1.2m East of Bearing I (9th bearing from west) at Centre Line

RCT 63 (labelled SP RCT 4 in the field)
- East Drain Trough
- 8.8m South of North Abutment Face
- 2.1m West of East End of the North Abutment

The slope paving predominantly has black rebar used in its construction between the drainage troughs locations and the drainage trough areas are reinforced with epoxy coated steel. All four test locations had chloride content over 0.09% by mass of concrete at the 5-20 mm level and the two test locations taken in the drainage trough areas had chloride contents over 0.09% by mass of concrete at the 40-60 mm level (rounding up the result for RCT 63).

Embankments

The embankments are in overall good condition. Key inspection findings are as follows:

- Runoff erosion hole on southwest embankment near SU2 pier, and on northwest embankment near SU4 pier.

4. CLOSURE

This report was prepared for the **City of Winnipeg** to summarize the results of our inspection and condition assessment of the Pembina Highway Overpass. The material in this report reflects **Stantec Consulting Limited's** best judgement, in the light of the information available to it, at the time of preparation.

If there are any questions regarding the contents of this report, please contact the undersigned.

Sincerely,
Stantec Consulting Limited

Troy Hengen, P.Eng.
Senior Bridge Engineer

Stantec Consulting Limited

Andrei Lazcano Perez, P.Eng.
Bridge Engineer

Stantec Consulting Limited

Appendix A

Detailed Condition Survey Summary Sheets

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

Component Type & Location: **Deck Top**

OSIM Identifier ___________________

1. Dimensions and Area

Width 38.5 m (Average) Length 87.50 m Height -- m

Diameter -- m Total Area Surveyed 3368.75 m^2 ***Deck wearing only***

2. Cracks (medium and wide)

Type			Total	
Medium Width	Clean	532.7	532.7	m
	Stained	--		
Wide Width	Clean	351.8	351.8	m
	Stained	--		

Remarks

Extensive narrow to wide transverse cracking was noted throughout the deck area, with the most notable cracking occurring over the piers in negative moment regions. Similar transverse cracking, although not as severe / extensive as noted at the piers' negative moment regions, was also noted in the girder positive moment areas. Localized longitudinal cracking in both lane directions was typically located in the two traffic lanes adjacent to the median in each lane direction.

3. Alkali aggregate reaction

Area of component with severe to very severe aggregate reaction -- m^2.

No AAR noted in petrographic analysis findings from deck cores.

4. Concrete Cover

Minimum	Maximum	Average	
-	-	-	mm

0 – 20 mm	--	40 – 60 mm	-	m^2
	--		-	%
20 – 40 mm	-	Over 60 mm	-	m^2
	-		-	%

Deck cover survey not completed during current assessment as was completed in previous assessment by others.

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

Component & Location: Deck Top

5. Corrosion Activity

Minimum	Maximum	Average	
--	--	--	V

0 to - 0.20	-0.20 to - 0.30	- 0.30 to - 0.35	- 0.35 to - 0.45	< - 0.45	V
--	--	--	--	--	m^2
--	--	--	--	--	%

Remarks

Corrosion potential survey was not completed as part of current assessment program due to deck having epoxy coated rebar.

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	104.3	0	0
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤ - 0.35	
104.3 m^2	3.1 %	--	--

Extensive delaminated areas were noted throughout the deck area that ranged in size from 0.3 m x 0.3 m to 0.9 m x 0.9 m, although previous extensive maintenance patching program was completed. Depth of delamination sounded as though delaminations were shallow; this may due to actual shallow delaminations being present and also cores partially becoming cracked or debonded deeper in deck section based on deck coring observations.

7. Scaling

Light	Medium	Severe to Very severe	
--	--	--	m^2
--	--	--	%

No scaling or honeycombing found on deck top.

8. Honeycombing

Total Area ____--____ m^2.

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

Component & Location: Deck Top

9. Adjusted Chloride Content Profile

Corrosion Activity at Core Location (Volts)		0 to - 0.20	- 0.20 to - 0.35	≤ - 0.35
Chloride Content *	5 - 10 mm	--	--	--
	40 - 60 mm	--	--	--
	70 - 90 mm	--	--	--
	120 - 140 mm	--	--	--
	150 - 170 mm	--	--	--
	190 - 210 mm	--	--	--

* Average chloride content as % chloride by weight of concrete after deducting background chlorides for all cores taken in each range of corrosion potential.

Remarks

Item # 9 is not part of current assessment scope. Corrosion potential survey was not completed as part of current assessment program due to deck having epoxy coated rebar.

10. Chloride Content at Level of Rebar

Core No.	D9	D11	D27	D30	--
Chloride content *	0.067	0.013	0.173	0.023	--

* Chloride content as % chloride by weight of concrete after deducting background chlorides

Chloride contents stated at 70 to 90mm test level.

See condition assessment report for chloride profile table.

11. AC Resistance Test Data of Epoxy Coated Rebar

Measured AC Resistance between Connection #1 and #2						Calculated AC Resistance *
Connection #1	Connection #2					
	G1	G2	G3	G4	G5	
G1	N/A					
G2		N/A				
G3			N/A			
G4				N/A		
G5					N/A	

* See Appendix 1E for calculating AC resistance contributed by individual rebar

Item # 11 is not part of current assessment scope.

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

12. IR Drop and True Half Cell Potential Measurements of Epoxy Coated Rebar

IR Drop Between Connection #1 and #2						True Half Cell Potential *
Connection #1 (positive)	Connection #2 (negative)					
	G1	G2	G3	G4	G5	
G1	N/A					
G2		N/A				
G3			N/A			
G4				N/A		
G5					N/A	

* Half cell reading taken on the same rebar with the ground connection

Remarks

Item # 12 is not part of current assessment scope. Enhanced chloride testing program completed in place of epoxy coated rebar corrosion potential surveys.

13. Concrete Air Entrainment

Concrete Air Entrained? Yes __X__ No __--__ Marginal __--__

Air void analysis test results from three cores taken from the deck indicate concrete meets CSA frost resistant concrete requirements.

14. Compressive Strength

Average Compressive Strength __50.9__ MPa

10 cores tested for compressive strength with a combination of both deck layers, HDO layer only, and girder top flange concrete only tested.

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

Component Type & Location: Deck Soffit

OSIM Identifier ___________________

1. Dimensions and Area

Width 54.76 m (Average) Length 86.8 m Height -- m

Diameter -- m Total Area Surveyed 4753 m^2

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	Total	
Medium Width	Clean	--	--	0	0	m
	Stained	--	--	--		
Wide Width	Clean	--	--	0	0	m
	Stained	--	--	--		

Remarks

The interior soffit was noted to have hairline to narrow cracking noted throughout, with cracking predominantly located at plastic rebar chair locations. Signs of leakage / interior girder drainage were noted from the weep holes on all spans. Longitudinal cracks were mostly located over Columns 3 and 4 (centremost column and first column to east of centre) over the piers.

See Soffit defect drawings for illustration.

3. Alkali aggregate reaction

Area of component with severe to very severe aggregate reaction -- m^2.

4. Concrete Cover

Item #s 3 and 4 are not part of current assessment scope

Minimum	Maximum	Average	
--	--	--	mm

0 – 20 mm	--	40 – 60 mm	--	m^2
	--		--	%
20 – 40 mm	--	Over 60 mm	--	m^2
	--		--	%

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

Component & Location: Deck Soffit

5. Corrosion Activity

Minimum	Maximum	Average	
--	--	--	V

0 to - 0.20	-0.20 to - 0.30	- 0.30 to - 0.35	- 0.35 to - 0.45	< - 0.45	V
--	--	--	--	--	m^2
--	--	--	--	--	%

Remarks

Item # 5 is not part of the current assessment scope.

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.22	0	--
Total Delaminations and Spalls		**Total Delaminations and Spalls in Areas ≤ - 0.35**	
0.22 m^2	0.005%	--	--

Rust staining near SU2 pier, appears to come from minor spall with exposed rebar.

7. Scaling

Light	Medium	Severe to Very severe	
--	--	--	m^2
--	--	--	%

No scaling or honeycomb found on deck soffit.

8. Honeycombing

Total Area ____--____ m^2.

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

Component & Location: Deck Soffit

9. Adjusted Chloride Content Profile

Remarks

Corrosion Activity at Core Location (Volts)		**0 to - 0.20**	**- 0.20 to - 0.35**	**≤ - 0.35**
Chloride Content *	**0 – 10 mm**	--	--	--
	20 –30 mm	--	--	--
	40 – 50 mm	--	--	--
	60 – 70 mm	--	--	--
	80 – 90 mm	--	--	--
	100 – 110 m	--	--	--

* Average chloride content as % chloride by weight of concrete after deducting background chlorides for all cores taken in each range of corrosion potential.

10. Chloride Content at Level of Rebar

Core No.	--	--	--	--	--
Chloride content *	--	--	--	--	--

* Chloride content as % chloride by weight of concrete after deducting background chlorides

Item #s 9 to 11 are not part of the current assessment scope.

11. AC Resistance Test Data of Epoxy Coated Rebar

Measured AC Resistance between Connection #1 and #2						Calculated AC Resistance *
Connection #1	Connection #2					
	G1	G2	G3	G4	G5	
G1	N/A					
G2		N/A				
G3			N/A			
G4				N/A		
G5					N/A	

* See Appendix 1E for calculating AC resistance contributed by individual rebar

DETAILED CONDITION SURVEY SUMMARY SHEET
EXPOSED CONCRETE COMPONENTS

Site No. B215

Component & Location: Deck Soffit

12. IR Drop and True Half Cell Potential Measurements of Epoxy Coated Rebar

IR Drop Between Connection #1 and #2						True Half Cell Potential *
Connection #1 (positive)	Connection #2 (negative)					
	G1	G2	G3	G4	G5	
G1	N/A					
G2		N/A				
G3			N/A			
G4				N/A		
G5					N/A	

* Half cell reading taken on the same rebar with the ground connection

Remarks

Item #s 12 to 14 are not part of the current assessment scope.

13. Concrete Air Entrainment

Concrete Air Entrained? Yes -- No -- Marginal --

14. Compressive Strength

Average Compressive Strength -- MPa

DETAILED CONDITION SURVEY SUMMARY SHEET
DRAINAGE

Site No. B215

Remarks

Deck Drains	Number	Type	Length	Angle	Depth*
	8	305 mm x 203 HSS drain down pipes	1450 & 1850 mm	--	--

* For asphalt covered deck, recess depth in mm between top of asphalt and top of drain

Deck and sidewalk drains are combined

Catch Basins	Yes		

* Identify location of catch basins as N/E, N/W, S/E etc. using the same direction of north as shown in the drawings

There are drainage catch basins below the drains at the NW, NE, SW, SE corners of the slope paving and corresponding drainage troughs.

.

Drainage Tube	No	Void Drains	No

Appendix B

Survey Equipment and Calibration

SURVEY EQUIPMENT AND CALIBRATION PROCEDURES

Site No. B215

Component Type & Location: Deck Top Northbound and Southbound Lanes

1. **Delaminations:**
   Weight of Chain: 1.68 kg/m; with 50 mm links
   Other Equipment: Rotary delamination tool

2. **Concrete Cover:**

   Covermeter Make & Model: Proceq Profometer
   Battery Check: Reading at Start of Test: OK
   Reading at End of Test: OK
   Concrete Cover Check: Location of Check: various locations throughout structure elements inspected

   Actual Depth & Rebar Dia: ____
   Reading Before Test: ____
   Reading Each 30 min During Test: ____
   Reading End of Test: ____

3. **Corrosion Activity:** Not in scope for assignment

   Half Cell Make & Model: ____
   Multimeter Make & Model: ____
   Length and Gauge of Lead Wires: ____
   Deck Temp: Start of Test: ____°C End of Test: ____°C
   Ambient Temp: Start of Test: ____°C End of Test: ____°C
   Battery Check: ____
   Ground Check: Method of Connection: ____
   Ground Location: ____ Check Location: ____
   Lead Resistance: ____ Voltage Drop (mV's): ____
   Resistance: ____ Resistance Reversed: ____

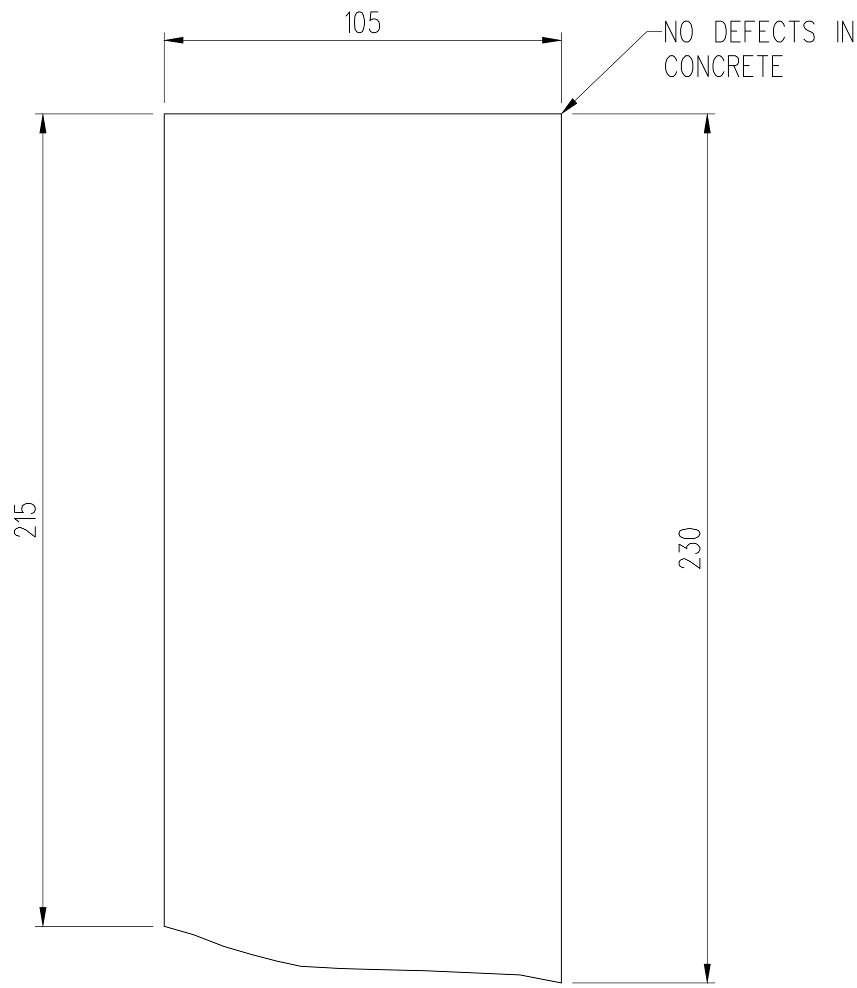
   Grid Point Potential Readings Check - See Table Below

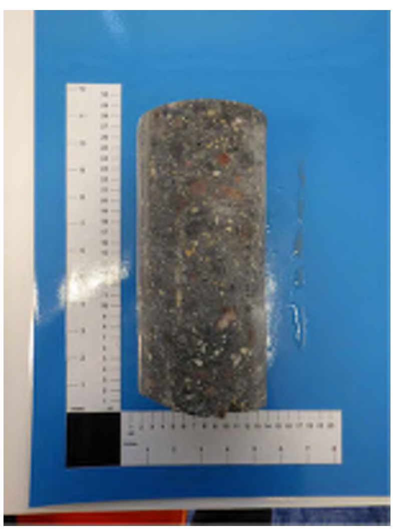
Location	Initial Reading	Check Reading∗	Check Reading-Latex Concrete Overlay ∗∗
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A

∗ Check at least 5 readings at beginning of test and each change in ground.
∗∗ On decks with latex modified concrete overlay, check at least 5 locations by drilling holes through the latex concrete overlay into the original concrete substrate.

Appendix C

Core Pictures and Sketches

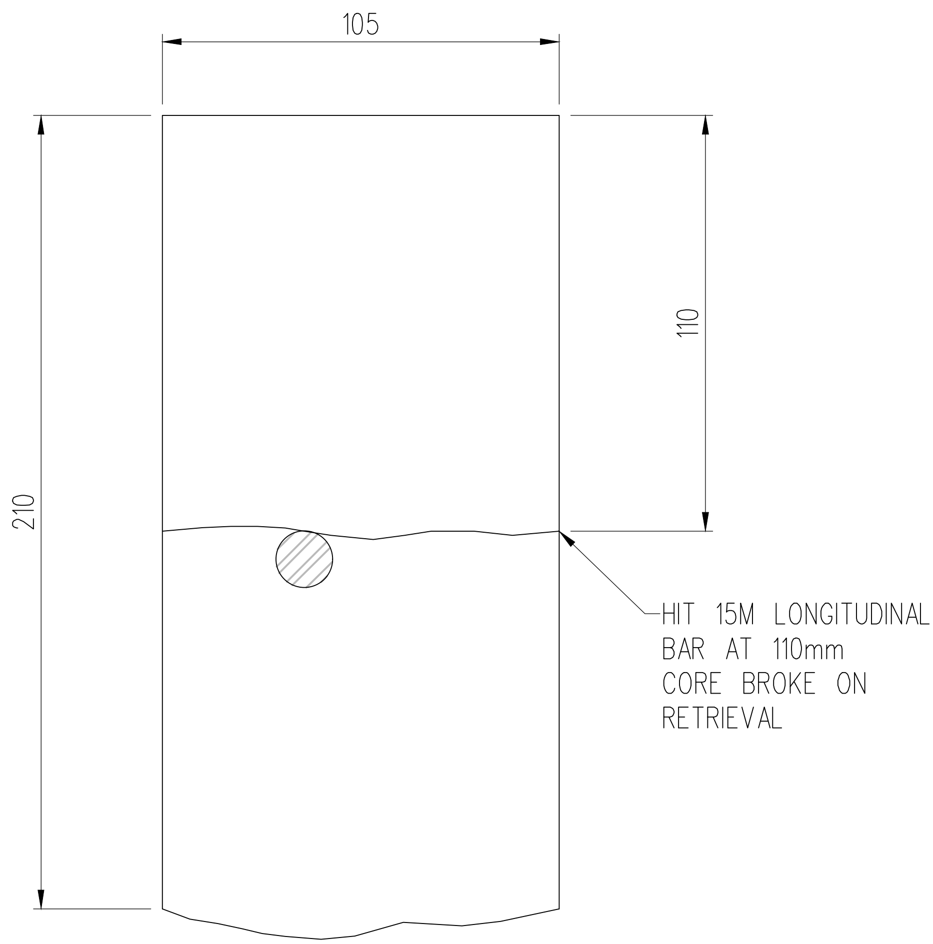




LEGEND

ORIGINAL CONCRETE

STEEL REINFORCEMENT



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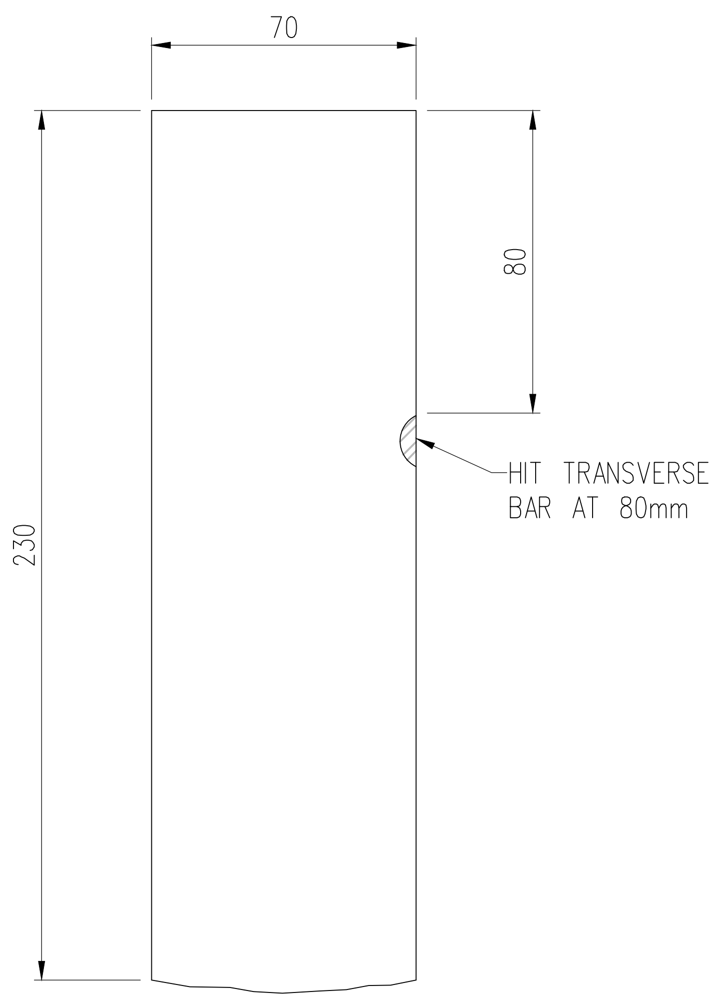

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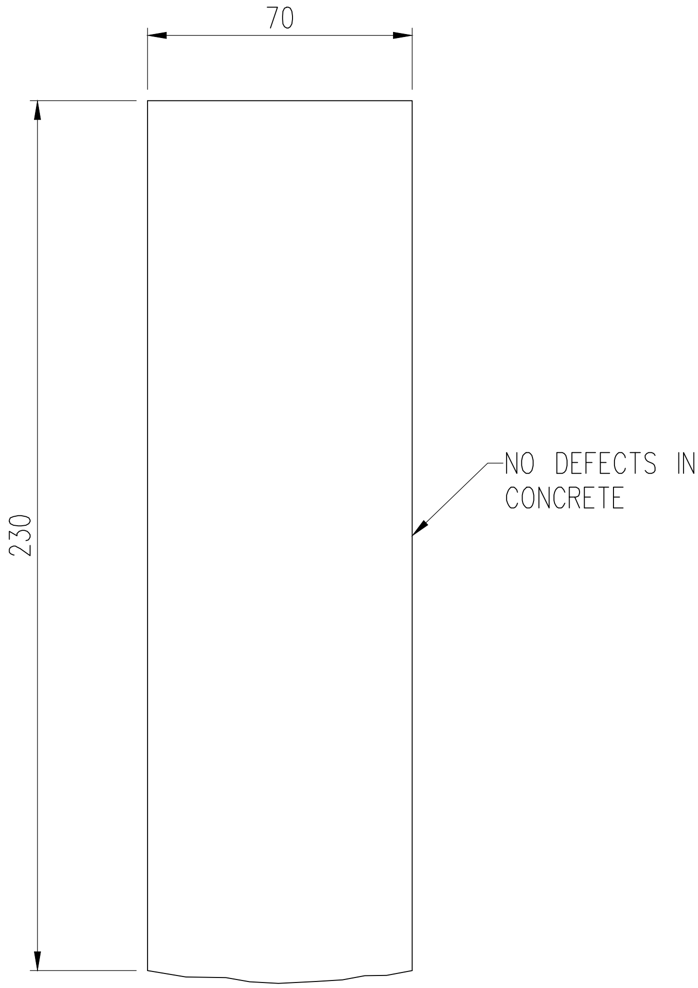

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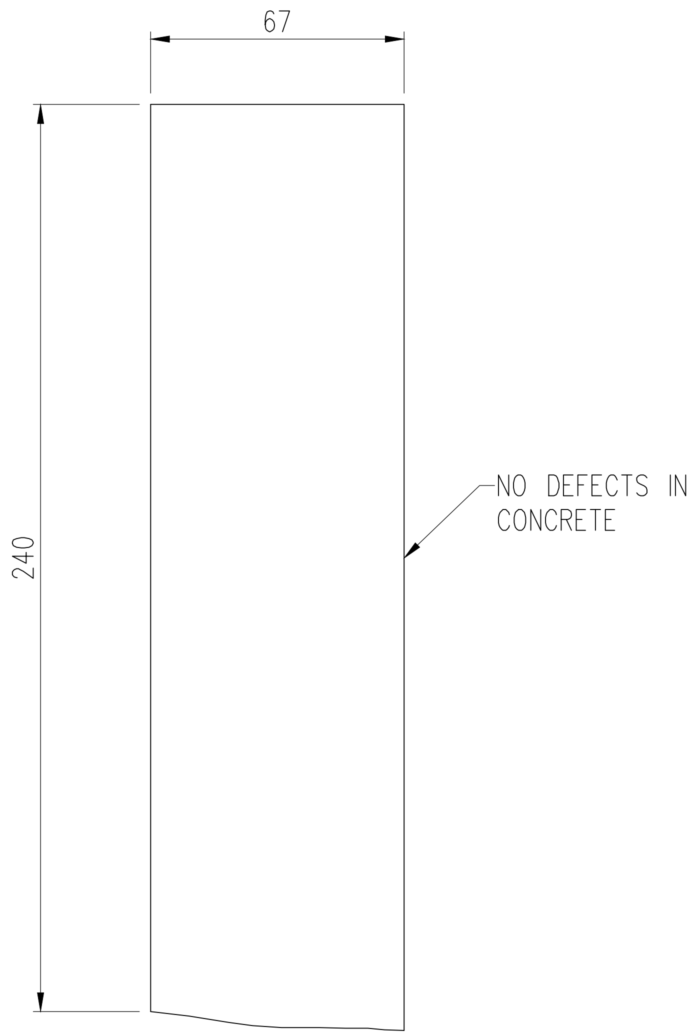
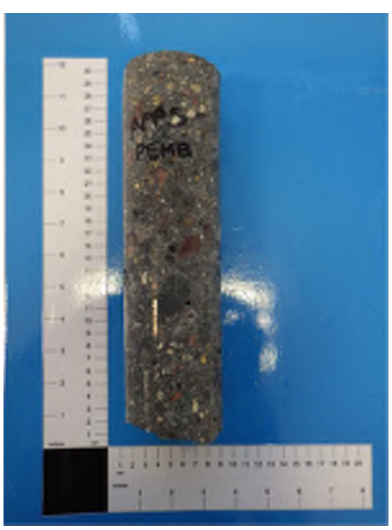
ORIGINAL CONCRETE

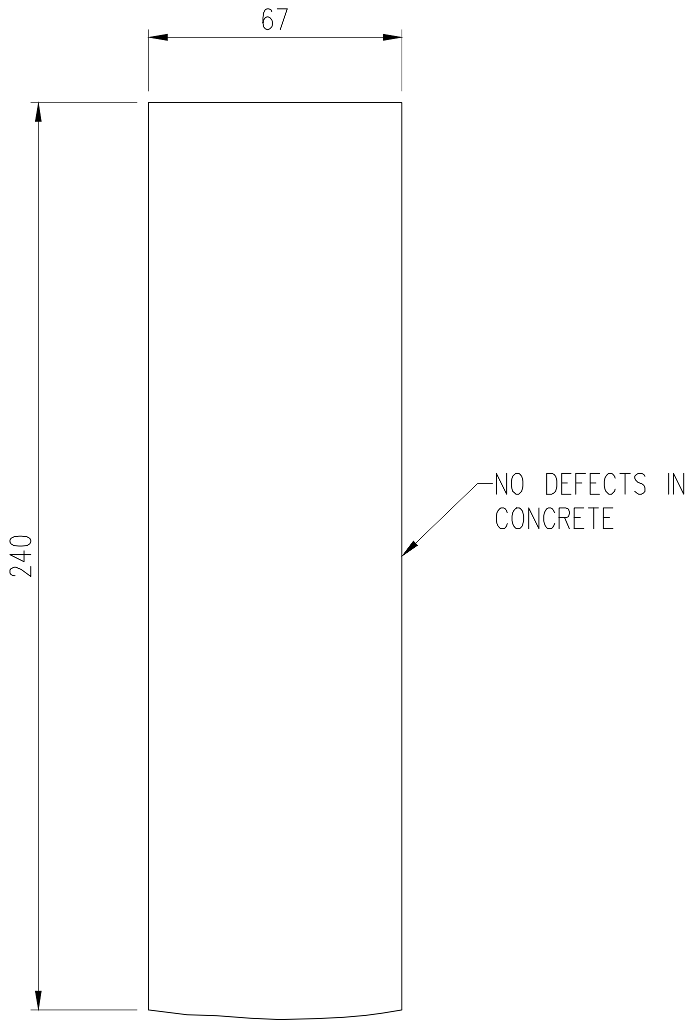
STEEL REINFORCEMENT





LEGEND

ORIGINAL CONCRETE   STEEL REINFORCEMENT



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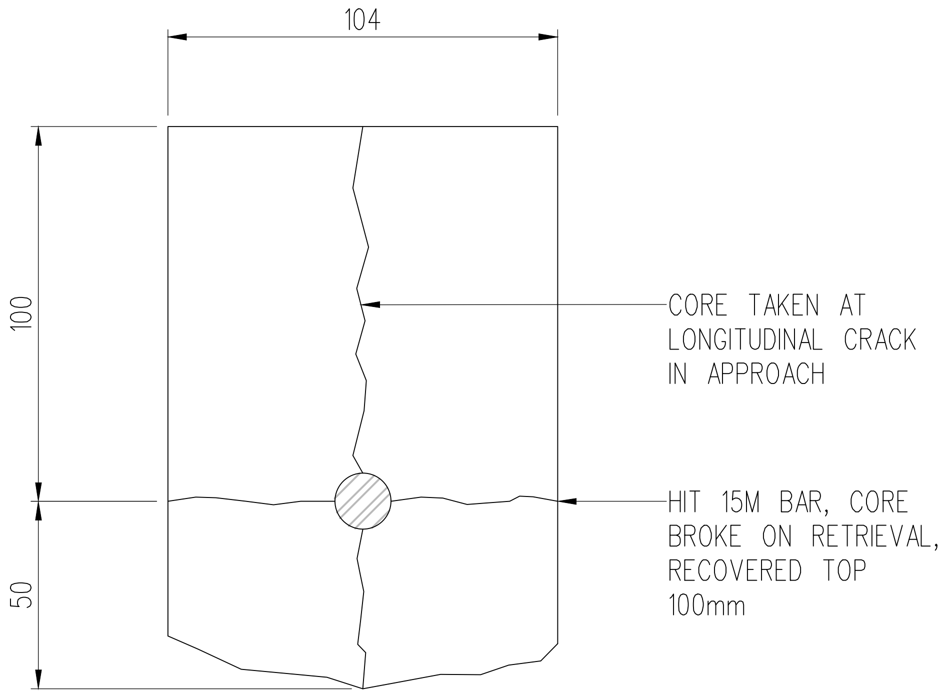
ORIGINAL CONCRETE

STEEL REINFORCEMENT



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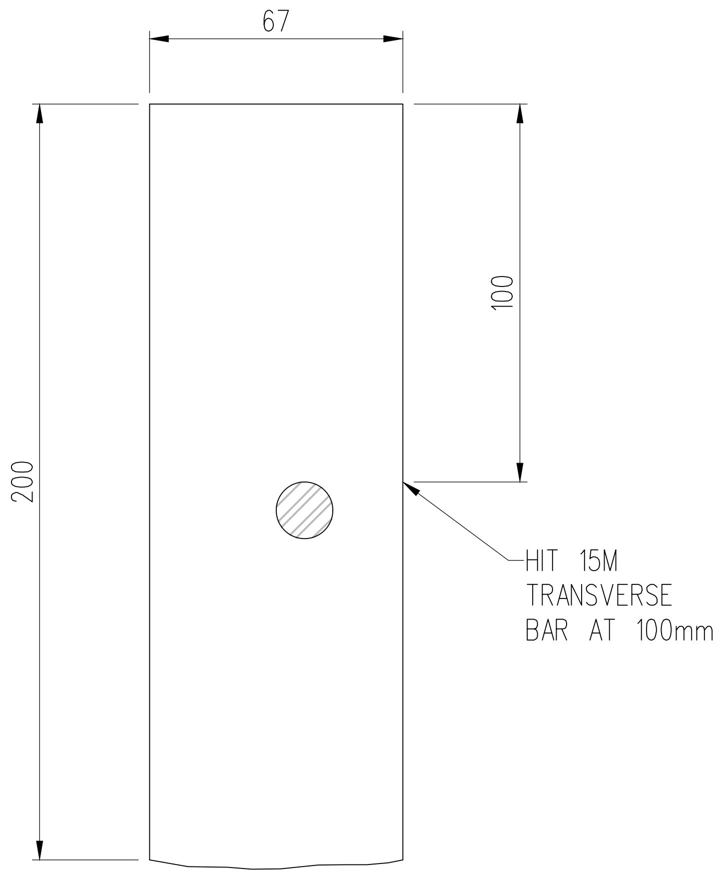
STEEL REINFORCEMENT



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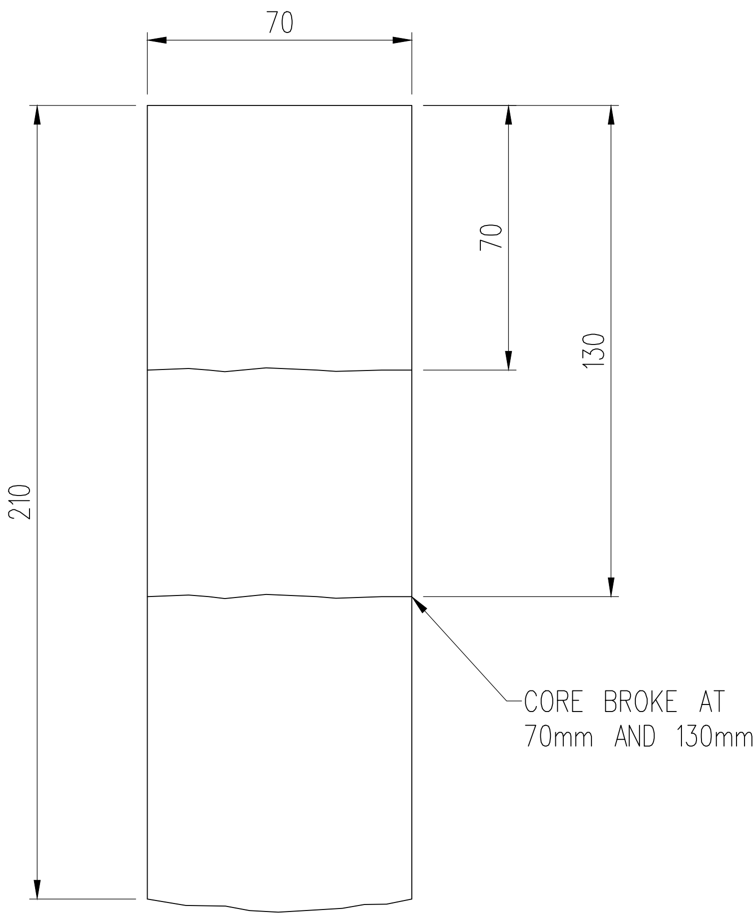
STEEL REINFORCEMENT



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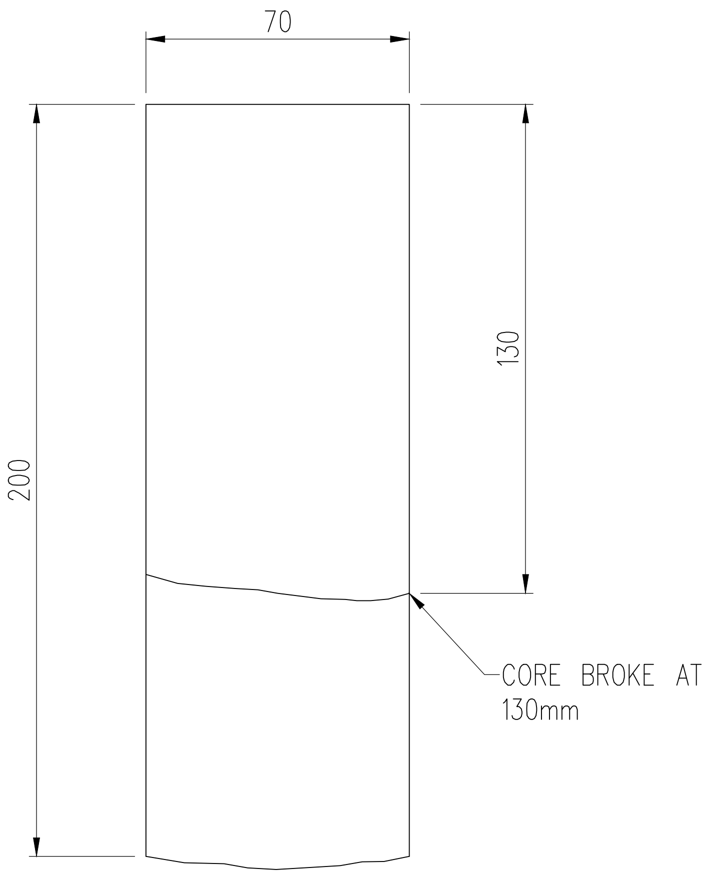
STEEL REINFORCEMENT



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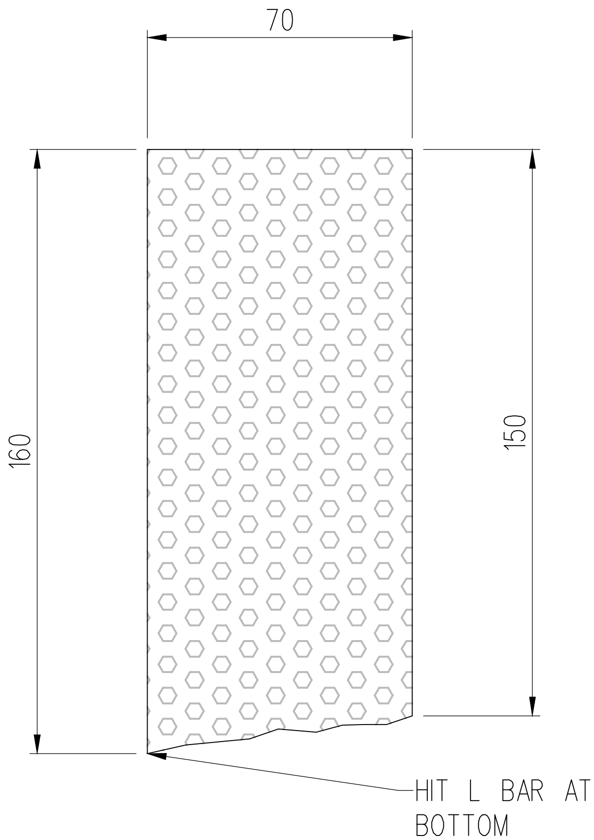
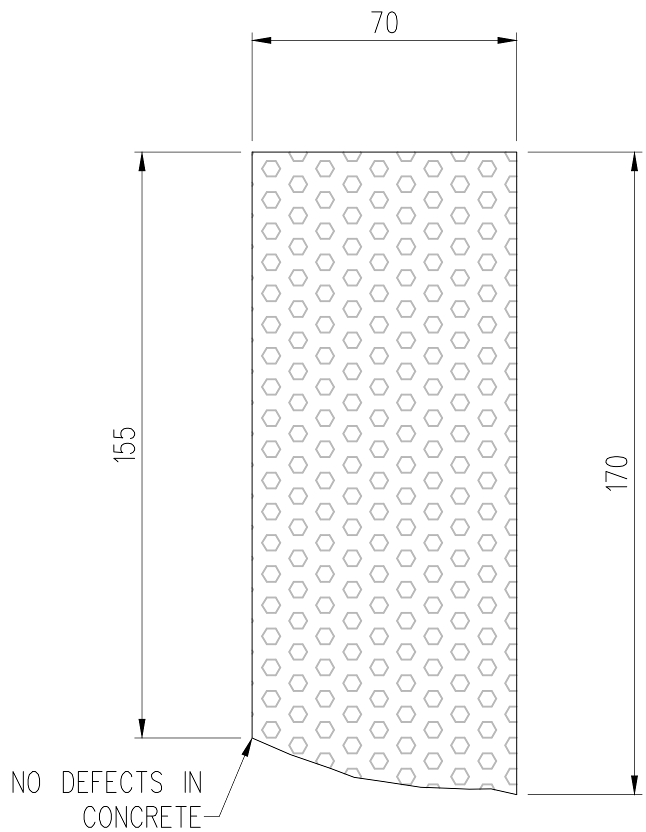
STEEL REINFORCEMENT



LEGEND

ORIGINAL CONCRETE

HIGH DENSITY OVERLAY



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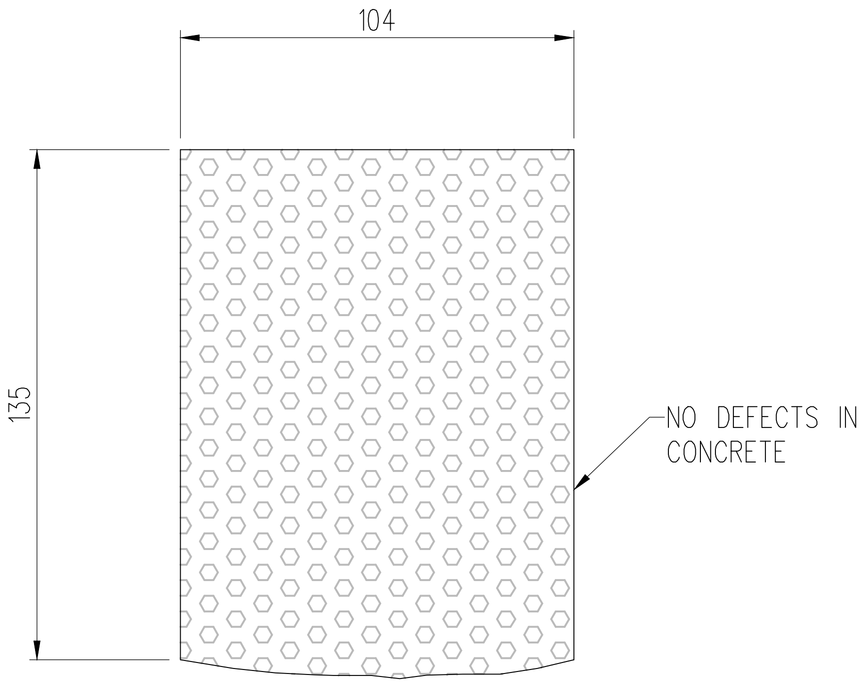
ORIGINAL CONCRETE

HIGH DENSITY OVERLAY



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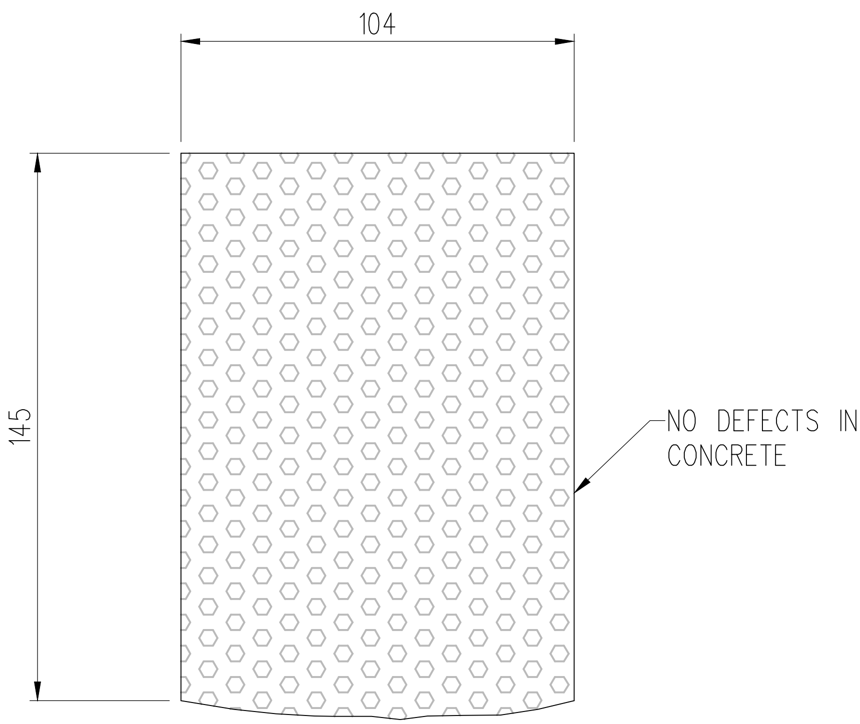
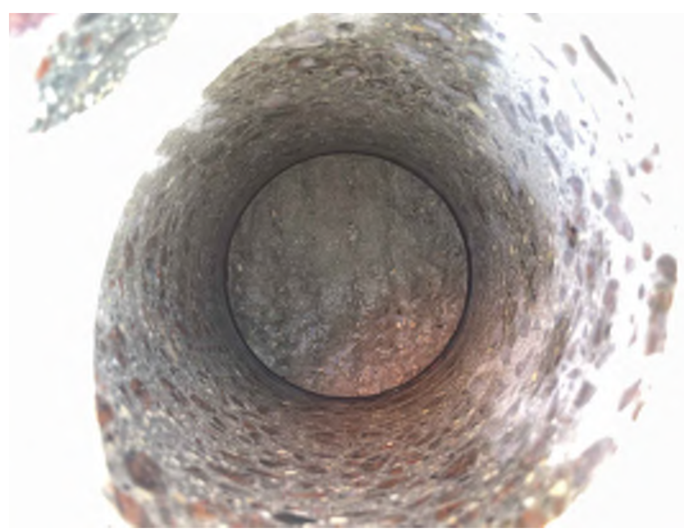
ORIGINAL CONCRETE

HIGH DENSITY OVERLAY





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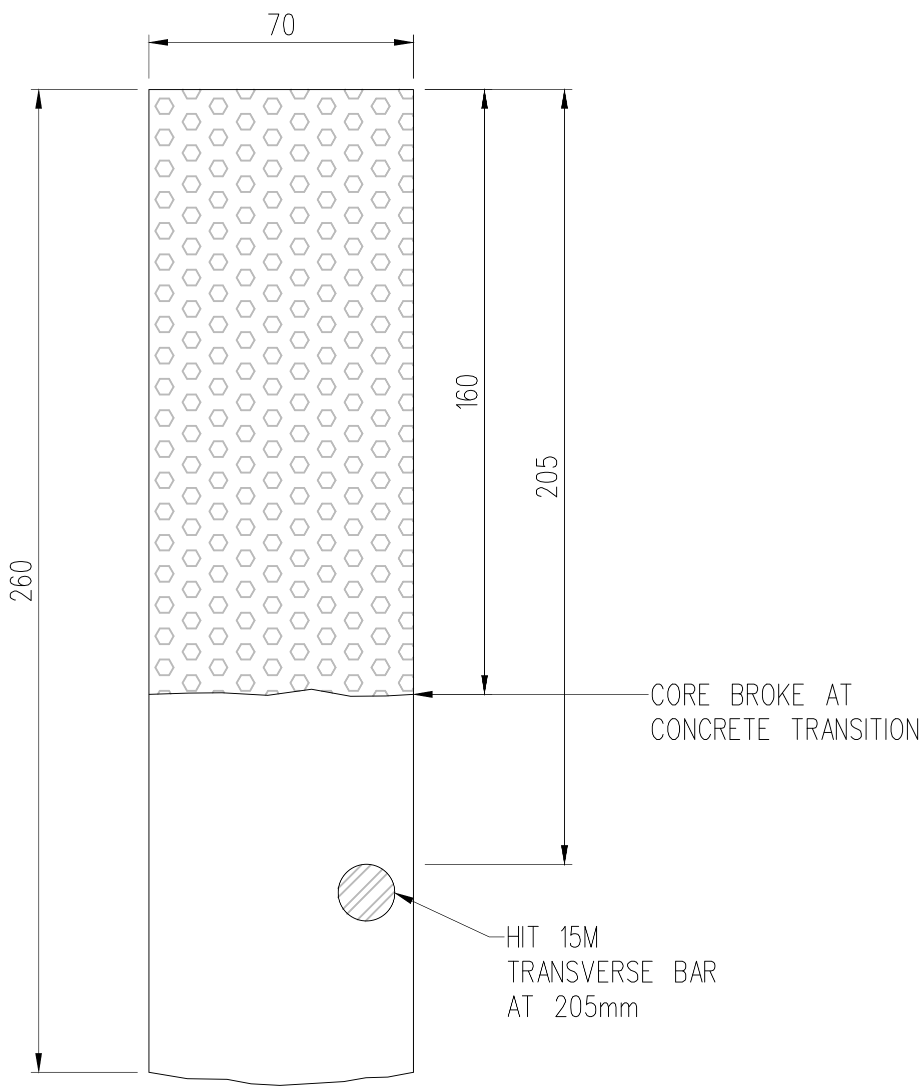
ORIGINAL CONCRETE

HIGH DENSITY OVERLAY



LEGEND

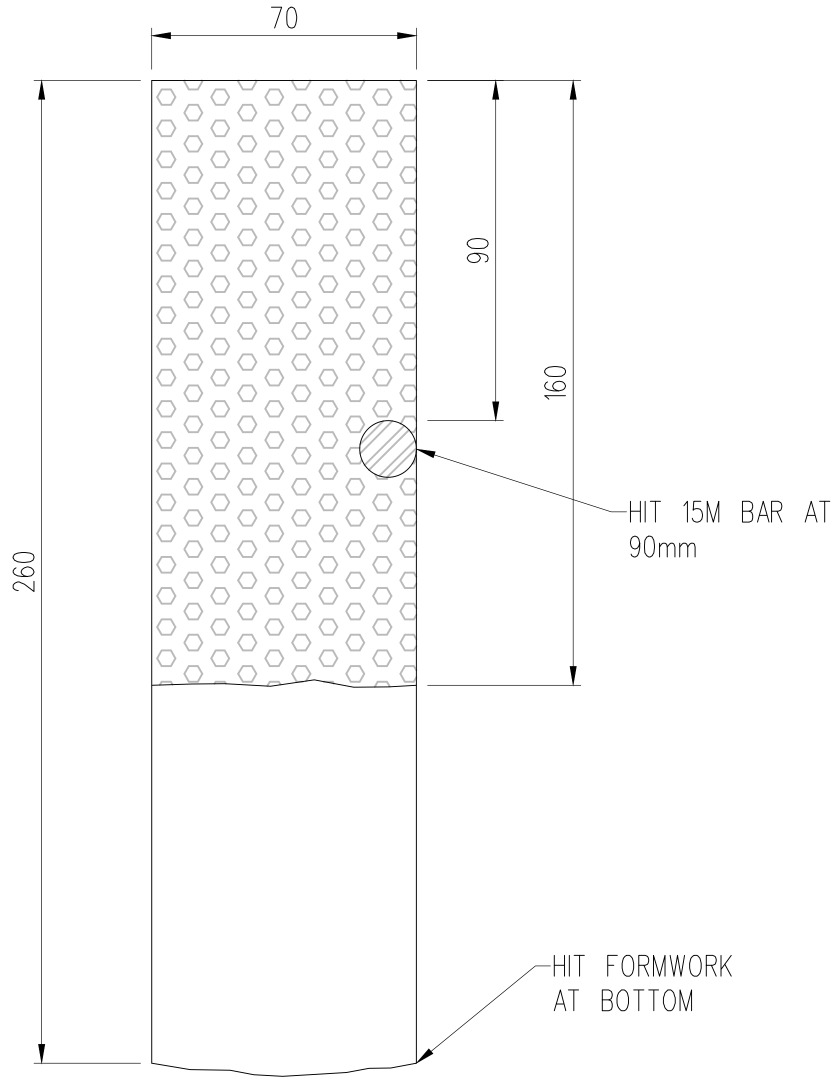
ORIGINAL CONCRETE | HIGH DENSITY OVERLAY | STEEL REINFORCEMENT

Morrison Hershfield | Winnipeg

PEMBINA / ABINOJII OVERPASS CONDITION ASSESSMENT
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

CORE: D5
LOCATION: NB CURB
CORE LOG SKETCH
SCALE = 1:2 - DRAWN BY: AS

Last Saved: December 14, 2023, by ascott Plotted: December 20, 2023, by Allan Scott

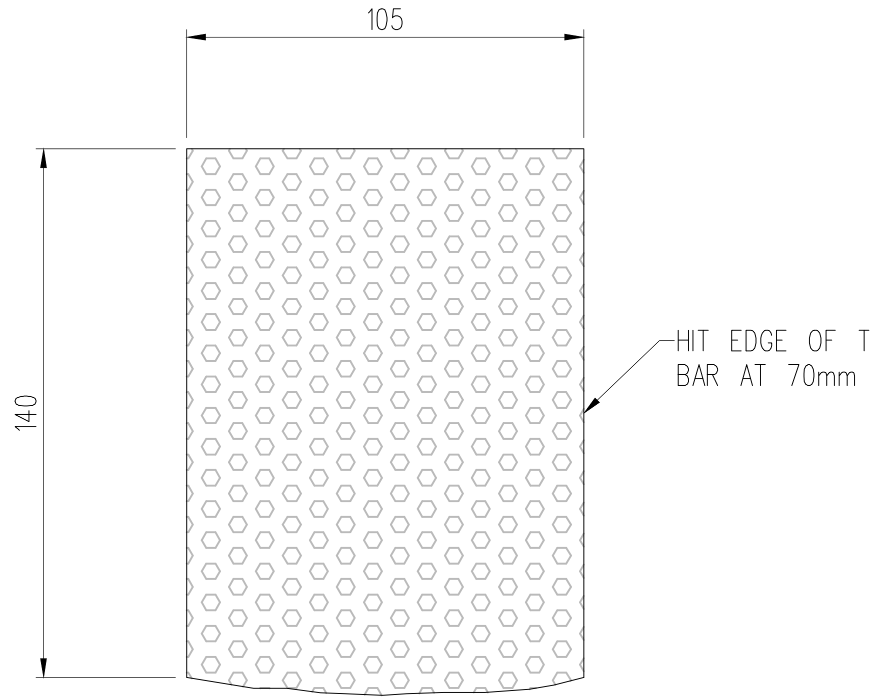


LEGEND

ORIGINAL CONCRETE

HIGH DENSITY OVERLAY

STEEL REINFORCEMENT

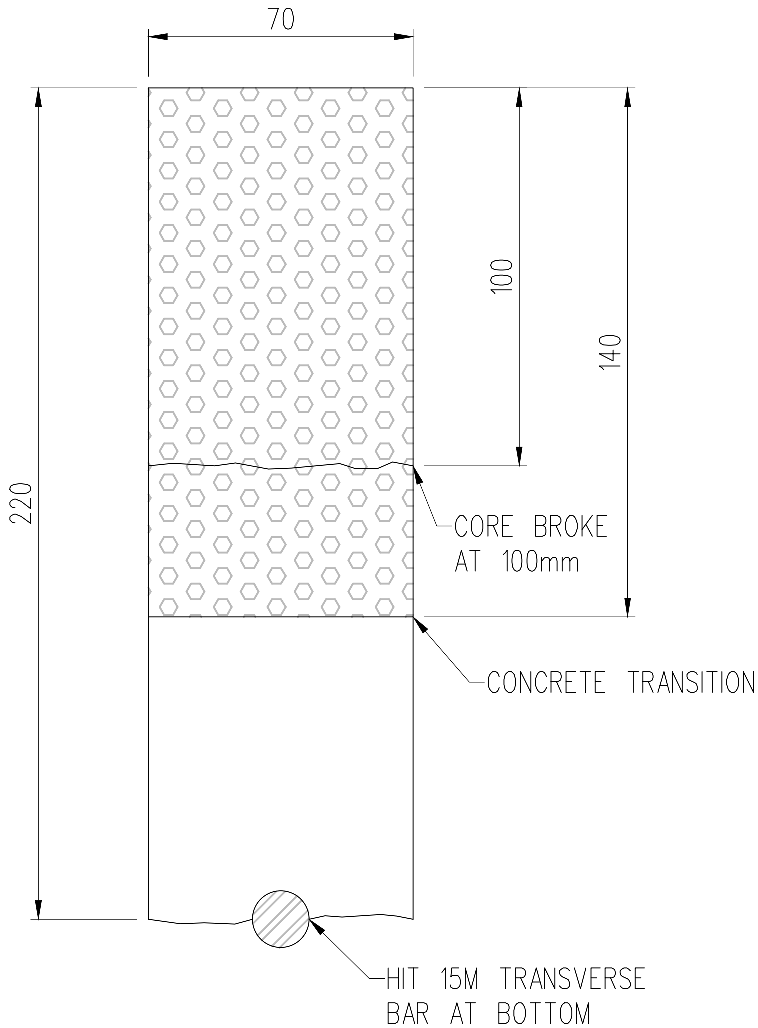


LEGEND

ORIGINAL CONCRETE

HIGH DENSITY OVERLAY

CORE: D7
LOCATION: NB CURB
CORE LOG SKETCH
SCALE = 1:2 - DRAWN BY: AS



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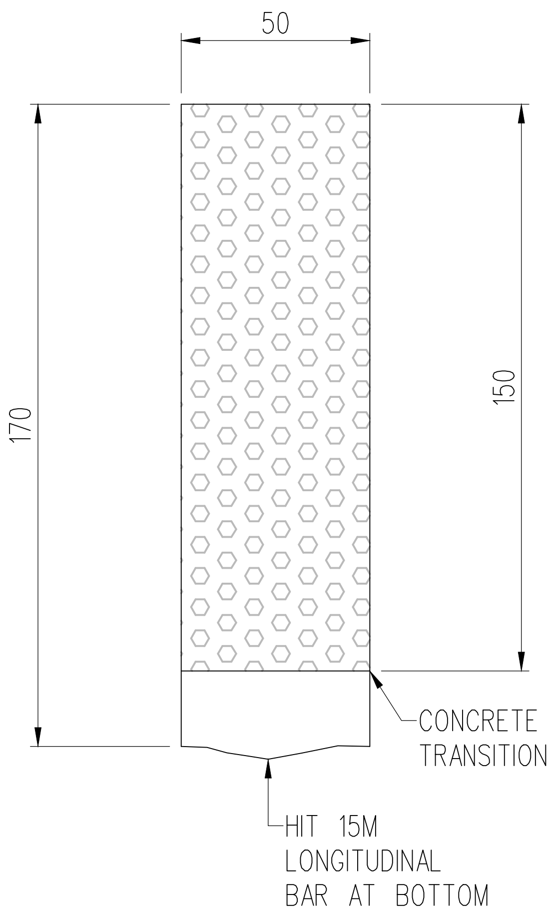
ORIGINAL CONCRETE | HIGH DENSITY OVERLAY | STEEL REINFORCEMENT



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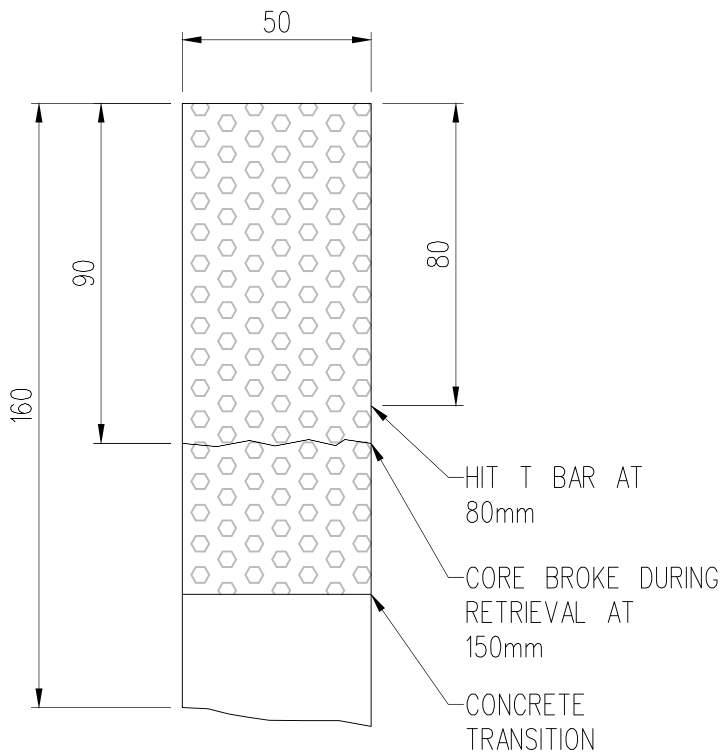

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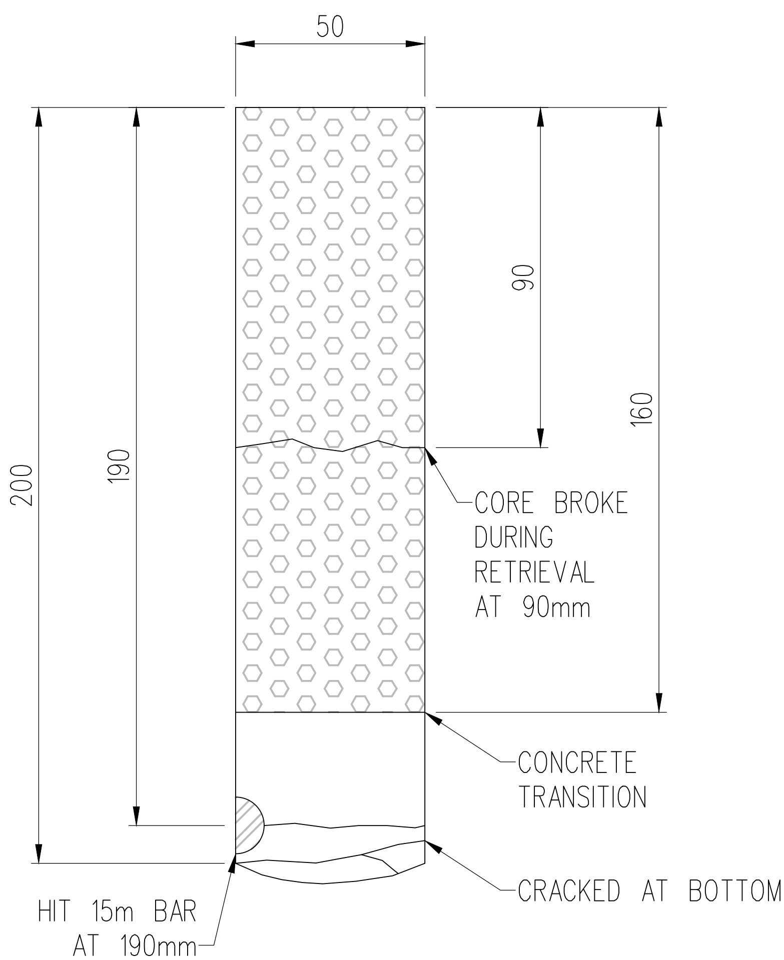

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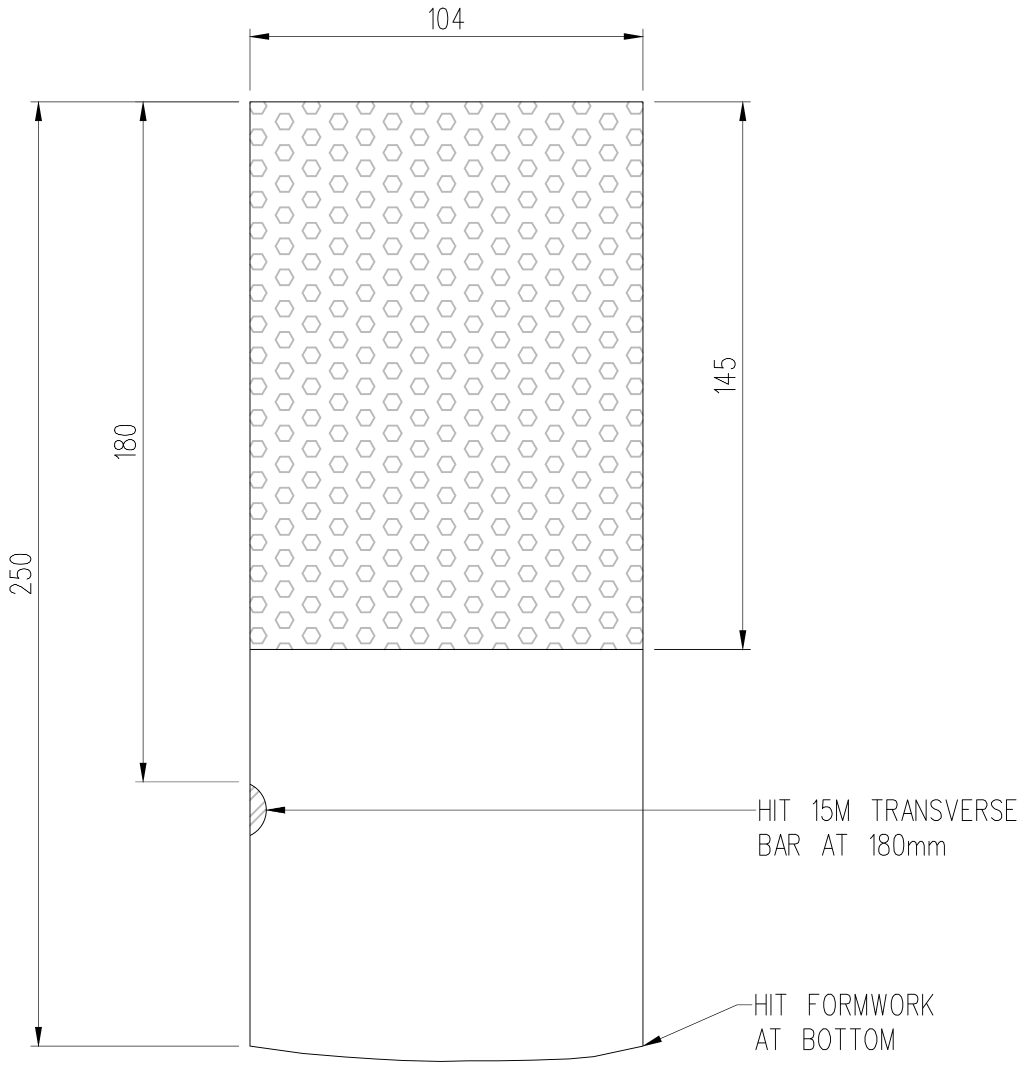
ORIGINAL CONCRETE | HIGH DENSITY OVERLAY | STEEL REINFORCEMENT



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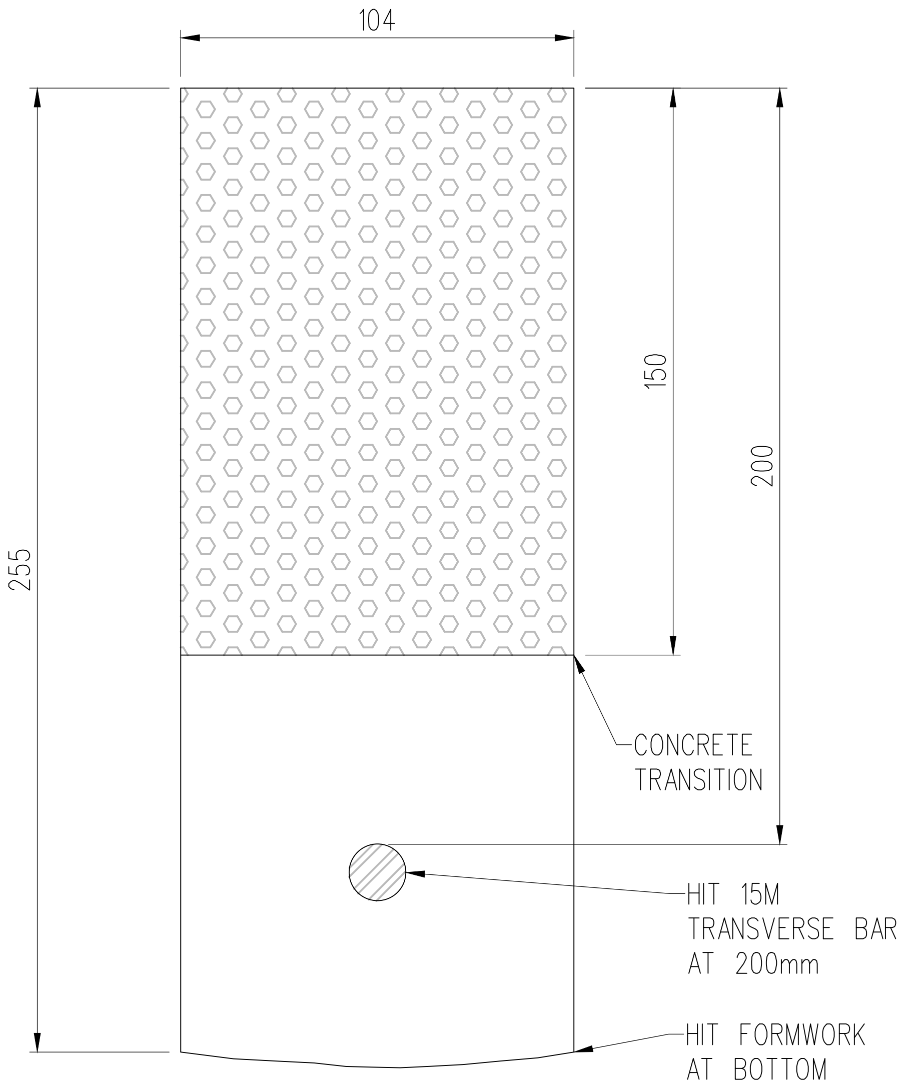
HIGH DENSITY OVERLAY

STEEL REINFORCEMENT



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ORIGINAL CONCRETE

HIGH DENSITY OVERLAY

STEEL REINFORCEMENT

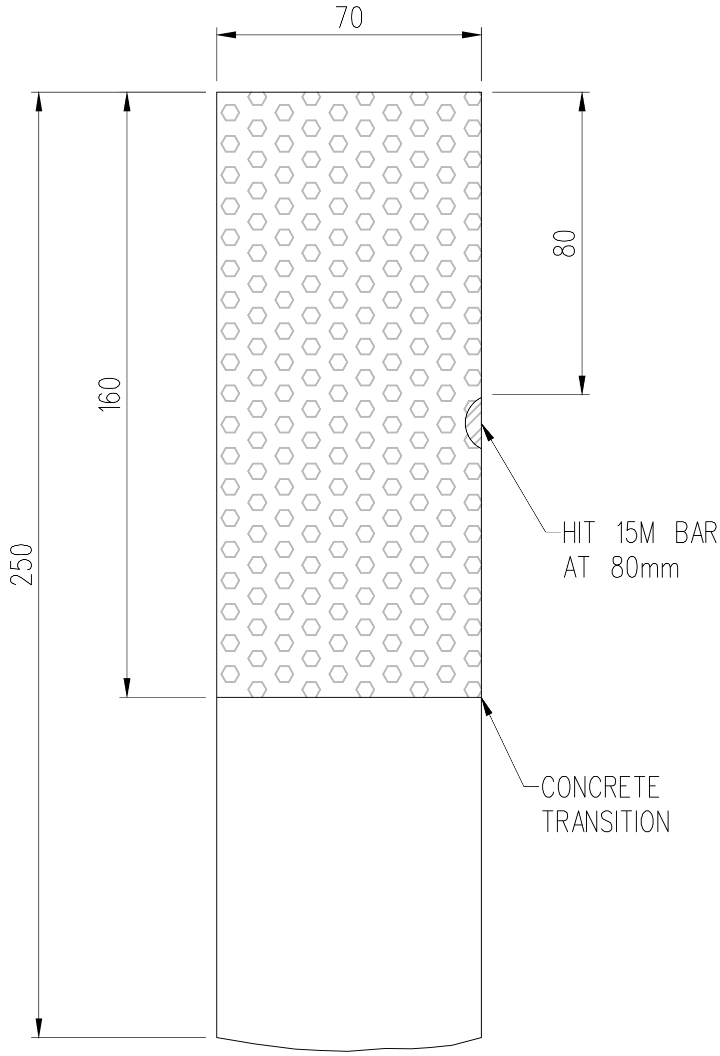
MORRISON HERSHFIELD

Winnipeg

PEMBINA / ABINOJII OVERPASS CONDITION ASSESSMENT
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

CORE: D13
LOCATION: NB MEDIAN
CORE LOG SKETCH
SCALE = 1:2 - DRAWN BY: AS

Last Saved: December 14, 2023, by ascott Plotted: December 20, 2023, by Allan Scott



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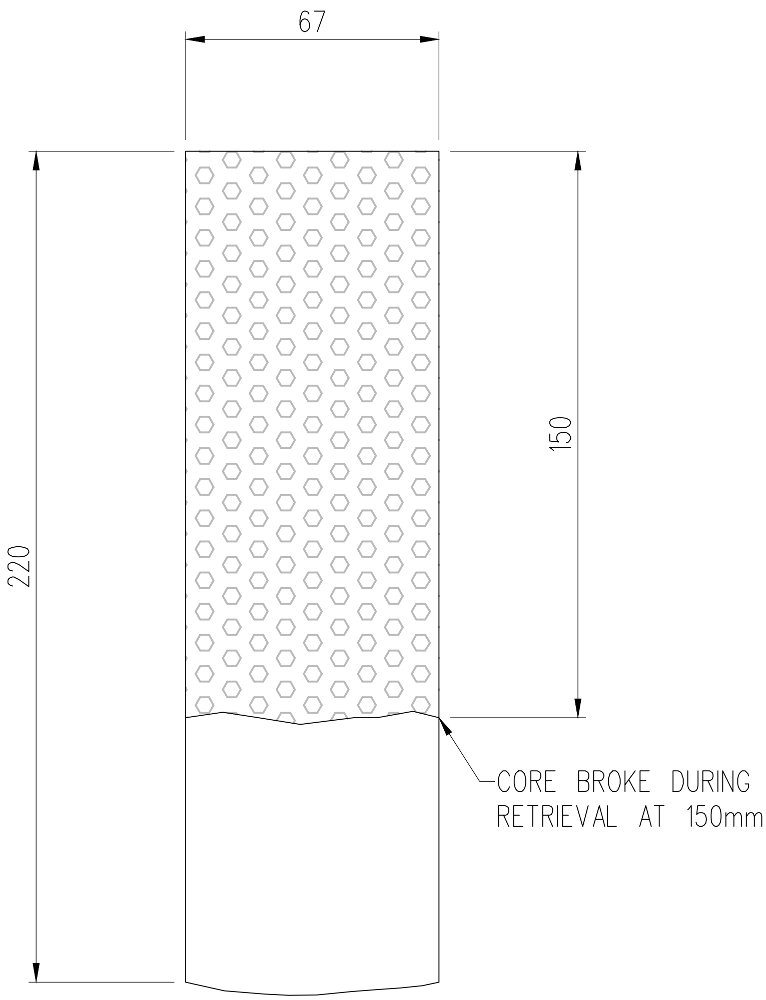
ORIGINAL CONCRETE | HIGH DENSITY OVERLAY | STEEL REINFORCEMENT



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HIGH DENSITY OVERLAY

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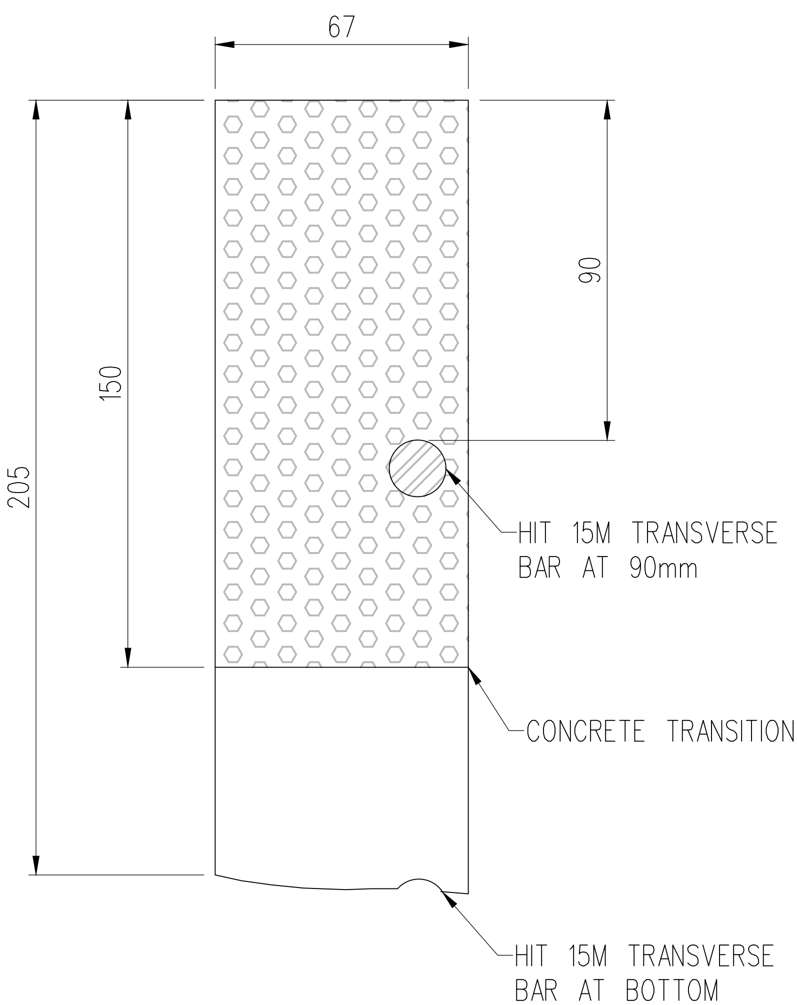

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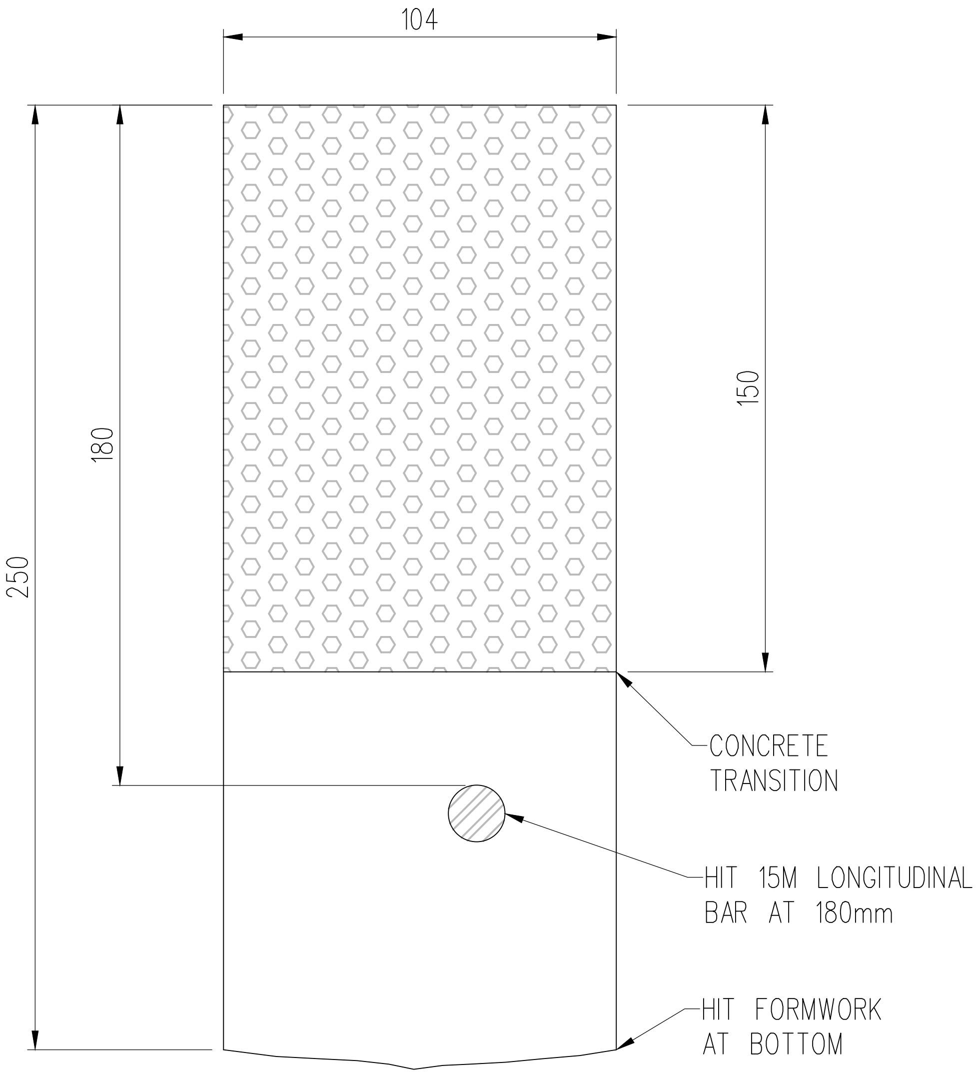

