Appendix M – Structural Assessment Report

Schedule “C” Class Environmental Assessment for Airport Road from Braydon Boulevard / Stonecrest Drive to Countryside Drive

Memo

Date:	Thursday, October 17, 2019
Project:	Airport Road Environmental Assessment Study (Braydon Boulevard/Stonecrest Drive to Countryside Drive)
To:	Tareq Mahmood – Peel Region
From:	Selva Balasundaram, P. Eng. – HDR
Subject:	Airport Road Structural Assessment at Tributary B and Tributary C of the West Humber River

Introduction

The Regional Municipality of Peel retained HDR to conduct a Schedule C Municipal Class Environmental Assessment (EA) Study to determine specific improvements to accommodate the current and future transportation needs of pedestrians, cyclists, transit users and motorists along the Airport Road corridor from Braydon Boulevard/Stonecrest Drive to Countryside Drive within the City of Brampton.

This Structural Assessment Memo has been prepared in support of the Class EA Study. The Airport Road Class EA Study limits are illustrated in **Figure 1**.

The Study Corridor spans approximately 2.2 km of Airport Road. Within the project limits, Airport Road is a four lane, north-south regional arterial road located in the City of Brampton. It intersects with a number of local roads and entrances, and the land use is primarily residential throughout the study corridor.

There are two watercourses that cross Airport within the project limits, both of which are tributaries to West Humber River. The locations of Tributary B and Tributary C are identified on **Figure 1**. At the point where these watercourses cross Airport Road, the general drainage direction is from west to east.

The objective of the Structural Assessment memo is to document the existing conditions at the two watercourse structures along the corridor and provide recommendations to support the proposed roadway improvements.

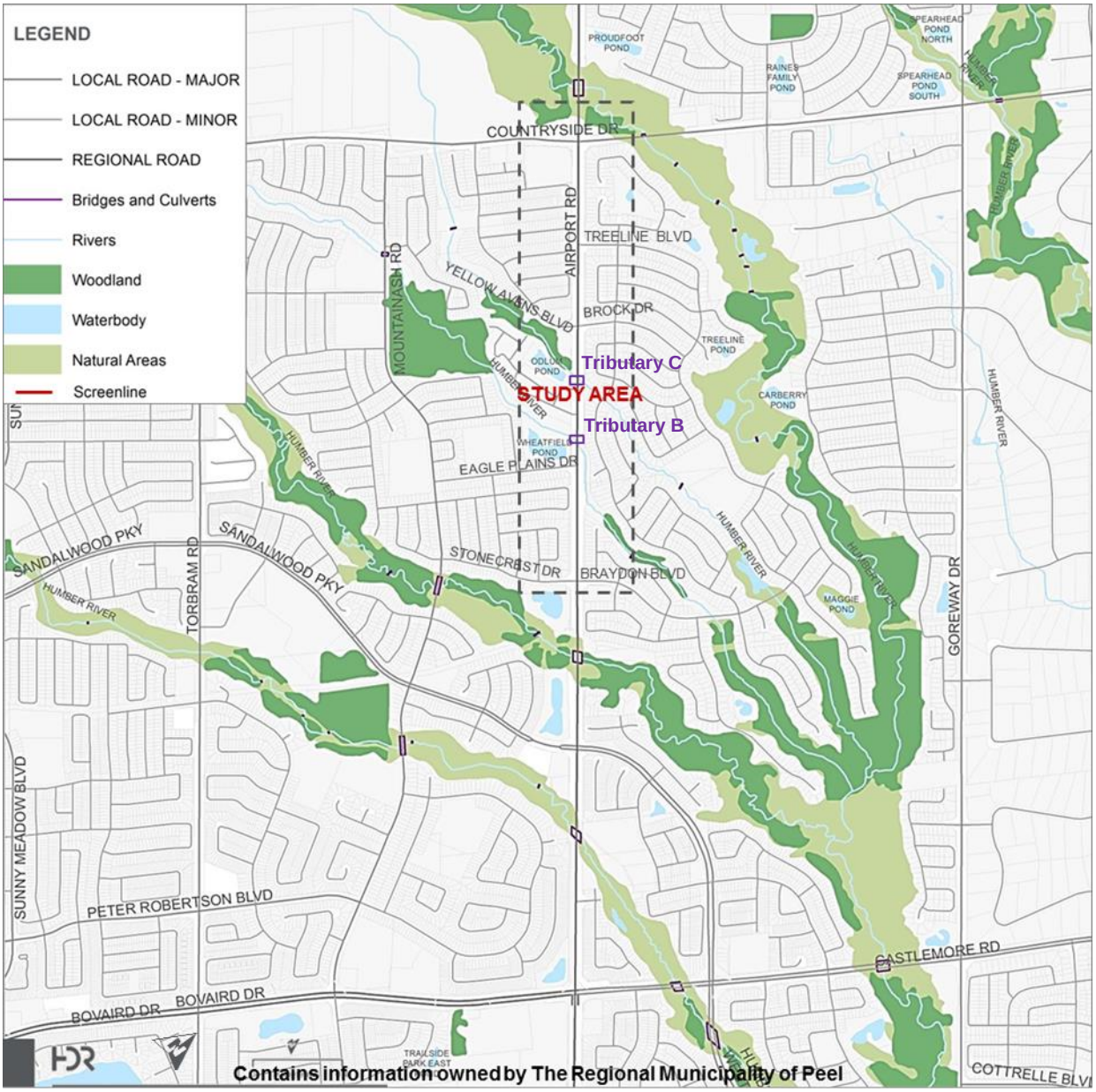

Figure 1: Study Area and Watercourse Locations

Tributary B

Background

The Airport Road crossing of Tributary B (structure No. 071510) is located approximately 110m north of Eagle Plains Drive. The existing structure is a 4500x1200mm concrete box culvert with a length of 94m, and includes 0.3m embedment.

The original culvert was constructed sometime before 2005 and consisted of a 4500x1600mm box section, 65.6m in length and included 0.7m embedment. As part of the Airport Road widening from two to four lanes undertaken in 2005 under Peel Region contract 01-4035, the original culvert was extended on the west side of Airport Road by a distance 32.4m to accommodate the roadway widening at that time. It is noted that the hydraulic opening from the original culvert (900mm) is consistent with the hydraulic opening from the 2005 extension (refer to **Figure 2**).

