Lake Simcoe Region conservation authority

Structural Design Memorandum

Pefferlaw Dam

Town of Georgina
Regional Municipality of York

D.M. Wills Project Number 19-5381

D.M. Wills Associates Limited
Partners in Engineering, Planning and Environmental Services
Peterborough

July 2020

Prepared for:
Lake Simcoe Region
Conservation Authority

Submissions Summary

Submission No.	Submission Title	Date of Release	Submissions Summary
1	Draft Report Submission	July 3, 2020	Submitted for Review
2	Final Report Submission	July 16, 2020	Issued as Final

This report / proposal has been formatted considering the requirements of the Accessibility for Ontarians with Disabilities Act.

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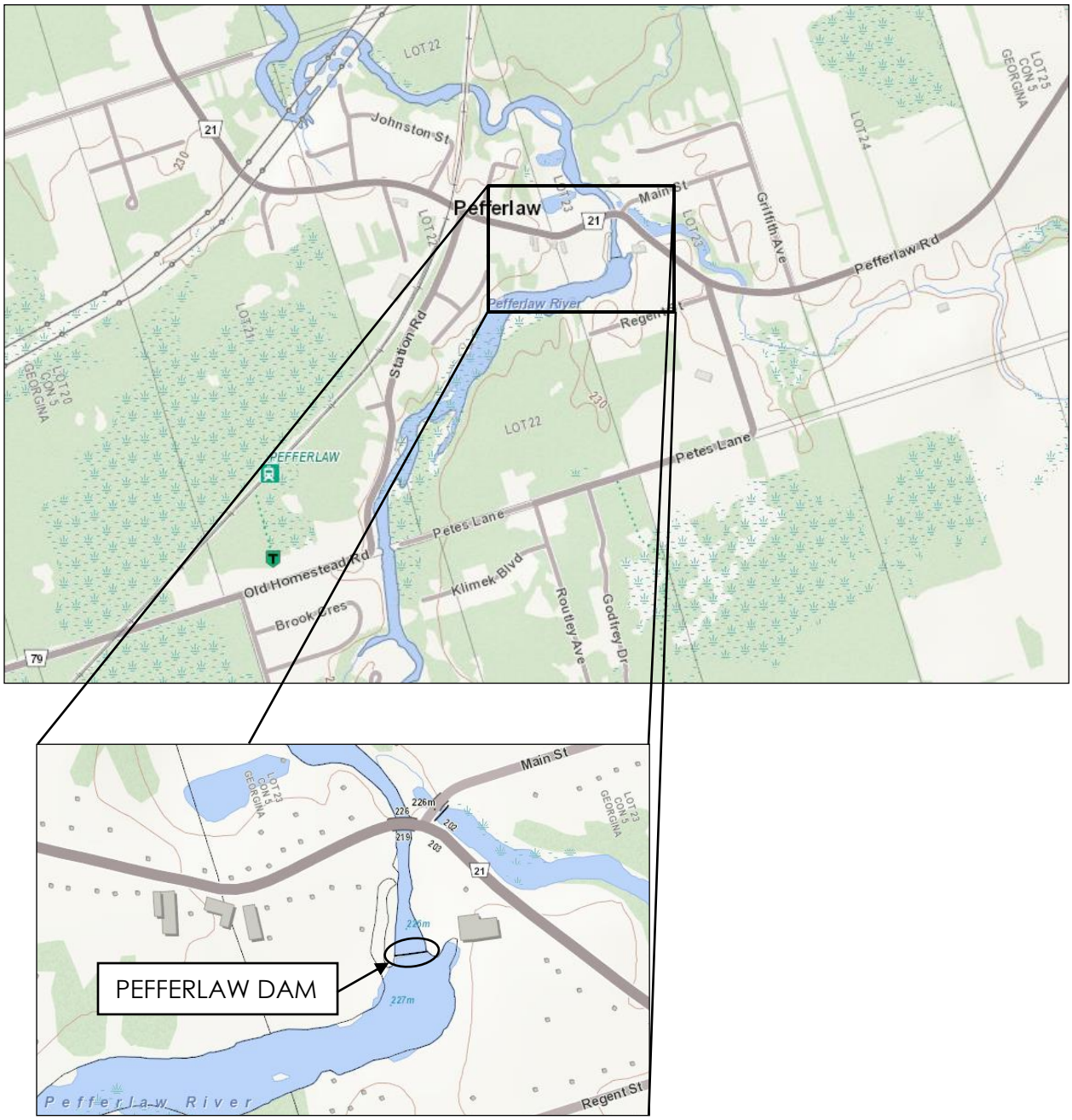

1.0 Introduction

In response to the recommendations within the 2019 Dam Inspection Report completed by D.M. Wills Associates Limited (Wills), the Lake Simcoe Region Conservation Authority (LSRCA) has retained the services of Wills to complete a Concrete Condition Assessment (CCA) and Structural Evaluation of the truss over the operational span of the Pefferlaw Dam and the reporting thereof. This Structural Design Memorandum has been prepared to summarize the findings of both the CCA and Structural Evaluation and provide alternatives for the rehabilitation of the structure. A life cycle cost analysis has been completed to recommend the most cost effective alternative to address the deterioration of the operation span by considering the expected costs over the life of the structure for each alternative.

1.1 Background

The Pefferlaw Dam is located on the Main Branch of the Pefferlaw River approximately 200 m south of Pefferlaw Road in the Village of Pefferlaw, Town of Georgina, Regional Municipality of York.

The substructure of the dam was originally constructed in the early 1880's. The original purpose of the dam was to provide water storage to power three (3) mills located on the watercourse. Mill races were constructed on both the east and west sides of the Main Branch of the Pefferlaw River to channel water to the mills. The mills have since ceased operations. The downstream channel and the headpond provide recreational uses and contribute to the general aesthetic of the area, as the former mill sites downstream of the dam have been redeveloped as a municipal park and a number of residences have been constructed adjacent to the headpond. Several residences have docks constructed on the headpond.

A major rehabilitation of the dam was completed in 1982, which included construction of the current steel truss pedestrian bridge, concrete repairs of the piers and substructure elements, and construction of a fish ladder (now removed). In 1990 the structure was converted from a twin sluice configuration to a single sluice.

The dam consists of a 31 m long concrete gravity structure with a 20 m long earth embankment on the west side and a 30 m long earth embankment on the east side. The concrete gravity structure includes a 13 m long concrete weir topped with timber flash boards on the left (west) side of the structure, a 4.8 m wide sluiceway with timber stoplogs in the middle of the structure and a 7.2 m long overflow weir on the right (east) side of the structure. There are concrete aprons below the weirs and the centre sluiceway as well as concrete wingwalls on both the left (west) and right (east) sides. Access across the dam is provided by a 1.1 m wide steel truss approach spans, and a 1.82 m wide steel truss operation span. The truss bridge is supported on a stub concrete abutment located behind the dams east wingwall, by steel posts at the sluiceway piers, and on a bearing seat at the dams west wingwall. The west approach span has existing fall arrest anchorage in place, while the operation span and east approach span do not. The dam is accessed from Pefferlaw Road, which is located approximately 200 m

north (downstream) of the structure. Access by motorized vehicles is available via a gravel road on the west side of the Pefferlaw River. A gate at Pefferlaw Road restricts unauthorized vehicles from accessing the west side access road. There is a secondary gated access on the east side of the Pefferlaw River that could be used as an emergency or maintenance access to the east side of the dam.

1.2 2019 Dam Inspection Summary

Wills conducted an inspection of the Pefferlaw Dam in November 2019. The inspection was generally comprised of visual inspection of the various elements of the structure, as well as documentation via several methods including - underwater, on ground, and aerial photography and videography, sketches, and physical measurements. Following the inspection, Wills provided the LSRCA with ten (10) recommendations.

Of the ten (10) recommendations presented in the Dam Inspection Report, LSRCA has opted to move forward in addressing four (4) recommendations, listed below:

1. Undertake a concrete condition assessment of the dam;
2. Complete a structural evaluation of the truss bridge and develop repair or replacement options;
3. Confirm that the truss/railing has sufficient capacity to act as a fall arrest anchor point for use by operators during stoplog operations; and
4. Complete a new Dam Safety Review.

This report has been prepared to address recommendations 1-3 listed above.

1.3 Reference Documents

The following documents were available in preparation of this report:

- Dam Inspection Report, D.M. Wills Associates Limited, December 2019.
- Draft Limited Condition Survey Report, Bridge Check Canada, June 2020.
- Original Tender Drawing (D3), Marshall Macklin Monaghan Ltd., May 1982.

2.0 Concrete Condition Assessment

Wills retained the services of Bridge Check Canada Ltd. to complete a limited condition survey of the dam in accordance with the requirements of the MTO Structural Rehabilitation Manual (2007). The condition survey consisted of a delamination and concrete deterioration survey on all exposed concrete components, as well as coring and physical testing of concrete core samples to determine air entrainment and compressive strength. A total of twelve (12) cores were extracted from across the structure; three (3) from the west abutment and retaining wall, two (2) from the east abutment and retaining wall, two (2) from the west apron slab and weir, three (3) from the east apron and weir, and one (1) from each of the east and west piers.

The findings of the limited condition survey report indicate that the majority of the concrete elements are experiencing deterioration in the form of wide cracks, efflorescence staining, delamination, and spalling, with areas of light, medium, and severe scaling. In general, the concrete elements of the dam are described as being in fair to poor condition, as summarized below:

- East Abutment / Retaining Wall in poor condition.
- West Abutment / Retaining Wall in fair to poor condition.
- East Weir in fair condition.
- East Apron in poor condition.
- West Weir in fair to poor condition.
- West Apron in poor condition.
- East Pier in fair condition.
- West Pier in fair to good condition.

The concrete cores tested for compressive strength results ranged from 21.7 MPa to 57.1 MPa. The original tender drawings for the dam restoration completed in 1982 specified a minimum concrete strength of 28 MPa, therefore the east abutment and retaining wall, west abutment and retaining wall, and west pier each recorded one concrete core with a compressive strength lower than the intended design strength (26.6 MPa, 21.7 MPa, and 24.5 MPa, respectively). In core samples where reinforcing steel was encountered, the steel was in good condition with no evidence of surface corrosion.

Delamination planes were noted in three (3) of the twelve (12) cores (25%), however, these cores were extracted from areas where delamination was known to be present through surface sounding. The depth at which the delamination planes were recorded ranges between 15-190 mm, with an average depth of 163 mm. Large aggregate was encountered below the 1982 rehabilitation work in several of the cores, which is common for early concrete dams.

Two (2) cores were extracted to determine the air entrainment of the existing concrete. The West retaining wall was found to not be air entrained, and the east weir was found to be air entrained.

The entirety of the Limited Condition Survey Report can be found in **Appendix B**.

2.1 Concrete Rehabilitation

Based on the extent of deterioration noted in the concrete condition assessment and remaining service life of the structure, rehabilitation of the concrete elements is required to extend their useful life. Given that deterioration is primarily attributed to the surface concrete, rehabilitation through crack injection and typical localized shallow depth removal and patch repairs is considered suitable. If the cumulative area of delamination and spalling on any given element covers the majority of the exposed

face, partial or complete refacing of the concrete element should be considered. Complete replacement of the east abutment retaining wall is recommended, and partial replacement or grouting below the east apron slab will be required.

The approximate cost to implement all concrete rehabilitation recommendations is $368,065. The detailed preliminary cost estimate can be found in **Appendix C**.

3.0 Pedestrian Truss Bridge – Operational Span Evaluation

The pedestrian truss bridge spans the entirety of the structure and is comprised of coated square HSS steel sections for the truss elements and a galvanized grate walking surface. The operational span, located between the east and west piers, includes an opening for stoplog operation. Erected in 1981, the steel truss is in year 39 of an assumed 75-year design life.

The 2019 Dam Inspection reported that the east and west spans are in fair condition, with coating failure and minor corrosion throughout. In addition, the inspection report indicated that the operational span is in poor condition with wide cracks in some corners of the square HSS. A bearing seat failure in the form of a spall was found at the southwest bearing of the west abutment. As a result of the 2019 Dam Inspection, an evaluation of the operational span has been completed.

The evaluation included creation of a model of the existing operational truss in SAP2000 as shown in **Figure 1**, including member dimensions from the design drawings that were verified onsite, and design strengths from the drawings. Various loading scenarios were applied to determine the demand on the elements of the operational truss to determine if elements of the truss are overstressed.

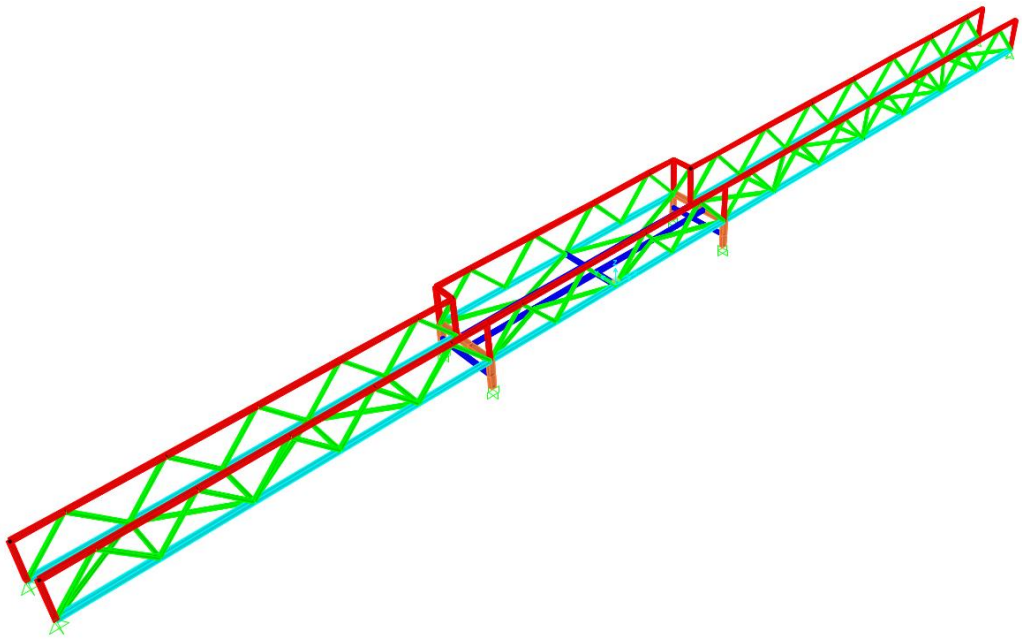

Figure 1 – Pefferlaw Dam Access Bridge SAP2000 Model

The operational span of the pedestrian bridge was analyzed using the following loads:

- Pedestrian Live Load of 3.95 kPa as per CHBDC, Clause 3.8.9
- Wind Load of 0.96 kPa
- Log stockpiling load (Max. five (5) of 200x300x4890 timber logs)

It was determined through the evaluation that the effect of the storing of stoplogs is less than the effect of the specified pedestrian live load. Furthermore, it was determined that the cracking at the end vertical HSS of the middle truss section are not due to overstressing. The operational span truss was found to be capable of carrying the above mentioned loads, and the anchorage at the pier posts were determined to be adequate.