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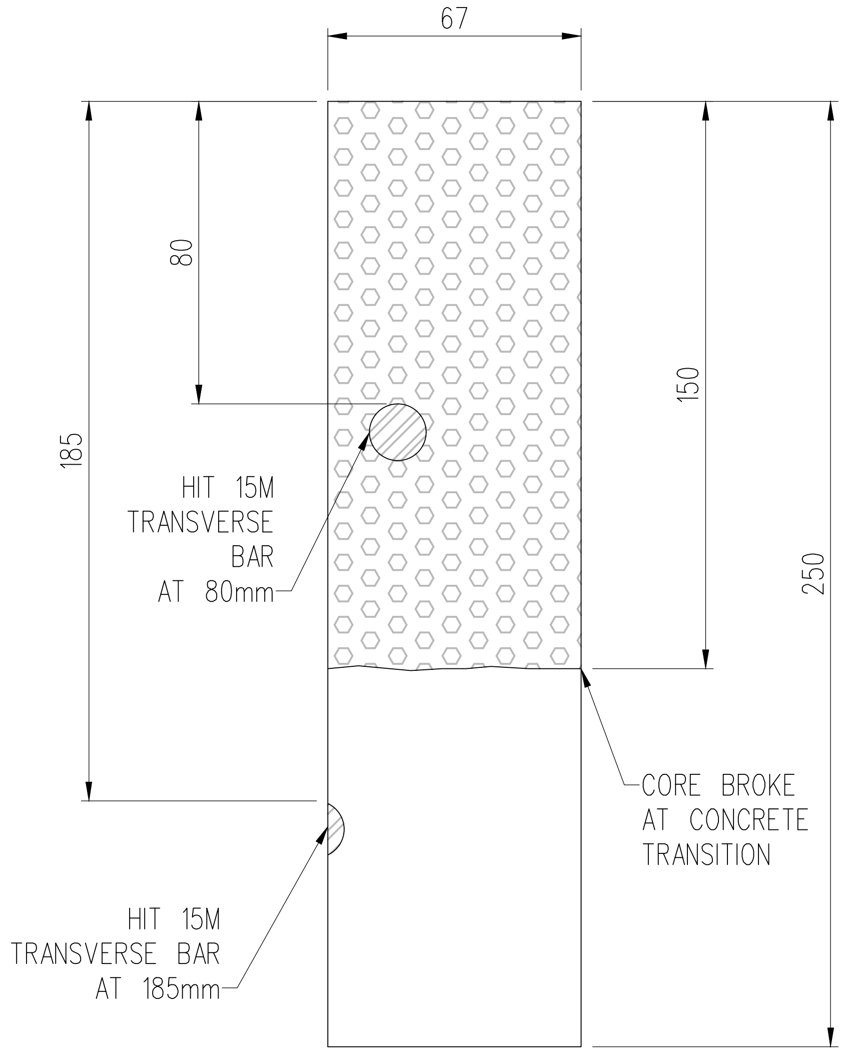

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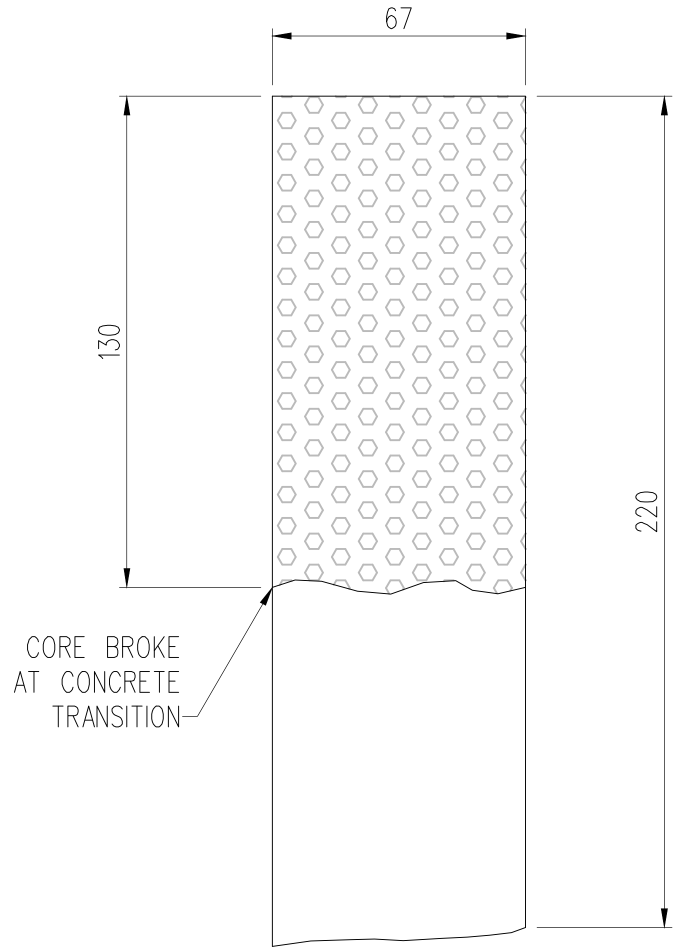
ORIGINAL CONCRETE

HIGH DENSITY OVERLAY

STEEL REINFORCEMENT



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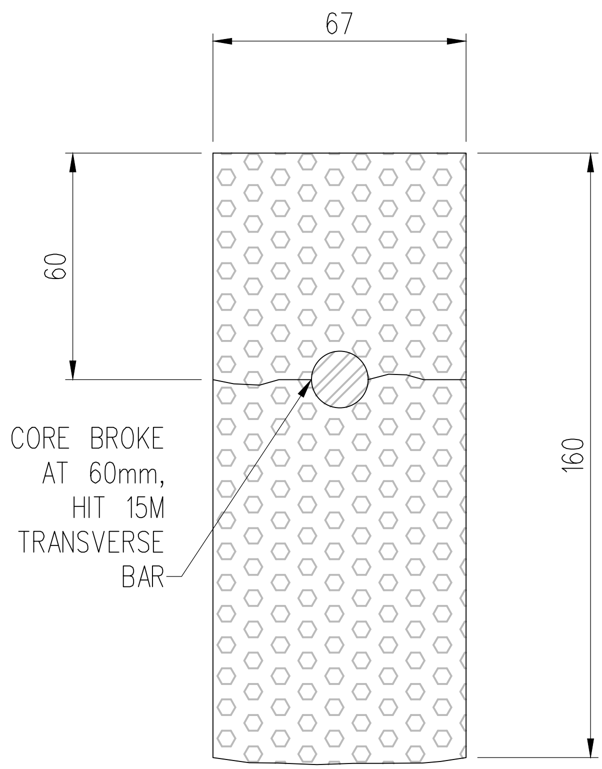

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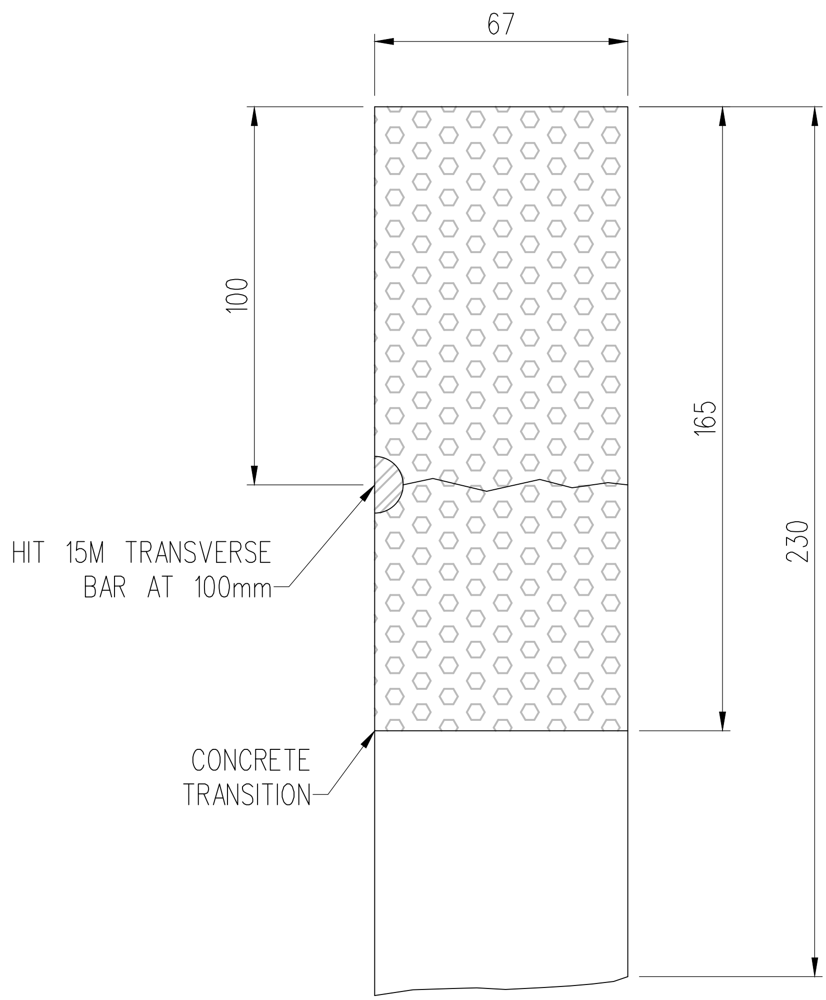

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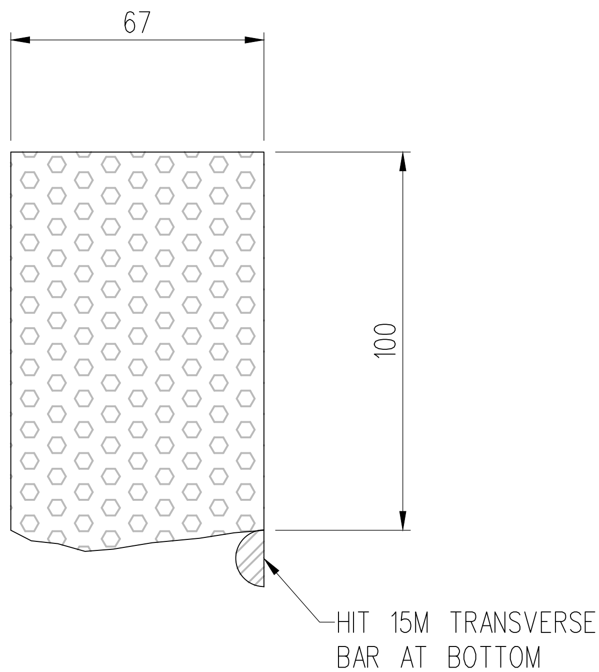

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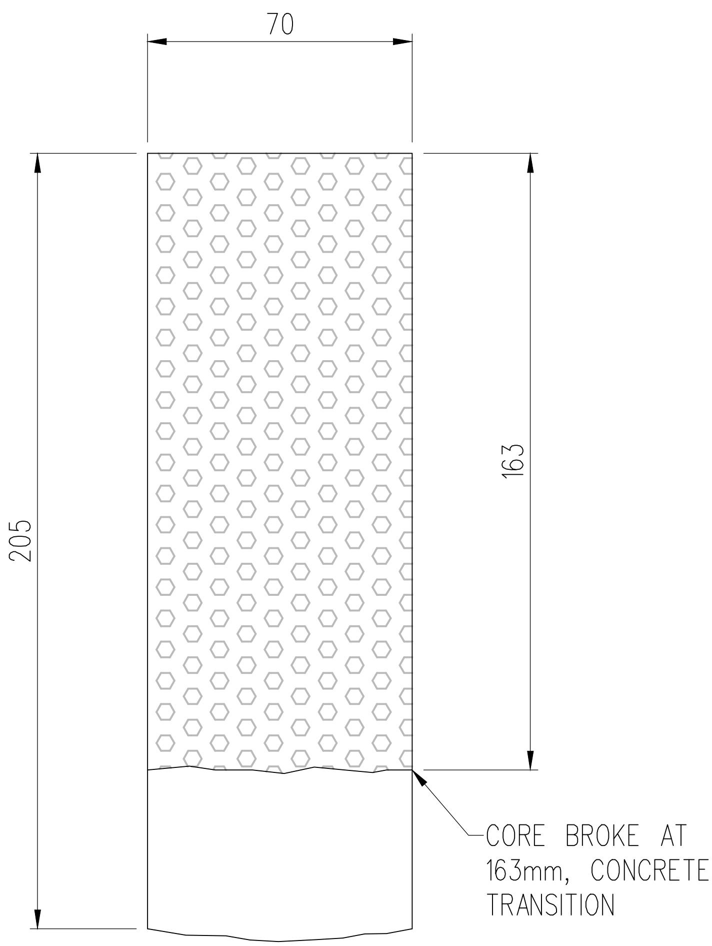
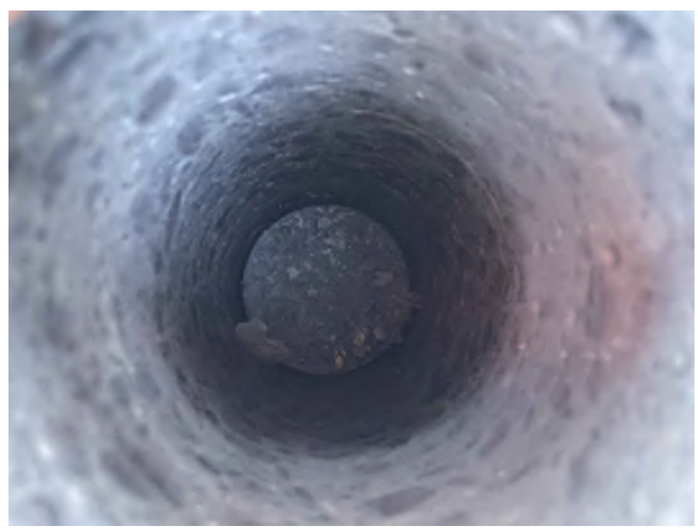
ORIGINAL CONCRETE　HIGH DENSITY OVERLAY　STEEL REINFORCEMENT





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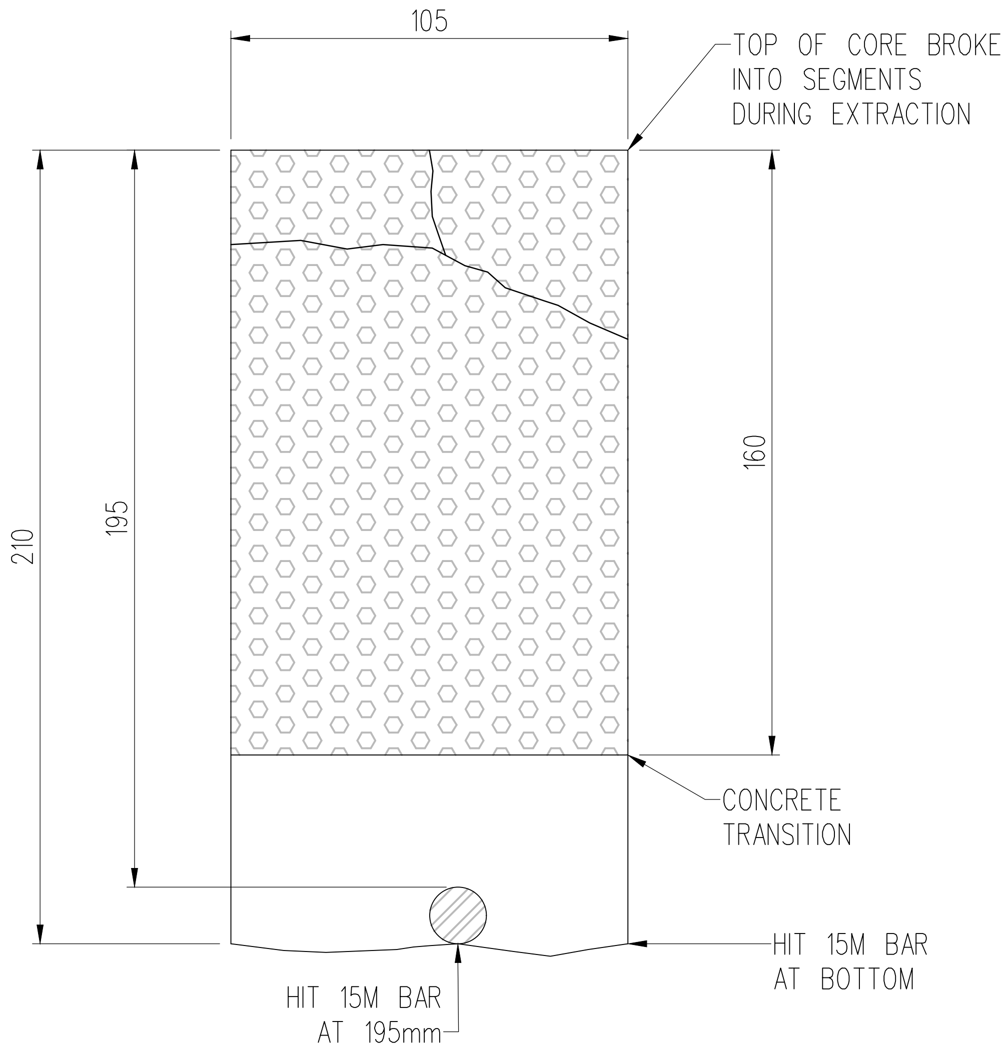

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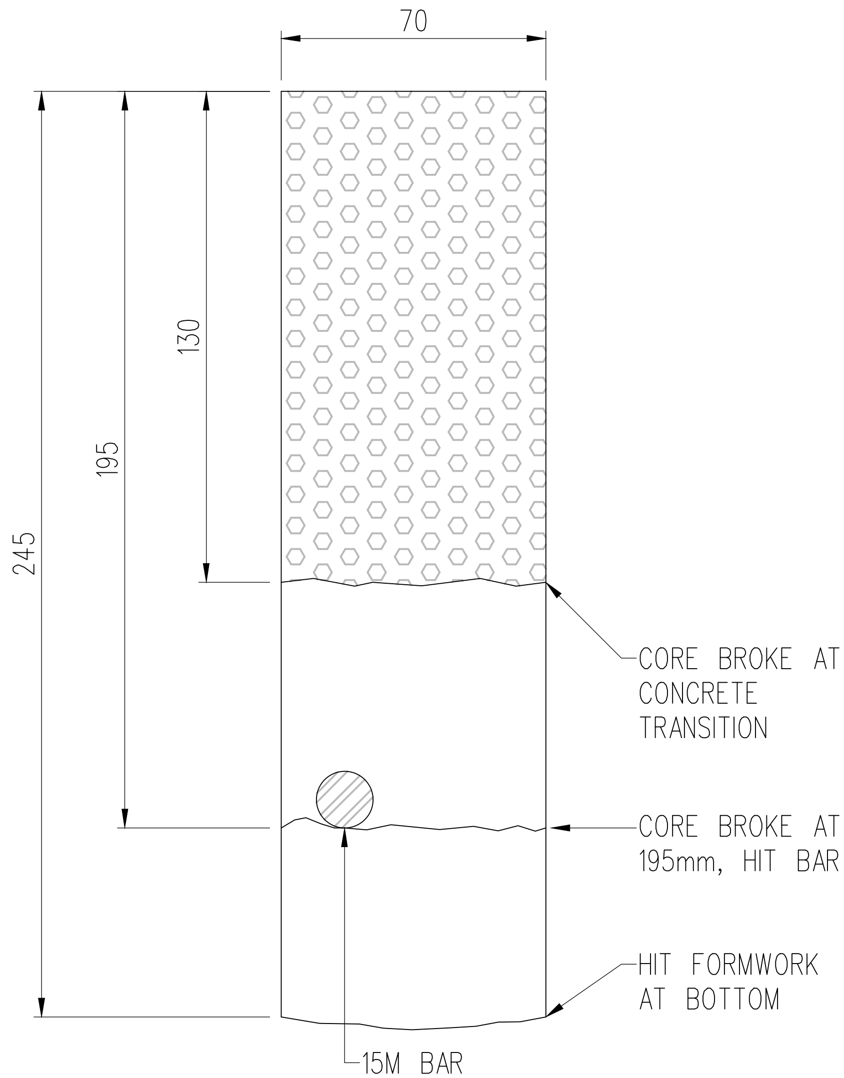
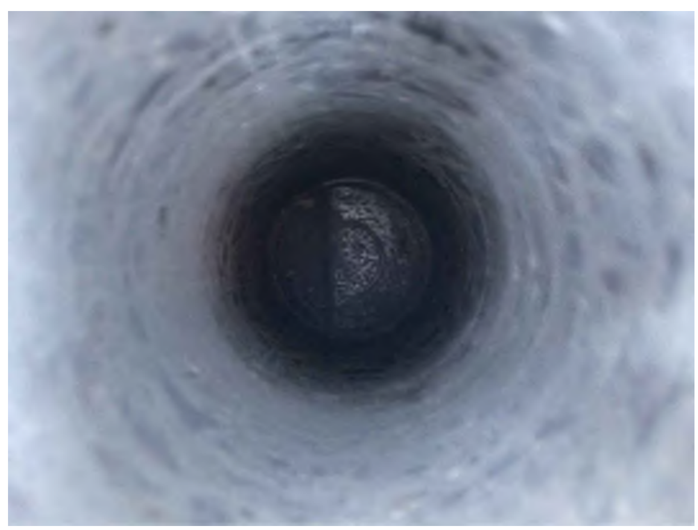
ORIGINAL CONCRETE | HIGH DENSITY OVERLAY | STEEL REINFORCEMENT





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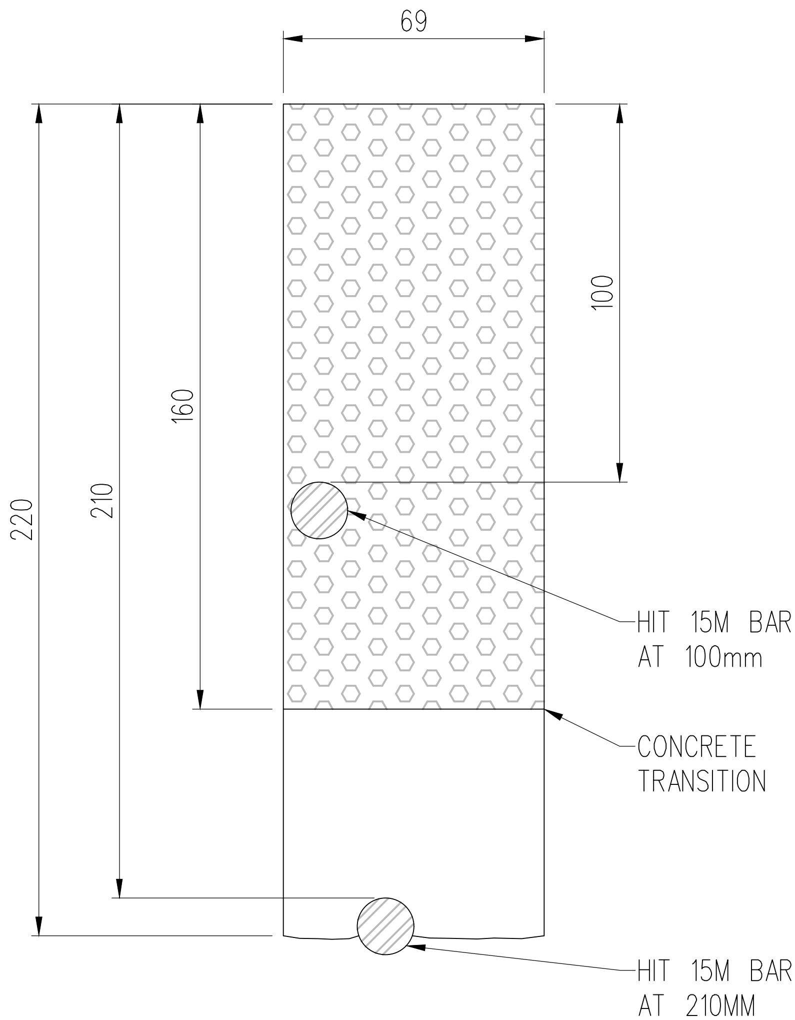
HIGH DENSITY OVERLAY

STEEL REINFORCEMENT



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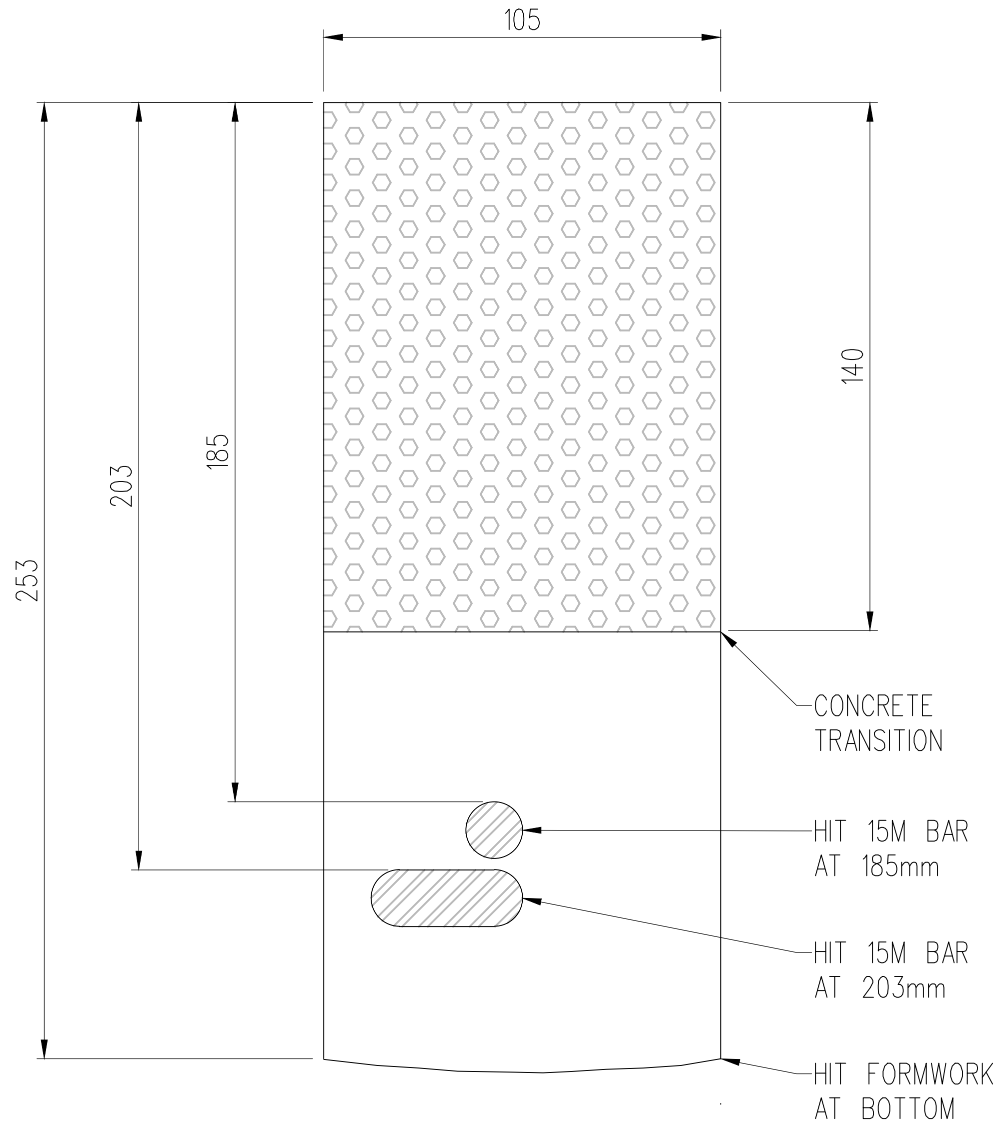

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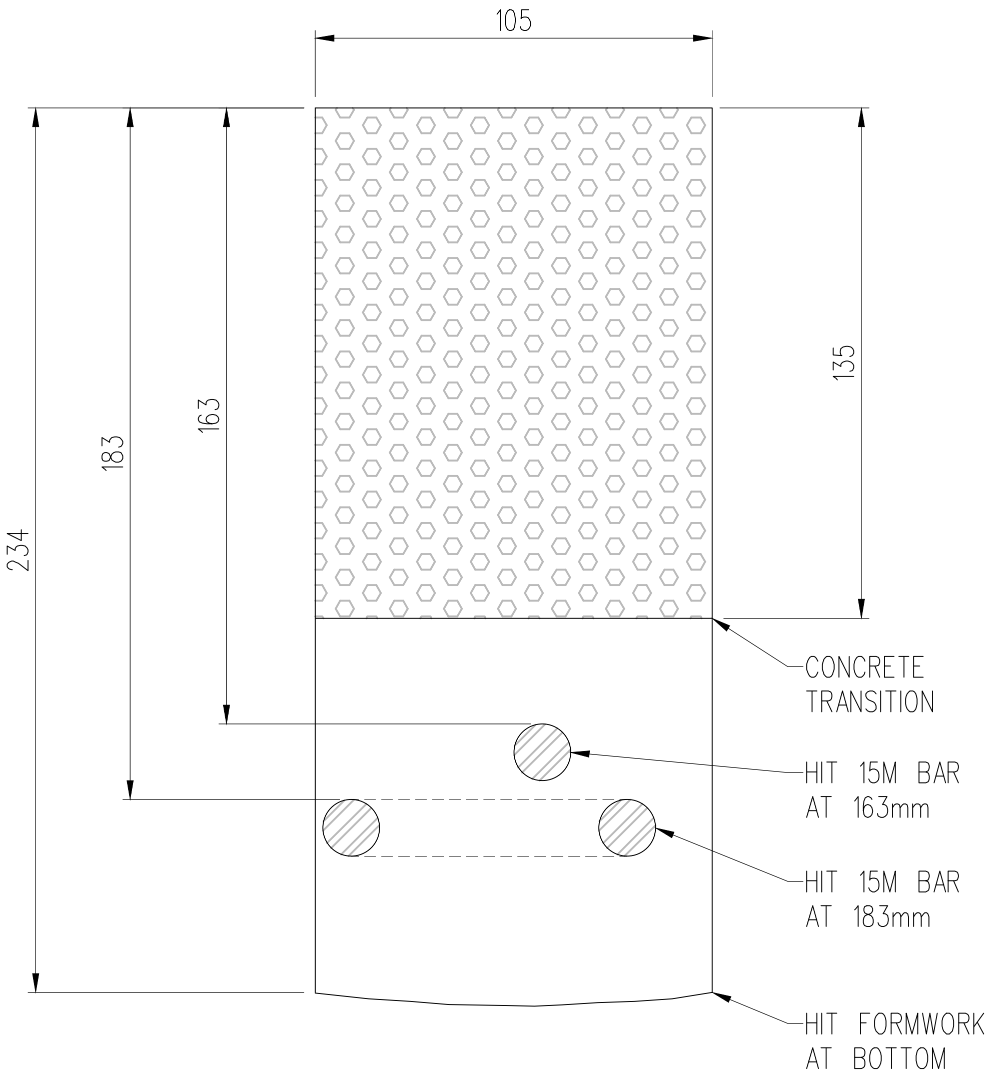

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HIGH DENSITY OVERLAY

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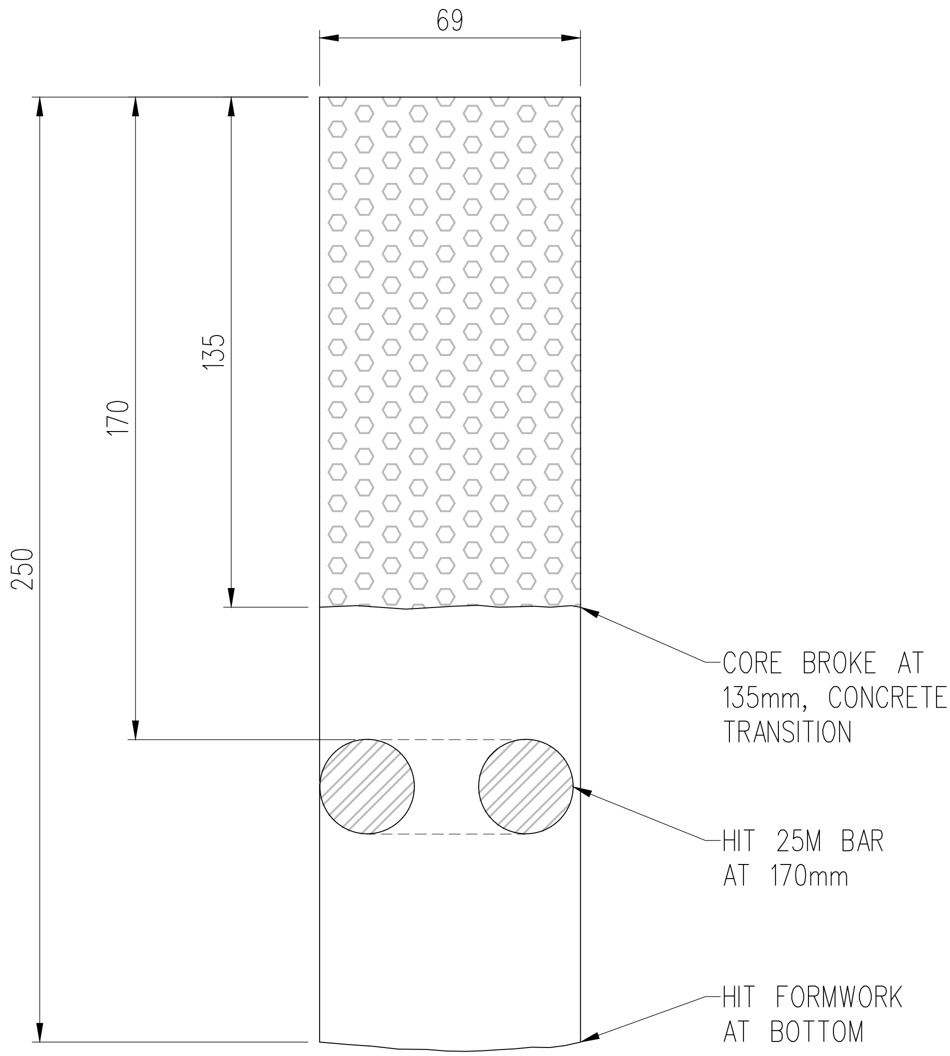

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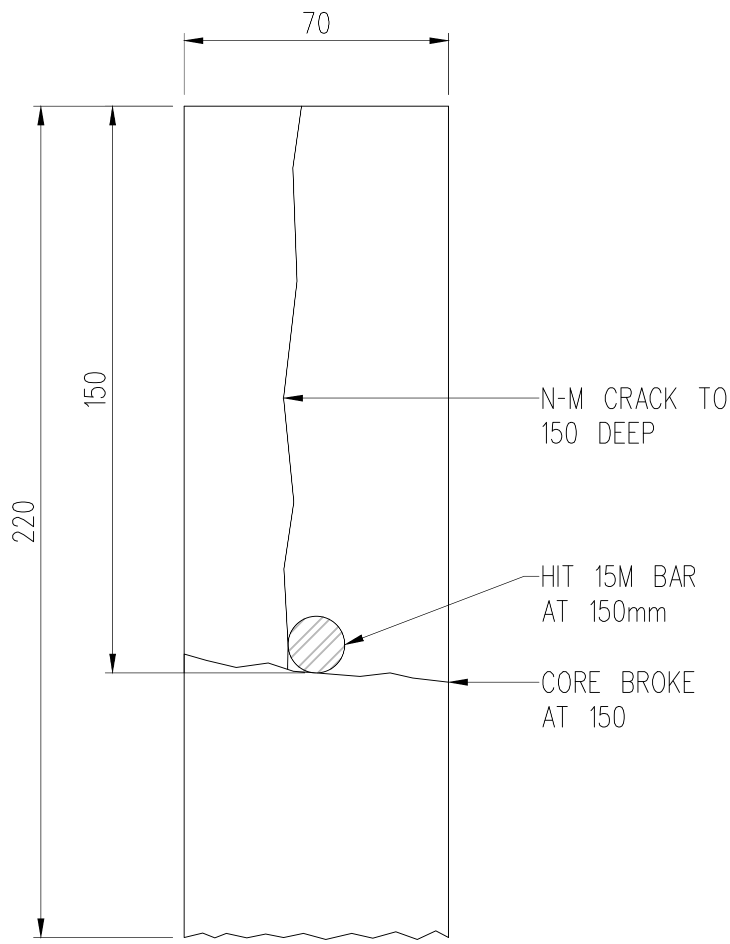
HIGH DENSITY OVERLAY

STEEL REINFORCEMENT



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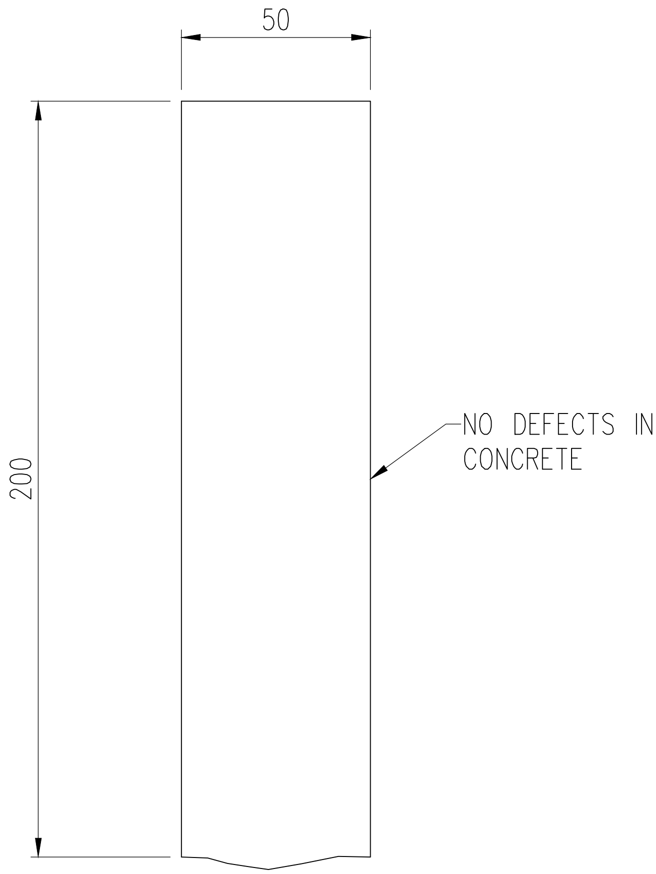

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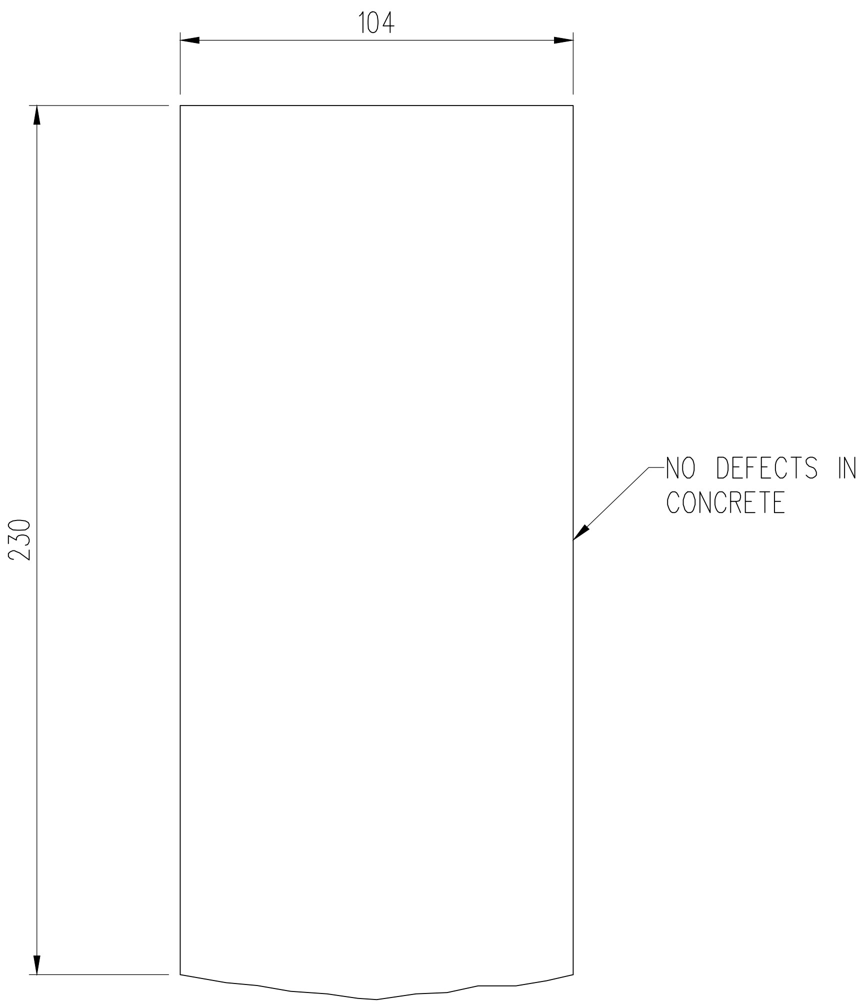

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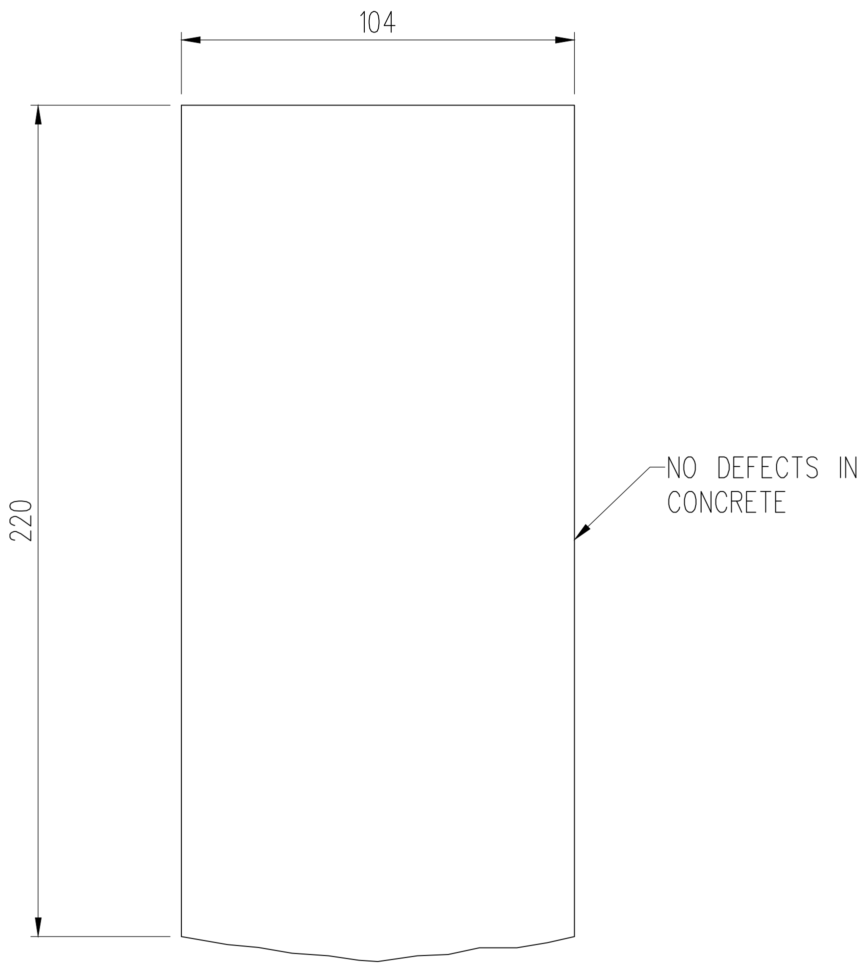

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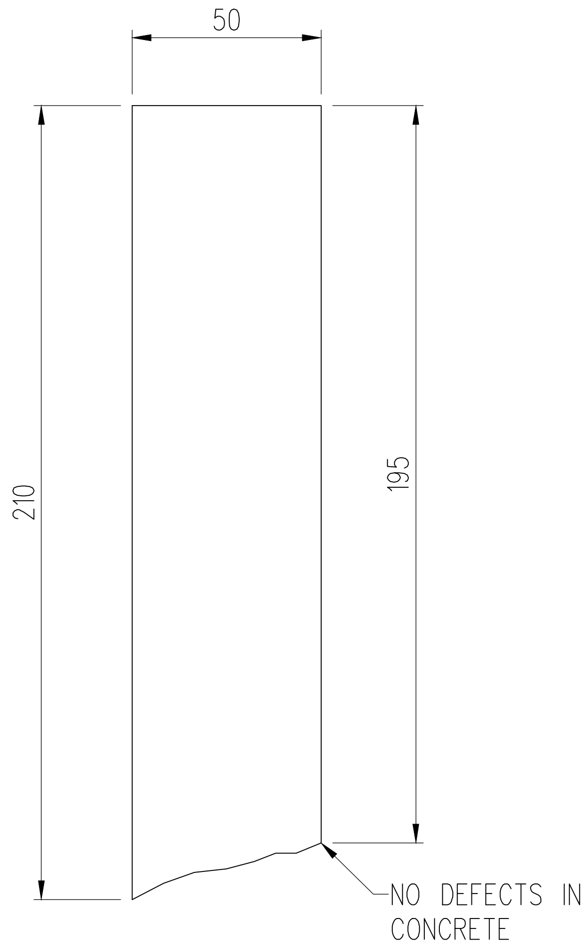

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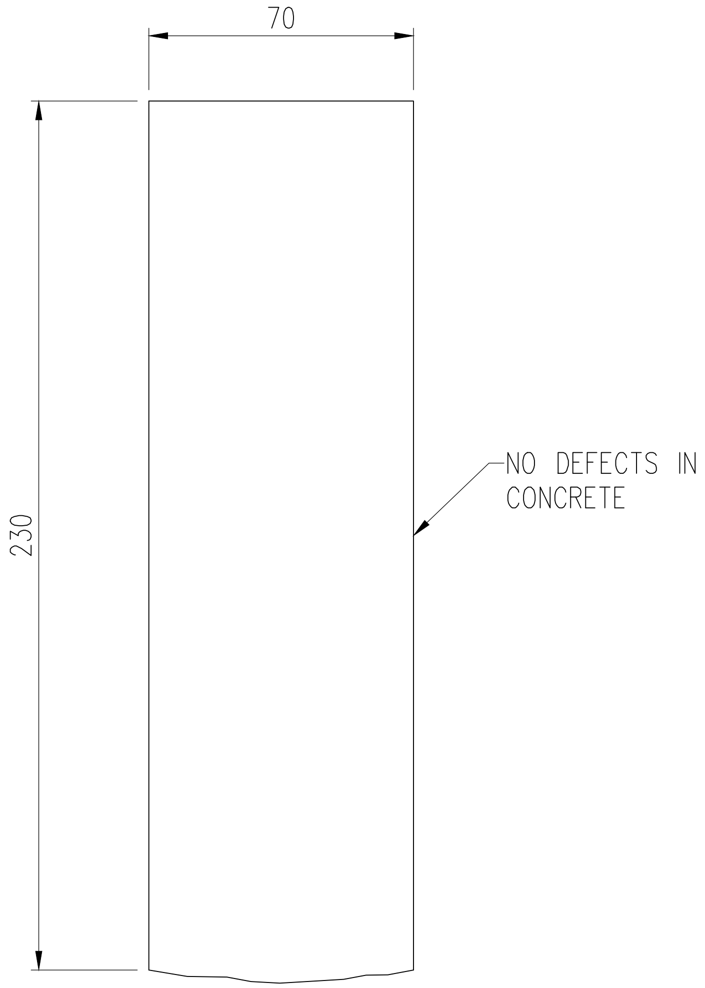

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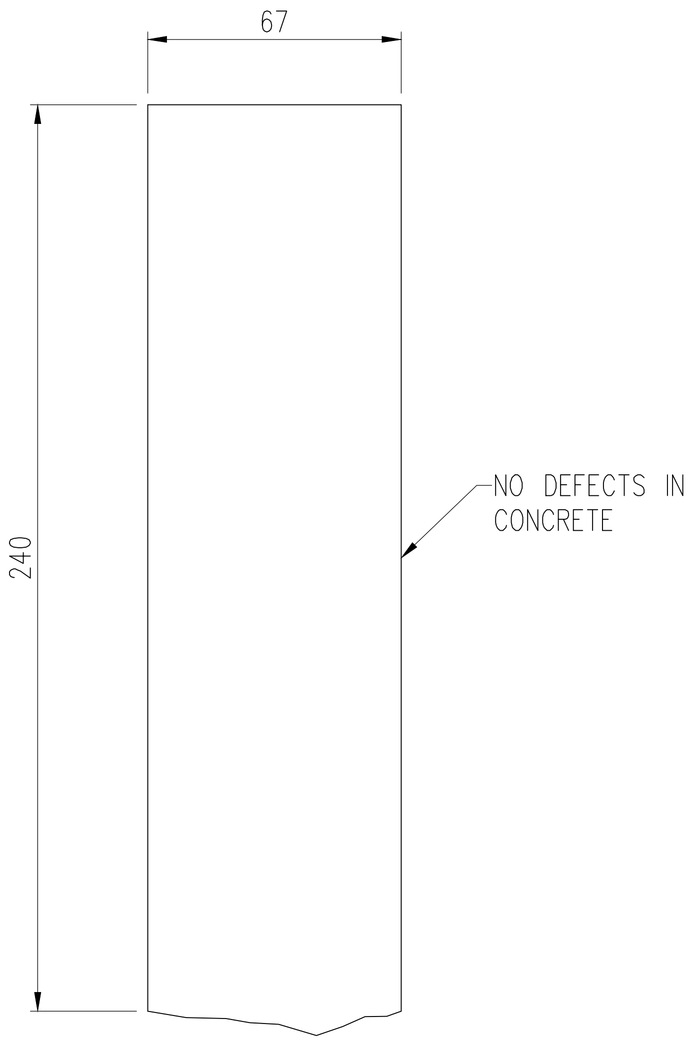


LEGEND

ORIGINAL CONCRETE

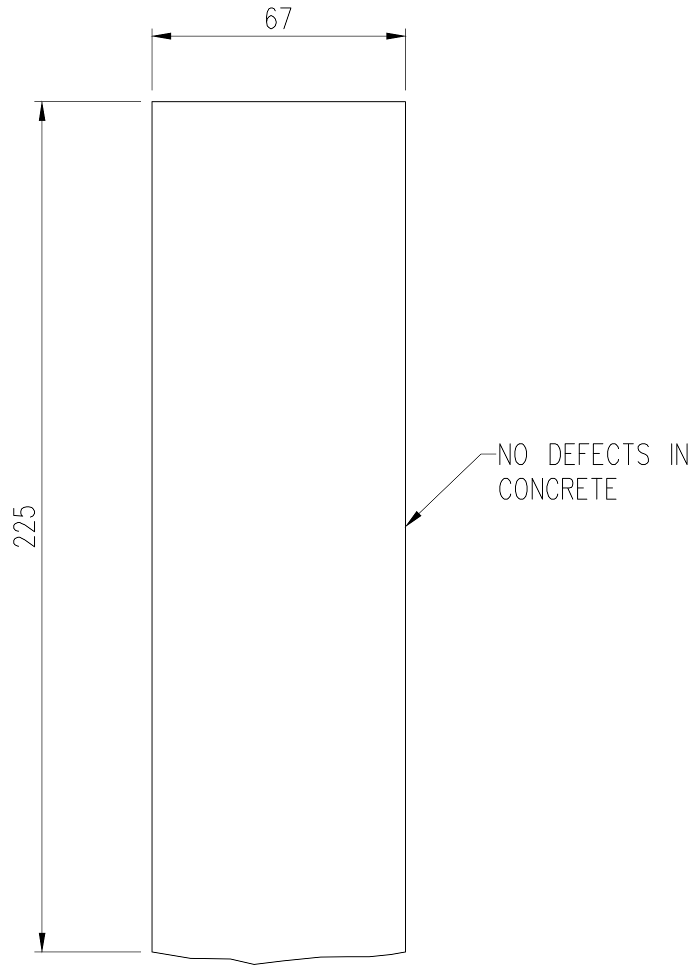
STEEL REINFORCEMENT

MORRISON HERSHFIELD

Winnipeg

PEMBINA / ABINOJII OVERPASS CONDITION ASSESSMENT
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

CORE: A7
LOCATION: SOUTH ABUTMENT
CORE LOG SKETCH
SCALE = 1:2 - DRAWN BY: AS



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ORIGINAL CONCRETE

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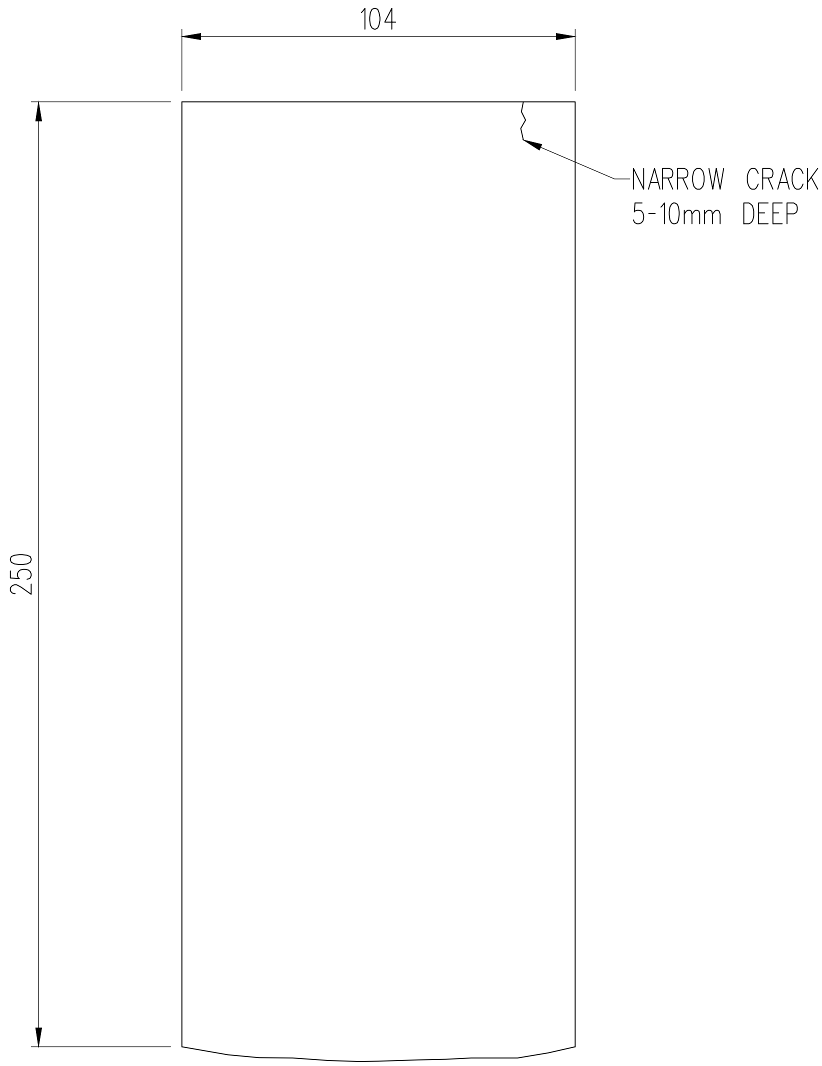
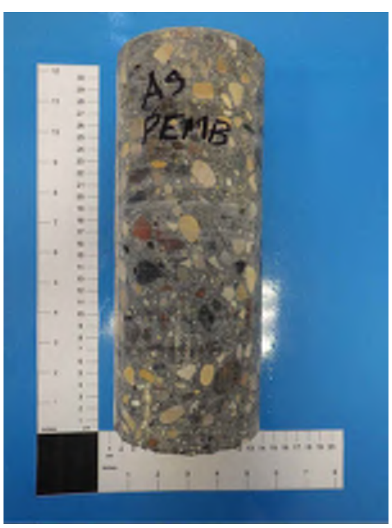




LEGEND

ORIGINAL CONCRETE

STEEL REINFORCEMENT

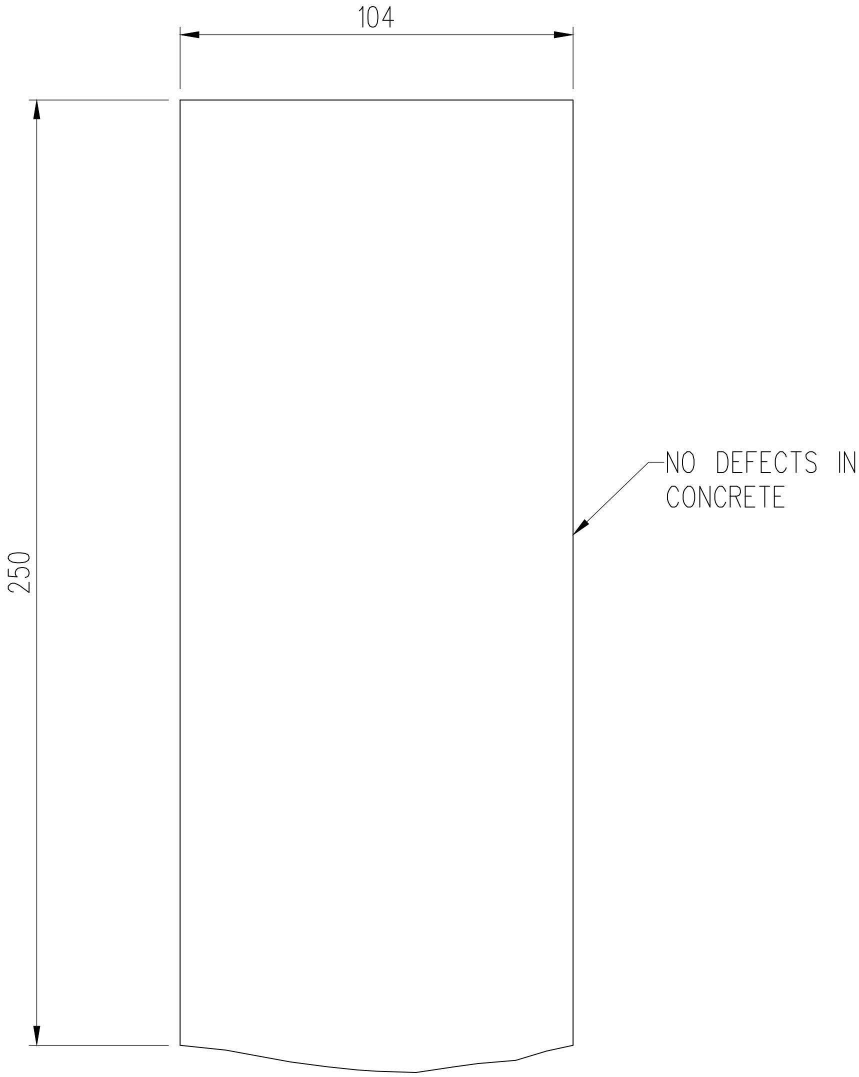
MORRISON HERSHFIELD

Winnipeg

PEMBINA / ABINOJII OVERPASS CONDITION ASSESSMENT
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

CORE: A9
LOCATION: SOUTH ABUTMENT
CORE LOG SKETCH
SCALE = 1:2 - DRAWN BY: AS

Last Saved: December 14, 2023, by ascott Plotted: December 14, 2023, by Allan Scott



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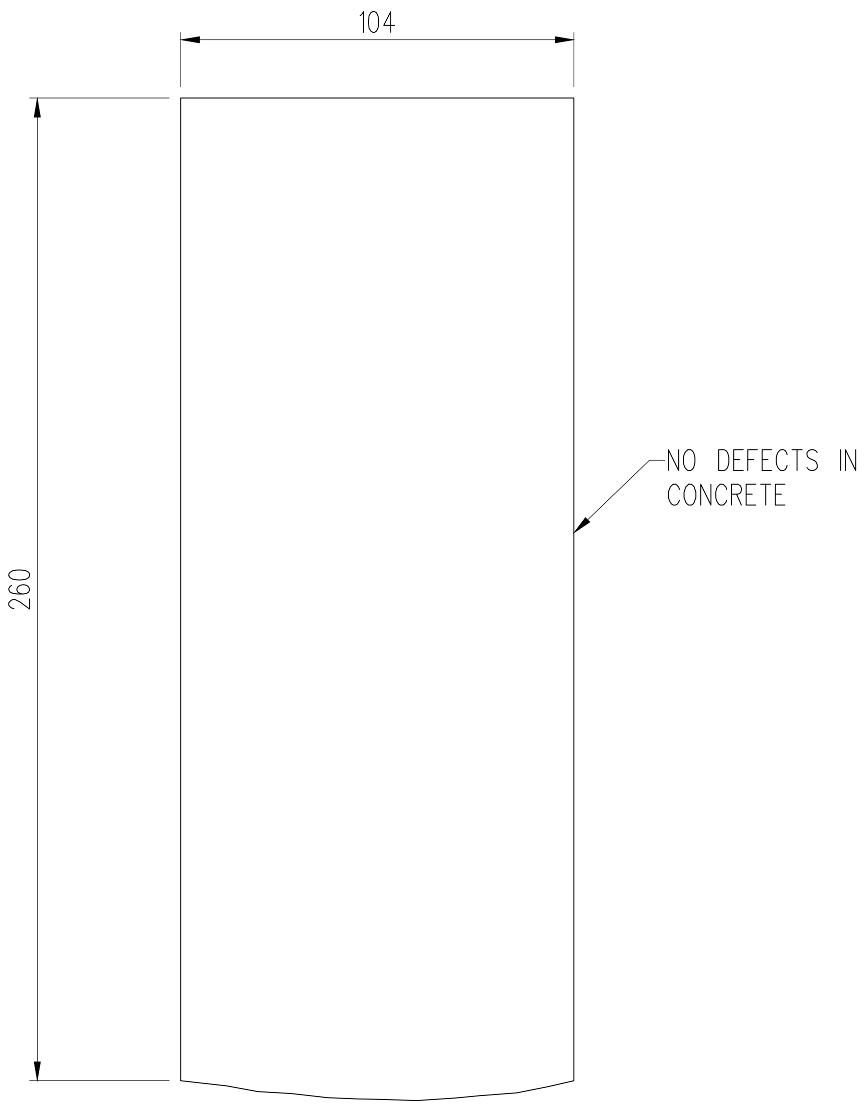
ORIGINAL CONCRETE

STEEL REINFORCEMENT



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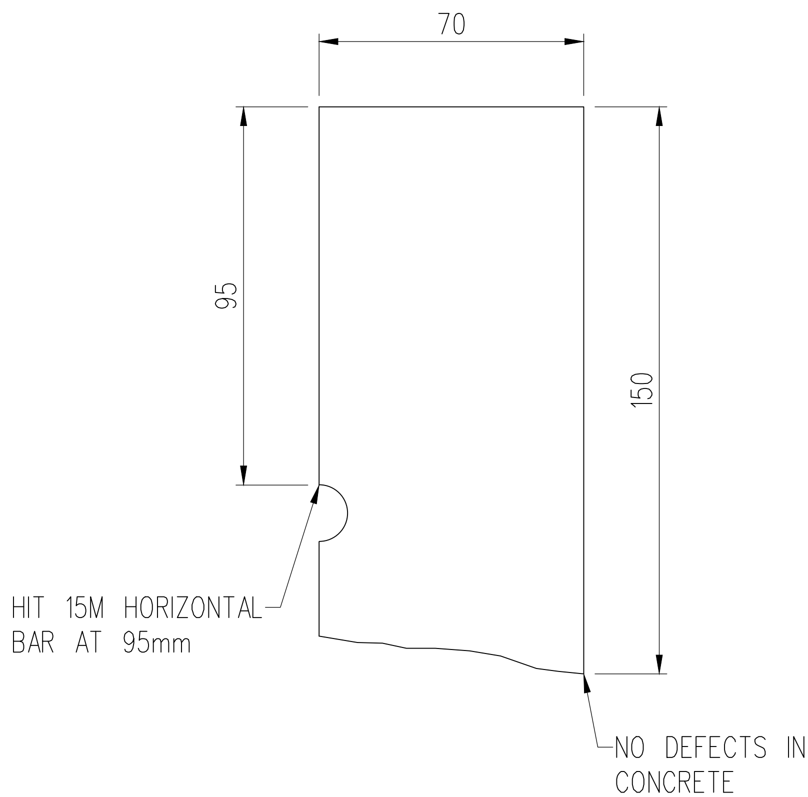

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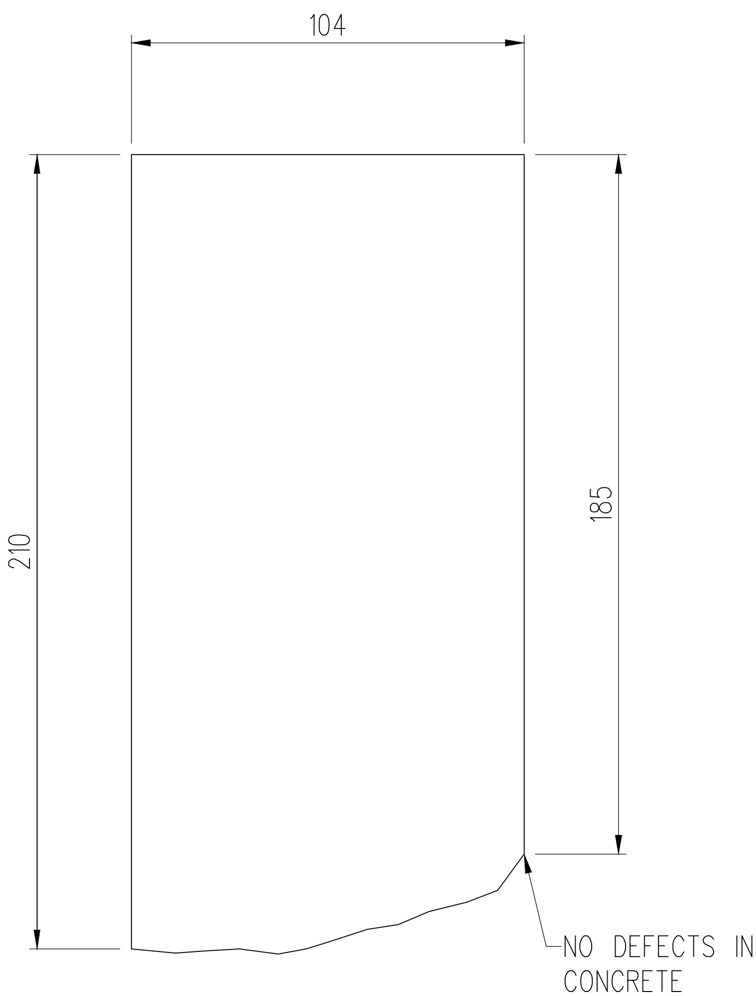

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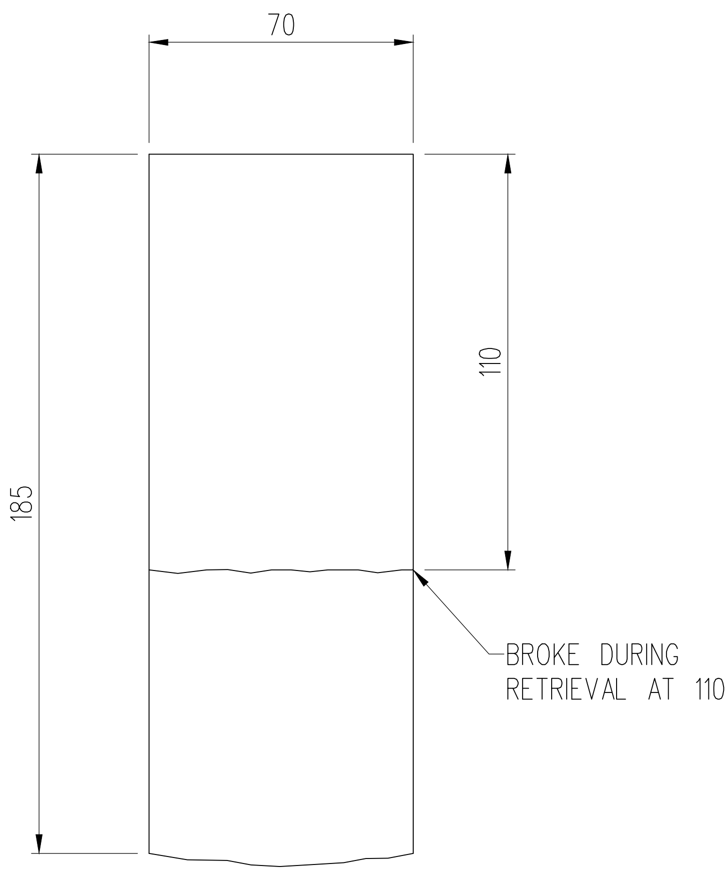

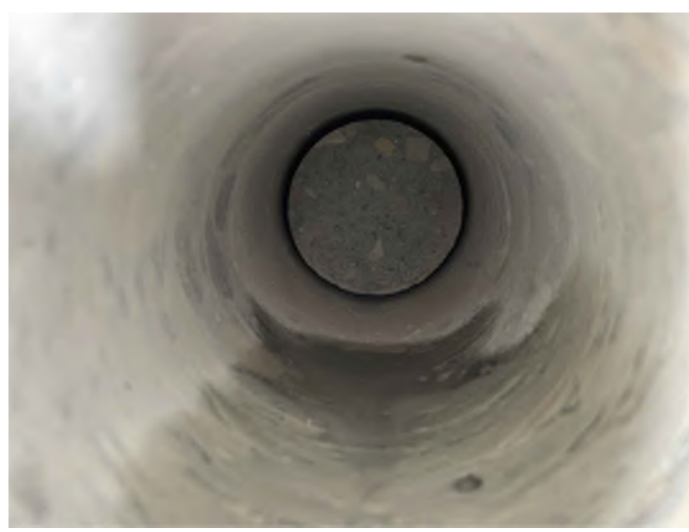

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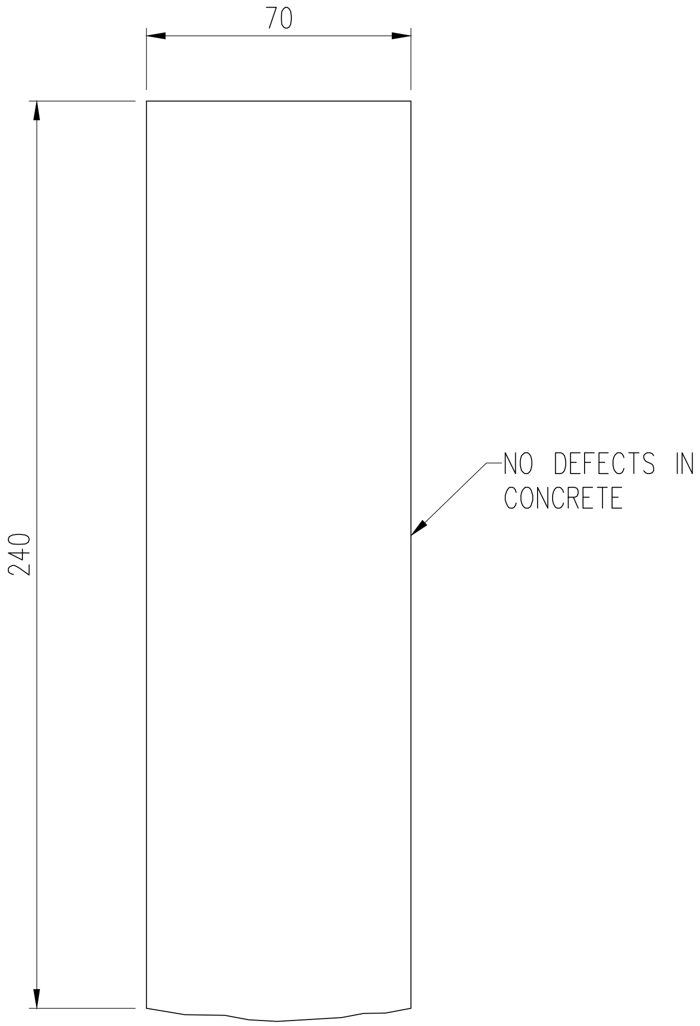
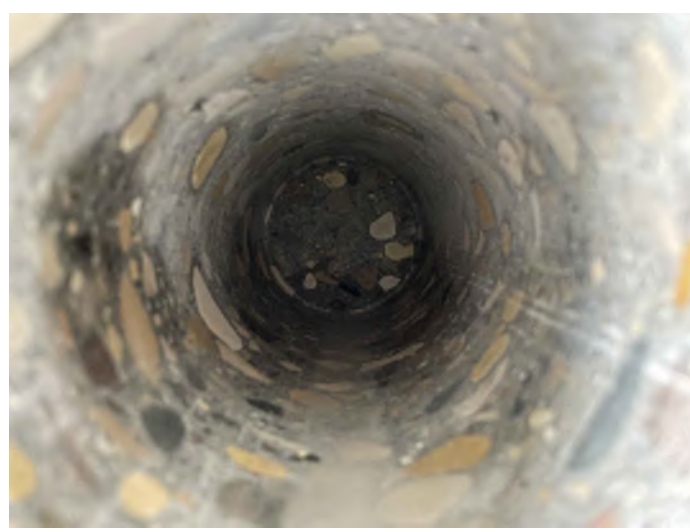




LEGEND

ORIGINAL CONCRETE

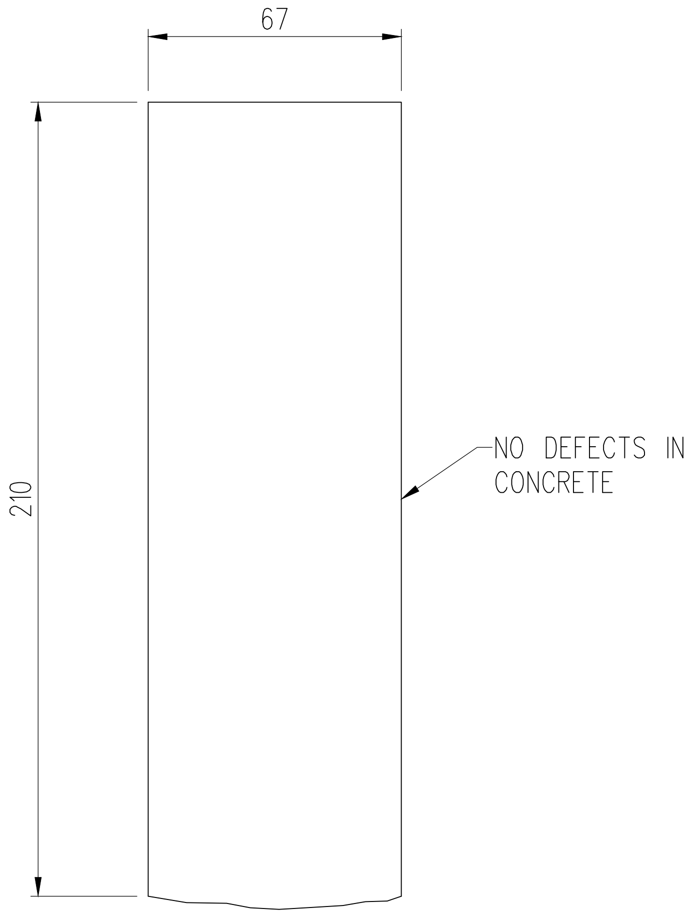
STEEL REINFORCEMENT

MORRISON HERSHFIELD

Winnipeg

PEMBINA / ABINOJII OVERPASS CONDITION ASSESSMENT
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

CORE: P4
LOCATION: SU4 NORTH PIER
CORE LOG SKETCH
SCALE = 1:2 - DRAWN BY: AS



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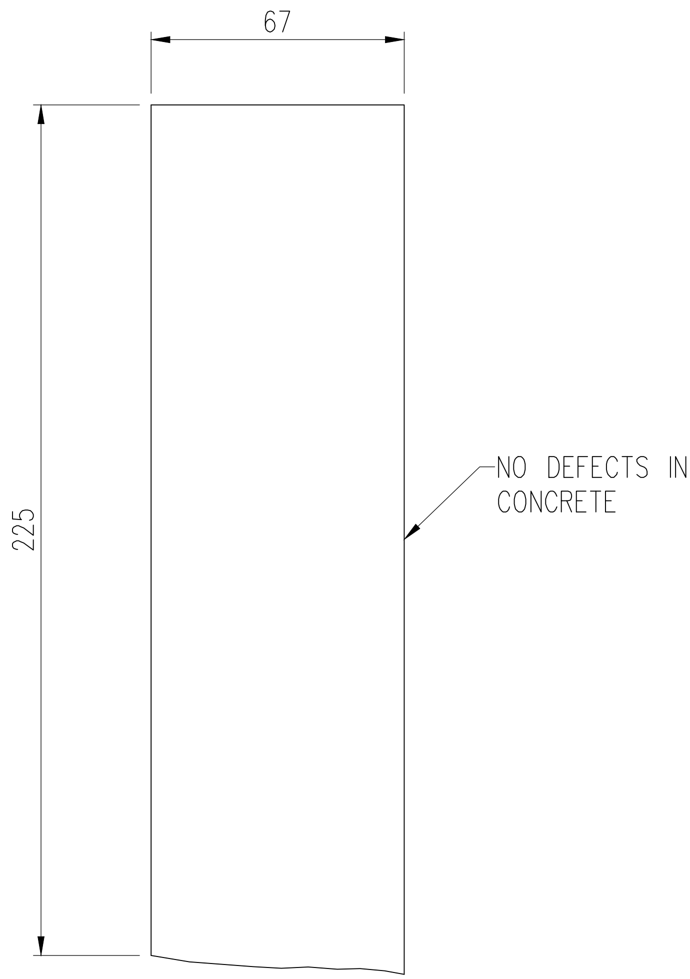
ORIGINAL CONCRETE   STEEL REINFORCEMENT



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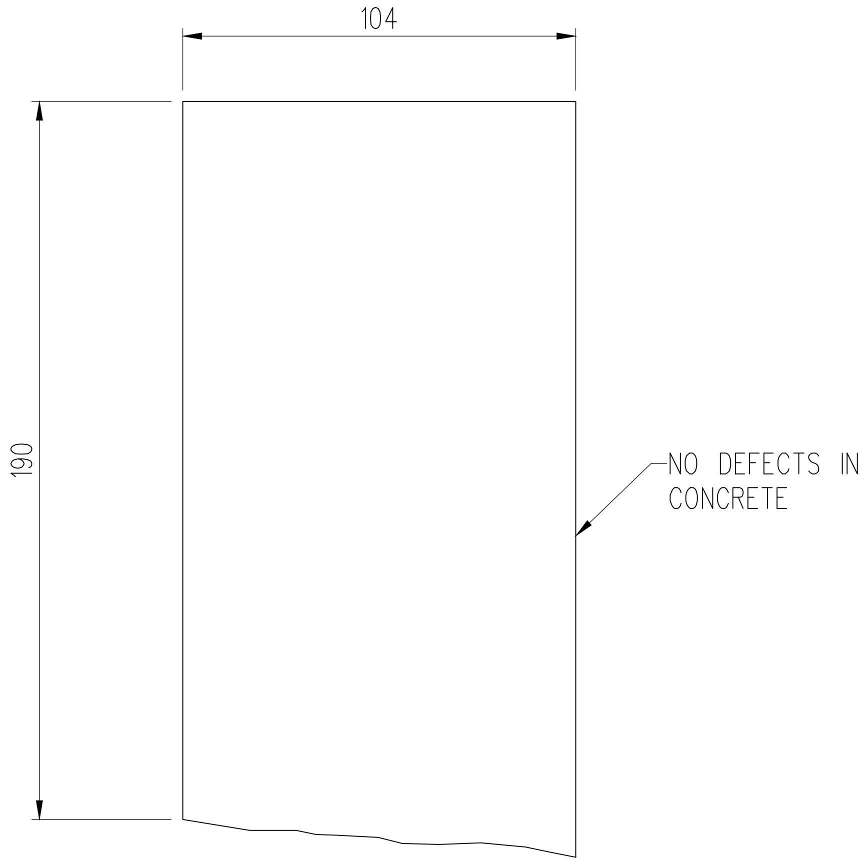

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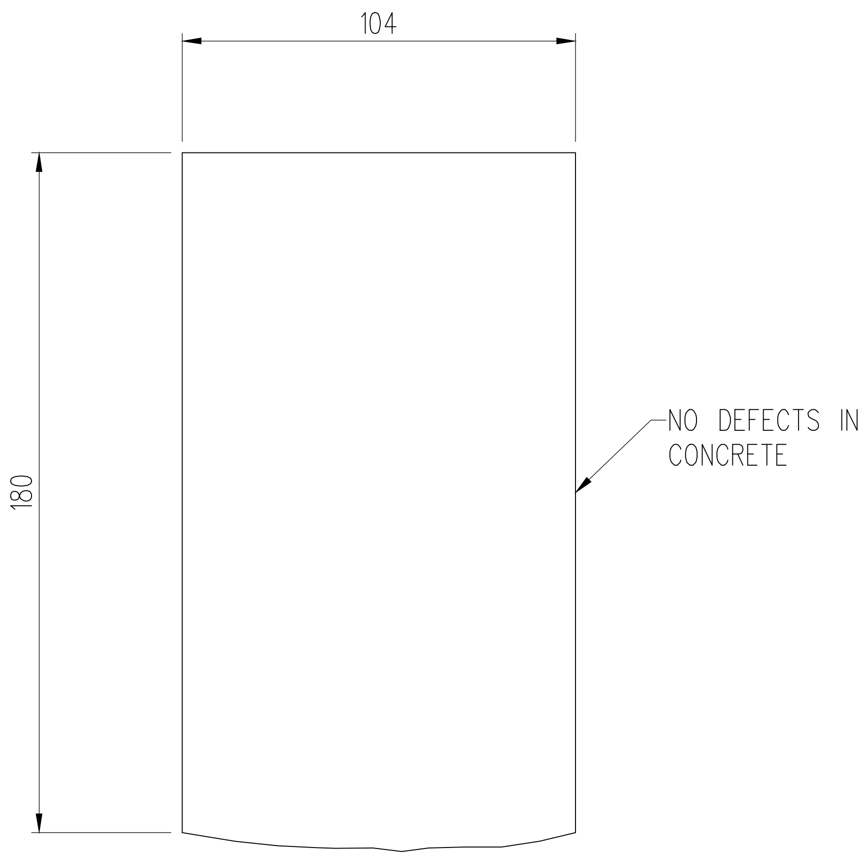

