

CITY OF CAMBRIDGE

STRUCTURAL INSPECTION OF RIVERSIDE DAM INSPECTION REPORT - FINAL

NOVEMBER 11, 2022





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CITY OF CAMBRIDGE

INSPECTION REPORT

PROJECT NO.: IM22108048.
DATE: NOVEMBER 11, 2022

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November 11, 2022

City of Cambridge
50 Dickson Street
Cambridge ON N1R 5W8

Attention: Mr. Scott MacDonald, Project Engineer, Engineering & Transportation Services

Dear Sir:

Subject: Riverside Dam Inspection

WSP Environment & Infrastructure Canada Limited (formerly Wood Environment & Infrastructure Solutions) has prepared the attached Draft of the Structural Inspection Report summarizing the findings from the visual inspections of the Riverside Dam. The report covers the complete dam structure including spillway, control structures, retaining walls, and sluiceway. Pending comments from the City, WSP will update the report accordingly.

Please be aware that, effective September 21st, 2022, Wood Environment & Infrastructure Solutions Canada Limited was acquired by WSP.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'Dante Shawil'.

Dante Shawil
Structural Designer




A handwritten signature in blue ink, appearing to read 'M Galloway'.

Matthew Galloway, M.Eng., P.Eng.
Senior Structural Engineer

SA/ds
Encl.

WSP ref.: IM22108048

QUALITY MANAGEMENT

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1 KEY PLAN

The plan below shows the location of the Riverside Dam in the City of Cambridge. The Dam is upstream of King Street, spanning the Speed River, adjacent to Riverside Park.



Figure 1: Riverside Dam, Cambridge, Ontario

2 INTRODUCTION

In 2022, WSP Environment & Infrastructure Canada Limited (formerly Wood Environment & Infrastructure) was retained by the Corporation of the City of Cambridge (City) to conduct a visual structural inspection of the Riverside Dam. The goal of the inspection was to assess and comment on the progression of deterioration on the dam since the 2018 inspection conducted by Wood, in addition to conducting a standard visual inspection.

The dam is located on the Speed River, just north of the CP Rail spur, servicing the industrial area to the northwest, and north of King Street. The Riverside Dam was constructed circa 1890 and consists of a rubble filled core, covered with a reinforced concrete shell that ranges in thickness from 0.42 m to 0.62 m and with an average of 0.11m cover to rebar. The rebar used for the dam comprises of either 12mm square bar or 10mm round bar. The dam is approximately 65 m long and 1.5 m high (measured from the top of the apron). The width of the top of the dam is 0.78 m. Additionally, the dam consists of two stop log structures, one located towards the north end and one towards the south end of the dam structure. There is also a sluiceway structure located along the north retaining wall (upstream of the dam).

The City of Cambridge retained Sanchez Engineering Inc. to carry out an evaluation of the Riverside Dam in 2008/2009 (ref. Riverside Dam Structural Evaluation and Detailed Design, Sanchez, 2009). The inspection by Sanchez was completed in 2008. The 2008 inspection revealed that the north stop log control structures were in poor to fair condition and the south stop log control structure needed emergency repair which was subsequently carried out by the City of Cambridge after the inspection in 2009. The repair was completed as a stop-gap measure to stabilize the control structure and so prevent potential catastrophic rapid failure of the dam.

In 2014, the City of Cambridge retained AMEC Environment & Infrastructure (Wood Environment & Infrastructure Solutions) to conduct a detailed structural investigation. The 2014 investigation included an inspection of the dam, coring for petrographic investigation, and recommendations on rehabilitation options. It concluded that:

1. The deterioration has advanced since the 2008 Sanchez Engineering Inc. inspection.
2. A two (2) – ten (10) year range on local failure was expected which could compromise integrity of the dam and annual inspections recommended.
3. Petrographic examination found that micro and macro cracking were present, and that the rubble core was loosely bound due to a lack of cementitious material; and
4. A review determined that repair of the structure would not be viable.

In 2017/2018, Wood Environment & Infrastructure Solutions (formerly Amec Foster Wheeler Environment & Infrastructure) was retained by the Corporation of the City of Cambridge (City) to conduct a visual structural inspection of the Riverside Dam. The goal of the inspection was to assess and comment on the progression of deterioration of the dam since the 2014 inspection conducted by Wood, in addition to conducting a standard visual inspection.

The 2017/2018 investigation concluded that:

1. The dam remains in poor condition.
2. The dam has continued to deteriorate since the 2014 inspection.
3. The debris buildup throughout the dam should be removed as soon as possible.
4. Based on the advancing deterioration of the structure, a significant local failure would compromise the integrity of the dam.
5. On this basis, it was recommended that inspection of the dam continue to be carried out annually, to monitor the dam's condition and assess short-term risk.