As there is no fall arrest anchorage provided across the operational span, the truss was also analyzed for the following load:

- Fall Arrest Load of 8 kN with a Factor of Safety of 2.0 (16 kN total) as per the Occupational Health and Safety Act, Construction Projects Regulation (O. Reg. 213/91, s.16)

It was determined through the evaluation that the top chord of the truss has inadequate capacity to be used as a fall arrest anchor. The operation span truss was found to be capable of carrying the fall arrest load if the anchor was located on the bottom chord at the convergence of diagonals and at the end posts. All fall arrest systems and anchorage should be verified to be in compliance with O. Reg. 213/91, s.16.

Figure 2 – Fall Arrest Anchor Possible Locations

The existing fall arrest system does not span the operational span of the truss. However, the existing system on the western span, comprised of a steel cable passing through eyelets welded to L-shaped HSS members which are fastened to the underside of the approach truss, should be assessed and if suitable can be extended over the operational span. Preferably new supports erected on top of the concrete piers would remove the fall arrest system from the truss altogether. This approach to the extension of the existing fall arrest system separates the operational span truss from the fall arrest system, which is preferred when considering future maintenance or replacement of either element.

Notwithstanding the adequacy of the existing truss structure, the following recommendations are presented as a result of the evaluation:

- Repair cracks at the operation span truss end vertical HSS.
- Repair concrete and repair the bearing seat at the west abutment.
- Recoat structural steel.
- Review current fall arrest anchorage practices and modify as necessary.

Based on the findings of the structural evaluation of the pedestrian truss bridge, two (2) alternatives for addressing the condition of the operational span are considered for further evaluation.

3.1 Alternative 1 – Truss Rehabilitation

Alternative 1 has been developed based on the recommendations of the structural evaluation and is comprised of the rehabilitation of the pedestrian truss bridge through weld repair, recoating of the structural steel over the operational span, as well as repair of the spalled concrete under the bearing at the west abutment. Alternative 1 is considered to be a short term solution and is intended to realize the remaining service life of the structure (36 years).

The approximate cost to implement Alternative 1 is $52,650. The detailed preliminary cost estimate can be found in **Appendix C**.

3.2 Alternative 2 – Truss Replacement

Alternative 2 addresses the recommendations from the structural evaluation through replacement of the operational span of the dam. Similar to Alternative 1, this alternative includes rehabilitation of the spalled concrete under the bearing seat at the west abutment. The purpose of Alternative 2 is to provide LSRCA with a long term solution and determine which of the short and long term solutions provides LSRCA the best value.

The approximate cost to implement Alternative 2 is $61,750. The detailed preliminary cost estimate can be found in **Appendix C**.

3.3 Life Cycle Cost Analysis

In order to determine which alternative to address the condition of the operational span presents the best value to LSCRA, a Life Cycle Cost Analysis (LCCA) is required. For the purposes of the LCCA, the costs related to the concrete rehabilitation have been discounted from each alternative, with the exception of the bearing concrete repair required under both Alternatives. The resulting net present value of the costs of Alternatives 1 & 2 are $67,902 and $63,959, respectively. At the end of their respective life cycles the cost to replace the truss was entered to represent a truss replacement at the dam in the future. Service lives of 35 and 75 years were assigned to Alternative 1 and 2, respectively, with 75 years used thereafter to represent subsequent truss replacements.

The results of the LCCA, found in **Appendix D**, indicate that there is greater value in replacing the operational span of the truss as opposed to its rehabilitation.

4.0 Conclusion and Recommendations

Having been constructed in 1981, the pedestrian truss bridge across the Pefferlaw Dam has progressed through 39 years of its assumed design life of 75 years. The 2019 Dam Inspection and subsequent Limited Condition Survey revealed several sources of deterioration across the dam which require intervention in the form of replacement and/or rehabilitation. Two (2) alternatives have been developed with consideration given to short and long term effectiveness, and the costs compared.

Alternative 1, truss repair / rehabilitation, was developed as a short term solution with the aim to address deterioration noted during the field investigations. Alternative 2, truss replacement, was developed to provide LSRCA with a long term solution against which Alternative 1 could be compared through an LCCA in order to determine which alternative presents the best value. Based on the results of the LCCA, Alternative 2 is the recommended rehabilitation solution for the Pefferlaw Dam. As stated in **Section 3.2**, the cost to implement Alternative 2 is **$ 61,750**.

The scope of this assignment limited evaluation of the pedestrian truss bridge to the operational span. Given that the protective coating of the structural steel is in poor condition across both the approach and operational spans, consideration should be given to the complete replacement of the pedestrian access bridge. If the structural steel over the operational span is replaced and no remedial work completed on the remainder of the pedestrian bridge, an additional rehabilitation of the remaining structural steel will be required in the next 5 – 10 years as deterioration progresses in the form of corrosion and section loss. Consideration should also be given to rehabilitating the Substructure Concrete during this rehabilitation cycle. If no remedial work is completed on the Substructure Concrete, an additional rehabilitation of the east abutment and truss bearing seat will be required in the next 1 - 5 years and rehabilitation of the remainder of the substructure within the next 5 – 10 years.

Completing all of the recommended work under a single contract will result in savings on items related to mobilization, construction layout, and environmental protection. Furthermore, replacement of all structural steel would be aesthetically preferential.

Note that completion of a Dam Safety Assessment is required prior to undertaking the recommended concrete rehabilitation work as the Ministry of Natural Resources and Forestry will require this information prior to issuing a permit for the work under the Lakes and Rivers Improvement Act. The current Dam Safety Assessment is outdated as it was completed in 2008 and the Hazard Potential Classification, Inflow Design Flood, and Hydraulic Capacity should be confirmed to determine if additional measures beyond those identified in this report are required. The current Dam Safety Assessment also identified stability deficiencies with the existing dam that should be addressed. Given this the estimates provided in this report should be considered a lower bound for the estimated concrete rehabilitation cost.

The general rehabilitation work, associated costs, and recommended timeline for implementation are tabulated below:

Table 1 – Recommended Rehabilitation Works; Description, Cost, Time Horizon

Rehabilitation Area	Description of Work	Associated Cost	Time Horizon
Substructure Concrete	Misc. localized concrete removal and form and pump patch repair, isolated refacing of widely deteriorated elements	$ 368,065	1 – 5 Yrs
* Operational Span (Replacement)	Replace pedestrian bridge over operational span, including extension of existing fall arrest system	$ 61,750	5 – 10 Yrs
* Pedestrian Access Bridge (Full Replacement)	Replace pedestrian bridge, including operational and approach spans	$ 165,750	5 – 10 Yrs

* Requires localized concrete repair under bearing at southwest edge of west abutment

If access across the pedestrian access bridge and operation of the dam is required in the interim prior to the implementation of the above recommendations, the following work is to be completed:

- Weld Crack Repair of the Operational Span

The estimated cost to complete this work is $ 5,000.

Prepared by:

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Structural EIT

Zach Staples, P.Eng.
Assistant Manager, Structural Engineering

Appendix A

Site Photographs

Photo 1 – Downstream Elevation, Looking South

Photo 2 – Upstream Elevation, Looking Northwest

Photo 3 – Upstream West Retaining Wall, Spalling at Top Edge

Photo 4 – West Abutment, Erosion at Waterline and Wide Vertical Cracking

Photo 5 – West Abutment, Spalling Under Southwest Bearing

Photo 6 – Downstream Retaining Wall at West Abutment, Wide Vertical Crack and Spalling at Weir

Photo 7 – West Overflow Weir, Wide Crack along Weir

Photo 8 – West Overflow Weir Concrete Apron, Severe Scaling (Typ.)

Photo 9 – West Pier, Downstream Face

Photo 10 – Underside of West Span of Pedestrian Bridge, Failed Protective Coating and Moderate Corrosion of Longitudinal HSS (Typ.)

Photo 11 – HSS Support at West Pier, Loss of Protective Coating and Light Corrosion (Typ.)

Photo 12 – Bearing Anchorage of HSS Support (Typ.)

Photo 13 – Underside of Pedestrian Bridge over Operational Span, Failing Protective Coating and Moderate Corrosion of Longitudinal HSS (Typ.)

Photo 14 – Joint Between Operational and East Span, Loss of Protective Coating and Light to Moderate Corrosion (Typ.)

Photo 15 – East Pier, East Face

Photo 16 – East Abutment and Upstream Retaining Wall

Photo 17 – East Concrete Apron, Severe Spalling and Undermining (Typ.)

Photo 18 – East Overflow Weir, Downstream Face

Photo 19 – Downstream East Retaining Wall, Severe Spalling, Disintegration, and Delamination with Wide Cracks (Typ.)

Photo 20 – East Concrete Apron, Medium Scaling (Typ.)

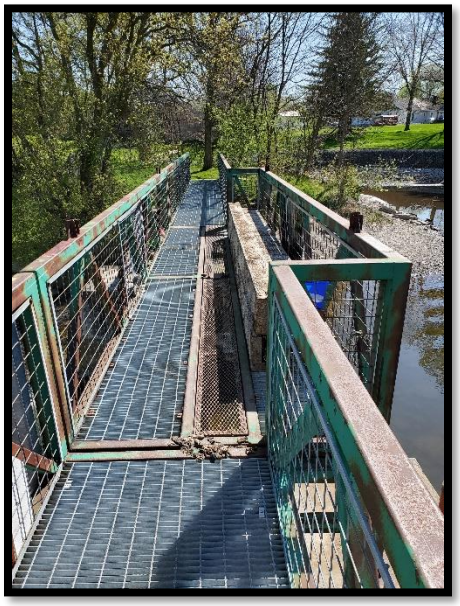

Photo 21 – Pedestrian Truss Bridge over Operational Span, Looking East, Loss of Protective Coating on HSS (Typ.)

Photo 22 – Winch Anchorage on Truss HSS, Moderate Corrosion (Typ.)

Photo 23 – Vertical HSS at Operational Span, Wide Cracks in Steel (1)

Photo 24 – Vertical HSS at Operational Span, Wide Cracks in Steel (2)

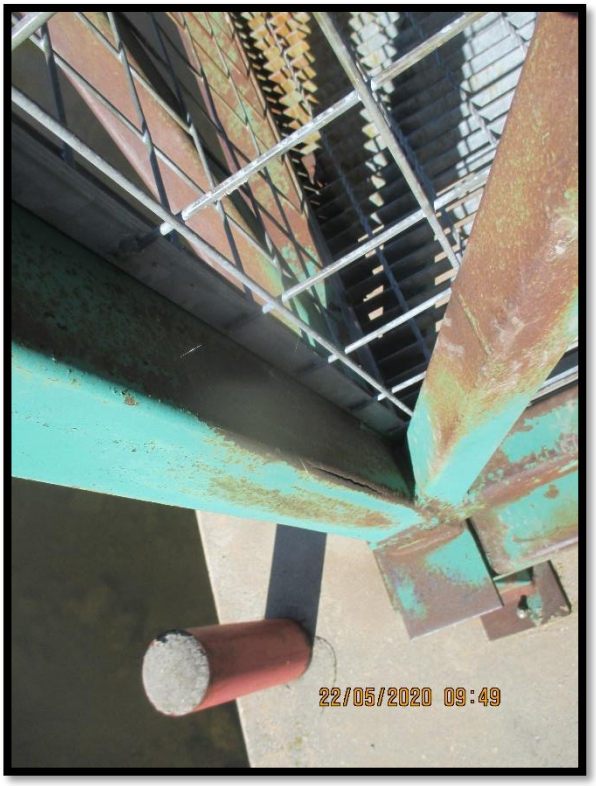

Photo 25 – Vertical HSS at Operational Span, Wide Cracks in Steel (3)

Appendix B

Limited Condition Survey Report

BRIDGE CHECK CANADA

Your Bridge & Concrete Inspection Specialists

LIMITED CONDITION SURVEY REPORT

Pefferlaw Dam Conservation Area

Prepared for: D.M. WillS Associates Limited

BCC Project No.: BCC20030
Report Date: June 12, 2020

Bridge Check Canada Ltd.
200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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Structure Identification Sheet

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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info@bridgecheckcanada.com

STRUCTURE IDENTIFICATION SHEET

GENERAL INFORMATION			
STRUCTURE NAME	***Pefferlaw Dam***		
SITE NUMBER	Pefferlaw Dam	**DISTRICT NUMBER**	N/A
HIGHWAY **above**	N/A	**Below**	N/A
TYPE OF STRUCTURE	Reinforced cast-in-place concrete dam		
NUMBER OF SPANS	N/A	**SPAN LENGTHS**	N/A
ROADWAY WIDTH	N/A	**YEAR BUILT**	1981
DIRECTION OF STRUCTURE	East to West		
SEQUENCE NUMBER	N/A	**TOWNSHIP NUMBER**	N/A
LHRS NUMBER	N/A	**MUNICIPAL BRIDGE NUMBER**	N/A
LOCATION	Pefferlaw Dam Conservation Area	**JURISDICTION**	Conservation Authority
INSPECTOR'S NAME	Mohammad Abdollahi P.Eng.,		
PARTY MEMBERS	A.Rashid P.Eng., A.Shantaf, P.Pandyan, J.Murray		
DATE OF INSPECTION	22-May-20		
TEMPERATURE	18 **°C**	**WEATHER**	sunny
MTO REGION	Central	**AADT**	
DECK RIDING SURFACE	Exposed concrete		
YEAR LAST REHABILITATED	N/A		

ENGINEER'S STAMP

Key Plan

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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KEY PLAN

Pefferlaw Dam, Georgina, ON

Summary of Significant Findings

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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SUMMARY OF SIGNIFICANT FINDINGS
Pefferlaw Dam, Pefferlaw Brook Watershed, Pefferlaw, ON

1.0 INTRODUCTION

Bridge Check Canada Ltd. was retained by D.M. Wills Associates to carry out a limited dam condition survey for Pefferlaw Dam under Lake Simcoe Region Conservation Authority's request. This report presents *Bridge Check Canada Ltd.*'s findings, through the field investigations and laboratory testing, for Pefferlaw Dam located on Pefferlaw Dam Conservation Area (44°18'50.0"N 79°11'50.8"W). First-time field investigations were carried out on May 22, 2020. The investigation included delamination survey and concrete cover survey for all concrete components that are in the DRY (2 piers, 2 abutments, 2 overflow weirs with apron slabs, and the west retaining wall), extraction of twelve (12) x 3-4" diameter concrete cores and Laboratory testing. Core locations were determined by D.M. Wills engineer on site.