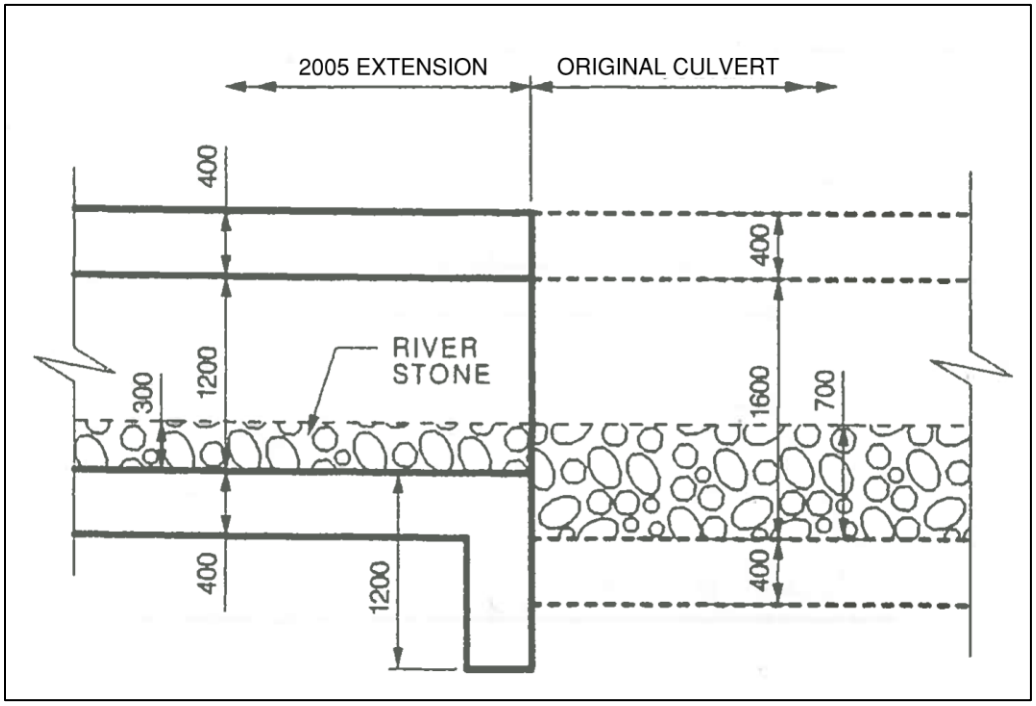

Figure 2: Original Tributary B Culvert and 2005 Extension

Photos of the existing Airport Road crossing of Tributary B are included in **Appendix A**.

Observations

A biennial inspection was conducted for this crossing in 2018. The key findings from this inspection indicate that the structure has not undergone any major deterioration and does not require any major rehabilitation works to be undertaken at this time. A copy of this report is included in **Appendix B**. Observations from the visual inspection conducted by HDR staff as

part of the Airport Road EA confirm these findings. As such, no structural upgrades or replacement are required at this time based on the findings of the existing condition review.

EA Recommendations at Tributary B

The Environmental Assessment for Airport Road recommends widening from four to six lanes along the entire study corridor. At this location, the proposed roadway cross-section can be accommodated on the existing structure, thereby not requiring a physical extension or modification to the existing culvert.

Tributary C

Background

The Airport Road crossing of Tributary C (Structure No. 071430) is located approximately 60m north of Camrose Street. The existing structure is a 3000x1250mm concrete box culvert with a length of 90.7m, and includes 0.3m embedment.

The original culvert was constructed sometime before 2005 and consisted of a 3000x1250mm box section, 57.5m in length and included 0.3m embedment. As part of the Airport Road widening from two to four lanes undertaken in 2005 under Peel Region contract 01-4035, the original culvert was extended on the west side of Airport Road by a distance 33.2m to accommodate the roadway widening at that time. It is noted that the size, embedment and hydraulic opening from the original culvert (950mm) are consistent with the hydraulic opening from the 2005 extension.

Photos of the existing Airport Road crossing of Tributary C are included in **Appendix A**.

Observations

A biennial inspection was not available for this structure at the time of the Airport Road EA. Observations from the visual inspection conducted by HDR staff as part of the Airport Road EA noted that the existing structure appears to be in good condition and no visible deterioration including exposed reinforcement or concrete cracks were observed at the inlet or outlet. However, minor spalling was observed at the inlet which can be addressed with minor rehabilitation works. No major structural upgrades are anticipated based on the findings of the existing condition review. Peel Region will be conducting OSIM investigations for this culvert as part of a separate undertaking and the findings should be reviewed and considered during the detailed design of Airport Road.

EA Recommendations at Tributary C

The Environmental Assessment for Airport Road recommends widening from four to six lanes along the entire study corridor. At this location, the proposed roadway cross-section can be accommodated on the existing structure, thereby not requiring a physical extension or modification to the existing culvert.

Conclusions

No modifications are proposed to the Airport Road crossings of Tributary B or Tributary C as part of the Airport Road improvements from Braydon Boulevard/Stonecrest Drive to Countryside Drive. Structural inspections indicate that both culverts are generally in good condition and do not require major repair or upgrade. Minor rehabilitation is recommended at Tributary C to address minor spalling observed at the inlet. At the time of detailed design, additional observations should be undertaken at both culverts to assess the latest conditions and requirements for repairs or upgrades at that time.

Appendix A: Site Photos

hdrinc.com 100 York Boulevard, Suite 300, Richmond Hill, ON, CA L4B 1J8
(289) 695-4600

Tributary B – Elevation at the inlet

Tributary B – Elevation at the outlet

Tributary C – Elevation at the inlet

Tributary C – Elevation at the outlet

Appendix B: Tributary B Biennial Inspection Report

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Biennial Inspection Report

Airport Rd Over W Humber River Trib. - 1.98km N of Bovaird Dr Culvert

Asset ID: 071510

May 13, 2018

Prepared By: Engineered Management Systems Inc.

42 Lakeshore Road East, Suite B
Mississauga, Ontario
L5G 1C8

405 Riverview Drive, Suite 302
Chatham, Ontario
N7M 5J5

Region of Peel
Working for you

engineered management systems inc.

Limitations

Data presented in this report reflects our assessment of value, condition, needs and their associated cost as per the date of inspection.

Recommendations and cost estimates are preliminary. They are based on a visual "from the ground" assessment and are intended for budgetary and planning purposes only. A far more detailed and exhaustive analysis should be provided during detailed design that addresses all deficencies and full compliance with the Canadian Highway Bridge Design Code.

Urgencies

Throughout this report the reader will see reference to the term "Urgencies". These are time frames that the inspector must attempt to predict, on-site, on an element-by-element basis, as to how long the recommended work can wait to be addressed before it becomes critical.

Urgencies are included as a requirement of the OSIM guidelines. We also apply a similar evaluation called Remaining Service Life. It adds flexiblity providing more than one time frame depending on the agency's in-house capabilities to carry out basic maintenance of their inventory. RSL's should not distate the management process except as fail safe points beyond which certain issues must be addressed during scheduling.

Respectfully Submitted:

engineered management systems inc.

Structure Summary

071510 - Airport Rd Over W Humber River Trib. - 1.98km N of Bovaird Dr Culvert

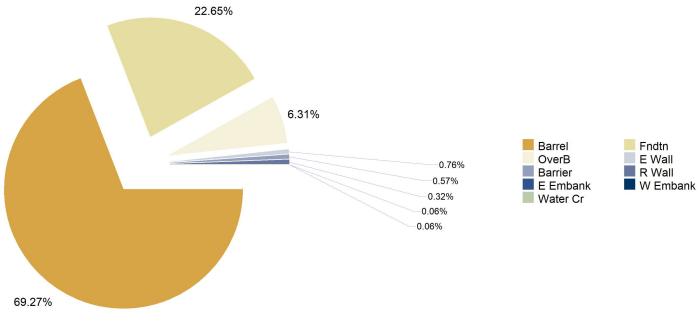
Type	Culvert	Replacement Cost	$1,585,000
Year Built	2005	Rehabilitative Needs	$1,000
Last Rehabilitated	N/A	NASVI	99.9
Last Inspection	May 13, 2018	DCI	5
GPS East	17601414	AADT	10393
GPS North	4847788	BCI	99.2
Location :		BSI	93.2

Airport Road

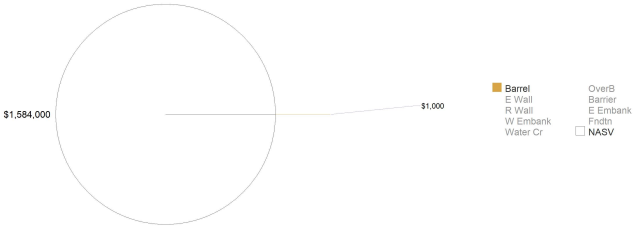
1.98km North of Bovaird Drive

General Comments :
The major concern at this site is isolated spalling of barrel end.