The City of Cambridge has requested WSP to carry out visual inspection(s) in 2022 to determine the condition of the structure.

2.1 SCOPE OF WORK

The purpose of this assignment was to carry out a visual inspection of the Riverside Dam to assess existing condition and determine progress of deterioration since the last inspection, in order to identify any critical concerns requiring immediate attention and provide recommendations for potential capital works.

WSP carried out their inspection on August 24, 2022.

3 INSPECTION

3.1 STOP LOG STRUCTURES, SLUICEWAY, AND RETAINING WALL

The sluiceway structure was inspected with access through the Riverside Park, North of the dam. The stop log structure and retaining walls were inspected with access from the Speed River on the downstream side of the dam. Access to the downstream side of the dam was achieved from the embankments of the King Street East Bridge and then walking towards the dam. Once on the downstream side of the dam, the apron acted as a reliable footing to traverse along the face of the dam.

Photographs from the inspections are attached in Appendix A.

The north stop log structure is a masonry structure with significant sections of the front face missing. The exposed core consists of varying sizes of boulder rocks with a low strength cement mortar. The joints have opened up, and vegetation is growing through the open joints. Several large masonry blocks from the fascia are missing, and others are on the verge of falling off the structure. Appendix B identifies locations where progression of deterioration on the stop log structure were observed since the 2018 inspection.

The top slab of the structure is cracked in several locations.

The timber stop logs are closed; however, they are leaking (Refer to Photo 2), resulting in a small flow of water through the raceways. This is typical at both raceways (arches shown in Photo 1) on the North structure. The wooden stop logs appear to be in poor condition.

The south stop log structure is generally in poor condition, with cracks, spalling and disintegration observed on the top face of the structure. A wide horizontal crack was visible in the wall around most of the structure. Debris, especially trees and vegetation, has built up upstream of the stop log structure. To prevent collapse or sliding of the south stop log structure, rip rap was placed directly downstream of the structure and used to block the raceways. As a result, no water flows through the structure.

It was determined too unsafe to climb on the stop log structure, therefore relevant comments have been carried over from the 2014 and 2017/2018 inspections and are as follows: The northern wingwall was found to have a medium to wide longitudinal crack along the length of the wall. The underwater investigation found that the concrete relating to the stop log structure was in fair condition with light to medium scaling

The retaining wall on the North side of the Speed River, just downstream from the dam is in poor condition. The footing structure is eroded, and the joints are open. Masonry blocks have popped out at several locations and concrete/mortar has eroded from the wall. Water was observed to be flowing behind the blocks.

The retaining wall on the South side (Southeast of the rail bridge) was found to be in poor condition. Due to erosion of the footing structure and loss of masonry blocks, a substantial cavity has formed (see Photo 17) which yields the ground directly behind the wall unsuitable for any loading. Fortunately, the ground behind the retaining wall is an abandoned industrial site so there is no immediate risk, if this area is closed off. In addition to the cavity, several blocks are eroded, and joints have lost their mortar.

The sluiceway structure was inspected and found to be in good condition. Only a medium horizontal crack at the base of the north wall was observed. The north sluiceway is blocked up with rip rap and granular material, which prevents water from flowing through the structure.

3.2 SPILLWAY STRUCTURE

The downstream face of the dam was inspected by a combination of visual observations (where turbulent water did not obscure the view) and by physically touching the structure. This inspection was conducted by walking along the apron. The dense algae growth on the spillway prevented a more detailed inspection during August 2022. Attempts to clean the algae were somewhat successful.

Erosion along the face of the spillway was observed. Within the white-water zones, the depth of concrete shell erosion typically ranged from 50 mm to a maximum of 100 mm (adjacent to the south stop log structure). Areas at the bottom of the dam wall and sections of the concrete apron nearest the wall (toe of the dam) have eroded, and three specific locations were noticed with erosion ranging from 75-150mm.

Two exposed rebars were found on the northern portion of the spillway (at the interface between the stop log structure). Concrete spalls were found at different locations. Depressions and erosion were observed along the full length.

A Structural Inspection Drawing originating from the 2018 inspection report titled “18-08-23 - Riverside Dam Inspection Report FINAL” has been updated and attached in Appendix ‘C’ addressing the additional changes to the condition of the dam.

4 CONCLUSIONS & RECOMMENDATIONS

The following summarizes the conclusions and recommendations of the investigation:

1. The 2022 inspection has established that the dam remains in poor condition.
2. The 2022 inspection has determined that the dam has continued to deteriorate since the 2017 & 2018 inspection. Concrete blocks have fallen out of the fascia on the North Stop Log Structure. More concrete erosion and deterioration has also been observed on the spillway and other elements of the dam structure.
3. Based on the advancing deterioration of the structure, a significant local failure would compromise the integrity of the dam. On this basis, it is recommended that inspection of the dam continues to be carried out annually to monitor the dam's condition and assess short-term risk.