A micro drone was used to take aerial photos of the structure (Photos P1 and P2). *Bridge Check Canada Ltd.*'s staff have received proper training to operate the drone.

The site, constructed circa 1981. The reinforced cast-in-place concrete dam consists of 2 piers, 2 abutments, 2 overflow weirs with apron slabs, steel access bridge, concrete west retaining wall and gabion walls on the northeast and northwest sides.

Photo P1 in Appendix E shows a view of the north elevation of the site. Photo P2 in Appendix E shows a view of the south elevation.

North Elevation of Pefferlaw Dam, Pefferlaw Brook Watershed

A dam safety assessment was done in 2006 by Totten Sims Hubicki, which the drawings are available.

2.0 METHODOLOGY

In general, the procedures followed to conduct the condition survey and delamination survey were those defined in Part 1 of the MTO Structure Rehabilitation Manual (2007). This assignment involved the observation and recording of surface defects, delamination detection, grid layouts (1.0 m x 1.0 m), concrete cores, concrete cover meter survey, and physical testing of the concrete cores.

The delaminations in the concrete were detected by striking the surface with a heavy hammer and noting the change in sound being emitted. It should be mentioned that, while this method is quite reliable, it may not detect delaminations at a depth greater than 100 mm. The hammer sounding method was used for all accessible vertical and overhead surfaces. If the striking object is highly resonant, the difference between sound and delaminated concrete may be difficult to distinguish. Therefore, additional care was taken when interpreting the sound produced. The chain drag method has been found to be the most suitable for detecting delaminations on the exposed horizontal concrete surfaces. The chain is moved from side-to-side in a swinging motion along the surface of the concrete. A change in the normal ringing sound to that of a dull sound would normally indicate that a delaminated area had been encountered. A heavy chain (2.2 kg/m with 50 mm links) has proved to be most suitable, especially, in areas where there is interference from traffic noise.

The areas and locations of patches, spalls, delaminations, exposed reinforcement, honey-combing, wet areas, scaling and other observed defects were recorded.

The concrete cover over the outer layer of reinforcing steel was measured using an approved MTO cover-meter (Elcometer Protovale 331). The covermeter measures the disturbance in a magnetic field and the magnitude of the disturbance is proportional to the size of the bar and its distance from the probe. The cover to the top bar in the top mat was measured nearest the grid point or by taking an average of the bars on either side of the grid point. The value recorded was the cover to the uppermost bar nearest to the intersection of the grid lines. A cover meter survey was carried out for the accessible exposed concrete components.

Twelve (12) cores {3 west abutment and retaining wall, 2 east abutment and retaining wall, 2 west apron slab and weir plan, 3 east apron slab and weir, 1 each east and west pier}, in compliance with the requirements of D.M. Wills engineer on site. The inside of the core holes was examined carefully for cracks and the condition of the concrete. All the test samples were reinstated to their original condition using MTO-approved products.

Enclosed with this report are detailed condition survey summary sheets, survey equipment and calibration procedures, core photos/sketches, core logs, site photos, laboratory test results and drawings.

3.0 DAM STRUCTURE

The abutments, retaining walls, weirs and piers were inspected and hammer sounded, where accessible, to check for delaminations. Field measurements are presented in the field summary sheets.

3.1 East Abutment and Retaining wall

The exposed surfaces of the east abutment and retaining wall were inspected and sounded to check for delaminations. The total surveyed area of the east abutment and retaining wall was 15.10 m^2. The deterioration is shown on Drawing 1a in Appendix G. General views of the east abutment and retaining wall are shown in Photos P5 to P7 in Appendix E. The east abutment and retaining wall are in poor condition. The field investigation of the east abutment and retaining wall revealed clean and stained medium width cracks (5.0 m), delaminations (6.00 m^2), spalls (1.50 m^2), light scaling (0.20 m^2), and severe scaling (3.71 m^2).

Cores C10 and C12 were extracted from the east abutment and retaining wall at locations shown on EDrawing 1a in Appendix G. Photo P52 in Appendix E shows the inside of the Corehole C12. Review of the concrete cores revealed a delamination plane in core C10. Full depth core C10 confirms 190 mm concrete thickness over rock material. The compressive strength of Cores C10 and C12 was 26.6 MPa and 34.4 MPa, respectively. Reinforcing steel, encountered in Core C12 was in good condition with no evidence of surface corrosion. The concrete cover for the east abutment and retaining wall ranged from 69 mm to 125 mm with an average cover of 103 mm. Drawing 2a in Appendix G shows the concrete cover data for the east abutment and retaining wall.

3.2 West Abutment and Retaining wall

The exposed surfaces of the west abutment and retaining wall were inspected and sounded to check for delaminations. The total surveyed area of the west abutment and retaining wall was 39.20 m^2. The deterioration is shown on Drawing 1a in Appendix G. General views of the west abutment and retaining wall are shown in Photos P8 to P15 in Appendix E. The west abutment and retaining wall are in fair to poor condition. The field investigation of the west abutment and retaining wall revealed clean and stained medium width cracks (14.0 m), clean wide width cracks (2.0 m), delaminations (1.50 m^2), spalls (2.90 m^2), light scaling (18.70 m^2), medium scaling (1.40 m^2) and severe scaling (1.20 m^2).

Cores C1, C2 and C6 were extracted from the west abutment and retaining wall at locations shown on Drawing 1a in Appendix G. Photo P46 in Appendix E shows the inside of the Corehole C1. Review of the concrete cores revealed a delamination plane in cores C1 and C2. Full depth core C1 confirms 225 mm concrete thickness over rock material. The compressive strength of Core C1 was 21.7 MPa. The concrete cover for the west abutment and retaining wall ranged from 70 mm to 125 mm with an average cover of 114 mm. Drawing 2a in Appendix G shows the concrete cover data for the west abutment and retaining wall.

Core C6 was tested to determine the air void system of the hardened concrete in accordance with ASTM C457 using the Modified Point Count Method. Test results are summarized below:

Core No.	Air Content (%)	Specific Surface (mm^{-1})	Spacing Factor (mm)
C6	2.7	93.70	0.073

Concrete is normally considered to be properly air entrained if the air content exceeds 3.0%, the specific surface exceeds 24 mm^{-1}, and the average spacing factor is less than 0.200 mm. Therefore, the air void system for this core is considered non air-entrained.

3.3 East Weir and Apron

The exposed surfaces of the east weir and apron were inspected and sounded to check for delaminations. The total surveyed area of the east weir was 32.26 m^2. The deterioration is shown on Drawing 1a in Appendix G. General views of the east weir and apron are shown in Photos P16 to P22 in Appendix E. The east weir is in fair condition. The field investigation of the east weir revealed stained medium width cracks (6.0 m), spalls (1.20 m^2), light scaling (8.45 m^2), and honeycombing (1.00 m^2).

The total surveyed area of the east apron was 37.94 m^2. The deterioration is shown on Drawing 1a in Appendix G. The east apron is in poor condition. The field investigation of the east apron revealed clean and stained medium width cracks (9.0 m), delaminations (1.30 m^2), spalls (10.20 m^2), light scaling (32.00 m^2), and medium scaling (3.30 m^2).

Cores C8, C9 and C11 were extracted from the east weir and apron at locations shown on Drawing 1a in Appendix G. Photos P50 and P51 in Appendix E show the inside of the Coreholes C8 and C9, respectively. Review of the concrete cores did not reveal any deteriorations. The compressive strength of Cores C8 and C11 was 35.9 MPa and 57.1 MPa, respectively. A review of the reinforcing steel revealed light rusting in Core C9. The concrete cover for the east weir ranged from 107 mm to 122 mm with an average cover of 114 mm. The concrete cover for the east apron ranged from 117 mm to 128 mm with an average cover of 124 mm. Drawing 2a in Appendix G shows the concrete cover data for the east weir and apron.

Core C9 was tested to determine the air void system of the hardened concrete in accordance with ASTM C457 using the Modified Point Count Method. Test results are summarized below:

Core No.	Air Content (%)	Specific Surface (mm^{-1})	Spacing Factor (mm)
C9	6.3	50.40	0.080

Concrete is normally considered to be properly air entrained if the air content exceeds 3.0%, the specific surface exceeds 24 mm^{-1}, and the average spacing factor is less than 0.200 mm. Therefore, the air void system for this core is considered air-entrained.

3.4 West Weir and Apron

The exposed surfaces of the west weir and apron were inspected and sounded to check for delaminations. The total surveyed area of the west weir was 60.10 m^2. The deterioration is shown on Drawing 1b in Appendix G. General views of the west weir and apron are shown in Photos P23 to P32 in Appendix E. The west weir is in fair to poor condition. The field investigation of the west weir revealed clean and stained medium width cracks (5.0 m), clean wide width cracks (24.0 m), delaminations (3.20 m^2), spalls (1.90 m^2), and light scaling (10.20 m^2).

The total surveyed area of the west apron was 55.42 m^2. The deterioration is shown on Drawing 1b in Appendix G. The west apron is in poor condition. The field investigation of the west apron revealed delaminations (10.10 m^2), spalls (7.50 m^2), patches (0.10 m^2), and medium scaling (35.56 m^2).

Cores C3 and C4 were extracted from the west weir and apron at locations shown on Drawing 1b in Appendix G. Photo P47 in Appendix E shows the inside of the Corehole C3. Review of the concrete cores revealed scaling on top of core C4. The compressive strength of Core C3 was 44.1 MPa. The concrete cover for the west weir ranged from 85 mm to 124 mm with an average cover of 112 mm. The concrete cover for the west apron ranged from 109 mm to 125 mm with an average cover of 121 mm. Drawing 2b in Appendix G shows the concrete cover data for the west weir and apron.

3.5 East Pier

The exposed surfaces of the east pier were inspected and sounded to check for delaminations. The total surveyed area of the east pier was 28.00 m^2. The deterioration is shown on Drawing 1b in Appendix G. General views of the east pier are shown in Photos P33 to P39 in Appendix E. The east pier is in fair condition. The field investigation of the east pier revealed clean and stained medium width cracks (19.0 m), pattern cracks (0.91 m^2), light scaling (7.50 m^2), and medium scaling (0.30 m^2).

Core C7 was extracted from the east pier at location shown on Drawing 1b in Appendix G. Photo P49 in Appendix E shows the inside of the Corehole C7. Review of the concrete cores did not reveal any defects. The compressive strength of Core C7 was 41.5 MPa. The concrete cover for the east pier ranged from 55 mm to 121 mm with an average cover of 84 mm. Drawing 2b in Appendix G shows the concrete cover data for the east pier.

3.6 West Pier

The exposed surfaces of the west pier were inspected and sounded to check for delaminations. The total surveyed area of the west pier was 28.70 m^2. The deterioration is shown on Drawing 1b in Appendix G. General views of the west pier are shown in Photos P40 to P45 in Appendix E. The west pier is in fair to good condition. The field investigation of the west pier revealed clean and stained medium width cracks (22.0 m), and light scaling (10.50 m^2).

Core C5 was extracted from the west pier at location shown on Drawing 1b in Appendix G. Photo P48 in Appendix E shows the inside of the Corehole C5. Review of the concrete cores did not reveal any defects. The compressive strength of Core C5 was 24.5 MPa. The concrete cover for the west pier ranged from 50

mm to 125 mm with an average cover of 78 mm. Drawing 2b in Appendix G shows the concrete cover data for the west pier.

Appendix A:

Detailed Condition Survey Summary Sheets

Exposed Concrete Components

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: East Abutment & Retaining Wall **OSIM Identifier: Abutments**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed		15.10 m²	

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	Total	
Medium Width	**Clean**	0.0	0.0	2.0	5.0	**m**
	Stained	1.0	1.0	1.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
69	125	103	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	0.0	m^2
	0.0		0.0	%
20 – 40 mm	0.0	**over 60 mm**	15.1	m^2
	0.0		100.0	%

Site No: **Pefferlaw Dam**

Component Type & Location: East Abutment & Retaining Wall **OSIM Identifier: Abutments**

5. Corrosion Activity

Remarks

Table # 5 is Not Applicable.

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	
-	-	-	-	-	m^2
-	-	-	-	-	%

Remarks

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	6.00	1.50	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
7.50 m²	49.7 %	N/A	N/A

*Wet areas = 0.00 m²

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
0.20	0.00	3.71	m^2
1.3	0.0	24.6	%

8. Honeycombing

Total Area 0.00 m²

Site No: **Pefferlaw Dam**

Component Type & Location: East Abutment & Retaining Wall **OSIM Identifier: Abutments**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: East Abutment & Retaining Wall **OSIM Identifier: Abutments**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: **30.5 MPa**

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: West Abutment & Retaining Wall **OSIM Identifier: Abutments**

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 39.20 m²

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	Total	
Medium Width	**Clean**	1.0	1.0	3.0	14.0	**m**
	Stained	4.0	1.0	4.0		
Wide Width	**Clean**	1.0	0.0	1.0	2.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
70	125	114	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	0.0	m^2
	0.0		0.0	%
20 – 40 mm	0.0	**over 60 mm**	39.2	m^2
	0.0		100.0	%

Site No: **Pefferlaw Dam**

Component Type & Location: West Abutment & Retaining Wall **OSIM Identifier: Abutments**

Remarks

Table # 5 is Not Applicable.

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

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	1.50	2.90	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
4.40 m^2	11.2 %	N/A	N/A

*Wet areas = 0.00 m^2

Remarks

7. Scaling

Light	Medium	Severe to Very Severe	
18.70	1.40	1.20	m^2
47.7	3.6	3.1	%

8. Honeycombing

Total Area 0.00 m^2

Site No: **Pefferlaw Dam**

Component Type & Location: West Abutment & Retaining Wall **OSIM Identifier: Abutments**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: West Abutment & Retaining Wall **OSIM Identifier: Abutments**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

	Yes	No	Marginal
Concrete Air Entrained:			
	C6	X	

14. Compressive Strength

Average Compressive Strength: **21.7 MPa**

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: East Weir **OSIM Identifier: Piers**

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 32.26 m²

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	Total	
Medium Width	**Clean**	0.0	0.0	0.0	6.0	**m**
	Stained	0.0	0.0	6.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
107	122	114	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	0.0	m^2
	0.0		0.0	%
20 – 40 mm	0.0	**over 60 mm**	32.3	m^2
	0.0		100.0	%

Site No: **Pefferlaw Dam**

Component Type & Location: East Weir **OSIM Identifier: Piers**

Remarks

Table # 5 is Not Applicable.