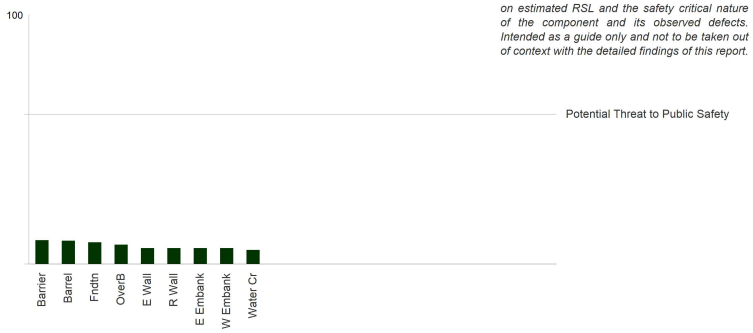
Distribution of $1,585,000 Replacement Value



Distribution of $1,000 Rehabilitation Cost



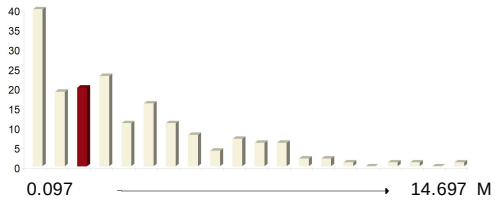
Safety Risk



Risk assessed on a scale of 0 to 100 based on estimated RSL and the safety critical nature of the component and its observed defects. Intended as a guide only and not to be taken out of context with the detailed findings of this report.

Network Comparison

Replacement Value	116 / 179
Rehabilitative Needs	144 / 179
NASVI	38 / 179
Est. 10 Year Deferral Cost	69 / 179
AADT	104 / 179



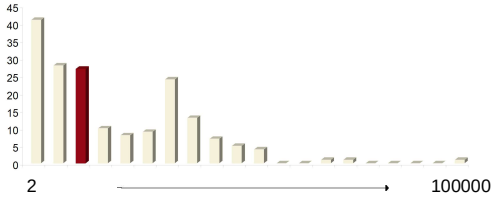


Table Of Contents

Table of Contents (cont.)

1. Narrative

1.1 Introduction

The inspection summarized in this report was undertaken in compliance with the requirements of the Public Transportation and Highway Improvement Act, Ontario Regulation 104/97. The last known detailed visual inspection of this structure took place in 2016. The inspection was carried out on Sunday, May 13, 2018 by Lin Yu under the direction of M. Wallrap P. Eng. At the time of inspection it was partly cloudy with temperatures between 25 and 30 degrees celsius. This report meets or exceeds all requirements for detailed visual surveys as set out in the Ontario Structure Inspection Manual 2000, rev. 2003, 2008.

1.2 General Information

The Airport Rd Over W Humber River Trib. - 1.98km N of Bovaird Dr culvert was built in 2005. The structure has a South-North orientation and is located on Airport Road 1.98 km North of Bovaird Drive in the Region of Peel. This Culvert carries 4 lanes of predominantly vehicular traffic across the West Humber River Tributary in 1 continuous span with a crossing length of 6.42m and a maximum clearance of 0.7m. The deck has a travel width of 14.4m and an overall width of 88m.

With an AADT of 10,393 the crossing is heavily used with truck volumes accounting for 10 to 25% of the total traffic. The speed limit at this location is 70 km/hr. There is no load limit posted at this site. There is no record of rehabilitation for this structure. The heritage designation is unknown. The total estimated replacement value is $1,585,000.

1.3 Observations

Each component is presented along with a discussion of any elements within that component that exhibit notable deterioration and/or a low estimated remaining service life. Thorough documentation of every element in the structure can be found in the detailed forms in Section 6.7 - Element Data.

The Airport Rd Over W Humber River Trib. - 1.98km N of Bovaird Dr culvert is comprised of the following components:

1.3.1 Over Burden

No significant defects were noted.

1.3.2 End Wall

No significant defects were noted.

1.3.3 Barrel

The cast-in-place barrel has an estimated mass of 641 tonnes. An estimated 1% of the element exhibits medium general deterioration. The estimated remaining service life in its current condition is 10 years.

The exterior surface (end) has an area of 0.3 square metres. The entire element exhibits medium disintegration requiring surface repair.

1.3.4 Barrier

No significant defects were noted.

1.3.5 Retaining Wall

No significant defects were noted.

1. Narrative (cont.)

1.3.6 East Embankment

No significant defects were noted.

1.3.7 West Embankment

No significant defects were noted.

1.3.8 Foundation

No significant defects were noted.

1.3.9 Watercourse

The west controlled upstream section has a surface area of 254 square metres. Most of the element exhibits medium aggradation although no immediate rehabilitative action is required.

The east controlled downstream section has a surface area of 254 square metres. Most of the element exhibits medium aggradation although no immediate rehabilitative action is required.

1.4 Conclusions and Further Investigation

Overall the structure is in very good condition with a Net Asset Salvage Value Index (NASVI) of 99.9. The calculated Bridge Condition Index (BCI) is 99.2 and the Bridge Sufficiency Index (BSI) is 93.2. For more information on how these indices are calculated please refer to the glossary at the end of this report. The major concern at this site is isolated spalling of barrel end.

1.4.1 Rehabilitative

The following summarizes the rehabilitative needs of the structure:

Barrel - Exterior Surface - (End)
Surface Repair

1.4.2 Pre-Emptive

No pre-emptive measures are currently recommended or required.

1. Narrative (cont.)

1.4.3 Maintenance

On-going maintenance procedures should be part of an annual regimen. Often these operations can be carried out by municipal staff however cost estimates have been provided in cases where it may be contracted out.