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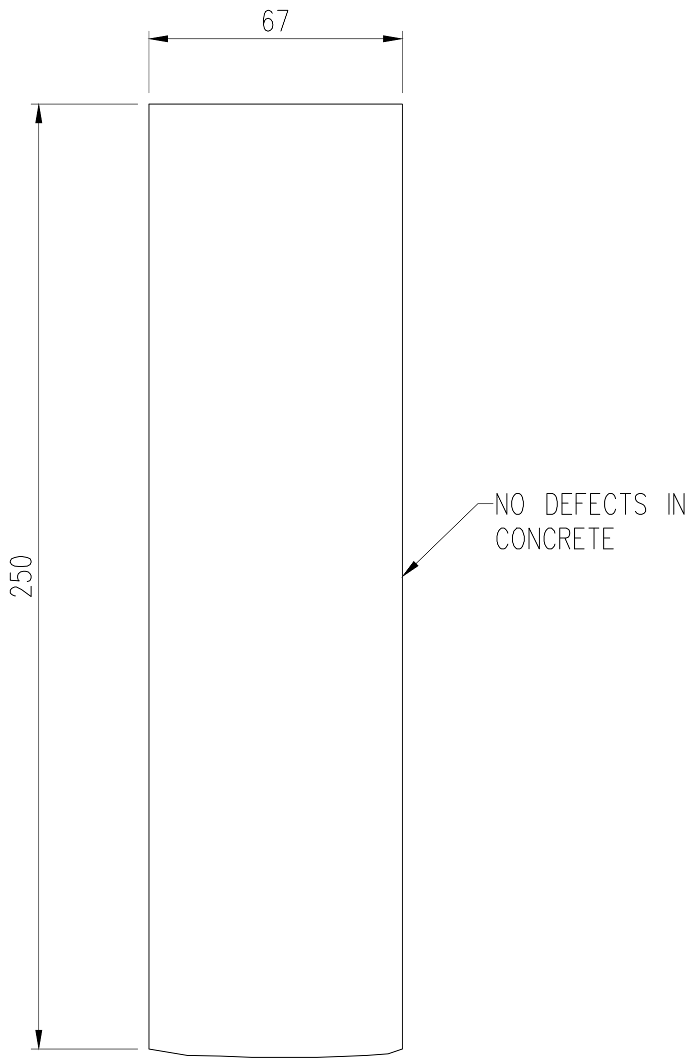
STEEL REINFORCEMENT



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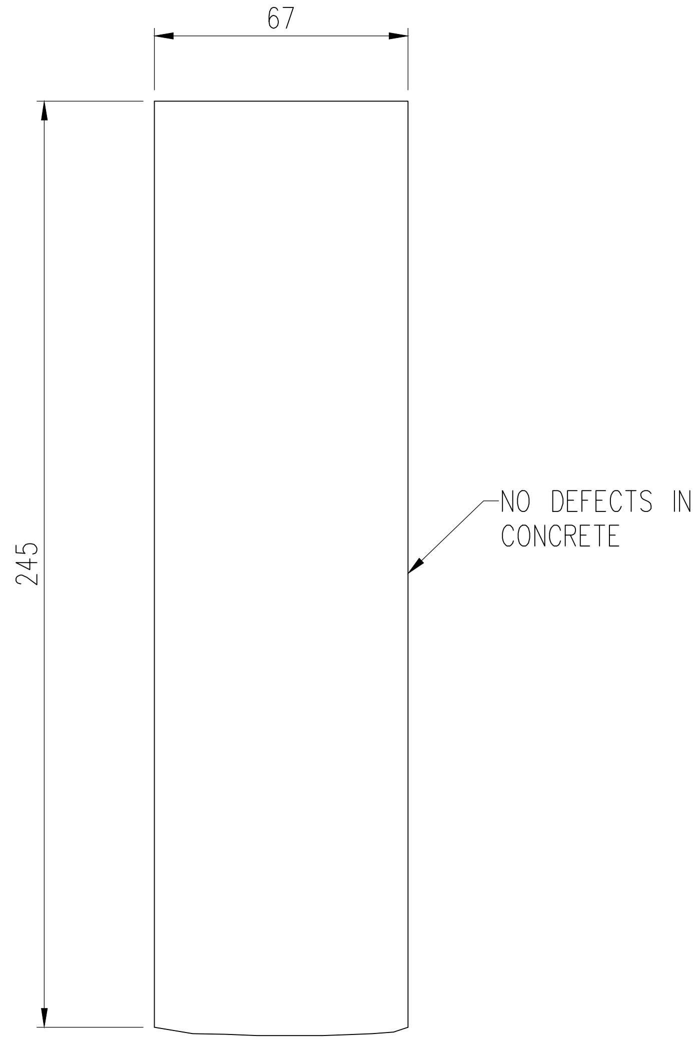

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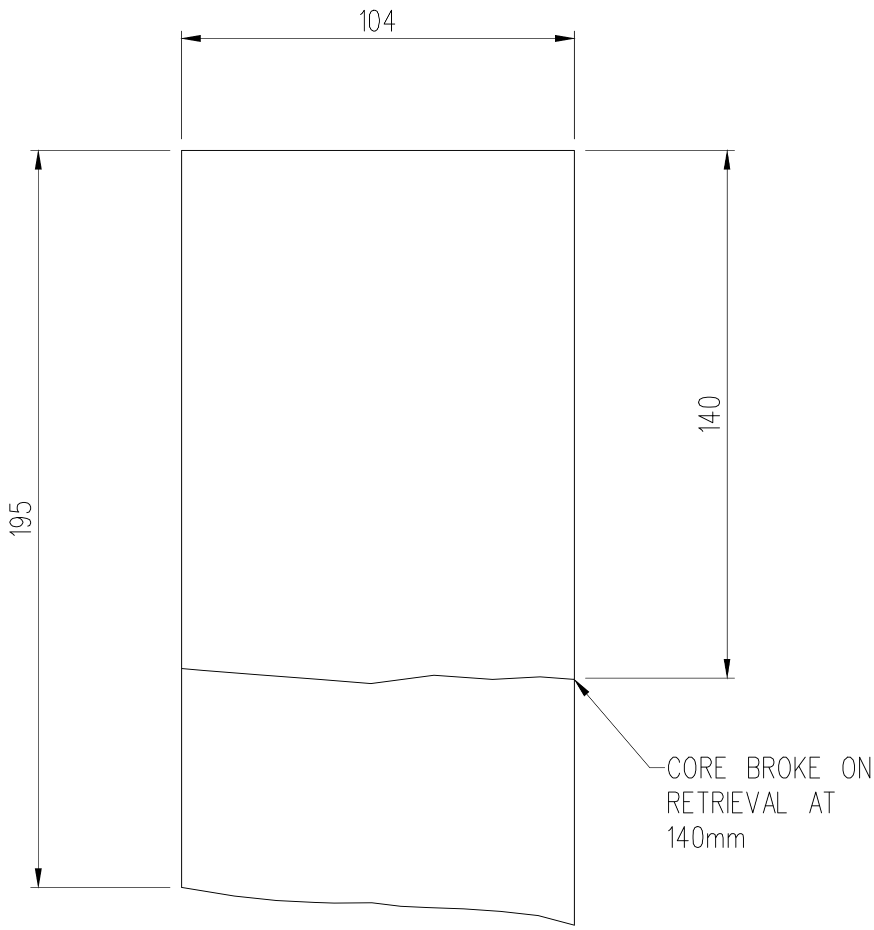

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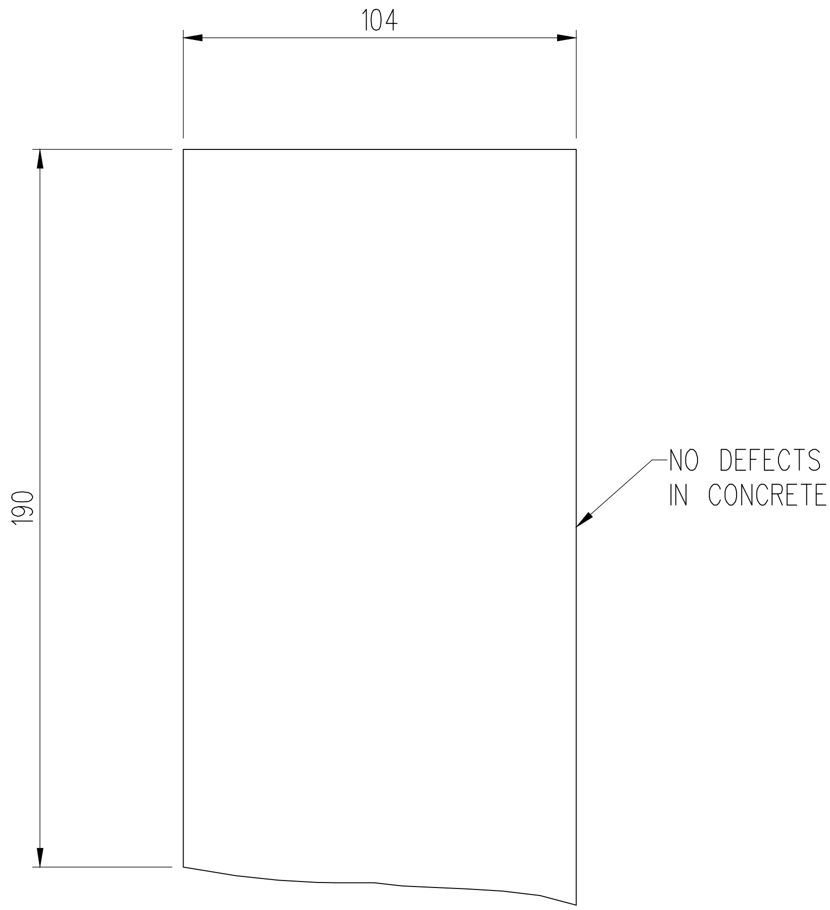

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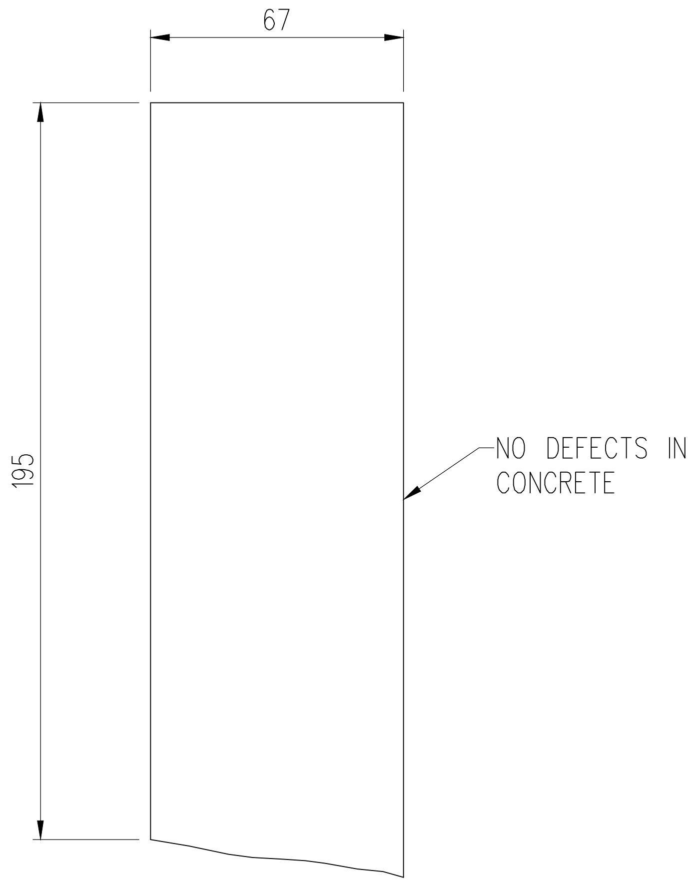

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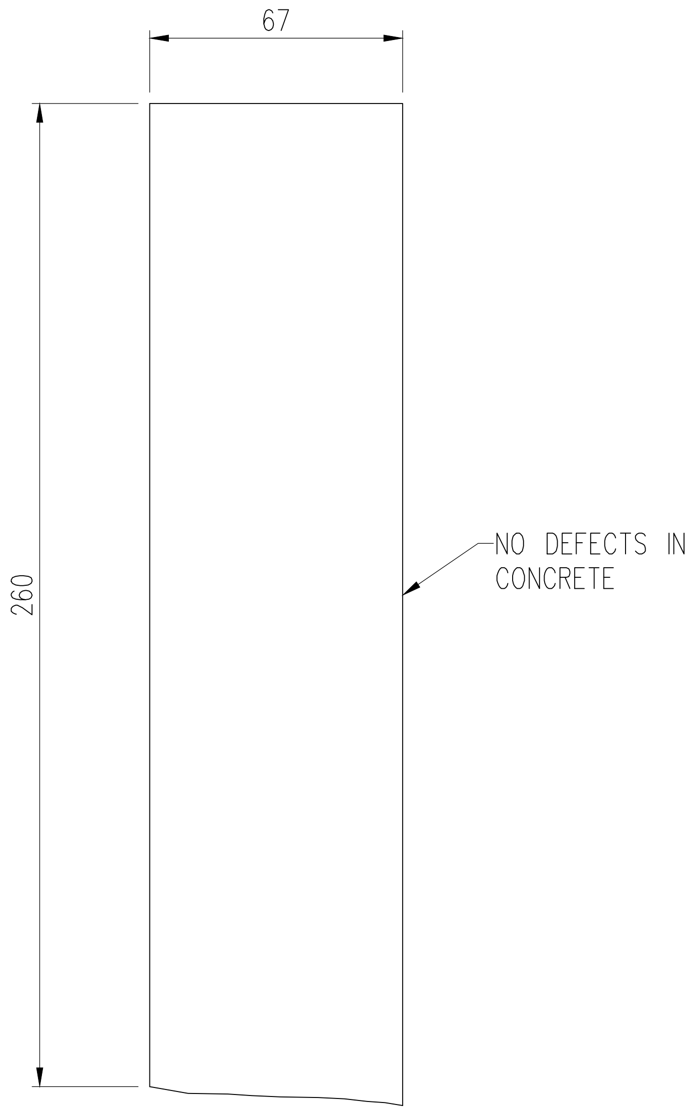

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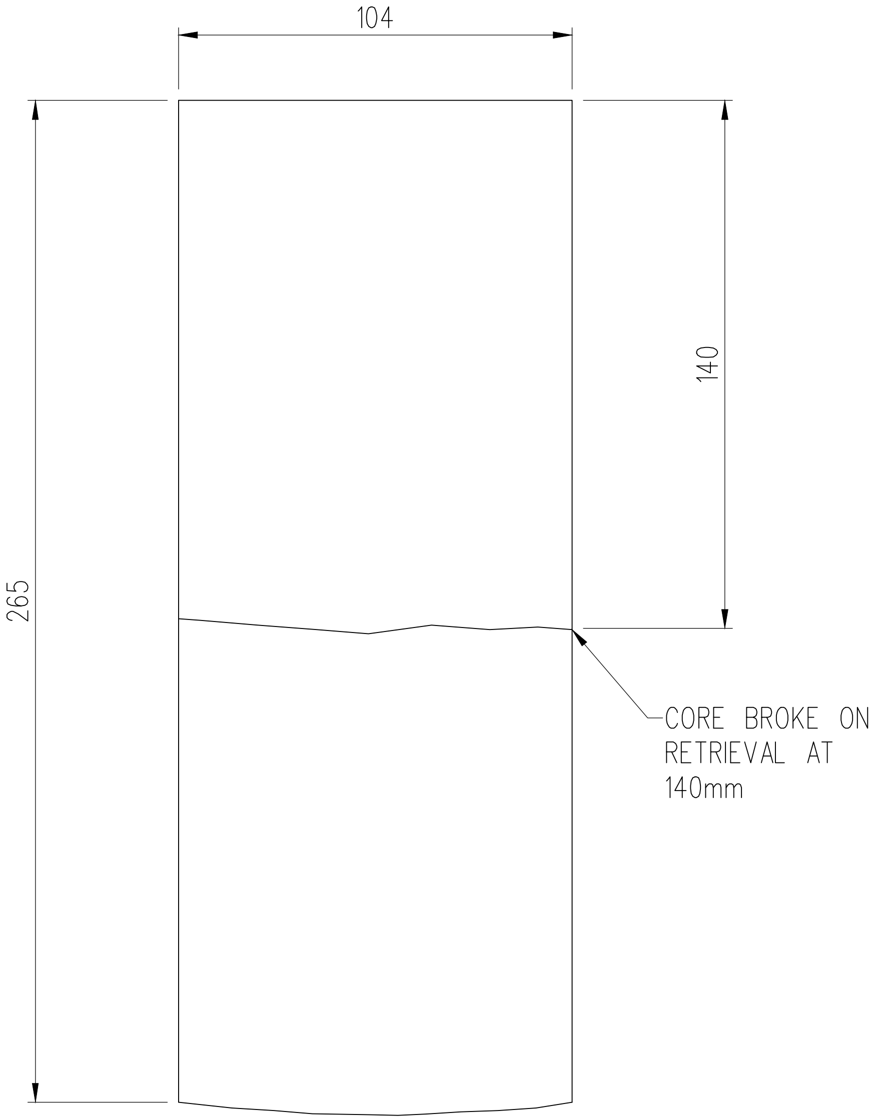


LEGEND

ORIGINAL CONCRETE

STEEL REINFORCEMENT

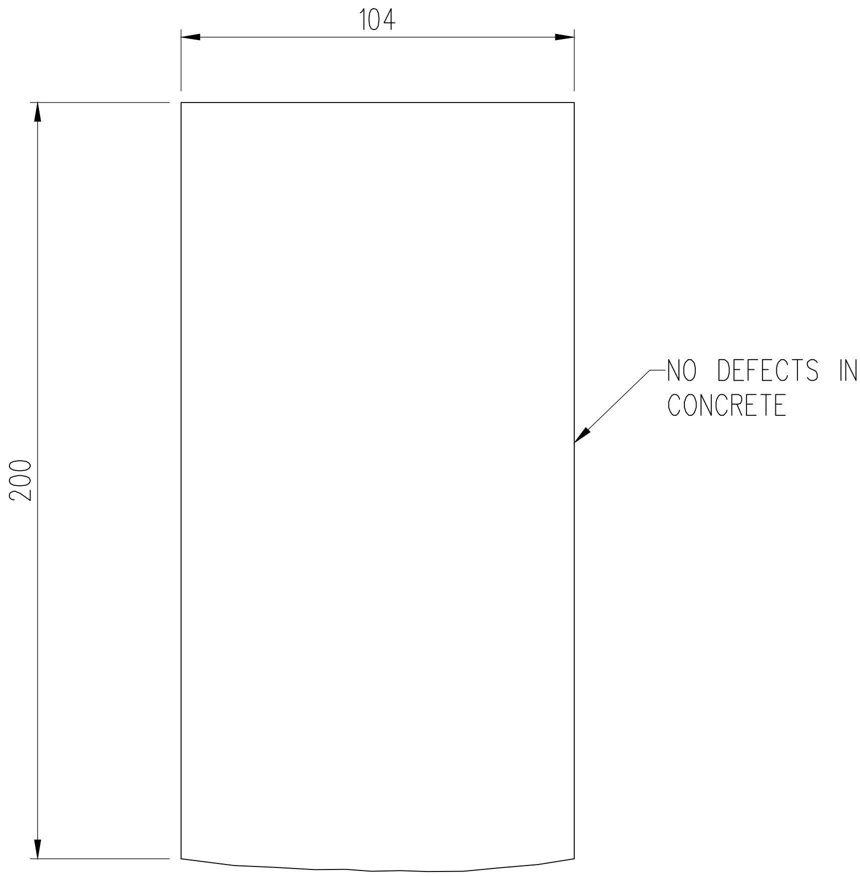
MORRISON HERSHFIELD

Winnipeg

PEMBINA / ABINOJII OVERPASS CONDITION ASSESSMENT
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

CORE: P15
LOCATION: SU4 NORTH PIER
CORE LOG SKETCH
SCALE = 1:2 - DRAWN BY: AS

Last Saved: December 20, 2023, by ascott Plotted: December 20, 2023, by Allan Scott



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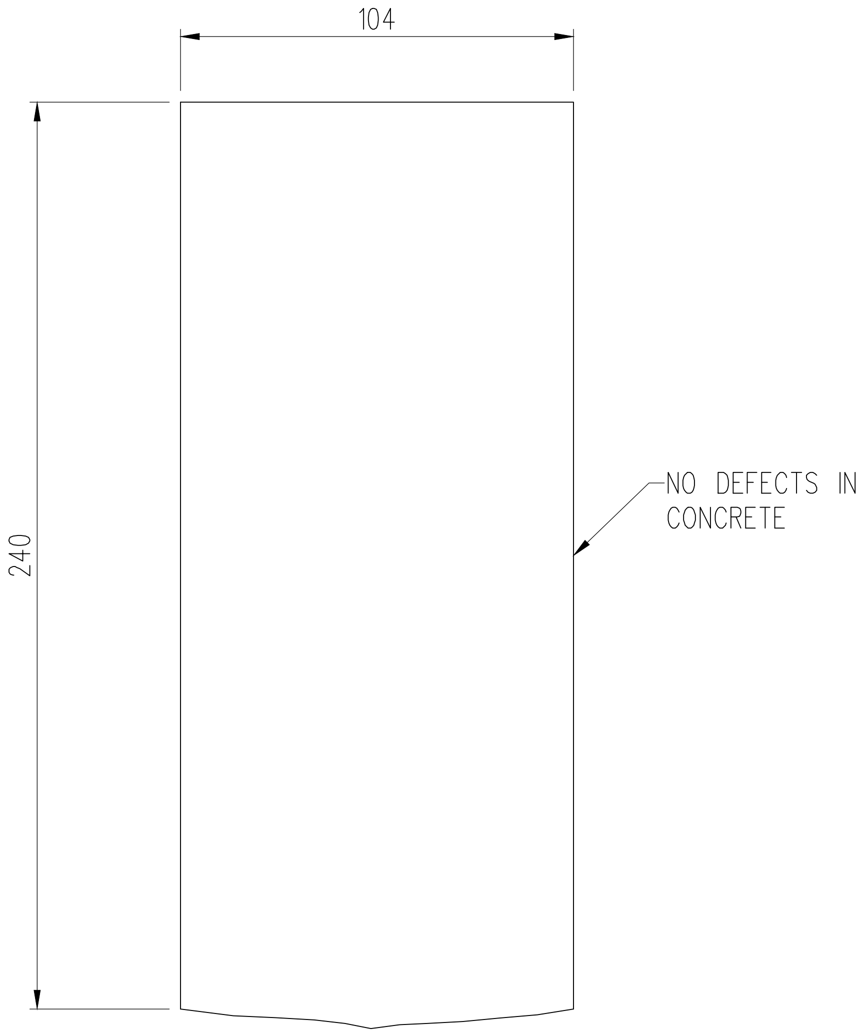

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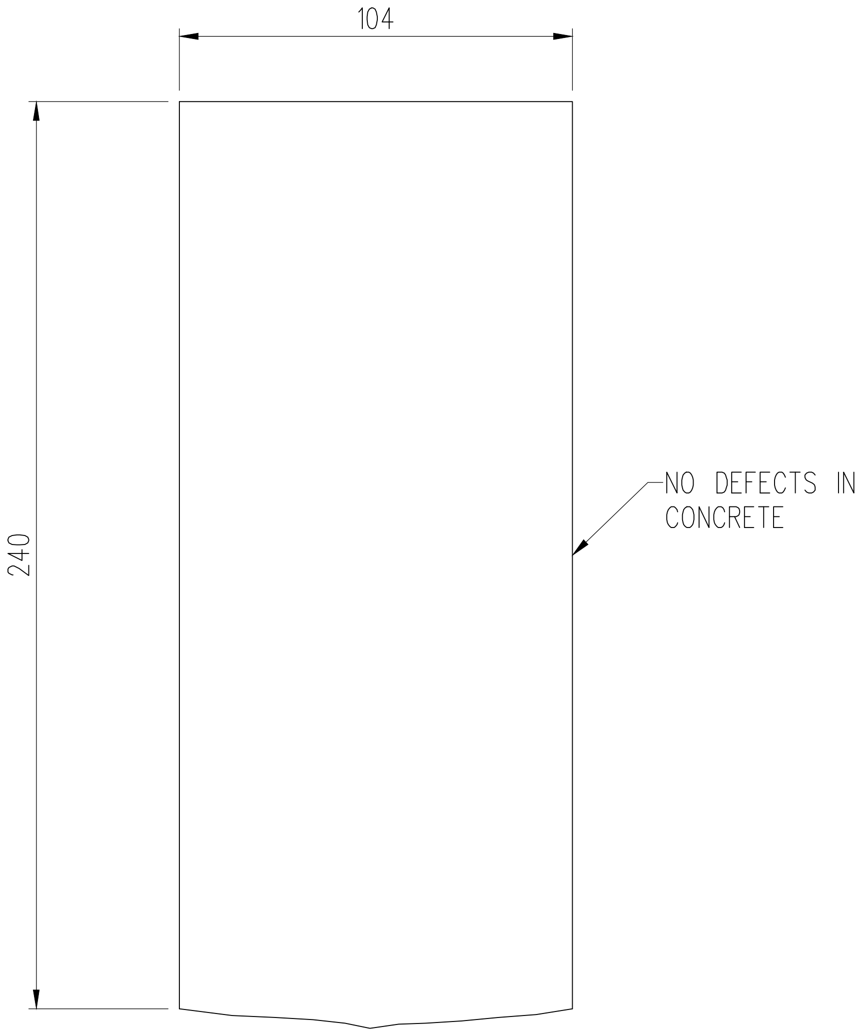

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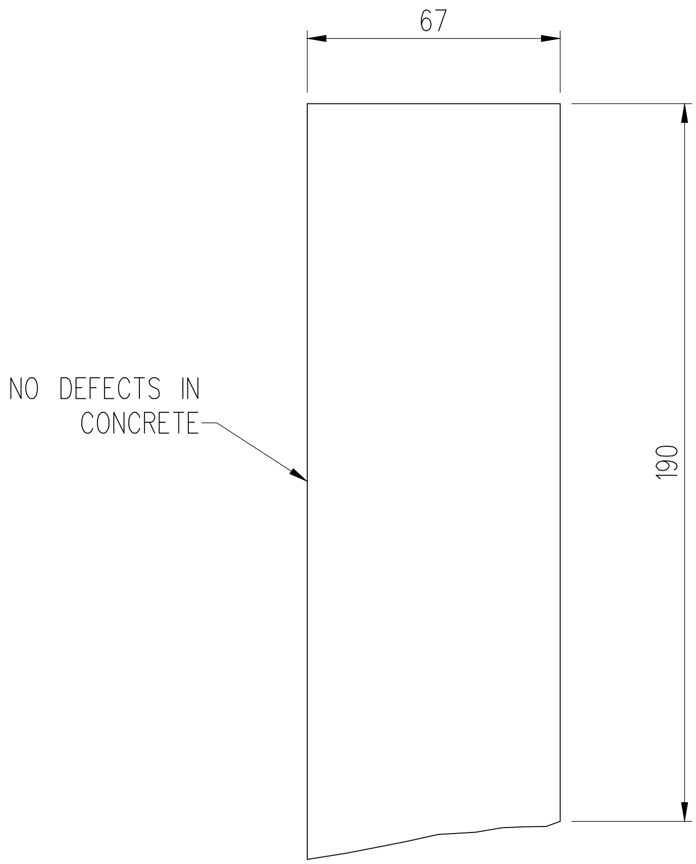

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ORIGINAL CONCRETE

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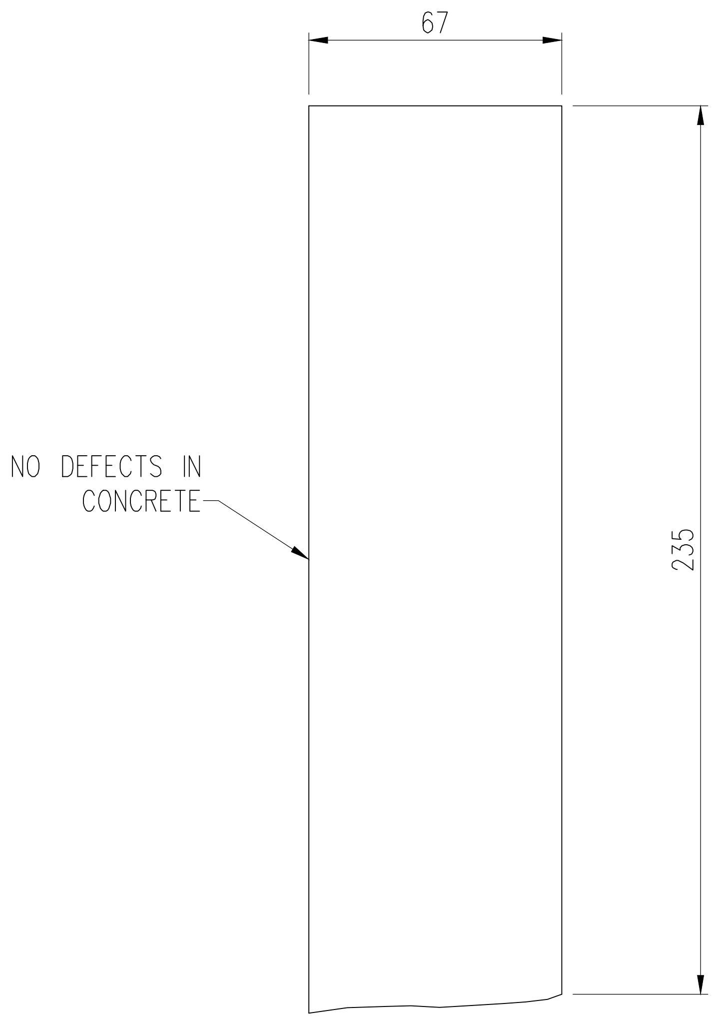

LEGEND

ORIGINAL CONCRETE

STEEL REINFORCEMENT

Appendix D

Core Logs

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	APP1				
Location	SE Approach gutter lane, Grid B6 (1.3m North, 1.1m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	105	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	215		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	78.43				
		Unit Weight	2369	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No concrete defects. Both concrete layers were tested for compressive strength.				

Core No.	APP2				
Location	SE Approach gutter lane, Grid C7 (0.7m South, 1.0 West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	105	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	210		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	5.3	%
			Specific Surface	25.8	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	181	µm
Remarks (Note 3.)	Core cracked on retrieval, hit 15M L rebar at 110mm, exopy coating in good condition. Both concrete layers were tested for air void analysis.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	APP3				
Location	NE approach, Grid C47 (1.0m North, 1.2m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	230		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	60.02				
		Unit Weight	2325	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit T rebar at 80mm. The girder top slab concrete layer was tested for compressive strength.				

Core No.	APP4				
Location	NE approach median lane, Grid G45 (0.6m North, 0.0m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	230		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	72.19				
		Unit Weight	2377	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete. Both concrete layers were tested for compressive strength.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	APP5				
Location	SW approach, Grid J3 (1.0m North, 0.0m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	240		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	66.3				
		Unit Weight	2382	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete. Both concrete layers were tested for compressive strength.				

Core No.	APP6				
Location	SW approach, Grid J3 (1.0m North, 0.0m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	240		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	5.7	%
			Specific Surface	30.8	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	154	µm
Remarks (Note 3.)	No defects in concrete. Both concrete layers were tested for air void analysis.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	APP7				
Location	NW approach, Grid I45 (0.6m South, 0.0m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	100		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	SR				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core drilled at logitudinal crack location to 150mm deep, 100mm core extracted. Rebar epoxy coating failure and severe corrosion >10%				

Core No.	APP8				
Location	NW approach, Grid I45 (0.0m North, 1.2m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	200		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	72.45				
		Unit Weight	2365	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit T rebar at 100mm. The high density concrete layer was tested for compressive strength				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	APP9				
Location	NW approach, Grid P44 (0.5m North, 0.7m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	210		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at 70mm deep and 130mm deep.				

Core No.	APP10				
Location	NW approach, Grid O45 (1.3m North, 0.7m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	200		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	83.9	Unit Weight	2358	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at 130mm deep. The high density concrete layer was tested for compressive strength.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D1				
Location	Northbound gutter lane, Grid A15 (0.6m North, 0.0m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	150		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	57.33				
		Unit Weight	2270	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit L rebar at 170mm (bottom). Both concrete layers were tested for compressive strength.				

Core No.	D2				
Location	Northbound gutter lane, Grid A23 (0.4m South, 0.2m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	155		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D3				
Location	Northbound lane, Grid C23 (1.0m South, 1.0m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	135		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No concrete defects.				

Core No.	D4				
Location	Northbound gutter lane, Grid A33 (0.5m North, 1.3m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	145		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

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Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D5				
Location	Northbound gutter lane, Grid A15 (0.6m North, 0.0m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	260		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	6.3	%
			Specific Surface	30.9	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	141	µm
Remarks (Note 3.)	Core broke during extraction at 160mm, hit 15M T rebar at 205. The girder top slab concrete layer was tested for air void analysis.				

Core No.	D6				
Location	Northbound gutter lane, Grid A23 (0.45m South, 0.2m West)				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	260		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	61.8				
		Unit Weight	2355	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit rebar at 90mm, hit formwork at bottom. The girder top slab concrete layer was tested for compressive strength.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D7				
Location	Northbound gutter lane, Grid C23 (1.0m South, 1.0m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	105	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	140		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	50.62				
		Unit Weight	2298	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M T rebar at 70mm. Both concrete layers were tested for compressive strength.				

Core No.	D8				
Location	Northbound gutter lane, Grid A41 (0.0m North, 0.0m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	220		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	43.72				
		Unit Weight	2279	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at 100mm during extraction, yellow bonding agent noted at 160mm, hit T rebar at 220mm. The high density concrete layer was tested for compressive strength				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

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Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D9				
Location	Northbound median lane, Grid F33 (1.8m North, 1.3m East).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	50	Acid-Soluble Chloride Content	5-20	0.738	-
Thickness of Concrete, mm	170		40-60	0.280	-
			70-90	0.075	-
Defects in Concrete (Note 1.)	None		120-140	<0.020	-
			150-170	<0.020	-
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M L rebar at 170mm.				

Core No.	D10				
Location	Northbound median lane, Grid F33 (1.8m North, 1.3m East).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	50	Acid-Soluble Chloride Content	70-80	-	11.82
Thickness of Concrete, mm	160		140-150	-	11.99
Defects in Concrete (Note 1.)	C				
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at 90mm during extraction, hit T rebar at 80mm				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D11				
Location	Northbound median lane, Grid G43 (0.2m North, 0.5m East).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	50	Acid-Soluble Chloride Content	5-20	0.580	-
Thickness of Concrete, mm	200		40-60	0.174	-
			70-90	0.021	-
Defects in Concrete (Note 1.)	C		120-140	<0.020	-
			150-170	0.021	-
			190-200	0.021	-
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at 90mm during extraction, concrete debonded at 160mm, hit 15M rebar at 190mm.				

Core No.	D12				
Location	Northbound median lane, Grid G23 (0.9m South, 0.6m East).				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
		Chloride Permeability	Sample depth (mm)	Charge Passed (Coulombs)	Chloride Ion Penetrability Rating
Compressive Strength, MPa			123-173	1113	Low
			199-250	1330	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M T rebar at 180mm, cored through formwork at bottom.				

Notes
1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D13				
Location	Northbound median lane, Grid G31 (0.5m North, 0.6m East).				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	255		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M T rebar at 200mm, hit bottom formwork (good condition).				

Core No.	D14				
Location	Northbound median lane, Grid G31 (0.5m North, 0.6m East).				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	61.18				
		Unit Weight	2299	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M T rebar at 80mm. The girder top slab layer concrete was tested for compressive strength.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

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Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D15				
Location	Northbound median lane, Grid F33 (1.8m North, 1.3m East).				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	50	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core fell through bottom formwork.				

Core No.	D16				
Location	Southbound lane, Grid H22 (0.6m North, 0.9m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	220		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at 150mm during retrieval, hit T rebar at 220mm.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D17				
Location	Southbound lane, Grid H22 (0.6m North, 0.9m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	205		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	Good				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	43.51				
		Unit Weight	2261	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M T rebar at 90mm and at 205mm. The girder top slab layer concrete was tested for compressive strength.				

Core No.	D18				
Location	Southbound lane, Grid H28 (1.0m North, 1.6m West)				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	Good				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
		Chloride Permeability	Sample depth (mm)	Charge Passed (Coulombs)	Chloride Ion Penetrability Rating
Compressive Strength, MPa			120-171	1669	Low
			205-255	1421	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit L rebar at 180mm, hit bottom formwork.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D19A				
Location	Southbound lane, Grid H31 (0.6m South, 1.0m West)				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	Good				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	5.6	%
			Specific Surface	33.8	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	154	µm
Remarks (Note 3.)	Core broke during retrieval at 150mm, core debonded at 150mm deep interface, hit 15M T rebar at 80mm, hit 15M T rebar at 185mm. The girder top slab concrete layer was tested for air void analysis				

Core No.	D19				
Location	Southbound lane, Grid J30 (0.0m North, 0.9m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	220		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
		Unit Weight (Top)	2196	kg/m³	
		Unit Weight (Bottom)	2277	kg/m³	
Compressive Strength (Top), MPa	37.12	Compressive Strength (Bottom), MPa	57.02		
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke during retrieval at 130mm. Both concrete layers were tested for compressive strength.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D20				
Location	Southbound lane, Grid I33 (0.1m North, 0.7m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Acid-Soluble Chloride Content	70-80	-	11.90
Thickness of Concrete, mm	160		140-150	-	11.87
Defects in Concrete (Note 1.)	C				
Condition of Rebar (Note 2.)	Good				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke during retrieval at 60mm, hit 15M T bar at 60mm, rebar epoxy debonded.				

Core No.	D21				
Location	Southbound lane, Grid I40 (0.0m North, 0.0m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	230		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	Good				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	63.47				
		Unit Weight	2272	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke during retrieval at 100mm, hit 15M T bar at 100mm, rebar epoxy debonded. The girder top slab concrete layer was tested for compressive strength.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D22				
Location	Southbound lane, Grid I40 (0.0m North, 0.0m West)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	100		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	Good				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M T bar at 100mm, rebar epoxy debonded.				

Core No.	D23				
Location	Southbound lane, Grid P38 (1.3m North, 0.4m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	205		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	33.26	Unit Weight	2182	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory			Spacing Factor		mm
Remarks (Note 3.)	Core broke at High Performance Concrete transition 163mm deep. The high density concrete layer was tested for compressive strength				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D24				
Location	Southbound lane, Grid P28 (0.9m South, 0.6m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	105	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	210		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Top of core broke at 25-50mm deep into segements during extraction with anchor. Hit 15M T rebar and 15M L rebar at 195mm				

Core No.	D26				
Location	Southbound lane, Grid P19 (0.4m South, 0.6m East)				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	245		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at High Performance Concrete transition 130mm deep, and broke at 15M rebar 195mm deep. Hit steel formwork at bottom.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Core D25 was not taken.

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D27				
Location	Southbound lane, Grid P8 (0.9m North, 0.6m East)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	69	Acid-Soluble Chloride Content	5-20	0.820	-
Thickness of Concrete, mm	220		40-60	0.430	-
			70-90	0.181	-
Defects in Concrete (Note 1.)	None		120-140	0.020	-
			150-170	<0.020	-
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M rebar at 100mm deep and 15M rebar at 210mm deep.				

Core No.	D28				
Location	Southbound lane, Grid P17 (0.8m North, 0.4m East)				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	105	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	253		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit 15M rebar at 185mm deep and 15M rebar at 203mm deep. Hit steel formwork at bottom.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Superstructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	D29				
Location	Southbound lane, Grid O11 (0.7m South, 0.8m East)				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	105	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	234		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	4.5	%
			Specific Surface	44.1	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	122	µm
Remarks (Note 3.)	Hit 15M rebar at 163mm deep and 15M rebar at 183mm deep. Hit bottom steel formwork.				

Core No.	D30				
Location	Southbound lane, Grid O13 (0.7m South, 0.7m East)				
Full Depth (Y/N)	Y		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	69	Acid-Soluble Chloride Content	5-20	0.538	-
Thickness of Concrete, mm	250		40-60	0.237	-
			70-90	0.031	-
Defects in Concrete (Note 1.)	C		120-140	<0.020	-
			150-170	<0.020	-
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at High Performance Concrete transition 135mm deep, hit 25M rebar at 170mm deep. Hit steel formwork at bottom.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	A1				
Location	North abutment, Grid 4.5 (0.9m West, 0.1m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	220		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke at 150mm, hit 15M rebar. N-M crack to 150mm deep				

Core No.	A2				
Location	North abutment, Grid 4.5 (0.9m West, 0.1m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	50	Acid-Soluble Chloride Content	5-20	0.063	-
Thickness of Concrete, mm	20U		40-60	0.025	-
			90-110	<0.020	-
Defects in Concrete (Note 1.)	None		120-140	<0.020	-
			150-170	<0.020	-
Condition of Rebar (Note 2.)	N/A				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	A3				
Location	North abutment, Grid 19.5 (0.35m West, 0.25m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	230		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
		Chloride Permeability	Sample depth (mm)	Charge Passed (Coulombs)	Chloride Ion Penetrability Rating
Compressive Strength, MPa			14-64	874	Low
			67-117	1281	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defect in concrete.				

Core No.	A4				
Location	North abutment, Grid 28.5 (0.4m West, 0.1m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	220		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	8.3	%
			Specific Surface	19.6	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	154	µm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	A5				
Location	North abutment, Grid 28.5 (0.5m West, 0.3m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	50	Acid-Soluble	40-60	-	11.88
Thickness of Concrete, mm	195	Chloride Content	90-110	-	11.89
Defects in Concrete (Note 1.)	None				
Condition of Rebar (Note 2.)	N/A				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	A6				
Location	North abutment, Grid 37.5 (0.4m East, 0.25m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble	10-20		
Thickness of Concrete, mm	230	Chloride Content	30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	N/A				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	59.52	Unit Weight	2383	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	A7				
Location	South abutment, Grid 36 (1.25m East, 0.25m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	240		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	49.14				
		Unit Weight	2334	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	A8				
Location	South abutment, Grid 36 (0.9m East, 0.25m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Acid-Soluble Chloride Content	5-20	0.084	-
Thickness of Concrete, mm	225		40-60	<0.020	-
			90-110	<0.020	-
Defects in Concrete (Note 1.)	None		120-140	<0.020	-
			150-170	<0.020	-
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	A9				
Location	South abutment, Grid 27 (0.35m West, 0.3m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	8.0	%
			Specific Surface	16.8	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	191	µm
Remarks (Note 3.)	Narrow crack East side extends in 5-10mm.				

Core No.	A10				
Location	South abutment, Grid 27 (0.65m West, 0.3m below bearing seat).				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point					
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

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Substructure Condition Assessment
Core Log for Exposed Concrete Elements

<table>
<tr><td>Core No.</td><td colspan="5">A11</td></tr>
<tr><td>Location</td><td colspan="5">South abutment, Grid 12 (0.7m East, 0.25m below bearing seat).</td></tr>
<tr><td>Full Depth (Y/N)</td><td>N</td><td></td><td>Sample depth (mm)</td><td>% by mass of concrete</td><td>pH Level</td></tr>
<tr><td>Diameter, mm</td><td>104</td><td rowspan="13">Water-Soluble Chloride Content</td><td>10-20</td><td></td><td></td></tr>
<tr><td rowspan="2">Thickness of Concrete, mm</td><td rowspan="2">260</td><td>30-40</td><td></td><td></td></tr>
<tr><td>50-60</td><td></td><td></td></tr>
<tr><td rowspan="3">Defects in Concrete (Note 1.)</td><td rowspan="3">None</td><td>80-90</td><td></td><td></td></tr>
<tr><td>100-110</td><td></td><td></td></tr>
<tr><td>140-150</td><td></td><td></td></tr>
<tr><td rowspan="2">Condition of Rebar (Note 2.)</td><td rowspan="2">None</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Corrosion Potential
(- mV)
At Closest Grid Point</td><td rowspan="4">N/A</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Compressive Strength, MPa</td><td rowspan="2">57.91</td><td></td><td></td><td></td></tr>
<tr><td>Unit Weight</td><td>2370</td><td>kg/m³</td><td></td></tr>
<tr><td rowspan="2">Background Chloride Content (Note 4.)</td><td rowspan="2">0.008</td><td rowspan="3">Air Void Analysis</td><td>Air Content</td><td></td><td>%</td></tr>
<tr><td>Specific Surface</td><td></td><td>mm2 / mm3</td></tr>
<tr><td>Testing Laboratory</td><td>Stantec</td><td>Spacing Factor</td><td></td><td>mm</td></tr>
<tr><td>Remarks (Note 3.)</td><td colspan="5">No defects in concrete.</td></tr>
</table>

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete

MORRISON HERSHFIELD

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P1				
Location	SU4, North face, Column 2 (1.2m above slope paving, 0.1m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	140		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	G				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	57.76	Unit Weight	2387	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Hit horizontal 15M rebar at 95mm.				

Core No.	P2				
Location	SU4, North face, Column 3 (1.2m above slope paving, at centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	185		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	56.3	Unit Weight	2387	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P3				
Location	SU4, North face, Column 3 (1.2m above slope paving, 0.2m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	185		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Broke during coring / retrieval at 110mm				

Core No.	P4				
Location	SU4, North face, Column 4 (1.3m above slope paving, 0.3m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	70	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	240		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	4.2	%
			Specific Surface	24.1	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	206	µm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

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Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P5				
Location	SU2, South Face, Column 1 (1.2m above slope paving, 0.1m West of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	210		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	N/A				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	59.61				
		Unit Weight	2392	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	P6				
Location	SU2, South Face, Column 1 (1.4m above slope paving, 0.5m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	225		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	N/A				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

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Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P7				
Location	SU2, South Face, Column 2 (1.4m above slope paving, 0.2m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	190		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	P8				
Location	SU2, South Face, Column 2 (1.4m above slope paving, 0.45m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	180		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A	Chloride Permeability	Sample depth (mm)	Charge Passed (Coulombs)	Chloride Ion Penetrability Rating
Compressive Strength, MPa			16-66	943	Low
			69-118	1501	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

MORRISON HERSHFIELD

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P9				
Location	SU2, South Face, Column 3 (1.35m above slope paving, 0.25m West of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	250		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	P10				
Location	SU2, South Face, Column 3 (1.35m above slope paving, 0.1m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	245		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	69.46				
		Unit Weight	2413	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P11				
Location	SU2, South Face, Column 4 (1.35m above slope paving, 0.05m West of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	195		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke on retrieval at 140mm.				

Core No.	P12				
Location	SU2, South Face, Column 4 (1.35m above slope paving, 0.1m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	190		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	3.1	%
			Specific Surface	27.1	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	210	µm
Remarks (Note 3.)	No defects in concrete.				

Notes
1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

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Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P13				
Location	SU2, South Face, Column 5 (1.5m above slope paving, 0.1m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	195		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	57.17				
		Unit Weight	2402	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	P14				
Location	SU2, South Face, Column 5 (1.5m above slope paving, 0.35m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	260		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes
1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

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Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P15				
Location	SU4, North face, Column 1 (1.55m above slope paving, 0.1m West of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	265		30-40		
			50-60		
Defects in Concrete (Note 1.)	C		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	Core broke on retrieval at 140mm.				

Core No.	P16				
Location	SU4, North face, Column 1 (1.55m above slope paving, 0.3m West of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	200		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	63.53				
		Unit Weight	2388	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P17				
Location	SU4, North Face, Column 5 (1.6m above slope paving, 0.1m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	240		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa	68.95				
		Unit Weight	2388	kg/m³	
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	P18				
Location	SU4, North Face, Column 5 (1.6m above slope paving, 0.4m West of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	104	Water-Soluble Chloride Content	10-20		
Thickness of Concrete, mm	240		30-40		
			50-60		
Defects in Concrete (Note 1.)	None		80-90		
			100-110		
			140-150		
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content	3.2	%
			Specific Surface	18.0	mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor	292	µm
Remarks (Note 3.)	No defects in concrete.				

Notes
1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

MORRISON HERSHFIELD

Substructure Condition Assessment
Core Log for Exposed Concrete Elements

Core No.	P19				
Location	SU4, South Face, Column 4 (1.3m above sidewalk, 0.25m West of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Acid-Soluble Chloride Content	40-60	-	11.90
Thickness of Concrete, mm	190		90-110	-	11.92
Defects in Concrete (Note 1.)	None				
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Core No.	P20				
Location	SU4, South Face, Column 4 (1.3m above sidewalk, 0.05m East of centre line)				
Full Depth (Y/N)	N		Sample depth (mm)	% by mass of concrete	pH Level
Diameter, mm	67	Acid-Soluble Chloride Content	5-20	0.256	-
Thickness of Concrete, mm	235		40-60	0.104	-
			90-110	0.025	-
Defects in Concrete (Note 1.)	None		120-140	0.021	-
			150-170	<0.020	-
			190-210	<0.020	-
Condition of Rebar (Note 2.)	None				
Corrosion Potential (- mV) At Closest Grid Point	N/A				
Compressive Strength, MPa					
Background Chloride Content (Note 4.)	0.008	Air Void Analysis	Air Content		%
			Specific Surface		mm2 / mm3
Testing Laboratory	Stantec		Spacing Factor		mm
Remarks (Note 3.)	No defects in concrete.				

Notes

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling
2. Condition of Rebar - LR = Light Rust, SR = Severe Rust, N/A No Rebar Exposed, G = Good
3. Orientation of Rebar - T = Transverse, L = Longitudinal
4. Chloride contents shall be stated as % by Mass of Concrete
5. Columns are in West to East direction.

Appendix E

Test Pit Logs

SITE NO. B215

MEDIAN TEST PIT SAMPLE LOG

Sample No.	TP – 1	TP – 2
Location	Grid 18 on median, located near centre line of median	Grid 22 on median, located 0.7 m west of inside face of east safety curb
Size, mm	600 X 700	650 X 700
Depth of Sample, mm	350±	350±
Condition of Concrete Surface (1)	G	G
Defects in Concrete (2)	None	None
Concrete Cover to Reinforcement, mm	Not measured	See Remarks
Condition of Rebar (3)	G	SR
Corrosion Potential @ nearest grid point	N/A	N/A
Remarks	– Test pit taken near centreline of median – No corrosion noted on median slab rebar – Concrete noted to be dry and in good condition below styrofoam	– Test pit taken at a deteriorated transverse joint in concrete; considered to be worst case test pit location – One longitudinal rebar below joint was corroded through (full section loss) – Concrete noted to be slightly wet and in good condition below styrofoam

1. Condition - G = Good, F = Fair, P = Poor
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Rebar Condition: LR = Light Rust; SR = Severe Rust; N/A = No Exposed Rebar

SITE NO. B215

TEST PIT SAMPLE LOG

Sample No.	TP – 3
Location	Grid 25 on median, located near inside face of east safety curb
Size, mm	600 X 700
Depth of Sample, mm	350±
Condition of Concrete Surface (1)	G
Defects in Concrete (2)	Sc
Concrete Cover to Reinforcement, mm	Not measured
Condition of Rebar (3)	G
Corrosion Potential @ nearest grid point	N/A
Remarks	– Test pit taken on inside face of safety curb adjacent to longitudinal joint between safety curb and median slab – No corrosion noted on median slab rebar – Concrete noted to be dry and in good condition below styrofoam

1. Condition - G = Good, F = Fair, P = Poor
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Rebar Condition: LR = Light Rust; SR = Severe Rust; N/A = No Exposed Rebar

Appendix F

Test Pit Photos

Photo 1 - Median Test Pit 1 - at start of removals

Photo 2 - Median Test Pit 1 - at start of removals, closer view

Photo 3 - Median Test Pit 1 - median slab rebar exposed, good condition

Photo 4 - Median Test Pit 1 - median slab concrete and styrofoam removed, concrete noted to be dry and in good condition

Photo 5 - Median Test Pit 1 - median slab concrete and styrofoam removed, concrete noted to be dry and in good condition, closer view

Photo 6 - Median Test Pit 2 - at start of removals, note deterioration at joint location

Photo 7 - Median Test Pit 2 - at start of removals, note deterioration at joint location, closer view

Photo 8 - Median Test Pit 2 - median slab concrete removed, styrofoam partially exposed, longitudinal bar under transverse joint corroded through

Photo 9 - Median Test Pit 2 - median slab concrete removed, styrofoam partially exposed, longitudinal bar under transverse joint corroded through additional view

Photo 10 - Median Test Pit 2 - median slab concrete and styrofoam removed, concrete noted to be slightly wet and in good condition

Photo 11 - Median Test Pit 2 - median slab concrete and styrofoam removed, concrete noted to be slightly wet and in good condition, closer view

Photo 12 - Median Test Pit 3 - at start of removals

Photo 13 - Median Test Pit 3 - at start of removals, closer view with demo started

Photo 14 - Median Test Pit 3 - median slab concrete removed, styrofoam exposed

Photo 15 - Median Test Pit 3 - median slab concrete and styrofoam removed, concrete noted to be dry and in good condition, light flaking surface chipping occurred during s

Photo 16 - Median Test Pit 3 - median slab concrete and styrofoam removed, concrete noted to be dry and in good condition, light flaking surface chipping occurred during s

Photo 17 - Typical Test Pit temporary plywood covers

Appendix G

OSIM Report and Overhead Sign Structures Inspection Memo

Ontario Bridge Management System (OBMS) - Bridge Inspection Form   Bridge ID : B-215

INVENTORY DATA:

Structure Name	Pembina Highway Overpass (Bridge ID: B-215)		
Main Hwy/Road #	Route 42	**On** x / **Under**	**Crossing Type:** Navi. Water [ ] Rail [ ] Non-Navig. [ ] Road [x] Ped. [ ] Other [ ]
Hwy/Road Name	Pembina Highway		
Structure Location	Pembina Highway over Abinojii Mikanah (Route 165)		
UTM X	632903	**UTM Y**	5520181
Owner(s)	City of Winnipeg	**Heritage Designation**	Not Consid: [ ] Cons/not App [ ] List/n.d. [ ] Design./not list [ ] Desig & List [ ]
Region	--	**Road Class:**	Freeway [ ] Arterial [ ] Collector [x] Local [ ]
Municipality	--	**Posted Speed**	60 — **No. of Lanes** 10
Parish	--	**AADT**	43569 — **% Trucks** --
Legal Description	--	**Control Section**	--
Structure Type	CIP Concrete Box Girder	**Km Into Control Section**	--
Total Deck Length	86.80 (m)	**Interchange Structure Number**	B-215
Overall Str. Width	47.00 (m)	**Min. Vertical Clearance**	5.00 (m)
Total Deck Area	4079.6 (sq.m)	**Special Rtes:**	Transit [ ] School [ ] Truck [ ] Bicycle [ ]
Roadway Width	15.50 & 23.17 (m)	**Detour Length**	-- (km)
Skew Angle	12.42 (degrees)	**Direction of Structure**	S-N
No. of Spans	4	**Fill on Structure**	N/A (m)
Span Lengths	20.0 / 25.0 / 22.8 / 19.0 (m)		

HISTORICAL DATA:

Year Built	1990	**Last Evaluation**	--
Last OSIM Inspection	8/23/2017	**Current Load Limit**	-- (tonnes)
Last Under Bridge Inspection	N/A	**Load Limit By-law #**	--
Last Condition Survey	8/23/2017	**By-Law Expiry Date**	--
Last Underwater Inspection	N/A	**Cost Center**	--

REHAB HISTORY

Year	Description of Work
2014	Delaminated concrete removed and patched. Galvanic anodes installed in patched areas and connected to existing reinforcing.

Scheduled Improvements:					
Work Activity	**Priority**	**Unit**	**Estimated Quantity**	**Avg. Unit Cost**	**Estimated Cost**
None					
			Total Estimated Cost		None

Appraisal Indices:		**Comments**
Fatigue	N/A	
Seismic	N/A	
Scour	N/A	
Flood	N/A	
Geometrics	N/A	
Barrier	N/A	
Curb	N/A	
Load Capacity	N/A	

FIELD INSPECTION INFORMATION	
Date of Inspection	October 24 - 26, 2023
Inspector	Noëlle Vialoux
Company Name	Morrison Hershfield
Others in Party	Troy Hengen, Andrew Gilarski, Sofia Faraz, Andrei Lazcano Perez, Allan Scott, and Vector
Equipment Used	Coring Machine, RCT Testing, Chain Drag, Borescope, Standard Equipment
Weather	Overcast
Temperature	-1 °C
Underbridge Used	No
Underbridge Req.d	No

ADDITIONAL INVESTIGATIONS REQUIRED	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	x		
Non-destructive Delamination Survey of Asphalt-Covered Deck:	x		
Substructure Condition Survey:	x		
Detailed Coating Condition Survey:	x		
Detailed Timber Investigation	x		
Post-Tensioned Strand Investigation	x		
Underwater Investigation:	x		
Fatigue Investigation:	x		
Structure Evaluation:	x		
Geotechnical Evaluation:	x		
Hydraulic Evaluation:	x		
Monitoring			
Monitoring of Deformations, Settlements and Movements:	x		
Monitoring Crack Width:	x		
Other:	x		
Replace Structure:	x		
Rehabilitate Structure:	x		

Special Notes:
OSIM inspection of the overpass completed as part of detailed condition assessment for rehabilitation preliminary design. No repair works are recommended based on inspection findings due to limiting expenditure on structure prior to rehabilitation. CoW and MHL to review if proactive deck patching maintenance should be completed prior to the rehabilitation.

Next Detailed Visual Inspection:	--

Element Data

Element Group:	Abutments					**Length:**	-
Element Name:	Abutment Walls					**Width:**	48.58
Location:	North and South Abutment					**Height:**	2.18
Description:	Abutment Walls					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	211.81
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	205.8	6.0	0.0		
Comments: - 18 x Full Height (FH) narrow to medium vertical cracks on South abutment (3 x medium, 15 x narrow). - 25 x FH narrow to medium vertical cracks on North abutment (8 x medium, 17 x narrow). - Several cracks have been previously repaired, and select cracks have efflorescence.							
Photo Ref.:	Photo 30	Photo 45	Photo 70	Photo 71			
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:			None>10 Years				

Element Group:	Abutments					**Length:**	-
Element Name:	Ballast Walls					**Width:**	41.81
Location:	North and South Abutments					**Height:**	1.75
Description:	Backwall					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	146.34
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	122.7	23.6	0.0		
Comments: - Evidence of leakage coming from expansion joint on North and South ballast walls. - 23 x FH medium vertical cracks with efflorescence on South abutment, rated fair. - 31 x FH medium vertical cracks with efflorescence on North abutment, rated fair.							
Photo Ref.:	Photo 31	Photo 46	Photo 68	Photo 69			
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:			None>10 Years				

Element Data

Element Group:	Abutments				**Length:**	-
Element Name:	Bearings				**Width:**	-
Location:	North and South Abutment				**Height:**	-
Description:	Pot Bearings				**Count:**	40
Material:	Steel				**Total Quantity:**	40
Element type:	Expansion Bearings				**Limited Inspection:**	No
Environment:	Moderate				**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Each	0	38	2	0		

Comments:
- Bearing on South abutment (11th from West end) has cracked bearing plate.
- Bearing on North abutment (3rd from East end) has corroded steel.

Photo Ref.:	Photo 32	Photo 47	Photo 72	Photo 73	

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Abutments				**Length:**	9.00
Element Name:	Wingwalls				**Width:**	-
Location:	North and South Abutments				**Height:**	1.22
Description:	4 Wingwalls				**Count:**	4
Material:	Cast-in-Place Concrete				**Total Quantity:**	43.92
Element type:	Reinforced Concrete				**Limited Inspection:**	No
Environment:	Benign				**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	42.5	1.3	0.1		

Comments:
- SE wingwall: Narrow to medium FH crack, rated fair.
- NE wingwall: Several hairline to narrow FH cracks. Spall at wingwall corner (0.1m x 0.15m).
- NW wingwall: Medium vertical crack 0.6m long. Several spalls on wingwall (0.1m x 0.1m & 0.2m x 0.15m).
- SW wingwall: Narrow to medium cracks, 3.5m rated fair.

Photo Ref.:	Photo 33	Photo 34	Photo 48	Photo 49	Photo 74	Photo 75

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Accessories					**Length:**	-
Element Name:	Electrical - Lights					**Width:**	-
Location:	Pier mounted					**Height:**	-
Description:	Under bridge roadway lighting					**Count:**	20
Material:						**Total Quantity:**	20
Element type:						**Limited Inspection:**	No
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Each	0	0	0	20		
Comments: The overall majority of lights were not operational as noted during evening hours.							
Photo Ref.:	Photo 23						
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:	None>10 Years						

Element Data

Element Group:	Approaches				**Length:**	10.00
Element Name:	Approach Slabs				**Width:**	20.05
Location:	North and South Approaches				**Height:**	0.35
Description:	Structural Slabs				**Count:**	4
Material:	Cast-in-Place Concrete				**Total Quantity:**	802.00
Element type:	Reinforced Concrete				**Limited Inspection:**	No
Environment:	Severe				**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	698.4	34.5	69.2		

Comments:
- Medium to wide cracking on approach slabs (Medium: 70.2m, Wide: 209.1m).
- Delaminations noted at both North and South approach slabs (Total: 16.9 sq.m).

Photo Ref.:	Photo 12	Photo 13	Photo 14	Photo 55	

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Approaches				**Length:**	10.00
Element Name:	Barriers				**Width:**	-
Location:	North and South Approaches				**Height:**	-
Description:	Traffic Barrier				**Count:**	4
Material:	Cast-in-Place Concrete				**Total Quantity:**	40.00
Element type:	Reinforced Concrete				**Limited Inspection:**	No
Environment:	Severe				**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	m	0.0	36.0	0.0	4.0		

Comments:
- NE: Spalls and delaminations throughout (Rated 3.4m poor).
- SE: Seals failing between barrier joints. Spall at corner with exposed rebar (Rated 0.6m poor).
- Limited inspection on NW and SW approach barriers due to snow cover.

Comments:	Photo 15	Photo 58	Photo 59		

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Approaches					**Length:**	10.00
Element Name:	Sidewalk / Curb					**Width:**	4.00
Location:	North and South Abutments					**Height:**	0.33
Description:	Median					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	93.00
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Severe					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	92.3	0.4	0.4		
Comments: - Spalls on median curb with exposed rebar on South approach NB lanes (1.2m x 0.3m).							
Photo Ref.:	Photo 11						
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:	None>10 Years						

Element Group:	Approaches					**Length:**	10.00
Element Name:	Sidewalk / Curb					**Width:**	1.83
Location:	North and South Abutments					**Height:**	0.15
Description:	Pedestrian Sidewalk					**Count:**	4
Material:	Cast-in-Place Concrete					**Total Quantity:**	79.00
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	79.0	0.0	0.0		
Comments: - Generally good condition.							
Photo Ref.:	Photo 17						
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:	None>10 Years						

Element Data

Element Group:	Barriers					**Length:**	89.01
Element Name:	Barriers - Exterior					**Width:**	0.27
Location:	Shoulder Barriers					**Height:**	0.74
Description:	Outside Face					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	131.38
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	129.4	1.0	1.0		

Comments:
- Seals falling between barrier joints, typical.
- FH narrow to medium cracks typical with some wide cracking noted, rated 1 sq.m fair and 1 sq.m poor.

Photo Ref.:	Photo 9				

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Barriers					**Length:**	89.01
Element Name:	Barriers - Interior					**Width:**	0.27
Location:	Shoulder Barriers					**Height:**	0.74
Description:	Inside Face					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	179.10
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Severe					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	174.9	2.1	2.1		

Comments:
- Spall on traffic barrier interior face with exposed rebar over Span 4 NB lanes (1.2m x 0.3m).
- Spalls on traffic barrier top face with exposed rebar over Span 4 SB lanes (0.1m x 0.15m & 0.15m x 0.1m) and over Span 3 SB lanes (2.4m x 0.3m).
- Seals falling between barrier joints, typical.
- Limited inspection on SB lanes traffic barrier inside face due to snow cover.
- FH narrow to medium cracks typical with some wide cracking noted, rated 1 sq.m fair and 1 sq.m poor.

Photo Ref.:	Photo 9	Photo 56	Photo 57		

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Barriers					**Length:**	112.18
Element Name:	Hand Railings					**Width:**	-
Location:	East & West Sidewalk					**Height:**	-
Description:	Pedestrian Handrail					**Count:**	2
Material:	Aluminum					**Total Quantity:**	224.36
Element type:	Pedestrian Barrier System					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	m	0.0	223.4	0.0	1.0		
Comments: - Differential movement of pedestrian handrail panels at NW, NE, SW, and SE corners over curb joints (ranging from 50 - 90mm). - Permanent deformation on 4 pickets and scuff marks on nearby end post at SE corner of bridge, rated 1m poor.							
Photo Ref.:	Photo 10	Photo 63	Photo 64	Photo 65	Photo 66	Photo 67	
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:		None>10 Years					

Element Group:	Barriers					**Length:**	109.22
Element Name:	Railing Systems					**Width:**	-
Location:	Top of Traffic Barriers					**Height:**	-
Description:	Traffic Barrier Rail					**Count:**	2
Material:	Aluminum					**Total Quantity:**	218.44
Element type:	Aluminum Barrier Rail & Post					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	m	0.0	218.4	0.0	0.0		
Comments: - Missing 2 nuts and washers for anchor bolts at NE corner of bridge.							
Photo Ref.:	Photo 9	Photo 60					
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:		None>10 Years					

Element Data

Element Group:	Beams					**Length:**	2.00
Element Name:	Inside Boxes					**Width:**	2.175
Location:	End					**Height:**	0.975
Description:						**Count:**	19
Material:	Cast in place concrete					**Total Quantity:**	156.75
Element type:						**Limited Inspection:**	Yes
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	156.8	0.0	0.0		

Comments:
- Limited inspection, used borescope through weeping holes. Generally good condition observed based on inspection locations reviewed with borescope and based on stay in place formwork condition.

Photo Ref.:						

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Beams					**Length:**	84.80
Element Name:	Inside Boxes					**Width:**	2.175
Location:	Middle					**Height:**	0.975
Description:						**Count:**	19
Material:	Cast in place concrete					**Total Quantity:**	6646.20
Element type:						**Limited Inspection:**	Yes
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	6646.2	0.0	0.0		

Comments:
- Limited inspection, used borescope through weeping holes and through two deck core hole locations. Generally good condition observed based on inspection locations reviewed with borescope and deck core hole locations.

Photo Ref.:						

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Decks					**Length:**	87.50
Element Name:	Deck Top					**Width:**	47.05
Location:						**Height:**	0.240
Description:						**Count:**	
Material:	Cast-in-Place Concrete					**Total Quantity:**	4116.88
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Severe					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	3687.2	237.5	192.3		
Comments: - Longitudinal and transverse cracking noted throughout. (Medium: 532.7m, Wide: 351.8m). - Delaminations noted throughout NB and SB lanes. (Total area 104.3 sq.m).							
Photo Ref.:	Photo 7	Photo 8	Photo 54				
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:		None>10 Years					

Element Group:	Decks					**Length:**	-
Element Name:	Drainage System					**Width:**	-
Location:	NW, NE, SW, SE Corners					**Height:**	-
Description:	Through drains					**Count:**	8
Material:	Steel					**Total Quantity:**	8
Element type:	Steel Grating					**Limited Inspection:**	No
Environment:	Severe					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Each	0	8	0	0		
Comments: - Generally good condition.							
Photo Ref.:	Photo 22						
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:		None>10 Years					

Element Data

Element Group:	Decks					**Length:**	2.00
Element Name:	Soffit - Inside Boxes					**Width:**	41.33
Location:	Ends					**Height:**	-
Description:	Stay in place formwork					**Count:**	-
Material:	Steel					**Total Quantity:**	82.65
Element type:	305x203x6 HSS					**Limited Inspection:**	Yes
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	82.7	0.0	0.0		

Comments:
- Limited inspection, used borescope through weeping holes. Generally good condition observed based on inspection locations reviewed with borescope and based on stay in place formwork condition. Galvanizing was noted to have oxidation / white corrosion but no steel corrosion was noted from inspection.

Photo Ref.:

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Decks					**Length:**	84.80
Element Name:	Soffit - Inside Boxes					**Width:**	41.33
Location:	Middle					**Height:**	-
Description:	Stay in place formwork					**Count:**	-
Material:	Steel					**Total Quantity:**	3504.36
Element type:	305x203x6 HSS					**Limited Inspection:**	Yes
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	3504.4	0.0	0.0		

Comments:
- Limited inspection, used borescope through weeping holes and through two deck core hole locations. Generally good condition observed based on inspection locations reviewed with borescope and deck core hole locations. Galvanizing was noted to have oxidation / white corrosion but no steel corrosion was noted from inspection.

Photo Ref.:

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Decks					**Length:**	2.00
Element Name:	Soffit - Thin Slab					**Width:**	49.19
Location:	End					**Height:**	-
Description:	Bottom Slab					**Count:**	-
Material:	Cast-in-Place Concrete					**Total Quantity:**	98.38
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	98.4	0.0	0.0		
Comments: - Hairline to narrow cracking noted throughout, mostly located going through plastic chairs. Generally good condition.							
Photo Ref.:	Photo 26	Photo 29					
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:		None>10 Years					

Element Group:	Decks					**Length:**	87.50
Element Name:	Soffit - Thin Slab					**Width:**	4.91
Location:	Exterior					**Height:**	-
Description:	Bottom Slab					**Count:**	-
Material:	Cast-in-Place Concrete					**Total Quantity:**	429.63
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	427.3	2.3	0.0		
Comments: - Narrow to medium cracks with efflorescence noted on both East and West exterior soffits (Total 9.2m rated fair).							
Photo Ref.:	Photo 24	Photo 25	Photo 77				
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:		None>10 Years					

Element Data

Element Group:	Decks					**Length:**	85.50
Element Name:	Soffit - Thin Slab (Interior)					**Width:**	44.28
Location:	Interior					**Height:**	-
Description:	Bottom Slab					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	3785.94
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	3778.4	7.5	0.0		

Comments:
- Hairline to narrow cracking noted throughout, mostly located going through plastic chairs. Signs of leakage noted coming from weeping holes on all spans. Longitudinal cracks were mostly located over columns 3 and 4 over piers.
- Span 1: Longitudinal cracking with efflorescence near piers with signs of leakage (6m rated fair). Rust staining near SU2 pier, appears to come from minor spall with exposed rebar (rated good).
- Span 2: Longitudinal cracking with efflorescence near piers (10m rated fair).
- Span 3: Longitudinal cracking with efflorescence near piers (8.5m rated fair). Small area of rust staining noted (rated good).
- Span 4: Longitudinal cracking with efflorescence noted mostly near SU4 pier (5.5m rated fair). Small isolated areas of rust staining (rated good).

Photo Ref.:	Photo 26	Photo 27	Photo 28	Photo 29	Photo 76

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Embankments & Streams				**Length:**	-
Element Name:	Embankments				**Width:**	-
Location:	North and South Abutments				**Height:**	-
Description:					**Count:**	4
Material:	Vegetation				**Total Quantity:**	4
Element type:					**Limited Inspection:**	No
Environment:	Benign				**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Each	0	4	0	0		

Comments:
- Runoff erosion hole on SW embankment near SU2 pier, and on NW embankment near SU4 pier.

Photo Ref.:	Photo 37	Photo 38	Photo 52	Photo 53	Photo 81

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Embankments & Streams				**Length:**	-
Element Name:	Slope Protection				**Width:**	-
Location:	North & South Abutments				**Height:**	-
Description:	Slope Paving				**Count:**	2
Material:	Cast-in-Place Concrete				**Total Quantity:**	2
Element type:	Reinforced Concrete				**Limited Inspection:**	No
Environment:	Benign				**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Each	0	0	2	0		

Comments:
- Transverse and longitudinal cracking throughout with previous patching wearing off / failing in exposed areas at ends. Wide cracks and spalls notes on drain troughs.
- Slope paving at both abutments appear to be settling ~50mm.
- Crack total (Narrow: 178m, Medium: 44m, Wide: 39m).
- Spalling total (0.11 sq.m).

Photo Ref.:	Photo 35	Photo 36	Photo 50	Photo 51	Photo 78	Photo 79

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Foundations					**Length:**	-
Element Name:	Below Ground					**Width:**	-
Location:	Piers and Abutments					**Height:**	-
Description:						**Count:**	-
Material:						**Total Quantity:**	ALL
Element type:						**Limited Inspection:**	Yes
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	ALL	0.0	0.0		
Comments: - Good condition assumed based on observed performance.							
Photo Ref.:							
Performance Deficiencies:							
Recommended Work:							
Recommended Work Priority:	None>10 Years						

Element Data

Element Group:	Joints					**Length:**	48.68
Element Name:	Armouring / Retaining Devices					**Width:**	-
Location:	North and South Abutments					**Height:**	-
Description:						**Count:**	2
Material:	Steel					**Total Quantity:**	97.37
Element type:	Galvanized Steel					**Limited Inspection:**	No
Environment:	Severe					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	m	0.0	97.4	0.0	0.0		

Comments:
- Generally good condition.

Photo Ref.:	Photo 18	Photo 19	Photo 20	Photo 21		

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Joints					**Length:**	48.68
Element Name:	Seals / Sealants					**Width:**	-
Location:	North and South Abutments					**Height:**	-
Description:						**Count:**	2
Material:	Neoprene Rubber					**Total Quantity:**	97.37
Element type:	Strip Seal					**Limited Inspection:**	No
Environment:	Severe					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	m	0.0	0.0	68.2	29.2		

Comments:
- Joint seals at both abutments area leaking. Rated 30% of length poor, remaining length rated fair.

Photo Ref.:	Photo 18	Photo 19	Photo 20	Photo 21		

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Piers					**Length:**	-
Element Name:	Bearings					**Width:**	-
Location:	Piers					**Height:**	-
Description:	Pot Bearings					**Count:**	60
Material:	Steel					**Total Quantity:**	60
Element type:	Fixed / Exp. Bearings					**Limited Inspection:**	Yes
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Each	0	60	0	0		

Comments:
- Limited inspection, ground based inspection only. Assumed all are in good condition.

Photo Ref.:									

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Piers					**Length:**	0.90
Element Name:	Caps					**Width:**	46.55
Location:						**Height:**	1.28
Description:	Pier Caps					**Count:**	3
Material:	Cast-in-Place Concrete					**Total Quantity:**	615.79
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	615.8	0.0	0.0		

Comments:
- Signs of leakage on caps suspected to be coming from weeping holes. Generally good condition.

Photo Ref.:	Photo 39	Photo 40	Photo 41	Photo 42	Photo 43	Photo 44			

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Piers					**Length:**	0.90
Element Name:	Shafts					**Width:**	3.26
Location:	Below Pier Caps					**Height:**	3.33
Description:	Pier Shafts					**Count:**	15
Material:	Cast-in-Place Concrete					**Total Quantity:**	415.46
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	415.5	0.0	0.0		

Comments:
- Light honeycombing noted. Generally good condition.

Photo Ref.:	Photo 39	Photo 40	Photo 41	Photo 42	Photo 43	Photo 44			

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Piers					**Length:**	0.90
Element Name:	Shafts					**Width:**	46.80
Location:	Base Pedestal at Ground Level					**Height:**	0.74
Description:	Pier Shafts					**Count:**	3
Material:	Cast-in-Place Concrete					**Total Quantity:**	211.22
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Benign					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	211.2	0.0	0.0		

Comments:
- Narrow vertical cracking noted with select cracks previously patched.

Photo Ref.:	Photo 39	Photo 40	Photo 41	Photo 42	Photo 43	Photo 44	Photo 80		

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Sidewalks / Curbs					**Length:**	89.46
Element Name:	Curbs					**Width:**	0.30
Location:	East and West of Bridge					**Height:**	0.15
Description:	Curb on Pedestrian Sidewalk					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	80.51
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	80.5	0.0	0.0		

Comments:
- FH light to medium cracks typical, rated all good.

Photo Ref.:	Photo 10					

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Group:	Sidewalks / Curbs					**Length:**	89.46
Element Name:	Sidewalks					**Width:**	1.53
Location:	East and West of Bridge					**Height:**	0.00
Description:	Pedestrian Sidewalk					**Count:**	2
Material:	Cast-in-Place Concrete					**Total Quantity:**	272.85
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Moderate					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	272.6	0.2	0.2		

Comments:
- Epoxy polymer surface is spalling off of ~50% of East and West sidewalks with light surface scaling on some of the exposed areas.
- Hairline to medium transverse cracks noted on some exposed areas.
- Pot hole / severe concrete spalling on East sidewalk (0.15 sq.m. rated poor).

Photo Ref.:	Photo 10	Photo 61	Photo 62			

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Element Data

Element Group:	Sidewalks / Curbs					**Length:**	89.46
Element Name:	Medians					**Width:**	4.00
Location:						**Height:**	0.33
Description:	Center Median					**Count:**	1
Material:	Cast-in-Place Concrete					**Total Quantity:**	415.99
Element type:	Reinforced Concrete					**Limited Inspection:**	No
Environment:	Severe					**Perform. Deficiencies**	**Maint. Needs**
Condition Data:	**Units**	**Exc.**	**Good**	**Fair**	**Poor**	None	None
	Sq.m.	0.0	415.8	0.1	0.1		

Comments:
- Typical narrow FH and longitudinal cracking, rated all good.
- Spall in NB lanes side with exposed rebar (0.3m x 0.3m).
- Limited inspection on SB lanes side due to snow cover.