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

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.00	1.20	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
1.2 m^2	3.7 %	N/A	N/A

*Wet areas = 0.00 m^2

Remarks

7. Scaling

Light	Medium	Severe to Very Severe	
8.45	0.00	0.00	m^2
26.2	0.0	0.0	%

8. Honeycombing

Total Area 1.00 m^2

Site No: **Pefferlaw Dam**

Component Type & Location: East Weir **OSIM Identifier: Piers**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: East Weir **OSIM Identifier: Piers**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

	Yes	No	Marginal
Concrete Air Entrained:			
C9	X		

14. Compressive Strength

Average Compressive Strength: **35.9 MPa**

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: East Apron Slab **OSIM Identifier: Decks**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed		37.94 m²	

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	0.0	1.0	0.0	9.0	**m**
	Stained	0.0	6.0	2.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
117	128	124	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	0.0	m^2
	0.0		0.0	%
20 – 40 mm	0.0	**over 60 mm**	37.9	m^2
	0.0		100.0	%

Site No: **Pefferlaw Dam**

Component Type & Location: East Apron Slab **OSIM Identifier: Decks**

Remarks

Table # 5 is Not Applicable.

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
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	1.30	10.20	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
11.50 m^2	30.3 %	N/A	N/A

*Wet areas = 0.00 m^2

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
32.00	3.30	0.00	m^2
84.3	8.7	0.0	%

8. Honeycombing

Total Area 0.00 m^2

Site No: **Pefferlaw Dam**

Component Type & Location: East Apron Slab **OSIM Identifier: Decks**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: East Apron Slab **OSIM Identifier: Decks**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: **57.1 MPa**

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: West Weir **OSIM Identifier: Piers**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed		60.10 m²	

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	2.0	0.0	1.0	5.0	**m**
	Stained	1.0	1.0	0.0		
Wide Width	**Clean**	0.0	24.0	0.0	24.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
85	124	112	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	0.0	m^2
	0.0		0.0	%
20 – 40 mm	0.0	**over 60 mm**	60.1	m^2
	0.0		100.0	%

Site No: **Pefferlaw Dam**

Component Type & Location: West Weir **OSIM Identifier: Piers**

Remarks

Table # 5 is Not Applicable.

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
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	3.20	1.90	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
5.10 m²	8.5 %	N/A	N/A

*Wet areas = 0.00 m²

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
10.20	0.00	0.00	m^2
17.0	0.0	0.0	%

8. Honeycombing

Total Area 0.00 m²

Site No: **Pefferlaw Dam**

Component Type & Location: West Weir **OSIM Identifier: Piers**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: West Weir **OSIM Identifier: Piers**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: **44.1 MPa**

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: West Apron Slab **OSIM Identifier: Decks**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed		55.42 m²	

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
109	125	121	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	0.0	m^2
	0.0		0.0	%
20 – 40 mm	0.0	**over 60 mm**	55.4	m^2
	0.0		100.0	%

Site No: **Pefferlaw Dam**

Component Type & Location: West Apron Slab **OSIM Identifier: Decks**

Remarks

Table # 5 is Not Applicable.

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

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	10.10	7.50	0.10
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
17.60 m^2	31.8 %	N/A	N/A

*Wet areas = 0.00 m^2

Remarks

7. Scaling

Light	Medium	Severe to Very Severe	
0.00	35.56	0.00	m^2
0.0	64.2	0.0	%

8. Honeycombing

Total Area 0.00 m^2

Site No: **Pefferlaw Dam**

Component Type & Location: West Apron Slab **OSIM Identifier: Decks**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: West Apron Slab **OSIM Identifier: Decks**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: not tested

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: East Pier **OSIM Identifier: Piers**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed		28.00 m²	

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	2.0	0.0	7.0	19.0	**m**
	Stained	3.0	3.0	4.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

Pattern cracks= 0.91m²

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
55	121	84	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	4.0	m^2
	0.0		14.3	%
20 – 40 mm	0.0	**over 60 mm**	24.0	m^2
	0.0		85.7	%

Site No: **Pefferlaw Dam**

Component Type & Location: East Pier

OSIM Identifier: Piers

Remarks

Table # 5 is Not Applicable.

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

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.00	0.00	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
0.00 m²	0.0 %	N/A	N/A

*Wet areas = 0.00 m²

Remarks

7. Scaling

Light	Medium	Severe to Very Severe	
7.50	0.30	0.00	m^2
26.8	1.1	0.0	%

8. Honeycombing

Total Area 0.00 m²

Site No: **Pefferlaw Dam**

Component Type & Location: East Pier **OSIM Identifier: Piers**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: East Pier **OSIM Identifier: Piers**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: **41.5 MPa**

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **Pefferlaw Dam**

Component Type & Location: West Pier **OSIM Identifier: Piers**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed		28.70 m²	

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	Total	
Medium Width	**Clean**	1.0	0.0	5.0	22.0	**m**
	Stained	3.0	2.0	11.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Minimum	Maximum	Average	
50	125	78	**mm**

0 – 20 mm	0.0	**40 – 60 mm**	9.6	m^2
	0.0		33.3	%
20 – 40 mm	0.0	**over 60 mm**	19.1	m^2
	0.0		66.7	%

Site No: **Pefferlaw Dam**

Component Type & Location: West Pier **OSIM Identifier: Piers**

Remarks

Remarks

Table # 5 is Not Applicable.

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

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.00	0.00	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
0.00 m²	0.0 %	N/A	N/A

*Wet areas = 0.00 m²

Remarks

7. Scaling

Light	Medium	Severe to Very Severe	
10.50	0.00	0.00	m^2
36.6	0.0	0.0	%

8. Honeycombing

Total Area 0.00 m²

Site No: **Pefferlaw Dam**

Component Type & Location: West Pier **OSIM Identifier: Piers**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

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 mm	-	-	-

* 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 Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

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

Remarks
Table # 11 is Not Applicable.

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.

Site No: **Pefferlaw Dam**

Component Type & Location: West Pier **OSIM Identifier: Piers**

Remarks
Table # 12 is Not Applicable.

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.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: **24.5 MPa**

Appendix B:

Survey Equipment and Calibration Procedures

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SURVEY EQUIPMENT AND CALIBRATION PROCEDURES

Component Type: Exposed Concrete Dam **Site Number:** Pefferlaw Dam

1. Delaminations:

Weight of Chain: 2.2 **kg/m**
Other Equipment: Hammer

2. Concrete Cover:

Covermeter Make and Model: ELCOMETER Protovale 331

Battery Check:	**Reading at Start of Test:**	OK
	Reading at End of Test:	OK
Concrete Cover Check:	**Location of Check:**	@ 'W Abut.'
	Actual Depth and Rebar Diameter:	-
	Reading Before Test:	70 mm
	Readings Each 30 minutes During Test:	70 mm
	Reading at End of Test:	70 mm

3. Corrosion Activity:

Half Cell Make and Model: MC MILLER Electrode RE-3a (3" ø)
Multimeter Make and Model: Mastercraft Digital Multimeter 3R93
Length and Gauge of Lead Wires: 150 m of 18 gauge

Deck Temperature:	**Start of Test:**	18	°C	**End of Test:**	18	°C
Ambient Temperature:	**Start of Test:**	18	°C	**End of Test:**	18	°C

Battery Check: O.K.

Ground Check:	**Method of Connection:**	self-tapping screw		
	Ground Location:	-	**Check Location:**	-
	Lead Resistance:	1.8 - 1.9 Ω	**Voltage Drop (mV's):**	0.1
	Resistance [c]:	1.8 - 1.9 Ω	**Resistance Reversed:**	1.8 - 1.9 Ω

Grid Point Potential Readings Check – See Table Below

Location	Initial Reading	Check Reading [a]	Check Reading – Latex Concrete Overlay [b]
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

[a] Check at least five readings at beginning of test and each change in ground.
[b] On decks with latex modified concrete overlay, check at least five locations by drilling holes through the latex concrete overlay into the original concrete substrate.
[c] Resistance is the net resistance after deducting the lead resistance.

Appendix C:

Core Photographs and Sketches

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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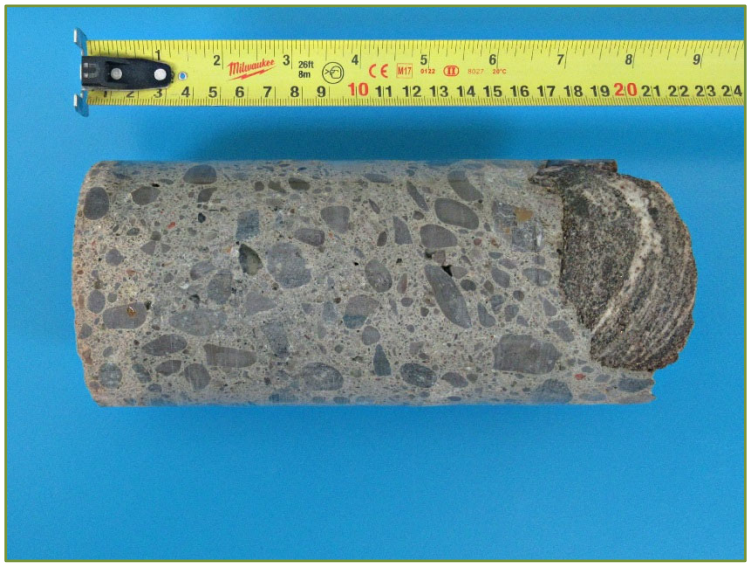
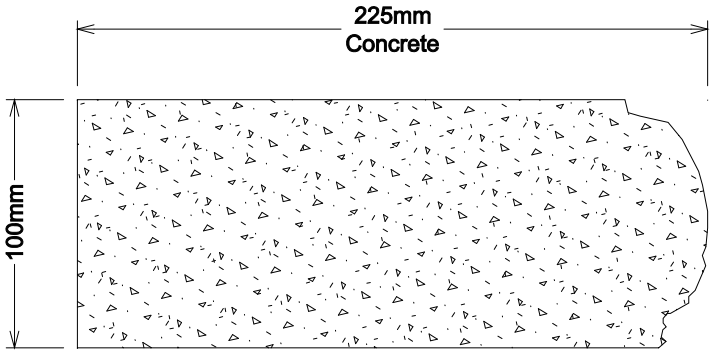
Core C1





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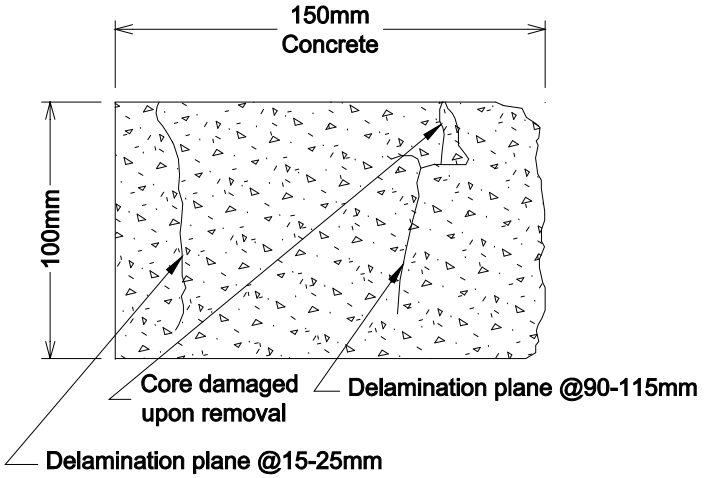
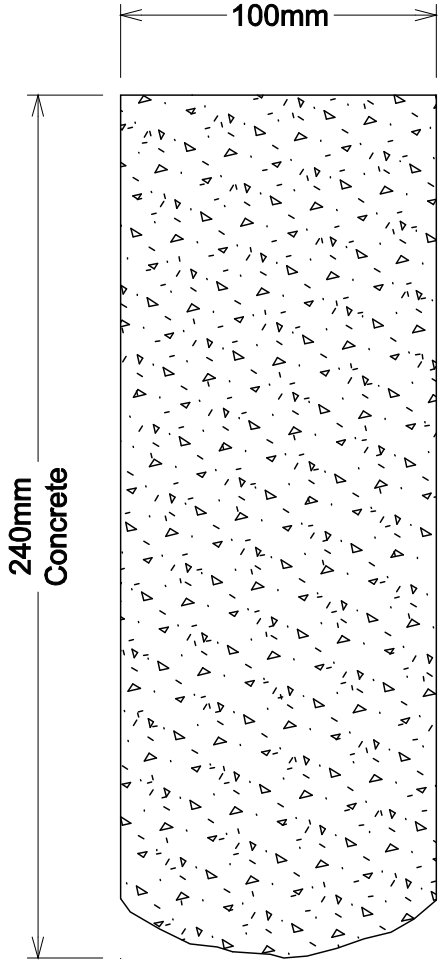

150mm
Concrete
100mm
Core damaged
upon removal
Delamination plane @90-115mm
Delamination plane @15-25mm

Core C3



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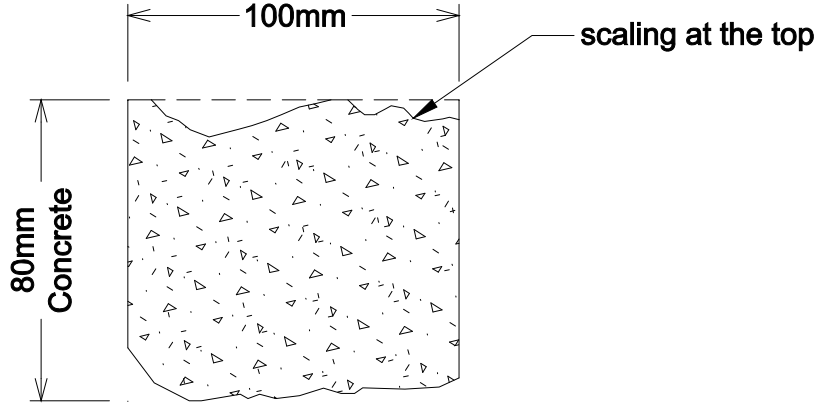
Core C4