Barrier - Exterior
Power Washing

Barrier - Interior
Power Washing

Barrier - East
Power Washing

Watercourse - West Upstream Section
Seasonal Maintenance

Watercourse - East Downstream Section
Seasonal Maintenance

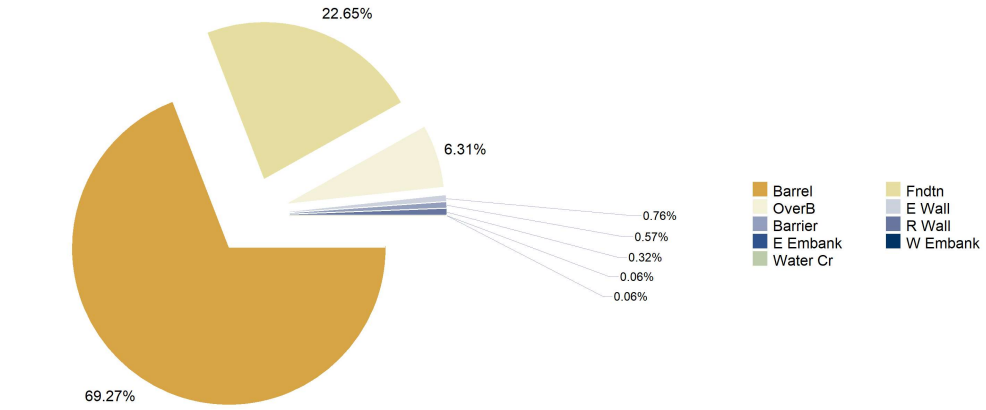
1.4.4 Further Investigation

The next biennial inspection should be scheduled no later than May, 2020.

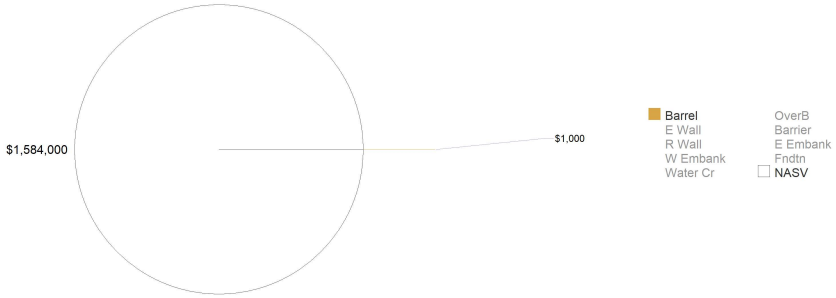
1. Narrative (cont.)

1.5 Statistical Summary

Distribution of $1,585,000 Replacement Value

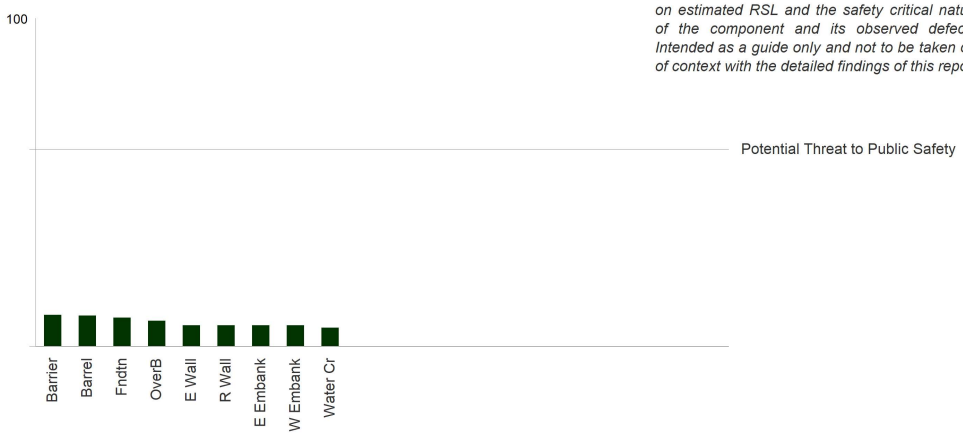


Distribution of $1,000 Rehabilitation Cost



Safety Risk

Risk assessed on a scale of 0 to 100 based on estimated RSL and the safety critical nature of the component and its observed defects. Intended as a guide only and not to be taken out of context with the detailed findings of this report.



2. Component Summary

		RSL		Urgency of Rehabilitative Needs Assuming all Maintenance Work is Completed						
	Replacement	1	2	Maint.	Pre-Emp	Urgent	< 1 year	1 - 5years	6 - 10 years	None\>10 yrs
Over Burden	$100,000	20	20							
End Wall	$12,000	20	20							
Barrel	$1,098,000	10	10						$1,000	
Barrier	$9,000	20	20	$900						
Retaining Wall	$5,000	20	20							
East Embankment	$1,000	20	20							
West Embankment	$1,000	20	20							
Foundation	$359,000	20	20							
Watercourse		15	15	$3,810						
Totals and Minimums	$1,585,000	10	10	$4,710	$0	$0	$0	$0	$1,000	$0

Total Estimated Rehabilitative Cost:	$1,000
Contingency:	$0
Provisional Allowance:	$0
Total Potential Project Cost:	$1,000

3. Element Summary

		RSL		Urgency of Rehabilitative Needs Assuming all Maintenance Work is Completed						
	Focus	1	2	Maint.	Pre-Emp.	Urgent	< 1 year	1 - 5years	6 - 10 years	None\>10 yrs
Over Burden	All	20	20							
End Wall	All	20	20							
West Inlet	All	20	20							
East Outlet	All	20	20							
Barrel	All	10	10							
Exterior Surface	End	10	10						$1,000	
Interior Surface	All	20	20							
Exterior Surface	All	20	20							
Barrier - Exterior	All	20	20	$300						
Exterior Surface	All	20	20							
Barrier - Interior	All	20	20	$300						
Hand Railing	All	20	20							
Barrier - East	All	20	20	$300						
Railing System	All	20	20							
Retaining Wall - South	All	20	20							
West Vertical Surface	All	20	20							
West Embankment	All	20	20							
Slope Protection	All	20	20							
East Embankment	All	20	20							
Slope Protection	All	20	20							
Foundation	All	20	20							
Watercourse	All	15	15							
Bottom	All	20	20							
West Upstream Section	All	15	15	$1,905						
East Downstream Section	All	15	15	$1,905						
Totals and Minimums		10	10	$4,710	$0	$0	$0	$0	$1,000	$0

Total Estimated Rehabilitative Cost:	$1,000
Contingency:	$0
Provisional Allowance:	$0
Total Potential Project Cost:	$1,000

4. Critical Maintenance Summary

There are no critical maintenance issues at this time.

5. General Maintenance Summary

Barrier - Exterior

Observed Defect: None

Suggested Maintenance: Pow er Washing

Barrier - Interior

Observed Defect: None

Suggested Maintenance: Pow er Washing

Barrier - East

Observed Defect: None

Suggested Maintenance: Pow er Washing

Watercourse - West Upstream Section

Observed Defect: Medium Aggradation

Suggested Maintenance: Seasonal Maintenance

5. General Maintenance Summary (cont.)

Watercourse - East Downstream Section

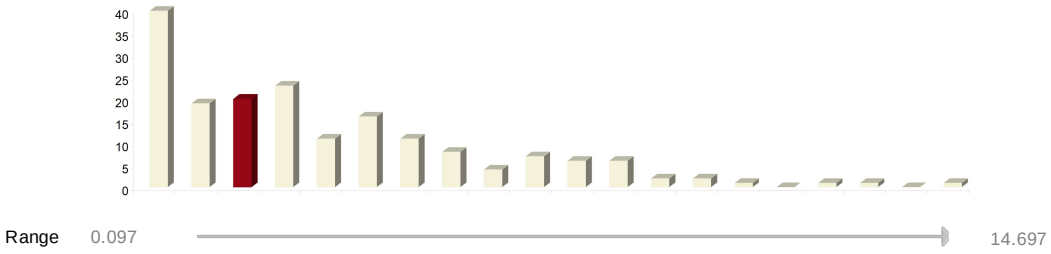
Observed Defect: Medium Aggradation

Suggested Maintenance: Seasonal Maintenance

6. Ranking Summary

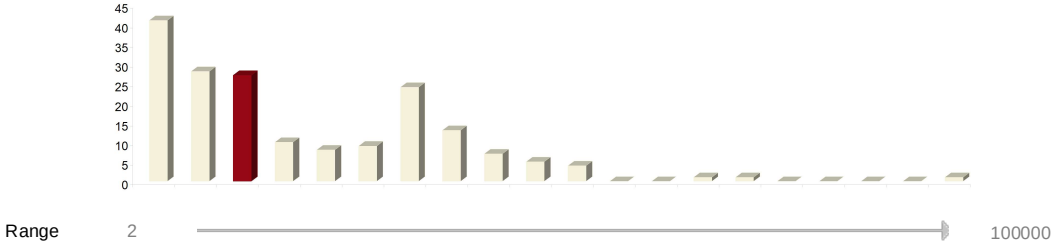
Replacement Value (millions)