Photo Ref.:	Photo 11					

Performance Deficiencies:

Recommended Work:

Recommended Work Priority: None>10 Years

Photo 1 - West elevation

Photo 2 - East elevation

Photo 3 - Route 165 looking West from structure

Photo 4 - Route 165 looking East from structure

Photo 5 - Roadway looking North

Photo 6 - Roadway looking South

Photo 7 - Bridge deck top looking South

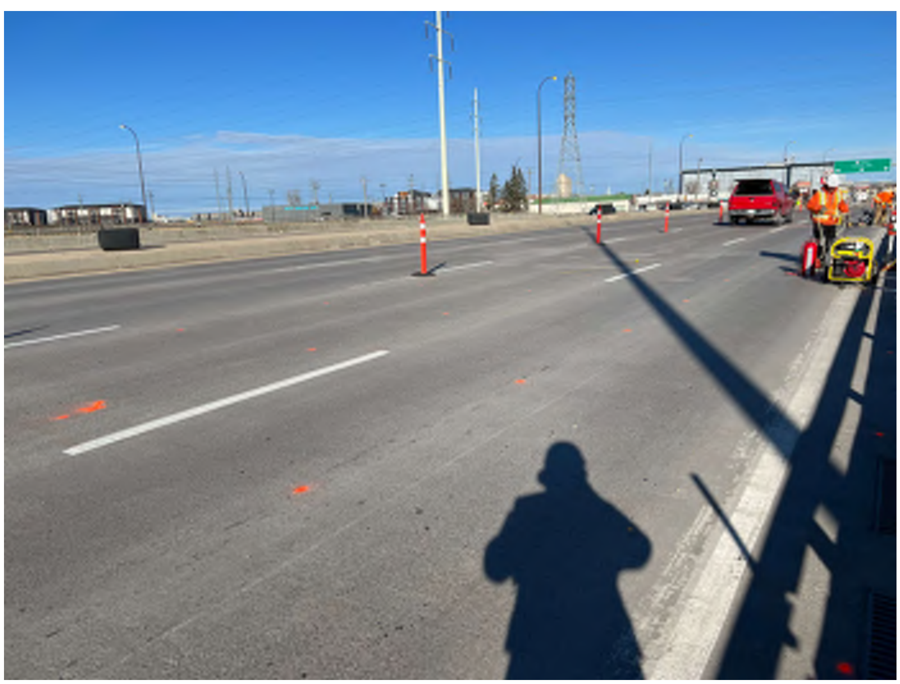


Photo 8 - Bridge deck top looking North

Photo 9 - Typical traffic barrier - exterior face and traffic barrier rail

Photo 10 - Typical sidewalk and pedestrian handrail

Photo 11 - Typical center median

Photo 12 - North approach slab, NB lanes

Photo 13 - South approach slab, NB lanes

Photo 14 - North approach slab, SB lanes

Photo 15 - South approach slab, SB lanes

Photo 16 - Typical approach traffic barrier

Photo 17 - Typical approach sidewalk

Photo 18 - SU1 expansion joint

Photo 19 - SU1 expansion joint over sidewalk

Photo 20 - SU5 expansion joint

Photo 21 - SU5 expansion joint over sidewalk

Photo 22 - Typical drains

Photo 23 - Typical pier mounted light

Photo 24 - West exterior soffit

Photo 25 - East exterior soffit

Photo 26 - Typical Span 1 soffit

Photo 27 - Typical Span 2 soffit

Photo 28 - Typical Span 3 soffit

Photo 29 - Typical Span 4 soffit

Photo 30 - SU1 South abutment elevation

Photo 31 - SU1 abutment backwall

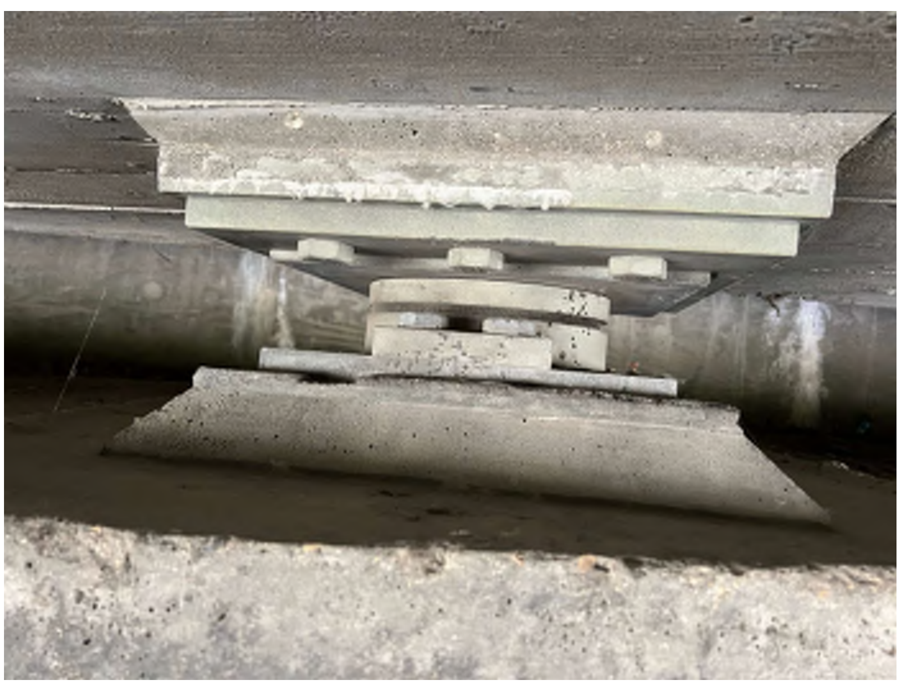


Photo 32 - Typical SU1 abutment bearing

Photo 33 - SW wingwall

Photo 34 - SE wingwall

Photo 35 - South abutment slope paving - bottom portion

Photo 36 - South abutment slope paving - top portion

Photo 37 - SW embankment

Photo 38 - SE embankment

Photo 39 - SU2 pier elevation

Photo 40 - Typical SU2 pier cap, shaft, and base pedestal

Photo 41 - SU3 pier elevation

Photo 42 - Typical SU3 pier cap, shaft, and base pedestal

Photo 43 - SU4 pier elevation

Photo 44 - Typical SU4 pier cap, shaft, and base pedestal

Photo 45 - SU5 North abutment elevation

Photo 46 - SU5 abutment backwall

Photo 47 - Typical SU5 abutment bearing

Photo 48 - NW wingwall

Photo 49 - NE wingwall

Photo 50 - North abutment slope paving - top portion

Photo 51 - North abutment slope paving - bottom portion

Photo 52 - NW embankment

Photo 53 - NE embankment

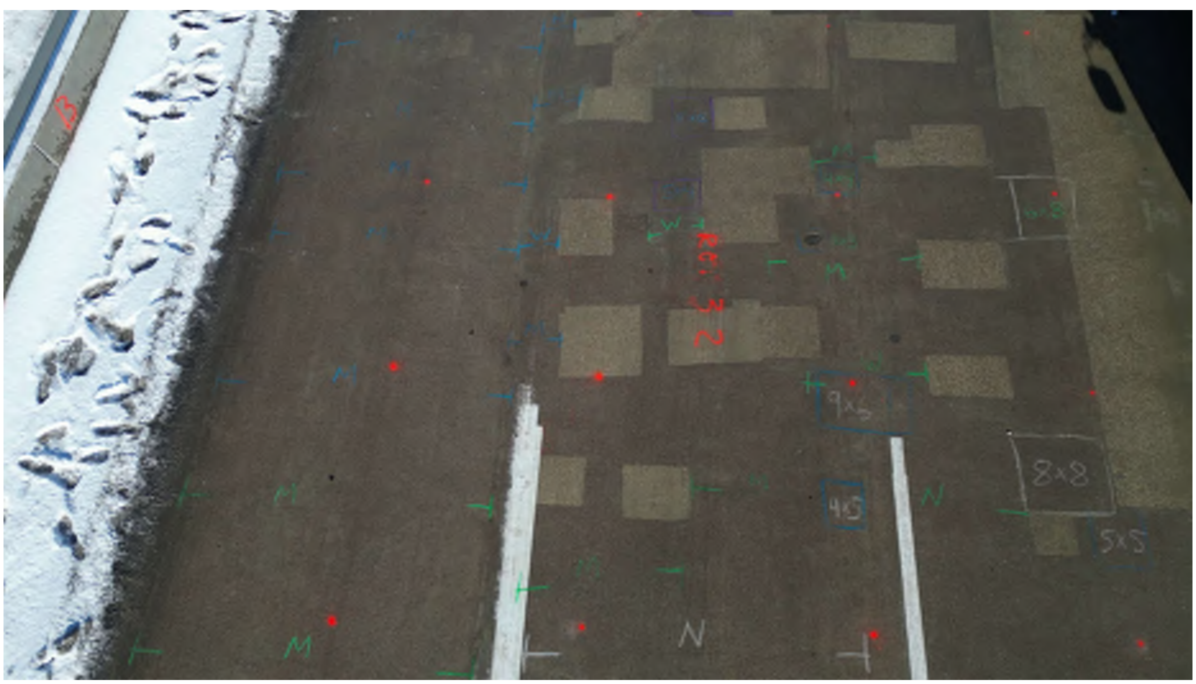


Photo 54 - Typical deck top cracking and delaminations

Photo 55 - Typical approach slab medium to wide cracking

Photo 56 - Typical vertical narrow to medium cracking on traffic barrier inside face

Photo 57 - West barrier and sidewalk area of severe scaling and spalling

Photo 58 - NE approach barrier, spalls with exposed rebar

Photo 59 - NE approach barrier, delaminations near expansion joint

Photo 60 - East traffic barrier rail showing post missing 2 nuts and washers.

Photo 61 - East sidewalk worn epoxy coating and pothole

Photo 62 - West sidewalk hairline to medium transverse cracks

Photo 63 - Pedestrian handrail panel with 4 broken pickets at SE corner

Photo 64 - Pedestrian handrail at NW corner showing differential settlement (~80mm)

Photo 65 - Pedestrian handrail at NE corner showing differential settlement (~90mm)

Photo 66 - Pedestrian handrail at SW corner showing differential settlement (~50mm)

Photo 67 - Pedestrian handrail at SE corner showing differential settlement (~50mm)

Photo 68 - Typical leakage on abutment backwall

Photo 69 - SU5 abutment backwall cracking at East end

Photo 70 - Leakage on abutment seat and slope paving

Photo 71 - Abutment wall typical narrow to medium vertical cracks

Photo 72 - SU1 abutment bearing 11 from West with cracked bearing plate

Photo 73 - SU5 abutment bearing 3 from East with corroded steel

Photo 74 - Spall on corner of NE wingwall

Photo 75 - Spall on corner of SE wingwall

Photo 76 - Typical soffit hairline to narrow cracking with efflorescence near piers

Photo 77 - Typical exterior soffit narrow cracks with efflorescence

Photo 78 - SW drain gutter typical wide cracking on slope paving

Photo 79 - NE drain gutter typical wide cracking on slope paving

Photo 80 - Typical narrow vertical cracks on pier base pedestals

Photo 81 - SW embankment near SU2 pier run off erosion hole

MEMORANDUM

TO:	Matt Hildebrand, P.Eng. Bridge Projects Engineer Engineering Division Bridge Planning and Operations Branch City of Winnipeg	**FROM:**	Troy Hengen, P.Eng. Senior Bridge Engineer
		PROJECT No.:	230376600
RE:	Pembina Highway Overpass at Abinojii Mikanah (Bishop Grandin) Visual Inspection Summary of Four Overhead Sign Structures (S647, S649, S650, and S653)	**DATE:**	11/22/2024

X:\PROJ\2021\210351000-ST VITAL BRIDGE OVER RED RIVER PD\08. WORKING\03. REPORTS\2. DECK CONDITION ASSESSMENT\REPORT\DRAFT SUBMISSION\APPENDIX L - OHSS VISUAL INSPECTIONS - FINAL DRAFT.DOCX

Dear Matt,

As per our project proposal, we are presenting the following findings from our visual inspections of four directional overhead sign structures (OHSS) in the vicinity of the Pembina Highway Overpass with structure locations as described below. Each structure was visually inspected from the ground, using binoculars to view above roadway components and upper portions of legs, and the lower portions of the legs and bases were visually inspected within arm's reach.

A written summary of our inspection findings, short term recommendations for the OHSSs, and inspection photos are included with this memo. Please contact me to discuss further if there are questions or clarifications.

Regards,

Troy Hengen, P.Eng.
Senior Bridge Engineer

1. S-647: SB Pembina at WB Abinojii Ramp Cantilever Structure

Visual Inspection Findings

- Date of inspection: October 26, 2023, and June 21, 2024
- Leg / Base – generally good condition
- Arm – generally good condition
- Front of Signs – generally good condition
- Sign Attachments – generally good condition

Short Term Recommendations for Structure

- No maintenance work is recommended for the structure

2. S-649: NB Pembina Exit to WB Abinojii Ramp (Advance Warning) Cantilever Structure

Visual Inspection Findings

- Date of inspection: October 26, 2023, and June 21, 2024
- Leg / Bases – light spalling on top of foundation, below grout pad (0.2m x 0.1m & 0.1m x 0.1m),
- Arm – generally good condition
- Front of signs – generally good condition
- Sign Attachments – generally good condition

Short Term Recommendations for Structure

- No maintenance work is recommended for the structure

3. S-650: SB Pembina Hwy Approaching University Crescent Monotube Bridge Structure

Visual Inspection Findings

- Date of inspection: October 26, 2023, and June 21, 2024
- West Leg – generally good condition
- East Leg – generally good condition
- Top Chord – generally good condition
- Front of Signs – generally good condition
- Sign Attachments – generally good condition

Short Term Recommendations for Structure

- No maintenance work is recommended for the structure

4. S-653 NB Pembina at WB Abinojii Exit Ramp Monotube Bridge Structure

Visual Inspection Findings

- Date of inspection: October 26, 2023, and June 21, 2024
- West Leg / Bases – narrow cracking on grout pads, generally good condition
- East Leg / Bases – narrow cracking on grout pads, generally good condition
- Top Chord – generally good condition
- Front of Signs – generally good condition
- Sign Attachments – generally good condition

Short Term Recommendations for Structure

- No maintenance work is recommended for the structure

PEMBINA / ABINOJII MIKANAH OVERPASS (SITE B-215) CONDITION ASSESSMENT REPORT
APPENDIX G - OHSS (STRUCTURE ID S-647) INSPECTION PHOTOS
2023-10-26

Photo 1 - Overhead sign structure, front view

Photo 2 - Overhead sign structure, side view

Photo 3 - Overhead sign structure, rear view

Photo 4 - Overhead sign structure, base plate and foundation

Photo 5 - Base plate, additional view 1

Photo 6 - Base plate, additional view 2

Photo 1 - Overhead sign structure, front view


Photo 2 - Overhead sign structure, side view

Photo 3 - Overhead sign structure, rear view

Photo 4 - Overhead sign structure, base plate and foundation

Photo 5 - Spalling on foundation top

Photo 1 - Overhead sign structure, front view

Photo 2 - Overhead sign structure, side view

Photo 3 - Overhead sign structure, rear view

Photo 4 - Overhead sign structure, base plate and foundation

Photo 5 - Overhead sign structure, median base plate and foundation

Photo 1 - Overhead sign structure, front view

Photo 2 - Overhead sign structure, side view

Photo 3 - Overhead sign structure, rear view

Photo 4 - Overhead sign structure, base plate and foundation

Photo 5 - Overhead sign structure, median base plate and foundation

Photo 6 - Narrow cracking on foundation grout pad

Appendix H

Condition Survey Photos

Photo 1 - Typical approach slab medium to wide longitudinal cracking

Photo 2 - Typical expansion joint, showing uneven expansion across bridge width

Photo 3 - Approach slab settlement, 10-20 mm noted at all approach slab locations, compared to deck blockout elevation

Photo 4 - Approach slab core APP7, taken through a wide longitudinal crack which extended the depth of the core

Photo 5 - Deck core D20, epoxy coated rebar conditon, coated has failed and is debonding

Photo 6 - Deck core D22, epoxy coated rebar conditon, coated has failed and is debonding

Photo 7 - Abutment wall, intermittment leakage across width of bridge and showing vertical cracking

Photo 8 - Abutment core A1, core taken through narrow to medium crack

Photo 9 - Typical bottom of pier condition note cracking on barrier wall at base of pier

Photo10 - Borescope inspection completed by VCS Engineering Ltd with rolling scaffold for access

Photo 11 - Deck core hole D12, view inside box girders, note white corrosion oxidation product on SIP formwork

Photo 12 - Deck core hole D12, view inside box girders, note white corrosion oxidation product on SIP formwork, additional view

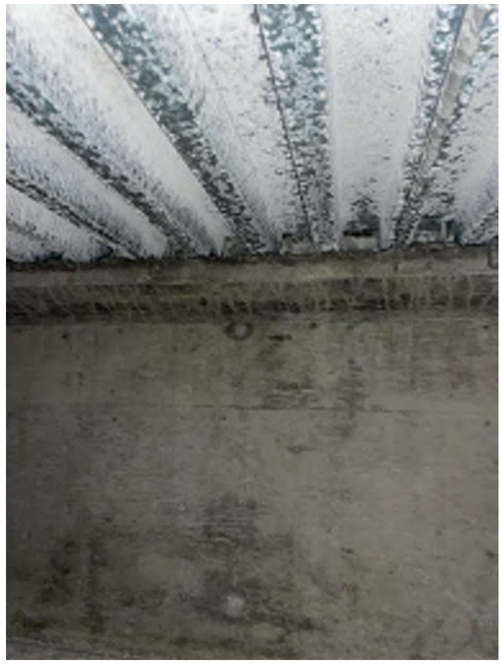


Photo 13 - Deck core hole D12, view inside box girders, girder web and top flange, note dampness and staining

Photo 14 - Deck core hole D29, view inside box girders, note white corrosion oxidation product on SIP formwork

Photo 15 - Deck core hole D29, view inside box girders, girder web and top flange, note dampness and staining

Photo16 - Deck core hole D29, view inside box girders, girder web and top flange, note dampness and staining, additional view

Photo 17 - Approach slab cores

Photo 18 - Deck cores, D1 to D12

Photo 19 - Deck cores, D12 to D23

Photo 20 - Deck cores, D19A to D30

Photo 01 - Girder RCT Locations 1 and 2, east exterior girder face near SU3

Photo 02 - East deck overhang, north half

Photo 03 - East deck overhang, south half

Photo 04 - SU3 Pier, Line “T” East exterior bearing

Photo 05 - SU3 Pier, Line “K” bearing near transverse centreline – note- confirmatory measurements taken on bearing

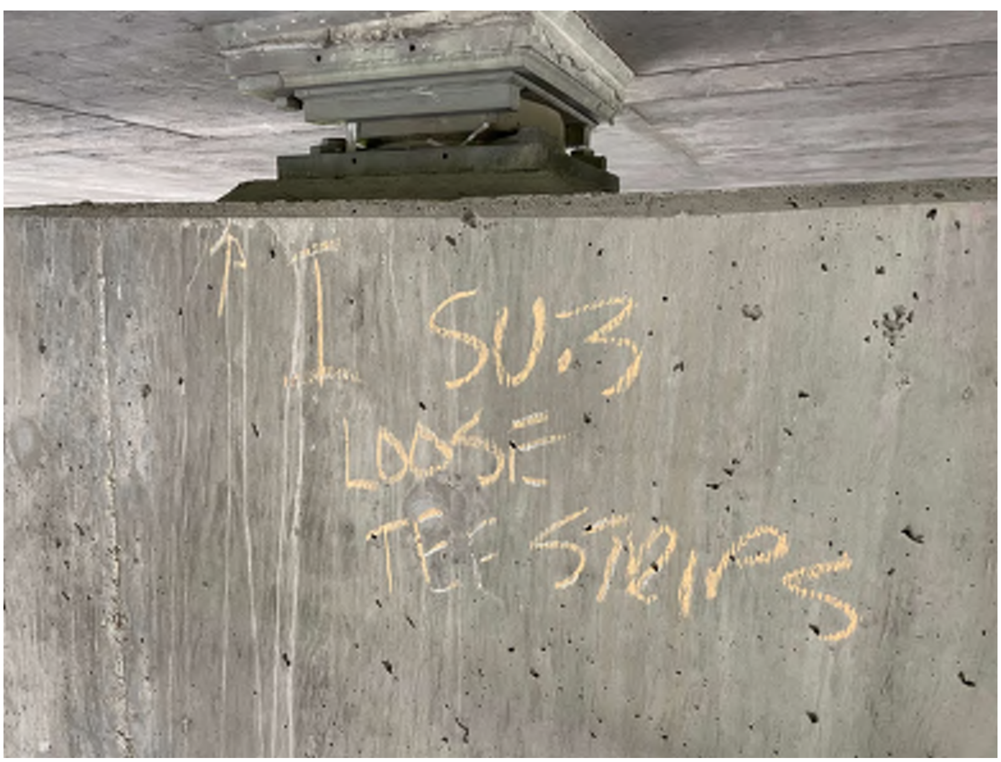


Photo 06 - SU3 Pier, Line “I” bearing, loose Teflon strip on south side

Photo 07 - SU3 Pier, Line "I" bearing, loose Teflon strips on south side, close up view

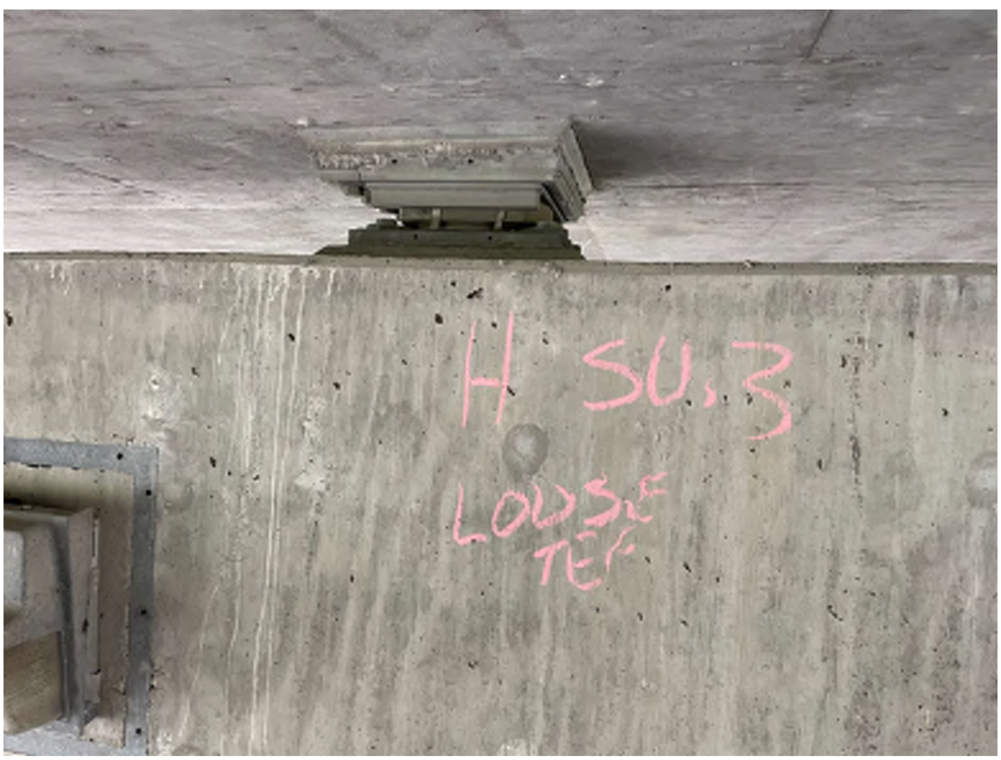


Photo 08 - SU3 Pier, Line "H" bearing, loose Teflon strips on south side

Photo 09 - SU3 Pier, Line “H” bearing, loose Teflon strips on south side, close up view

Photo 10 - SU3 Pier, Line ‘D” bearing, coating failure on west side of bearing

Photo 11 - SU2 Pier, Line “T” East exterior bearing

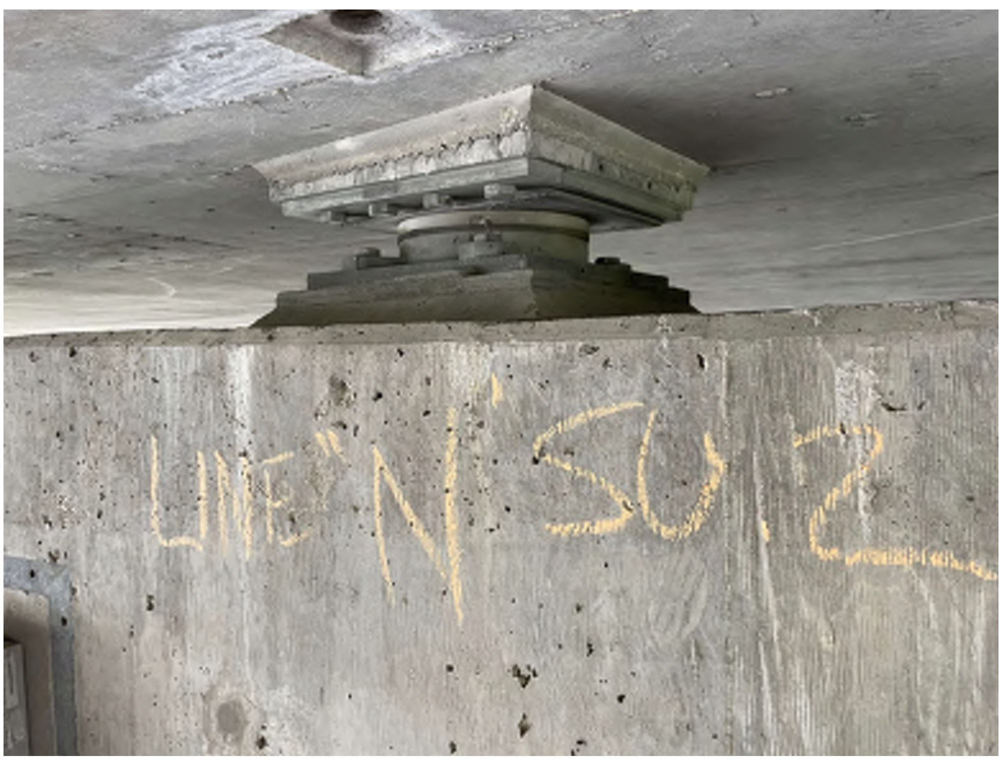


Photo 12 - SU2 Pier, Line “N”, coating spatter on sliding plate

Photo 13 - SU2 Pier, Line “N”, coating spatter on sliding plate, closer view

Photo 14 - Span 2, narrow crack with efflorescence near SU2 Pier

Photo 15 - Span 2, narrow crack with efflorescence and wetness near Line “L”

Photo 16 - SU2, Line “J”, showing bearing type near centreline of bridge

Photo 17 - Deck overhang at sidewalk curb joint near SU2, note wetness and efflorescence

Photo 18 - Span 1, west deck overhang

Photo 19 - SU4, Line “A” west exterior bearing

Photo 20 - SU4, Line “B” bearing, minor coating failure, Line “D” and “H” similar

Photo 21 - SU4, Line “E” bearing, minor rust stain

Photo 22 - SU4, Line “K” unidirectional bearing

Photo 23 - SU4, light temporarily repaired near east end on south face

Photo 24 - Girder RCT Locations 3 and 4, east exterior girder face near SU4

Photo 25 - SW slope paving drainage trough

Photo 26 - SW slope paving lower catch basin

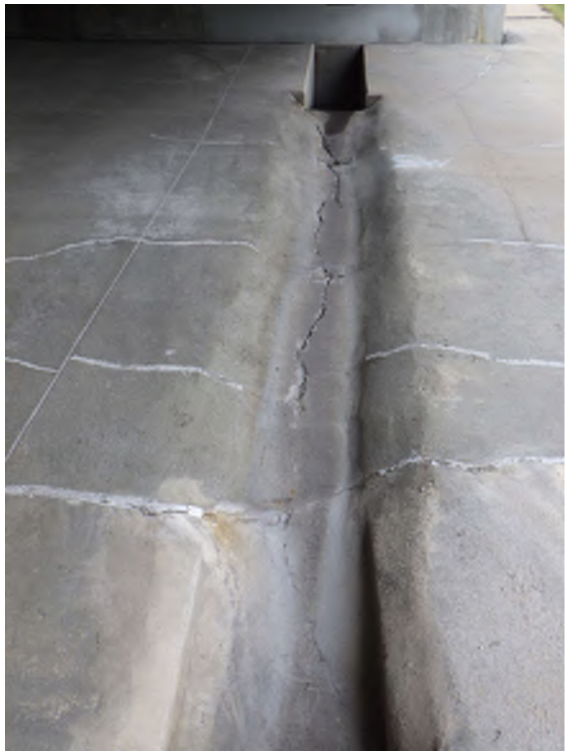


Photo 27 - SW slope paving drainage trough, closer view of wide cracking

Photo 28 - SE slope paving lower catch basin, small areas of delamination and spalling

Photo 29 - SE slope paving drainage trough, closer view of wide cracking and localized small delaminations

Photo 30 - Slope Paving RCT Location No. 1

Photo 31 - Slope Paving RCT Location No. 2

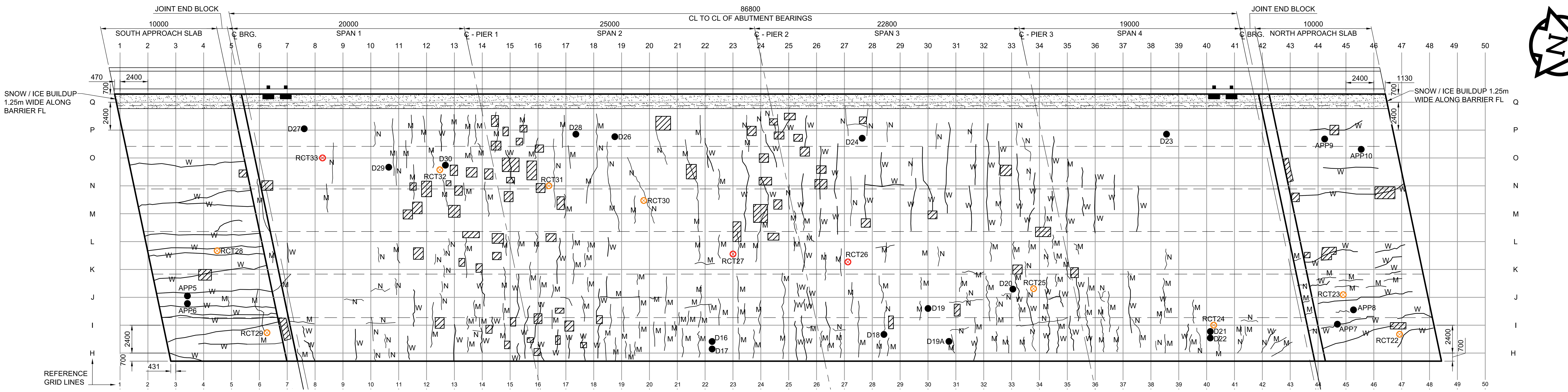
Photo 32 - Slope Paving RCT Location No. 3

Photo 33 - Slope Paving RCT Location No. 4

Photo 34 - NE slope paving, delamination 1.0 m x 2.4 m

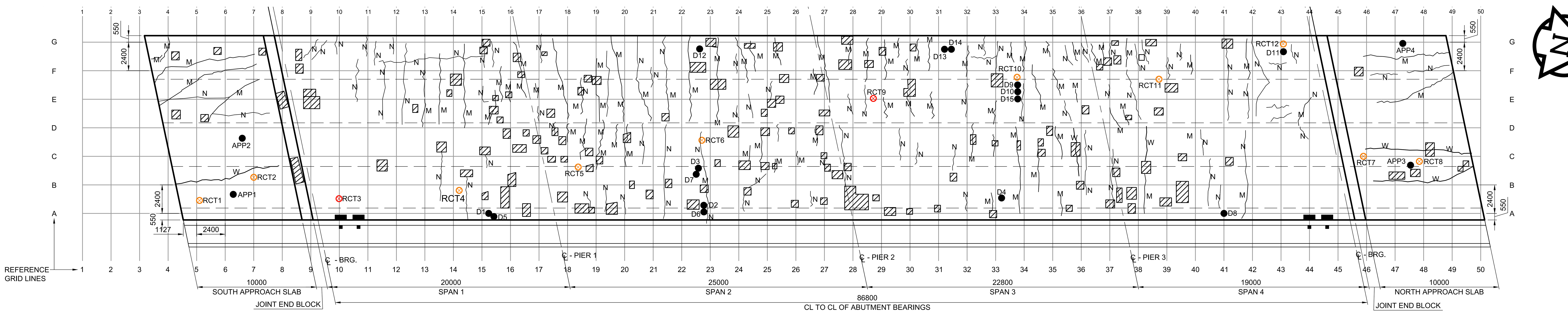
Appendix I

Detailed Condition Survey Drawings



SOUTHBOUND DECK TOP

SCALE 1:175



NORTHBOUND DECK TOP

SCALE 1:175

LEGEND:

- LANE LINE
- DECK DRAIN
- CONCRETE CORE (D)
- RCT TEST (RCT)
- NARROW CRACK (N)
- MEDIUM CRACK (M)
- WIDE CRACK (W)
- DELAMINATION

NOTES:

1. INSPECTION COMPLETED IN NOVEMBER, 2023
2. CORE "D12" AND "D29" WERE TAKEN THROUGH THE DECK AND INSIDE OF SUPERSTRUCTURE WAS INSPECTED.
3. DECK TOP BETWEEN BARRIERS AND MEDIAN INCLUDED CURRENT DETAILED CONDITION ASSESSMENT SCOPE. OSIM INSPECTION ONLY COMPLETED ON BARRIERS, MEDIAN, AND SIDEWALK IN CURRENT ASSESSMENT SCOPE.
4. PREVIOUS CONCRETE PATCHES ARE NOT SHOWN FOR CLARITY.
5. SEE APPENDICES E AND F FOR MEDIAN TEST PIT LOGS AND MEDIAN TEST PIT PHOTOS, RESPECTIVELY.
6. TEST DEPTH IN MILLIMETERS AND MEASURED FROM SURFACE. RESULTS DISPLAYED IN RED ARE GREATER THAN 0.05% CI BY CONCRETE MASS.
7. CHLORIDE CONTENT TEST RESULTS PRESENTED ARE TEST RESULTS EXCLUDING BACKGROUND CHLORIDES (DETERMINED TO BE 0.008% BY MASS OF CONCRETE).

RCT LEGEND:

% CI BY WEIGHT > 0.05% AT GREATER THAN 50 mm DEEP	RCT-X
% CI BY WEIGHT > 0.05% UP TO AND INCLUDING 50 mm DEPTH	RCT-X
% CI BY WEIGHT LESS THAN 0.05% AT ALL DEPTHS	RCT-X

MORRISON HERSHFIELD

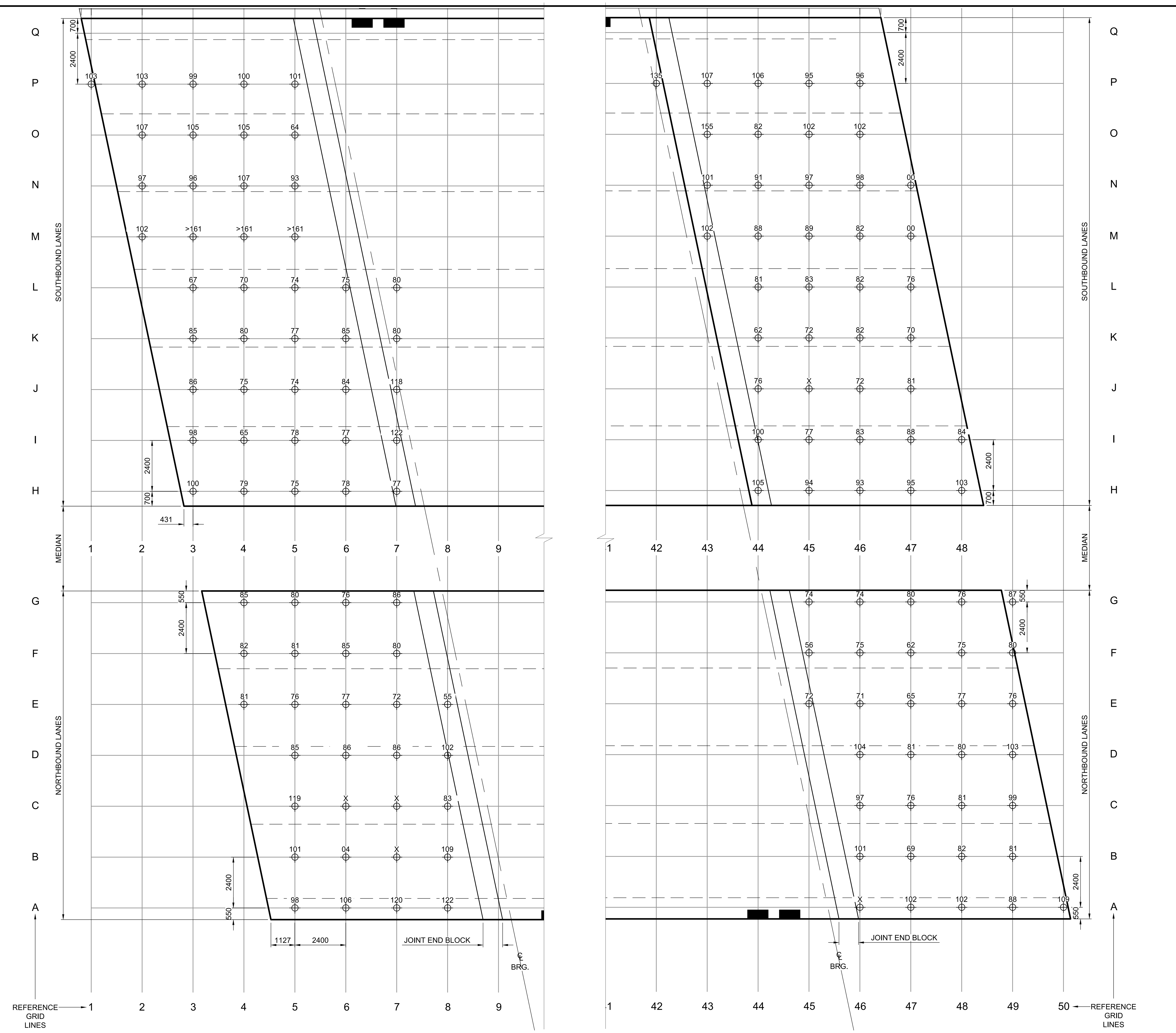
Winnipeg

NOTES
- THIS DRAWING IS PRELIMINARY AND IS NOT FOR CONSTRUCTION.
- DIMENSIONS ARE IN MILLIMETERS (mm)

PEMBINA HIGHWAY OVERPASS AT ABINOJII MIKANAH (BISHOP GRANDIN)
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

DECK TOP
DETAILED CONDITION ASSESSMENT
SCALE: AS SHOWN
DRAWN BY: AS

1 OF 7
DRAWING No.
1



SOUTH APPROACH
SCALE 1:100

NORTH APPROACH
SCALE 1:100

LEGEND:

LANE LINE

DECK DRAIN

COVER SURVEY MEASUREMENTS

NOTES:

1. "X" DENOTES COVER MEASUREMENT WAS UNABLE TO BE TAKEN DUE TO COVER DEPTH.
2. SPECIFIED COVER FROM AS-BUILT DRAWINGS IS 70 mm ± 5 mm

MORRISON HERSHFIELD

Winnipeg

NOTES
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- DIMENSIONS ARE IN MILLIMETERS (mm)

PEMBINA HIGHWAY OVERPASS AT ABINOJII MIKANAH (BISHOP GRANDIN)
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

APPROACHES
DETAILED CONDITION ASSESSMENT
SCALE: AS SHOWN
DRAWN BY: AS

2 OF 7
DRAWING No.
2

SOFFIT PLAN VIEW

SCALE 1:150

LEGEND:

GIRDER OUTLINE	
DECK DRAIN	
NARROW CRACK	N
EFFLORESCENCE	E
WET / STAINED	S
CURB JOINT	CJ
DELAMINATION	
WET AREA	

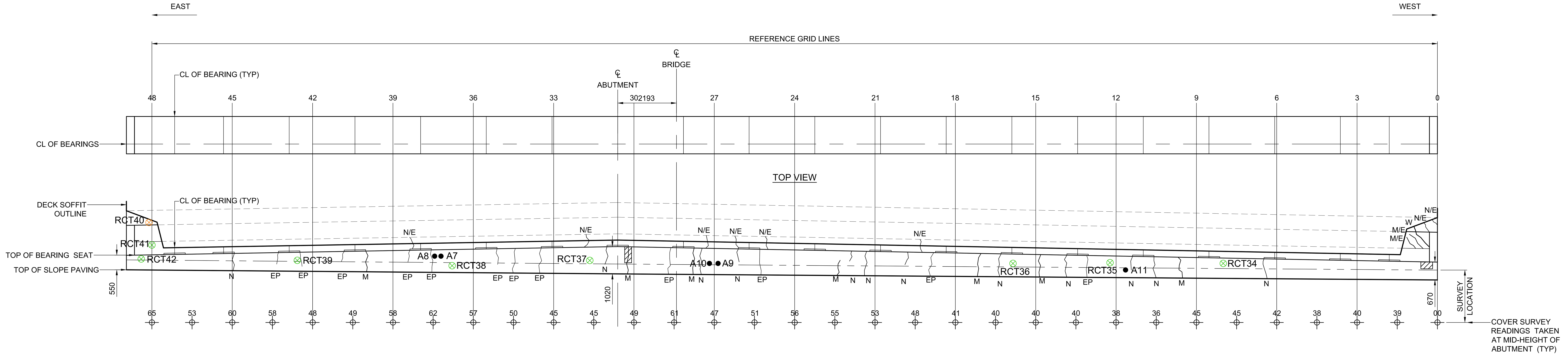
MORRISON HERSHFIELD

Winnipeg

NOTES
- THIS DRAWING IS PRELIMINARY AND IS NOT FOR CONSTRUCTION.
- DIMENSIONS ARE IN MILLIMETERS (mm)

PEMBINA HIGHWAY OVERPASS AT ABINOJII MIKANAH (BISHOP GRANDIN)
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

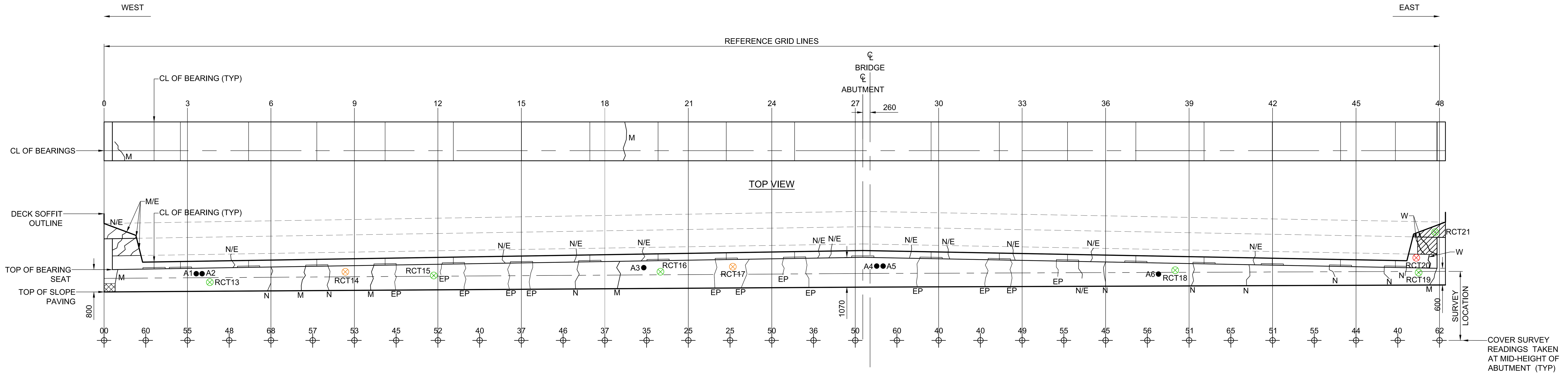
SOFFIT
DETAILED CONDITION ASSESSMENT
SCALE: AS SHOWN
DRAWN BY: AS



FRONT VIEW

SOUTH ABUTMENT

SCALE 1:80



FRONT VIEW

NORTH ABUTMENT

SCALE 1:80

LEGEND:

CONCRETE CORE LOCATION	● A
RCT TEST LOCATION	⊗ RCT
COVER SURVEY MEASUREMENT	00
NARROW CRACK	N
MEDIUM CRACK	M
WIDE CRACK	W
EPOXIED CRACK	EP
EFFLORESCENCE	E
DELAMINATION	
SPALL	

NOTES:

1. INSPECTION COMPLETED IN NOVEMBER, 2023
2. TEST DEPTH IN MILLIMETERS AND MEASURED FROM SURFACE. RESULTS DISPLAYED IN RED ARE GREATER THAN 0.05% CI BY CONCRETE MASS.
3. CHLORIDE CONTENT TEST RESULTS PRESENTED ARE TEST RESULTS EXCLUDING BACKGROUND CHLORIDES (DETERMINED TO BE 0.008% BY MASS OF CONCRETE).

RCT LEGEND:

% CI BY WEIGHT > 0.05% AT GREATER THAN 50 mm DEEP	RCT-X
% CI BY WEIGHT > 0.05% UP TO AND INCLUDING 50 mm DEPTH	RCT-X
% CI BY WEIGHT LESS THAN 0.05% AT ALL DEPTHS	RCT-X

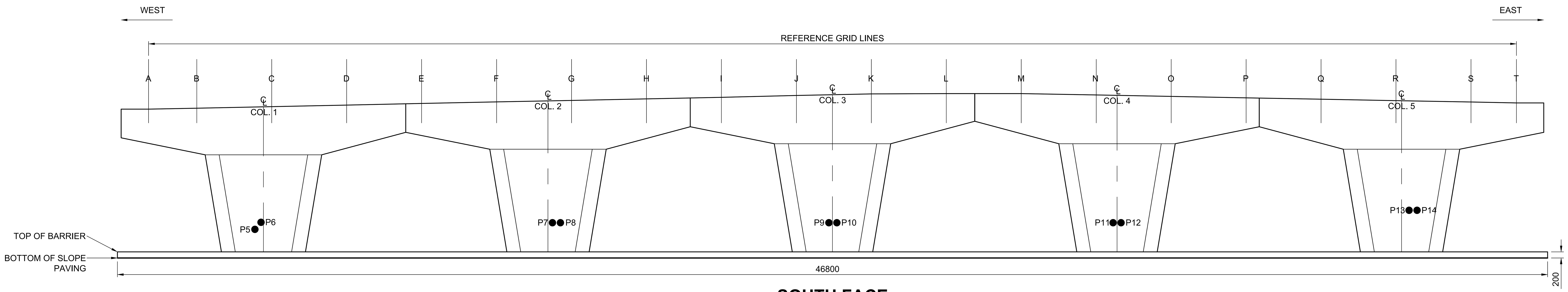
MORRISON HERSHFIELD

Winnipeg

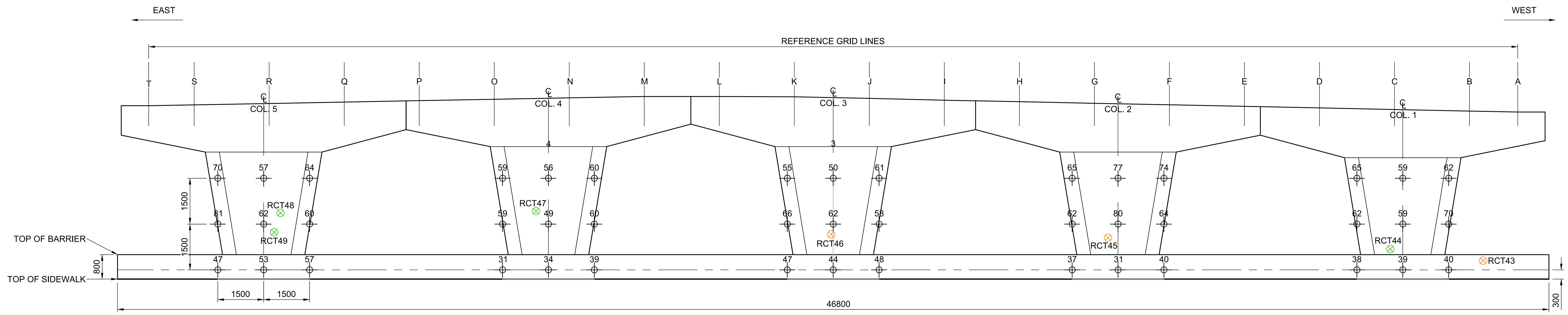
NOTES
- THIS DRAWING IS PRELIMINARY AND IS NOT FOR CONSTRUCTION.
- DIMENSIONS ARE IN MILLIMETERS (mm)

PEMBINA HIGHWAY OVERPASS AT ABINOJII MIKANAH (BISHOP GRANDIN)
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

ABUTMENTS
DETAILED CONDITION ASSESSMENT
SCALE: AS SHOWN
DRAWN BY: AS



SOUTH FACE



NORTH FACE

PIER 1 (SU2)

SCALE 1:80

LEGEND:

- CONCRETE CORE LOCATION — P
- RCT TEST LOCATION — RCT
- COVER SURVEY MEASUREMENT — 00

NOTES:

1. INSPECTION COMPLETED IN NOVEMBER, 2023
2. TEST DEPTH IN MILLIMETERS AND MEASURED FROM SURFACE. RESULTS DISPLAYED IN RED ARE GREATER THAN 0.05% Cl BY CONCRETE MASS.
3. CHLORIDE CONTENT TEST RESULTS PRESENTED ARE TEST RESULTS EXCLUDING BACKGROUND CHLORIDES (DETERMINED TO BE 0.008% BY MASS OF CONCRETE).

RCT LEGEND:

- % Cl BY WEIGHT > 0.05% AT GREATER THAN 50 mm DEEP — RCT-X
- % Cl BY WEIGHT > 0.05% UP TO AND INCLUDING 50 mm DEPTH — RCT-X
- % Cl BY WEIGHT LESS THAN 0.05% AT ALL DEPTHS — RCT-X

MORRISON HERSHFIELD

Winnipeg

NOTES

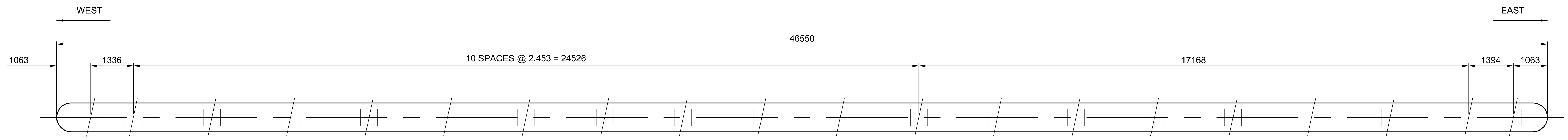
- THIS DRAWING IS PRELIMINARY AND IS NOT FOR CONSTRUCTION.
- DIMENSIONS ARE IN MILLIMETERS (mm)

PEMBINA HIGHWAY OVERPASS AT ABINOJII MIKANAH (BISHOP GRANDIN)
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

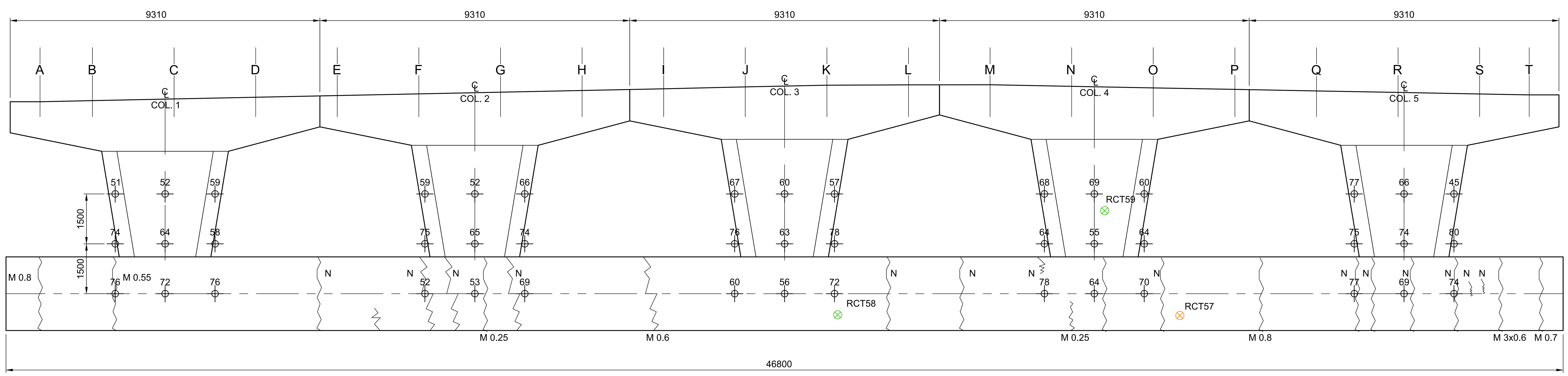
PIER 1 (SU2)
DETAILED CONDITION ASSESSMENT
SCALE: AS SHOWN
DRAWN BY: AS

5 OF 7

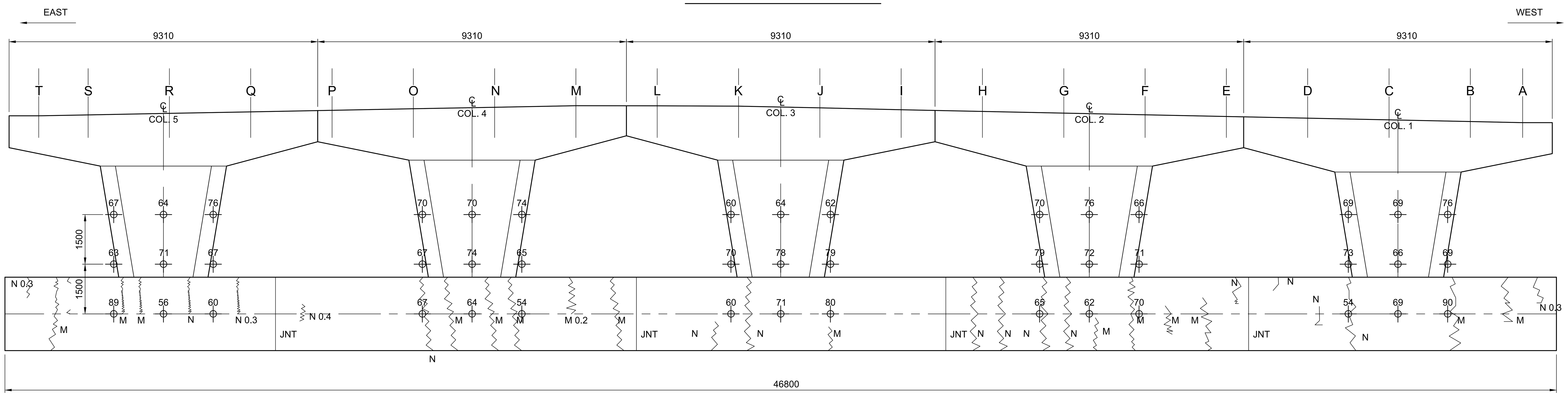
DRAWING No.
5



PIER 2 - PLAN



PIER 2 - SOUTH FACE



PIER 2 - NORTH FACE

LEGEND:

CONCRETE CORE LOCATION	● A
RCT TEST LOCATION	⊗ RCT
COVER SURVEY MEASUREMENT	00
NARROW CRACK	N
MEDIUM CRACK	M
WIDE CRACK	W
EPOXIED CRACK	EP
EFFLORESCENCE	E
DELAMINATION	
SPALL	

NOTES:

1. INSPECTION COMPLETED IN OCTOBER, 2023 FROM GROUND LEVEL NOTED.
2. TEST DEPTH IN MILLIMETERS AND MEASURED FROM SURFACE. RESULTS DISPLAYED IN RED ARE GREATER THAN 0.05% CI BY CONCRETE MASS.
3. CHLORIDE CONTENT TEST RESULTS PRESENTED ARE TEST RESULTS INCLUDING BACKGROUND CHLORIDES (DETERMINED TO BE 0.008% BY MASS OF CONCRETE).

RCT LEGEND:

% CI BY WEIGHT > 0.05% AT GREATER THAN 60 mm DEEP	RCT-X
% CI BY WEIGHT > 0.05% UP TO AND INCLUDING 60 mm DEPTH	RCT-X
% CI BY WEIGHT LESS THAN 0.05% AT ALL DEPTHS	RCT-X
CONCRETE SMAPLE NOT TESTED	RCT-X

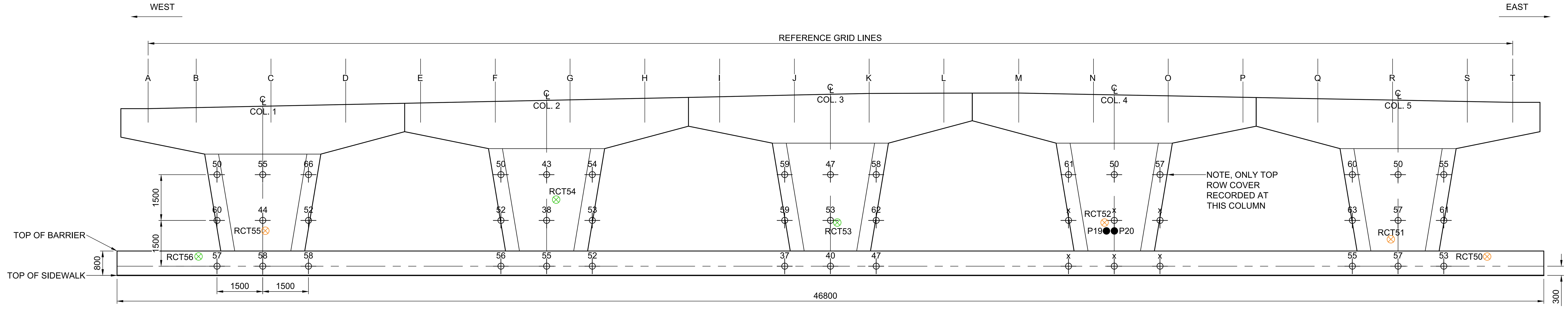
MORRISON HERSHFIELD

Winnipeg

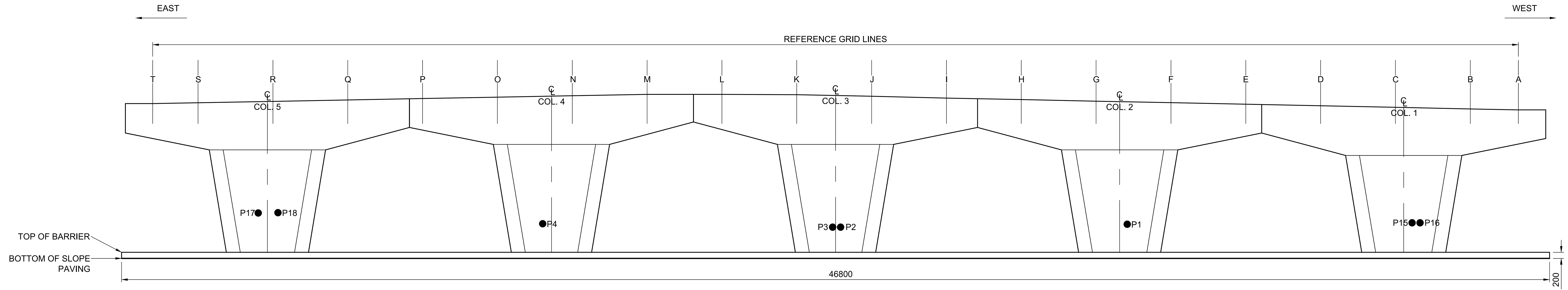
NOTES
- THIS DRAWING IS PRELIMINARY AND IS NOT FOR CONSTRUCTION.
- DIMENSIONS ARE IN MILLIMETERS (mm)

PEMBINA HIGHWAY OVERPASS AT ABINOJII MIKANAH (BISHOP GRANDIN)
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

PIER 2 (SU3)
DETAILED CONDITION ASSESSMENT
SCALE: AS SHOWN
DRAWN BY: AS



SOUTH FACE



NORTH FACE

PIER 3 (SU4)

SCALE 1:80

LEGEND:

- CONCRETE CORE LOCATION — P
- RCT TEST LOCATION — RCT
- COVER SURVEY MEASUREMENT — 00

NOTES:

1. INSPECTION COMPLETED IN NOVEMBER, 2023
2. TEST DEPTH IN MILLIMETERS AND MEASURED FROM SURFACE. RESULTS DISPLAYED IN RED ARE GREATER THAN 0.05% Cl BY CONCRETE MASS.
3. CHLORIDE CONTENT TEST RESULTS PRESENTED ARE TEST RESULTS EXCLUDING BACKGROUND CHLORIDES (DETERMINED TO BE 0.008% BY MASS OF CONCRETE).

RCT LEGEND:

% Cl BY WEIGHT > 0.05% AT GREATER THAN 50 mm DEEP	RCT-X
% Cl BY WEIGHT > 0.05% UP TO AND INCLUDING 50 mm DEPTH	RCT-X
% Cl BY WEIGHT LESS THAN 0.05% AT ALL DEPTHS	RCT-X

MORRISON HERSHFIELD

Winnipeg

NOTES
- THIS DRAWING IS PRELIMINARY AND IS NOT FOR CONSTRUCTION.
- DIMENSIONS ARE IN MILLIMETERS (mm)

PEMBINA HIGHWAY OVERPASS AT ABINOJII MIKANAH (BISHOP GRANDIN)
CLIENT: CITY OF WINNIPEG
MHL JOB NO. 230376600

PIER 3 (SU4)
DETAILED CONDITION ASSESSMENT
SCALE: AS SHOWN
DRAWN BY: AS

7 OF 7
DRAWING No.
7

Appendix J

Rapid Chloride Testing Results

DECK TOP RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)							
RCT SAMPLE LOCATION		TEST DEPTH (mm)					
No.	Lane Dir.	5 - 20	40 - 60	70 - 90	120 - 140	150 - 170	190 - 210
3	NB	0.528	0.395	0.186	0.005	0.001	0.000
4	NB	0.560	0.144	0.014	0.000	0.000	0.034
5	NB	0.418	0.138	0.006	0.000	0.000	--
6	NB	0.383	0.070	0.000	0.000	0.000	0.000
9	NB	0.558	0.236	0.098	0.000	0.002	0.002
10	NB	0.442	0.138	0.014	0.004	0.000	0.051
11	NB	0.629	0.212	0.029	0.000	0.000	0.029
12	NB	0.385	0.053	0.000	0.000	0.000	0.000
24	SB	0.416	0.216	0.060	0.003	0.002	0.003
25	SB	0.596	0.197	0.043	0.005	0.002	0.004
26	SB	0.511	0.402	0.165	0.117	0.068	0.027
27	SB	0.503	0.182	0.097	0.007	0.006	0.004
30	SB	0.390	0.202	0.028	0.000	0.001	0.008
31	SB	0.630	0.274	0.087	0.000	0.004	--
32	SB	0.519	0.208	0.025	0.000	0.000	0.000
33	SB	0.558	0.367	0.135	0.001	0.000	--
Average Chloride Content		**0.502**	**0.215**	**0.062**	**0.009**	**0.005**	**0.010**

APPROACH SLAB RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)							
RCT SAMPLE LOCATION		TEST DEPTH (mm)					
No.	Lane Dir.	5 - 20	40 - 60	70 - 90	120 - 140	150 - 170	190 - 210
1	NB	0.518	0.110	0.000	0.000	0.000	0.000
2	NB	0.602	0.125	0.029	0.000	0.002	0.000
7	NB	0.442	0.077	0.008	0.000	0.000	0.000
8	NB	0.322	0.117	0.028	0.000	0.000	0.000
22	SB	0.301	0.040	0.005	0.000	0.000	0.000
23	SB	0.435	0.145	0.074	0.003	0.005	0.001
28	SB	0.641	0.145	0.021	0.007	0.004	0.005
29	SB	0.552	0.221	0.077	0.008	0.016	0.015
Average Chloride Content		**0.477**	**0.123**	**0.030**	**0.002**	**0.003**	**0.003**

Notes:

1. Red cells equal chloride content greater than 0.090% by mass of concrete
2. City of Winnipeg chloride content corrosion threshold for epoxy coated rebar is 0.09% by mass of concrete.
3. Background chlorides of 0.008% chlorides by mass of concrete subtracted from raw measured chloride values.

ABUTMENT RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	ABUTMENT	5 - 20	40 - 60	90-110
13	NORTH	0.017	0.008	0.001
14	NORTH	0.289	0.164	0.044
15	NORTH	0.070	0.077	--
16	NORTH	0.064	0.035	--
17	NORTH	0.115	0.090	0.028
18	NORTH	0.055	0.000	0.014
19	NORTH	0.063	0.004	0.005
20	NORTH	0.164	0.078	0.149
21	NORTH	0.077	0.038	0.027
34	SOUTH	0.050	0.000	0.016
35	SOUTH	0.039	0.006	0.001
36	SOUTH	0.012	0.003	0.001
37	SOUTH	0.081	0.000	0.003
38	SOUTH	0.035	0.027	0.031
39	SOUTH	0.008	0.000	0.004
40	SOUTH	0.157	0.048	0.010
41	SOUTH	0.030	0.007	0.003
42	SOUTH	0.073	0.047	0.027
Average Chloride Content (Overall)		**0.078**	**0.035**	**0.020**
Average Chloride Content (Abutment Wall)		**0.069**	**0.033**	**0.013**
Average Chloride Content (Ballast Wall)		**0.107**	**0.043**	**0.047**

Notes:

1. Red cells equal chloride content greater than 0.090% by mass of concrete.
2. City of Winnipeg chloride content corrosion threshold for epoxy coated rebar is 0.09% by mass of concrete.
3. Background chlorides of 0.008% chlorides by mass of concrete subtracted from raw measured chloride values.

SLOPE PAVING CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	LOCATION	5 - 20	40 - 60	70 - 90
60*	NORTH	0.354	0.129	0.039
61*	NORTH	0.307	0.001	0.000
62*	NORTH	0.184	0.002	0.000
63*	NORTH	0.245	0.089	0.031
Average Chloride Content		**0.273**	**0.055**	**0.018**

Notes:

1. Red cells equal chloride content greater than 0.090% by mass
2. City of Winnipeg chloride content corrosion threshold for epoxy
3. Background chlorides of 0.008% chlorides by mass of concrete
4. Samples marked with (*) were extracted during the Spring portion of the condition assessment

EXTERIOR GIRDER RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	Location	5 - 20	40 - 60	70 - 90
64*		0.004	0.001	0.011
65*		0.006	0.000	0.002
66*		0.104	0.066	0.034
67*		0.004	0.008	0.012
Average Chloride Content		**0.030**	**0.019**	**0.015**

Notes:

1. Red cells equal chloride content greater than 0.090% by mass of concrete.
2. City of Winnipeg chloride content corrosion threshold for epoxy coated rebar is 0.09% by mass of concrete.
3. Background chlorides of 0.008% chlorides by mass of concrete subtracted from raw measured chloride values.
4. Samples marked with (*) were extracted during the Spring portion of the condition assessment.

PIER RAPID CHLORIDE TEST RESULTS (% CHLORIDES BY MASS OF CONCRETE)				
RCT SAMPLE LOCATION		TEST DEPTH (mm)		
No.	SU# / COL.	5 - 20	40 - 60	90-110
43	SU2 - BASE	0.136	0.057	0.016
44	SU2 - P1	0.075	0.008	0.000
45	SU2 - P2	0.159	0.022	0.001
46	SU2 - P3	0.124	0.016	0.001
47	SU2 - P4	0.044	0.000	0.000
48	SU2 - P5	0.055	0.000	0.000
49	SU2 - P5	0.075	0.004	0.002
50	SU4 - BASE E	0.093	0.011	0.007
51	SU4 - P5	0.188	0.025	0.001
52	SU4 - P4	0.149	0.020	0.002
53	SU4 - P3	0.081	0.014	0.000
54	SU4 - P2	0.071	0.006	0.018
55	SU4 - P1	0.099	0.002	0.001
56	SU4 - BASE W	0.028	0.005	0.000
57*	SU3 - BASE E	0.091	0.012	0.001
58*	SU3 - BASE CL	0.065	0.017	0.000
59*	SU3 - P3	0.051	0.006	0.000
Average Chloride Content		**0.093**	**0.013**	**0.003**

Notes:

1. Red cells equal chloride content greater than 0.090% by mass.
2. City of Winnipeg chloride content corrosion threshold for epoxy coated rebar is 0.09% by mass of concrete.
3. Background chlorides of 0.008% chlorides by mass of concrete subtracted from raw measured chloride values.
4. Samples marked with (*) were extracted during the Spring portion of the condition assessment (May 2024)

Pembina Overpass over Abinojii Mikanah
Comparison of Lab and RCT Chloride Content Results

Core / RCT Sample Nos.	Sample Depth (mm)	Lab Test Chloride Content (% by mass of concrete)	RCT Test Chloride Content (% by mass of concrete)
D9 and RCT 10	5 to 20	0.730	0.442
	40 to 60	0.272	0.138
	70 to 90	0.067	0.014
	120 to 140	0.012	0.004
	150 to 170	0.012	0.000
D11 and RCT 12	5 to 20	0.572	0.385
	40 to 60	0.166	0.053
	70 to 90	0.013	0.000
	120 to 140	0.012	0.000
	150 to 170	0.013	0.000
	190 to 200	0.013	0.000
D27 and RCT 33	5 to 20	0.812	0.558
	40 to 60	0.422	0.367
	70 to 90	0.173	0.135
	120 to 140	0.012	0.001
	150 to 170	0.012	0.000
D30 and RCT 32	5 to 20	0.530	0.519
	40 to 60	0.229	0.208
	70 to 90	0.023	0.025
	120 to 140	0.012	0.000
	150 to 170	0.012	0.000
A2 and RCT 13	5 to 20	0.055	0.017
	40 to 60	0.017	0.008
	90 to 110	0.012	0.001
	120 to 140	0.012	No test at depth
	150 to 170	0.012	No test at depth
A8 and RCT 38	5 to 20	0.076	0.035
	40 to 60	0.012	0.027
	90 to 110	0.012	0.031
	120 to 140	0.012	No test at depth
	150 to 170	0.012	No test at depth
P20 and RCT 52	50 to 20	0.248	0.149
	40 to 60	0.096	0.020
	90 to 110	0.017	0.002
	120 to 140	0.013	No test at depth
	150 to 170	0.012	No test at depth
	190 to 210	0.012	No test at depth

Notes:

1. Red cells equal chloride content greater than 0.090% by mass of concrete.
2. City of Winnipeg chloride content corrosion threshold for epoxy coated rebar is 0.09% by mass of concrete.
3. Background chlorides of 0.008% chlorides by mass of concrete subtracted from raw measured chloride values.

Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

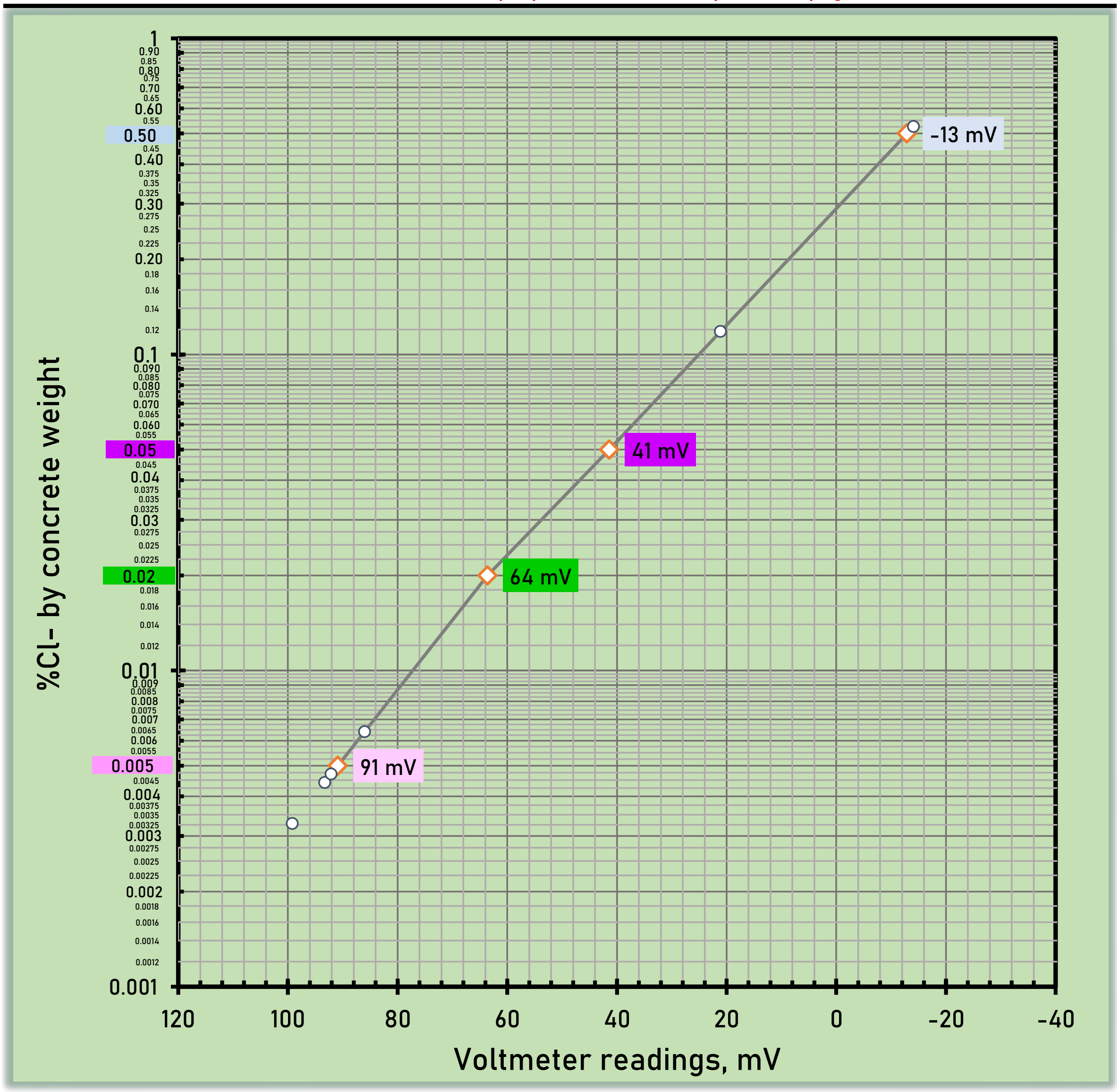
1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

Report #:	230376600	Structure:		Project:	Pembina / Abinojii
Date:	11/17/2023	Electrode #:		Person:	ALP
Testing Lab:	MH	Phone:		Fax:	
Address:					

Enter the calibration values for the electrode in this table:				
Liquid:	Clear	Purple	Green	Pink
% Cl⁻ :	0.005	0.020	0.050	0.500
mV :	91	64	41	-13

* The chart below will update automatically when values are captured in the enclosed tables. *

** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl^- by concrete weight	Remarks
RCT 1-1	-14	0.526	SE Approach Slab
RCT 1-2	21	0.118	
RCT 1-3	86	0.006	
RCT 1-4	99	0.003	
RCT 1-5	93	0.004	
RCT 1-6	92	0.005	

Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

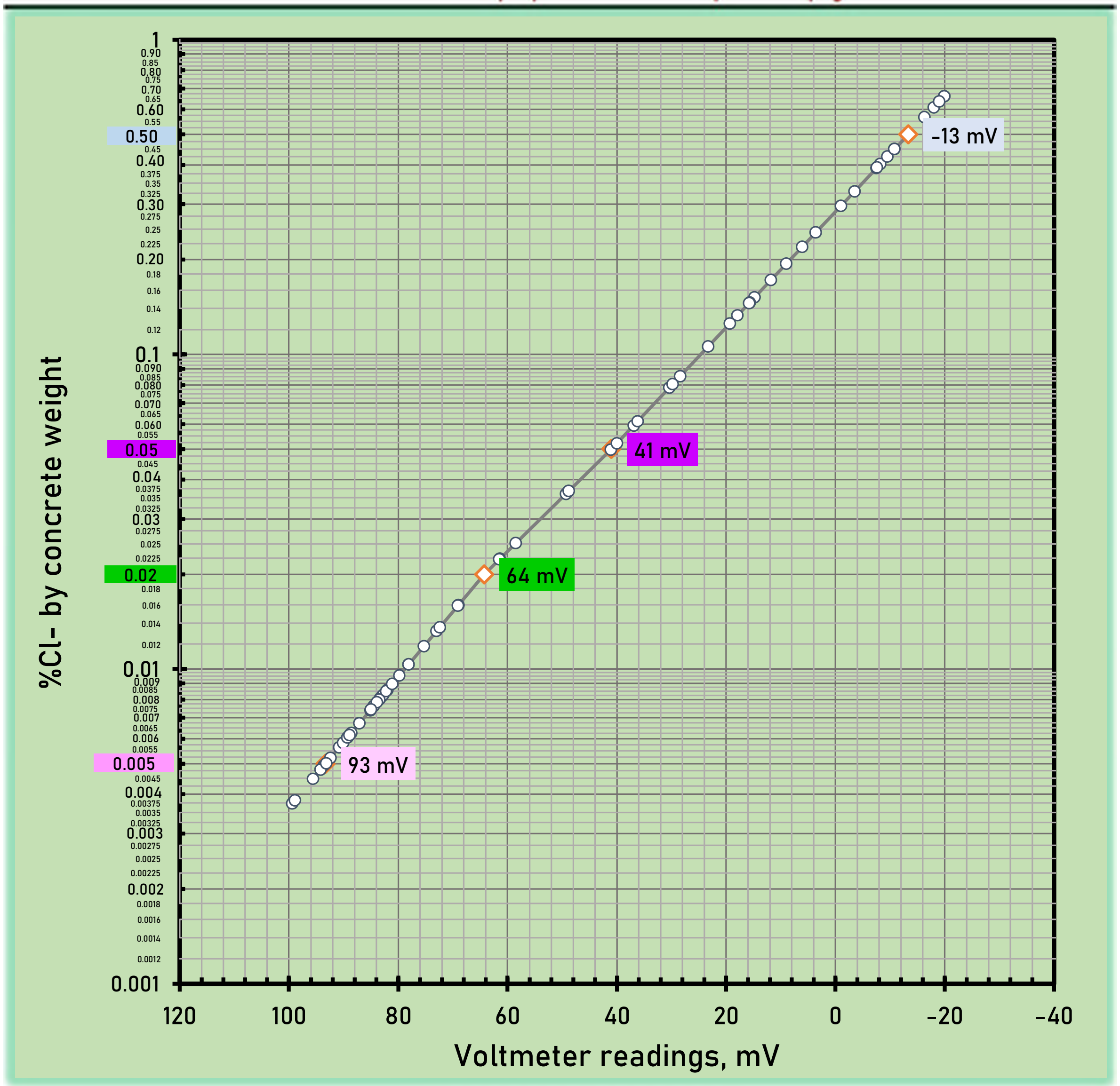
1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

Report #:	230376600	Structure:		Project:	Pembina / Abinojii		
Date:	11/21/2023	Electrode #:		Person:	AS		
Testing Lab:	MH	Phone:		Fax:			
Address:							

Enter the calibration values for the electrode in this table:				
Liquid:	Clear	Purple	Green	Pink
% Cl⁻ :	0.005	0.020	0.050	0.500
mV :	93	64	41	-13

* The chart below will update automatically when values are captured in the enclosed tables. *

** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl^- by concrete weight	Remarks
RCT 2-1	-18	0.610	SE approach slab
RCT 2-2	18	0.133	
RCT 2-3	49	0.037	
RCT 2-4	89	0.006	
RCT 2-5	78	0.010	
RCT 2-6	89	0.006	
RCT 3-1	-20	0.661	Actual read of -20.2 off chart for %CL
RCT 3-2	-8	0.403	NB Deck, Span 1
RCT 3-3	9	0.194	
RCT 3-4	73	0.013	
RCT 3-5	82	0.009	
RCT 3-6	83	0.008	
RCT 4-1	-16	0.568	NB Deck, Span 1
RCT 4-2	15	0.152	
RCT 4-3	61	0.022	
RCT 4-4	96	0.004	
RCT 4-5	91	0.006	
RCT 4-6	37	0.059	Low value, tested twice
RCT 5-1	-10	0.426	NB Deck, Span 2
RCT 5-2	16	0.146	
RCT 5-3	72	0.014	
RCT 5-4	99	0.004	
RCT 5-5	94	0.005	No sample 6
RCT 6-1	-8	0.391	NB Deck, Span 2
RCT 6-2	30	0.078	
RCT 6-3	94	0.005	
RCT 6-4	83	0.008	
RCT 6-5	92	0.005	
RCT 6-6	93	0.005	
RCT 7-1	-11	0.450	NE approach slab
RCT 7-2	28	0.085	
RCT 7-3	69	0.016	
RCT 7-4	90	0.006	
RCT 7-5	83	0.008	
RCT 7-6	85	0.008	
RCT 8-1	-4	0.330	NE approach slab
RCT 8-2	19	0.125	
RCT 8-3	49	0.036	
RCT 8-4	84	0.008	
RCT 8-5	85	0.008	
RCT 8-6	89	0.006	
RCT 9-1	-20	0.661	Actual read of -21.5 off chart for %CL
RCT 9-2	4	0.244	NB Deck, Span 3
RCT 9-3	23	0.106	
RCT 9-4	85	0.007	
RCT 9-5	80	0.010	
RCT 9-6	78	0.010	

Enter Sample no.	Enter mV readings	% Cl by concrete weight	Remarks
RCT 10-1	-11	0.450	NB Deck, Span 3
RCT 10-2	16	0.146	
RCT 10-3	62	0.022	
RCT 10-4	75	0.012	
RCT 10-5	84	0.008	
RCT 10-6	30	0.080	Low value
RCT 11-1	-19	0.637	NB Deck, Span 4
RCT 11-2	6	0.220	
RCT 11-3	49	0.037	
RCT 11-4	85	0.007	
RCT 11-5	82	0.008	
RCT 11-6	41	0.050	Low value
RCT 12-1	-8	0.393	NB Deck, Span 4
RCT 12-2	36	0.061	
RCT 12-3	87	0.007	
RCT 12-4	99	0.004	
RCT 12-5	89	0.006	
RCT 12-6	89	0.006	
RCT 13-1	59	0.025	North abutment
RCT 13-2	69	0.016	
RCT 13-3	81	0.009	Only 3 samples
RCT 14-1	-1	0.297	North abutment
RCT 14-2	12	0.172	
RCT 14-3	40	0.052	Only 3 samples

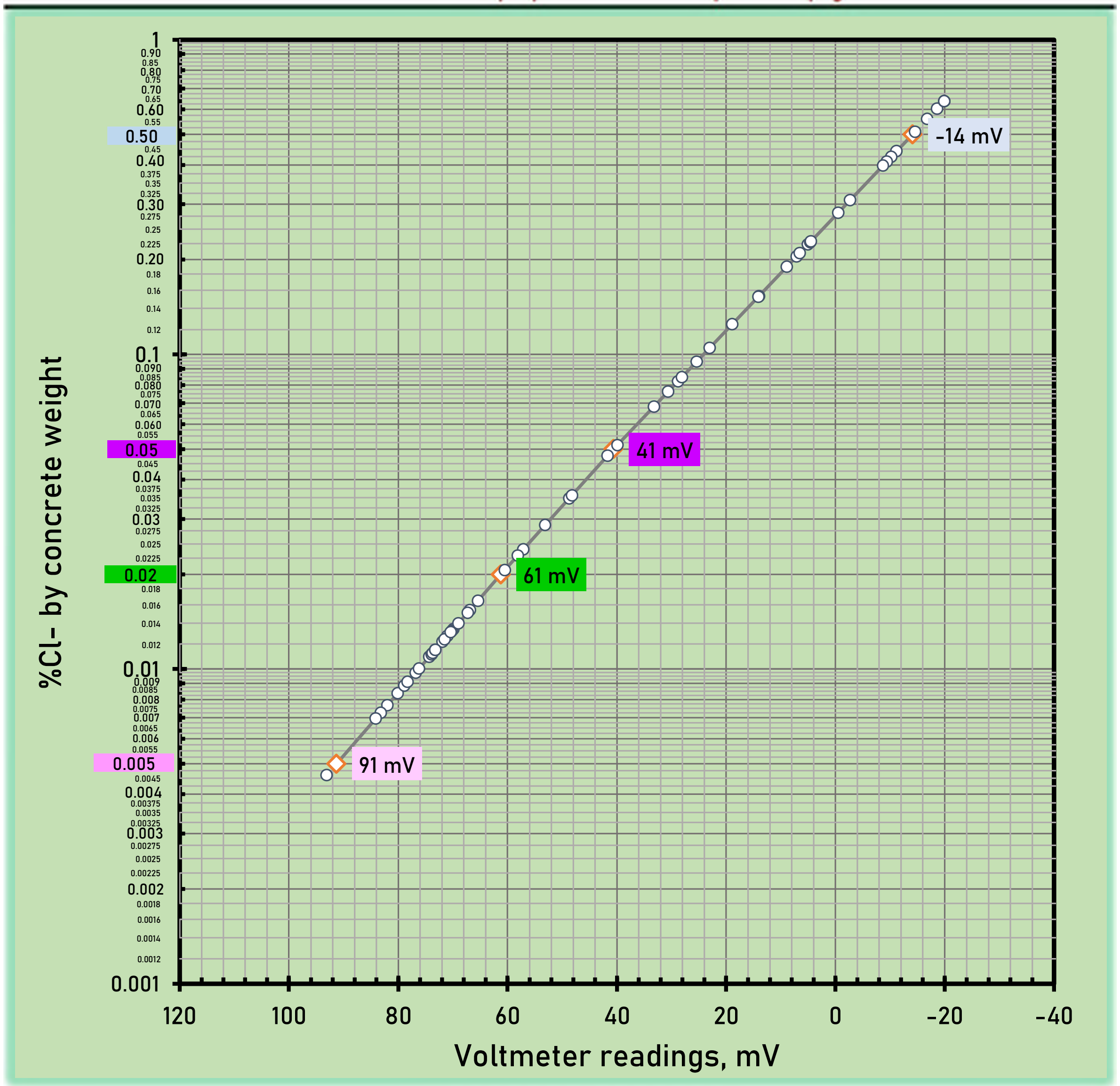
Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