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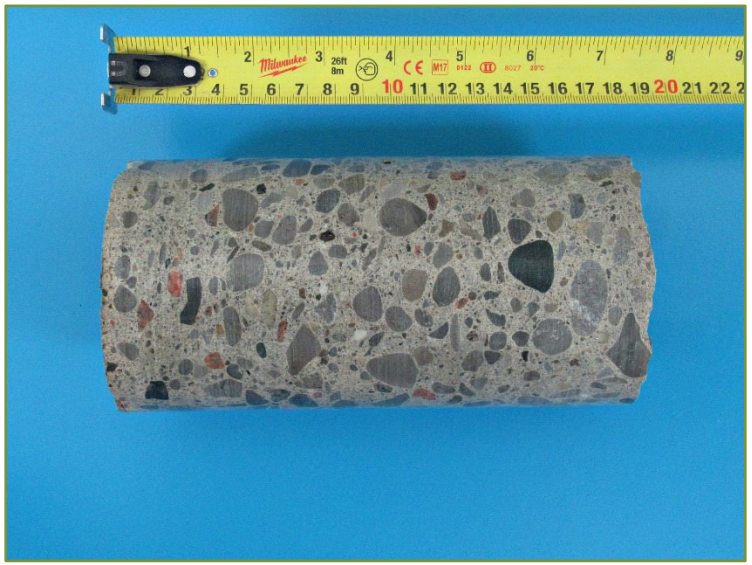

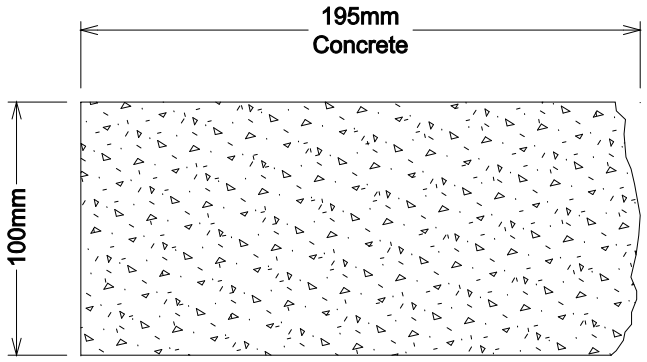

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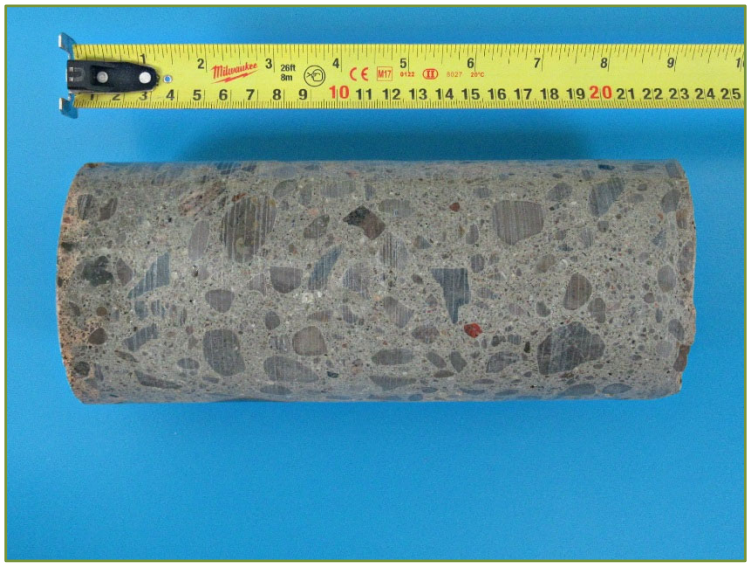
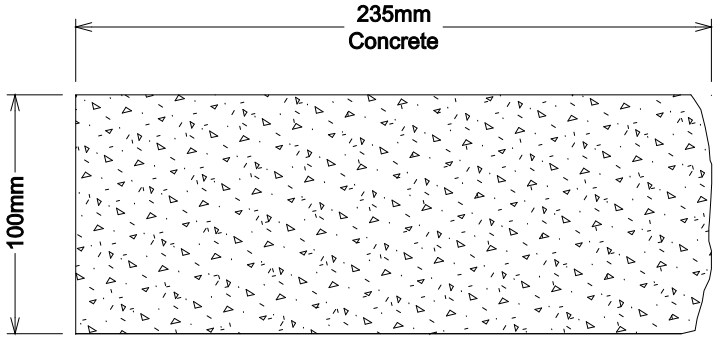
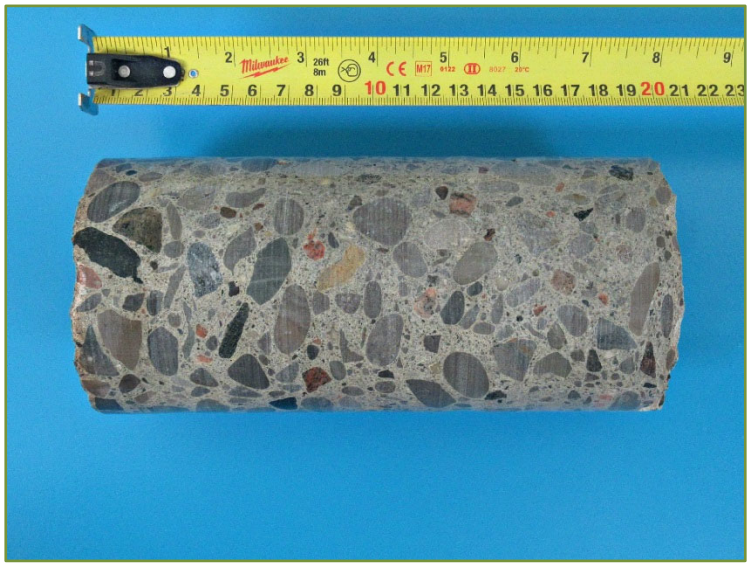
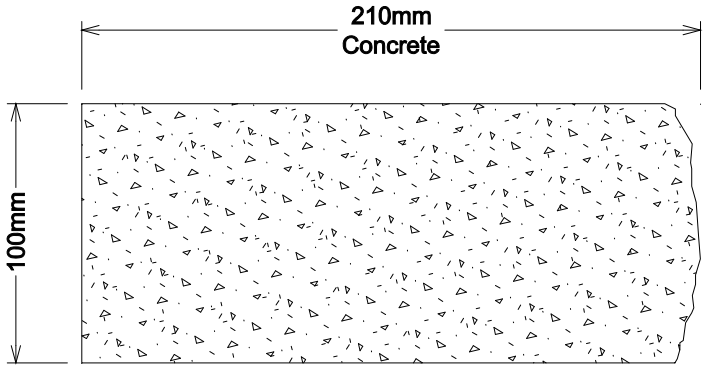




Core C7





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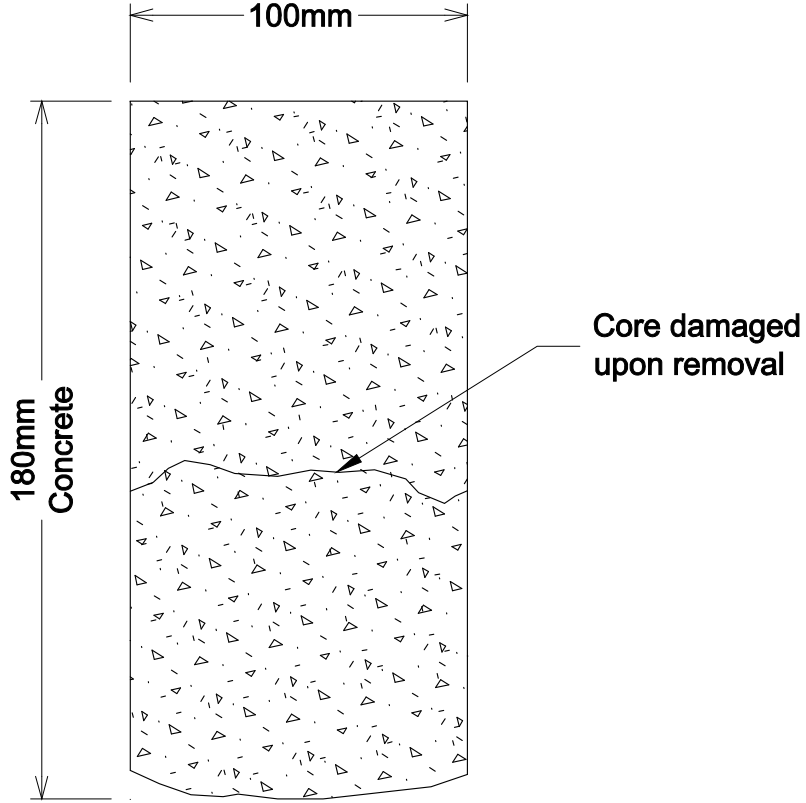

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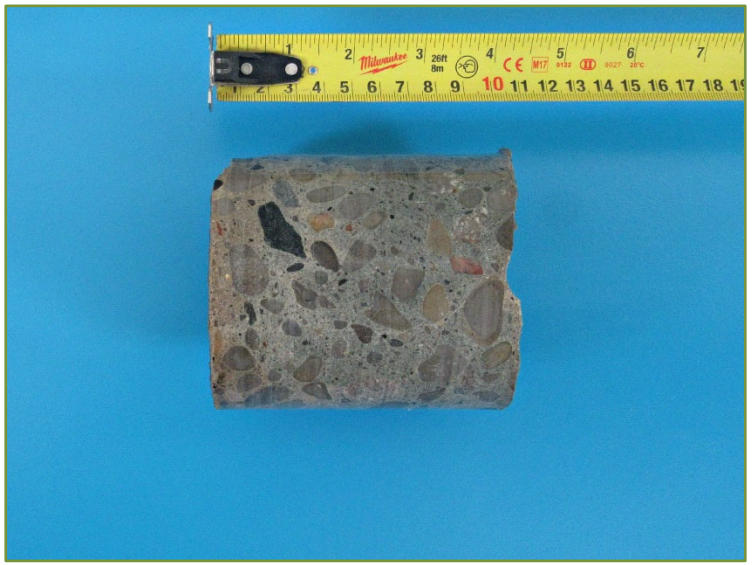
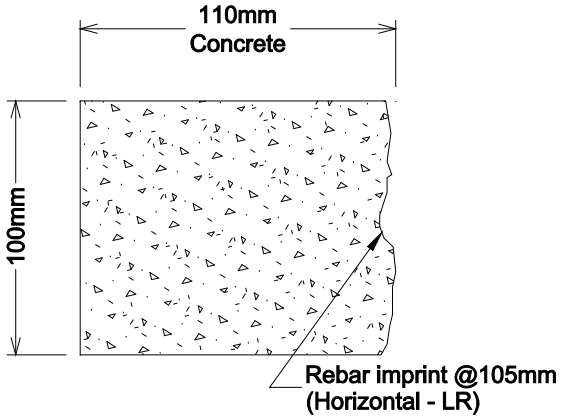
Core C9





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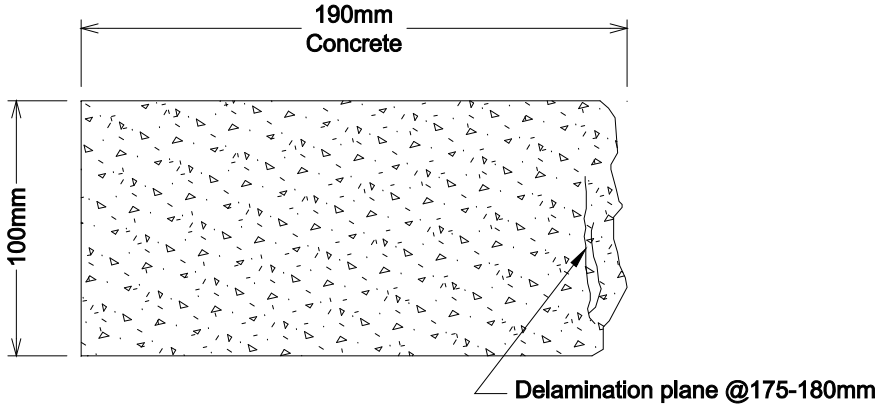

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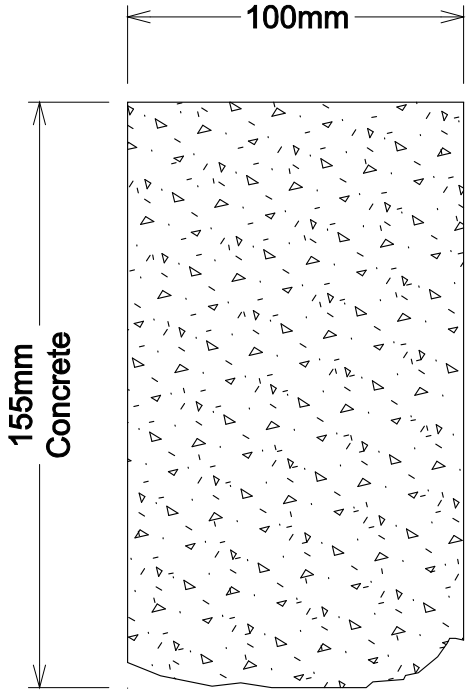

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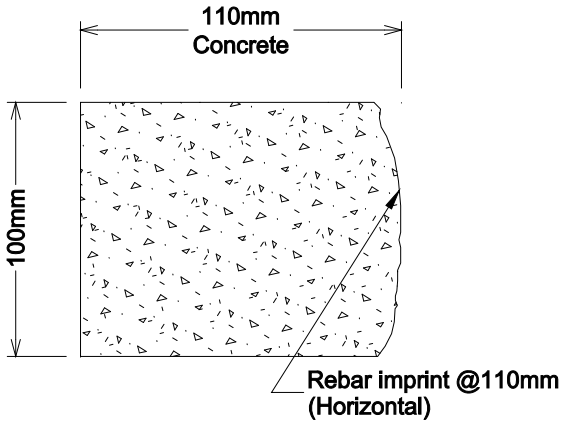
Core C12



Appendix D:

Core Logs

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CORE LOG FOR EXPOSED CONCRETE

Site: **Pefferlaw Dam**

Core No.		**C1**		**C2**		**C3**	
Location (between gridlines)		West Abutment and Retaining Wall		West Abutment and Retaining Wall		West Weir Plan	
Diameter, mm		100.0		100.0		100.0	
Length, mm		225.0		150.0		240.0	
Full Depth (yes/no)		Yes		No		No	
Defects in Concrete [1]		D		D		-	
Condition of Rebar [2]		N/A		N/A		N/A	
Corrosion Potential							
Compressive Strength, MPa		21.7				44.1	
Chloride Content % Chloride by Weight of Concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0-10 mm						
	20-30 mm						
	40-50 mm						
	60-70 mm						
	80-90 mm						
AIR VOIDS	**Air Content,%**						
	Spec. Surf.,mm^2/mm^3						
	Spacing Factor, mm						
TEST LABORATORY		BCC				BCC	
REMARKS **- orientation of rebars and cover** **- presence of overlay, patch and thickness** **- other observed defects**		Delamination Plane @ 190mm.		Delamination Plane @ 15-25mm. Delamination Plane @ 90-115mm. Core damage upon removal.			