This Structure: $1,585,000 Rank: 116 / 179



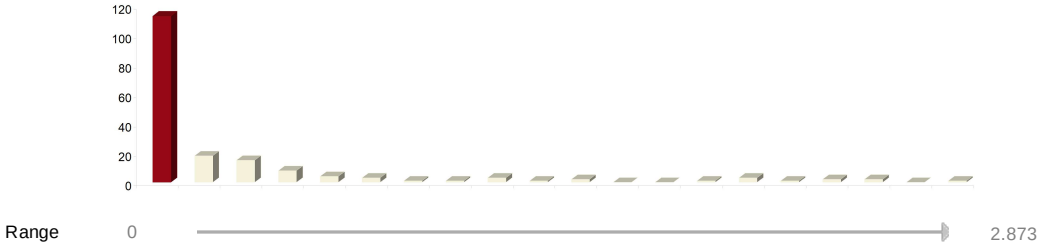
AADT

This Structure: 10393 Rank: 104 / 179



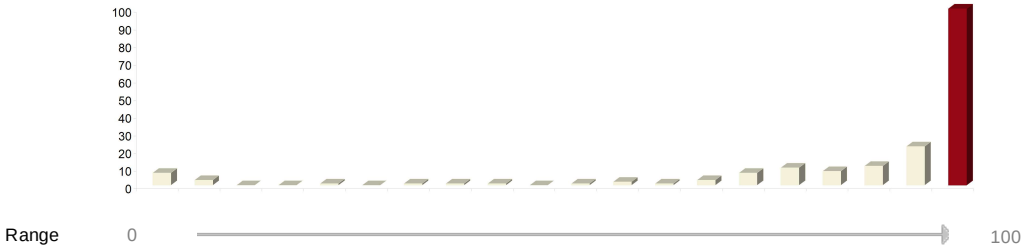
Rehabilitative Needs (millions)

This Structure: $1,000 Rank: 144 / 179



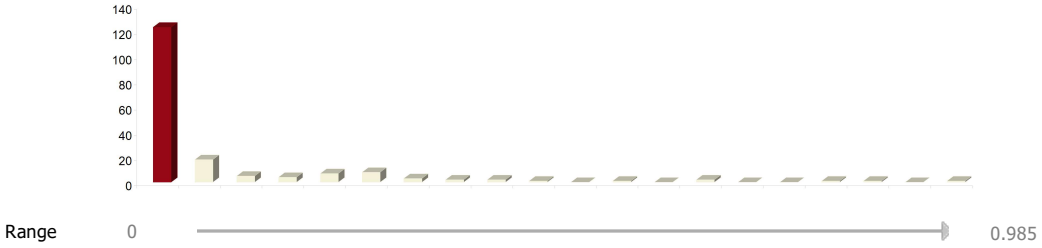
Condition Index

This Structure: 99.9 Rank: 38 / 179



Est. 10 Year Deferral Cost (millions)

This Structure: Rank: 69 / 179



Notes:

Data calculated at time of inspection.

Rankings are higest in category.

Histograms illustrate distribution of all structures in inventory from the low to high ranges indicated.

Vertical axis = number of structures.

Red columns represent category in which this structure resides.

7. OSIM Reporting

7.1 Inventory Data

Structure Name	Airport Rd Over W Humber River Trib. - 1.98km N of Bovaird Dr		Site Number	071510	
Main Hwy/Road #	7 On ☑ Under ☐		Crossing Type:	Navigable Water ☐ Non-Navig. Water ☑	
Hwy/Road Name	Airport Road			Rail ☐ Road ☐ Ped. ☐ Other ☐	
Structure Location	NA Park - NA				
Latitude	4847788		Longitude	17601414	
Owner(s)	Peel Region		Heritage Designation:	Not Cons. ☐ Cons./Not App. ☐ List/Not Desig. ☐ Desig./Not List ☐ Desig. & List ☐	
MTO Region	Central		Road Class:	Freeway ☐ Arterial ☑ Collector ☐ Local ☐	
MTO District	Unknown		Posted Speed	70	No. of Lanes 4
Old County	Unknown		AADT	10393	No. of Trucks 10
Geographic Twp.	Region of Peel		Inspection Route Sequence	Unknown	
Structure Type	Culvert		Interchange Number	Unknown	
Total Deck Length	6.42	(m)	Interchange Structure Number	Unknown	
Overall Str. Width	88	(m)	Minimum Vertical Clearance	0.64	(m)
Total Deck Area	565	(sq.m)	Special Routes:	Transit ☐ Truck ☐ School ☐ Bicycle ☐	
			Special Routes Details:	None	
Roadway Width	14.4	(m)	Detour Length Around Bridge	4	(km)
Skew Angle	34	(Degrees)	Direction of Structure	South-North	
No. of Spans	1		Fill on Structure	0.76	(m)
Span Lengths	5.78				(m)

7.2 Historical Data

Year Built	2005	Year of Last Major Rehab.	
Last OSIM Inspection	2016	Last Evaluation	Unknown
Last Enhanced OSIM Inspection	Unknown	Current Load Limit	None (tonnes)
Enhanced Access Equipment			
Last Underwater Inspection	Unknown	Load Limit By-Law #	Not Applicable/Unknown
Last Condition Survey	Unknown	By-Law Expiry Date	Not Applicable/Unknown
Rehabilitation History	None		

7. OSIM Reporting (cont.)

7.3 Scheduled Improvements

Regional Priority Number

Programmed Work Year

Nature of Program Work

7.4 Appraisal Indices

	Comments
Fatigue	
Seismic	
Scour	
Flood	
Geometrics	
Barrier	
Curb	
Load Capacity	

7. OSIM Reporting (cont.)

7.5 Field Inspection Information

Date of Inspection	May-13-18	Type of Inspection	☑ OSIM ☐ Enhanced OSIM
Inspector	Lin Yu		
Others in Party	None		
All Equipment Used	, Camera		
Weather	Partly Cloudy		
Temperature	25 to 30 C		

7.6 Additional Investigations Required

	None	Normal	Urgent	Est. Cost
Detailed Deck Condition Survey	X			
Non-Destructive Delamination Survey of Asphalt Covered Deck	X			
Concrete Substructure Condition Survey	X			
Detailed Coating Condition Survey	X			
Detailed Timber Investigation	X			
Post-Tensioned Strand Investigation	X			
Underwater Investigation	X			
Fatigue Investigation	X			
Seismic Investigation	X			
Structure Evaluation	X			
Monitoring of Deformations, Settlements and Movements	X			
Other* None	X			
Next Detailed Visual Inspection May, 2020			Total Est. Cost	

The major concern at this site is isolated spalling of barrel end.