Report #:	230376600	Structure:		Project:	Pembina / Abinojii
Date:	11/22/2023	Electrode #:		Person:	AS
Testing Lab:	MH	Phone:		Fax:	
Address:					

Enter the calibration values for the electrode in this table:				
Liquid:	Clear	Purple	Green	Pink
% Cl⁻ :	0.005	0.020	0.050	0.500
mV :	91	61	41	-14

* The chart below will update automatically when values are captured in the enclosed tables. *
** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl^- by concrete weight	Remarks
RCT 22-1	-3	0.309	NW approach slab
RCT 22-2	42	0.048	
RCT 22-3	70	0.013	
RCT 22-4	80	0.008	
RCT 22-5	82	0.008	
RCT 22-6	83	0.007	
RCT 23-1	-11	0.443	NW approach slab
RCT 23-2	14	0.153	
RCT 23-3	29	0.082	
RCT 23-4	74	0.011	
RCT 23-5	70	0.013	
RCT 23-6	79	0.009	
RCT 24-1	-10	0.424	SB Deck, Span 4
RCT 24-2	5	0.224	
RCT 24-3	33	0.068	
RCT 24-4	74	0.011	
RCT 24-5	77	0.010	
RCT 24-6	74	0.011	
RCT 25-1	-19	0.604	SB Deck, Span 3
RCT 25-2	7	0.205	
RCT 25-3	40	0.051	
RCT 25-4	71	0.013	
RCT 25-5	76	0.010	
RCT 25-6	72	0.012	
RCT 26-1	-20	0.638	Actual reading -20.3, above max %CL calc.
RCT 26-2	-9	0.410	SB Deck, Span 3
RCT 26-3	5	0.228	
RCT 26-4	19	0.125	
RCT 26-5	31	0.076	
RCT 26-6	49	0.035	Tested twice to confirm value
RCT 27-1	-15	0.511	SB Deck, Span 2
RCT 27-2	9	0.190	
RCT 27-3	23	0.105	
RCT 27-4	67	0.015	
RCT 27-5	69	0.014	
RCT 27-6	72	0.012	
RCT 28-1	-20	0.638	Actual reading -22.4, above max %CL calc.
RCT 28-2	14	0.153	SW approach slab
RCT 28-3	53	0.029	
RCT 28-4	67	0.015	
RCT 28-5	73	0.012	
RCT 28-6	70	0.013	
RCT 29-1	-17	0.560	SW approach slab
RCT 29-2	5	0.229	
RCT 29-3	28	0.085	
RCT 29-4	65	0.016	
RCT 29-5	57	0.024	
RCT 29-6	58	0.023	

Enter Sample no.	Enter mV readings	% Cl by concrete weight	Remarks
RCT 30-1	-9	0.398	SB Deck, Span 2
RCT 30-2	7	0.210	
RCT 30-3	48	0.036	
RCT 30-4	93	0.005	
RCT 30-5	78	0.009	
RCT 30-6	61	0.021	Low value, tested twice to confirm value
RCT 31-1	-20	0.638	Actual reading -23.0, above max %CL calc.
RCT 31-2	-1	0.282	SB Deck, Span 2
RCT 31-3	25	0.095	
RCT 31-4	84	0.007	
RCT 31-5	73	0.012	Only 5 samples

Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

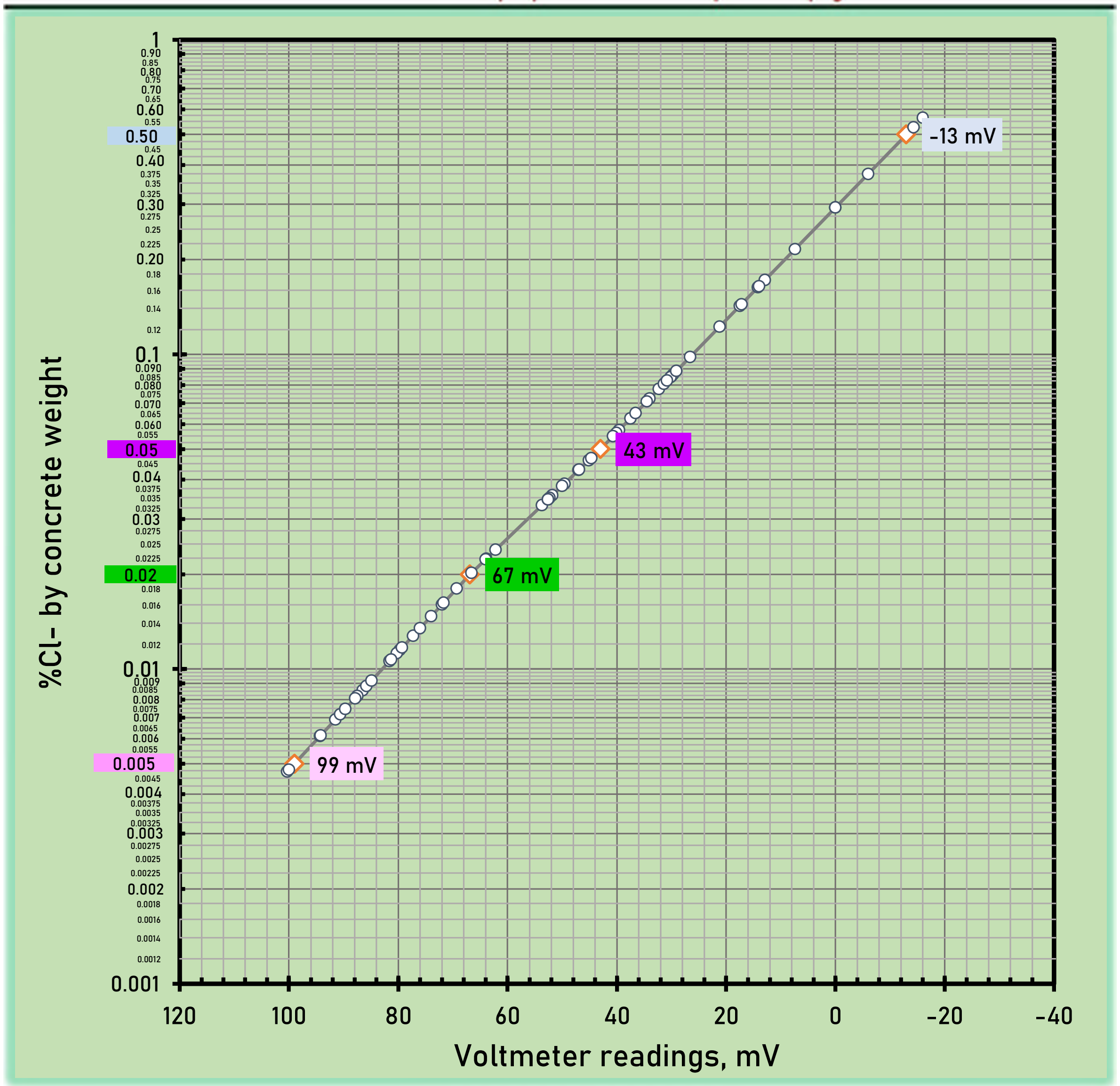
1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

Report #:	230376600	Structure:		Project:	Pembina / Abinojii
Date:	11/23/2023	Electrode #:		Person:	AS
Testing Lab:	MH	Phone:		Fax:	
Address:					

Enter the calibration values for the electrode in this table:				
Liquid:	Clear	Purple	Green	Pink
% Cl⁻ :	0.005	0.020	0.050	0.500
mV :	99	67	43	-13

* The chart below will update automatically when values are captured in the enclosed tables. *

** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl⁻ by concrete weight	Remarks
RCT 15-1	32	0.078	North abutment
RCT 15-2	30	0.085	
RCT 15-3	0	0.293	Bad test, readings do not stabilize, potential contamination
RCT 16-1	34	0.072	
RCT 16-2	47	0.043	
RCT 16-3	0	0.293	Bad test, readings do not stabilize, potential contamination
RCT 17-1	21	0.123	North abutment
RCT 17-2	27	0.098	
RCT 17-3	52	0.036	
RCT 18-1	38	0.063	North abutment
RCT 18-2	94	0.006	
RCT 18-3	64	0.022	
RCT 19-1	35	0.071	North abutment
RCT 19-2	80	0.012	
RCT 19-3	77	0.013	
RCT 20-1	13	0.172	North abutment
RCT 20-2	30	0.086	
RCT 20-3	14	0.163	
RCT 21-1	30	0.085	North abutment
RCT 21-2	45	0.046	
RCT 21-3	52	0.035	
RCT 32-1	-14	0.527	SB Deck, Span 1
RCT 32-2	7	0.216	
RCT 32-3	54	0.033	
RCT 32-4	92	0.007	
RCT 32-5	100	0.005	
RCT 32-6	100	0.005	
RCT 33-1	-16	0.566	SB Deck, Span 1
RCT 33-2	-6	0.375	
RCT 33-3	18	0.143	
RCT 33-4	87	0.009	
RCT 33-5	94	0.006	
RCT 34-1	40	0.058	South abutment
RCT 34-2	88	0.008	
RCT 34-3	64	0.022	
RCT 35-1	45	0.047	South abutment
RCT 35-2	76	0.014	
RCT 35-3	86	0.009	
RCT 36-1	67	0.020	South abutment
RCT 36-2	82	0.011	
RCT 36-3	85	0.009	
RCT 37-1	29	0.089	South abutment
RCT 37-2	88	0.008	
RCT 37-3	80	0.011	
RCT 38-1	47	0.043	South abutment
RCT 38-2	53	0.035	
RCT 38-3	50	0.039	

Enter Sample no.	Enter mV readings	% Cl by concrete weight	Remarks
RCT 39-1	72	0.016	South abutment
RCT 39-2	91	0.007	
RCT 39-3	79	0.012	
RCT 40-1	14	0.165	South abutment
RCT 40-2	40	0.056	
RCT 40-3	69	0.018	
RCT 41-1	50	0.038	South abutment
RCT 41-2	74	0.015	
RCT 41-3	81	0.011	
RCT 42-1	31	0.081	South abutment
RCT 42-2	41	0.055	
RCT 42-3	53	0.035	
RCT 43-1	17	0.144	Pier 1, North face
RCT 43-2	37	0.065	
RCT 43-3	62	0.024	
RCT 44-1	31	0.083	Pier 1, North face
RCT 44-2	72	0.016	
RCT 44-3	90	0.007	

Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

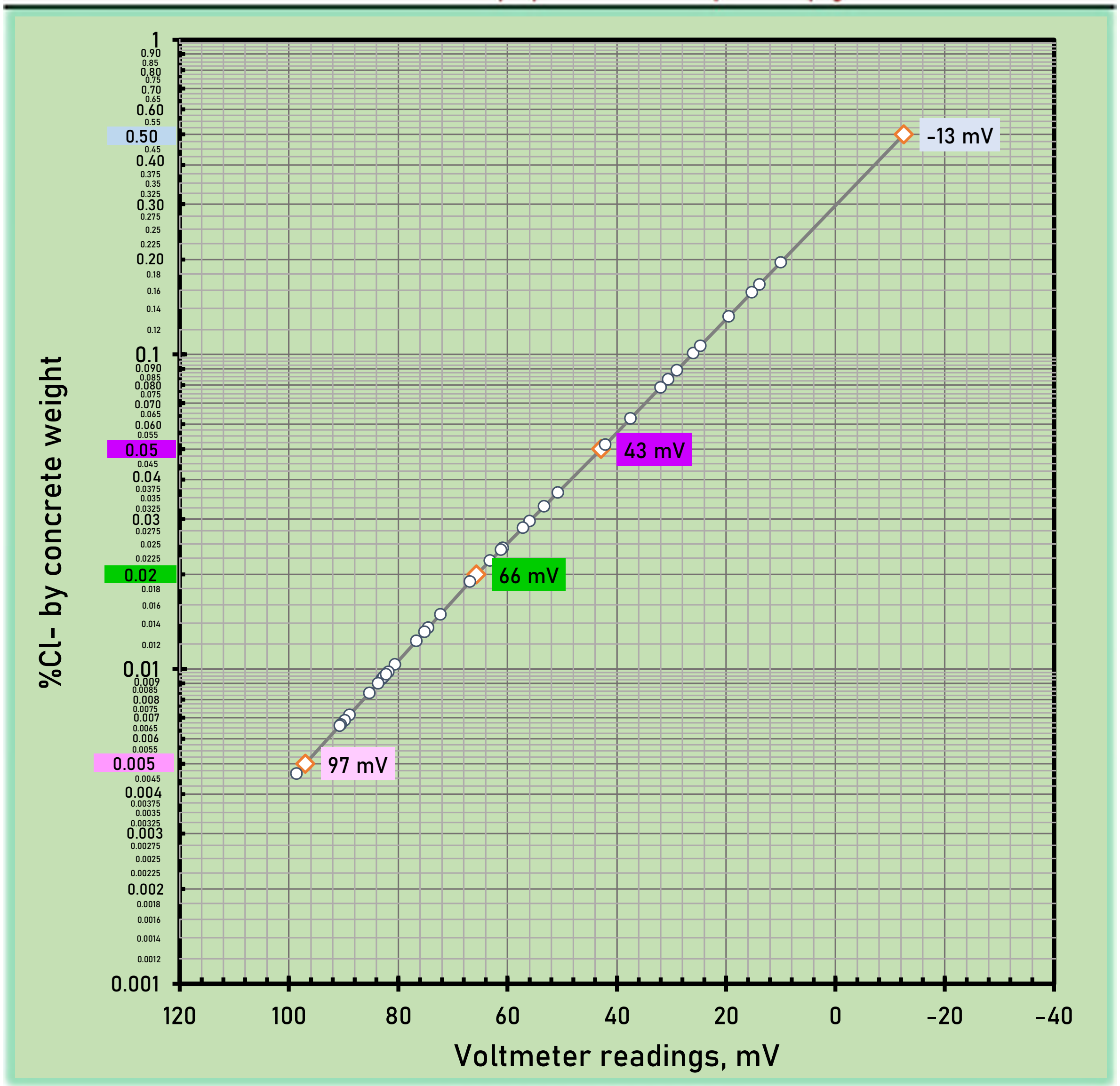
1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

Report #:	**230376600**	Structure:		Project:	**Pembina / Abinojii**
Date:	**11/24/2023**	Electrode #:		Person:	**AS**
Testing Lab:	**MH**	Phone:		Fax:	
Address:					

Enter the calibration values for the electrode in this table:				
Liquid:	Clear	Purple	Green	Pink
% Cl$^-$:	0.005	0.020	0.050	0.500
mV :	97	66	43	-13

* The chart below will update automatically when values are captured in the enclosed tables. *

** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl^- by concrete weight	Remarks
RCT 45-1	14	0.167	Pier 1, North face
RCT 45-2	56	0.030	
RCT 45-3	83	0.009	
RCT 46-1	20	0.132	Pier 1, North face
RCT 46-2	61	0.024	
RCT 46-3	83	0.009	
RCT 47-1	42	0.052	Pier 1, North face
RCT 47-2	89	0.007	
RCT 47-3	90	0.007	
RCT 48-1	38	0.063	Pier 1, North face
RCT 48-2	91	0.007	
RCT 48-3	91	0.007	
RCT 49-1	31	0.083	Pier 1, North face
RCT 49-2	77	0.012	
RCT 49-3	81	0.010	
RCT 50-1	26	0.101	Pier 3, South face
RCT 50-2	67	0.019	
RCT 50-3	72	0.015	
RCT 51-1	10	0.196	Pier 3, South face
RCT 51-2	53	0.033	
RCT 51-3	83	0.009	
RCT 52-1	15	0.157	Pier 3, South face
RCT 52-2	57	0.028	
RCT 52-3	82	0.010	
RCT 53-1	29	0.089	Pier 3, South face
RCT 53-2	63	0.022	
RCT 53-3	99	0.005	
RCT 54-1	32	0.079	Pier 3, South face
RCT 54-2	75	0.014	
RCT 54-3	61	0.024	
RCT 55-1	25	0.107	Pier 3, South face
RCT 55-2	82	0.010	
RCT 55-3	84	0.009	
RCT 56-1	51	0.036	Pier 3, South face
RCT 56-2	75	0.013	
RCT 56-3	85	0.008	

Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

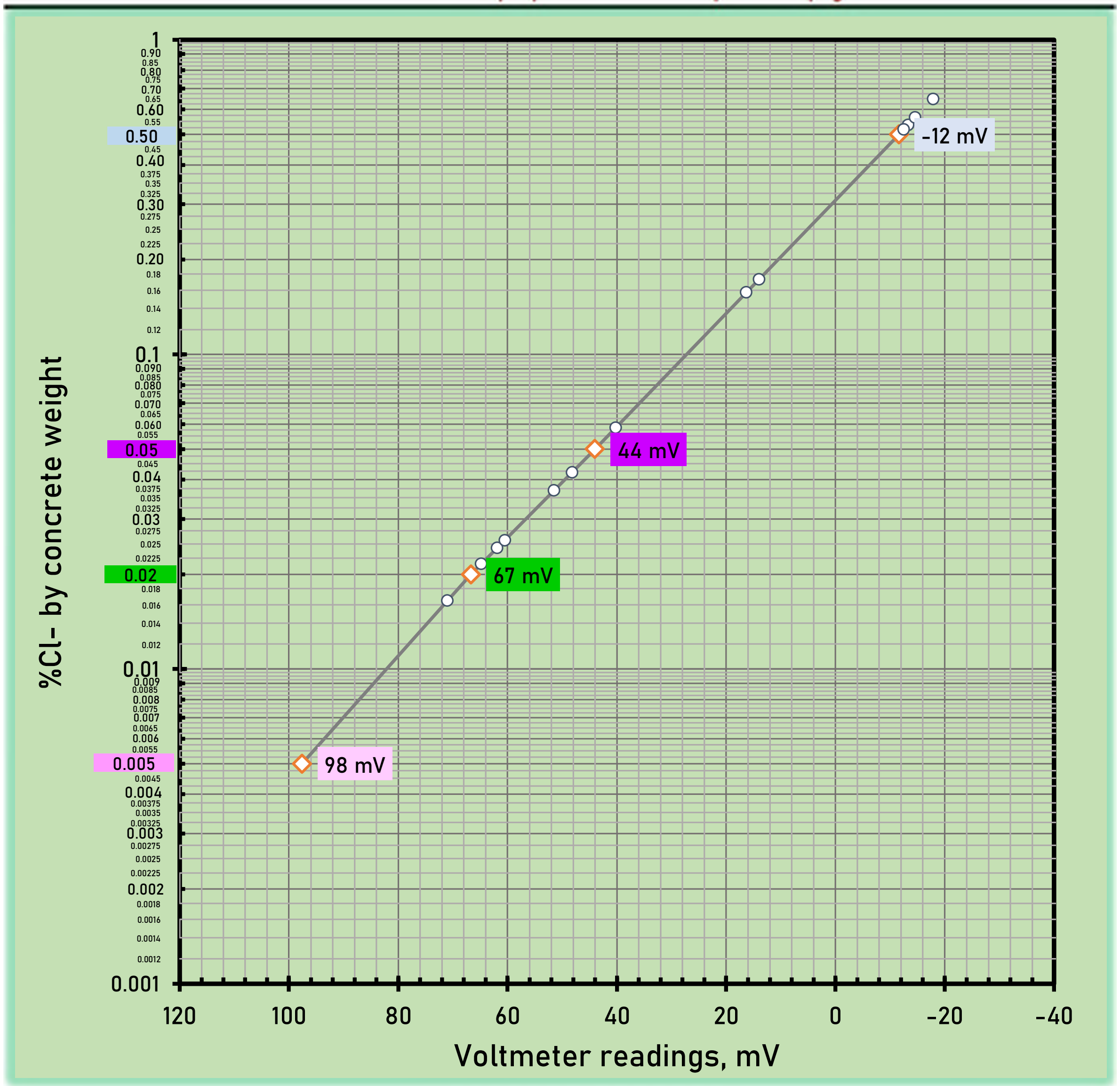
Report #:	230376600	Structure:		Project:	Pembina / Abinojii
Date:	12/6/2023	Electrode #:		Person:	AS
Testing Lab:	MH	Phone:		Fax:	
Address:	Re-tested samples				

Enter the calibration values for the electrode in this table:

Liquid:	Clear	Purple	Green	Pink
% Cl⁻ :	0.005	0.020	0.050	0.500
mV :	98	67	44	-12

* The chart below will update automatically when values are captured in the enclosed tables. *

** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl^- by concrete weight	Remarks
RCT 3-1	-13	0.536	NB Deck, Span 1
RCT 4-6	48	0.042	NB Deck, Span 1
RCT 9-1	-15	0.566	NB Deck, Span 3
RCT 10-6	40	0.059	NB Deck, Span 3
RCT 11-6	52	0.037	NB Deck, Span 4
RCT 26-1	-13	0.519	SB Deck, Span 3
RCT 26-3	14	0.173	SB Deck, Span 3
RCT 28-1	-18	0.649	SW Approach Slab
RCT 30-6	71	0.016	SB Deck, Span 2
RCT 31-1			SB Deck, Span 2 - Not enough sample to re-test
RCT 18-3	65	0.022	North Abutment
RCT 20-3	16	0.157	North Abutment
RCT 34-3	62	0.024	South Abutment
RCT 54-3	61	0.026	Pier 3, South Face

Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

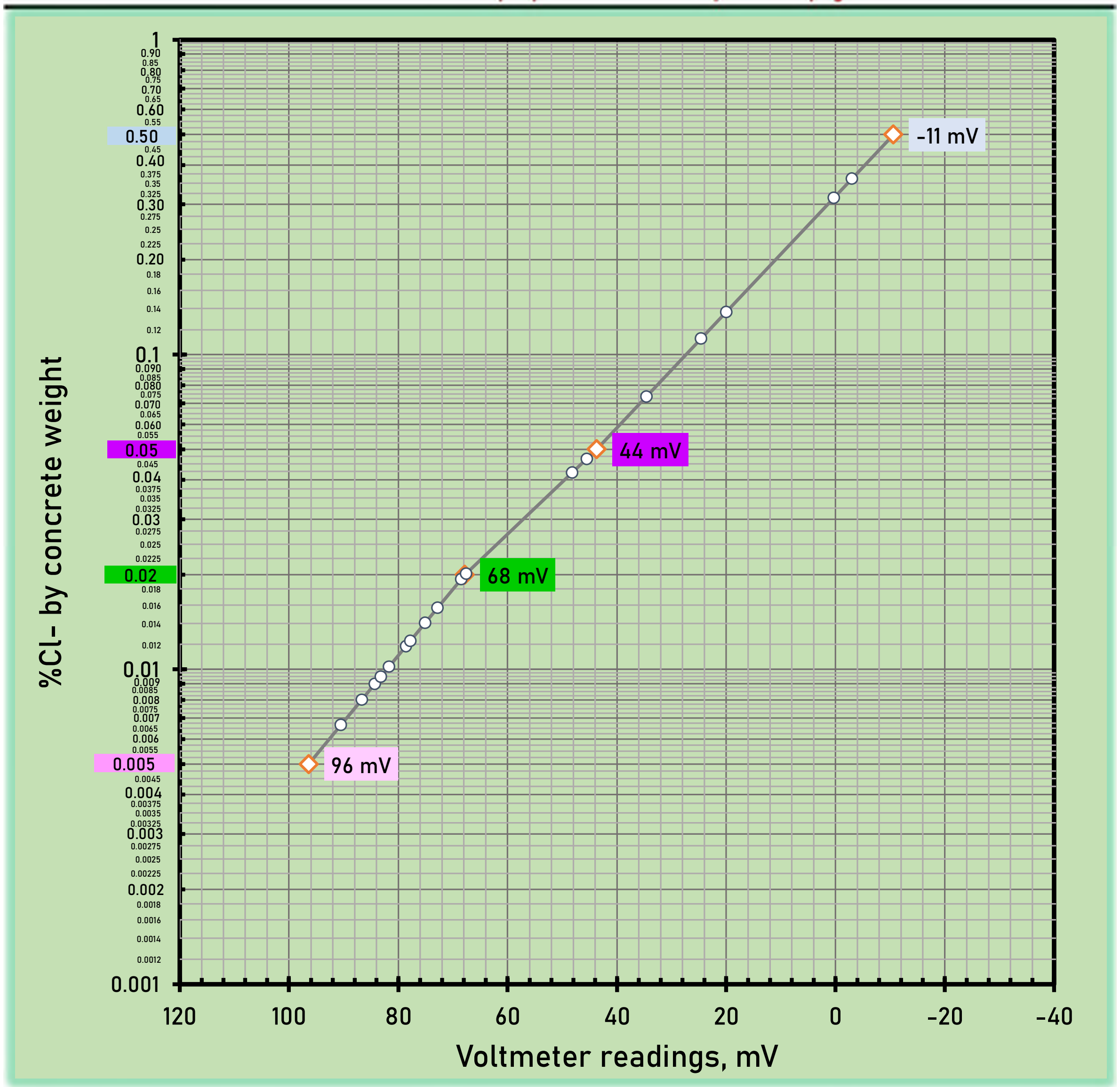
1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

Report #:	1	Structure:		Project:	Pembina / Abinojii
Date:	8/1/2024	Electrode #:		Person:	ALP
Testing Lab:	MHnS	Phone:		Fax:	
Address:					

Enter the calibration values for the electrode in this table:				
Liquid:	Clear	Purple	Green	Pink
% Cl⁻ :	0.005	0.020	0.050	0.500
mV :	96	68	44	-11

* The chart below will update automatically when values are captured in the enclosed tables. *

** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl^- by concrete weight	Remarks
RCT 64-1	79	0.012	"Sample bag labeled G1"
RCT 64-2	84	0.009	
RCT 64-3	69	0.019	
RCT 65-1	75	0.014	"Sample bag labeled G2"
RCT 65-2	87	0.008	
RCT 65-3	82	0.010	
RCT 66-1	25	0.112	"Sample bag labeled G3"
RCT 66-2	35	0.074	
RCT 66-3	48	0.042	
RCT 67-1	78	0.012	"Sample bag labeled G4"
RCT 67-2	73	0.016	
RCT 67-3	68	0.020	
RCT 60-1	-3	0.362	"Sample bag labeled SP1"
RCT 60-2	20	0.137	
RCT 60-3	46	0.047	
RCT 61-1	0	0.315	"Sample bag labeled SP2"
RCT 61-2	83	0.009	
RCT 61-3	91	0.007	

Measurement of the acid soluble chloride content of HARDENED CONCRETE by the RCT method

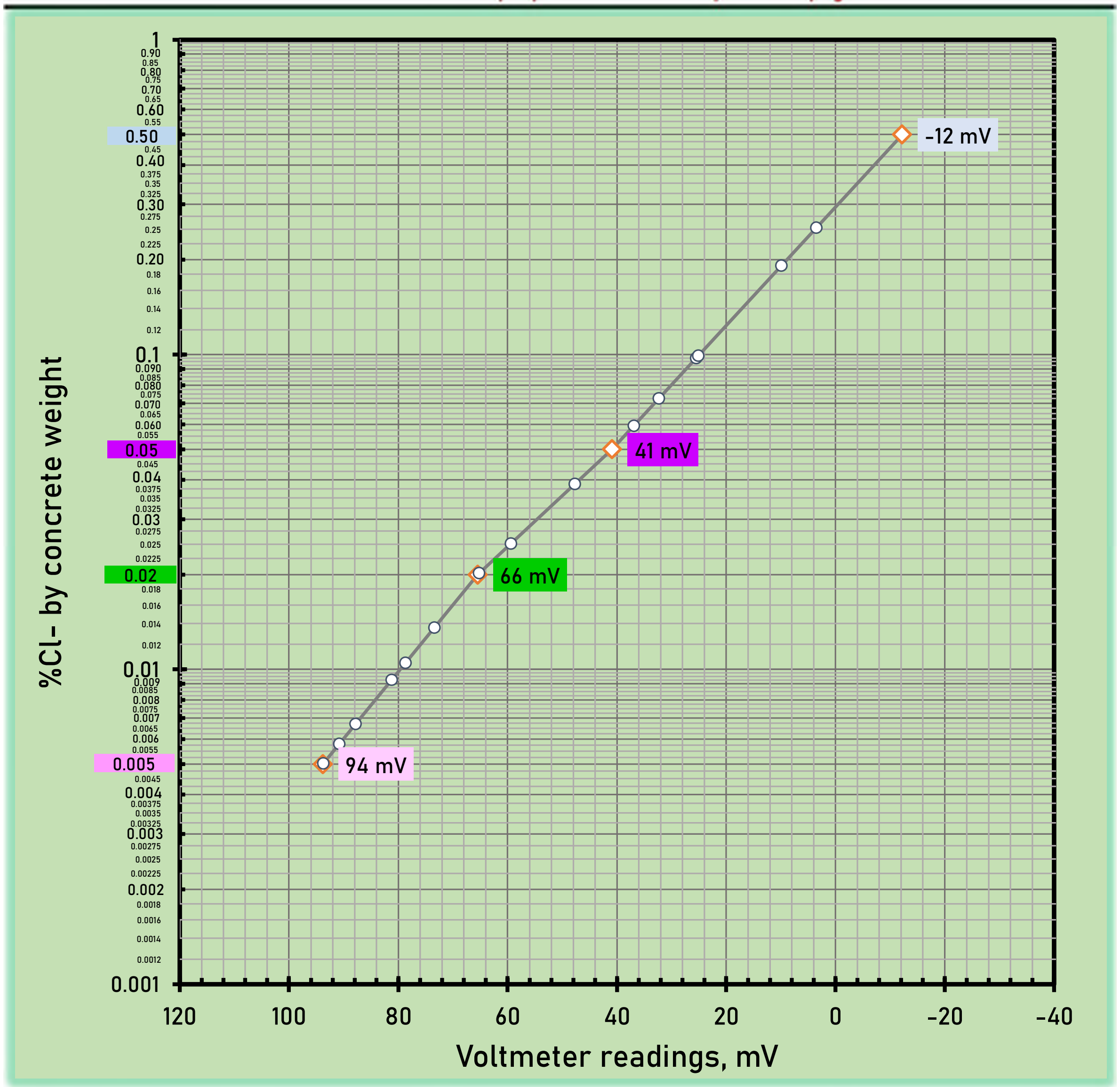
1.5 gram of concrete dust dissolved in a RCT-1023 vial with 10 ml of extraction liquid

Report #:	2	Structure:		Project:	Pembina / Abinojii
Date:	8/9/2024	Electrode #:		Person:	ALP
Testing Lab:	MHnS	Phone:		Fax:	
Address:					

Enter the calibration values for the electrode in this table:				
Liquid:	Clear	Purple	Green	Pink
% Cl⁻ :	0.005	0.020	0.050	0.500
mV :	94	66	41	-12

* The chart below will update automatically when values are captured in the enclosed tables. *

** This chart and tables are prepared for 240 samples on 6 pages. **



Enter Sample no.	Enter mV readings	% Cl^- by concrete weight	Remarks
RCT 62-1	10	0.192	"Sample labeled SP3"
RCT 62-2	79	0.010	
RCT 62-3	91	0.006	
RCT 63-1	4	0.253	"Sample labeled SP4"
RCT 63-2	26	0.097	
RCT 63-3	48	0.039	
RCT 57-1	25	0.099	Sample bag labeled "Pier 2 B1"
RCT 57-2	65	0.020	Located in Pier 2 South face base.
RCT 57-3	81	0.009	2.6m East of Col. 4 centre line, 0.45m from ground line.
RCT 58-1	32	0.073	Sample bag labeled "Pier 2 B2"
RCT 58-2	59	0.025	Located in Pier 2 South face base.
RCT 58-3	88	0.007	1.6m East of Col. 3 centre line, 0.45m from ground line.
RCT 59-1	37	0.059	Sample bag labeled "Pier 2 P1"
RCT 59-2	73	0.014	Located in Pier 2, Col. 4, South face.
RCT 59-3	94	0.005	0.3m East of Col. 4 centre line, 3.6m from ground line.

Appendix K

Laboratory Testing Results

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg MB R3Y 1G4

December 21, 2023
File: 123316833

Attention: Mr. Troy Hengen
Morrison Hershfield
Unit 1 – 59 Scurfield Boulevard
Winnipeg, MB R3Y 1V2

Good day Troy,

Reference: Pembina Highway Bridge over Bishop Grandin Boulevard - Core Testing

On November 23, 2023, fifty-four (54) core samples were submitted to our laboratory for testing. It was reported that the core samples were obtained from the superstructure and substructure elements of the Pembina Highway Bridge over Bishop Grandin Boulevard in Winnipeg, Manitoba. The testing performed and the corresponding results for each core sample are identified below.

COMPRESSIVE STRENGTH & UNIT WEIGHT

Twenty-five (25) core samples were tested for compressive strength in accordance with *CSA A23.2-14C; Obtaining and Testing Drilled Cores for Compressive Strength* and for unit weight in accordance with Section 9.1.1 of *ASTM C1084; Standard Test Method for Portland-Cement of Hardened Concrete*. As requested, core no. D19 was tested twice, once for each of the top and bottom portion of the core. The core samples were conditioned in water at room temperature for 48 hours prior to testing.

The compressive strength results ranged from 33.3 to 83.9 MPa with an average of 59.3 MPa. The unit weight results ranged 2182 to 2413 with an average of 2335. The summary of the compressive strength and unit rate test data is provided in **Appendix A, Table 1**.

AIR VOID PARAMETERS IN HARDENED CONCRETE

Ten (10) core samples were tested of air void parameters in accordance with the modified linear point count method outlined in *ASTM C457; Test Method for Microscopical Determination of Parameters of the Air Void System in Hardened Concrete*.

The total air content of the core samples ranged from 3.1 to 8.3% with an average of 5.4%. The spacing factor ranged from 122 to 292 µm with an average of 181 µm. The test results comply with CSA A23.1-19 specification limits for frost resistant concrete, except for core no. P19 where the spacing factor exceeded 260 µm maximum individual limit. A summary of the air void parameter test data is provided in **Appendix B, Table 2**.

Reference: **Pembina Highway Bridge over Bishop Grandin Boulevard - Core Testing**

RAPID CHLORIDE PENETRABILITY

Four (4) core samples were tested for chloride ion penetrability in accordance with *CSA A23.2-23C; Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration*.

The total charge passing the core samples ranged from 1075 to 1545 coulombs with an average of 1266 coulombs resulting in a chloride ion penetrability rating of low for each sample. The chloride ion penetrability test data is provided in **Appendix C, Table 3a to 3d**.

ACID-SOLUBLE CHLORIDE ION CONTENT & PH LEVEL

Seven (7) core samples were prepared for chloride ion content determination by trimming 10 mm slices at prescribed depth intervals from the surface of the core sample. Testing of the 10 mm slices was performed by CARO Analytical Services in accordance with *ATU TLT-520; Alberta Test Procedure for Total Chloride Content In Cement, Mortar, and Concrete*.

Additionally, four (4) cores prepared for pH level determination by trimming 10 mm slices at prescribed depth intervals from the surface of the core sample. Testing of the 10 mm slices was also performed by CARO Analytical Services in accordance with *Carter 16.2/SM 4500-H+ B; Determination of pH Value in Solids*.

A summary of the chloride ion content and pH level test data is provided in **Appendix D, Table 4**. A copy of CARO's analytical report is also attached.

PETROGRAPHIC EVALUATION

Four (4) core samples (core nos. D13, D28, P7, A10, and P9) were submitted to American Engineering Testing (AET) in Saint Paul, Minnesota where they were examined in accordance with *ASTM G856; Standard Practice for Petrographic Examination of Hardened Concrete*. The petrographic evaluation report found in **Appendix E** provides detailed information on the concrete matrix of the core samples.

CLOSING

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

We appreciate the opportunity to assist you with this assignment.

Reference: **Pembina Highway Bridge over Bishop Grandin Boulevard - Core Testing**

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

Attachment: Appendix A – Compressive Strength & Unit Weight Test Data
Appendix B – Air Void Parameter Test Data
Appendix C – Rapid Chloride Penetrability Test Data
Appendix D – Acid-Soluble Chloride Ion Content & pH Level Test Data
Appendix E – Petrographic Evaluation Report

c. Bill Ebenspanger – Morrison Hershfield

APPENDIX A

Compressive Strength & Unit Weight Test Data

Table 1 - Compressive Strength & Unit Weight Test Data

Stantec Sample No.	Client Core Identification	Unit Weight (kg/m³)	Compressive Strength (MPa)
3379	APP1	2369	78.43
3381	APP3	2325	60.02
3382	APP4	2377	72.19
3383	APP5	2382	66.30
3385	APP8	2365	72.45
3386	APP10	2358	83.90
3387	D1	2270	57.33
3389	D6	2355	61.80
3390	D7	2298	50.62
3391	D8	2279	43.72
3397	D14	2299	61.18
3398	D17	2261	43.51
3401 – Top	D19 -Top	2196	37.12
3401 – Bottom	D19 – Bottom	2277	57.02
3403	D21	2272	63.47
3404	D23	2182	33.26
3425	A6	2383	59.52
3426	A7	2334	49.14
3430	A11	2370	57.91
3431	P1	2387	57.76
3432	P2	2387	56.31
3434	P5	2392	59.61
3437	P10	2413	69.46
3439	P13	2402	57.17
3440	P16	2388	63.53
3441	P17	2388	68.95

APPENDIX B

Air Void Parameters Test Data

Table 2 - Air Void Parameters Test Data

Stantec Sample No.	Client Core Identification	Total Air Content (%)	Specific Surface (mm^{-1})	Paste Content (%)	Spacing Factor (μm)
3380	APP2	5.3	25.8	27.2	181
3384	APP6	5.7	30.8	30.2	154
3388	D5	6.3	30.9	29.1	141
3400	D19A	5.6	33.8	36.2	154
3407	D29	4.5	44.1	31.1	122
3423	A4	8.3	19.6	25.0	154
3428	A9	8.0	16.8	25.6	191
3433	P4	4.2	24.1	24.4	206
3438	P12	3.1	27.1	24.4	210
3442	P18	3.2	18.0	21.0	292
CSA limits for frost resistant concrete		**3.0 min**	**---**	**---**	**230 max avg. 260 max indiv.**

Notes:

1. All results noted in the Table above complied the CSA limits, with the exception of the 1 highlighted result in Red font.

APPENDIX C

Rapid Chloride Ion Penetrability Test Data

Stantec

Table 3a - Rapid Chloride Ion Penetrability Test Data

Test Parameters	Trial 1	Trial 2
Type of specimen	Core	Core
Stantec sample no.	3395	3395
Client core identification	D12	D12
Source of specimen related to structure	NB Span 2 Median Lanes Grid G23	
Curing history	Field	Field
Date tested	November 23, 2023	November 23, 2023
Location of specimen within sample	123 to 173 mm from top of core	199 to 250 mm from top of core
Specimen preparation	Germann's Proove'It	Germann's Proove'It
Charge passed in 6 hours (Coulombs)	1113	1330
Average Total Charge Passed (Coulombs)	**1222**	
Chloride Ion Penetrability Rating	**Low**	

CSA A23.2-23C – Chloride Penetrability Rating Based on Charge Passed	
Charge Passed (Coulombs)	**Penetrability Rating**
>4000	High
2000 – 4000	Moderate
1000 – 2000	Low
100 – 1000	Very Low
<100	Negligible

Table 3b - Rapid Chloride Ion Penetrability Test Data

Test Parameters	Trial 1	Trial 2
Type of specimen	Core	Core
Stantec sample no.	3399	3399
Client core identification	D18	D18
Source of specimen related to structure	SB Span 2 Median Lanes Grid H31	
Curing history	Field	Field
Date tested	November 23, 2023	November 23, 2023
Location of specimen within sample	120 to 171 mm from top of core	205 to 255 mm from top of core
Specimen preparation	Germann's Proove'It	Germann's Proove'It
Charge passed in 6 hours (Coulombs)	**1669**	**1421**
Average Total Charge Passed (Coulombs)	**1545**	
Chloride Ion Penetrability Rating	**Low**	

CSA A23.2-23C – Chloride Penetrability Rating Based on Charge Passed	
Charge Passed (Coulombs)	**Penetrability Rating**
>4000	High
2000 – 4000	Moderate
1000 – 2000	Low
100 – 1000	Very Low
<100	Negligible

Stantec

Table 3c - Rapid Chloride Ion Penetrability Test Data

Test Parameters	Trial 1	Trial 2
Type of specimen	Core	Core
Stantec sample no.	3422	3422
Client core identification	A3	A3
Source of specimen related to structure	North abutment Grid 19.5 0.35 m west, 0.25 m below bearing sear	
Curing history	Field	Field
Date tested	November 28, 2023	November 28. 2023
Location of specimen within sample	14 to 64 mm from top of core	67 to 117 mm from top of core
Specimen preparation	Germann's Proove'It	Germann's Proove'It
Charge passed in 6 hours (Coulombs)	**874**	**1281**
Average Total Charge Passed (Coulombs)	**1078**	
Chloride Ion Penetrability Rating	**Low**	

CSA A23.2-23C – Chloride Penetrability Rating Based on Charge Passed	
Charge Passed (Coulombs)	**Penetrability Rating**
>4000	High
2000 – 4000	Moderate
1000 – 2000	Low
100 – 1000	Very Low
<100	Negligible

Stantec

Table 3d - Rapid Chloride Ion Penetrability Test Data

Test Parameters	Trial 1	Trial 2
Type of specimen	Core	Core
Stantec sample no.	3436	3436
Client core identification	P8	P8
Source of specimen related to structure	SU2, South face, Column 2 (2nd from west) 1.4 m above slope paving, 0.45 m east of centerline	
Curing history	Field	Field
Date tested	November 28, 2023	November 28, 2023
Location of specimen within sample	16 to 66 mm from top of core	69 to 118 mm from top of core
Specimen preparation	Germann's Proove'It	Germann's Proove'It
Charge passed in 6 hours (Coulombs)	**943**	**1501**
Average Total Charge Passed (Coulombs)	**1222**	
Chloride Ion Penetrability Rating	**Low**	

CSA A23.2-23C – Chloride Penetrability Rating Based on Charge Passed	
Charge Passed (Coulombs)	**Penetrability Rating**
>4000	High
2000 – 4000	Moderate
1000 – 2000	Low
100 – 1000	Very Low
<100	Negligible

APPENDIX D

Acid-Soluble Chloride Ion Content & pH Level Test Data

Stantec

Table 4 - Acid-Soluble Chloride Ion Content & pH Level Test Data

Stantec Sample No.	Client Core Identification	Sample Depth (mm)	Acid-Soluble Chloride Content (% by mass of concrete)	pH Level
3392	D9	5 to 20	0.738	---
		40 to 60	0.280	---
		70 to 90	0.075	---
		120 to 140	<0.020	---
		150 to 170	<0.020	---
3393	D10	70 to80	---	11.82
		140 to 150	---	11.99
3394	D11	5 to 20	0.580	---
		40 to 60	0.174	---
		70 to 90	0.021	---
		120 to 140	<0.020	---
		150 to 170	0.021	---
		190 to 200	0.021	---
3402	D20	70 to80	---	11.90
		140 to 150	---	11.87
3405	D27	5 to 20	0.820	---
		40 to 60	0.430	---
		70 to 90	0.181	---
		120 to 140	0.020	---
		150 to 170	<0.020	---
3408	D30	5 to 20	0.538	---
		40 to 60	0.237	---
		70 to 90	0.031	---
		120 to 140	<0.020	---
		150 to 170	<0.020	---
3421	A2	5 to 20	0.063	---
		40 to 60	0.025	---
		90 to 110	<0.020	---
		120 to 140	<0.020	---
		150 to 170	<0.020	---
3424	A5	40 to 60	---	11.88
		90 to 110	---	11.89

Stantec Sample No.	Client Core Identification	Sample Depth (mm)	Acid-Soluble Chloride Content (% by mass of concrete)	pH Level
3427	A8	5 to 20	0.084	---
		40 to 60	<0.020	---
		90 to 110	<0.020	---
		120 to 140	<0.020	---
		150 to 170	<0.020	---
3443	P19	40 to 60	---	11.90
		90 to 110	---	11.92
3444	P20	50 to 20	0.256	---
		40 to 60	0.104	---
		90 to 110	0.025	---
		120 to 140	0.021	---
		150 to 170	<0.020	---
		190 to 210	<0.020	---

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 limit are highlighted in Red font.

CERTIFICATE OF ANALYSIS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg) 199 Henlow Bay Winnipeg, MB R3Y 1G4		
ATTENTION	Jason Thompson, C.E.T	**WORK ORDER**	23K2833
PO NUMBER		**RECEIVED / TEMP**	2023-11-23 10:50 / 20.0°C
PROJECT	123316833	**REPORTED**	2023-12-07 11:50
PROJECT INFO		**COC NUMBER**	No Number

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks

You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry

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Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

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https://www.caro.ca/terms-conditions

If you have any questions or concerns, please contact me at pmand@caro.ca

Authorized By:

Preena Chandi
Account Manager

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K2833
PROJECT	123316833	**REPORTED**	2023-12-07 11:50

Analyte	Result	RL	Units	Analyzed	Qualifier
3392 (5-20mm) (23K2833-01) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.738**	0.020	%	2023-12-06	
3392 (40-60mm) (23K2833-02) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.280**	0.020	%	2023-12-06	
3392 (70-90mm) (23K2833-03) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.075**	0.020	%	2023-12-06	
3392 (120-140mm) (23K2833-04) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-06	
3392 (150-170mm) (23K2833-05) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-06	
3394 (5-20mm) (23K2833-06) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.580**	0.020	%	2023-12-06	
3394 (40-60mm) (23K2833-07) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.174**	0.020	%	2023-12-06	
3394 (70-90mm) (23K2833-08) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.021**	0.020	%	2023-12-06	
3394 (120-140mm) (23K2833-09) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-06	RE2

Analyte	Result	RL	Units	Analyzed	Qualifier
3394 (150-170mm) (23K2833-10) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.021**	0.020	%	2023-12-06	RE2
3394 (190-200mm) (23K2833-11) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.021**	0.020	%	2023-12-06	
3405 (5-20mm) (23K2833-12) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.820**	0.020	%	2023-12-06	
3405 (40-60mm) (23K2833-13) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.430**	0.020	%	2023-12-06	
3405 (70-90mm) (23K2833-14) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.181**	0.020	%	2023-12-06	
3405 (120-140mm) (23K2833-15) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.020**	0.020	%	2023-12-06	
3405 (150-170mm) (23K2833-16) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-06	
3408 (5-20mm) (23K2833-17) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.538**	0.020	%	2023-12-06	
3408 (40-60mm) (23K2833-18) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					

Analyte	Result	RL	Units	Analyzed	Qualifier
3408 (40-60mm) (23K2833-18) | Matrix: Solid | Sampled: 2023-11-22, Continued					
General Parameters, Continued					
Chloride, Acid-Soluble	**0.237**	0.020	%	2023-12-06	
3408 (70-90mm) (23K2833-19) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	**0.031**	0.020	%	2023-12-06	
3408 (120-140mm) (23K2833-20) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-06	
3408 (150-170mm) (23K2833-21) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-06	
3393 (70-80mm) (23K2833-22) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
pH (1:2 H2O Solution)	**11.82**	0.10	pH units	2023-11-30	
3393 (140-150mm) (23K2833-23) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
pH (1:2 H2O Solution)	**11.99**	0.10	pH units	2023-11-30	
3402 (70-80mm) (23K2833-24) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
pH (1:2 H2O Solution)	**11.90**	0.10	pH units	2023-11-30	
3402 (140-150mm) (23K2833-25) | Matrix: Solid | Sampled: 2023-11-22					
General Parameters					
pH (1:2 H2O Solution)	**11.87**	0.10	pH units	2023-11-30	

Sample Qualifiers:

RE2 Result was confirmed by re-analysis prior to reporting.

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K2833
PROJECT	123316833	**REPORTED**	2023-12-07 11:50

Analysis Description	Method Ref.	Technique	Accredited	Location
Chloride, Acid-Soluble in Solid	ATU TLT-520	HNO3 Extraction / Potentiometric Titration		Richmond
pH in Solid	Carter 16.2 / SM 4500-H+ B (2021)	1:2 Soil/Water Slurry / Electrometry	✓	Richmond

Glossary of Terms:

RL	Reporting Limit (default)
%	Percent
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
pH units	pH < 7 = acidic, ph > 7 = basic
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

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APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K2833
PROJECT	123316833	**REPORTED**	2023-12-07 11:50

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS)**: A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS)**: A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B3K2765										
Blank (B3K2765-BLK1)				Prepared: 2023-11-28, Analyzed: 2023-12-06						
Chloride, Acid-Soluble	< 0.020	0.020	%							
Blank (B3K2765-BLK2)				Prepared: 2023-11-28, Analyzed: 2023-12-06						
Chloride, Acid-Soluble	< 0.020	0.020	%							
Duplicate (B3K2765-DUP1)		**Source: 23K2833-19**		Prepared: 2023-11-28, Analyzed: 2023-12-06						
Chloride, Acid-Soluble	0.031	0.020	%		0.031				20	
Duplicate (B3K2765-DUP2)		**Source: 23K2833-01**		Prepared: 2023-11-28, Analyzed: 2023-12-06						
Chloride, Acid-Soluble	0.769	0.020	%		0.738			4	20	
General Parameters, Batch B3K3033										
Reference (B3K3033-SRM1)				Prepared: 2023-11-30, Analyzed: 2023-11-30						
pH (1:2 H2O Solution)	6.82	0.10	pH units	7.05		97	95-105			

CERTIFICATE OF ANALYSIS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg) 199 Henlow Bay Winnipeg, MB R3Y 1G4		
ATTENTION	Jason Thompson, C.E.T	**WORK ORDER**	23K3106
PO NUMBER		**RECEIVED / TEMP**	2023-11-27 12:00 / 16.5°C
PROJECT	123316833	**REPORTED**	2023-12-11 13:41
PROJECT INFO		**COC NUMBER**	No #

Introduction:

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If you have any questions or concerns, please contact me at pmand@caro.ca

Authorized By:

Preena Chandi
Account Manager

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K3106
PROJECT	123316833	**REPORTED**	2023-12-11 13:41

Analyte	Result	RL	Units	Analyzed	Qualifier
3421 (5-20mm) (23K3106-01) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	**0.063**	0.020	%	2023-12-11	
3421 (40-60mm) (23K3106-02) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	**0.025**	0.020	%	2023-12-11	
3421 (90-110mm) (23K3106-03) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3421 (120-140mm) (23K3106-04) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3421 (150-170mm) (23K3106-05) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3427 (5-20mm) (23K3106-06) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	**0.084**	0.020	%	2023-12-11	
3427 (40-60mm) (23K3106-07) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3427 (90-110mm) (23K3106-08) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3427 (120-140mm) (23K3106-09) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K3106
PROJECT	123316833	**REPORTED**	2023-12-11 13:41

Analyte	Result	RL	Units	Analyzed	Qualifier
3427 (150-170mm) (23K3106-10) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3443 (5-20mm) (23K3106-11) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	**0.256**	0.020	%	2023-12-11	
3443 (40-60mm) (23K3106-12) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	**0.104**	0.020	%	2023-12-11	
3443 (90-110mm) (23K3106-13) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	**0.025**	0.020	%	2023-12-11	
3443 (120-140mm) (23K3106-14) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	**0.021**	0.020	%	2023-12-11	
3443 (150-170mm) (23K3106-15) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3443 (190-210mm) (23K3106-16) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
Chloride, Acid-Soluble	< 0.020	0.020	%	2023-12-11	
3424 (40-60mm) (23K3106-17) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
pH (1:2 H2O Solution)	**11.88**	0.10	pH units	2023-12-01	
3424 (90-110mm) (23K3106-18) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					

TEST RESULTS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K3106
PROJECT	123316833	**REPORTED**	2023-12-11 13:41

Analyte	Result	RL	Units	Analyzed	Qualifier
3424 (90-110mm) (23K3106-18) | Matrix: Solid | Sampled: 2023-11-24, Continued					
General Parameters, Continued					
pH (1:2 H2O Solution)	**11.89**	0.10	pH units	2023-12-01	
3443 (40-60mm) (23K3106-19) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
pH (1:2 H2O Solution)	**11.90**	0.10	pH units	2023-12-01	
3443 (90-110mm) (23K3106-20) | Matrix: Solid | Sampled: 2023-11-24					
General Parameters					
pH (1:2 H2O Solution)	**11.92**	0.10	pH units	2023-12-01	

CARO ANALYTICAL SERVICES

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K3106
PROJECT	123316833	**REPORTED**	2023-12-11 13:41

Analysis Description	Method Ref.	Technique	Accredited	Location
Chloride, Acid-Soluble in Solid	ATU TLT-520	HNO3 Extraction / Potentiometric Titration		Richmond
pH in Solid	Carter 16.2 / SM 4500-H+ B (2021)	1:2 Soil/Water Slurry / Electrometry	✓	Richmond

Glossary of Terms:

RL	Reporting Limit (default)
%	Percent
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
pH units	pH < 7 = acidic, ph > 7 = basic
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Stantec Consulting Ltd. (Winnipeg)	**WORK ORDER**	23K3106
PROJECT	123316833	**REPORTED**	2023-12-11 13:41

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS)**: A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS)**: A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B3K3100										
Blank (B3K3100-BLK1)				Prepared: 2023-11-30, Analyzed: 2023-12-11						
Chloride, Acid-Soluble	< 0.020	0.020	%							
Duplicate (B3K3100-DUP1)		**Source: 23K3106-16**		Prepared: 2023-11-30, Analyzed: 2023-12-11						
Chloride, Acid-Soluble	< 0.020	0.020	%		< 0.020				20	
General Parameters, Batch B3K3116										
Duplicate (B3K3116-DUP1)		**Source: 23K3106-20**		Prepared: 2023-12-01, Analyzed: 2023-12-01						
pH (1:2 H2O Solution)	11.93	0.10	pH units		11.92			< 1	4	
Reference (B3K3116-SRM1)				Prepared: 2023-12-01, Analyzed: 2023-12-01						
pH (1:2 H2O Solution)	7.06	0.10	pH units	7.05		100	95-105			
Reference (B3K3116-SRM2)				Prepared: 2023-12-01, Analyzed: 2023-12-01						
pH (1:2 H2O Solution)	7.00	0.10	pH units	7.05		99	95-105			

APPENDIX E

Petrographic Evaluation Report

REPORT OF PETROGRAPHIC ANALYSIS

Project:
Pembina Hwy Overpass

Reported To:
Stantec
199 Henlow Bay
Winnipeg, MB, CA R3Y 1G4

Attn: Kevin Hiraoka

AET Project No.: P-0028901

Date: December 21, 2023

INTRODUCTION

This report presents the results of laboratory work performed by our firm on four concrete core samples submitted by Kevin Hiraoka of Stantec. We understand the concrete cores were obtained from the Pembina Highway Overpass over the Bishop Grandin Blvd in Manitoba, CA. We understand that two of the core samples - D13 3396 and D28 3406 - consisted of both a base slab concrete and an overlay concrete; these two samples were received on November 22, 2023. The other two samples - A10 3429 and P7 3435 - were taken from an abutment and pier from the same bridge, consisted of only one concrete each, and were received on December 4, 2023. The scope of our work was limited to performing petrographic analysis on the samples to analyze the bond between the base and repair concrete in samples D13 3396 and D28 3406, as well as to analyze the general overall condition of the concrete in all four samples.

CONCLUSIONS

Based on our observations and analysis:

1. The base and overlay concretes in sample D13 3396 were well-bonded and well-consolidated, with no observed loss of cohesion. The top surface of the base concrete was oriented sub-horizontally, was undulose / wavy in profile, and appeared to have been rake-finished. The concrete overlay was observed filling topographic lows in the top surface of the base concrete. Depth of carbonation from the top surface of the base concrete ranged from negligible to 1 mm (1/32"). The general overall condition of the base and overlay concrete was considered good with no evidence of mass deterioration mechanisms, such as freeze-thaw cracking, alkali-aggregate reactivity, or corrosion of steel reinforcement observed. Both concretes were of visually similar composition and appeared air entrained.

2. The base and overlay concretes in sample D28 3406 were separated by a 1 mm (1/32") to 2 mm (1/16") thick layer of discontinuous, very light gray, very soft (Mohs hardness < 2), cementitious 'slurry'. The source of this material was not clear based on our examination. While the two concretes were well-consolidated and did not separate from one another during saw-cutting and sample preparation, the slurry layer represents a physical plane of weakness between the two concretes. Further, when the core was struck with a rock hammer at the contact, it fractured mostly along the contact plane. The top surface of the base concrete was oriented sub-horizontally, was undulose / wavy in profile, and appeared to have been rake-finished but with less amplitude compared to sample D13 3396. Depth of carbonation from the top surface of the base concrete ranged from negligible to 1 mm (1/32"). The general overall condition of the base and overlay concretes was considered good, with no evidence of mass deterioration mechanisms observed. Both concretes were of visually similar composition. The base concrete appeared air entrained, and the overlay concrete contained only a small amount of spherical entrained-sized air voids.

3. The base concretes in samples D28 3396 and D28 3406 were visually composed of portland cement, a quarried/crushed granitic coarse aggregate, and a natural sand fine aggregate. The concrete was placed at a moderately low w/c, estimated between 0.40 and 0.45. The base concrete appeared air entrained.

4. The general overall condition of the concrete in samples A10 3429 and P7 3435 was considered good, with no evidence of mass deterioration mechanisms observed. Both samples were of visually similar composition, consisting of portland cement, a 19 mm (3/4") nominal sized natural gravel, and a natural sand. The concrete was placed at a low w/c, estimated between 0.35 and 0.40. The concrete contained a small amount of entrained-sized air voids. Sample A10 3429 exhibited a surface-parallel zone of concrete up to 25 mm (1") thick located between 76 mm (3") and 102 mm (4") depth exhibited greatly reduced air void content.

SAMPLE IDENTIFICATION

Sample Type: Hardened Concrete Cores

Sample ID	Diameter	Length
D13 3396	102 mm (4")	254 mm (10")
D28 3406	102 mm (4")	260 mm (10-1/4")
A10 3429	102 mm (4")	267 mm (10-1/2")
P7 3435	102 mm (4")	210 mm (8-1/4")

TEST RESULTS

Our complete petrographic analysis documentation appears on the attached sheets entitled 24-LAB-001 "Petrographic Examination of Hardened Concrete, ASTM C856." A brief summary of the general physical characteristics of the concrete is as follows:

1. The coarse aggregate in both the base and repair concrete of samples D13 3396 and D28 3406 consisted of 19 mm (3/4") nominal sized quarried and crushed gravel consisting of granite that was well-graded and exhibited good overall distribution; the fine aggregate in these samples was a natural sand. The coarse aggregate in both samples A10 3429 and P7 3435 consisted of 19 mm (3/4") nominal sized natural gravel that was well-graded and exhibited good overall distribution; the fine aggregate in these samples was a natural sand.

2. The paste color in the base concrete of samples D13 3396 and D28 3406 was light gray to medium light gray; the paste hardness was moderate to moderately hard with the paste-aggregate bonded considered fair to good. The paste color in samples A10 3429 and P7 3435 was light gray to medium light gray; the paste hardness was moderately hard with the paste-aggregate bonded considered fair to good.

3. The top surface condition of the repair concrete in samples D13 3396 and D28 3406 was ground / traffic-worn. The outer surface condition of the concrete in samples A10 3429 and P7 3435 was formed. Depth of carbonation from the top surface of the base concrete in samples D13 3396 and D28 3406 ranged from 1 mm (1/32") to 2 mm (1/16"). Depth of carbonation from the outer surface of samples A10 3429 and P7 3435 ranged from 8 mm (5/16") to 15 mm (9/16").

4. The w/cm of the base concrete in samples D13 3396 and D28 3406 was estimated to be between 0.40 and 0.45 with approximately 5 to 7% residual portland cement clinker particles. The w/cm of the base concrete in samples A10 3429 and P7 3435 was estimated to be between 0.35 and 0.40 with approximately 10 to 15% residual portland cement clinker particles. No supplementary cementitious materials were observed in the concrete samples.

TEST PROCEDURES

Laboratory testing was performed on November 22, 2023 and subsequent dates. Our procedures were as follows:

1.0 Petrographic Analysis

A petrographic analysis was performed in accordance with AET Standard Operating Procedure 24-LAB-001, "Petrographic Examination of Hardened Concrete," ASTM C856-latest revision. The petrographic analysis consisted of reviewing the cement paste and aggregate qualities on a whole basis on saw cut, lapped, and fractured sections. Reflected light microscopy was performed under an Olympus SZX-12 binocular stereozoom microscope at magnifications up to 160x. The depth of carbonation was documented using a phenolphthalein pH indicator solution applied on freshly saw cut and lapped surfaces of the concrete sample. The paste-coarse aggregate bond quality was determined by fracturing a sound section of the concrete in the laboratory with a rock hammer.

The water/cementitious of the concrete was estimated by viewing a thin section of the concrete under a Nikon E600 polarizing light microscope at magnifications of up to 600x. Thin section analysis was performed in accordance with Standard Operating Procedure 24-LAB-009, "Determining the Water/Cement of Portland Cement Concrete, AET Method." An additional, smaller, saw cut subdivision of the concrete sample is epoxy impregnated, highly polished, and then attached to a glass slide using an optically clear epoxy. Excess sample is saw cut from the glass and the thin slice remaining on the slide is lapped and polished until the concrete reaches 25 microns or less in thickness. Thin section analysis allows for the observation of portland cement morphology, including: phase identification, an estimate of the amount of residual material, and spatial relationships. Also, the presence and relative amounts of supplementary cementitious materials and pozzolans may be identified and estimated.

REMARKS

The test samples will be retained for a period of at least sixty days from the date of this report. Unless further instructions are received by that time, the samples may be discarded. Test results relate only to the items tested. No warranty, expressed or implied, is made.

We appreciate the opportunity to have been of service to you on this project. If you have any questions regarding the information presented in this report or if we can be of additional assistance, please contact us.

Report Prepared By
American Engineering Testing, Inc.

William Reely

William Reely, GIT
Petrographer
wreely@teamAET.com

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337
blemcke@teamAET.com
Work: 651-659-1362

24-LAB-001 PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

Project No.	P-0028901	**Date:**	12/13/2023	**Date reviewed:**	12/20/2023
Sample ID:	D13 3396	**Performed by:**	W. Reely	**Reviewed by:**	B. Lemcke

I. GENERAL OBSERVATIONS

1. Sample Dimensions: Our analysis was performed on a 254 mm (10") x 102 mm (4") x 45 mm thick lapped profile section and a 76 mm (3") x 52 mm (2") thin section that were saw-cut and prepared from the original 102 mm (4") diameter x 254 mm (10") long composite core.

2. Surface Conditions:
   Top: Fairly smooth, planar, mechanically ground / traffic worn surface
   Bottom: Mostly smooth, irregular, formed surface

3. Reinforcement: One 13 mm (1/2") diameter, epoxy-coated steel rebar was observed at 203 mm (8") from the top surface; no corrosion was observed.

4. General Physical Conditions: The sample was a composite core consisting of a 102 mm (4") to 110 mm (4-5/16") thick base concrete with lighter-colored paste, overlain by a 147 mm (5-3/4") to 161 mm (6-5/16") topping concrete with darker-colored paste. The two concretes were well-bonded to one another. The topping concrete filled topographic lows in the underlying base concrete. The top surface of the base concrete was oriented sub-horizontally, was undulose / wavy in profile, and appeared to have been rake-finished.

   The top surface of the topping concrete had been mechanically ground / traffic worn with many exposed and truncated aggregate particles. The exposed aggregates appeared to have been smoothed and rounded by subsequent traffic wear. Depth of carbonation from the top surface of the topping concrete ranged from negligible to 3 mm (1/8"). A few sub-vertical microcracks propagated from the top surface to a depth of up to 30 mm (1-3/16"). The topping concrete appeared air-entrained; a greater amount of finer, entrained-sized air voids were observed in the top up to 15 mm (9/16") of the topping concrete. Several clusters of closely-spaced, entrained sized voids were observed at various depths in the topping concrete. No evidence of active alkali-aggregate reactivity was observed in the topping concrete.

   The top surface of the base concrete was undulose and appeared rake-finished. Depth of carbonation from the top surface of the base concrete ranged from negligible to 1 mm (1/32"). The base concrete was air entrained. A few clusters of closely-spaced, entrained-sized air voids were observed at various depths throughout the base concrete. No evidence of active alkali-aggregate reactivity was observed in the base concrete.

   Sections II and III refer only to qualities of the base concrete unless otherwise specified.

II. AGGREGATE

1. Coarse: 19 mm (3/4") nominal sized quarried and crushed rock consisting of granite. The particles were mostly sub-angular in shape. The coarse aggregate appeared well graded and exhibited good overall distribution.

2. Fine: Natural quartz, feldspar, and lithic sand (granite, carbonates, graywacke, chert, several amphibole, pyroxene, mica, and iron oxide grains). The grains were mostly sub-rounded with many smaller sub-angular particles. The fine aggregate appeared fairly graded and exhibited good overall uniform distribution.

III. CEMENTITIOUS PROPERTIES

1. Air Content: Not documented.
2. Depth of carbonation: Ranged from negligible to 1 mm (1/32") from the top surface.
3. Paste/aggregate bond: Fair to good.
4. Paste color: Light gray to medium light gray (Munsell® N7 to N6).
5. Paste hardness: Moderate (Mohs ≈ 3).
6. Microcracking: None observed.
7. Secondary deposits: None observed.
8. w/cm: Estimated at between 0.40 and 0.45 with approximately 5 to 7% residual portland cement clinker particles.
9. Cement hydration: Alites: well to fully
   Belites: low to well

24-LAB-001 PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

Project No.	P-0028901	**Date:**	12/13/2023	**Date reviewed:**	12/20/2023
Sample ID:	D28 3406	**Performed by:**	W. Reely	**Reviewed by:**	B. Lemcke

I. GENERAL OBSERVATIONS

1. Sample Dimensions: Our analysis was performed on a 253 mm (10") x 102 mm (4") x 45 mm thick lapped profile section and a 76 mm (3") x 52 mm (2") thin section that were saw-cut and prepared from the original 102 mm (4") diameter x 260 mm (10-1/4") long composite core.

2. Surface Conditions:
   Top: Fairly smooth, planar, mechanically ground / traffic worn surface
   Bottom: Mostly smooth, irregular, formed surface

3. Reinforcement: Two 13 mm (1/2") diameter, epoxy-coated steel rebar and one 3 mm (1/8") diameter, epoxy-coated steel mesh member were observed between 180 mm (7-1/16") and 216 mm (8-1/2") depth from the top surface of the sample; no corrosion was observed. The epoxy coating around one of the steel rebars was incomplete, with only approximately 50% of the outer surface of the rebar observed in profile covered.

4. General Physical Conditions: The sample was a composite core consisting of a 110 mm (4-5/16") to 114 mm (4-1/2") thick base concrete overlain by a 142 mm (5-9/16") to 144 mm (5-11/16") topping concrete. The top surface of the base concrete was oriented sub-horizontally, was undulose / wavy in profile, and appeared to have been rake-finished. An up to 2 mm (1/16") thick layer of very light gray, very soft (Mohs hardness < 2), discontinuous layer of cementitious paste or 'slurry' was observed between the two concretes. The cementitious layer was discontinuous and did not appear to be an intentional application. Despite the soft layer, the two concretes appeared well-bonded.

   The top surface of the topping concrete had been mechanically ground / traffic worn, with many exposed and truncated aggregate particles. The exposed aggregates appeared to have been smoothed and rounded by subsequent traffic wear. Depth of carbonation from the top surface of the topping concrete ranged from negligible to 4 mm (5/32"). A few sub-vertical microcracks propagated from the top surface to a depth of up to 16 mm (5/8"). One sub-horizontal microcrack up to 9 mm (3/8") in length was observed between 2 mm (1/16") and 3 mm (1/8") depth. The topping concrete contained few entrained-sized air voids. No evidence of active alkali-aggregate reactivity was observed in the topping concrete.

   The top surface of the base concrete was rough, irregular, rake-finished and partially covered with a thin cementitious 'slurry' layer. Depth of carbonation from the top surface of the base concrete ranged from 1 mm (1/32") to 2 mm (1/16"). Overall the base concrete appeared air-entrained, and exhibited several irregular-shaped zones of concrete containing few air voids. A few clusters of closely-spaced, entrained-sized air voids were observed at various depths throughout the base concrete. No evidence of active alkali-aggregate reactivity was observed in the base concrete.

Sections II and III refer only to qualities of the base concrete unless otherwise specified.

II. AGGREGATE

1. Coarse: 19 mm (3/4") nominal sized quarried and crushed rock consisting of granite. The particles were mostly sub-angular in shape. The coarse aggregate appeared well graded and exhibited good overall distribution.
2. Fine: Natural quartz, feldspar, and lithic sand (granite, graywacke, carbonates, and chert, with several amphibole, mica, and iron oxide grains). The grains were mostly sub-rounded with many smaller sub-angular particles. The fine aggregate appeared fairly graded and exhibited good overall uniform distribution.

III. CEMENTITIOUS PROPERTIES

1. Air Content:	Not documented.
2. Depth of carbonation:	Ranged from 1 mm (1/32") to 2 mm (1/16") from the top surface.
3. Paste/aggregate bond:	Fair to good.
4. Paste color:	Medium light gray (Munsell® N6).
5. Paste hardness:	Moderately hard (Mohs ≈).
6. Microcracking:	None observed.
7. Secondary deposits:	None observed.
8. w/cm:	Estimated at between 0.40 and 0.45 with approximately 5 to 7% residual portland cement clinker particles.
9. Cement hydration:	Alites: well to fully Belites: low to well

24-LAB-001 PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

Project No.	P-0028901	**Date:**	12/13/2023	**Date reviewed:**	12/20/2023
Sample ID:	A10 3429	**Performed by:**	W. Reely	**Reviewed by:**	B. Lemcke

I. GENERAL OBSERVATIONS

1. Sample Dimensions: Our analysis was performed on a 267 mm (10-1/2") x 102 mm (4") x 51 mm (2") thick lapped profile section and a 76 mm (3") x 52 mm (2") thin section that were saw-cut and prepared from the original 102 mm (4") diameter x 267 mm (10-1/2") long concrete core.

2. Surface Conditions:
   Outer: Fairly smooth, formed surface
   Inner: Rough, irregular, fractured surface

3. Reinforcement: None observed

4. General Physical Conditions: The outer surface was fairly smooth and formed. The outer up to 2 mm (1/16") of the concrete was characterized by darker-colored paste. Depth of carbonation from the outer surface ranged from 1 mm (1/32") to 8 mm (5/16"). A few surface-perpendicular microcracks propagated from the outer surface to a depth of up to 4 mm (5/32"). Overall, the concrete appeared air-entrained; a surface-parallel zone of concrete up to 25 mm (1") thick located between 76 mm (3") and 102 mm (4") depth exhibited greatly reduced air void content. The concrete was well consolidated. No evidence of active alkali-aggregate reactivity was observed.

II. AGGREGATE

1. Coarse: 19 mm (3/4") nominal sized naturally occurring gravel consisting of quartzite, limestone, dolostone, granite, and gneiss. The particles were mostly round to sub-round in shape in shape. The coarse aggregate appeared well graded and exhibited good overall distribution.

2. Fine: Natural quartz, feldspar, and lithic sand (granite, carbonates, and quartzite, with several amphibole, mica, and iron oxide grains). The grains were mostly sub-rounded with many smaller sub-angular particles. The fine aggregate appeared fairly graded and exhibited good overall uniform distribution.

III. CEMENTITIOUS PROPERTIES

1. Air Content: Not documented.
2. Depth of carbonation: Ranged from 1 mm (1/32") to 8 mm (5/16") from the outer surface.
3. Paste/aggregate bond: Fair to good.
4. Paste color: Light gray to medium light gray (Munsell® N7 to N6).
5. Paste hardness: Moderately hard (Mohs ≈ 3.5).

6. Microcracking: A few sub-vertical microcracks propagated from the outer surface to a depth of up to 4 mm (5/32").
7. Secondary deposits: None observed.
8. w/cm: Estimated at between 0.35 and 0.40 with approximately 10 to 15% residual portland cement clinker particles.
9. Cement hydration: Alites: moderate to fully
   Belites: negligible to low

24-LAB-001 PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

Project No.	P-0028901	**Date:**	12/13/2023	**Date reviewed:**	12/20/2023
Sample ID:	P7 3435	**Performed by:**	W. Reely	**Reviewed by:**	B. Lemcke

I. GENERAL OBSERVATIONS

1. Sample Dimensions: Our analysis was performed on a 210 mm (8-1/4") x 102 mm (4") x 47 mm (1-7/8") thick lapped profile section and a 76 mm (3") x 52 mm (2") thin section that were saw-cut and prepared from the original 102 mm (4") diameter x 210 mm (8-1/4") long concrete core.

2. Surface Conditions:
   Outer: Fairly smooth, planar, formed surface
   Inner: Rough, irregular, fractured surface

3. Reinforcement: None observed

4. General Physical Conditions: The outer surface was fairly smooth, formed and appeared to be placed in wood formwork. Depth of carbonation from the outer surface ranged from 5 mm (3/16") to 15 mm (9/16"). A few surface-perpendicular microcracks propagated from the outer surface to a depth of up to 15 mm (9/16"). The concrete contained many entrained-sized air voids but did not appear intentionally air entrained. No evidence of active alkali-aggregate reactivity was observed.

II. AGGREGATE

1. Coarse: 19 mm (3/4") nominal sized naturally occurring gravel consisting of granite, gneiss, limestone, and quartzite. The particles were mostly round to sub-round in shape in shape. The coarse aggregate appeared well graded and exhibited good overall distribution.

2. Fine: Natural quartz, feldspar, and lithic sand (granite, gneiss, and carbonates, with several amphibole and iron oxide grains). The grains were mostly sub-rounded with many smaller sub-angular particles. The fine aggregate appeared fairly graded and exhibited good overall uniform distribution.

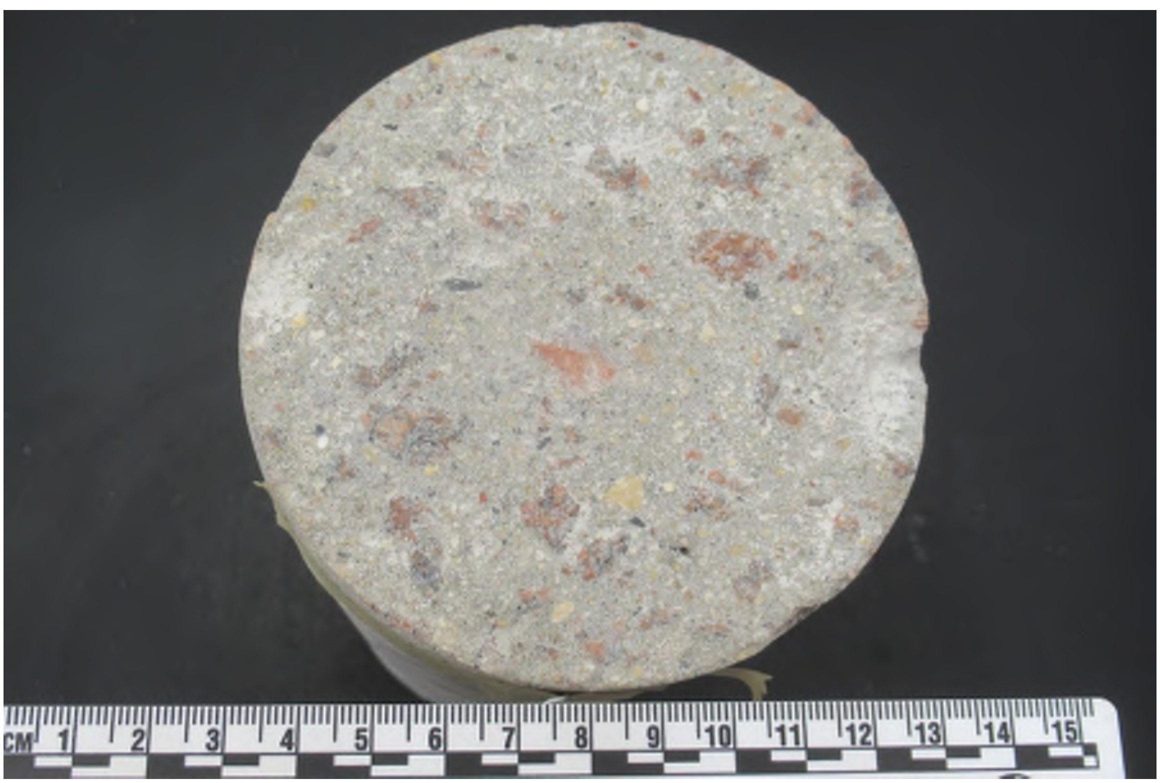
III. CEMENTITIOUS PROPERTIES

1. Air Content: Not documented.
2. Depth of carbonation: Ranged from 5 mm (3/16") to 15 mm (9/16") from the outer surface.
3. Paste/aggregate bond: Fair to good.
4. Paste color: Light gray to medium light gray (Munsell® N7 to N6).
5. Paste hardness: Moderately hard (Mohs ≈ 3.5).
6. Microcracking: A few sub-vertical microcracks propagated from the outer surface to a depth of up to 15 mm (9/16").
7. Secondary deposits: None observed.
8. w/cm: Estimated at between 0.35 and 0.40 with approximately 10 to 15% residual portland cement clinker particles.
9. Cement hydration: Alites: moderate to fully
   Belites: negligible to low

Photo: 1

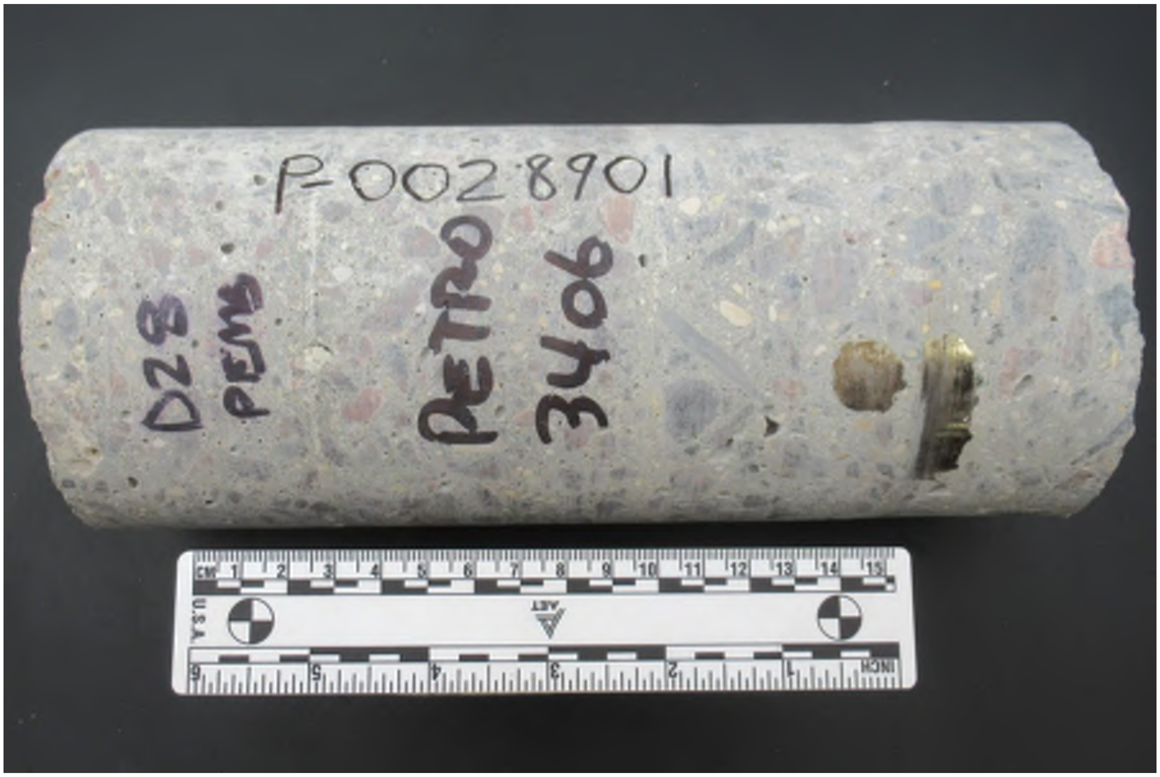
Sample ID: D13 3396 **Description:** The overall profile of the sample as received with the top surface oriented to the left.