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
2. Condition Rebar - G = Good, LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed
   Condition of Epoxy Coating – ECG = Good, ECF = Fair, ECP = Poor-rusted & debonded areas

CORE LOG FOR EXPOSED CONCRETE

Site: Pefferlaw Dam

Core No.		**C4**		**C5**		**C6**	
Location (between gridlines)		West Apron Slab Plan		West Pier - North Face		West Abutment and Retaining Wall	
Diameter, mm		100.0		100.0		100.0	
Length, mm		80.0		195.0		235.0	
Full Depth (yes/no)		No		No		No	
Defects in Concrete [1]		-		-		-	
Condition of Rebar [2]		N/A		N/A		N/A	
Corrosion Potential							
Compressive Strength, MPa				24.5			
Chloride Content % Chloride by Weight of Concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0-10 mm						
	20-30 mm						
	40-50 mm						
	60-70 mm						
	80-90 mm						
AIR VOIDS	**Air Content,%**					2.7	
	Spec. Surf.,mm^2/mm^3					93.7	
	Spacing Factor, mm					0.073	
TEST LABORATORY				BCC		BCC	
REMARKS **- orientation of rebars and cover** **- presence of overlay, patch and thickness** **- other observed defects**		Note scaling at the top.					

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
2. Condition Rebar - G = Good, LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed
   Condition of Epoxy Coating – ECG = Good, ECF = Fair, ECP = Poor-rusted & debonded areas

CORE LOG FOR EXPOSED CONCRETE

Site: Pefferlaw Dam

Core No.		**C7**		**C8**		**C9**	
Location (between gridlines)		East Pier - East Face		East Weir Plan		East Wier - North Elevation	
Diameter, mm		100.0		100.0		100.0	
Length, mm		210.0		180.0		110.0	
Full Depth (yes/no)		No		No		No	
Defects in Concrete [1]		-		-		-	
Condition of Rebar [2]		N/A		N/A		LR	
Corrosion Potential							
Compressive Strength, MPa		41.5		35.9			
Chloride Content % Chloride by Weight of Concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0-10 mm						
	20-30 mm						
	40-50 mm						
	60-70 mm						
	80-90 mm						
AIR VOIDS	**Air Content,%**					6.3	
	Spec. Surf.,mm^2/mm^3					50.4	
	Spacing Factor, mm					0.080	
TEST LABORATORY		BCC		BCC		BCC	
REMARKS **- orientation of rebars and cover** **- presence of overlay, patch and thickness** **- other observed defects**				Core damage upon removal.		Rebar imprint @ 105mm (Horizontal-LR).	

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
2. Condition Rebar - G = Good, LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed
   Condition of Epoxy Coating – ECG = Good, ECF = Fair, ECP = Poor-rusted & debonded areas

CORE LOG FOR EXPOSED CONCRETE

Site: Pefferlaw Dam

Core No.		**C10**		**C11**		**C12**	
Location (between gridlines)		East Abutment and Retaining Wall		East Apron Plan		East Abutment and Retaining Wall	
Diameter, mm		100.0		100.0		100.0	
Length, mm		190.0		155.0		110.0	
Full Depth (yes/no)		Yes		No		No	
Defects in Concrete [1]		D		-		-	
Condition of Rebar [2]		N/A		N/A		G	
Corrosion Potential							
Compressive Strength, MPa		26.6		57.1		34.4	
Chloride Content % Chloride by Weight of Concrete	**0-10 mm**	Total	Corrected	Total	Corrected	Total	Corrected
	20-30 mm						
	40-50 mm						
	60-70 mm						
	80-90 mm						
AIR VOIDS	**Air Content,%**						
	Spec. Surf.,mm^2/mm^3						
	Spacing Factor, mm						
TEST LABORATORY		BCC		BCC		BCC	
REMARKS **- orientation of rebars and cover** **- presence of overlay, patch and thickness** **- other observed defects**		Delamination plane @ 175-180mm.				Rebar imprint @ 110mm (Horizontal).	

1. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
2. Condition Rebar - G = Good, LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed
   Condition of Epoxy Coating – ECG = Good, ECF = Fair, ECP = Poor-rusted & debonded areas

Appendix E:

Site Photographs

Photo P1 North Elevation

Photo P2 South Elevation

Photo P3 Aerial Overview of Pefferlaw Dam

Photo P4 Dam – Access Bridge, looking east

Photo P5 **East Abutment and Retaining Wall** (fair to poor condition – cracks, spall, delamination and light to severe scaling)

Photo P6 **East Abutment and Retaining Wall** (cracks, spall, delamination and light to severe scaling)

Photo P7 **East Abutment and Retaining Wall** (cracks, delamination and severe scaling)

Photo P8 **West Abutment and Retaining Wall** (fair condition – cracks, spall, delamination, light to medium scaling and staining) note undermining, and alkali aggregate reaction on the surface

Photo P9 **West Abutment and Retaining Wall** (cracks, spall and light to medium scaling)

Photo P10 **West Abutment and Retaining Wall** (light scaling) note undermining

Photo P11 West Abutment and Retaining Wall (severe scaling) note undermining

Photo P12 West Abutment and Retaining Wall (cracks, spall, light to severe scaling and staining) note undermining

Photo P13 West Abutment and Retaining Wall (wide crack, spall and delamination)

Photo P14 West Abutment and Retaining Wall (cracks, spall and delamination)

Photo P15 West Abutment and Retaining Wall – Top Face (spall and light scaling)

Photo P16 East Weir and Apron Slab, North Elevation (fair to poor condition – cracks, spall, delamination, honeycombing and light to medium scaling)

Photo P17 East Weir and Apron Slab, North Elevation (spall, delamination and medium scaling)

Photo P18 East Weir, North Elevation (cracks, spall and honeycombing)

Photo P19 East Weir, North Elevation (light to medium scaling)

Photo P20 East Apron Slab Plan (cracks, spall and light scaling and staining)

Photo P21 East Apron Slab Plan (cracks, spall and light scaling and staining)

Photo P22 East Weir – South Elevation (good condition – light scaling)

Photo P23 West Weir and Apron Slab Plan (poor condition – wide cracks, spall, delamination and light to medium scaling)

Photo P24 West Apron Slab Plan (spall and medium scaling)

Photo P25 West Apron Slab Plan (spall, delamination and medium scaling)

Photo P26 West Weir Plan (wide cracks, spall and delamination)

Photo P27 West Weir and Apron Slab – North Elevation (fair to poor condition – spall and medium scaling)

Photo P28 West Weir and Apron Slab – North Elevation (spall, delamination and medium scaling) note, undermining

Photo P29 West Weir and Apron Slab – North Elevation (spall, delamination and medium scaling) note, undermining

Photo P30 West Weir and Apron Slab – North Elevation (spall and medium scaling)

Photo P31 West Weir – South Elevation (good condition – spall and light scaling)

Photo P32 West Weir – South Elevation (spall and light scaling)

Photo P33 East Pier – Top Face (good condition – cracks and light scaling)

Photo P34 East Pier – Top Face (cracks)

Photo P35 East Pier – Top Face (cracks and staining)

Photo P36 East Pier – West Face (fair to good condition – cracks, light scaling and wet stain)

Photo P37 East Pier – East Face (fair to good condition – cracks, light scaling and wet stain)

Photo P38 East Pier – South Face (fair to good condition - cracks, light scaling and wet stain)

Photo P39 East Pier – North Face (fair condition - cracks, medium scaling and wet stain)

Photo P40 West Pier – Top Face (good condition - cracks and light scaling)

Photo P41 West Pier – Top Face (light scaling)

Photo P42 West Pier – East Face (fair to good condition – cracks, light scaling and wet stain)

Photo P43 West Pier – West Face (fair to good condition – cracks, light scaling and wet stain)

Photo P44 West Pier – South Face (fair to good condition – cracks, light scaling and wet stain)

Photo P45 West Pier – North Face (fair to good condition – cracks, light scaling and wet stain)

Photo P46 Typical Condition of Inside Core – C1 (delamination)

Photo P47 Typical Condition of Inside Core – C3

Photo P48 Typical Condition of Inside Core – C5

Photo P49 Typical Condition of Inside Core – C7

Photo P50 Typical Condition of Inside Core – C8

Photo P51 Typical Condition of Inside Core – C9

Photo P52 Typical Condition of Inside Core – C12

Photo P53 Upstream, looking north

Photo P54 Downstream, looking south

Appendix F:

Laboratory Test Results

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AIR VOID TEST RESULTS

(Modified Point Count – ASTM C457, Procedure B)

Project No.:	BCC20030
Site No.:	
Location:	***PEFFERLAW DAM, DETAILED CONCRETE CONDITION SURVEY***

Core ID	**C6**	**C9**
Lab No.	T20-1013	T20-1016
Air Content (%)	2.7	6.3
Specific Surface (mm^{-1})	93.7	50.4
Spacing Factor (mm)	0.073	0.080
Length of Traverse (mm)	3819.2	3819.2
Dimensions of Tested Sample	125mm x 90mm	125mm x 90mm
Area Traversed (mm^2)	11075.68	11075.68
Average Chord Length	0.043	0.079
Number of Stops	1364	1364
No. of Voids per mm	0.635	0.795
Paste-Air Ratio	11.811	4.047
Paste Content (%)	32.0	25.5
Aggregate Content (%)	65.3	68.2

Tested By: Brad Wiersma
Date Tested: June 4, 2020

Savio DeSouza, M.A.Sc., P.Eng.
Senior Principal Engineer

COMPRESSIVE STRENGTH OF CONCRETE CORES

(CSA A23.2-14C)

Project No.:	**BCC20006**
Site No.:	----------
Location:	***PEFFERLAW DAM, DETAILED CONCRETE CONDITION SURVEY***

Core ID	C1	C3	C5
Location	West Abutment and Retaining Wall	West Weir Plan	West Pier - North Face
Lab No.	T20-1010	T20-1011	T20-1012
Date Cast	----------	----------	----------
Date Cored	May 22, 2020	May 22, 2020	May 22, 2020
Date Tested	May 29, 2020	May 29, 2020	May 29, 2020
Capped Height (mm)	157.0	200.0	176.0
Average Diameter (mm)	100.0	100.0	100.0
Density (kg/m^3)	2313	2307	2352
Corrected Compressive Strength (MPa)	21.7	44.1	24.5
*** Direction of Loading**	Perpendicular	Perpendicular	Same
Moisture Contact at Time of Test	Moist	Moist	Moist
Remarks			

*Relative to the direction of original placement.

COMPRESSIVE STRENGTH OF CONCRETE CORES

(CSA A23.2-14C)

Project No.:	**BCC20006**
Site No.:	----------
Location:	***PEFFERLAW DAM, DETAILED CONCRETE CONDITION SURVEY***

Core ID	C7	C8	C10
Location	*East Pier - East Face*	East Weir Plan	East Abutment and Retaining Wall
Lab No.	T20-1014	T20-1015	T20-1017
Date Cast	----------	----------	----------
Date Cored	May 22, 2020	May 22, 2020	May 22, 2020
Date Tested	May 29, 2020	May 29, 2020	May 29, 2020
Capped Height (mm)	196.0	100.0	159.0
Average Diameter (mm)	100.0	100.0	100.0
Density (kg/m^3)	2369	2271	2251
Corrected Compressive Strength (MPa)	41.5	35.9	26.6
*** Direction of Loading**	Same	Perpendicular	Perpendicular
Moisture Contact at Time of Test	Moist	Moist	Moist
Remarks			

COMPRESSIVE STRENGTH OF CONCRETE CORES

(CSA A23.2-14C)

Project No.:	**BCC20006**
Site No.:	----------
Location:	***PEFFERLAW DAM, DETAILED CONCRETE CONDITION SURVEY***

Core ID	C11	C12
Location	*East Apron Plan*	East Abutment and Retaining Wall
Lab No.	T20-1018	T20-1019
Date Cast	----------	----------
Date Cored	May 22, 2020	May 22, 2020
Date Tested	May 29, 2020	May 29, 2020
Capped Height (mm)	140.0	103.0
Average Diameter (mm)	100.0	100.0
Density (kg/m^3)	2393	2281
Corrected Compressive Strength (MPa)	57.1	34.4
*** Direction of Loading**	Same	Perpendicular
Moisture Contact at Time of Test	Moist	Moist
Remarks		

Savio DeSouza, M.A.Sc., P.Eng.
Senior Principal Engineer

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Appendix G:

ACAD Drawings

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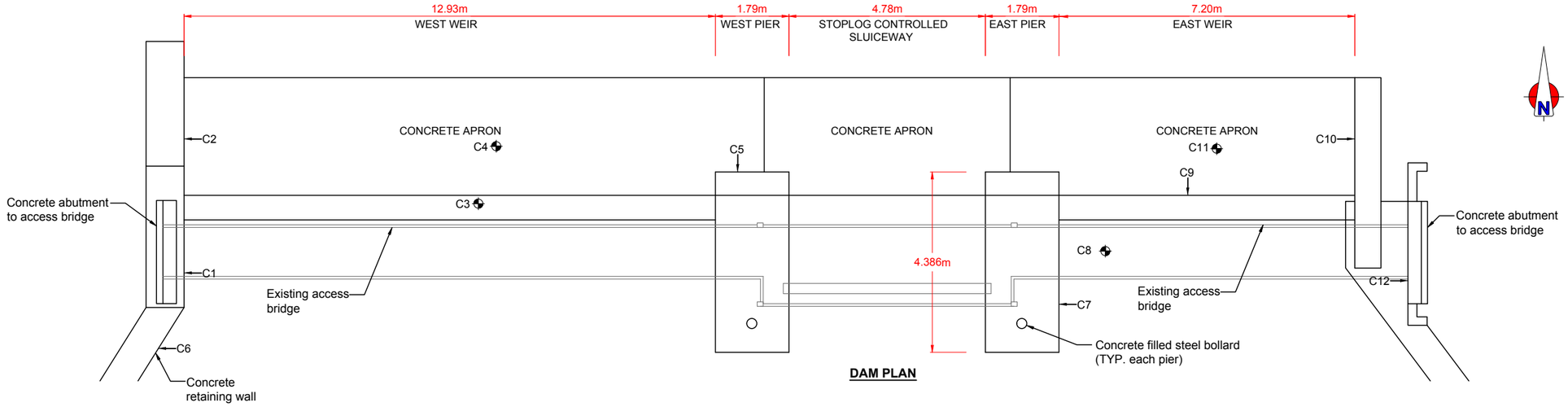
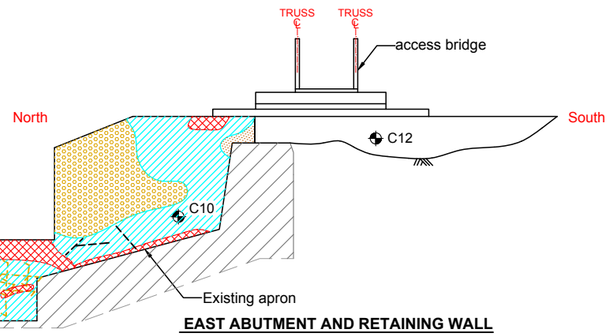
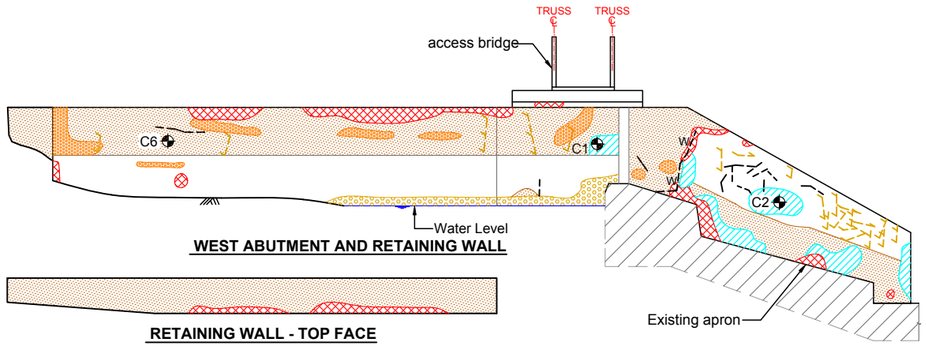


DAM PLAN

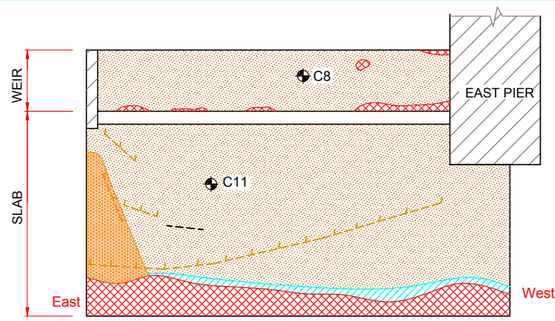


EAST ABUTMENT AND RETAINING WALL

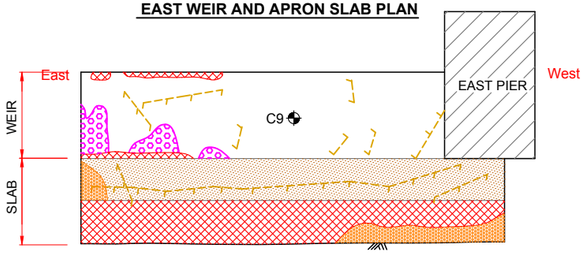


WEST ABUTMENT AND RETAINING WALL

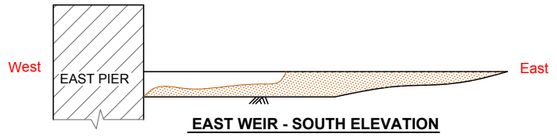
RETAINING WALL - TOP FACE



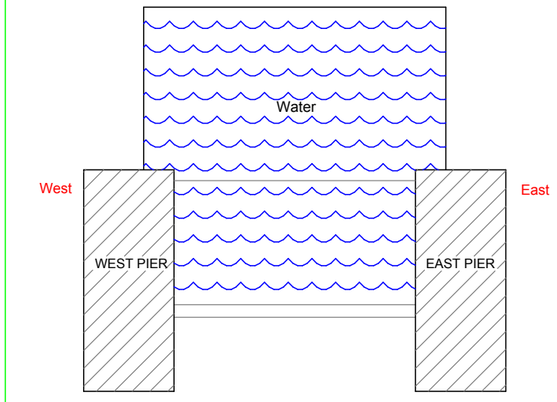
EAST WEIR AND APRON SLAB PLAN



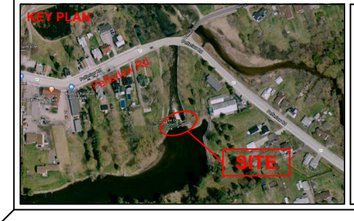
EAST WEIRAND APRON SLAB - NORTH ELEVATION



EAST WEIR - SOUTH ELEVATION



STOPLOG CONTROLLED SLUICEWAY - PLAN



LEGEND:

- Drain
- C1 Core Sample Location
- Patched Spalls
- Delaminations
- Spalls
- Light Scaling
- Medium Scaling
- Severe Scaling
- Honeycombed Areas
- Wet Areas
- Concrete Pattern Cracks
- Medium Concrete Cracks
- W Wide Concrete Cracks
- Medium Stained/ Efflorescence Cracks

BRIDGE CHECK CANADA

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Vaughan, ON L4K 3N8
T: 905-660-6608 F: 905-660-6609

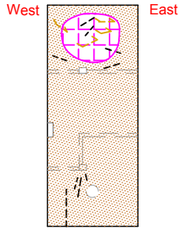
PROJECT:

Pefferlaw Dam
Georgina, ON

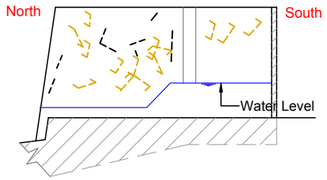
TITLE:

SURFACE DETERIORATION OF ABUTMENTS, EAST WEIR, AND APRON SLAB

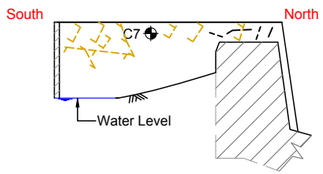
Drawing No.:	1a
Project No.:	BCC20030
Date:	June 2020
Scale:	1:125
Drawn by:	JL
Checked by:	MA



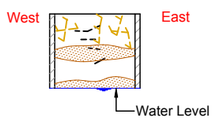
EAST PIER - TOP FACE



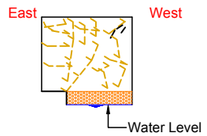
EAST PIER - WEST FACE



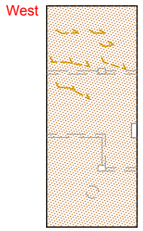
EAST PIER - EAST FACE



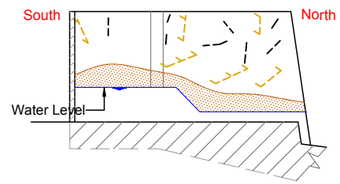
EAST PIER - SOUTH FACE



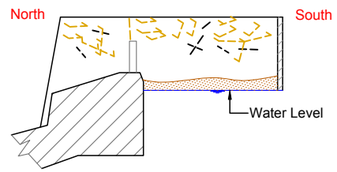
EAST PIER - NORTH FACE



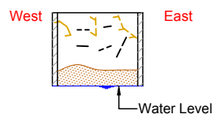
WEST PIER - TOP FACE



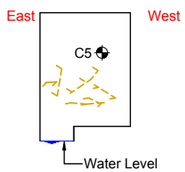
WEST PIER - EAST FACE



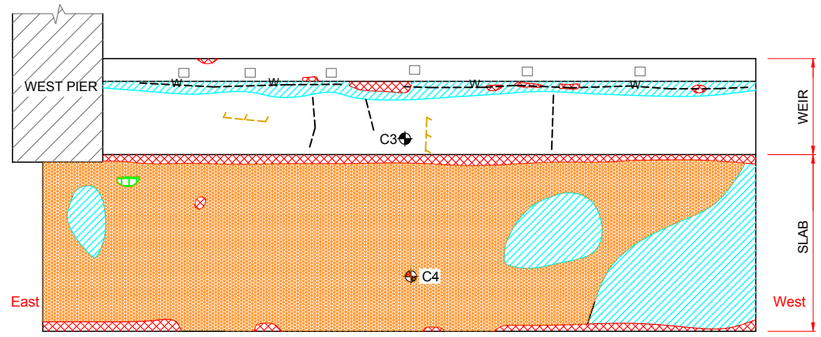
WEST PIER - WEST FACE



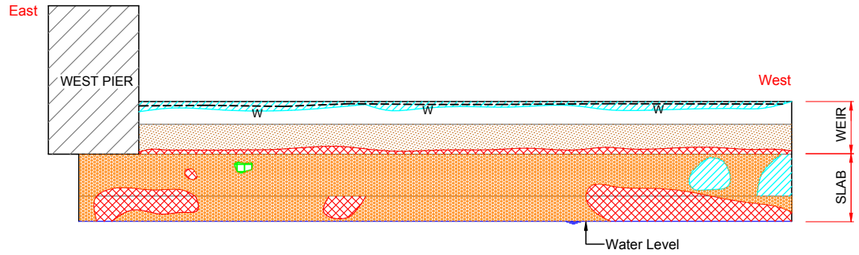
WEST PIER - SOUTH FACE



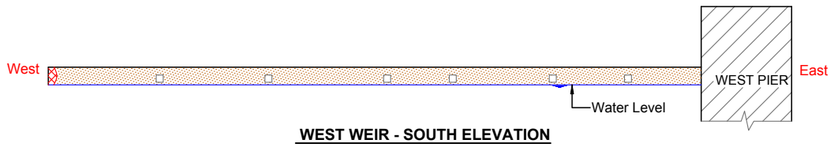
WEST PIER - NORTH FACE



WEST WEIR AND APRON SLAB PLAN



WEST WEIRAND APRON SLAB - NORTH ELEVATION



WEST WEIR - SOUTH ELEVATION

LEGEND:

- Drain
- C1 Core Sample Location
- Patched Spalls
- Delaminations
- Spalls
- Light Scaling
- Medium Scaling
- Severe Scaling
- Honeycombed Areas
- Wet Areas
- Concrete Pattern Cracks
- Medium Concrete Cracks
- W Wide Concrete Cracks
- Medium Stained/ Efflorescence Cracks

BRIDGE CHECK CANADA

200 Viceroy Road, Unit 4
Vaughan, ON L4K 3N8
T: 905-660-6608 F: 905-660-6609

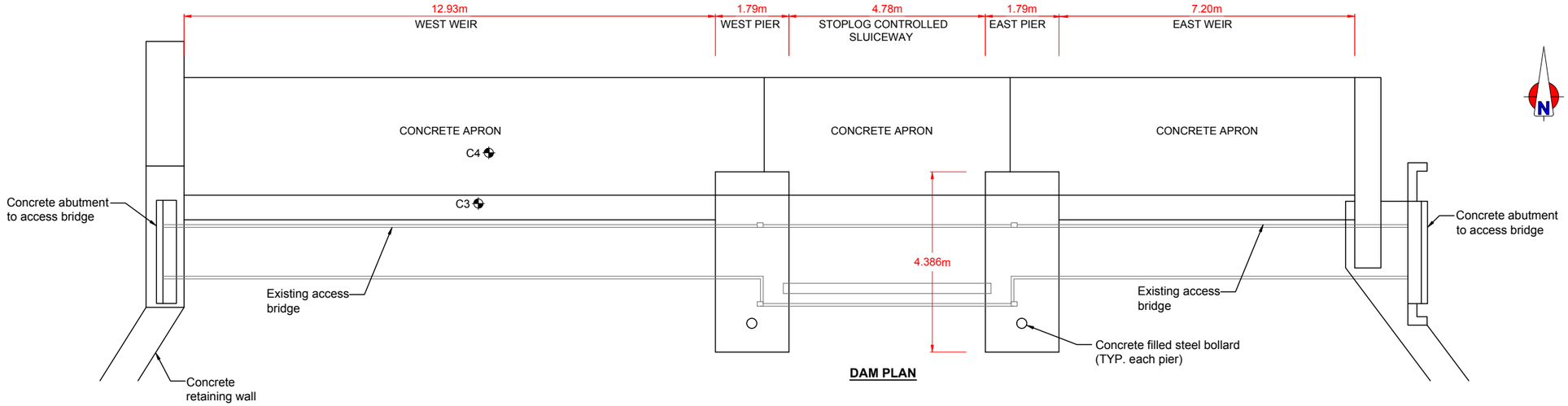
PROJECT:

Pefferlaw Dam
Georgina, ON

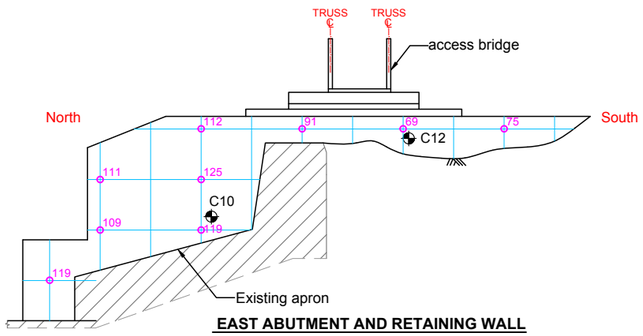
TITLE:

SURFACE DETERIORATION OF PIERS, WEST WEIR AND APRON SLAB

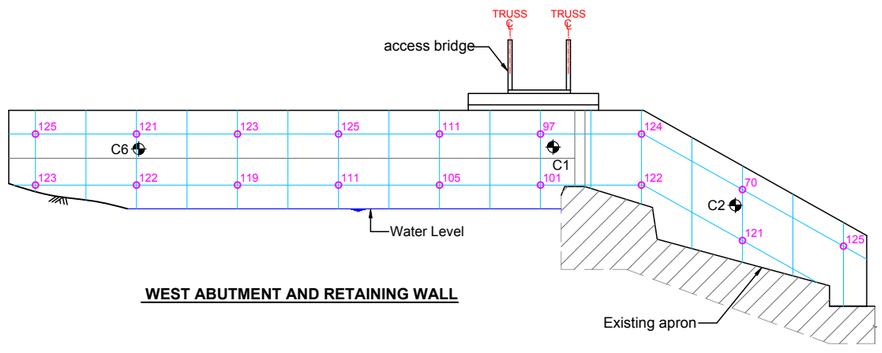
Drawing No.:	1b
Project No.:	BCC20030
Date:	June 2020
Scale:	1:125
Drawn by:	JL
Checked by:	MA