Suspected Performance Deficiencies

00 None
01 Load carrying capacity
02 Excessive deformations (deflections & rotations)
03 Continuing settlement
04 Continuing movements
05 Seized bearings
06 Bearing not uniformly loaded/unstable
07 Jammed expansion joint
08 Pedestrian/vehicular hazard
09 Rough riding surface
10 Surface ponding
11 Drainage
12 Slippery surfaces
13 Flooding/channel blockage
14 Undermining of foundation
15 Unstable embankments
16 Other

Maintenance Needs

00 None
01 Lift and Swing Bridge Maintenance
02 Bridge Cleaning
03 Bridge Handrail Maintenance
04 Painting Steel Bridge Structures
05 Bridge Deck Joint Repair
06 Bridge Bearing Maintenance
07 Repair to Structural Steel
08 Repair of Bridge Concrete
09 Repair of Bridge Timber
10 Bailey bridges - Maintenance
11 Animal/Pest Control
12 Bridge Surface Repair
13 Erosion Control at Bridges
14 Concrete Sealing
15 Rout and Seal
16 Bridge Deck Drainage
17 Remove Loose OverHead Material
18 Other

* eg. monitoring crack widths, trip hazards, issues impacting pedestrian or vehicular control

7. OSIM Reporting (cont.)

7.7 Element Data

7.7.1 Over Burden - Over Burden

Element Group:	Over Burden	Length:	10
Element Name:	Over Burden	Width:	88
Location:	Single Element	Height:	1.46
Material:	Soil	Count:	1
Element Type:	Primary Element	Total Quantity:	1
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	each	0	1	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

East View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.2 End Wall - End Wall

Element Group:	End Wall	Length:	N/A
Element Name:	End Wall	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Cast-In-Place Concrete	Count:	N/A
Element Type:	Primary Element	Total Quantity:	9.34
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	tonnes	0	9.34	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

East Surface

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.3 End Wall - West Inlet

Element Group:	End Wall	Length:	N/A
Element Name:	West Inlet	Width:	N/A
Location:	West	Height:	N/A
Material:	Cast-In-Place Concrete	Count:	1
Element Type:	Any	Total Quantity:	3.2
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	0	3.2	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Overall Surface

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.4 End Wall - East Outlet

Element Group:	End Wall	Length:	N/A
Element Name:	East Outlet	Width:	N/A
Location:	East	Height:	N/A
Material:	Cast-In-Place Concrete	Count:	1
Element Type:	Any	Total Quantity:	2.4
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	0	2.4	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

East Surface

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.5 Barrel - Barrel

Element Group:	Barrel	Length:	N/A
Element Name:	Barrel	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Cast-In-Place Concrete	Count:	N/A
Element Type:	Primary Element	Total Quantity:	640.8
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	tonnes	627.98	0	12.82	0	00	00

Comments: None.

Urgency : None ☐ 6-10 years ☑ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : Defer to Element Level

West View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.6 Barrel - Exterior Surface

Element Group:	Barrel	Length:	0.55
Element Name:	Exterior Surface	Width:	0.55
Location:	Single Element	Height:	0.1
Material:	Cast-In-Place Concrete	Count:	1
Element Type:	Any	Total Quantity:	0.3
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	0	0	0	0.3	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : Surface Repair

Southw est Edge 2012

Exterior Surface 2014

Exterior Surface

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.7 Barrel - Interior Surface

Element Group:	Barrel	Length:	5.78
Element Name:	Interior Surface	Width:	88
Location:	Single Element	Height:	0.64
Material:	Cast-In-Place Concrete	Count:	1
Element Type:	Any	Total Quantity:	621.2
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	614.99	0	6.21	0	00	00

Comments: Barrel leakage between precast concrete joints is evident. Note: limited inspection due to low clearance.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Interior Surface

North View

South View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.8 Barrel - Exterior Surface

Element Group:	Barrel	Length:	6.42
Element Name:	Exterior Surface	Width:	88
Location:	Single Element	Height:	1.05
Material:	Cast-In-Place Concrete	Count:	1
Element Type:	Any	Total Quantity:	756
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	756	0	0	0	00	18

Comments: The interior barrel shows signs of leakage at precast joints and therefore waterproofing should be applied to the exterior barrel to prevent future leakage.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

East Elevation

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.9 Barrier - ExteriorBarrier

Element Group:	Barrier	Length:	N/A
Element Name:	ExteriorBarrier	Width:	N/A
Location:	Exterior	Height:	N/A
Material:	Cast-In-Place Concrete	Count:	N/A
Element Type:	Barrier Wall	Total Quantity:	5.57
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	tonnes	5.57	0	0	0	00	02

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.10 Barrier - Exterior Surface

Element Group:	Barrier	Length:	14.5
Element Name:	Exterior Surface	Width:	N/A
Location:	Single Element	Height:	0.8
Material:	Cast-In-Place Concrete	Count:	1
Element Type:	Any	Total Quantity:	11.6
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	11.6	0	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Exterior Surface

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.11 Barrier - InteriorBarrier

Element Group:	Barrier	Length:	N/A
Element Name:	InteriorBarrier	Width:	N/A
Location:	Interior	Height:	N/A
Material:	Steel	Count:	N/A
Element Type:	Primary Element	Total Quantity:	0.1
Environment:	Severe	Limited Inspection	☐
Protection System:	Galvanized Steel		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	tonnes	0.1	0	0	0	00	02

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.12 Barrier - Hand Railing

Element Group:	Barrier	Length:	12.9
Element Name:	Hand Railing	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Steel	Count:	1
Element Type:	Any	Total Quantity:	12.9
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m	12.9	0	0	0	00	00

Comments: None.

Urgency :	None ☑	6-10 years ☐	1-5 years ☐	< 1 year ☐	Urgent ☐
Recommended Work :	None				

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.13 Barrier - EastBarrier

Element Group:	Barrier	Length:	N/A
Element Name:	EastBarrier	Width:	N/A
Location:	East	Height:	N/A
Material:	Steel	Count:	N/A
Element Type:	Primary Element	Total Quantity:	0.72
Environment:	Severe	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	tonnes	0.72	0	0	0	00	02

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.14 Barrier - Railing System

Element Group:	Barrier	Length:	24
Element Name:	Railing System	Width:	N/A
Location:	Single Element	Height:	1.8
Material:	Steel	Count:	1
Element Type:	Any	Total Quantity:	24
Environment:	Severe	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m	24	0	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.15 Retaining Wall - SouthRetaining Wall

Element Group:	Retaining Wall	Length:	N/A
Element Name:	SouthRetaining Wall	Width:	N/A
Location:	South	Height:	N/A
Material:	Cast-In-Place Concrete	Count:	N/A
Element Type:	Primary Element	Total Quantity:	7.6
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	tonnes	7.6	0	0	0	00	00

Comments: None.