The following work is recommended to be completed within the next year (<1 year):

1. For the South Retaining Wall Structure, it is recommended that the abandoned industrial site directly behind the wall be blocked off with barriers to prevent accidental vehicle or pedestrian loading. The barriers should be placed at a minimum 10m radius from the front face of the wall. As mentioned in Section 3, due to the formation of the cavity, the ground above has lost most, if not all its capacity to carry any heavy loads.

The following work is recommended to be carried out within the next 1-2 years:

1. The debris buildup throughout the dam should be removed as soon as possible. This includes the buildup around the north and south stop log structures, and the scattered debris jammed on the spillway.
2. For the North Stop Log Structure, it is recommended that the raceways be blocked up as was previously done for the South Stop Log Structure as failure of the stop log structure would compromise the integrity of the dam. The details of this work would need to be determined through a separate design assignment. Two (2) options that are possible are:
 - a. Install large riprap inside the raceways and in front of the structure, like what was done at the South Stop Log Structure.
 - b. Completely fill the raceways with grout. (Some riprap could also be installed in the front of the structure).

The following work is recommended to be carried out within the next 3-5 years:

1. For the North Retaining Wall Structure, it is recommended that the wall be repaired, and two possible options include:
 - a. For short-term repairs, a two-stage approach can be utilized comprising of first stabilizing the soil behind the wall with chemical grouting and second, forming and pumping grout at locations of voids on the face of the wall; and
 - b. For a long-term repair, a combination of soil anchors drilled through the wall and sprayed on shotcrete can be utilized.

It should be noted that it is difficult to predict the weather conditions and there is risk that during high flood events or during ice impact, the wall may be at risk of collapse. However, it is believed that the failure of the wall would not lead to major impact to the public.

The above recommended work will serve multiple purposes to address areas of immediate concern that could compromise the integrity of the dam and concerns that could impact the public, as well as extend the life of the asset.

5 CLOSURE

We trust that this report is adequate for your purposes. If you have any questions or concerns, please feel free to contact the undersigned at your convenience.

Respectfully submitted by:

WSP Environment & Infrastructure Solutions
A Division of WSP Canada Limited


Prepared by: Saad Afram, EIT
Technical Professional 1 – Structural

Signature: 

Reviewed by: Dante Shawil
Structural Designer

Signature: 

Reviewed by: Matthew Galloway, M.Eng., P.Eng.
Senior Structural Engineer

Signature: 

APPENDIX

A SITE INSPECTION PHOTOGRAPHS

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APPENDIX



Photo 1 - Elevation View of North Stop Log Structure



Photo 2 - Top Left Corner of North Stop Log Structure

APPENDIX



Photo 3 – Top Right Corner of North Stop Log Structure



Photo 4 – Significant Exposure of Core of the North Stop Log Structure

APPENDIX



Photo 5 – Leaking Timber Stop Logs on Left Raceway of North Stop Log (Note the Exposed Masonry Blocks)



Photo 6 - Leaking Timber Stop Logs on Right Raceway of North Stop Log (Note the Exposed Masonry Blocks)

APPENDIX



Photo 7 – Vegetation on North Stop Log Structure (1)



Photo 8 – Vegetation on North Stop Log Structure (2)

APPENDIX



Photo 9 – North Retaining Wall / Loss of Concrete Cover and Mortar - No noticeable change since 2018



Photo 10 – Pop-out / Water Penetrating under Concrete Blocks

APPENDIX



Photo 11 – North Spillway / Erosion along Front Face



Photo 12 – Central Spillway / Erosion along Front Face

APPENDIX



Photo 13 – Sluiceway



Photo 14 – Big Concrete Spall at the top

APPENDIX



Photo 15 – Concrete Spall near the middle / Depressions



Photo 16 – Concrete Spall near the top and the middle

APPENDIX



Photo 17 - Severe erosion and loss of material behind retaining wall

APPENDIX

B CHANGES IN STOP LOG STRUCTURE

APPENDIX



Photo 1 – North Stop Log Structure 2017

APPENDIX



Photo 1 – North Stop Log Structure 2022

APPENDIX

C STRUCTURAL INSPECTION DRAWING

Plotted: 2022-10-14
Last Saved: 2022-10-14
Plotted By: marlusz.eizenbort
Last Saved By: marlusz.eizenbort
Path: P:\2017\Projects\TPB175082 - Structural Inspection Of The Riverside Dam\TPB175082 - Structural Inspection Of The Riverside Dam.dwg