DAM PLAN



EAST ABUTMENT AND RETAINING WALL



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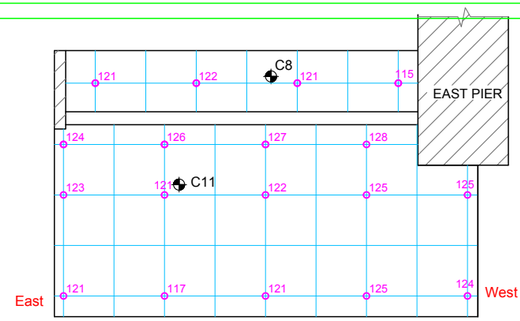
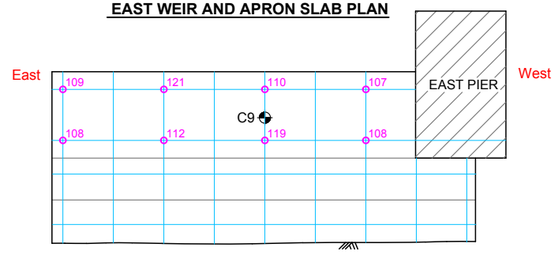
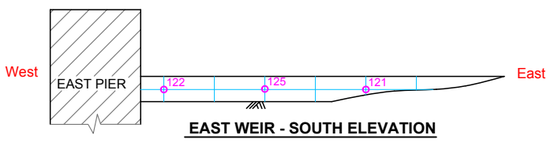


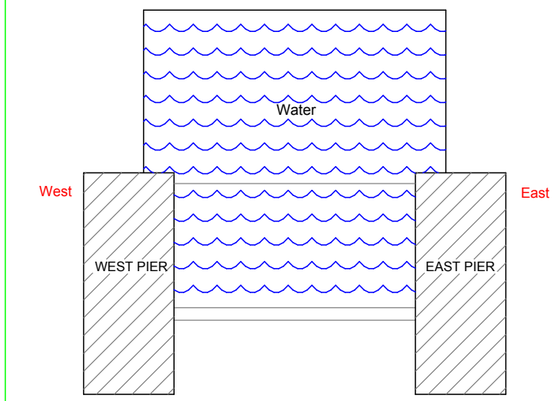
EAST WEIR AND APRON SLAB PLAN



EAST WEIR AND APRON SLAB - NORTH ELEVATION



EAST WEIR - SOUTH ELEVATION



STOPLOG CONTROLLED SLUICEWAY - PLAN

LEGEND:

- Drain
- C1 Core Sample Location
- 80 Concrete cover-mm
- Cover over 60mm
- Cover from 40mm to 60mm
- Cover from 20mm to 39mm
- Cover less than 20mm

BRIDGE CHECK CANADA

200 Viceroy Road, Unit 4
Vaughan, ON L4K 3N8
T: 905-660-6608 F: 905-660-6609

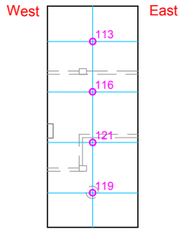
PROJECT:

Pefferlaw Dam
Georgina, ON

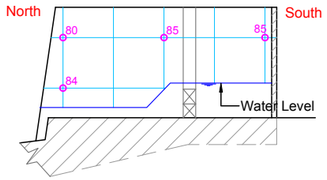
TITLE:

CONCRETE COVER
OF ABUTMENTS, EAST WEIR,
AND APRON SLAB

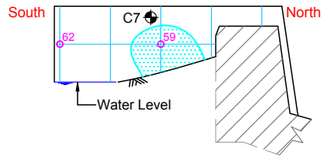
Drawing No.:	2a
Project No.:	BCC20030
Date:	June 2020
Scale:	1:125
Drawn by:	JL
Checked by:	MA



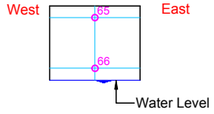
EAST PIER - TOP FACE



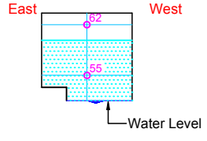
EAST PIER - WEST FACE



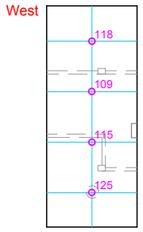
EAST PIER - EAST FACE



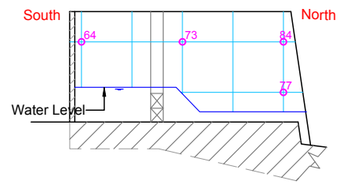
EAST PIER - SOUTH FACE



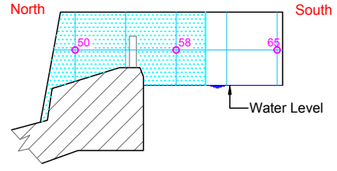
EAST PIER - NORTH FACE



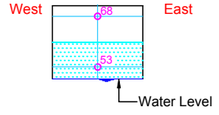
WEST PIER - TOP FACE



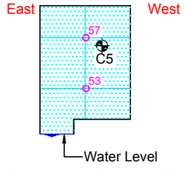
WEST PIER - EAST FACE



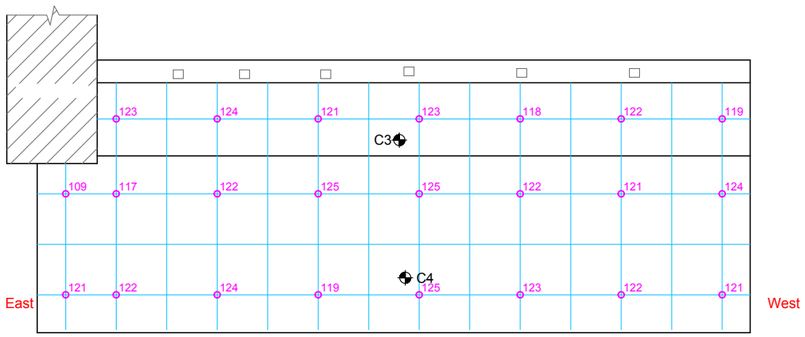
WEST PIER - WEST FACE



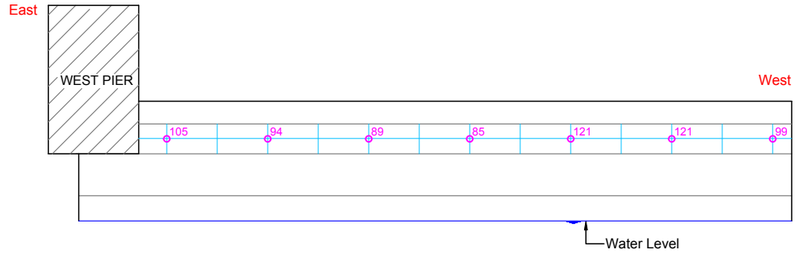
WEST PIER - SOUTH FACE



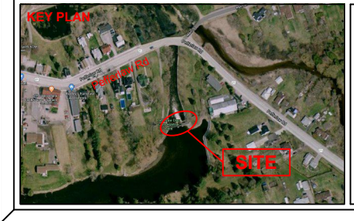
WEST PIER - NORTH FACE



WEST WEIR AND APRON SLAB PLAN



WEST WEIR AND APRON SLAB- NORTH ELEVATION



LEGEND:

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BRIDGE CHECK CANADA
200 Viceroy Road, Unit 4
Vaughan, ON L4K 3N8
T: 905-660-6608 F: 905-660-6609

PROJECT:
Pefferlaw Dam
Georgina, ON

TITLE:
CONCRETE COVER
OF PIERS, WEST WEIR AND
APRON SLAB

Drawing No.:	2b
Project No.:	BCC20030
Date:	June 2020
Scale:	1:125
Drawn by:	JL
Checked by:	MA

Appendix C

Preliminary Cost Estimates

Pefferlaw Dam Structural Design Memorandom

Wills Project No.: 19-5381

Preliminary Cost Estimate
Concrete Rehabilitation

Item No.	Description	Unit	Quantity	Est. Unit Price	Extension
1	Mobilization and Demobilization	L/S	1	$15,000.00	$15,000.00
	Environmental / Watercourse Protection	L/S	1	$12,000.00	$12,000.00
2	Dewatering and Temp. Flow Control	L/S	1	$30,000.00	$30,000.00
3	Concrete in Substructure and Retaining Walls	m^3	13.0	$7,500.00	$97,500.00
4	Concrete Removal - Partial Depth, Type A	m^3	8.0	$4,000.00	$32,000.00
5	Concrete Removal - Partial Depth, Type C	m^3	3.6	$8,000.00	$28,800.00
6	Abrasive Blast Cleaning of Reinforcing Steel	m^2	50	$65.00	$3,250.00
7	Concrete Patches, Unformed Surface	m^3	8.0	$3,000.00	$24,000.00
8	Concrete Patches, Form and Pump	m^3	2.0	$10,000.00	$20,000.00
9	Concrete Refacing, Form and Pump	m^3	1.5	$12,000.00	$18,000.00
10	Crack Injection	m	2	$500.00	$1,000.00
11	Dowels into Concrete	ea.	35	$45.00	$1,575.00
				Subtotal	$283,125.00
				30% Contingency	$84,940.00
				Total Estimated Project Cost	**$368,065.00**

Pefferlaw Dam Structural Design Memorandom

Wills Project No.: 19-5381

Preliminary Cost Estimate
Alternative 1 - Truss Rehabilitation and Bearing Seat Repair

Item No.	Description	Unit	Quantity	Est. Unit Price	Extension
1	Mobilization and Demobilization	L/S	1	$5,000.00	$5,000.00
2	Coating of Structural Steel	L/S	1	$25,000.00	$25,000.00
3	Extension of Existing Fall Arrest System	L/S	1	$5,000.00	$5,000.00
4	Concrete Removal - Partial Depth, Type C	m^3	0.1	$8,000.00	$800.00
5	Concrete Refacing, Form and Pump	m^3	0.1	$12,000.00	$1,200.00
6	Dowels into Concrete	ea.	5	$100.00	$500.00
7	Weld Crack Repair	m	2	$1,500.00	$3,000.00
				Subtotal	$40,500.00
				30% Contingency	$12,150.00
				Total Estimated Project Cost	**$52,650.00**

Pefferlaw Dam Structural Design Memorandom

Wills Project No.: 19-5381

Preliminary Cost Estimate
Alternative 2 - Truss Replacement and Bearing Seat Repair

Item No.	Description	Unit	Quantity	Est. Unit Price	Extension
1	Mobilization and Demobilization	L/S	1	$5,000.00	$5,000.00
2	Removal of Bridge Structure	L/S	1	$5,000.00	$5,000.00
3	Prefabricated Bridge	L/S	1	$30,000.00	$30,000.00
4	Extension of Existing Fall Arrest System	L/S	1	$5,000.00	$5,000.00
5	Concrete Removal - Partial Depth, Type C	m^3	0.1	$8,000.00	$800.00
6	Concrete Refacing, Form and Pump	m^3	0.1	$12,000.00	$1,200.00
7	Dowels into Concrete	ea.	5	$100.00	$500.00
				Subtotal	$47,500.00
				30% Contingency	$14,250.00
				Total Estimated Project Cost	**$61,750.00**

Pefferlaw Dam Structural Design Memorandom

Wills Project No.: 19-5381

Preliminary Cost Estimate
Truss Rehabilitation (Full Coating) and Bearing Seat Repair

Item No.	Description	Unit	Quantity	Est. Unit Price	Extension
1	Mobilization and Demobilization	L/S	1	$5,000.00	$5,000.00
2	Coating of Structural Steel	L/S	1	$90,000.00	$90,000.00
3	Extension of Existing Fall Arrest System	L/S	1	$5,000.00	$5,000.00
4	Concrete Removal - Partial Depth, Type C	m^3	0.1	$8,000.00	$800.00
5	Concrete Refacing, Form and Pump	m^3	0.1	$12,000.00	$1,200.00
6	Dowels into Concrete	ea.	5	$100.00	$500.00
7	Weld Crack Repair	m	2	$1,500.00	$3,000.00
				Subtotal	$105,500.00
				30% Contingency	$31,650.00
				Total Estimated Project Cost	**$137,150.00**

Pefferlaw Dam Structural Design Memorandom

Wills Project No.: 19-5381

Preliminary Cost Estimate
Complete Truss Replacement and Bearing Seat Repair

Item No.	Description	Unit	Quantity	Est. Unit Price	Extension
1	Mobilization and Demobilization	L/S	1	$5,000.00	$5,000.00
2	Removal of Bridge Structure	L/S	1	$15,000.00	$15,000.00
3	Prefabricated Bridge	L/S	1	$105,000.00	$105,000.00
4	Concrete Removal - Partial Depth, Type C	m^3	0.1	$8,000.00	$800.00
5	Concrete Refacing, Form and Pump	m^3	0.1	$12,000.00	$1,200.00
6	Dowels into Concrete	ea.	5	$100.00	$500.00
7					
				Subtotal	$127,500.00
				30% Contingency	$38,250.00
				Total Estimated Project Cost	**$165,750.00**

Appendix D

Life Cycle Cost Analysis

Lake Simcoe Region Concervation Authority
Pefferlaw Dam, Township of Georgina
LIFE CYCLE ANALYSIS (4% Discount Rate)

Year	Alternative 1 Truss Rehabilitation		Alternative 2 Truss Replacement		Alternative 3 None	
	Cost	Pres.Value	Cost	Pres.Value	Cost	Pres.Value
0	$52,650	$52,650	$61,750	$61,750		
5						
10						
15						
20						
25						
30						
35	$61,750	$15,648				
40						
45						
50						
55						
60						
65						
70						
75			$61,750	$3,259		
80						
85						
90						
95						
100						
Total Present Value:		$68,298		$65,009		
Residual Value :		($397)		($1,051)		
Net Present Value :		**$67,902**		**$63,959**		

RESIDUAL VALUE ANALYSIS

Option	Replacement / Rehab. Cost	Year of Replacement (Next Cycle)	Residual Years	Value at 100 years	Residual Value at 100 Years	Present Residual Value
1	$61,750	110	10	$41,716	-$20,034	-$397
2	$61,750	150	50	$8,689	-$53,061	-$1,051
3						

Appendix D - Life-Cycle Cost Analysis