Urgency :	None ☑	6-10 years ☐	1-5 years ☐	< 1 year ☐	Urgent ☐

Recommended Work : None

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.16 Retaining Wall - West Vertical Surface

Element Group:	Retaining Wall	Length:	8.4
Element Name:	West Vertical Surface	Width:	N/A
Location:	West	Height:	1.5
Material:	Cast-In-Place Concrete	Count:	1
Element Type:	Any	Total Quantity:	12.6
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	12.6	0	0	0	00	00

Comments: None.

Urgency :	None ☑	6-10 years ☐	1-5 years ☐	< 1 year ☐	Urgent ☐
Recommended Work :	None				

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.17 West Embankment - Embankment

Element Group:	West Embankment	Length:	N/A
Element Name:	Embankment	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Soil	Count:	1
Element Type:	Primary Element	Total Quantity:	1
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	all	0	1	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

South View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.18 West Embankment - Slope Protection

Element Group:	West Embankment	Length:	N/A
Element Name:	Slope Protection	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Soil	Count:	1
Element Type:	Any	Total Quantity:	1
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	all	0	1	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

North View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.19 East Embankment - Embankment

Element Group:	East Embankment	Length:	N/A
Element Name:	Embankment	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Soil	Count:	1
Element Type:	Primary Element	Total Quantity:	1
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	all	0	1	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

South View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.20 East Embankment - Slope Protection

Element Group:	East Embankment	Length:	N/A
Element Name:	Slope Protection	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Soil	Count:	1
Element Type:	Any	Total Quantity:	1
Environment:	Moderate	Limited Inspection	☐
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	all	0	1	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

North View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.21 Foundation - Foundation

Element Group:	Foundation	Length:	N/A
Element Name:	Foundation	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Compacted Fill	Count:	1
Element Type:	Primary Element	Total Quantity:	1
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	each	0	1	0	0	00	00

Comments: None.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

West Elevation

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.22 Watercourse - Watercourse

Element Group:	Watercourse	Length:	N/A
Element Name:	Watercourse	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Any	Count:	1
Element Type:	Straight	Total Quantity:	1
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	all	0	0.6	0.4	0	00	18

Comments: Seasonal maintenance should be performed to ensure no blockages occur.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.23 Watercourse - Bottom

Element Group:	Watercourse	Length:	N/A
Element Name:	Bottom	Width:	N/A
Location:	Single Element	Height:	N/A
Material:	Paving Stones	Count:	N/A
Element Type:	Constructed	Total Quantity:	509
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	0	509	0	0	00	00

Comments: None.

Urgency :	None ☑	6-10 years ☐	1-5 years ☐	< 1 year ☐	Urgent ☐
Recommended Work :	None				

Interior View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.24 Watercourse - West Upstream Section

Element Group:	Watercourse	Length:	N/A
Element Name:	West Upstream Section	Width:	N/A
Location:	West	Height:	N/A
Material:	Paving Stones	Count:	N/A
Element Type:	Controlled	Total Quantity:	254
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	0	127	127	0	00	02

Comments: Aggradation of the upstream watercourse does not currently impact water flow, however seasonal maintenance should be performed to prevent future blockages.

Urgency :	None ☑	6-10 years ☐	1-5 years ☐	< 1 year ☐	Urgent ☐

Recommended Work : None

Overall View

7. OSIM Reporting (cont.)

7.7 Element Data (cont.)

7.7.25 Watercourse - East Downstream Section

Element Group:	Watercourse	Length:	N/A
Element Name:	East Downstream Section	Width:	N/A
Location:	East	Height:	N/A
Material:	Paving Stones	Count:	N/A
Element Type:	Controlled	Total Quantity:	254
Environment:	Moderate	Limited Inspection	☑
Protection System:	None		

Condition Data:	Units	Exc.	Good	Fair	Poor	Performance Deficiencies	Maintenance Needs
	m2	0	127	127	0	00	02

Comments: Aggradation of the downstream watercourse does not currently impact water flow, however seasonal maintenance should be performed to prevent future blockages.

Urgency : None ☑ 6-10 years ☐ 1-5 years ☐ < 1 year ☐ Urgent ☐

Recommended Work : None

Overall View

8. Glossary

Abutment

A substructure unit which supports the end of the structure and retains the approach fill.

Asset

A collection of Components that are most economically and/or practically replaced, rehabilitated or maintained together under a single contract or initiative. The timing of such an initiative is weighed against the timing of treating other Assets.

Asset Value Contribution

The portion of the total replacement value attributable to a particular component.

Auxiliary Components

Any component which does not share in the load carrying capacity of the structure.

BCI

Bridge Condition Index (0-100). Developed by the Ministry of Transportation Ontario. The BCI attempts to calculate a NASV based on the limited information in a typical OSIM biennial inspection. Replacement costs and rehabilitative needs are calculated based on areas instead of tonnages and only include certain components which are weighted based on condition state. In many cases the BCI will differ substantially from the NASVI calculated in our reports. The key difference is not only the accuracy of the calculation but also the fact that NASVI considers complete, practical rehabilitative strategies based on condition and age. As an example a structure that is approaching the end of its design service life and is obviously well beyond economic restoration will have a NASVI of 0. That's not to say it has to be replaced immediately, on the contrary, if the structure can safely carry load it should be kept in service as long as practical to allow other assets with more pressing concerns to be addressed. BCI, on the other hand, may be 60 in this case because 40% of the surface area of certain components are in poor or very poor condition. It gives no indication of the cost the agency should be prepared for when rehabilitation occurs.

Benign

Not exposed. e.g. girders, pier caps (unless joints are leaking)

Bridge

A structure which provides a roadway or walkway for the passage of vehicles across an obstruction, gap or facility and which is greater than 3 m in span.

BSI

Bridge Sufficiency Index (0-100). The BSI is essentially a modification of the BCI to reflect functional obsolescence or perceived importance that would pose a significant negative impact if the structure were not in service. In both cases a reduction in BCI is the result making rehabilitation more urgent in a "Condition Index Prioritization" scheme.

Chord

The upper and lower main longitudinal component in trusses or arches extending the full length of the structure.

Coating

The generic term for paint, lacquer, enamel, sealers, galvanizing, metalizing, etc.

Component

A major feature of an Asset that performs a particular function. Often in multiple occurrences.

Critical Quantity

The single quantity that defines the Element for costing purposes.

Culvert

Any bridge that is embedded in fill and is used to convey water, pedestrians or animals through it.

DCI

Deferral Cost Index (1-6). A measure of how the cost of a structures rehabilitation is likely to increase over time in increments of 5 and 10 years. A DCI of 1 is the most aggressive with significant increases expected over the short term (5 years or less). A DCI of 6 is the least aggressive with almost negligible cost escalation predicted over the next 10 years. Inflation is not considered as this applies to all structures more or less equally. Typically, DCI Prioritization is significantly more efficient than BCI Prioritization schemes.

Deck Condition Survey

A detailed inspection of a concrete deck in accordance with The Structure Rehabilitation Manual.

Defect

An identifiable, unwanted condition that was not part of the original intent of design.

Detailed Visual Inspection

An element by element visual assessment of material defects, performance deficiencies and maintenance needs of a structure.