Photo: 2



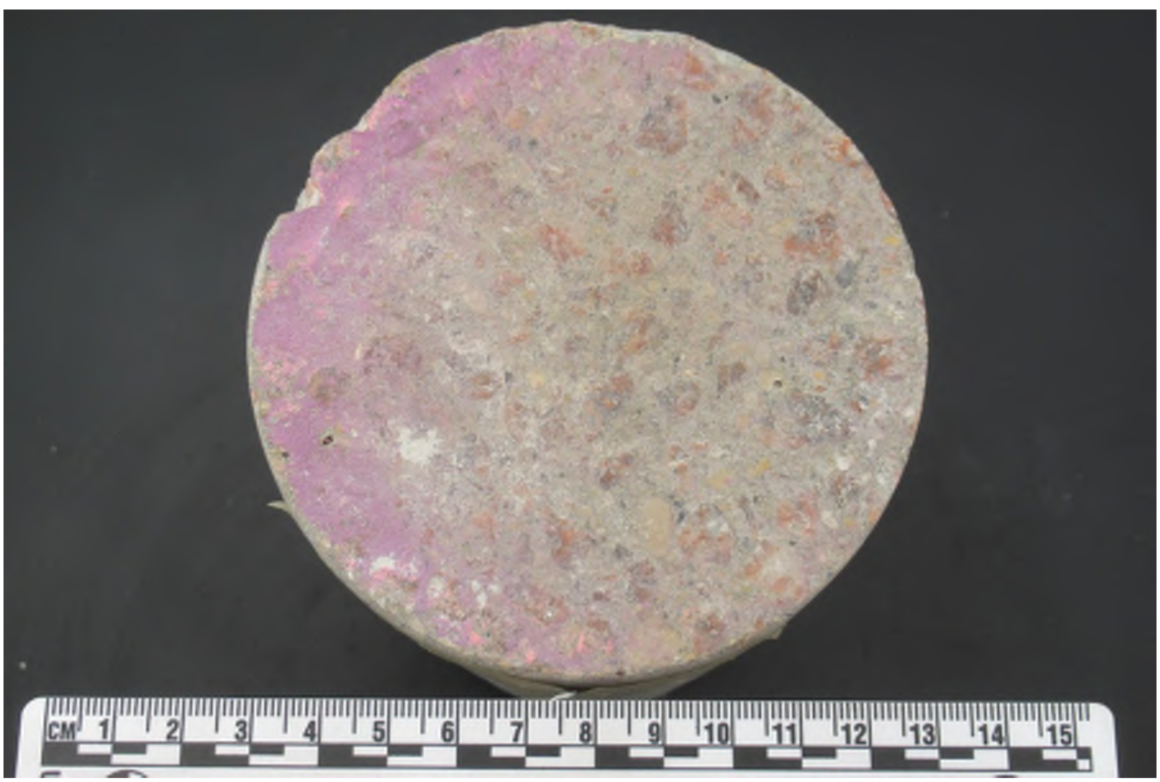
Sample ID: D13 3396 **Description:** The top surface of the sample as received.

Photo: 3



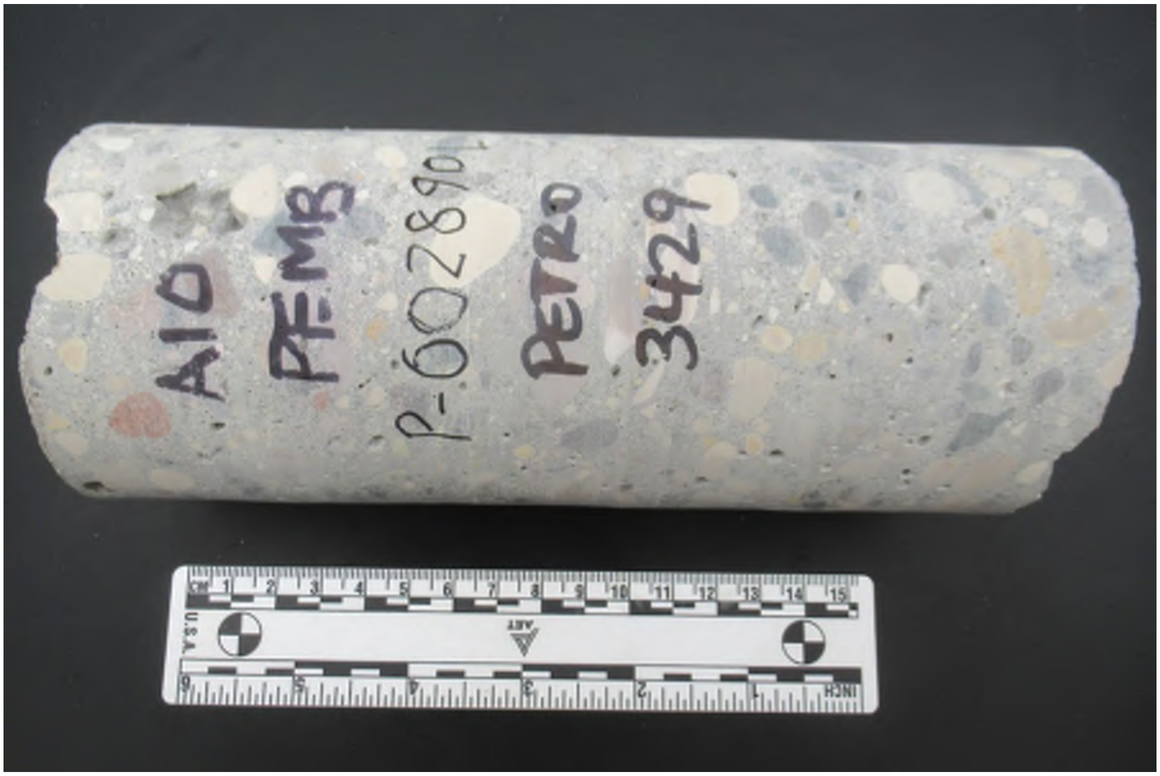
Sample ID: D28 3406 **Description:** The overall profile of the sample as received with the top surface oriented to the left.

Photo: 4



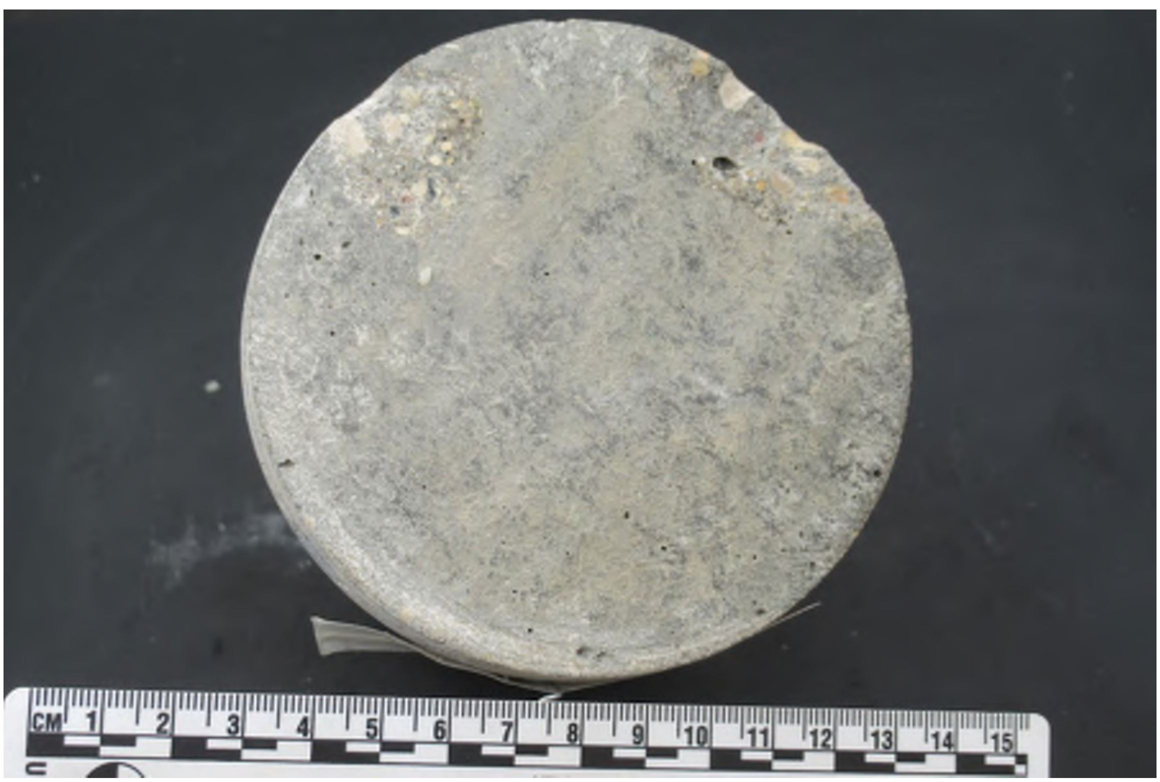
Sample ID: D28 3406 **Description:** The top surface of the sample as received.

Photo: 5



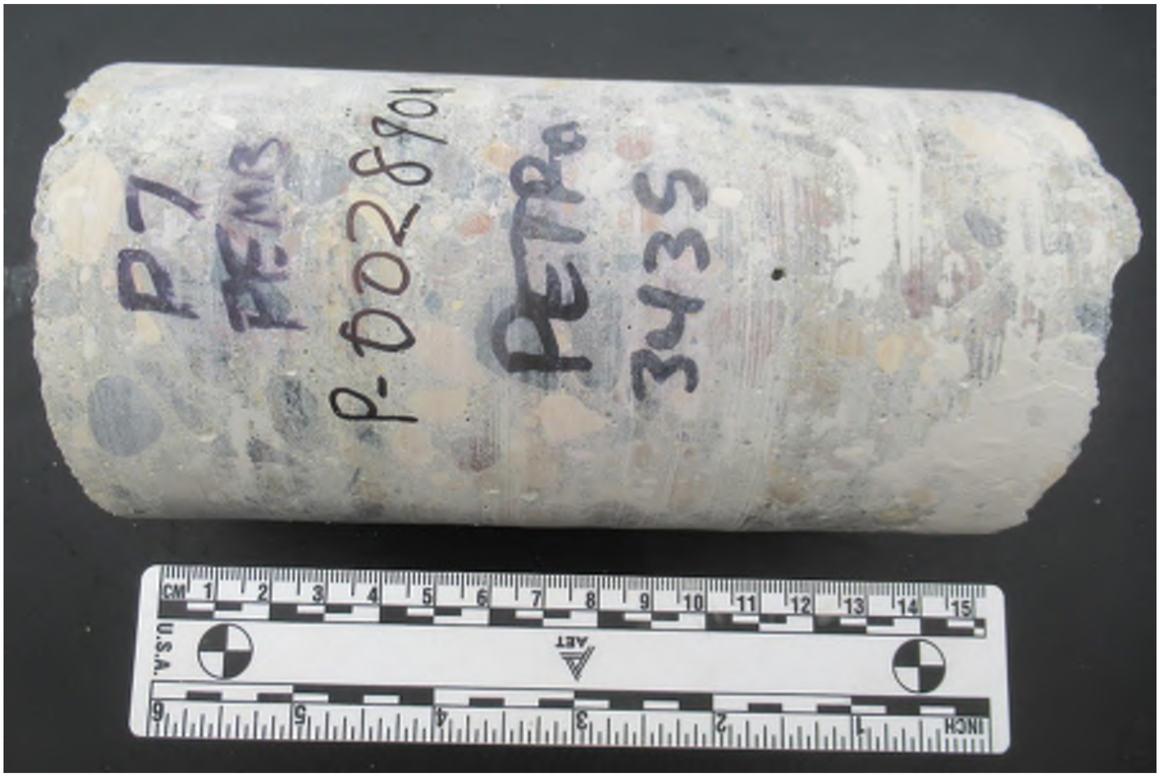
Sample ID: A10 3429 **Description:** The overall profile of the sample as received with the top surface oriented to the left.

Photo: 6



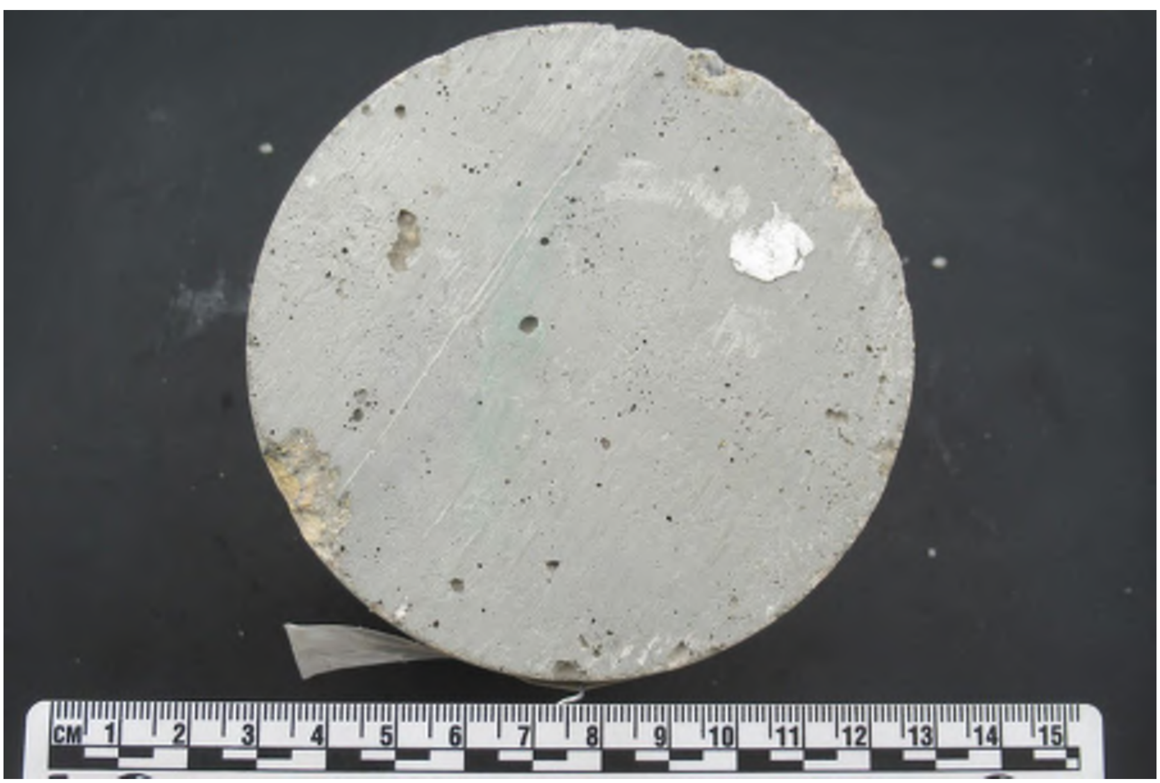
Sample ID: A10 3429 **Description:** The outer surface of the sample as received.

Photo: 7



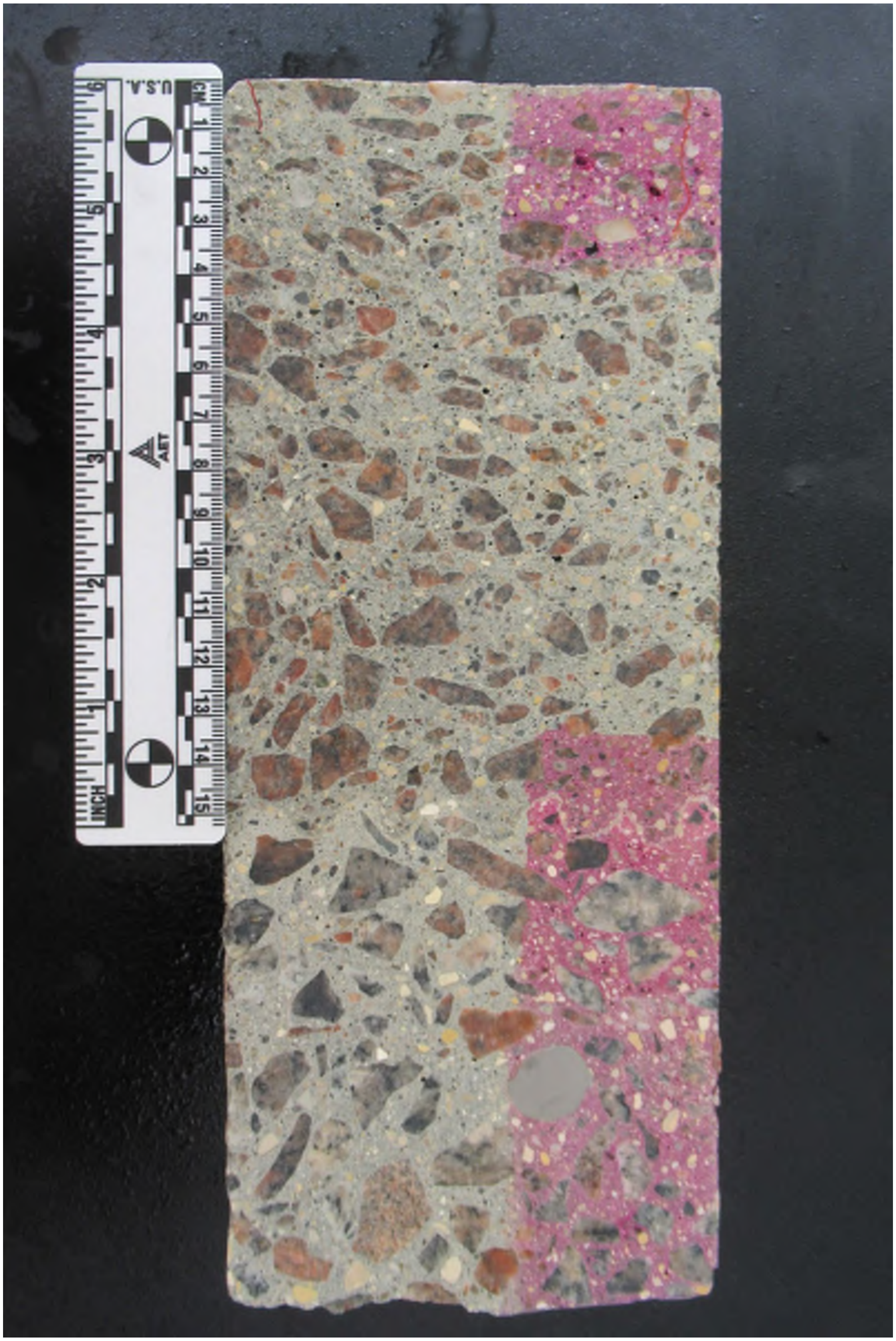
Sample ID: P7 3435 **Description:** The overall profile of the sample as received with the top surface oriented to the left.

Photo: 8



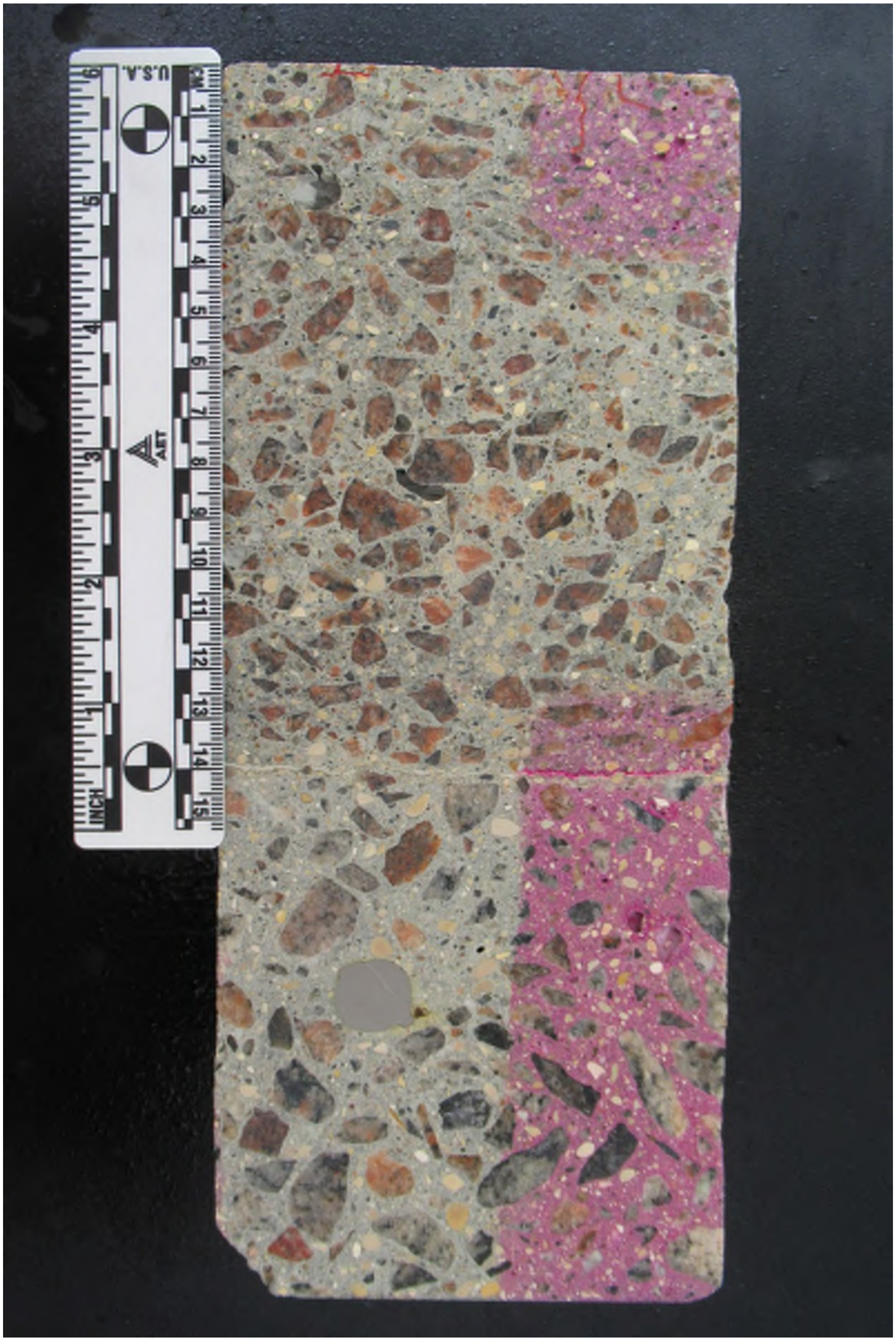
Sample ID: P7 3435 **Description:** The outer surface of the sample as received.

Photo: 9



Sample ID: D13 3396 **Description:** Saw-cut and lapped cross section of the sample with the top surface oriented up, after application of phenolphthalein pH indicator (pink stain) and mapping microcracks with red ink.

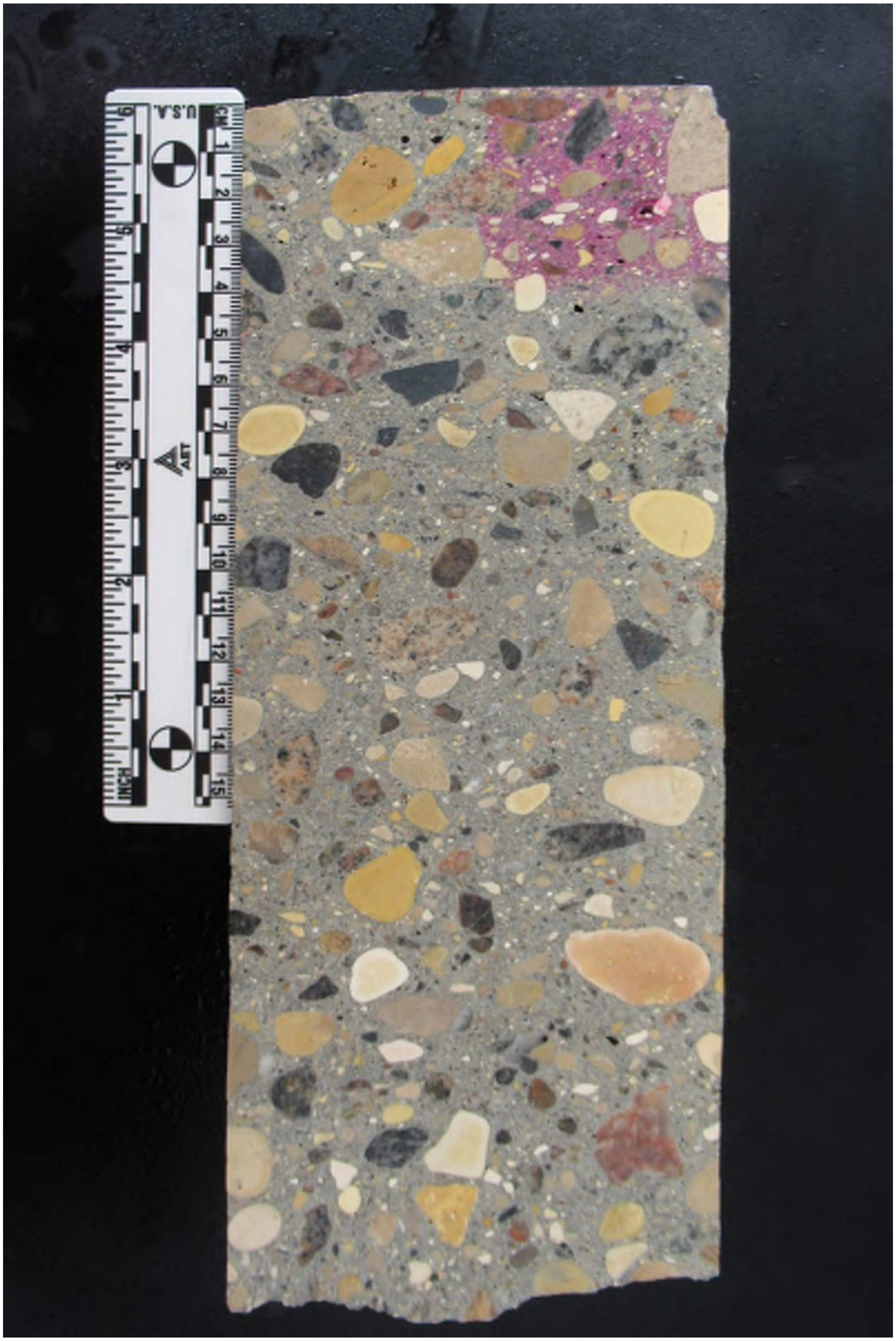
Photo: 10



Sample ID: D28 3406

Description: Saw-cut and lapped cross section of the sample with the top surface oriented up, after application of phenolphthalein pH indicator (pink stain) and mapping microcracks with red ink.

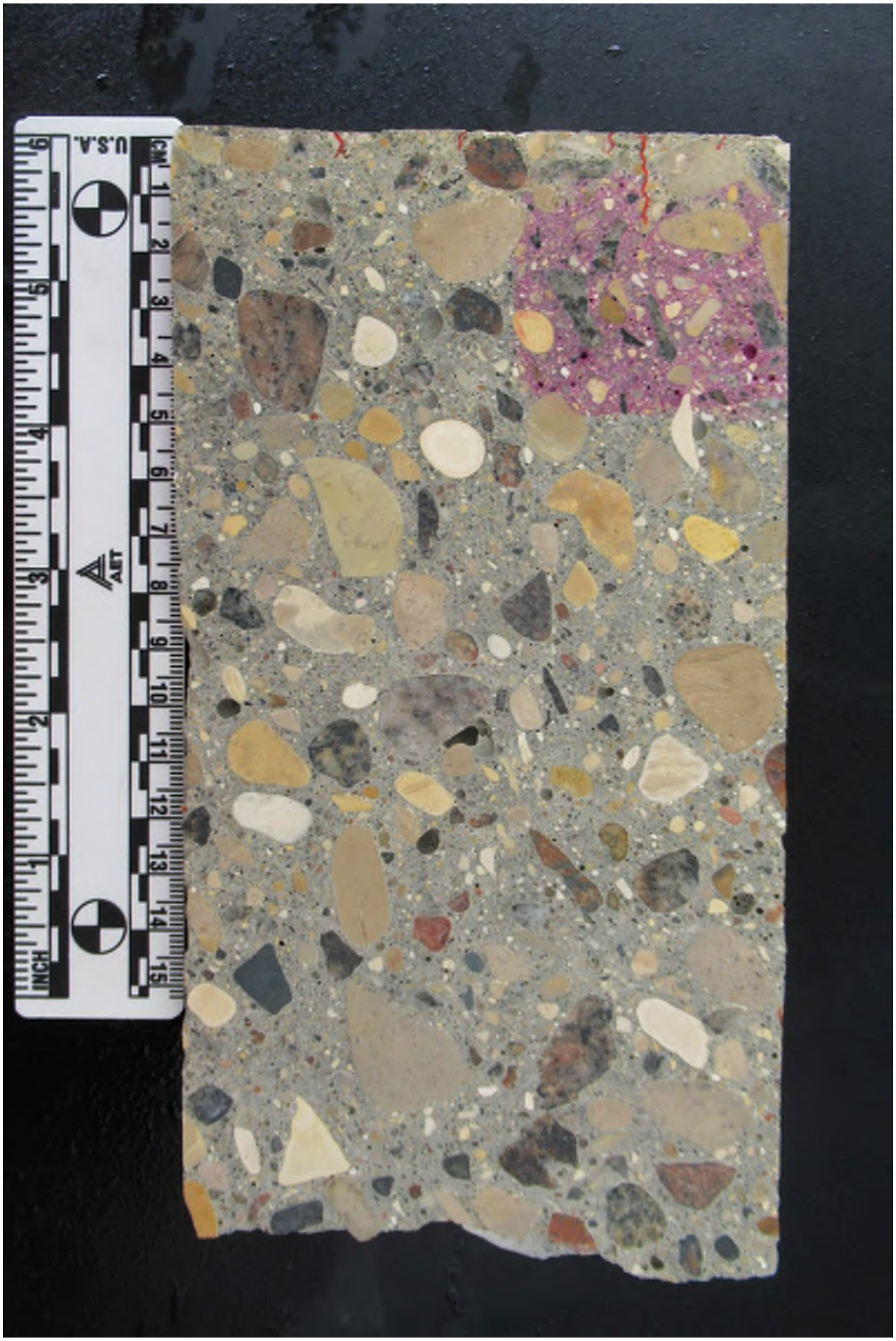
Photo: 11



Sample ID: A10 3429

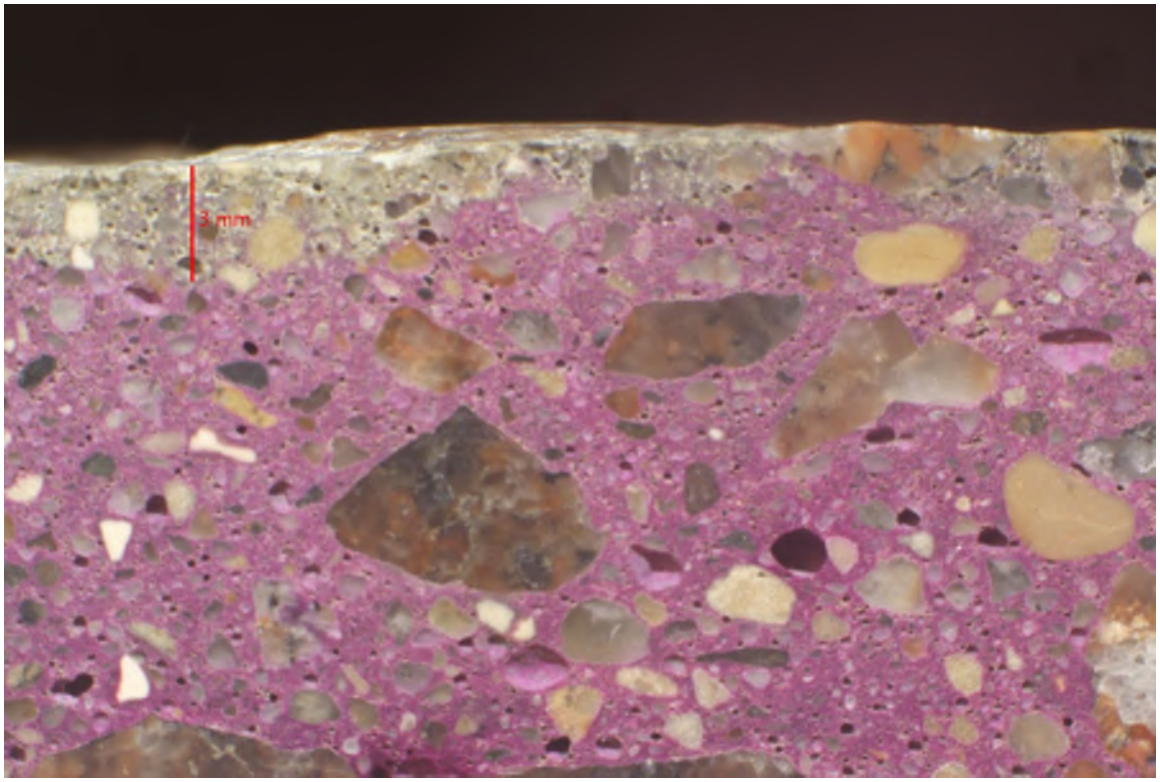
Description: Saw-cut and lapped cross section of the sample with the top surface oriented up, after application of phenolphthalein pH indicator (pink stain) and mapping microcracks with red ink.

Photo: 12



Sample ID: P7 3435 **Description:** Saw-cut and lapped cross section of the sample with the top surface oriented up, after application of phenolphthalein pH indicator (pink stain) and mapping microcracks with red ink.

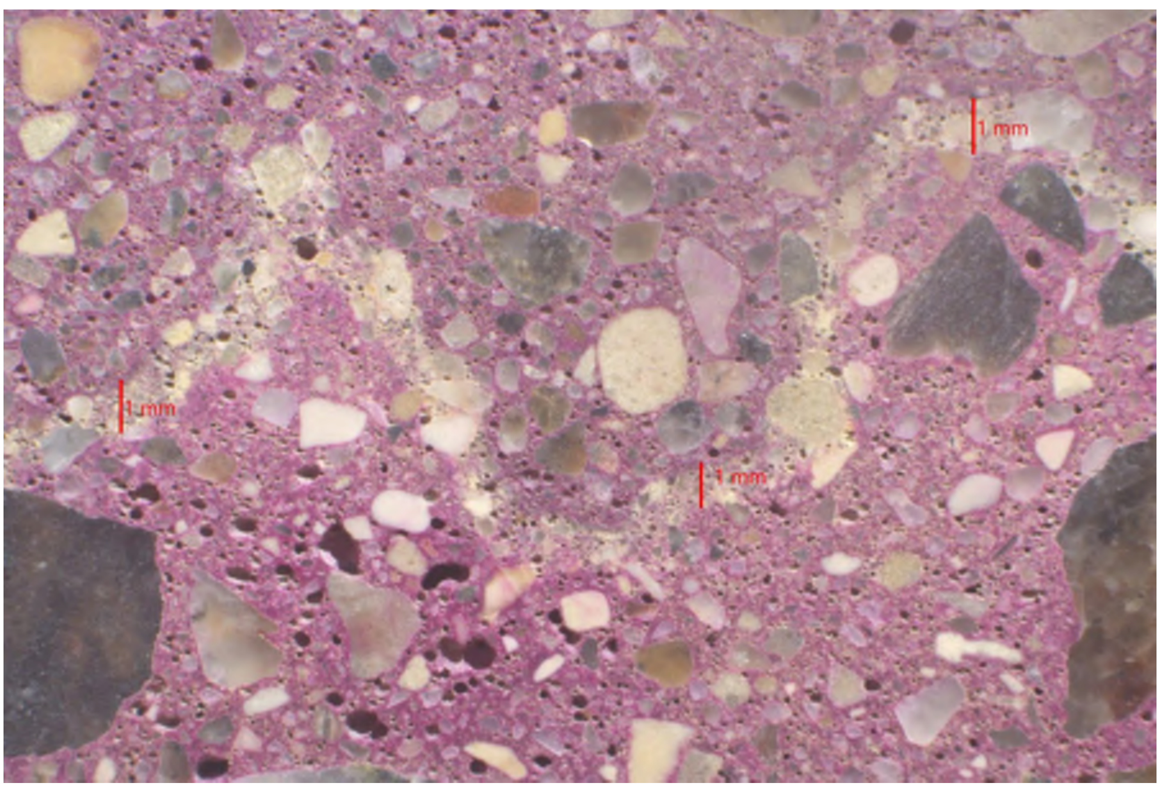
Photo: 13



Sample ID: D13 3396
Mag: 5x

Description: Carbonation (unstained paste) proceeded up to 3 mm (1/8") from the top surface of the repair concrete; on a saw-cut and lapped cross section of the sample after application of phenolphthalein pH indicator (pink stain).

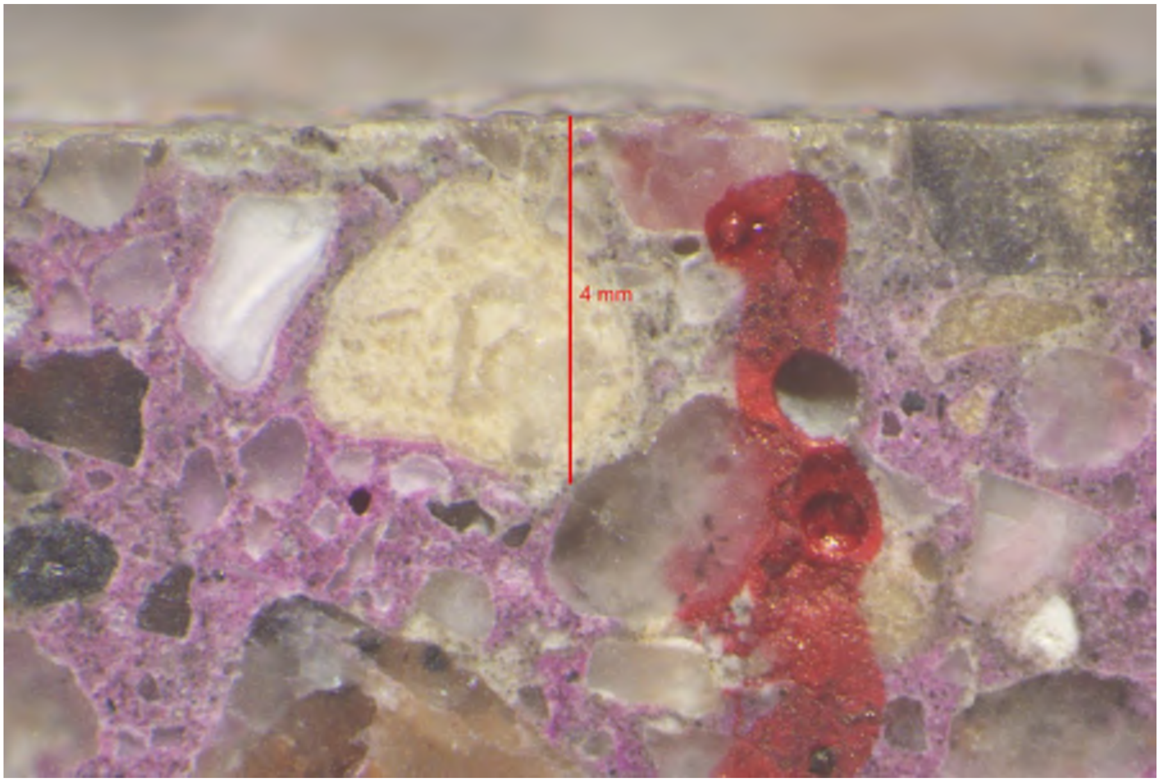
Photo: 14



Sample ID: D13 3396
Mag: 5x

Description: Carbonation (unstained paste) proceeded up to 1 mm (1/32") from the top surface of the base concrete.

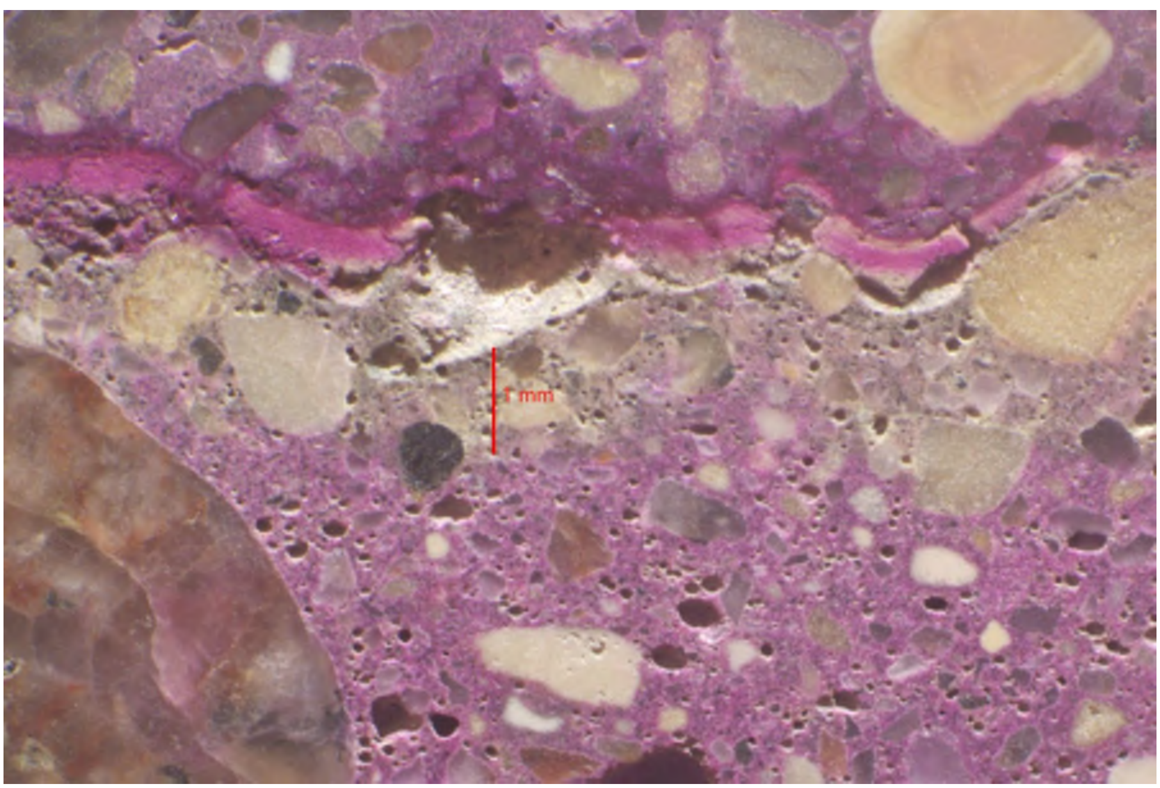
Photo: 15



Sample ID: D28 3406
Mag: 20x

Description: Carbonation (unstained paste) proceeded up to 4 mm (5/32") from the top surface of the repair concrete.

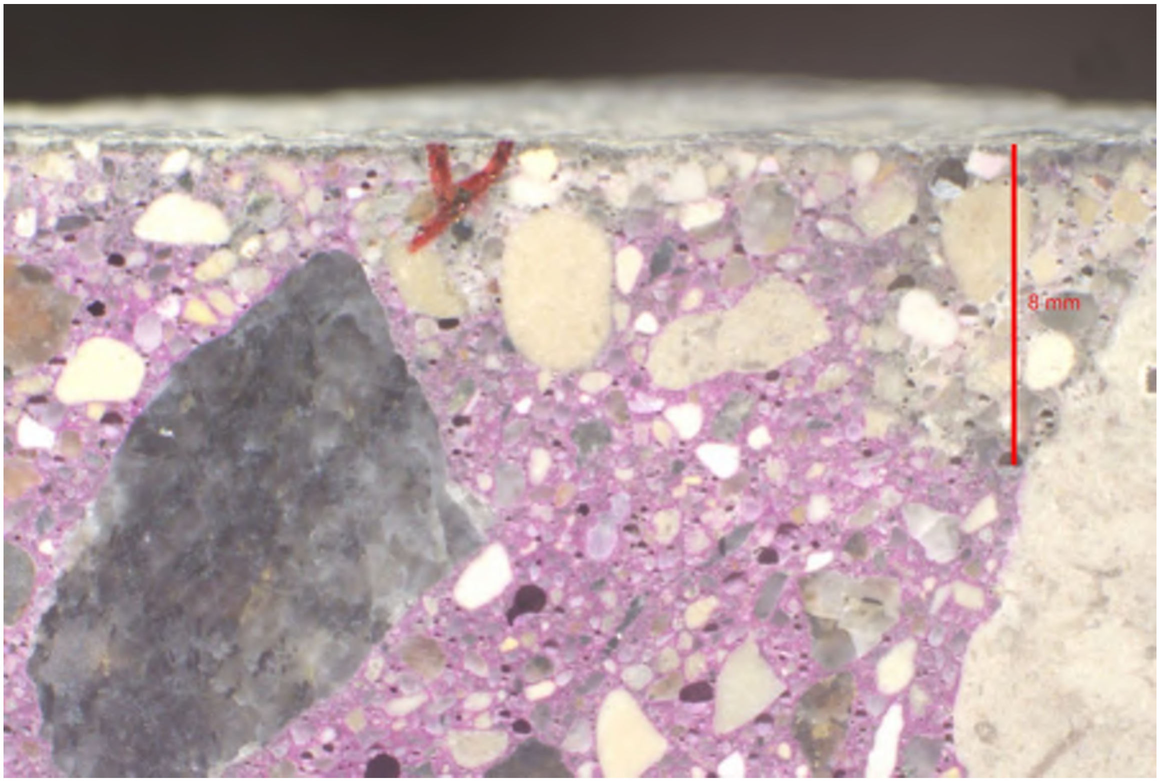
Photo: 16



Sample ID: D24 3406
Mag: 10x

Description: Carbonation (unstained paste) proceeded up to 1 mm (1/32") from the top surface of the base concrete.

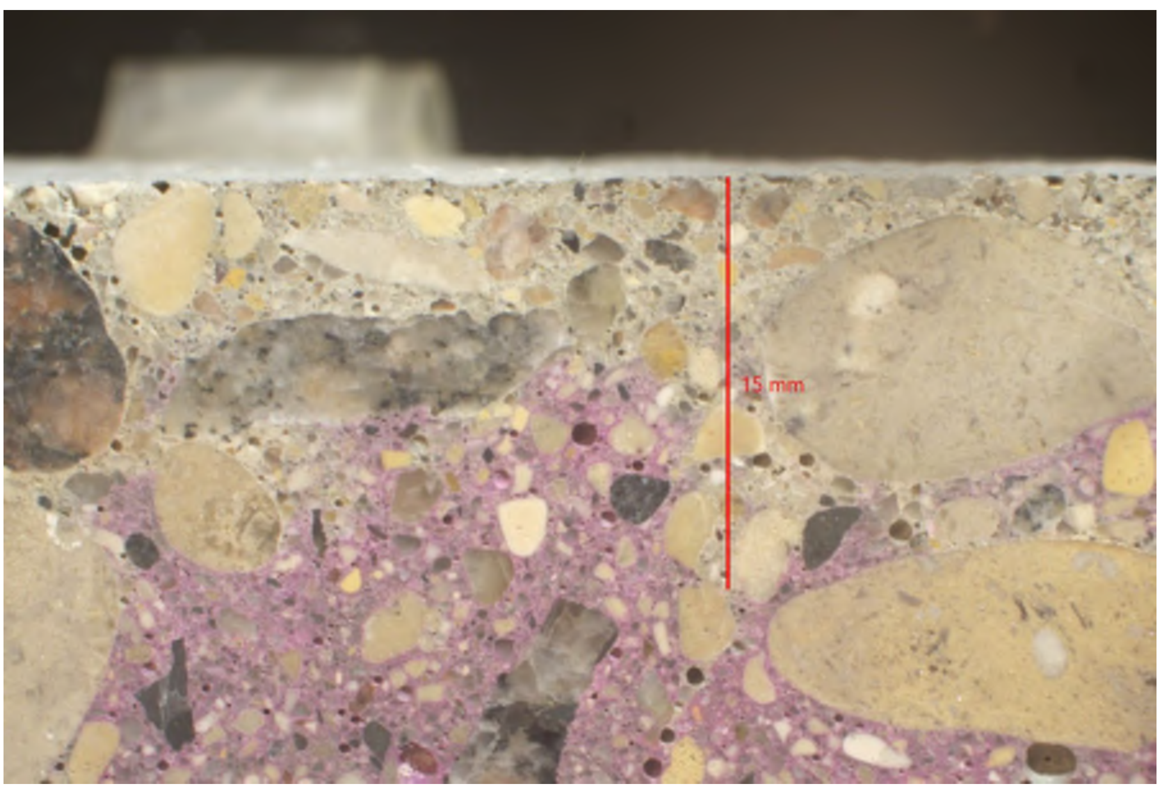
Photo: 17



Sample ID: A10 3429
Mag: 5x

Description: Carbonation (unstained paste) proceeded up to 8 mm (5/16") from the top surface of the concrete.

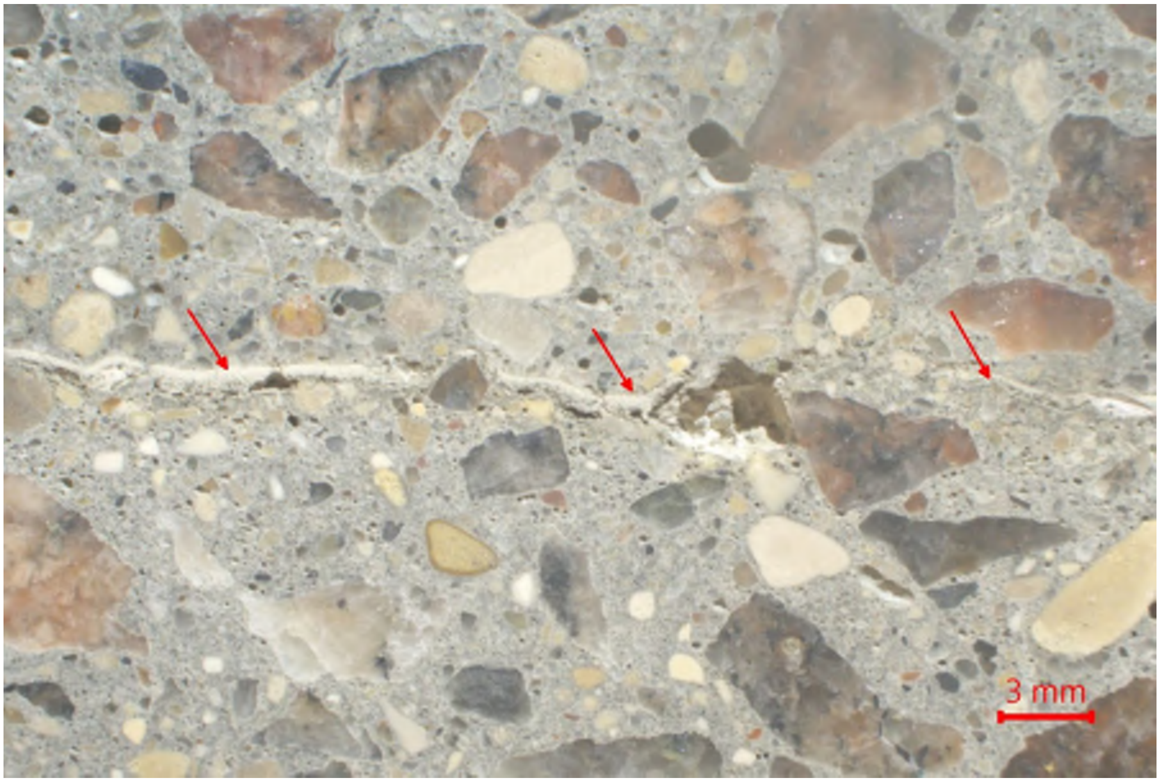
Photo: 18



Sample ID: P7 3435
Mag: 3.5x

Description: Carbonation (unstained paste) proceeded up to 15 mm (9/16") from the top surface of the concrete.

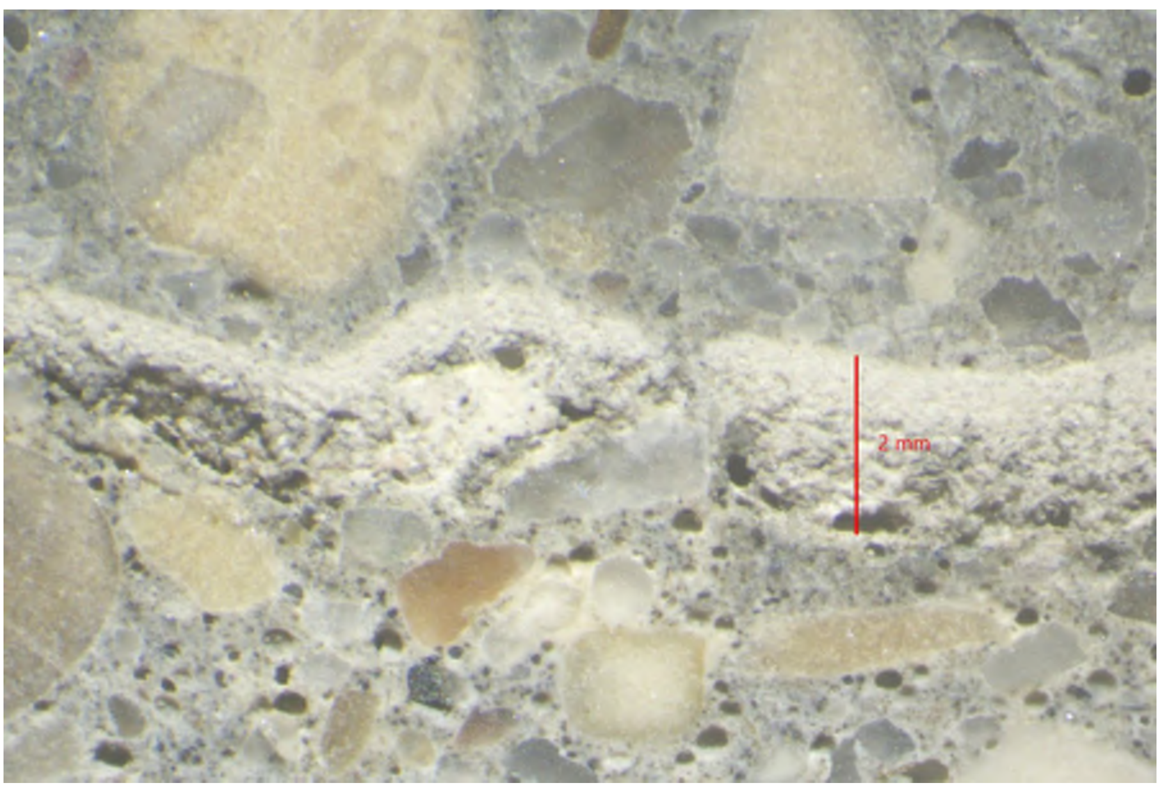
Photo: 19



Sample ID: D28 3406
Mag: 3.5x

Description: Thin layer of soft, cementitious slurry material (red arrows) between the base concrete (bottom) and overlay concrete (top).

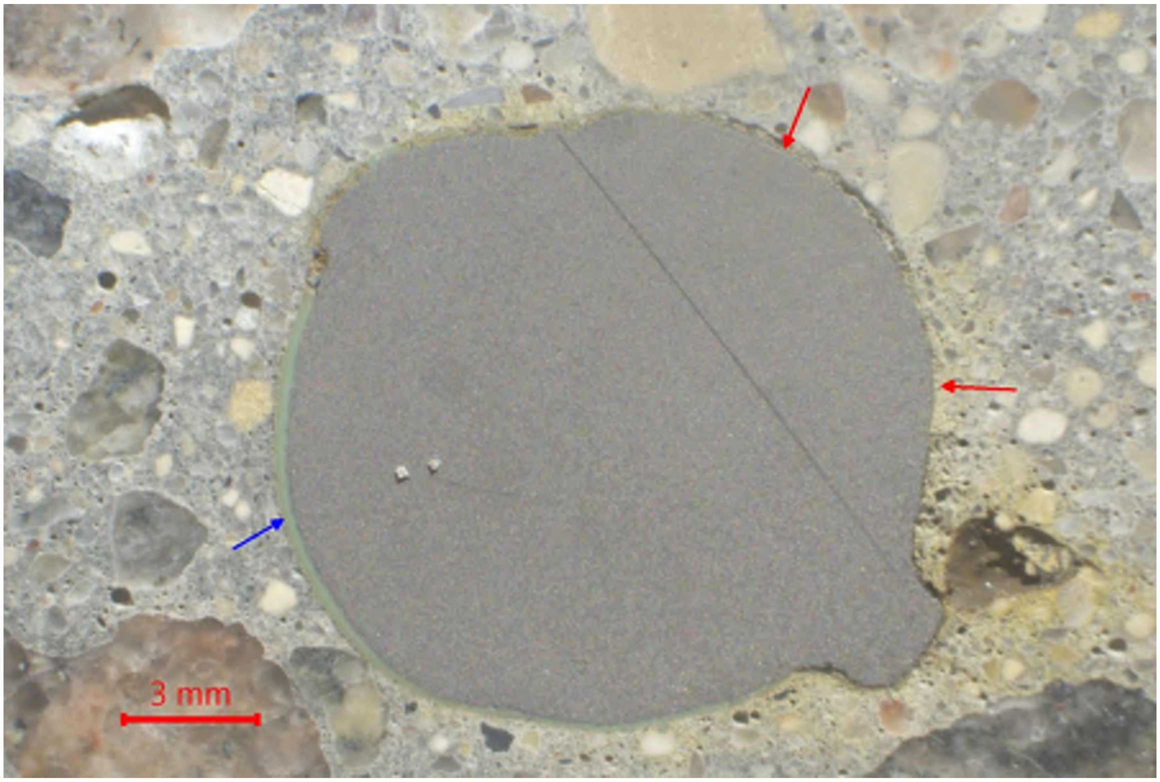
Photo: 20



Sample ID: D28 3406
Mag: 20x

Description: Higher-magnification image of the soft, cementitious slurry layer between the base concrete and overlay concrete.

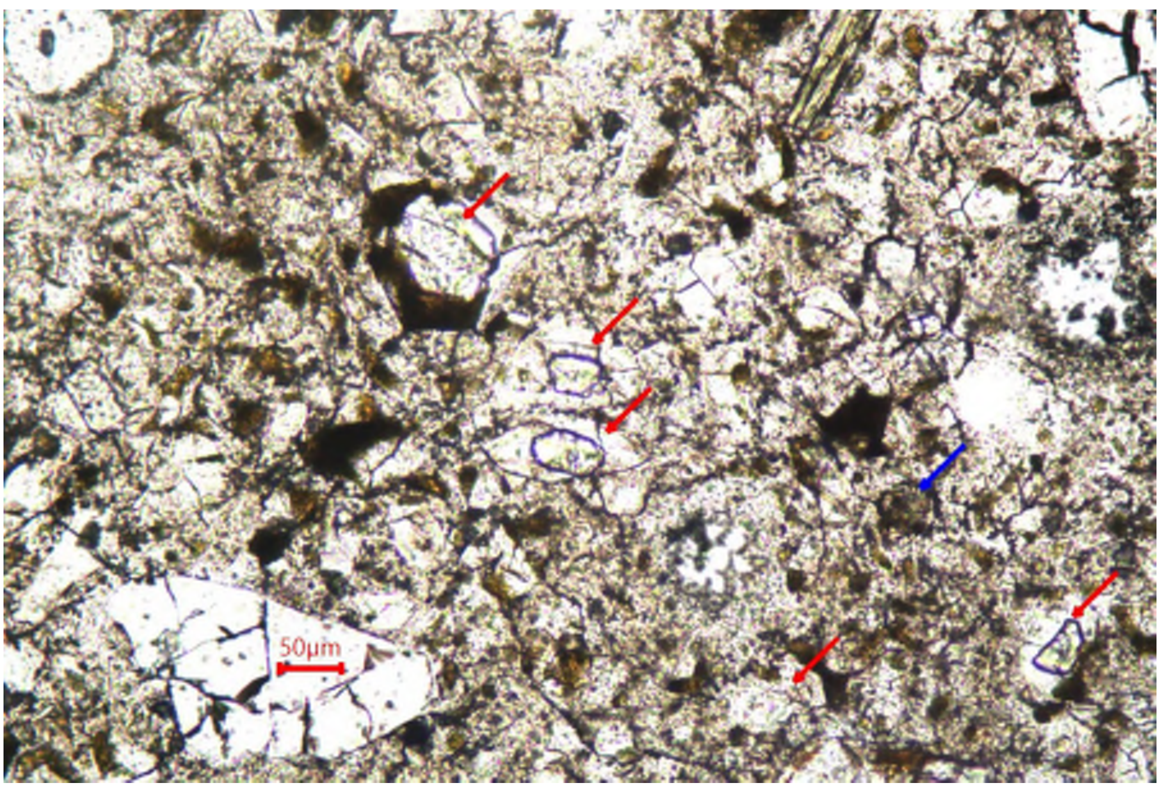
Photo: 21



Sample ID: D28 3406
Mag: 5x

Description: Steel rebar in the base concrete, note the green epoxy coating (blue arrow) and areas lacking epoxy coating (red arrows).

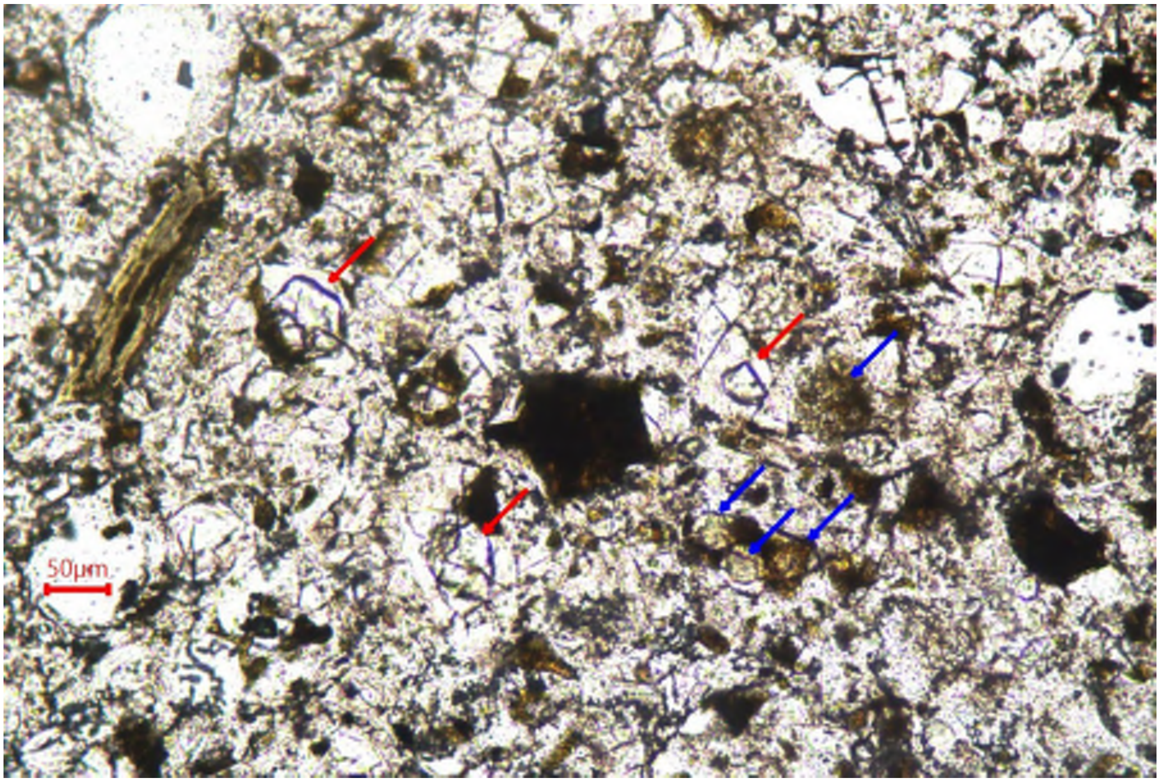
Photo: 22



Sample ID: D13 3396
Mag: 400x

Description: Moderately to well hydrated residual alite (red arrows) and residual belite exhibiting low levels of hydration (blue arrow), in a thin section of concrete viewed under plane-polarized light.

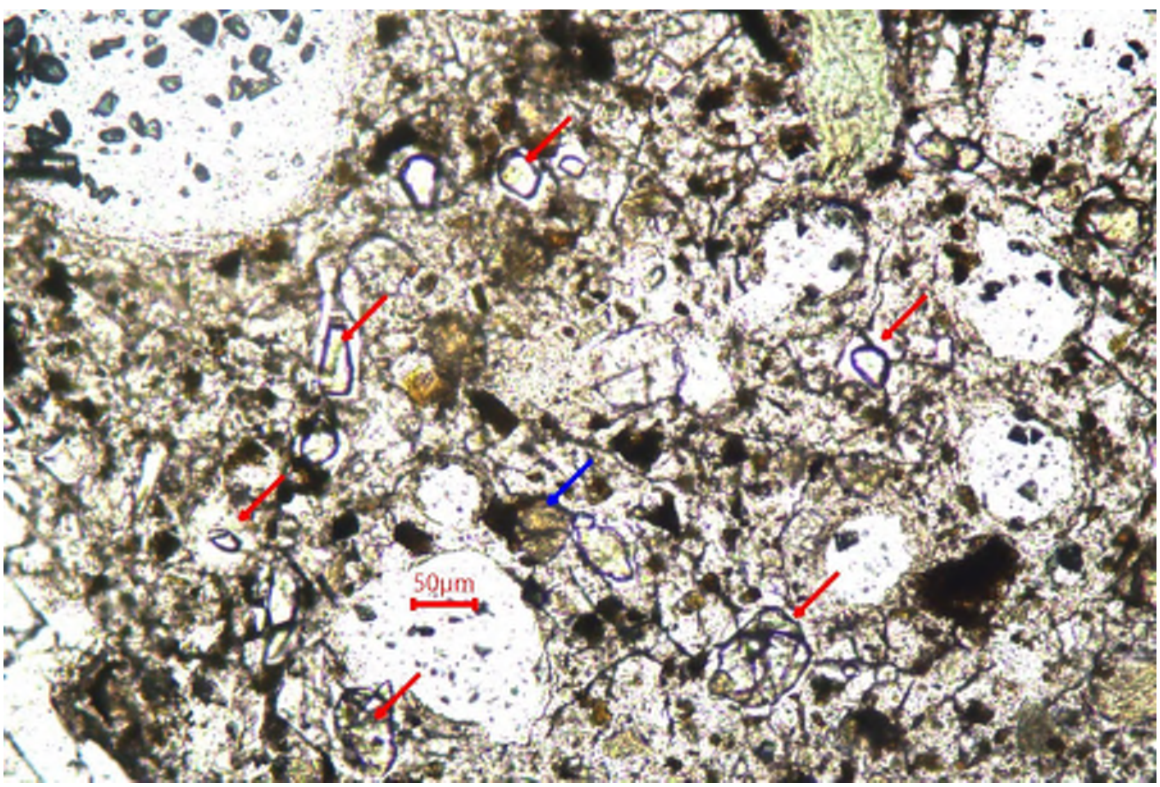
Photo: 23



Sample ID: D28 3406
Mag: 400x

Description: Moderately to well hydrated residual alite (red arrows) and moderately-hydrated belite (blue arrows), in a thin section of concrete viewed under plane-polarized light.

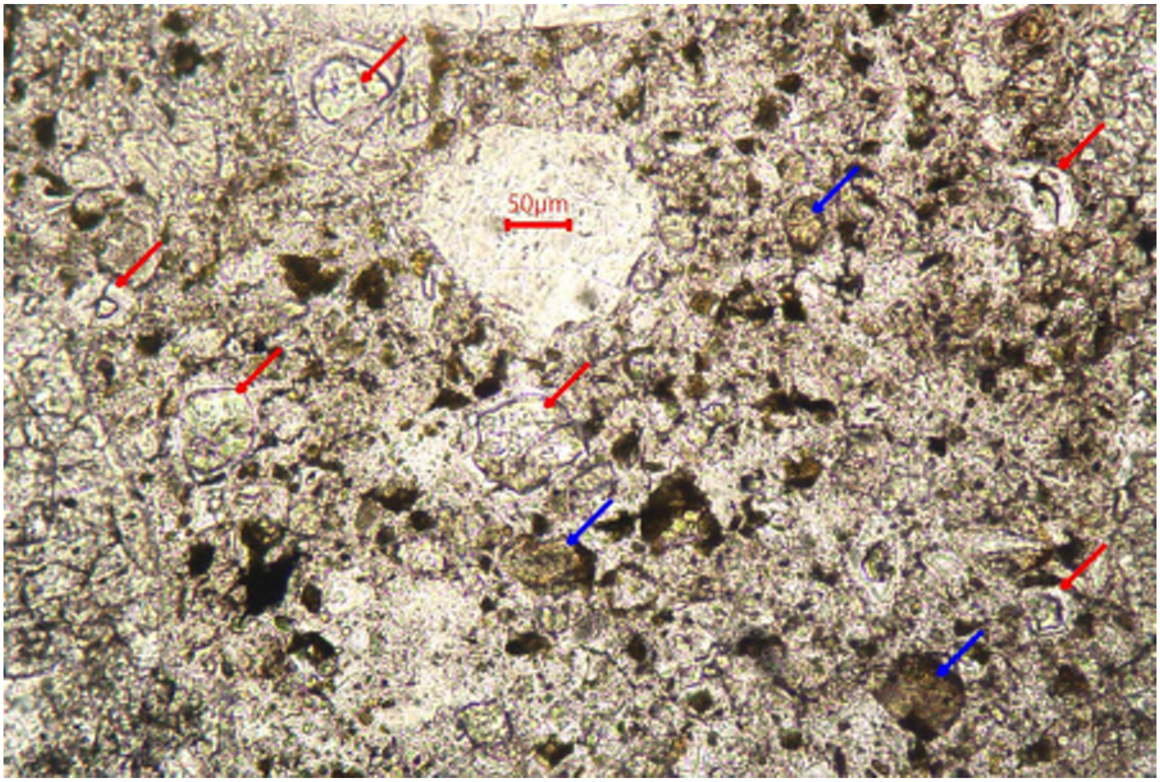
Photo: 24



Sample ID: A10 3429
Mag: 400x

Description: Moderately to well hydrated residual alite (red arrows) and residual belite exhibiting low levels of hydration (blue arrow), in a thin section of concrete viewed under plane-polarized light.

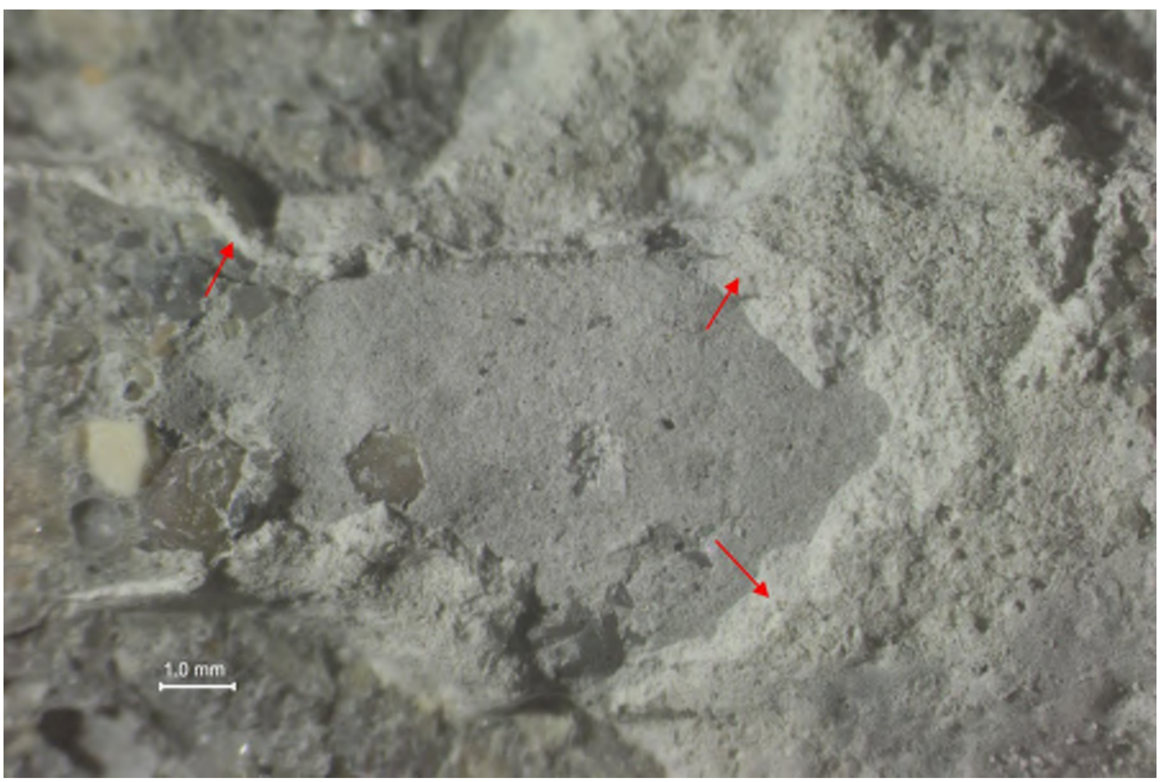
Photo: 25



Sample ID: P7 3435
Mag: 400x

Description: Moderately to well hydrated residual alite (red arrows) and residual belite exhibiting negligible to low levels of hydration (blue arrows), in a thin section of concrete viewed under plane-polarized light.

Photo: 26



Sample ID: D28 3406
Mag: 8x

Description: Soft cementitious slurry material (red arrows) between base concrete and overlay concrete, viewed on fracture/contact surface under magnification.

Photo: 27

Sample ID: D28 3406

Description: Contact surface between base concrete (right) and overlay concrete (left) after striking core half near the contact/bond surface in the laboratory. The core broke fairly cleanly along the contact surface and the lighter-colored slurry-like material can be seen coating portions of the surface.

Appendix L

Borescope Inspection Report

VCS LTD.
474E Dovercourt Drive, Winnipeg, MB R3Y 1G4
Info@VCS-Engineering.com

PEMBINA OVER ABINOJI MIKANAH BRIDGE
WINNIPEG, MANITOBA
BORESCOPE INSPECTION

Prepared for:
Troy Hengen
Morrison Hershfield

Prepared by:
Natallia Shanahan, PhD, PE, NACE CP-2
Senior Project Manager – VCS

Reviewed by:
Shayan Yazdani, PE, NACE CP-2
Project Manager – VCS

VCS Project Number – W23017MB
1 December 2023

Introduction

The Pembina over Abinojii Mikanah bridge is located in Winnipeg, MB and carries the Pembina Highway over Abinojii Mikanah Boulevard (Figure 1). The bridge deck utilizes reinforced concrete construction with stay-in-place galvanized steel deck forms. The deck is supported by integral box girders. A detail of the deck and girder cross-section is shown in Figure 2. The bridge substructure consists of north and south abutments and three piers (Figure 3). For the purpose of this report, piers were labeled 1 through 3 from south to north and girders were labeled 1 through 20 from east to west.

Since the interior of the box girders were not accessible, Morrison Hershfield (MH) reached out to VCS Engineering Ltd. (VCS) to perform borescope inspections through the drainage holes in the bottom of the girders to visually inspect the condition of the deck underside.

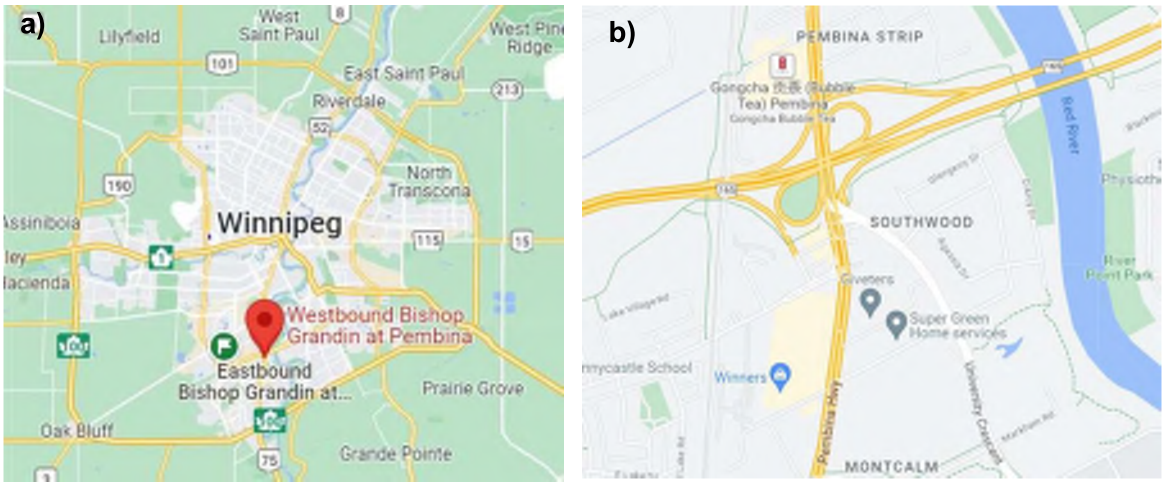


Figure 1: Overview of the Pembina over Abinojii Mikanah Bridge Location a) General Location and b) Zoomed-in View

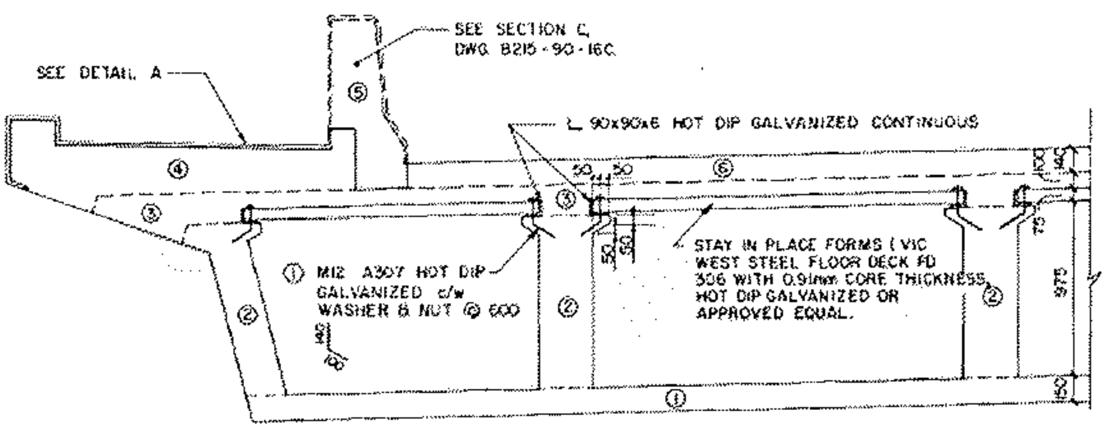


Figure 2: Typical Deck Cross-Section Detail

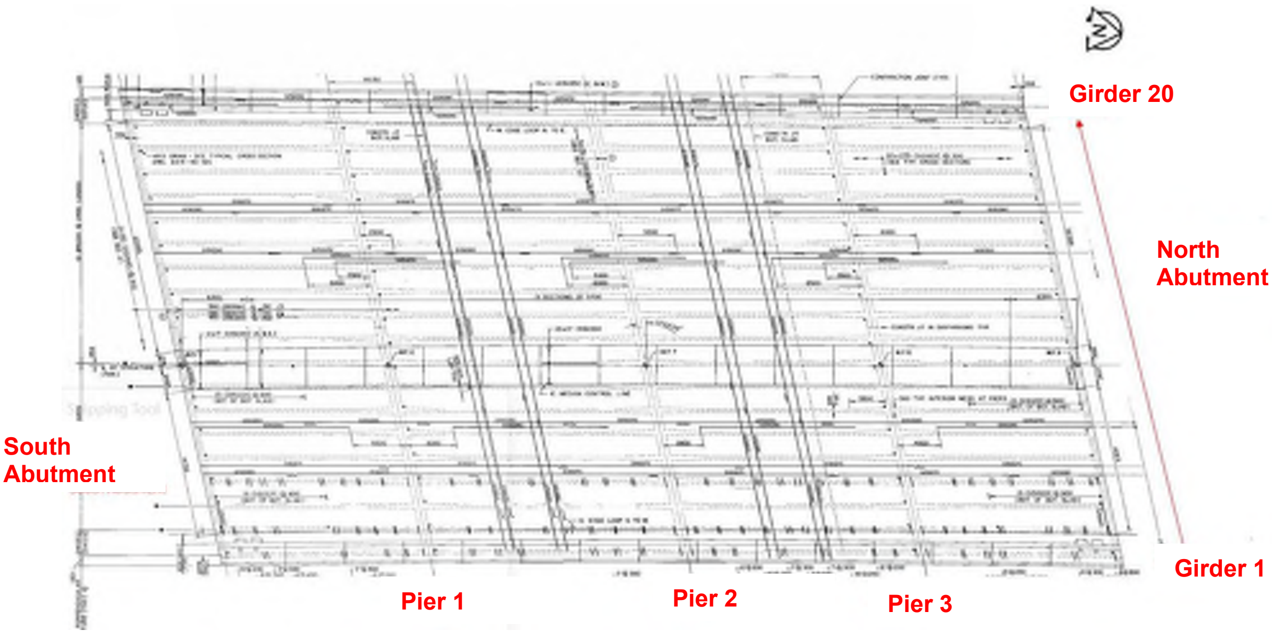


Figure 3: Plan View of the Bridge

Borescope Inspection

VCS performed borescope inspections at the north abutment (NA), south abutment (SA), and at Piers 1 and 3 (P1 and P3). At each of these locations, a visual inspection was conducted through the drainage holes at the bottom of the girder (Figure 4). For ease of reference, each inspected location was labeled by VCS onsite. The label consisted of a combination of both the pier/abutment ID and the girder number. For example, location label SAG1 indicates that the borescope inspection location was at the south abutment at girder G1.