Deterioration

A defect that has occurred over a period of time.

Diagonals

Component which spans between the top and bottom chord of a truss or arch in a diagonal direction.

Distress

A defect produced by loading.

Element

A feature of a Component distinguished in terms of condition, material, base of measurement or unit cost of repair.

Engineer

A member or licensee of the Professional Engineers of Ontario.

Environment

An element's exposure to chloride contamination and freeze-thaw cycling

Estimated Remaining Service Life

The Remaining Service Life (RSL) is an estimate, in years, over which an element may remain in service without repair or replacement. It is assumed that the conditions to which the element has been exposed will not change significantly and is based solely on visual observation.

Estimated Remaining Service Life (ERSL)

This is an estimate, in years, as to how long an element can be expected to continue to perform satisfactorily without the predominant deficiency being addressed. In the case of a Primary Element, it is the time remaining before the element must be addressed at Primary Element Level if nothing is done. It is based on judgment and experience and is tempered by the need to control liability of our clients. In cases where no physical testing results are available, ERSL's will tend to be more conservative. The ESRL assigned to a component represents the minimum ERSL assigned to any element comprising that component.

Evaluation

The determination of the load carrying capacity of structures in accordance with the requirements of the Ontario Highway Bridge Design Code or the Canadian Highway Bridge Design Code, when implemented.

Floor Beam

Transverse beams that span between trusses, arches or girders and transmit loads from the deck and stringers to the trusses, arches or girders.

Focus

At the element level, focus refers to the portion of the element in question. In most cases the focus is simply stated as "All" or, in other words, the entire element is being reported on under one designation. As elements deteriorate over time it is often desirable to differentiate between areas that are deteriorating more rapidly or differently. In other cases, elements are comprised of different materials and would be repaired differently as a result. These too should be separated and referred to by their focus. The focus of a primary element is always set to "All".

Highway

A common and public thoroughfare including street, avenue, parkway, driveway, square, place, bridge, designed and intended for, or used by, the general public for passage of vehicles, pedestrians or animals.

Lateral Bracing

Bracing which lies in the plane of the top or bottom chords or flanges and provides lateral stability and resistance to wind loads.

Maintenance

Any action which is aimed at preventing the development of defects or preventing deterioration of a structure or its components.

Masonry

Structure made up of natural stones separated by mortar joints, usually in uniform courses. Masonry in existing structures is usually in retaining walls, abutments, piers or arches.

Masonry Ashlar

Stone worked to a square shape or cut square with uniform coursing height and vertical joints staggered. The stone has a minimum course height of 200 mm set in joints with an average thickness of 10 mm or less.

Masonry Rubble

Stone masonry constructed with rough field stones or only roughly squared stones set in mortar joints with average thickness greater than 20 mm. Also any squared stone masonry in which the joints are greater than 20 mm, but less than 30 mm in thickness.

Masonry Squared Stone

Stone in natural bed thicknesses or roughly squared stones with course height less than 200 mm and joints greater than 10mm but not over 20mm.

Moderate

Exposed but element protected e.g. asphalt covered and waterproofed deck

Net Asset Salvage Value (NASV)

The current NASV of an asset is equal to its Replacement Value minus the estimated cost of rehabilitating the asset back to its original condition. NASV changes continually with time, diminishing in step with the continued deterioration of the asset. It is important to recognize that whether a component such as a bridge deck is replaced or fully repaired it will still be reset to its full Asset Value Contribution. Recognition of the difference in longevity of the two strategies will be revealed by the subsequent behaviour of the post-rehabilitation performance model.

Net Asset Salvage Value Index (NASVI)

Calculated as NASV / Replacement Value of the Asset. Expressed from 0 - 100 the NASVI gives an immediate indication of the remaining net worth of the asset.

Owner

An agency having jurisdiction and control over the bridge.

Performance Model

A plot of NASVI over time. The vertical scale represents the Index from 0 to 100, the horizontal scale represents time in years. The plot will reflect the Index of the Asset since original construction to the present and from the present to the end of the analysis period. The impact of rehabilitative work (already carried out since construction as well as that planned for the future) will be reflected in the curve as will the anticipated subsequent performance of that Rehabilitation.

Person

An individual, board, commission, partnership or corporation, including a municipal corporation, and employees, agents, successors and assigns of any of them.

Plans

All drawings, descriptions and specifications, being parts of the contract, and all drawings and descriptions produced by the constructor for the erection of a bridge or structure, and all revisions thereto.

Portal Bracing

Overhead bracing at the ends of a through truss or arch and provides lateral stability and shear transfer between trusses.

Primary Components

The main load carrying components of the structure.

Primary Element

The elemental equivalent of the component it comprises. For example, an Abutment consists of the elements, Wngwalls, Abutment Wall, Ballast Wall, Bearings. It also has an element called "Abutment". This element is needed so that costing (which is carried out at the element level) can account for replacement of the entire component. This element is referred to as the Primary Element.

Rehabilitation

Any modification, alteration, retrofitting or improvement to a structure sub-system or to the structure which is aimed at correcting existing defects or deficiencies. May involve repair of existing elements or complete replacement.

Repair

Any modification, alteration, retrofitting or improvement to a component of the structure which is aimed at correcting existing defects or deficiencies.

Replacement Cost

Replacement Cost is the expenditure required to build, on a new site, or replace at an existing site, a bridge that meets all present and projected requirements of the site, community and current codes.

Replacement Value

Traditionally, Replacement Value refers to the cost in today's dollars for the identical replacement of an existing bridge. In other words, it is the value of the existing installation.

Retaining Wall

Any structure that holds back fill and is not connected to a bridge.

Secondary Components

Any component which helps to distribute loads to primary components, or carries wind loads, or stabilizes primary components.

Severe

Exposed and element not protected e.g. Exposed concrete deck, Barrier Wall

Sign Support

A metal, concrete or timber structure, including supporting brackets, service walks and mechanical devices where present, which support a luminaire, sign or traffic signal and which span or extend over a highway.

Span

The horizontal distance between adjacent supports of the superstructure of a bridge, or the longest horizontal dimension of the cross-section of a culvert or tunnel taken perpendicular to the walls.

Stringers

Stringers span between floor beams and provide the support for the deck above.

Structure

Bridge, culvert, tunnel, retaining wall or sign support.

Suspected Performance Deficiency

A Suspected Performance Deficiency should be recorded during an inspection, if an element's ability to perform its intended function is in question, and one or more performance defects exist.

Sway Bracing

Vertical bracing spanning between through trusses or arches, or outside of half-through trusses or arches and providing lateral stability and shear transfer between the trusses or arches.

Tunnel

Any bridge that is constructed through existing ground, and is used to convey highway or railway traffic through it.

Utility

Refers to a local utility such as hydro, gas, telephone etc. not part of the structure itself but rather utilizing it to provide passage. Typically carried between girders or hanging from the underside of the deck. Of significance only because the integrity of its connection to the structure impacts public safety.

Verticals

Components which span between the top and bottom chords of a truss or arch in the vertical direction.

Whisker Graphs

Simple frequency distribution charts that are intended, at a glance, to convey a comparative reference. They are shown on the Structure Summary to give the reader an immediate sense of how the bridge compares to the rest of the network based on various criteria.