Figure 4: Typical View of Drainage Holes Used for Borescope Inspection

Overall, the stay-in-place forms on the deck underside appear to be in good condition. White zinc corrosion product was commonly observed. Figure 6 and Figure 7 show typical corrosion of the zinc galvanizing. The bridge was constructed in 1988, hence some corrosion of the zinc galvanizing deck forms is to be expected. However, there was no indication of steel corrosion at the present time. None of the borescope videos showed the presence of brown corrosion byproduct which is indicative of steel corrosion.

Figure 5 through Figure 20 show the borescope images of the deck underside at the south abutment. Drainage holes at girders 2, 5, 8, and 9 were inaccessible. These locations were not inspected. Drainage holes at girders 12 and 14 were blocked, and it was not possible for VCS to perform visual assessment of the deck underside at these locations.

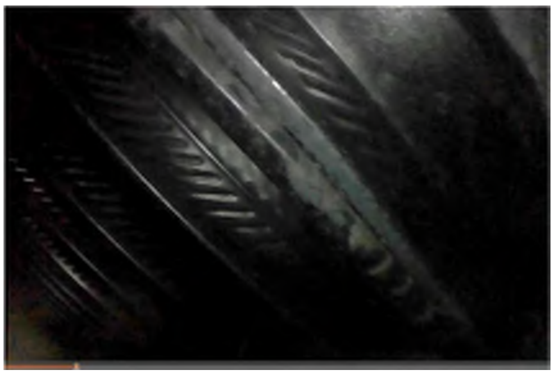


Figure 5: Stay-in-place Deck Forms at SAG1


Figure 6: Stay-in-place Deck Forms at SAG3

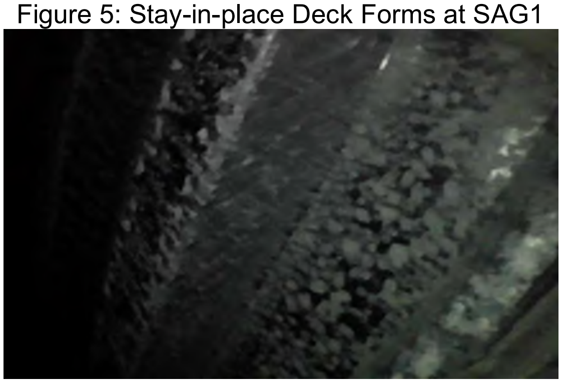


Figure 7: Stay-in-place Deck Forms at SAG4


Figure 8: Stay-in-place Deck Forms at SAG6


Figure 9: Stay-in-place Deck Forms at SAG7


Figure 10: Stay-in-place Deck Forms at SAG10


Figure 11: Stay-in-place Deck Forms at SAG11


Figure 12: Blocked Drainage Hole at SAG12


Figure 13: Stay-in-place Deck Forms at SAG13


Figure 14: Blocked Drainage Hole at SAG14


Figure 15: Stay-in-place Deck Forms at SAG15


Figure 16: Stay-in-place Deck Forms at SAG16


Figure 17: Stay-in-place Deck Forms at SAG17


Figure 18: Stay-in-place Deck Forms at SAG18


Figure 19: Stay-in-place Deck Forms at SAG19


Figure 20: Stay-in-place Deck Forms at SAG20

Figure 21 through Figure 33 show the condition of the deck underside along pier P1. However, drainage holes at girders 14 through 20 were inaccessible due to the sidewalk being too short to access the openings with the scaffold. At girder 10 the hole was blocked, so it was not possible for VCS to perform visual assessment at these locations (Figure 30).


Figure 21: Stay-in-place Deck Forms at P1G1


Figure 22: Stay-in-place Deck Forms at P1G2


Figure 23: Stay-in-place Deck Forms at P1G3


Figure 24: Stay-in-place Deck Forms at P1G4


Figure 25: Stay-in-place Deck Forms at P1G5


Figure 26: Stay-in-place Deck Forms at P1G6


Figure 27: Stay-in-place Deck Forms at P1G7


Figure 28: Stay-in-place Deck Forms at P1G8

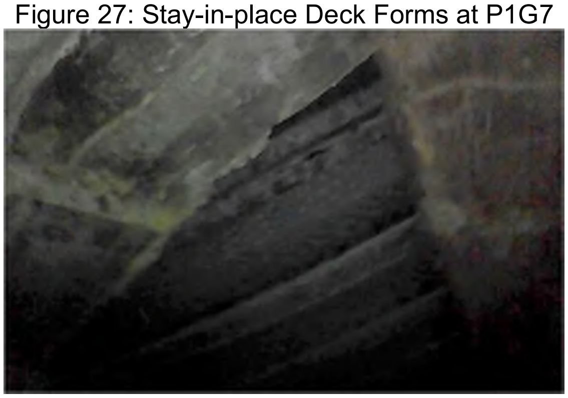


Figure 29: Stay-in-place Deck Forms at P1G9


Figure 30: Blocked Drainage Hole at P1G10


Figure 31: Stay-in-place Deck Forms at P1G11


Figure 32: Stay-in-place Deck Forms at P1G12

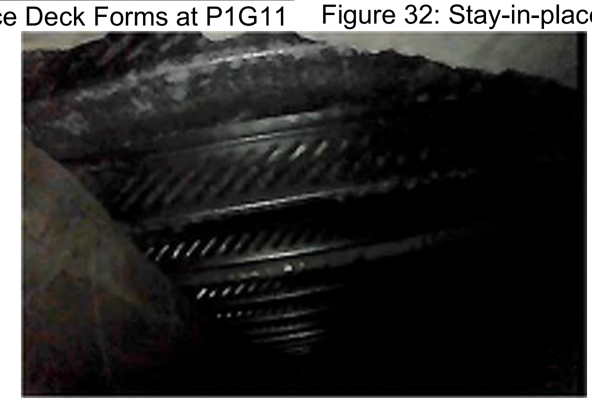


Figure 33: Stay-in-place Deck Forms at P1G13

Figure 34 through Figure 44 show the condition of the deck underside along pier P3. Drainage holes at girders 1 through 8 were inaccessible due to the sidewalk being too short to access the openings with the scaffold. The drainage hole at girder 12 was blocked, so it was not possible for VCS to perform visual assessment at these locations (Figure 36).

Figure 34: Stay-in-place Deck Forms at P3G9

Figure 35: Stay-in-place Deck Forms at P3G10

Figure 36: Blocked Drainage Hole at P3G12

Figure 37: Stay-in-place Deck Forms at P3G13

Figure 38: Stay-in-place Deck Forms at P3G14

Figure 39: Stay-in-place Deck Forms at P3G15

Figure 40: Stay-in-place Deck Forms at P3G16

Figure 41: Stay-in-place Deck Forms at P3G17

Figure 42: Stay-in-place Deck Forms at P3G18

Figure 43: Stay-in-place Deck Forms at P3G19

Figure 44: Stay-in-place Deck Forms at P3G20

Figure 45 through Figure 63 show the condition of the deck underside at the drainage holes along the north abutment. The drainage hole at girder 8 was inaccessible. Borescope inspection at girders 3 and 9 was performed approximately 3 to 4 m from the north abutment.

Figure 45: Stay-in-place Deck Forms at NAG1

Figure 46: Stay-in-place Deck Forms at NAG2

Figure 47: Stay-in-place Deck Forms at NAG3

Figure 48: Stay-in-place Deck Forms at NAG4

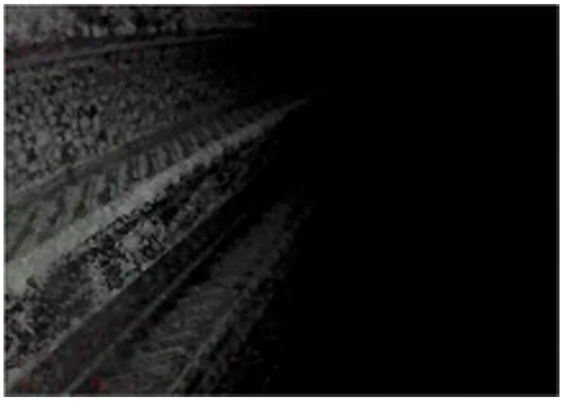


Figure 49: Stay-in-place Deck Forms at NAG5

Figure 50: Stay-in-place Deck Forms at NAG6

Figure 51: Stay-in-place Deck Forms at NAG7

Figure 52: Stay-in-place Deck Forms at NAG9

Figure 53: Stay-in-place Deck Forms at NAG10

Figure 54: Stay-in-place Deck Forms at NAG11

Figure 55: Stay-in-place Deck Forms at NAG12

Figure 56: Stay-in-place Deck Forms at NAG13


Figure 57: Stay-in-place Deck Forms at NAG14


Figure 58: Stay-in-place Deck Forms at NAG15


Figure 59: Stay-in-place Deck Forms at NAG16


Figure 60: Stay-in-place Deck Forms at NAG17


Figure 61: Stay-in-place Deck Forms at NAG18


Figure 62: Stay-in-place Deck Forms at NAG19

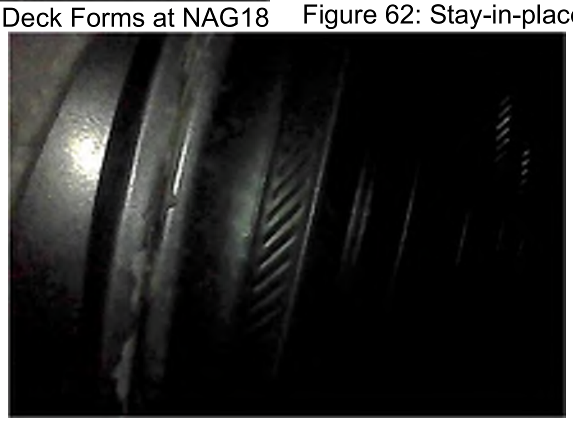


Figure 63: Stay-in-place Deck Forms at NAG20

As requested, VCS also attempted to image the back of the girders at the north and south abutments. However, it was not possible to adequately articulate the borescope head due to the small gap between the end of the girder and the abutment wall, so the videos were very dark, and it was not possible to analyze the condition of the girder ends. However, during the imaging of the girder ends, VCS noticed that there was some corrosion present at the bearing plate at the NAG15 location as shown in Figure 64.

Figure 64: NAG15 Bearing Plate

Summary

The stay-in-place deck forms at the inspected locations appear to be in good condition. While corrosion of the galvanizing was commonly observed as expected, there were no visible indications that the steel in the forms is corroding. Corrosion of the bearing plate was observed in one location at the north abutment.

Thank you for the opportunity to work with you on this project and if you have any questions, please don’t hesitate to contact me directly.

Sincerely,

VCS

Natallia Shanahan, Ph.D., PE, NACE CP-2
Senior Project Manager
natallias@vcservices.com

Morrison Hershfield now Stantec

Transportation

City of Winnipeg

B-215 Pembina Highway Overpass over Bishop Grandin Boulevard Bridge Deck Investigation Report - Final

Prepared by:

AECOM
99 Commerce Drive 204 477 5381 tel
Winnipeg, MB, Canada R3P 0Y7 204 284 2040 fax
www.aecom.com

Project Number:

60548328

Date:

December 8, 2022

Statement of Qualifications and Limitations

The attached Report B-215 Pembina Highway Overpass over Bishop Grandin Boulevard
Bridge Deck Investigation Report - Final (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the City of Winnipeg ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

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- may be based on information provided to AECOM which has not been independently verified;
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- was prepared for the specific purposes described in the Report and the Agreement; and
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AECOM
99 Commerce Drive 204 477 5381 tel
Winnipeg, MB, Canada R3P 0Y7 204 284 2040 fax
www.aecom.com

December 8, 2022

Mr. Mohamed Mady, Ph.D., P.Eng.
City of Winnipeg
Public Works Department
106-1155 Pacific Avenue
Winnipeg, MB R3E 3P1

Dear Mr. Mady:

Project No: 60548328

Regarding: B-215 Pembina Highway Overpass over Bishop Grandin Boulevard
Bridge Deck Investigation Report - Final

We are enclosing one (1) PDF copy and three (3) hard copies of our final report of B-215 Pembina Highway Overpass over Bishop Grandin Boulevard
Bridge Deck Investigation Report - Final.

Please do not hesitate to contact me if you have any questions regarding the report.

Sincerely,
AECOM Canada Ltd.

Eric B. Loewen, P.Eng.
Senior Structural Engineer, Transportation
EBL:dlh
Encl.

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
0	DKD	Dec. 22/17	Draft
1	DKD/EBL	March 09/18	Revised based on City comments
2	NV/EBL	August 30, 2022	Final
3	EBL	December 8, 2022	Final Revised based on City comments

AECOM Signatures

Report Prepared By:

Noëlle Vialoux, P.Eng.
Structural Engineer, Transportation

Report Reviewed By:

Eric B. Loewen, P.Eng.
Senior Structural Engineer, Transportation

Executive Summary

The existing Pembina Highway Overpass over Bishop Grandin Boulevard is a 4 span (20.0m / 25.0m / 22.8m / 19.0 m) 86.8 m long skewed concrete bridge supported by concrete abutments and piers. All piers and abutments are founded on precast prestressed concrete pile foundations. The bridge was constructed in 1990 and is 32 years old.

The bridge width is approximately 47.0 m and provides a total of 10 lanes of traffic with shy distances (4 and 6 lanes in NB and SB directions, respectively) separated with a 4.0 m wide concrete median curb, along with two 1.53 m wide sidewalks (one in each direction) protected by aluminum traffic barrier rails supported on concrete shoulder traffic barriers. The roadway widths are approximately 15.5 and 23.0 m in the NB and SB directions, respectively.

The superstructure is composed of a cast-in-place concrete multi-cell box deck (total of 19 cells) reinforced with epoxy coated reinforcing bars, with a 140 mm thick high density concrete top slab. No protective wearing surface is present on the bridge deck, with the exception of the epoxy polymer layer on the sidewalks. The approach slabs at each end of the bridge are 9.0 m in length.

In addition to the routine maintenance for the structure over the course of its life, an extensive maintenance program was completed in 2014 to repair the delaminated concrete areas on the deck and median curb. All delaminated areas were removed up to 100 mm deep and patched with standard concrete mix including galvanic anodes.

In 2017, AECOM Canada Ltd. performed a bridge deck investigation of the Pembina Highway Overpass over Bishop Grandin Boulevard. This assessment was used to establish the current condition of the bridge and to determine the repairs needed to be carried out in the 2018 maintenance program. The work undertaken by AECOM included:

- OSIM inspection in summer 2017 of the bridge deck, sidewalks, approach slabs, expansion joints, and traffic barriers.
- Deck condition survey/investigation in accordance with the Ontario Structure Rehabilitation Manual (OSRM).
- Deck delamination survey, crack mapping survey; and deck cover survey.
- Concrete coring of bridge deck and barriers for: compressive strength, hardened air void analysis, petrographic analysis, permeability testing, and chloride content testing.
- Rapid Chloride Testing to determine the chloride content of the bridge deck and related components;
- Analysis of results and review of potential causes of cracking and delamination.
- Additional inspection in winter 2018 during melting conditions of expansion joints, deck top, abutments and underside of deck.
- Test patches on the deck in spring 2018.
- Review of publications and discussion with the City of Winnipeg and industry with respect to epoxy coated reinforcing performance.
- Determination of repairs to be carried out in 2018.

The average compressive strength of the concrete cores was 43.4 MPa. The design strength was 30 MPa, as noted in the original construction specifications. The air void analysis cores showed air void results of 7.08%, with a design air void content of 5 – 8%. The petrographic analysis of the concrete core showed the concrete was in generally good condition, with a very minor degree of alkali-silica reactivity (ASR) and had an air-void system consistent with the current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.

Based on the inspection and deck testing, the average chloride levels in the concrete deck at the depth of the reinforcing steel are at the threshold level for corrosion of epoxy coated reinforcing. This is based on a threshold of 0.09% Cl- for epoxy coated reinforcing, as opposed to a threshold of 0.030% Cl- for black steel. Also, the average cover generally meets the design cover value, however there are a few areas of low cover. Some of those areas of low cover correspond to current or previous areas of delamination. Currently, there is delamination of approximately 2.13% of the deck area.

Traffic barriers were in generally good condition, with localized areas of delamination, spalls, and isolated narrow vertical cracks. The concrete sidewalks were also in generally good condition, with very minimal delamination noted. The expansion joints were beginning to show wear in the hot summer temperatures. A follow-up inspection in winter months of 2018 was completed to inspect the expansion joints in colder temperatures. Based on the winter inspection, the expansion joints are considered to be in poor condition, with leakage creating further issues at the north abutment concrete girder ends and one bearing.

Based on the 2017 inspection, we expect the corrosion propagation period may extend for another 6 to 10 years. The structure will require repairs of the existing delaminated areas in 2018. A new bridge deck investigation should be carried out in 6 years (in 2023) to update the deck condition report and to complete a life cycle analysis to determine the timing of the major rehabilitation works.

Note that the testing was completed in 2017 and 2018, with spot repairs throughout the deck completed in the 2018 maintenance program. The report was updated in 2022 based on current site observations and discussions between AECOM and the City of Winnipeg.

Table of Contents

List of Tables

List of Figures

List of Photos

Appendices

1. Introduction

The existing Pembina Highway Overpass over Bishop Grandin Boulevard is a 4 span (20.0m / 25.0m / 22.8m / 19.0 m) 86.8 m long skewed concrete bridge supported by concrete abutments and piers. All piers and abutments are founded on precast prestressed concrete pile foundations. The bridge was constructed in 1990 and is 32 years old.

The bridge width is approximately 47.0 m and provides a total of 10 lanes of traffic with shy distances (4 and 6 lanes in NB and SB directions, respectively) separated with a 4.0 m wide concrete median curb, along with two 1.53 m wide sidewalks (one in each direction) protected by aluminum traffic barrier rails supported on concrete shoulder traffic barriers. The roadway widths are approximately 15.5 and 23.0 m in the NB and SB directions, respectively.

The superstructure is composed of a cast-in-place concrete multi-cell box deck (total of 19 cells) reinforced with epoxy coated reinforcing bars, with a 140 mm thick high density concrete top slab. No protective wearing surface is present on the bridge deck, with the exception of the epoxy polymer layer on the sidewalks. The approach slabs at each end of the bridge are 9.0 m in length.

An extensive maintenance program was completed in 2014 to repair the delaminated concrete areas on the deck and median curb. After a chain drag test was completed, all delaminated areas were removed up to a total thickness of 100 mm and patched with standard concrete mix. Galvanic anodes were installed in the patch areas and connected to the reinforcing.

In June 2017, the City of Winnipeg retained AECOM to undertake:

- OSIM-type inspection of the bridge deck (top surface only), sidewalk (top surface only), approach slab, expansion joint, and traffic barriers;
- Deck Condition Survey/Investigation in accordance with the Ontario Structure Rehabilitation Manual (OSRM);
- Deck Delamination Survey;
- Crack Mapping Survey;
- Deck Cover Survey;
- Deck Corrosion Potential Survey – Half Cell testing;
- Concrete Coring of Bridge Deck and Barriers; and compressive strength, hardened air void analysis, petrographic analysis, permeability testing, and chloride content testing.
- Rapid Chloride Testing to determine the chloride content of the bridge deck and related components; and
- Determination of the repairs needed to be addressed in the 2018 maintenance program;

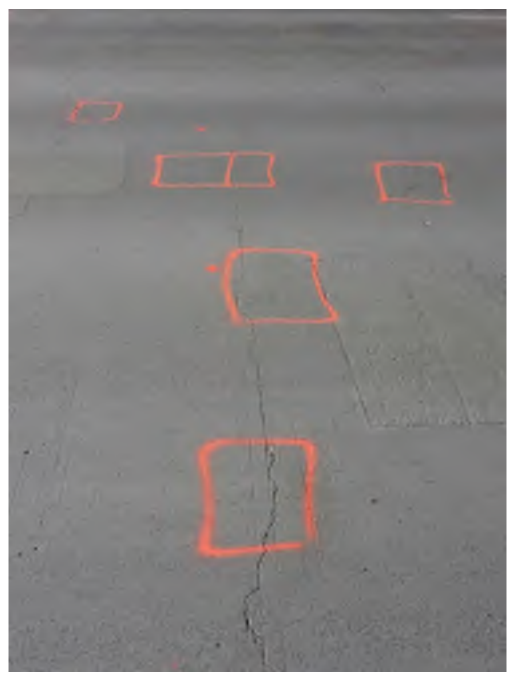


Photo 1.1 – Delamination Survey and Map Cracking at Night

The testing was carried out in August of 2017. Due to the high amount of daytime traffic on the Pembina Highway Overpass, AECOM elected to complete the deck testing at night. Mast lighting was moved onto the ends of the bridge each night to illuminate the deck and all detailed desk testing proceeded in relatively warm conditions with virtually no impact to traffic.

The Traffic Control Management was done as per the City of Winnipeg Traffic Control Manual.

Photo 1.2 – Cover Survey at Night

2. Existing Conditions

2.1 Discussion of Condition, Surface Defects & Delamination

2.1.1 Concrete Deck

A delamination survey using a chain drag was performed on the deck top to provide useful information on the condition of the deck slab and to determine the area of delaminated concrete.

Photo 2.1 – Delamination with Wide Crack in Northbound Lanes

The results of the chain drag survey indicated that approximately 2.13% of the concrete is delaminated or spalled. An additional 5.37% or 220.13 m^2 of the deck has previously repaired patches. Some of these patch repairs are from 2010 and 2011, however most of them were completed in 2014. A typical delamination with a wide transverse crack through the delamination area in the northbound lanes is shown in Photo 2.1. A typical previous repair area at the North Abutment Expansion Joint is shown in Photo 2.2. The wider patch area in the foreground exhibits map cracking. Some, but not all of the patches in the northbound lanes have map cracking. Map cracking was not observed in the southbound lane patches. Areas of delamination and patching can be seen on the drawing in Appendix A, with additional photos in Appendix E.

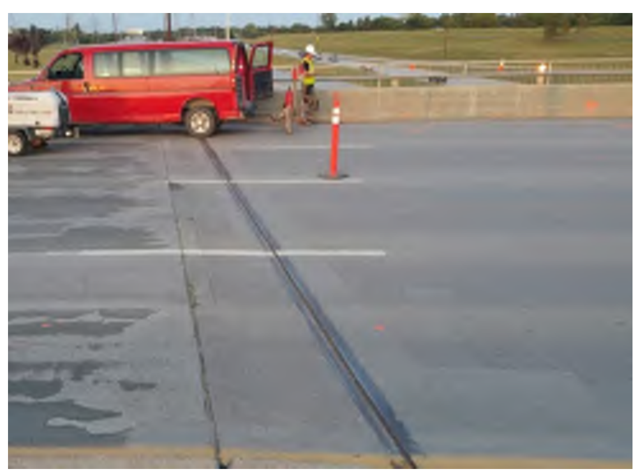


Photo 2.2 – Previous Patch with Map Cracking at North Abutment

There is a higher concentration of transverse cracking, previously patched areas, and delamination in the tension zones over the piers. Transverse cracks are typically medium width (0.35 to 1mm), however wider cracks ranging from 1 to 2mm, with a maximum width of approximately 2.5mm, are common in the northbound lanes, especially over the piers. Most of the previously patched areas and new delamination areas are associated with the transverse cracks in the deck.

In general the patches repaired in 2014 appear to be performing well and do not appear to be producing a halo effect of further deterioration adjacent to the patch (which would indicate a local corrosion cell is occurring). It appears that the galvanic anodes installed in the patches are functioning as intended and are not allowing local corrosion cells to develop.

Photo 2.3 – Typical High Concentration of Cracks, Patches and Delamination over Pier Area with Cracks through 2014 Repairs

In some cases the transverse cracks have reappeared at the 2014 patch locations, and in other cases they have not. A smaller number of patches were also completed in 2010 and 2011 according to the City, and these patches are adjacent to the 2014 patches in most cases. The reappearance of the cracks in the patch areas suggests that they are in part related to live load, and that they may be deeper in some cases than the repair depth of 100mm. Previous concrete repairs to the median are noted to have occurred in 2006 according to the City's 2015 inspection report. In general the number of patches and delamination show on increasing rate of deterioration of the deck, however the overall deck condition also suggests that the deck is still at a stage where preventative maintenance will be beneficial and cost effective.

2.1.2 Concrete Sidewalk

A delamination survey using a chain drag was performed on the sidewalk as well, to provide useful information on the condition of the concrete and to determine the area of delaminated concrete.

The results of the chain drag survey indicated that a very small area of approximately 0.01% of the concrete sidewalk, or a total of 0.54 m^2 is delaminated. Most transverse cracking on the roadway deck was not observed to extend through into the sidewalk areas.

2.1.3 Expansion Joints

A visual inspection of the expansion joints was performed in the summer of 2017 and the joints were observed to generally be in good condition, however they were very compressed in the hot summer temperatures and were beginning to show wear. A follow-up inspection on a day with melting temperatures in the winter of 2018 indicated leakage at four distinct locations, including two locations with leaks on the north abutment and two locations on the south abutment. Refer to Photos 41 to 49 in Appendix E. At the worst location near the west end of the north abutment, the bearing near the leak has extensive surface corrosion due to the leakage, and a crack and spall has developed along the back of the girder ends. Based on the winter inspection the expansion joints are considered to be in poor condition, with the leakage creating further issues at the north abutment concrete girder ends and one bearing.

2.1.4 Approach Slabs

The south and north approaches were found to be in overall good condition with some narrow to medium transverse and longitudinal cracking throughout. A small amount of previous repairs and delamination was observed. The previously applied thin epoxy polymer overlay applied to the north approach slab has delaminated over more than 50% of the area and is no longer functioning.

2.1.5 Traffic Barriers

Delaminations / spalls of a total of 1.36m^2 were noted in localized areas of the traffic barrier faces. This is equivalent to approximately 0.03% of the traffic barrier area. Isolated narrow vertical cracks were also noted in random areas on the barriers throughout the length of the bridge. Photographs detailing the defects can be referenced in Appendix E. In general the traffic barriers appear to be in good condition.

2.2 Cover Survey

Deck cover depth measurements were taken on a 2.4m grid pattern using a pachometer. The concrete cover survey data can be found in Appendix B and a drawing detailing the cover depths across the concrete deck, barriers, and sidewalks can be referenced in Appendix A. Average cover depths and standard deviations can be found below in Table 2.1 – Cover Depth Results.

Table 2.1 – Cover Depth Results

Location	Cover Depth (mm)	
	Average	Standard Deviation
Deck	78	11
Barriers	75	13
Sidewalks	67	13

In general the cover on the bridge deck is in accordance with the original design drawings, which specified the cover as 75mm +/-5mm. The reduced cover depth on the sidewalks is also consistent with the original design drawings. Low cover areas measured, less than or equal to 50mm, are specifically identified (with red dots and depth of cover) on the drawing in Appendix A. These are typically in isolated areas, and the lowest cover was 30mm at one location in the northbound lanes, and 30mm at two locations in the southbound lanes. Otherwise the low cover areas are typically between 40 to 50mm, which is not excessively low. These areas of low cover (30mm), though isolated, do coincide with two of the largest areas previously patched.

2.3 Chloride Testing

Chloride testing involves taking samples of concrete from various test locations on the bridge deck, barriers, and abutment/approach slabs. Samples consist of concrete dust collected from drilling into the deck with a 19.0mm diameter drill bit. These samples are tested with rapid chloride test (RCT) kits. The results provide the acid soluble chloride ion concentration in the concrete sample. A template approach is used to determine the approximate individual test locations. The actual test locations are adjusted on site to avoid cracks, surface pop-outs or other defects that would affect chloride diffusion rates. The sample depths are measured to an accuracy of 3.0mm. The test holes and drill bits are continuously cleaned with compressed air between drilling operations in order to limit contamination between powder samples from different depths.

Samples are taken at the 12.5mm, 50mm and 100mm depths where possible. Surface chloride contents fluctuate from winter to summer due to the flushing action of rain, therefore, tests taken at the 12.5mm depth provide reliable data related to the amount of chlorides applied to the bridge that does not significantly fluctuate. Since chlorides diffuse from higher to lower concentrations, chloride contents at the 12.5mm depth provide an indication of the future migration of chlorides into the underlying concrete. By taking samples at various depths, the chloride penetration into the concrete deck can be established and ultimately, the time until corrosion is initiated at the reinforcement level.

The Pembina Highway Overpass has epoxy coated reinforcing, and as a result the threshold for chlorides has been considered to be 0.090% Cl- per unit weight of concrete (three times higher than for black steel). Once the chlorides at the reinforcement level exceed the assumed threshold level corrosion of the reinforcement will be accelerated.

A total of 24 samples were taken on the bridge deck and 4 on the barriers. Results are summarized in Appendix C. Cores were also tested for water soluble chloride concentration as required by the OSRM. These results can be seen in Appendix D.

Table 2.2 – Summary of Chloride Test Data and Reinforcing Cover Measurements

Sample Depth	Average % Cl- per unit Wt. of Concrete
Bridge Deck	
12.5 mm	**0.485**
50 mm	**0.188**
100 mm	0.018
Reinforcing Steel Cover	78mm (Std. dev. = 11mm)
Barriers	
12.5 mm	**0.174**
50 mm	0.036
100 mm	0.003
Reinforcing Steel Cover	75mm (Std. dev. = 13mm)

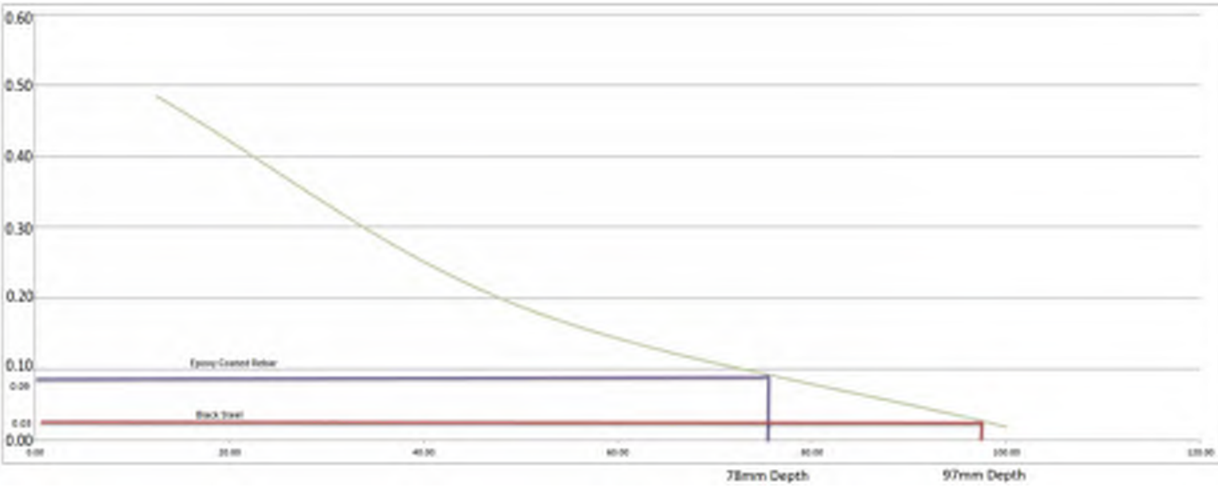
Note: Values in **bold** are greater than the threshold of 0.090% for epoxy coated reinforcing.

On the basis of average concrete cover depths, the epoxy coated reinforcing in the barriers are encapsulated by concrete below the threshold to accelerate corrosion, and chlorides are not a major concern at this time with an assumed threshold of 0.090% Cl-.

For the concrete deck, based on the average cover depth of 78mm, the reinforcing steel is encapsulated by concrete above the threshold limit of 0.090% Cl- (see Figure 2.1), which indicates that corrosion has likely begun in the deck reinforcing. In areas of less than average cover (40-50mm), the reinforcing will be exposed to even higher chloride levels. The concrete deck may still function until the chlorides propagate through to the majority of the deck, which is in agreement with the delamination percentage identified in the inspection, which might extend the deck life for a period of 6 to 10 years.

The following graph, Figure 2.1 represents the Average percentage of chloride per unit weight of concrete.

Figure 2.1 – Average % Cl- per unit Wt. of Concrete



2.4 Compressive Strength

The results for compressive strength testing of three cores from the bridge deck were 46.2, 40.3, and 43.8MPa with an average of 43.43MPa. The design strength was 30MPa, as noted in the original construction specifications. Compressive strength results and locations can also be seen in Appendix A – Drawings, and Appendix D – Core Test Results.

2.5 Air Void Analysis

Air void analysis cores from the bridge deck showed air void results of 7.08% compared to the design air content of 5 – 8% for both fresh and hardened concrete. Air void analysis and location can be seen in Appendix A – Drawings and Appendix D – Core Test Results.

2.6 Petrographic Analysis

One core was taken from the deck for Petrographic analysis and consisted of a single concrete layer, the results of which are summarized in laboratory reports in Appendix D. In general the core represented concrete that was in good condition. The core exhibited a very minor degree of alkali-silica reactivity (ASR) and had an air-void system consistent with the current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.

2.7 Water Soluble Chloride Ion Content

Two cores were submitted for Water Soluble Chloride Ion Content. The results can be found in Table 2.3 – Water Soluble Chloride Ion Content below. Detailed results can be found in Appendix D – Core Test Results.

Table 2.3 – Water Soluble Chloride Ion Content

Core No.	Results	
	Horizon Depth (mm)	Water Soluble Chloride Ion Content (% CI by weight of concrete)
8	10 – 20	**1.160**
8	30 – 40	**0.697**
8	50 – 60	**0.341**
8	70 – 80	0.080
8	90 – 100	0.005
8	110 – 120	0.004
9	10 – 20	**0.792**
9	30 – 40	**0.479**
9	50 – 60	**0.274**
9	70 – 80	**0.112**

Note: Values in **bold** are greater than threshold of 0.090% for epoxy coated reinforcing.

The chloride content varies considerably between the two test methods at shallow depths of 10mm to 20mm, but in both cases is high. At the depth of the deck reinforcing the two test methods provide similar results, with both approximately near 0.090% Cl-, the assumed threshold level for epoxy coated reinforcing.

2.8 Rapid Chloride Permeability Testing

The permeability of the concrete was tested in accordance with ASTM C1202, which is an electrical indication of concrete's ability to resist chloride ion penetration based on charge passed. The tested core indicated a Chloride Penetrability Rating of Very Low, with a total charge passed of 552 Coulombs. This is generally consistent with the fact that high density concrete was specified in the original design for the top 140mm of the 240mm deck slab (top slab of box girder) thickness.

2.9 Corrosion Potential Survey

A corrosion potential survey could not be undertaken. The epoxy coating on the reinforcing prevented electrical continuity between bars. The lack of continuity when tested suggests the epoxy on the reinforcement is generally intact and in good condition.

2.10 Test Patches

In order to verify the results of the deck testing, and to provide additional information prior to the 2018 maintenance program, three test patches were opened up on the northbound lanes. The test patches were approximately 450 mm by 600 mm and approximately 75 mm deep, or down to the reinforcing depth. The test patches were selected to be at wide crack locations. The concrete cover to reinforcing ranged from 60 to 75 mm, which was consistent with the cover survey. Within the test patches it was noted that the epoxy coated reinforcing had significant corrosion where cracks were located directly above the reinforcing, and that the cracks extended down to the reinforcing. The epoxy coating was intact on the reinforcing where cracks did not exist. It was also noted that there was shallow delamination, at approximately 20 to 30 mm depth, across one of the test patches, indicating that at least some of the areas noted in the delamination survey are at shallow depth, as opposed to at the reinforcing depth.

Photo 2.4 – Test Patch at Wide Crack with Failed Epoxy Coating and Corroded Reinforcing Directly Below Crack

Photo 2.5 – Test Patch with Shallow Delamination

2.11 General Discussion of Inspection and Test Results

As noted previously there is a concentration of transverse cracking, previously patched areas, and delamination in the tension zones over the piers. Overall, the crack width and percentage of previously patched areas and current delamination are also greater in the northbound lanes. Most of the previously patched areas and new delamination areas are associated with the transverse cracks in the deck. When reinforcing was exposed during the 2014 repairs it was found that there was little to no corrosion of the epoxy coated reinforcing, and as a result it is unlikely that the delamination is a result of, or predominantly caused by, corrosion of the reinforcement.

At the time of the 2017 inspection, the chloride levels were determined to be at or near the threshold level of 0.09% Cl- at the depth of reinforcing. This indicates the high potential of steel corrosion in the reinforcing and overall degradation of the deck, with a propagation period typically of 6-10 years. Additional deck investigations and life cycle cost analysis will need to be completed in 6 years (in 2023) to determine the timing of a major deck rehabilitation.

Several cracks have been noted in the underside of the box girders with efflorescence, both in AECOM's current inspection, and as per the City of Winnipeg's inspection report from 2014. Though these cracks are limited in number, this suggests that some of the deck cracks are deep, and are allowing water to travel through the entire box girder cross-section. The reappearance of cracks through previously patched areas also suggests that some cracks are greater than 100mm deep at the deck level. A second inspection was performed in January of 2018 during melting conditions. This inspection did not identify any active leakage through the box girders, however the interior and underside of the girders would still have been at temperatures below freezing despite the melting temperatures on the deck top, so any leakage would likely have frozen prior to being visible on the underside.

Transverse cracks also appear in the compression zones at each midspan, with almost no cracks at the free ends of the bridge. This suggests that many of the transverse cracks are a result of initial shrinkage of the deck after casting, and that these cracks have then been propagated and widened due to the effects of live load. The higher concentration and wider cracks in the northbound lanes could also be a result of the timing and differential shrinkage between casting of the northbound and southbound box girder and deck slab pours. The deck top slab was cast after the sidewalks and barriers, so there was a delay between the box girder and top slab pours. In addition, there does not appear to have been a pour sequence drawing for the original deck top slab pours, and as a result the pour sequence may have contributed to the tension and cracking in the deck. Finally, the box girders were designed to support the superimposed dead load of the deck top slab without shoring, and the top mat of reinforcing does not have additional longitudinal reinforcing over the piers. As a result the entire system may be adequately designed for live load, but the deck top slab may be susceptible to additional cracking from live load.

3. Recommended Repairs

The recommended repairs to be completed in 2018 include the following:

- Sawcut and removal of delamination areas.
- Surface repair preparation with sand blasting.
- Repair epoxy coating on reinforcing.
- Install localized galvanic anodes at low concrete cover and spot repair areas.
- Surface sealer / healer preparation with sand blasting / shot blasting and pressure washing.
- Apply sealer / healer over entire deck and approach slabs.

Typical repair sketches can be found in Appendix G.

Appendix A

Pembina Drawing

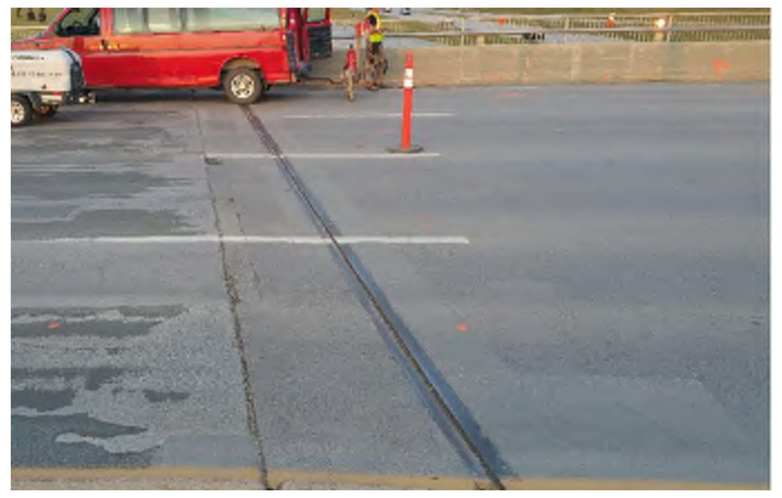
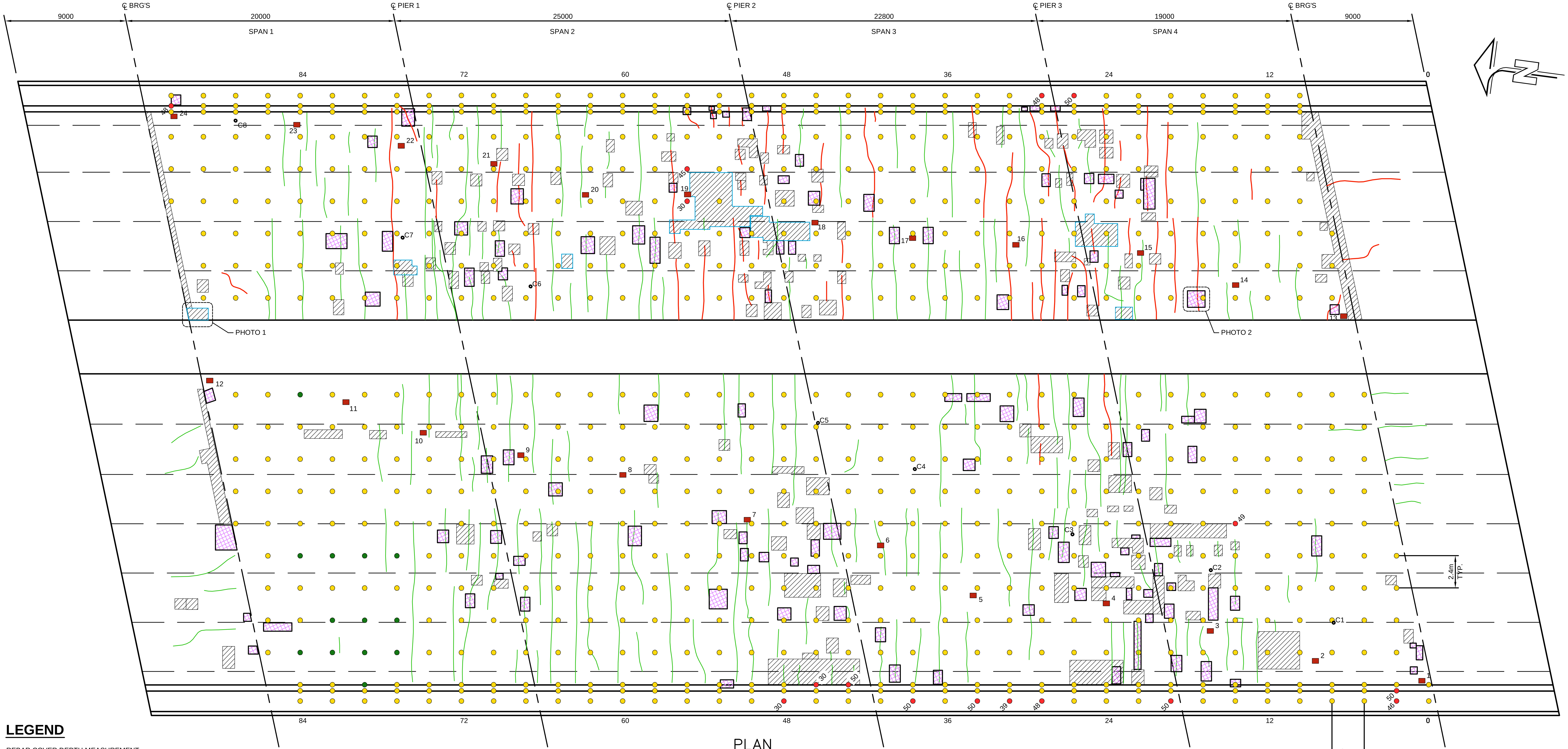


PHOTO 1

PHOTO 2



PLAN
SCALE 1:150

LEGEND

REBAR COVER DEPTH MEASUREMENT
- < 50mm (COVER mm)
- 51-100mm
- > 101mm

CHLORIDE ION SAMPLE (% Cl⁻ AT 50mm DEPTH)
- < 0.010%
- 0.011-0.030%
- > 0.031%

DELAM/SPALL AREA

EXISTING PATCH AREA

EXISTING PATCH AREA WITH MAP CRACKING

TEST LOCATION NUMBER: 7

MEDIUM CRACK

WIDE CRACK (MAX. 2.5mm)

Based on 2017 Investigation

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

B.M. ELEV. SOUTH WEST BOLT OF LIGHT STANDARD, EAST OF MAIN STREET AND SOUTH OF RAIL BRIDGE. 227.646

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY	–	CHECKED BY	–
DRAWN BY	KJC	APPROVED BY	EBL
HOR. SCALE:	1:150	RELEASED FOR CONSTRUCTION BY:	
VERTICAL:			
DATE	2015/03/05	DATE	

ENGINEER'S SEAL

CONSULTANT DRAWING NO. CT-02_PEMBINA

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

PEMBINA HIGHWAY OVERPASS
2017 BRIDGE DECK INVESTIGATION

CITY DRAWING NUMBER

SHEET 1 OF 1

PLAN VIEW

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Appendix B

Rebar Cover Survey

Pembina Highway Overpass - cover meter raw data

starting from 0, 0
Data taken every 2.4m.

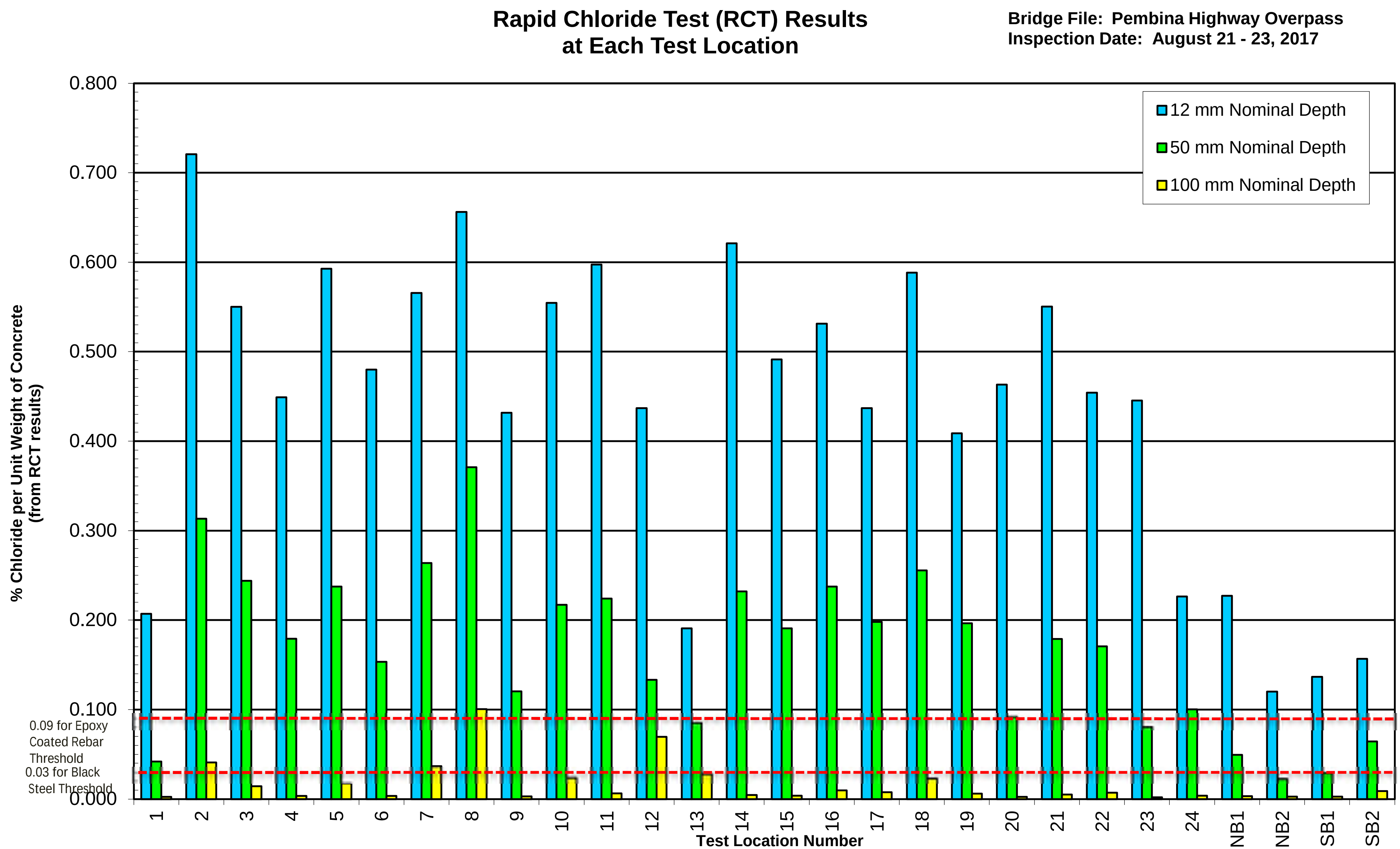
Location #	Grid point	SB Sidewalk	SB Barrier	SB 0.0	SB 2.4	SB 4.8	SB 7.2	SB 9.6	SB 12.0	SB 14.4	SB 16.8	SB 19.2	SB 21.6	Median	NB 28.8	NB 31.2	NB 33.6	NB 36	NB 38.4	NB 40.8	NB Gutter	NB Barrier	NB sidewalk
1	0	75	Steel	77																			
2	2.4	46	50	84	82	95	89	73	83														
3	4.8	55	72	71	91	108	96	77	83	74	83	72	75										
4	7.2	68	61	78	94	103	97	87	81	75	82	84	94		74	60	74						
5	9.6	86	84	80	91	100	87	75	79	73	82	94	82		86	86	78	69	82	91	67	75	66
6	12	71	66	85	92	92	80	78	71	62	72	80	87		81	75	75	82	82	88	78	68	66
7	14.4	64	56	80	86	87	74	68	49	63	71	82	87		77	70	71	76	85	86	89	65	58
8	16.8	67	56	64	83	85	68	58	52	65	67	81	74		77	70	87	79	79	79	81	78	55
9	19.2	50	65	66	78	79	62	72	60	61	69	80	67		69	77	74	74	76	79	86	104	66
10	21.6	62	88	60	73	68	85	88	77	56	67	72	64		66	70	69	79	62	70	81	66	57
11	24	53	61	66	79	82	81	86	72	70	62	85	68		66	66	61	72	63	74	78	73	63
12	26.4	59	81	67	84	86	77	87	74	69	73	76	68		72	62	95	62	57	65	67	104	50
13	28.8	48	68	69	82	84	86	74	80	77	73	79	75		81	78	84	62	73	71	54	74	48
14	31.2	39	53	63	93	90	90	93	78	72	83	90	76		81	77	81	71	74	70	69	96	58
15	33.6	50	79	66	92	85	85	80	77	81	86	92	82		87	80	71	82	89	73	77	95	57
16	36	52	76	70	87	90	87	87	73	76	84	85	81		77	73	74	79	82	80	81	86	70
17	38.4	50	84	78	83	87	85	81	77	88	81	87	88		83	76	67	82	76	84	76	77	67
18	40.8	61	69	81	84	80	88	85	76	77	84	89	88		69	84	71	76	79	92	88	88	74
19	43.2	71	78	50	61	85	81	79	67	74	81	89	77		69	74	68	79	86	93	85	51	82
20	45.6	64	82	30	51	81	63	64	75	63	77	84	77		67	63	58	78	77	85	81	93	68
21	48	30	89	62	68	82	74	76	77	63	71	72	67		65	57	52	68	75	80	72	59	82
22	50.4	56	78	69	75	87	79	81	72	67	63	77	82		60	68	55	68	71	61	62	79	67
23	52.8	66	66	78	95	90	72	69	78	70	60	73	87		62	66	56	59	55	60	93	60	62
24	55.2	74	85	94	86	98	86	69	76	68	75	74	78		66	67	58	30	45	73	61	67	57
25	57.6	76	67	89	89	95	89	77	75	85	68	82	70		69	60	64	62	59	70	55	66	64
26	60	70	82	74	92	94	94	89	68	73	71	82	85		78	76	65	67	75	78	62	65	54
27	62.4	68	83	76	87	98	75	78	74	78	82	80	85		75	73	67	68	78	82	66	79	69
28	64.8	65	81	66	85	89	80	80	70	68	77	82	87		79	70	72	69	84	85	66	80	83
29	67.2	61	87	84	93	72	62	80	68	79	76	88	97		76	77	76	78	92	97	71	70	86
30	69.6	67	86	70	80	79	77	75	61	70	68	77	83		83	65	77	82	86	85	70	62	86
31	72	79	95	79	94	92	70	77	69	69	81	82	70		73	68	73	71	84	81	63	64	83
32	74.4	76	94	76	100	98	84	91	68	75	79	76	83		70	82	74	78	81	72	53	66	71
33	76.8	65	88	81	102	103	88	101	82	87	90	89	90		72	63	75	85	91	82	59	60	77
34	79.2	83	60	111	107	108	89	102	78	92	90	91	90		73	73	76	83	83	82	74	67	86
35	81.6	81	86	95	104	108	97	105	87	91	89	78	91		82	75	76	89	83	90	80	56	81
36	84	91	91	95	107	91	89	107	76	91	92	96	102		76	79	83	83	92	89	88	73	86
37	86.4				93	69	84	91	83	88	91	84	99		78	85	76	82	82	85	83	85	82
38	88.8								56	76	79	88	91		78	83	80	89	92	89	76	74	91
39	91.2														72	63	73	92	96	95	63	71	86
40	93.6																	89	92	80	66	48	93

Rebar Cover Depth Measurement
<50mm
51-100mm
>101mm

	avg.	st. dev.
deck	78.072	11.08677
sidewalk	67.361	13.33988
barriers	74.521	13.07108

Appendix C

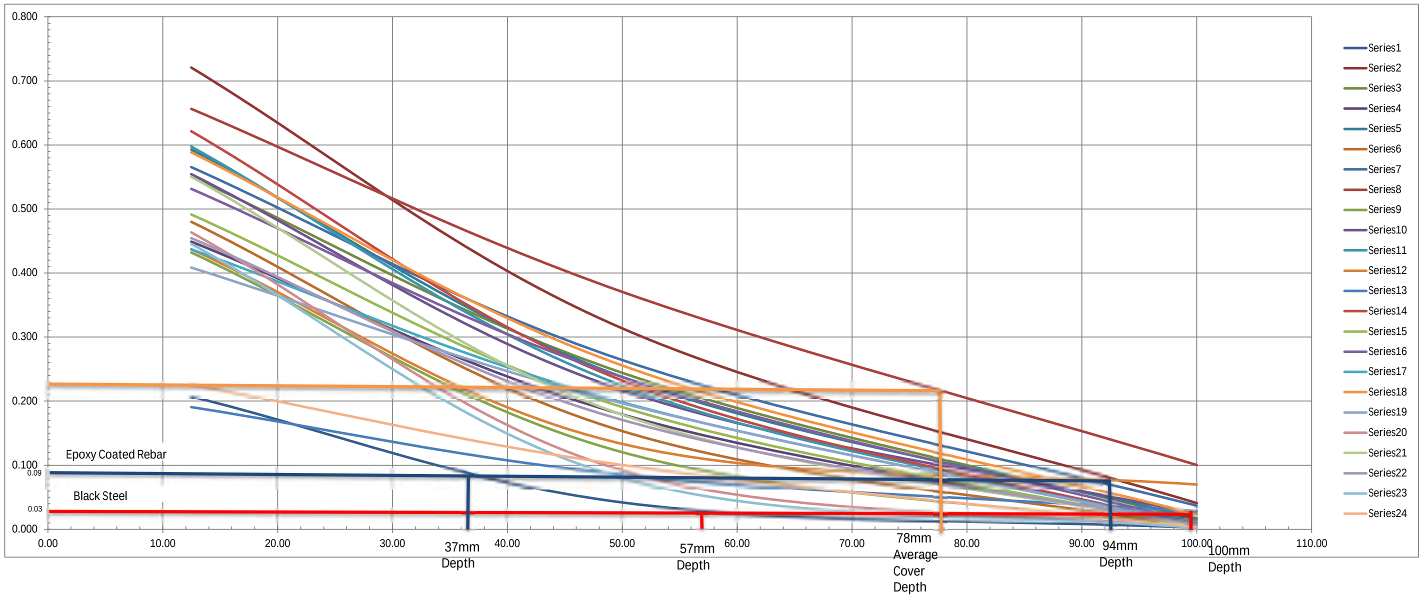
Chloride Data



Note: - Corrosion is initiated when chlorides exceed 0.030 %Cl- for black steel and 0.090% for expoy coated rebar per unit weight of concrete.

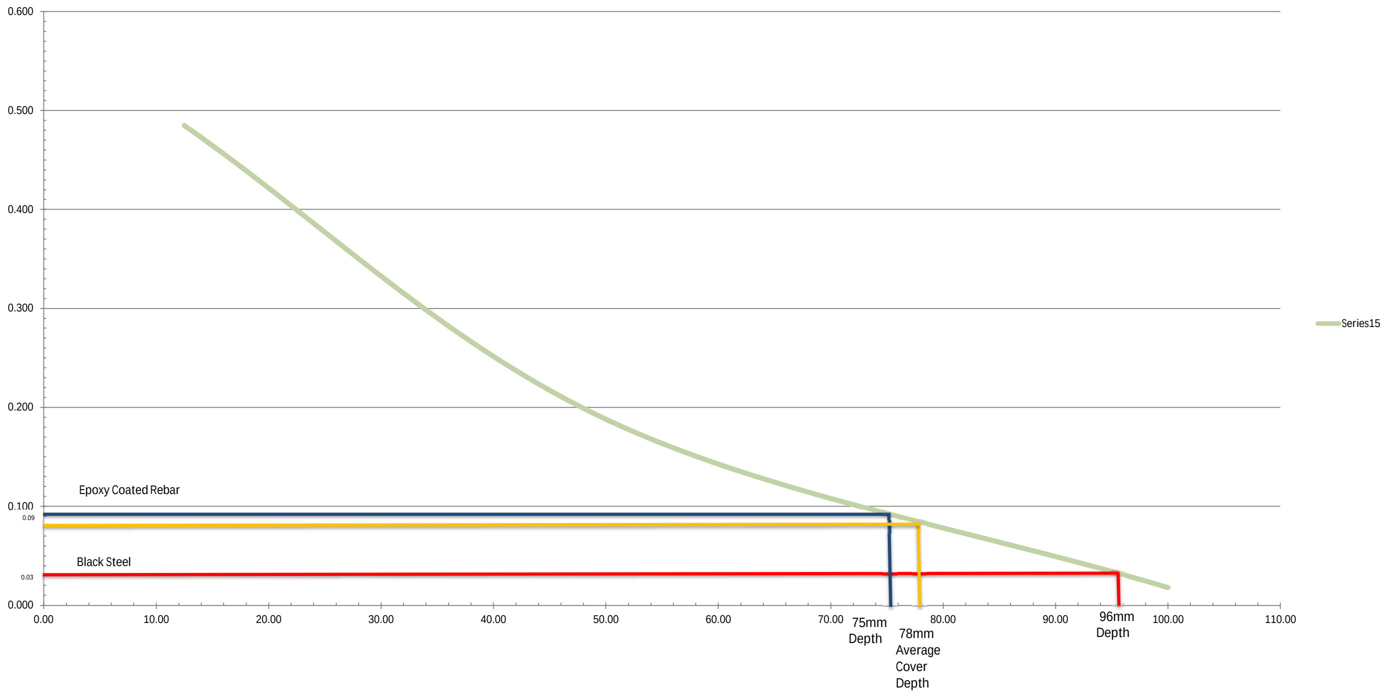
Rapid Chloride Test Result of Deck

Location Number			
Depth in mm (mm)/%Cl	12.5	50	100
	12.50	50.00	100.00
1	0.207	0.042	0.002
2	0.721	0.313	0.041
3	0.550	0.244	0.014
4	0.449	0.179	0.004
5	0.593	0.237	0.017
6	0.480	0.153	0.003
7	0.566	0.264	0.037
8	0.656	0.371	0.100
9	0.432	0.120	0.003
10	0.555	0.217	0.024
11	0.597	0.224	0.006
12	0.437	0.133	0.070
13	0.191	0.085	0.028
14	0.621	0.232	0.004
15	0.491	0.191	0.004
16	0.531	0.237	0.010
17	0.437	0.198	0.008
18	0.588	0.255	0.023
19	0.409	0.196	0.006
20	0.463	0.092	0.002
21	0.550	0.179	0.005
22	0.454	0.171	0.007
23	0.445	0.080	0.002
24	0.226	0.100	0.004



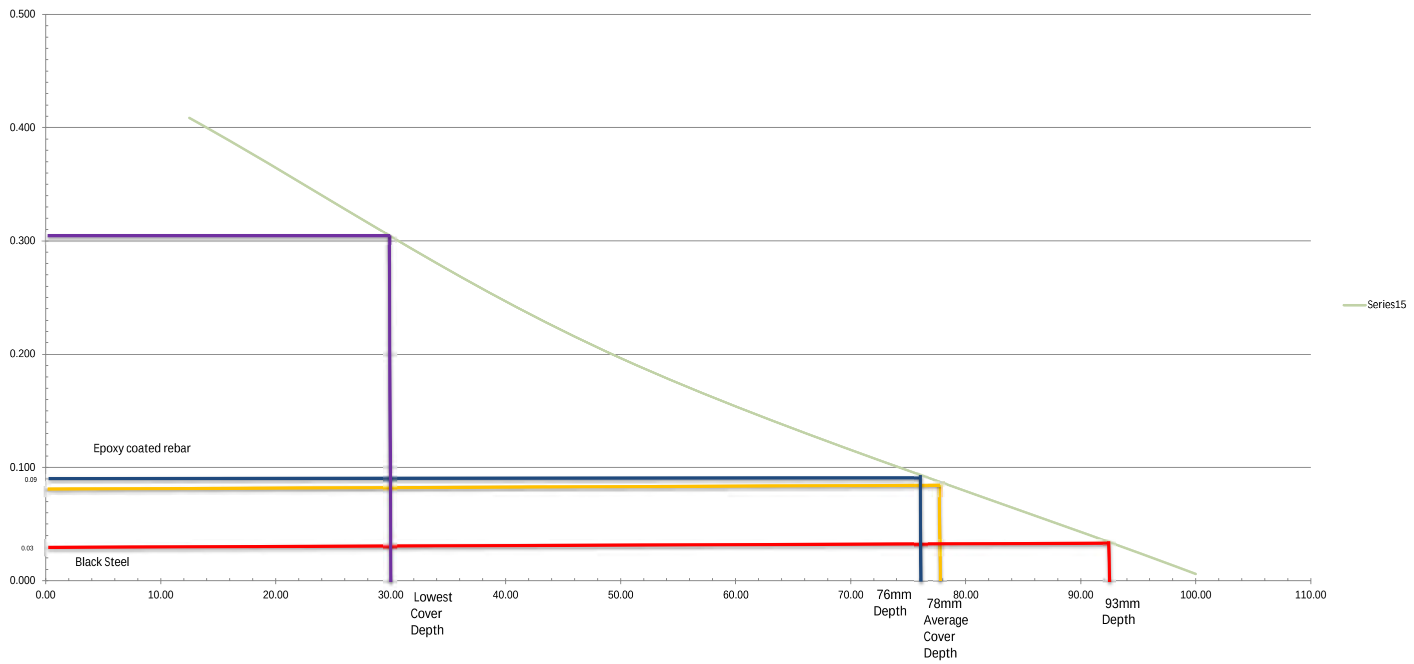
Rapid Chloride Test Result of Deck (Average)

Location Number			
Depth in mm (mm)/%Cl avg	12.5	50	100
	12.50	50.00	100.00
1	0.485	0.188	0.018



Location Number			
Depth in mm (mm)/%Cl avg	12.5	50	100
	12.50	50.00	100.00
19	0.409	0.196	0.006

Location 19 has the lowest cover on deck



Appendix D

Core/Laboratory Results

ENG-TECH Consulting Limited

420 Turenne Street, Winnipeg, Manitoba R2J 3W8
Phone: (204) 233-1694 Fax: (204) 235-1579
E-mail: engtech@mymts.net
www.eng-tech.ca

November 30, 2017

File No.: 17-027-02

AECOM Canada Ltd.
99 Commerce Dr.
Winnipeg, Manitoba
R3P 0Y7

ATTENTION: Noelle Vialoux, P. Eng / Murray Kowerko, C.E.T.

RE: Bridge Deck Investigation Results; Slaw-Rebchuk Overpass, Pembina Highway Overpass, Route 20 Twin Overpass

Dear Ms. Vialoux and Mr. Kowerko,

1.0 Introduction

ENG-TECH Consulting Limited (ENG-TECH) was retained by AECOM Canada Ltd. to perform coring on four bridge decks in the City of Winnipeg. The cores were taken in July and August 2017. The samples were obtained for Compressive Strength Testing as well as for Microscopic Air Voids, Water Soluble Chloride Ion Testing, Rapid Chloride Permeability, and for Petrographic Analysis.

The ENG-TECH representative took seven (7) cores from Southbound Route 20 at Concordia, nine (9) cores from Northbound Route 20, nine (9) cores from the Route 42 Pembina Highway Overpass at Bishop Grandin, and nine (9) cores from the Slaw-Rebchuk Overpass joining Salter Street and Isabel Street.

One core from each location was submitted for Petrographic Analysis. The Pembina Highway (Route 42) core consisted of a simple concrete layer, while the other three (3) cores had a base concrete and a concrete overlay. The Petrographic Analysis focused on the concrete overlay. The concrete was a Portland-cement only mix.

The Water Soluble Chloride Ion Content was tested in accordance with CSA standard A23.2-4B sampling and determination of Water Soluble Chloride Ion Content in hardened concrete or grout. Eight (8) cores were submitted for testing, with two (2) from each bridge deck. The samples were prepared into slices and analyzed by Golder Associates Ltd. The chloride levels decreased with depth.

The results are summarized below:

2.0 Test Locations

2.1 Route 20 Southbound Overpass

Seven (7) cores were taken from the overpass.

Compressive Strength

Due to time constraints, the ENG-TECH representative was not able to extract a barrier core and only took one core for Compressive Strength Testing. This core Ref. No. 17-27-2-1 (5) contained both deck topping and substrate material and broke at 44.4 MPa. A majority of the cores contained a cementitious deck topping which was the material tested.

Rapid Chloride Permeability

Core No. 1 of Ref. No. 17-27-2-1 was used for a Rapid Chloride Permeability test and was rated very low.

Microscopic Analysis

Core No. 2 of Ref. No. 17-27-2-1 was used for Microscopic Analysis. The core had an air content of 7.2% (5.0% entrained) with a spacing factor of 126.2 µm. The maximum spacing factor is 230 µm.

Petrographic Analysis

Core Ref. No. 17-27-2-1 (4) was submitted for Petrographic testing and contained 4.3% air (3.2% entrained) with a spacing factor of 152 µm. The core exhibited a very minor degree of alkali-silica reactivity (ASP) and had an air - void system consistent with the current American Concrete Institute regulations for freeze - thaw resistance.

Water Soluble Chloride Ion Content

Two cores were submitted for Water Soluble Chloride Ion Content, with the results shown in the following table.

Ref. No.	Core No.	Golder Lab No.	Horizon Depth (mm)	Water Soluble Chloride Ion Content (% Cl by weight of concrete)
17-27-2-1	6	C-17-1126	10 - 20	0.600
17-27-2-1	6	C-17-1126	30 - 40	0.416
17-27-2-1	6	C-17-1126	50 - 60	0.230
17-27-2-1	7	C-17-1127	10 - 20	0.467
17-27-2-1	7	C-17-1127	30 - 40	0.257

2.2 Route 20 Northbound Overpass

ENG-TECH took nine (9) cores from the Northbound overpass, including one (1) from the barrier. The deck concrete consisted of a concrete substrate and a concrete overlay, with an epoxy-based wear course.

Compressive Strength

Three (3) cores were tested for Compressive Strength, with results of 28.5 MPa, 31.3 MPa and one (1) very high result of 72.5 MPa.

Rapid Chloride Permeability

One (1) core was submitted for Rapid Chloride Permeability test and was 309 coulombs (very low).

Microscopic Analysis

Core Ref. No. 17-27-2-2 (1) was examined for Microscopic Air Voids and contained 6.7% air content (4.9% entrained) with a spacing factor of 142 µm.

Petrographic Analysis

Core Ref. No. 17-27-2-2 (5) was submitted for Petrographic Analysis and contained 3.9% air (2.6% entrained) with a spacing factor of 152 µm. The core exhibited a very minor degree of alkali-silica reactivity (ASP). The core had an air - void system that was **inconsistent** with the current American Concrete Institute regulations for freeze - thaw resistance.

Water Soluble Chloride Ion Content

Ref. No.	Core No.	Golder Lab No.	Horizon Depth (mm)	Water Soluble Chloride Ion Content (% Cl by weight of concrete)
17-27-2-2	2	C-17-1128	10 - 20	0.753
17-27-2-2	2	C-17-1128	30 - 40	0.411
17-27-2-2	7	C-17-1129	10 - 20	0.591
17-27-2-2	7	C-17-1129	30 - 40	0.228
17-27-2-2	7	C-17-1129	50 - 60	0.050

2.3 Pembina Highway Overpass

ENG-TECH took nine cores, including one from a barrier. The concrete consisted of a single layer of material.

Compressive Strength Test

Three (3) cores were tested for Compressive Strength, with results of 46.2 MPa, 40.3 MPa and 43.8 MPa.

Rapid Chloride Permeability

One (1) core was submitted for Rapid Chloride Permeability test and was 552 coulombs (very low).

Microscopic Analysis

Core Ref. No. 17-27-2-3 (6) was examined for Microscopic Air Voids and contained an air content of 7.1% (4.6% entrained) with a spacing factor of 133 µm.

Petrographic Analysis

Core Ref. No. 17-27-2-3 (5) was submitted for Petrographic Analysis and consisted of a single concrete layer. The overall condition of the concrete overlays and concrete was good. The overlays were well bonded to the substrate. The core contained an air content of 9.7% (8.1% entrained) with a spacing factor of 102 µm. The core exhibited a very minor degree of alkali-silica reactivity (ASR) and had an air - void system consistent with the current American Concrete Institute regulations for freeze - thaw resistance.

Water Soluble Chloride Ion Content

Ref. No.	Core No.	Golder Lab No.	Horizon Depth (mm)	Water Soluble Chloride Ion Content (% Cl by weight of concrete)
17-27-2-3	8	C-17-1130	10 - 20	1.160
17-27-2-3	8	C-17-1130	30 - 40	0.697
17-27-2-3	8	C-17-1130	50 - 60	0.341
17-27-2-3	8	C-17-1130	70 - 80	0.080
17-27-2-3	8	C-17-1130	90 - 100	0.005
17-27-2-3	8	C-17-1130	110 - 120	0.004
17-27-2-3	9	C-17-1131	10 - 20	0.792
17-27-2-3	9	C-17-1131	30 - 40	0.479
17-27-2-3	9	C-17-1131	50 - 60	0.274
17-27-2-3	9	C-17-1131	70 - 80	0.112

2.4 Slaw - Rebchuk Overpass

ENG-TECH took nine cores from the overpass, including one from the barrier.

Compressive Strength Test

Three (3) cores were tested for Compressive Strength, with results of 39.1 MPa, 41.8 MPa and 43.6 MPa.

Rapid Chloride Permeability

One (1) core was submitted for Rapid Chloride Permeability test and was 202 coulombs (very low).

Microscopic Analysis

Core Ref. No. 17-27-2-4 (1) was examined for Microscopic Air Voids and contained an air content of 6.3% (3.4% entrained) with a spacing factor of 163 μm.

Petrographic Analysis

Core Ref. No. 17-27-2-4 (5) was submitted for Petrographic Analysis and contained an air content of 8.0% (5.8% entrained) with a spacing factor of 152 μm. The core exhibited a very minor degree of alkali-silica reactivity (ASR) and had an air - void system consistent with the current American Concrete Institute regulations for freeze - thaw resistance.

Water Soluble Chloride Ion Content

Ref. No.	Core No.	Golder Lab No.	Horizon Depth (mm)	Water Soluble Chloride Ion Content (% Cl by weight of concrete)
17-27-2-4	6	C-17-1133	10 - 20	0.393
17-27-2-4	6	C-17-1133	30 - 40	0.284
17-27-2-4	6	C-17-1133	50 - 60	0.124
17-27-2-4	3	C-17-1132	10 - 20	0.461
17-27-2-4	3	C-17-1132	30 - 40	0.304
17-27-2-4	3	C-17-1132	50 - 60	0.198

3.0 Closure

This completes our summary of the core test results. The test data and photographs are provided in the attachments.

ENG-TECH Consulting Limited trusts the information presented in this letter is satisfactory. If there are any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

Jeff Baturin, P. Eng.
General Manager - Laboratory

Reviewed by,

Clark Hryhoruk, M.Sc., P. Eng.
President

JRB/mvw

Email: noelle.vialoux@aecom.com
Email: murray.kowerko@aecom.com

Attachments: Appendix A – Compressive Strength Test Results
Appendix B – Petrographic and Air Void Test Results
Appendix C – Water Soluble Chloride Test Results

APPENDIX A

Compressive Strength Test Results

Concrete Core Test Results
Microscopical Analysis of Hardened Concrete
Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
Core Photographs

ENG-TECH Consulting Limited
420 Turenne Street
Winnipeg, Manitoba
R2J 3W8
engtech@mymts.net
www.eng-tech.ca

CONCRETE CORE

CERTIFIED BY CCIL
Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7

File No.: 17-027-02
Ref. No.: 17-27-2-3

Attention: Noelle Vialoux, P. Eng. / Murray Kowerko, C.E.T.
Project: BRIDGE DECK INVESTIGATION OF THE SLAW REBCHUK OVERPASS, PEMBINA HIGHWAY OVERPASS AND ROUTE 20 TWIN OVERPASSES

Date Cored: Aug 21 - 24/17 Cored By: ENG-TECH (Nick Hryhoruk)

Date Received: Aug 25/17 Tested By: ENG-TECH (Paul L'Anglais)

Core No.	Location on Structure Pembina Hwy. Overpass	Density (kg/m^3)	Length: Cored (mm)	Length: Tested (mm)	Average Diameter (mm)	Compressive Strength (MPa)	Date Tested (m/d/y)	Type of Fracture
1	Station 7, 5 meters East of West barrier, Southbound curb lane, Route 42.	-	160	-	-	-	-	-
2	Station 15, 8.6 meters East of West barrier, Southbound lane 4, Route 42.	2212	175	115	102.0	46.2	Sep16/17	1
3	Station 25, 12 meters East of West barrier, Southbound lane 4, Route 42.	2212	175	127	102.0	40.3	Sep16/17	1
4	Barrier; Station 44, 2.4 meters South of North end of barrier, Southbound, Route 42.	-	137	-	-	-	-	-
5	Station 36, 7.2 meters West of East barrier, Southbound lane 2, Route 42.	-	142	-	-	-	-	-
6	Station 46, 2.4 meters West of East barrier, Southbound median lane, Route 42.	-	143	-	-	-	-	-

Deviations from test procedure: None.

cc: Email: Murray.Kowerko@aecom.com
Email: Noelle.Vialoux@aecom.com

ENG-TECH Consulting Limited

Per [signature]

Jeff Baturin, P Eng., Materials Engineer
Ph: (204) 233-1694 Fx: (204) 235-1579

ENG-TECH
CONSULTING LIMITED

420 Turenne Street
Winnipeg, Manitoba
R2J 3W8
engtech@mymts.net
www.eng-tech.ca

CONCRETE CORE

Project: BRIDGE DECK INVESTIGATION OF THE SLAW REBCHUK OVERPASS, PEMBINA HIGHWAY OVERPASS AND ROUTE 20 TWIN OVERPASSES
File No.: 17-027-02
Ref. No.: 17-27-2-3
Date Cored: Aug 21 - 24/17

Core No.	Location on Structure Pembina Hwy. Overpass	Density (kg/m^3)	Length Cored (mm)	Length Tested (mm)	Average Diameter (mm)	Compressive Strength (MPa)	Date Tested (m/d/y)	Type of Fracture
7	Station 70, 1.3 meters East of West barrier, Northbound median lane, Route 42.	2195	177	134	102.0	43.8	Sep 16/17	1
8	Station 77, 7.2 meters East of West barrier median lane, Northbound Route 42.	-	138	-	-	-	-	-
9	Station 70, 1.3 meters East of West barrier median lane, Northbound Route 42.	-	102	-	-	-	-	-

Core Conditioning: None. Direction of Load: Perpendicular to placement.

Comments: Cores were recovered from Pembina Highway Overpass.
Core No. 1 was retained for rapid chloride permeability test.
Core No. 4 was obtained from the barrier and was held for testing at a later date.
Core No. 5 was retained for petrographic test.
Core No. 6 was retained for air void analysis of hardened concrete test.
Cores No. 8 and 9 were retained for water soluble chloride tests.

Deviations from test procedure: None.

cc: Email: Murray.Kowerko@aecom.com
Email: Noelle.Vialoux@aecom.com

ENG-TECH Consulting Limited

Per Jeff Baturin

Jeff Baturin, P Eng., Materials Engineer
Ph: (204) 233-1694 Fx: (204) 235-1579

420 Turenne Street
Winnipeg, Manitoba
R2J 3W8
engtech@mymts.net
www.eng-tech.ca

MICROSCOPICAL ANALYSIS OF HARDENED CONCRETE

AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7

File No.: 17-027-02
Ref. No.: 17-27-2-7

Pembina Hwy. Overpass

Attention: Noelle Vialoux, P. Eng. / Murray Kowerko, C.E.T.
Project: BRIDGE DECK INVESTIGATION OF THE SLAW REBCHUK OVERPASS, PEMBINA HIGHWAY OVERPASS AND ROUTE 20 TWIN OVERPASSES

Type Of Sample:	Core	Cored By:	ENG-TECH (Nick Hryhoruk)
Date Received:	Aug 25/17	Date Cored:	Aug 21 – 24/17
Date Tested:	Sept 19/17	Client I.D. No.:	17-27-2-3 (6)

Test Results		Concrete Mix Information	
Length Of Traverse (mm):	2600	28 Day Design Strength (MPa):	-
Number Of Stops:	1625	Cement Type:	-
Surface Area (mm^2):	4160	Fly Ash (%):	-
Air Content (%):	7.08	Air Content (%):	-
Specific Surface (mm^2/mm^3):	28.60870	Slump (mm):	-
Spacing Factor (µm):	132.8	Mix Code:	-
Paste Content (%):	26.89	Temp. (^oC):	-
Density (kg/m^3):	2296	Plastic Density (kg/m^3):	-

Comments: Core was obtained from Southbound median lane Pembina Highway Overpass and was prepared and traversed along the vertical face. See Concrete Core Report Ref. No. 17-27-2-3 for additional information.

Note: The test was conducted by ENG-TECH Consulting Limited in accordance with ASTM C-457 using the Modified Point Count Method (Procedure B).

cc: Email: Murray.Kowerko@aecom.com
Email: Noelle.Vialoux@aecom.com

ENG-TECH Consulting Limited

Per

Jeff Baturin, P Eng., Materials Engineer
Ph: (204) 233-1694 Fx: (204) 235-1579

ENG-TECH CONSULTING LIMITED
420 Turenne Street
Winnipeg, Manitoba
R2J 3W8
engtech@mymts.net
www.eng-tech.ca

ELECTRICAL INDICATION OF CONCRETE'S ABILITY TO RESIST CHLORIDE ION PENETRATION

AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7

File No.: 17-027-02

Ref. No.: 17-27-2-12

Attention: Noelle Vialoux, P. Eng. / Murray Kowerko, C.E.T.

Pembina Hwy. Overpass

Project: BRIDGE DECK INVESTIGATION OF THE SLAW REBCHUK OVERPASS, PEMBINA HIGHWAY OVERPASS AND ROUTE 20 TWIN OVERPASSES

Date of Test: Sept 15/17 Date Received: Aug 25/17 Tested By: ENG-TECH (Pan Ding)

Type of Specimen	Core
Core Ref. No.	17-27-2-3 (1)
Source of Specimen Related to Concrete Structure	Station 7, 5 meters East of West barrier, Southbound curb lane
Date Cored	Aug 21 – 24, 2017
Age at Test (Days)	-
Curing History	As per CSA A23.2-3C
Location of Specimen within Sample:	10 mm from top of the core
Specimen Preparation Comments	Cut with diamond saw; conditioned with epoxy
Total Charge Passed (Coulombs):	552
Chloride Ion Penetrability Rating (ASTM C1202):	Very Low

Table 1
Chloride Ion Penetrability Based on Charge Passed

> 4000	High
2000 - 4000	Moderate
1000 - 2000	Low
100 - 1000	Very Low
< 100	Negligible

Concrete Mix Properties: Concrete properties information not available.

Comments: Specimen was cored by ENG-TECH from Pembina Highway Overpass Southbound curb lane. See Concrete Core Report Ref. No. 17-27-2-3 for additional information.

Deviations From Test Procedure: None.

cc: Email: Murray.Kowerko@aecom.com
Email: Noelle.Vialoux@aecom.com

ENG-TECH Consulting Limited

Per

Jeff Baturin, P Eng., Materials Engineer
Ph: (204) 233-1694 Fx: (204) 235-1579

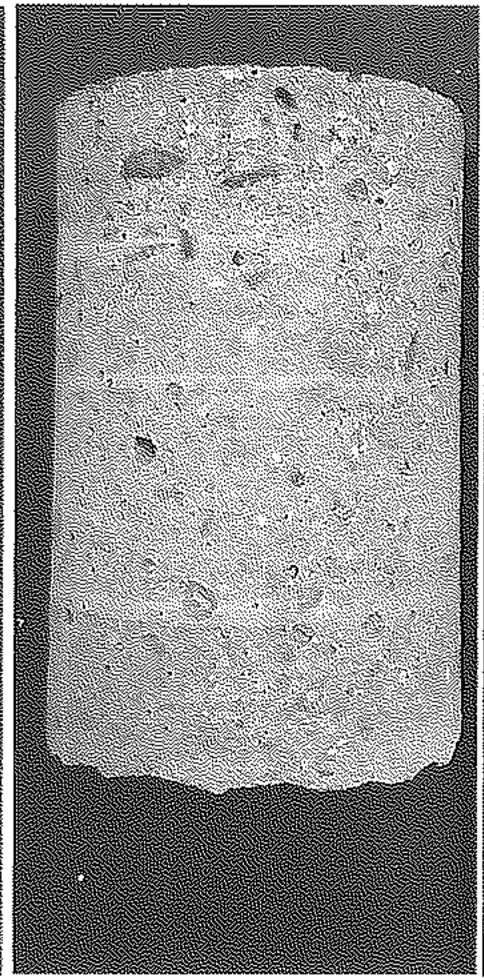
Core 1

Core 2

Core 3

Pembina Highway Overpass

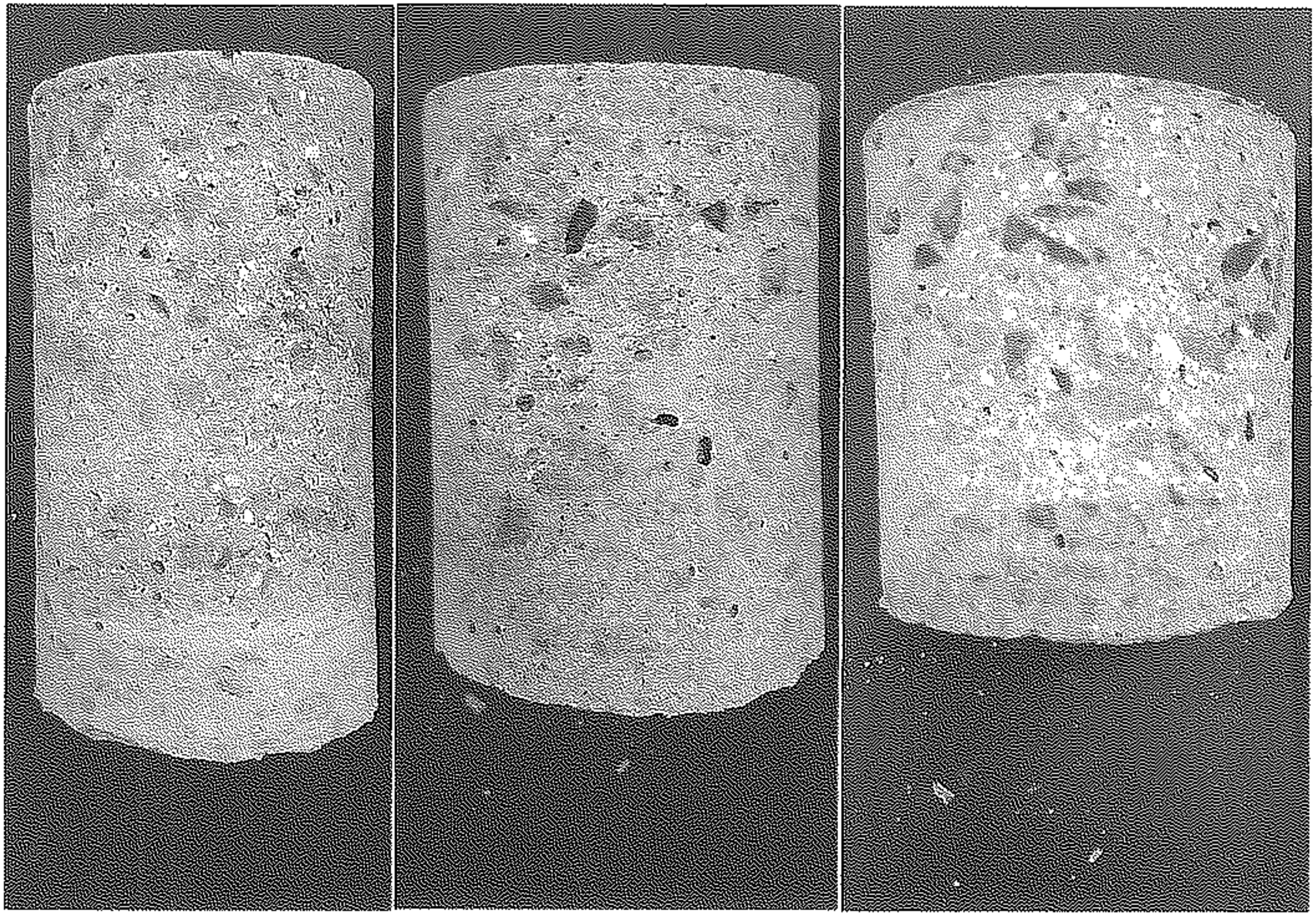
Core 4



Core 5

Core 6

Pembina Highway Overpass



Core 7 | Core 8 | Core 9

Pembina Highway Overpass

APPENDIX B

Petrographic Test Results
Air Voids Test Results

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
- ENVIRONMENTAL
- GEOTECHNICAL
- MATERIALS
- FORENSICS

REPORT OF CONCRETE ANALYSIS

PROJECT:

BRIDGE DECK INVESTIGATION
SLAW REBCHUCK, PEMBINA HIGHWAY
ROUTE 20 LAGIMODIERE BLVD
TWIN OVERPASS
FILE NO.: 17-027-02

AET PROJECT NO: 24-02333

REPORTED TO:

AECOM CANADA, LTD
99 COMMERCE DRIVE
WINNIPEG, MANITOBA
R3P 0Y7

ATTN: NOELLE VIALOUX, P. ENG

DATE: NOVEMBER 6, 2017

INTRODUCTION

This report presents the results of laboratory work performed by our firm on four concrete core samples submitted by Ms. Darci Babisky of Eng-Tech Consulting Limited on, September 25, 2017. We understand the concrete cores were obtained from various bridge decks. Three of the cores (27-2-1(4), 27-2-2(5) and 27-2-4 (5) are made up of a base concrete and a concrete overlay. Cores 27-2-2 (5) and 27-2-4(5) are overlain by an epoxy-based wear course and in core 27-2-2(5) the concrete overlay was also partially covered by a repair concrete. Core 27-2-3(5) is made up of a single concrete. The ages of the concretes were not known to us. The scope of our work was limited to performing petrographic analysis on the overlay concretes to document the general overall condition of the concrete.

CONCLUSIONS

Based on our observations and testing, we believe:

1. The overall condition of the three concrete overlays and sample 27-2-3(5) was good. Each of the concrete overlays were well bonded its base concrete and samples 27-2-2 (5) and 27-2-4(5) were well bonded to the overlying epoxy-based wear course. The overlay concrete in sample 27-2-2(5) was also partially overlain by a repair/patching concrete; these two concretes were poorly bonded. The concrete overlays and sample 27-2-3(5) were each portland cement only mixes and were placed at a moderate water-to-cement ratio estimated to be between 0.40 and 0.48.

2. Each of the concretes examined exhibited a very minor degree of alkali-silica reactivity. Clear to white alkali-silica gel was observed lining or filling a few voids in each sample and partially filled a microcracks oriented sub-parallel to the outer surface in core 27-2-1(4). The offending aggregate particles were only able to be identified in sample 27-2-2(5) and included a chert coarse aggregate particle and meta-granite, quartzite and chert fine aggregate particles. The alkali-silica reactivity (ASR) observed in the samples has not caused any damage to the concretes. ASR is a reaction between reactive silica within aggregates, the alkalis from the concrete paste, and water/moisture. The level of distress

in the individual cores is likely a result of variation in those factors. The reaction produces a silica gel product that takes on water (hygroscopic) and expands; cracking the offending aggregates and the paste. The deterioration of the concrete will continue only if all three reactants are available.

3. The concrete overlays in core samples 27-2-1(4) and 27-2-2(5) were of similar composition and contained of natural gravel coarse and fine aggregate and were portland cement only mixes. The concrete overlay in sample 27-2-4(5) was similar to the concrete in sample 27-2-3(5). Both contained quarried and crushed granitic coarse aggregate, natural fine aggregate and were portland cement only mixed. The patch/repair material observed in core 27-2-2(5) appeared similar to these concretes. Each of the concretes analyzed was air entrained and each concrete except for sample 27-2-2(5) contained an air void system consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance. The spacing factor in sample 27-2-2-(5) was calculated to be 0.009 inches (290μm). ACI recommends a spacing factor ≤0.008 inches for concrete to be considered freeze-thaw durable (ACI 212.3R-10). CSA A23.2-3C considers a spacing factor of ≤ 230μm as durable.

4. Sample 27-2-2(5) was fractured within the top 12 mm (1/2") of the base concrete, exposing a heavily corroded 13 mm (1/2") rebar. Corrosion product observed lining a macrocrack at up to 9 mm (3/8") into the overlay, on the opposite side of the core from the rebar, was likely produced by a reinforcement member not intersected by the core sample.

SAMPLE IDENTIFICATION

Sample ID:	27-2-1(4) Route 20 SB	27-2-2(5) Route 20 NB	27-2-3(5) Pembina Hwy. Overpass	27-2-4(5) Slaw Rebchuk Overpass
Sample Type:	102 mm (4") Diameter Hardened Concrete Cores			
Sample Length:	222 mm (8-3/4")	152 mm (6")	152 mm (6")	197 mm (7-3/4")

TEST RESULTS

Our complete petrographic analysis documentation appears on the attached sheets entitled 27-LAB-001 "Petrographic Examination of Hardened Concrete, ASTM C856." A brief summary of the general physical characteristics of the concrete is as follows:

1. The coarse aggregate in the overlay concrete of cores 27-2-1(4) and 27-2-2(5) was comprised of 13 mm (1/2") nominal sized natural gravel that appeared well graded and exhibited good overall distribution in both concretes. The coarse aggregate in sample 27-2-3(5) and in the overlay concrete of sample 27-2-4(5) was comprised of 13 mm (1/2") nominal sized quarried and crushed granite and meta-granite. The fine aggregate in all four concretes was a natural glacial sand.

2. The paste color of the overlay concrete in samples 27-2-1(4) and 27-2-2(5) was medium gray and in samples 27-2-3(5) and 27-2-4(5) the paste was medium light gray. The paste in all four concretes was judged to be moderately hard with the paste/aggregate bond considered to be good.

3. The top surface condition of the concretes ranged from rough, irregular spalled (27-2-1(4) and 27-2-2(5)) to fairly smooth and abraded (27-2-4(5)) to fairly smooth and traffic worn (27-2-3(5). The depth of carbonation ranged from negligible to 4 mm (5/32") depth, "spiking up to 13 mm (1/2") along sub-vertical microcracking. Carbonation occurred intermittently throughout the samples along the perimeter of carbonate aggregate particles.

4. Overall, the w/cm of the four concretes was estimated to be between 0.40 and 0.48 with approximately 5 to 11% residual portland cement clinker particles. No supplementary cementitious materials were observed in the concrete samples.

Air Content Testing

Sample ID	27-2-1(4) Route 20 SB	27-2-2(5) Route 20 NB	27-2-3(5) Pembina Hwy. Overpass	27-2-4(5) Slaw Rebchuk Overpass
Total Air Content (%)	4.3	3.9	9.7	8.0
"Entrained" Air (%) voids < 1mm (0.040")	3.1	2.6	8.1	5.8
"Entrapped" Air (%) voids > 1mm (0.040")	1.2	1.3	1.6	2.2
Spacing Factor, in.	152µm (0.006)	229µm (0.009)	102µm (0.004)	152 µm (0.006)

TEST PROCEDURES

Laboratory testing was performed on September 27, 2017 and subsequent dates. Our procedures were as follows:

Petrographic Analysis
A petrographic analysis was performed in accordance with AET Standard Operating Procedure 24-LAB-001, "Petrographic Examination of Hardened Concrete," ASTM C856-latest revision. The petrographic analysis consisted of reviewing the cement paste and aggregate qualities on a whole basis on saw cut and lapped, and fractured sections. Reflected light microscopy was performed under an Olympus SZX-12 binocular stereozoom microscope at magnifications up to 160x. The depth of carbonation was documented using a phenolphthalein pH indicator solution applied on freshly saw cut and lapped surfaces of the concrete sample. The paste-coarse aggregate bond quality was determined by fracturing a sound section of the concrete in the laboratory with a rock hammer.

The water/cementitious of the concrete was estimated by viewing a thin section of the concrete under an Olympus BX-51 polarizing light microscope at magnifications of up to 1000x. Thin section analysis was performed in accordance with Standard Operating Procedure 24-LAB-009, "Determining the Water/Cement of Portland Cement Concrete, AET Method." An additional, smaller, saw cut subdivision of the concrete sample is epoxy impregnated, highly polished, and then attached to a glass slide using an optically clear epoxy. Excess sample is saw cut from the glass and the thin slice remaining on the slide is lapped and polished until the concrete reaches 25 microns or less in thickness. Thin section analysis allows for the observation of portland cement morphology, including: phase identification, an estimate of the amount of residual material, and spatial relationships. Also, the presence and relative amounts of supplementary cementitious materials and pozzolans may be identified and estimated.

Air Content Testing

Air content testing was performed using Standard Operating Procedure 24-LAB-003, "Microscopical Determination of Air Void Content and Parameters of the Air Void System in Hardened Concrete, ASTM C457-latest revision." The linear traverse method was used. The concrete core was saw cut perpendicular with respect to the horizontal plane of the concrete as placed and then lapped prior to testing.

REMARKS

The test samples will be retained for a period of at least sixty days from the date of this report. Unless further instructions are received by that time, the samples may be discarded. Test results relate only to the items tested. No warranty, express or implied, is made.

Report Prepared By:
American Engineering Testing, Inc.

Christine A. Tillema

Christine Tillema
Senior Petrographer
Phone: 651-659-1353
ctillema@amengtest.com

American Engineering Testing, Inc.

Gerard Moulzolf, PG
Vice President/Principal Petrographer
MN License #30023
Phone:651-659-1346
gmoulzolf@amengtest.com

Pembina Hwy. Overpass

24-LAB-001 Petrographic Examination of Hardened Concrete
ASTM C856

Project No.	24-02333	Date:	10-26-2017	Date reviewed:	10-27-2017
Sample ID:	27-2-3(5)	Performed by:	S. Massignan	Reviewed by:	C. Tillema

I. General Observations

1. Sample Dimensions: Our analysis was performed on a 153 mm (6") x 102 mm (4") x 45 mm (1-3/4") thick lapped profile section and a 76 mm (3") x 52 mm (2") thin section that were saw-cut and prepared from the original 102 mm (4") diameter x 152 mm (6") long core.

2. Surface Conditions:
   Top: Fairly smooth, fairly planar, traffic worn surface.
   Bottom: Rough, irregular fractured surface.

3. Reinforcement: None observed.

4. General Physical Conditions: The top surface of the sample was traffic-worn, which exposed numerous truncated aggregate particles. A few sub-vertical microcracks proceeded from the top surface up to 15 mm (9/16") maximum observed depth. Carbonation ranged from negligible to 4 mm (5/32") depth from the top. The concrete was air-entrained, with a 9.7% total air void content and 8.1% entrained air content. The sample exhibited a 0.004" spacing factor and a 780 in^2/in^3 specific surface. The overall air void system was consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance. The concrete between approximately 104 mm (4-1/8") and 136 mm (5-3/8") depth contained significantly less entrained air than the rest of the sample. No obvious cold-joints were observed. White, acicular ettringite was observed lining several air voids throughout the overlay. Clear to white alkali-silica gel was observed lining a few air voids scattered throughout the sample. The offending aggregate particles were not observed.

II. Aggregate

1. Coarse: 13 mm (1/2") nominal sized quarried and crushed granite and meta-granite. The aggregate was mostly sub-rounded to sub-angular in shape. The coarse aggregate appeared well graded and exhibited good overall distribution.

2. Fine: Natural quartz, feldspar, and lithic sand (carbonates, granite, meta-granite, greywacke, and chert, with a few iron oxide and mica particles). The grains were mostly sub-rounded with many smaller sub-angular particles. The fine aggregate appeared fairly graded and exhibited good overall uniform distribution.

III. Cementitious Properties

1.	Air Content:	9.7% total
2.	Depth of carbonation:	Ranged from negligible to 4 mm (5/32") depth from the top surface.
3.	Paste/aggregate bond:	Good
4.	Paste color:	Medium light gray (Munsell® N6).
5.	Paste hardness:	Moderately hard (Mohs ≈3.5).
6.	Microcracking:	A few sub-vertical microcracks proceeded from the top surface of the sample up to 15 mm (9/16") maximum observed depth.
7.	Secondary deposits:	White, acicular ettringite was observed lining several air voids throughout the non-carbonated paste. Clear to white, alkali-silica gel was observed lining a few air voids scattered throughout the sample.
8.	w/cm:	Estimated at between 0.43 and 0.48 with approximately 5 to 7% residual portland cement clinker particles.
9.	Cement hydration:	Alites: Well to fully Belites: Moderate

AIR VOID ANALYSIS

American Engineering Testing, Inc.

PROJECT:
BRIDGE DECK INVESTIGATION
SLAW REBCHUCK, PEMBINA HIGHWAY
ROUTE 20 LAGIMODIERE BLVD
TWIN OVERPASS
FILE NO.: 17-027-02
Pembina Hwy. Overpass

AET PROJECT NO: 24-02333

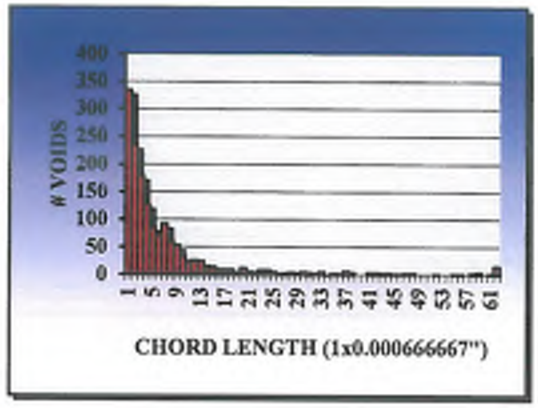
REPORTED TO:
AECOM CANADA, LTD
99 COMMERCE DRIVE
WINNIPEG, MANITOBA
R3P 0Y7

ATTN: NOELLE VIALOUX, P. ENG

DATE: NOVEMBER 6, 2017

Sample ID: 27-2-3(5)

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.

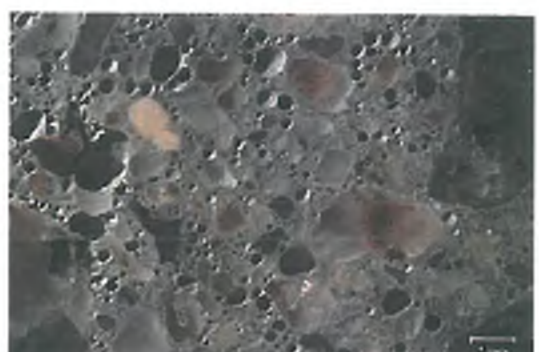


Sample Data

Description: Hardened Concrete Core
Dimensions: 102 mm (4") diameter by 152 mm (6") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	9.7
Entrained, % < 0.040"(1mm)	8.1
Entrapped, %> 0.040"(1mm)	1.6
Air Voids/inch	19.0
Specific Surface, in²/in³	780
Spacing Factor, inches	0.004
Paste Content, % estimated	27
Magnification	75x
Traverse Length, inches	80
Test Date	10/19/2017
Test Performed By	S. Massignan



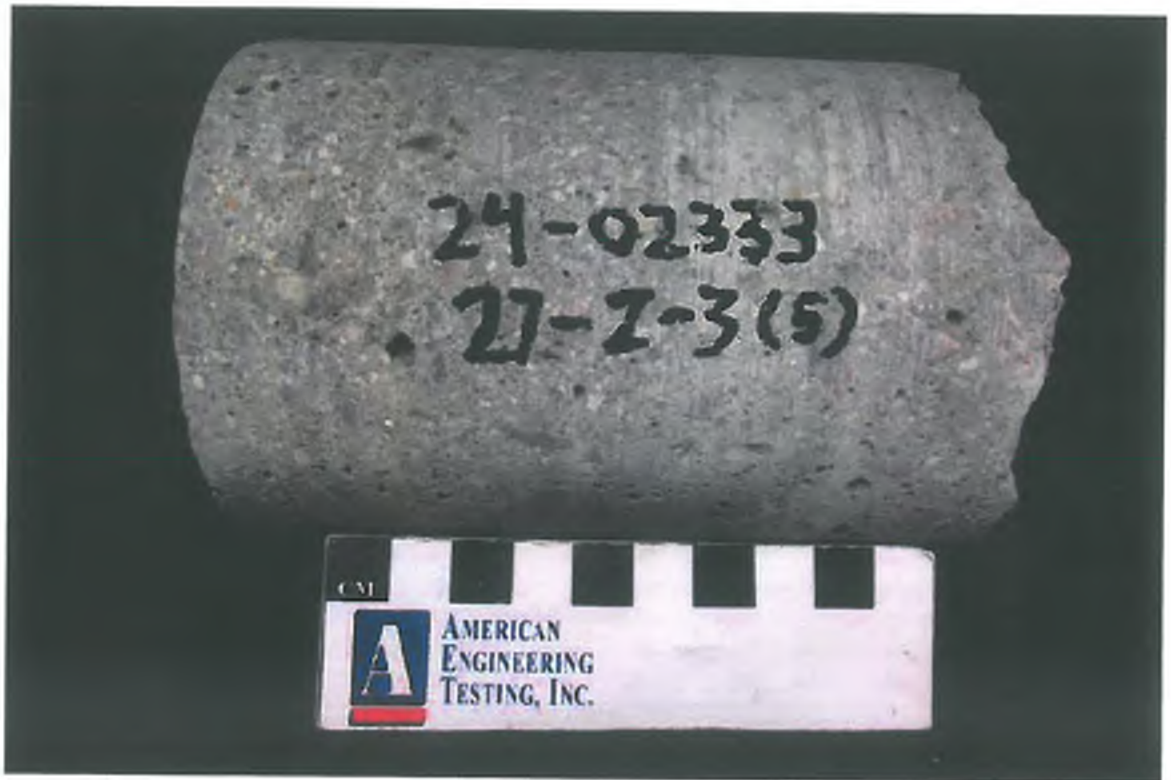
Magnification: 15x
Description: Hardened air void system.

550 Cleveland Avenue North | Saint Paul, MN 55114
Phone (651) 659-9001 | (800) 972-6364 | Fax (651) 659-1379 | www.amengtest.com | AA/EEO

AET PROJECT NO: 24-02333 **DATE:** NOVEMBER 6, 2017

PROJECT: BRIDGE DECK INVESTIGATION; SLAW REBCHUCK, PEMBINAHIGHWAY, ROUTE 20 LAGIMODIERE BLVD.-TWIN OVERPASS

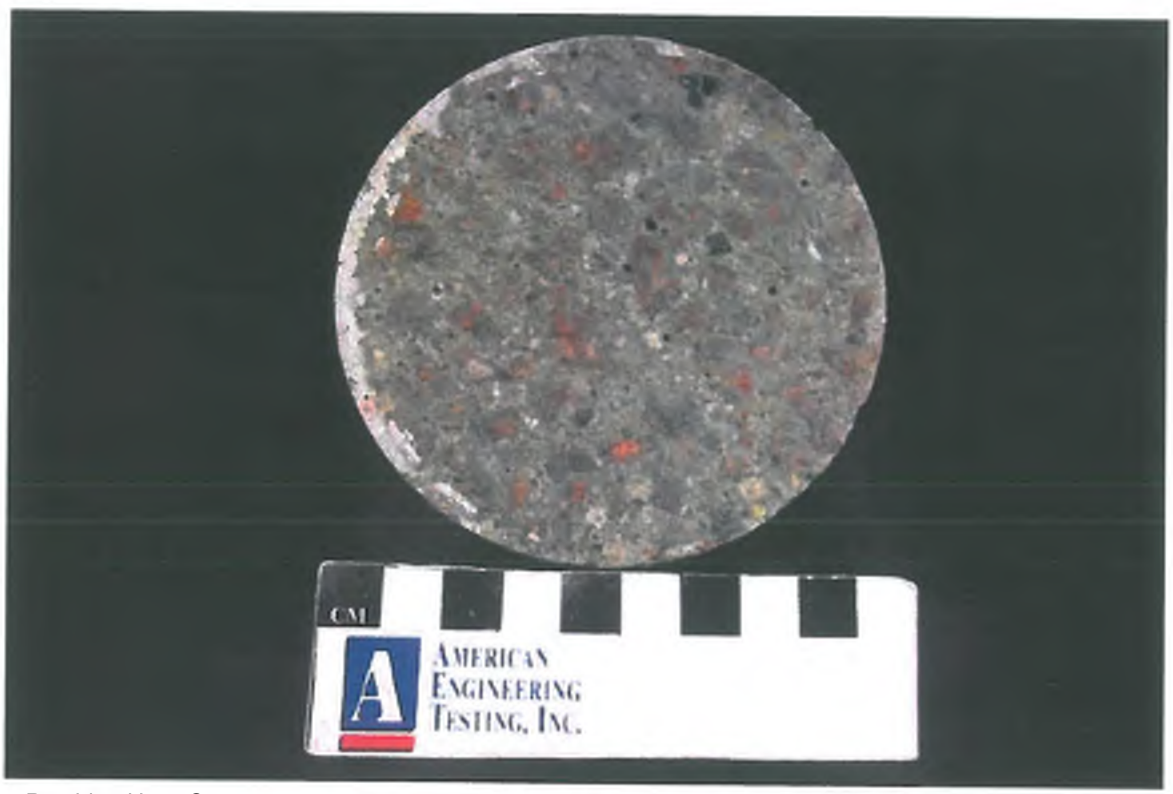
PHOTO: 5



Pembina Hwy. Overpass

SAMPLE ID: 27-2-3(5) **DESCRIPTION:** Profile of the core sample as received with the top surface to the left.

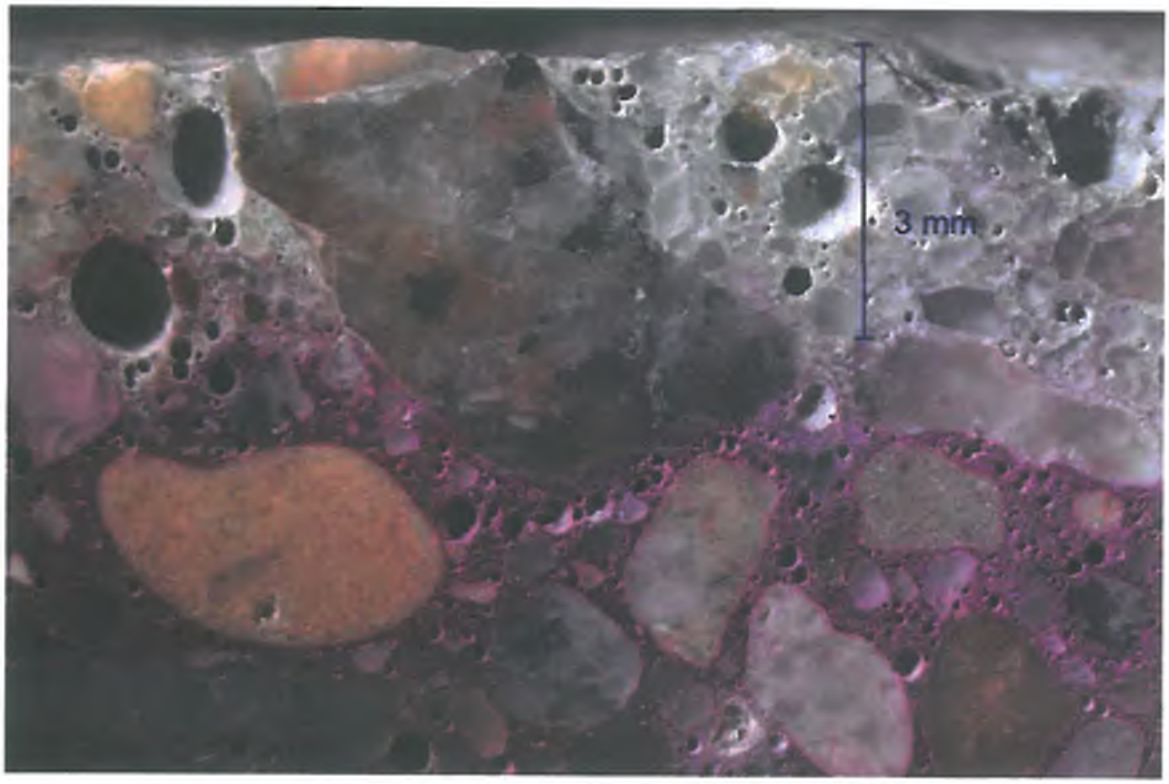
PHOTO: 6



Pembina Hwy. Overpass

SAMPLE ID: 27-2-3(5) **DESCRIPTION:** Top surface of the sample as received. Many truncated aggregate surfaces are visible.

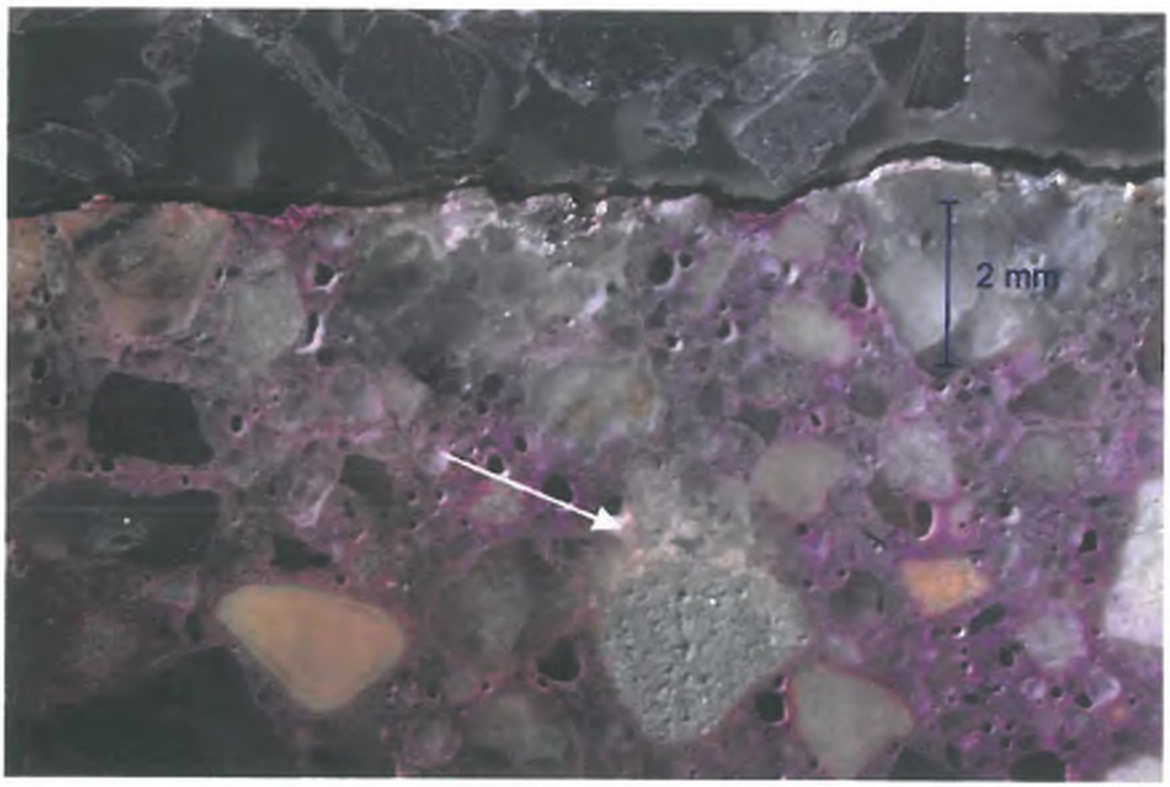
PHOTO: 11



Pembina Hwy. Overpass

SAMPLE ID: 27-2-3(5) DESCRIPTION: Carbonation (unstained paste) proceeded up to 3 mm (1/8") depth from the top surface.
MAG: 15x Observed on a freshly saw-cut and lapped profile of the sample treated with the pH indicator phenolphthalein.

PHOTO: 12



Slaw Rebchuk Overpass

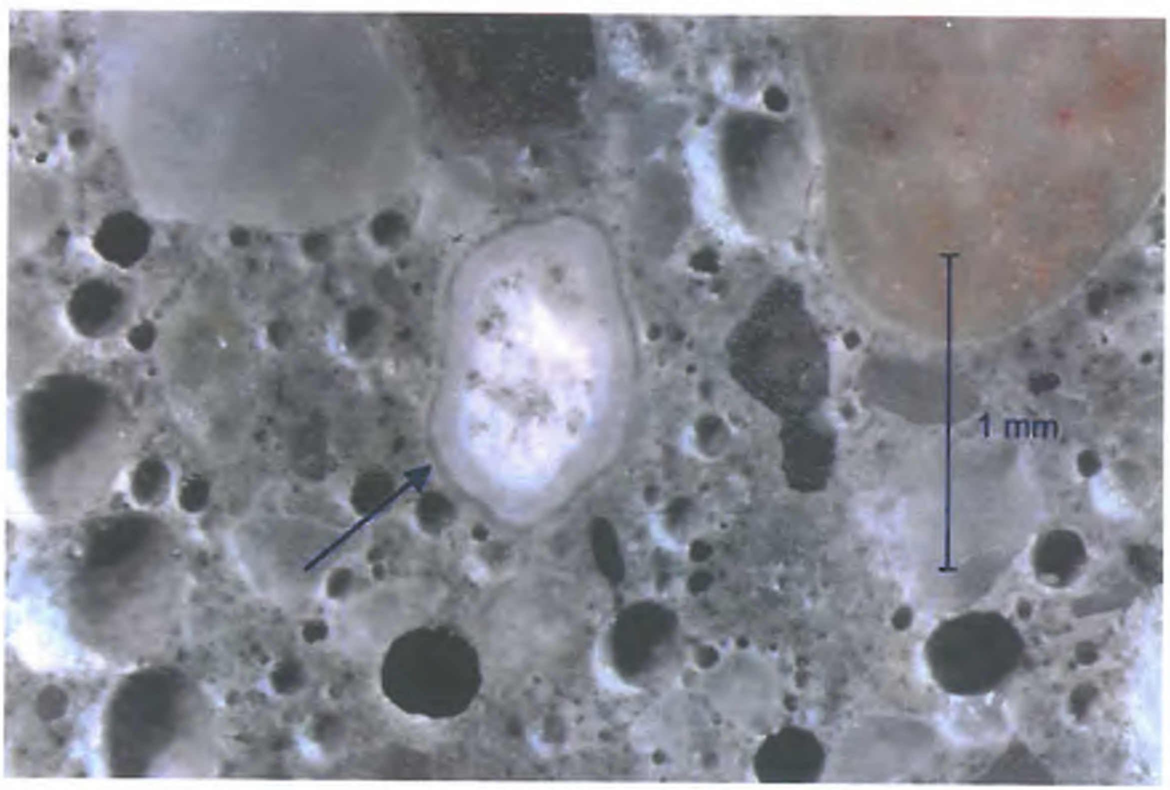
SAMPLE ID: 27-2-4(5) DESCRIPTION: Carbonation (unstained paste) was negligible from the top surface and occurred intermittently along the perimeter of carbonate aggregate particles.
MAG: 15x

PHOTO: 13

Route 20 Southbound

SAMPLE ID: 27-2-1(4) DESCRIPTION: Colorless to white alkali-silica gel lines an air void observed at depth within the sample.
MAG: 50x

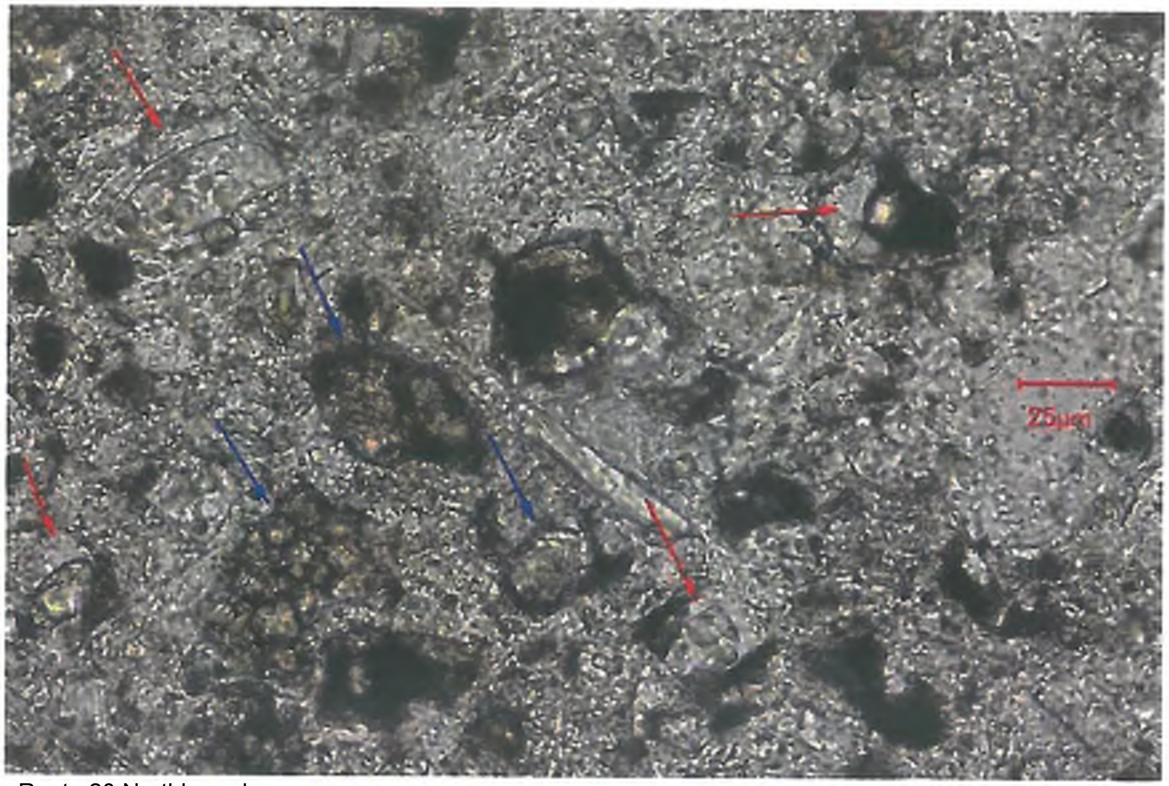
PHOTO: 14



Pembina Hwy. Overpass

SAMPLE ID: 27-2-3(5) DESCRIPTION: Colorless to white alkali-silica gel lines an air void observed at depth within the sample.
MAG: 50x

PHOTO: 17

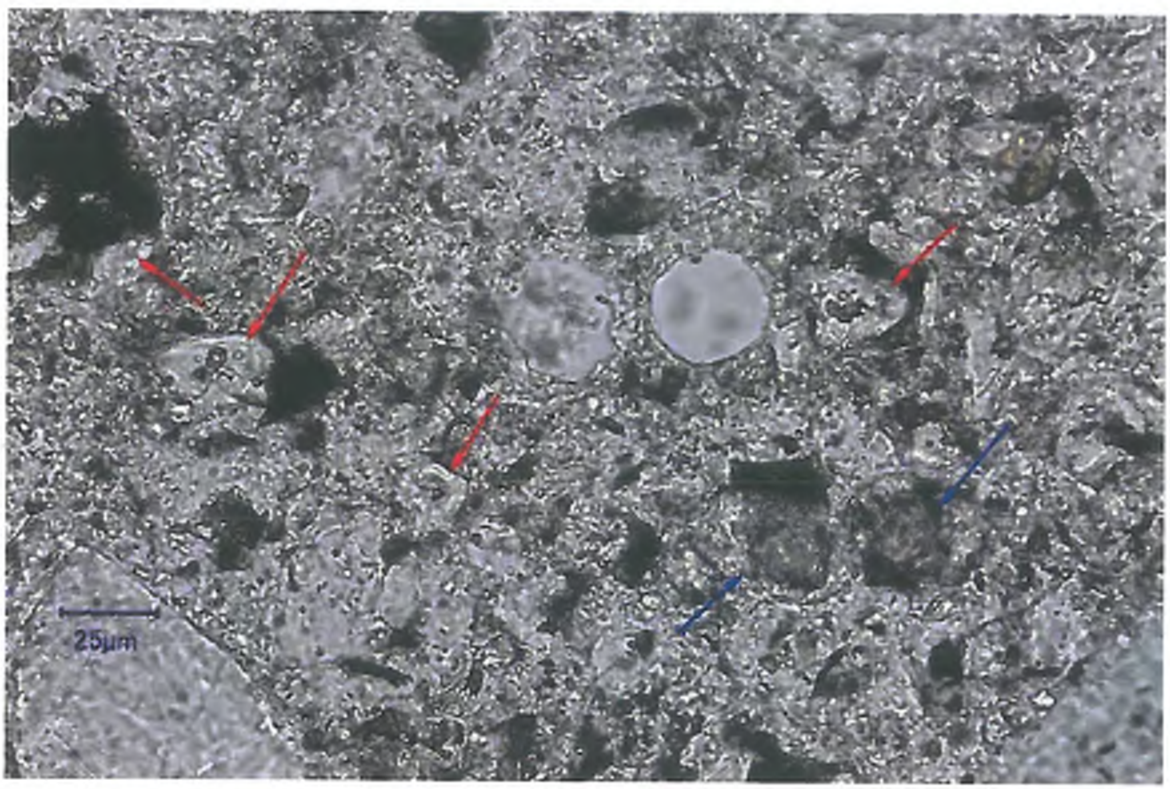


Route 20 Northbound

SAMPLE ID: 27-2-2(5)
MAG: 400x

DESCRIPTION: Well hydrated residual alite (red arrows) portland cement particles and residual belite (blue arrows) portland cement particles exhibiting a minor degree of hydration. In thin section of concrete paste viewed with transmitted plane polarized light.

PHOTO: 18



Pembina Hwy. Overpass

SAMPLE ID: 27-2-3(5)
MAG: 400x

DESCRIPTION: Well to fully hydrated residual alite (red arrows) portland cement particles and residual belite (blue arrows) portland cement particles exhibiting a moderate degree of hydration. In thin section of concrete paste viewed with transmitted plane polarized light.

APPENDIX C

Water Soluble Chloride Test Results

WATER SOLUBLE CHLORIDE ION CONTENT IN CONCRETE
(CSA A23.2-4B)

Golder Associates

October 23, 2017

Golder Project Number: 1521090-1010

AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, MB R3P 0Y7

Attention: Noelle Vialoux, P Eng.

Project ID:	**File No. 17-027-02, Bridge Deck Investigation; Route 42 Pembina Highway**
Location:	**Northbound Median Lane, 7.2m East of West Barrier - Station 77**

Date Cored: August 21-24, 2017
Date Received: October 3, 2017
Date Tested: October 6, 2017

Tested By: J. Allen

Ref No. Pembina Hwy. Overpass	**Core Number:**	**Golder Lab Number:**	**Horizon Depth (mm)**	**Water Soluble Chloride Ion Content (% Cl by weight of concrete)**
17-27-2-3	8	C-17-1130	10- 20	1.160
			30 - 40	0.697
			50 – 60	0.341
			70 – 80	0.080
			90 - 100	0.005
			110 - 120	0.004
Remarks:				

Reviewed by:
Jeremy Rose, Laboratory Manager

CCIL

WATER SOLUBLE CHLORIDE ION CONTENT IN CONCRETE
(CSA A23.2-4B)

October 23, 2017

Golder Project Number: 1521090-1010

AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, MB R3P 0Y7

Attention: Noelle Vialoux, P Eng.

Project ID:	**File No. 17-027-02, Bridge Deck Investigation; Route 42 Pembina Highway**
Location:	**Northbound Curb Lane, 2.4m West of East Barrier - Station 88**

Date Cored: August 21-24, 2017
Date Received: October 3, 2017
Date Tested: October 10, 2017

Tested By: J. Allen

Ref No. Pembina Hwy. Overpass	**Core Number:**	**Golder Lab Number:**	**Horizon Depth (mm)**	**Water Soluble Chloride Ion Content (% Cl by weight of concrete)**
17-27-2-3	9	C-17-1131	10- 20	0.792
			30 - 40	0.479
			50 – 60	0.274
			70 – 80	0.112
Remarks:				

Reviewed by: ______________________________
Jeremy Rose, Laboratory Manager

Appendix E

Photographs

Pembina Highway Overpass

Photo 01
West elevation.

Photo 02
West elevation looking south.

Photo 03
East elevation.

Photo 04
East elevation.

Pembina Highway Overpass

Photo 05
Southbound looking north.

Photo 06
Looking north from median.

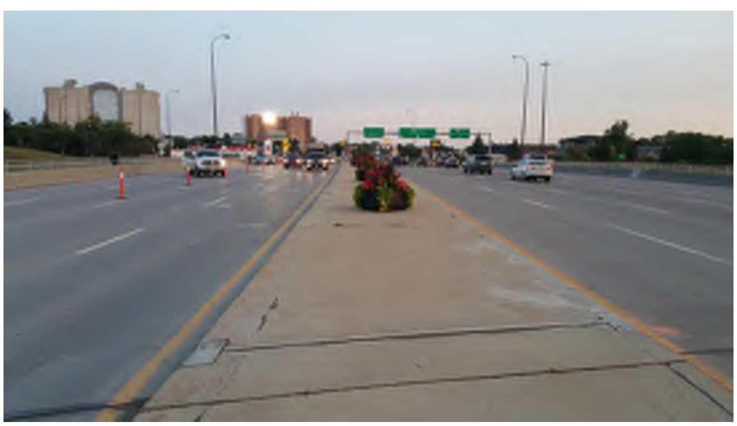


Photo 07
Looking south from median.

Photo 08
Northbound looking north.

Pembina Highway Overpass

Photo 09
Southbound looking north.

Photo 10
Southbound lanes looking south.

Photo 11
North approach slab, southbound lane with delamination of epoxy-polymer overlay.

Photo 12
South approach slab, northbound lanes.

Pembina Highway Overpass

Photo 13
Span 4 at south approach slab, northbound lanes.

Photo 14
Span 4, northbound lanes, wide crack through delamination.

Photo 15
Over pier 4, northbound lanes. 2011 and 2014 repairs, delaminations and wide cracks.

Photo 16
Span 3, northbound lanes.

Photo 17
Over pier 3, northbound lanes. 2011 and 2014 repairs, delaminations and wide cracks.

Photo 18
Span 2, northbound lanes.

Photo 19
Span 1, northbound lanes.

Photo 20
Span 1, northbound lanes.

Pembina Highway Overpass

Photo 21
Expansion joint between north approach slab and span 1, northbound lanes.

Photo 22
North approach slab, southbound lanes, with delamination of epoxy-polymer overlay.

Photo 23
Expansion joint between north approach slab and span 1, southbound lanes, very narrow gap.

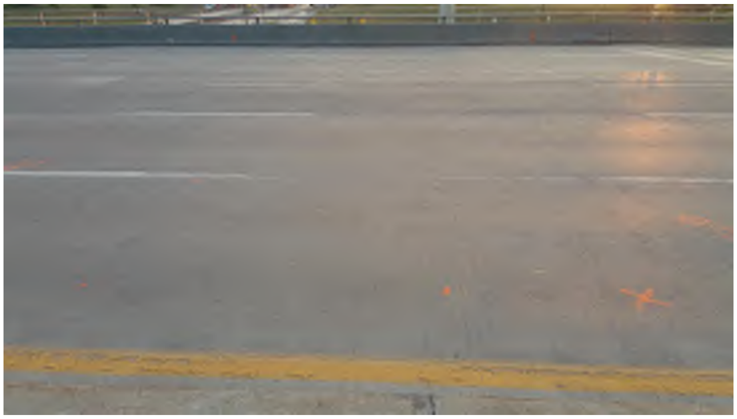
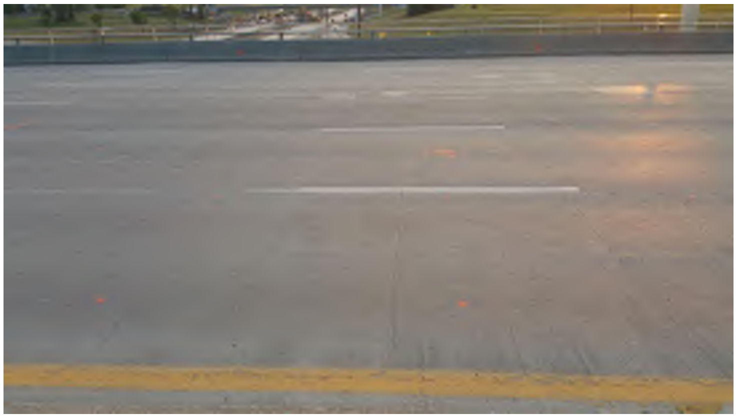


Photo 24
Span 1, southbound lanes.



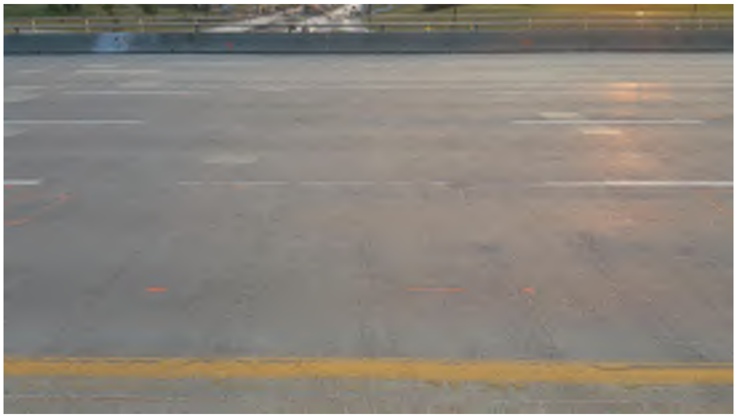


Photo 25
Span 2, southbound lanes.

Photo 26
Span 2/3, southbound lanes.

Photo 27
Span 3, southbound lanes.

Photo 28
Over pier 3, southbound lanes. Previous repairs, delaminations and cracks.

Pembina Highway Overpass

Photo 29
Expansion joint between south approach and span 4, southbound lanes, very narrow gap.

Photo 30
West sidewalk looking north.

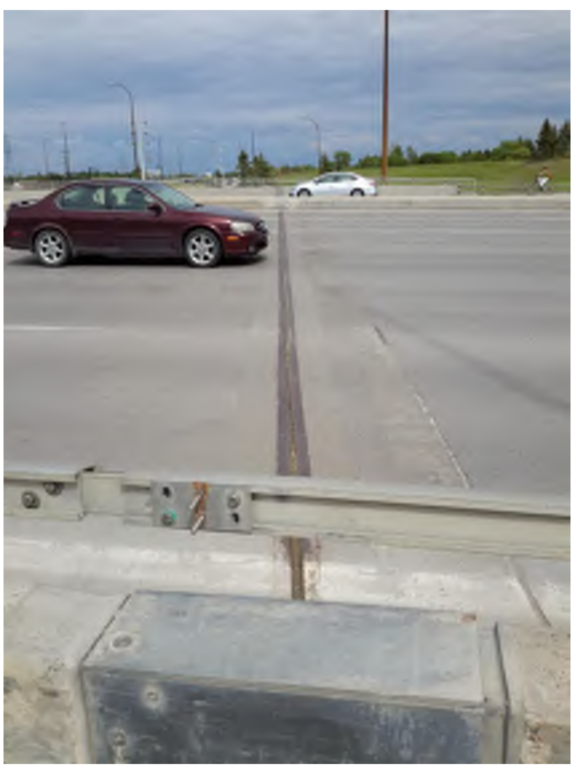


Photo 31
South expansion joint, southbound lanes, very narrow gap.
2017-08-23

Photo 32
South expansion joint, southbound lanes, narrow gap.
2018-01-19

Pembina Highway Overpass

Photo 33
North expansion joint, southbound lanes, very narrow gap.
2018-01-19

Photo 34
Typical traffic barrier joint.

Photo 35
West sidewalk looking north. Epoxy-polymer overlay visible.

Photo 36
East sidewalk spalling at north joint.

Pembina Highway Overpass

Photo 37
East sidewalk looking south.

Photo 38
East traffic barrier looking north.

Photo 39
Southeast traffic barrier, note impact damage to rail.

Photo 40
Southeast corner, note missing concrete curb with exposed rebar.

Pembina Highway Overpass

Photo 41
Leakage at north abutment expansion joint, looking east.

Photo 42
Leakage at north abutment expansion joint, between 4th and 5th bearing from west.

Photo 43
North abutment, corrosion on 4th bearing from west. Drain not plugged, leakage from expansion joint.

Photo 44
Leakage at north abutment expansion joint, between 10th and 11th bearing from west.

Pembina Highway Overpass

Photo 45
Leakage at north abutment expansion joint, between 10th and 11th bearing from west.

Photo 46
Spall on girder ends at north abutment with leakage from expansion joint.

Photo 47
Leakage at south abutment expansion joint, between 2nd and 3rd bearing from east.

Photo 48
Leakage at south abutment expansion joint, between 4th and 5th bearing from west.

Photo 49
Leakage at south abutment expansion joint, between 4th and 5th bearing from west.

Photo 50
Underside of the bridge deck, looking west. No signs of cracks, efflorescence or leakage. Frost at girder lines.

Photo 51
Underside of the bridge deck, looking west. No signs of cracks, efflorescence or leakage. Frost at girder lines.

Photo 52
Spalling at curb on east side wing wall of north abutment.

Photo 53
Spalling at curb on east side wing wall of north abutment.

Photo 54
West elevation, minimal signs of leakage at sidewalk construction joints.

Appendix F
OSIM Inspection Report

Manitoba Structure Inspection Manual - Inspection Form

Site Number: B-215

Inventory Data:

Structure Name		**Water Shed**	
Main Hwy/Road #	Route 42 — **On** ☑ **Under** ☐	**Crossing Type:**	**Navig. Water** ☐ **Non-Navig. Water** ☐ **Rail** ☐ **Road** ☑ **Ped.** ☐ **Other** ☐
Hwy/Road Name	Pembina Highway		
Structure Location	Pembina Highway Overpass		
UTM X	632903	**UTM Y**	5520181
Owner(s)	City of Winnipeg	**Heritage Destination:**	**Not Cons.** **Cons./not App.** **List/not Design.** **Design./not List** **Design. & List**
Region	-	**Road Class:**	**Freeway** **Arterial** ☑ **Collector** **Local**
Municipality	-	**Posted Speed**	60 — **No. of Lanes** 10
Parish	-	**AWDT**	47, 900 — **% Trucks** -
Legal Description	-	**Control Section**	-
Structure Type	Cast-in-Place Concrete Box	**Km Into Control Section**	-
Total Deck Length	86.80 **(m)**	**Interchange Structure Number**	
Overall Str. Width	47.00 **(m)**	**Min. Vertical Clearance**	5.00 **(m)**
Total Deck Area	4080.00 **(sq.m)**	**Special Routes:**	**Transit** **Truck** **School** **Bicycle**
Roadway Width	15.50 & 23.17 **(m)**	**Detour Length**	**(km)**
Skew Angle	12.42 **(Degrees)**	**Direction of Structure**	N-S
No. of Spans	4	**Fill on Structure**	N/A **(m)**
Span Lengths	20.0 / 25.0 / 22.8 / 19.0 **(m)**		

Historical Data:

Year Built	1990	**Last Evaluation**	-
Last Level 2 Inspection	05-26-15	**Current Load Limit**	- **(tonnes)**
Last Under Bridge Inspection	Unknown	**Load Limit By-Law #**	
Last Condition Survey	-	**By-Law Expiry Date**	
Last Underwater Inspection	N/A	**Cost Center**	-

Rehab History:

Year	Description of Work
2014	Delaminated concrete removed and patched. Galvanic anodes installed in patched areas and connected to existing reinforcing.

Site Number: B-215

Scheduled Improvements:

GWAG	Priority	Unit	Estimated Quantity	Avg. Unit Cost	Estimated Cost
Deck Rehabilitation - See detailed bridge deck investigation report					
				Subtotal	
				Regional Factor	
				Total Estimated Cost	

Appraisal Indices:		Comments
Fatigue		
Seismic		
Scour		
Flood		
Geometrics		
Barrier		
Curb		
Load Capacity		

Field Inspection Information:	
Date of Inspection:	Aug. 21 - 23, 2017
Inspector:	Murray Kowerko
Others in Party:	Noëlle Vialoux, Amanda Pushka & Eng-Tech
Equipment Used:	Chain Drag, Pachometer, RCT Testing, Coring Machine, Standard Equipment
Weather:	Clear, Artificially Illuminated (Overnight Inspection)
Temperature:	5 - 15°C

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	x		
Non-destructive Delamination Survey of Asphalt-Covered Deck:	x		
Substructure Condition Survey:	x		
Detailed Coating Condition Survey:	x		
Underwater Investigation:	x		
Fatigue Investigation:	x		
Structure Evaluation:	x		
Monitoring of Deformations, Settlements and Movements:	x		
Replace Structure:	x		
Rehabilitate Structure:	x		
Hydraulic Evaluation:	x		
Geotechnical Evaluation:	x		
Other:	x		
Special Notes:			
Next Detailed Visual Inspection:	-		

Suspected Performance Deficiencies

00 None
01 Load carrying capacity
02 Excessive deformations (deflections & rotations)
03 Continuing settlement
04 Continuing movements
05 Seized bearings
06 Bearing not uniformly loaded/unstable
07 Jammed expansion joint
08 Pedestrian/vehicular hazard
09 Rough riding surface
10 Surface ponding
11 Deck drainage
12 Slippery surfaces
13 Flooding/channel blockage
14 Undermining of foundation
15 Unstable embankments
16 Other

Maintenance Needs

01 Lift and Swing Bridge Maintenance
02 Bridge Cleaning
03 Bridge Handrail Maintenance
04 Painting Steel Bridge Structures
05 Bridge Deck Joint Repair
07 Repair to Structural Steel
08 Repair of Bridge Concrete
09 Repair of Bridge Timber
10 Bailey bridges - Maintenance
11 Animal/Pest Control
13 Erosion Control at Bridges
14 Concrete Sealing
15 Rout and Seal
16 Bridge Deck Drainage
17 Other

Element Data

Element Group:	**Approaches**		Length:	9.00			
Element Name:	**Approach Slabs**		Width:	38.67			
Location:	North and South		Height:	0.14			
Material:	Cast-in-place Concrete		Count	2			
Element Type:	Epoxy Coated Reinforced		Total Quantity:	696.06			
Environment:	Benign ☐ Moderate ☐ Severe ☑		Limited Inspection ☐				
Protection System:	None					Perform. Deficiencies	Maint. Needs
Condition Data:	Units	Exc.	Good	Fair	Poor*		
	m²	0.00	627.21	25.75	43.10	16	12

Comments:
NB lane: 23.17m wide & SB lane: 15.50m wide. Isolated areas of concrete spalls and delamination, generally near the bridge joints (~11.6m² total). Isolated longitudinal cracks visible throughout lanes (~103m medium and 126m wide total). Remnants of thin, delaminated epoxy polymer overlay on north approach, not causing any concern.

Recommended Work: None ☐ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☑ Urgent ☐
Apply sealer/healer over entire approach slabs.

Element Group:	**Barriers**		Length:	86.80			
Element Name:	**Barrier**		Width:	N/A			
Location:	East and West		Height:	0.81			
Material:	Pre-cast Concrete		Count	2			
Element Type:			Total Quantity:	140.62			
Environment:	Benign ☐ Moderate ☐ Severe ☑		Limited Inspection ☐				
Protection System:	None					Perform. Deficiencies	Maint. Needs
Condition Data:	Units	Exc.	Good	Fair	Poor*		
	m²	0.00	136.06	4.00	0.56	00	00

Comments:
Generally in good condition with isolated narrow- medium vertical cracks (~16m medium total) and spalls between barrier sections (~0.56m² total with depths up to 50mm). Sealant failing between the barrier sections primarily at the road surface.

Recommended Work: None ☑ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☐ Urgent ☐

Element Group:	**Barriers**		Length:	109.20			
Element Name:	**Hand Railings**		Width:	N/A			
Location:	East and West Barrier		Height:	N/A			
Material:	Aluminum		Count	2			
Element Type:	Barrier Railing		Total Quantity:	218.40			
Environment:	Benign ☐ Moderate ☐ Severe ☑		Limited Inspection ☐				
Protection System:	None					Perform. Deficiencies	Maint. Needs
Condition Data:	Units	Exc.	Good	Fair	Poor*		
	m	0.00	218.40	0.00	0.00	00	00

Comments:
Generally in good condition.

Recommended Work: None ☑ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☐ Urgent ☐

* A quantity must be estimated using the appropriate unit (e.g. m^2). Percentage should not be used.

Element Data

Element Group:	**Barriers**		Length:	112.20			
Element Name:	**Railing Systems**		Width:	N/A			
Location:	East and West Sidewalk		Height:	1.07			
Material:	Aluminum		Count	2			
Element Type:	Panel		Total Quantity:	224.40			
Environment:	Benign ☐ Moderate ☐ Severe ☑		Limited Inspection ☐				
Protection System:	None					Perform. Deficiencies	Maint. Needs
Condition Data:	Units	Exc.	Good	Fair	Poor*		
	m	0	224.40	0.00	0.00	00	00

Comments:
Approach railing height: 0.92m & deck railing height: 1.07m. Generally in good condition.

Recommended Work: None ☑ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☐ Urgent ☐

Element Group:	**Deck**		Length:	86.80			
Element Name:	**Deck Top**		Width:	38.67			
Location:			Height:	0.140			
Material:	Cast-in-place Concrete		Count	N/A			
Element Type:	Epoxy Coated Reinforced		Total Quantity:	3356.56			
Environment:	Benign ☐ Moderate ☐ Severe ☑		Limited Inspection ☐				
Protection System:	None					Perform. Deficiencies	Maint. Needs
Condition Data:	Units	Exc.	Good	Fair	Poor*		
	m^2	0.00	2980.81	227.50	148.25	09	12

Comments:
NB lane: 23.17m wide & SB lane: 15.50m wide. Numerous areas of previously patched concrete throughout deck top, approximately 220m² total. Deck is generally in good condition with isolated areas of delamination (~87m² total), medium transverse cracking (~910m total) and wide transverse cracking (~245m total).

Recommended Work: None ☐ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☑ Urgent ☐

Sawcut and remove delaminated areas. Repair epoxy coating on reinforcing. Install localized galvanic anodes at low concrete dover and spot repair areas. Apply sealer/healer over entire deck area.

Element Group:	**Joints**		Length:	N/A			
Element Name:	**Armouring/Retaining Devices**		Width:	47.00			
Location:	North and South Abutments		Height:	N/A			
Material:	Steel		Count	2			
Element Type:	Single Strip Seal		Total Quantity:	94.00			
Environment:	Benign ☐ Moderate ☐ Severe ☑		Limited Inspection ☐				
Protection System:	None					Perform. Deficiencies	Maint. Needs
Condition Data:	Units	Exc.	Good	Fair	Poor*		
	m	0	94.00	0.00	0.00	00	00

Comments:
Generally in good condition with isolated areas of light corrosion.

Recommended Work: None ☑ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☐ Urgent ☐

* A quantity must be estimated using the appropriate unit (e.g. m^2). Percentage should not be used.

Element Data

Element Group:	**Joints**	Length:	1.40
Element Name:	**Concrete End Dams**	Width:	47.00
Location:	North and South Abutments	Height:	N/A
Material:	Cast-in-Place Concrete	Count	2
Element Type:		Total Quantity:	131.60
Environment:	Benign ☐ Moderate ☐ Severe ☑	Limited Inspection ☐	
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor*	Perform. Deficiencies	Maint. Needs
	m²	0.00	129.08	2.50	0.02	00	00

Comments:
Light to medium longitudinal cracks in both north and south end dams (~10m medium total). Spalls in north end dam in southbound lane (~0.02m² total). Patched areas at south end dam in northbound lane.

Recommended Work: None ☑ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☐ Urgent ☐

Element Group:	**Joints**	Length:	N/A
Element Name:	**Seals / Sealants**	Width:	47.00
Location:	North and South Abutments	Height:	N/A
Material:	Neoprene	Count	2
Element Type:	Single Strip Seal	Total Quantity:	94.00
Environment:	Benign ☐ Moderate ☐ Severe ☑	Limited Inspection ☐	
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor*	Perform. Deficiencies	Maint. Needs
	m	0.00	0.00	94.00	0.00	00	00

Comments:
Expansion joints were very compressed with evidence of localized leaks.

Recommended Work: None ☑ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☐ Urgent ☐

Element Group:	**Sidewalks/Curbs**	Length:	86.80
Element Name:	**Sidewalks and Medians**	Width:	1.53
Location:	East and West	Height:	N/A
Material:	Cast-in-Place Concrete	Count	2
Element Type:		Total Quantity:	265.61
Environment:	Benign ☐ Moderate ☐ Severe ☐	Limited Inspection ☐	
Protection System:			

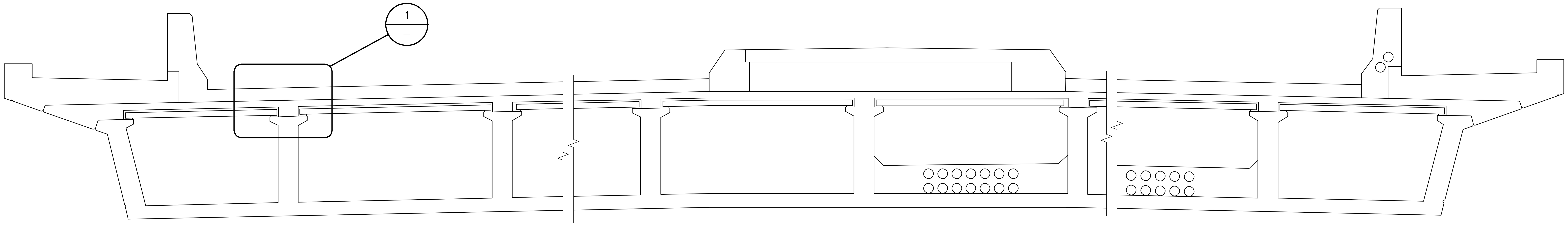
Condition Data:	Units	Exc.	Good	Fair	Poor*	Perform. Deficiencies	Maint. Needs
	m²	0.00	265.61	0.00	0.00	00	00

Comments:
Generally in good condition with several areas of delaminated epoxy polymer layer.

Recommended Work: None ☑ 6-10 Years ☐ 1-5 Years ☐ <1 Year ☐ Urgent ☐

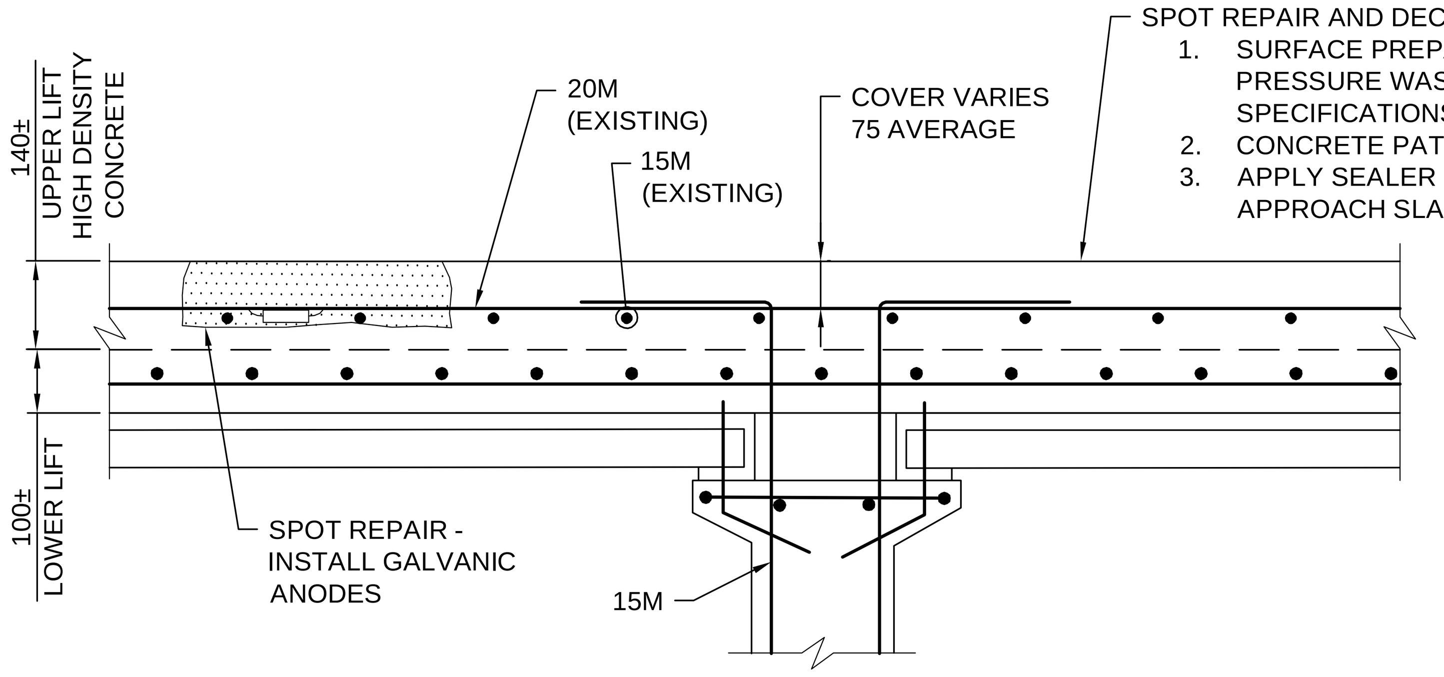
* A quantity must be estimated using the appropriate unit (e.g. m²). Percentage should not be used.

Appendix G
Typical Repair Sketches



TYPICAL CROSS SECTION

SCALE 1:25

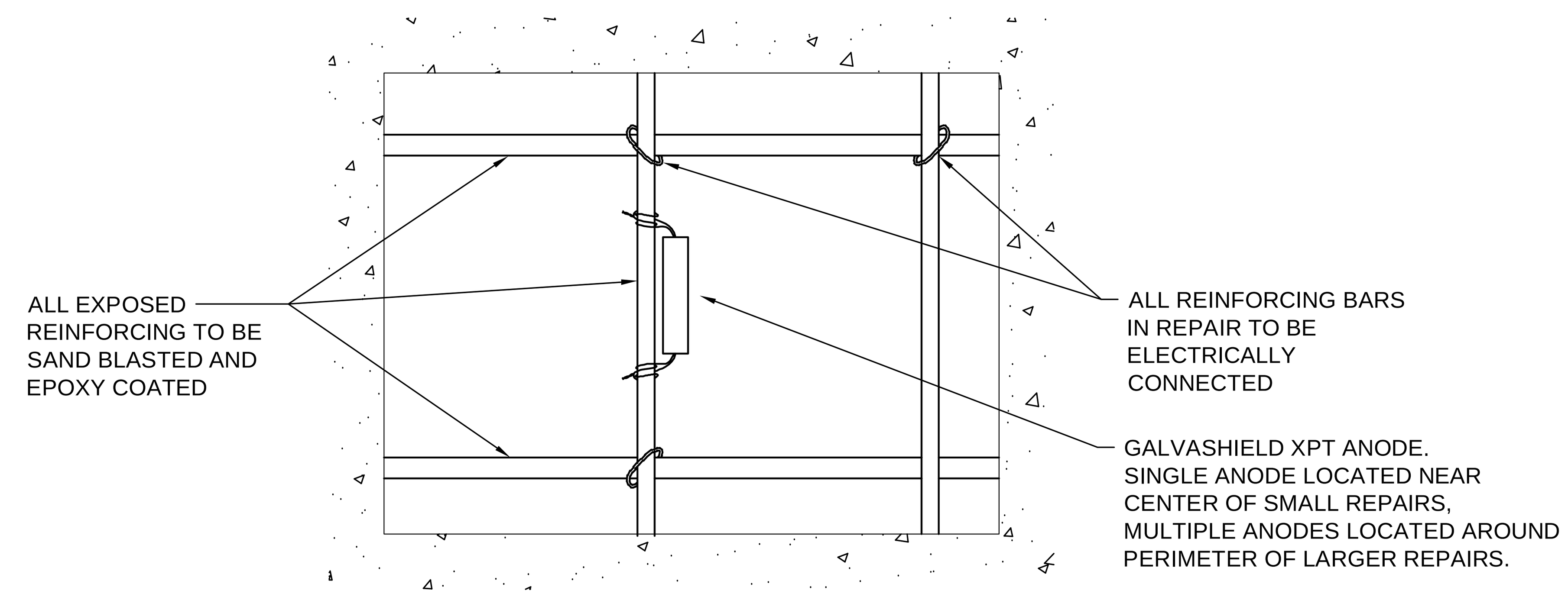


SPOT REPAIR AND DECK/CRACK SEALING

1. SURFACE PREPARATION WITH SAND BLASTING AND PRESSURE WASH AND AS PER MANUFACTURERS SPECIFICATIONS.
2. CONCRETE PATCHING FOR ALL DELAMINATION AREAS.
3. APPLY SEALER / HEALER OVER ENTIRE DECK AND APPROACH SLABS.

1 — DETAIL

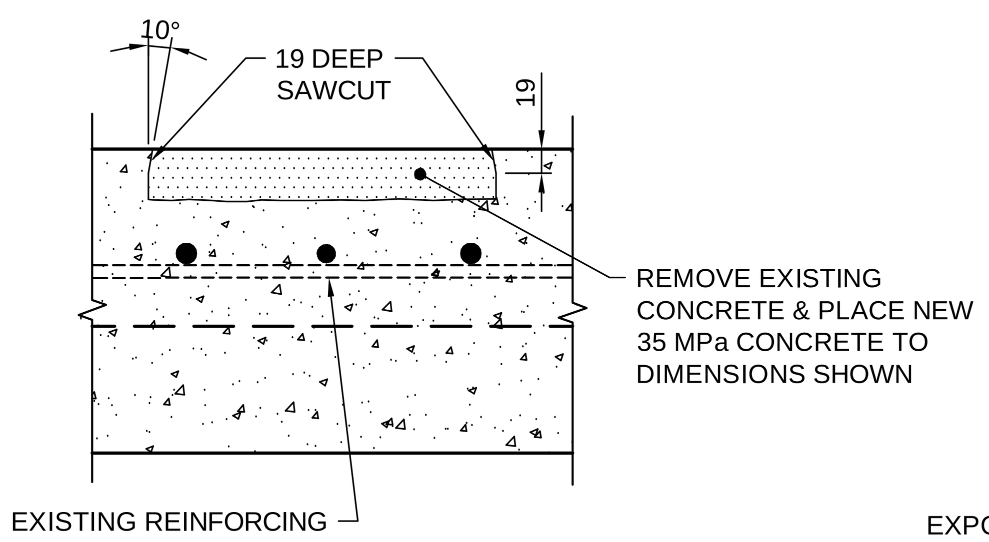
SCALE 1:10



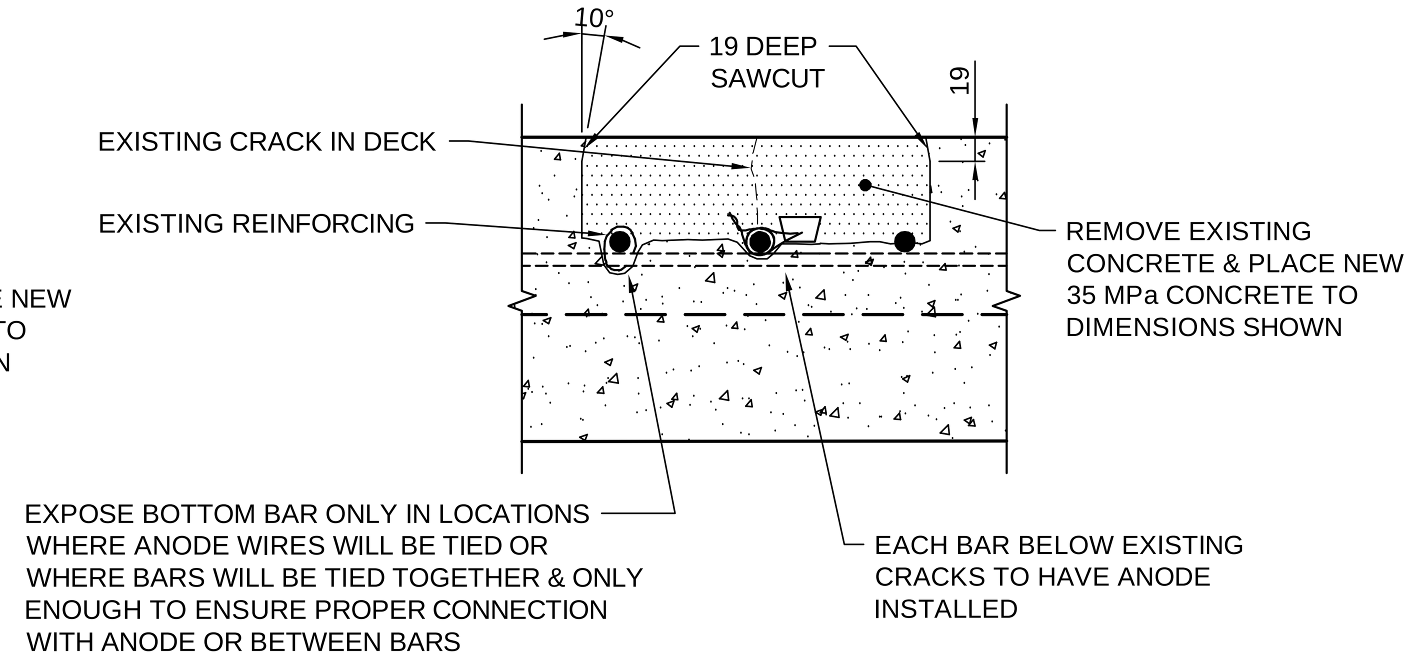
PLAN VIEW

REPAIR AREA (mm)	MINIMUM NUMBER OF ANODES
300 X 300	1
350 X 350	2
400 X 400	3
> 400 X 400	AT MAX. 500 SPACING AROUND PERIMETER
ALL LOCATIONS	AT EACH BAR BELOW EXISTING CRACK

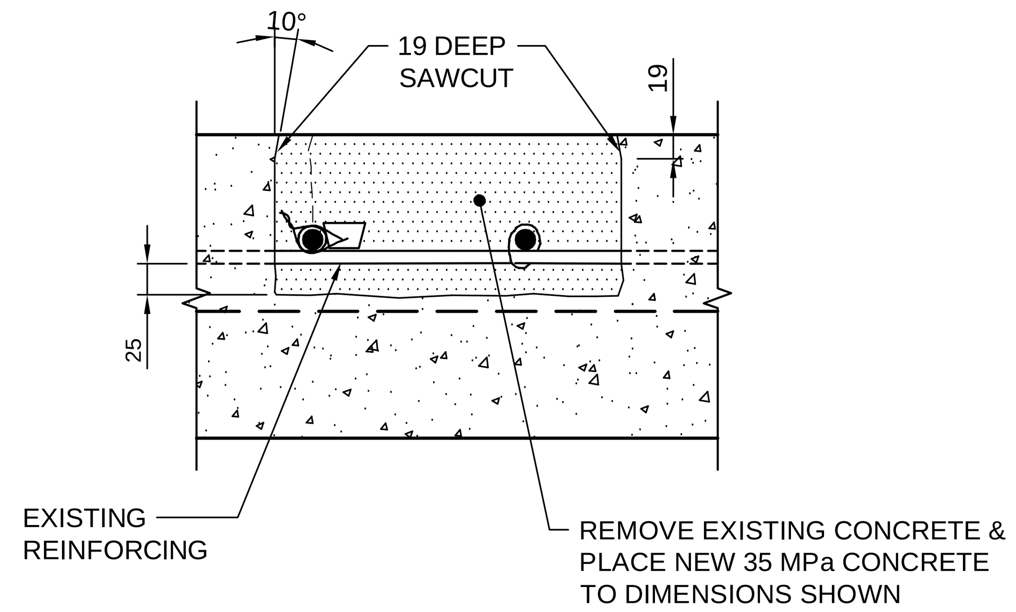
AND AS DIRECTED BY CONTRACT ADMINISTRATOR



TYPE 1 REPAIR
SHALLOW DEPTH
(20 - 40 mm DEEP)



TYPE 2 REPAIR
PARTIAL DEPTH
(40 - 74 mm DEEP TO
MID-HEIGHT OF TOP BARS)



TYPE 3 REPAIR
FULL DEPTH
(75 - 100 mm DEEP)

TYPICAL DECK REPAIR DETAILS

SCALE N.T.S.

METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

B.M.
ELEV.

NO.	REVISIONS	DATE	BY
0	ISSUED FOR REPORT	22/11/15	EBL

AECOM

DESIGNED BY	DKD	CHECKED BY	EBL
DRAWN BY	KAM	APPROVED BY	EBL
HOR. SCALE:	1:150	RELEASED FOR CONSTRUCTION BY:	
VERTICAL:			
DATE	2018/05/25	DATE	

ENGINEER'S SEAL

CONSULTANT DRAWING NO.
CS-02_REPORT

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

PEMBINA HIGHWAY OVERPASS
2018 BRIDGE DECK REPAIRS

CITY DRAWING NUMBER

SHEET 1 OF 1

DECK REPAIR DETAILS