Structural Inspection of the Riverside Dam

Inspection Report – FINAL

Cambridge, Ontario

Project #TPB175082, The Corporation of the City of Cambridge

Prepared for:

City of Cambridge

50 Dickson Street, Cambridge ON N1R 8S1

8/23/2018

Wood Environment & Infrastructure Solutions
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8/23/2018

Mr. Scott MacDonald, P.Eng.
Project Engineer, Development & Infrastructure
City of Cambridge
50 Dickson Street
Cambridge ON, N1R 8S1

Dear Sir,

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, Wood will update the report accordingly.

Sincerely,

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited

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

Karam Albazi, P.Eng.,
Senior Bridge Lead Engineer

DS/nk

c: Ron Scheckenberger, Wood

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Table of contents

Contents

List of figures

Appendices

1.0 Key Plan

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

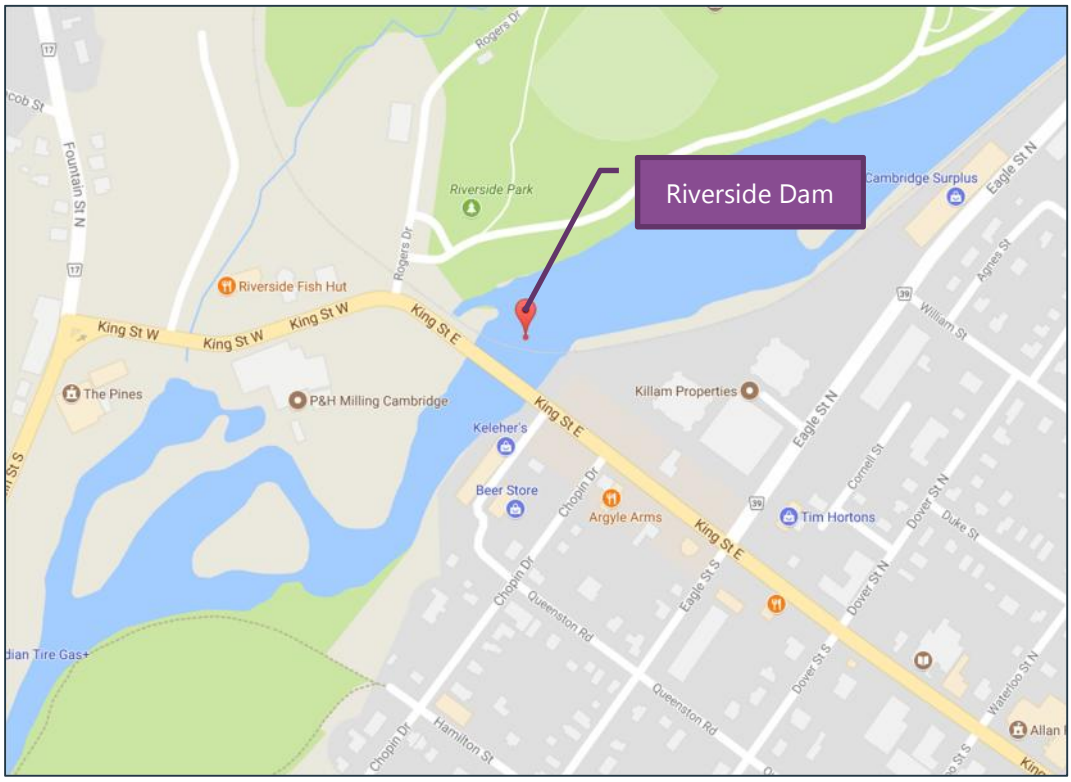

Figure 1: Riverside Dam, Cambridge Ontario

2.0 Introduction

In 2017, 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 on the dam since the 2014 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's 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 a 0.11m cover on top. The rebar used for the dam comprise of either a 12mm square bar or a 10mm round bar. The dam is approximately 65 m long by 1.5 m high (from the apron). The width at the top of the dam is 0.78 m. Additionally, the dam consists of two stop log structures located north and south along the structure. A sluiceway structure is 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 in so doing prevent catastrophic rapid failure of the dam.

In 2014, the City of Cambridge retained AMEC Environment & Infrastructure (now Wood Environment & Infrastructure Solutions) to conduct a detailed structural investigation. The 2014 investigation concluded that:

1. The deterioration has advanced since the 2008 Sanchez Engineering Inc. inspection;
2. A two (2) – ten (10) year range on concrete pop-out failure was expected with 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.

As the most recent inspection of the dam was completed in 2014, the City of Cambridge has requested Wood to carry out visual inspection(s) to determine the condition of the structure, in accordance with the recommendations of the 2014 inspection.

2.1 Scope of Work

The scope of the work has been to determine the condition of the structure, with a focus to identify any critical changes from the previous inspection.

Initial inspections were carried out by Wood structural inspectors on four (4) separate days:

- August 24, 2017 Inspection of the downstream side of the dam
- August 25, 2017 Inspection of the crest and upstream side of the dam
- May 17, 2018 Spillway inspection at time of year when algae bloom is not present
- July 13, 2018 Underwater inspection

3.0 Inspection

3.1 Stop Log Structures, Sluiceway, and Retaining Wall

These structures were accessed using a ladder down the north retaining wall near the rail bridge. The inspection of the downstream face of the dam started at the north stop log structure. The apron allowed the inspectors to walk across the length of the dam to observe all the exposed elements. Additional photos of these elements were taken from the rail bridge. 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 larger boulder rock with a low strength cement mortar. The joints are opened and vegetation is growing through the open joints. Several large sections 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.

The top slab of the structure is cracked in several locations. The top of the east arch is severely delaminated and reinforcing steel is exposed.

The timber stop logs are leaking (Refer to Photo 2). This is typical of both raceways (arches shown in Photo 1) on the west structure. The wooden stop logs appear to be in fair 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 the majority 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 and it no longer helps to control of flow of water over the dam. 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 footings are eroded and the joints are open. Masonry blocks have popped out at several locations and concrete/mortar has eroded from the wall. Failure of the retaining wall could compromise the dam.

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 2017. Attempts to clean the algae were unsuccessful due to the thickness of the algae and the speed of the flow. Therefore, a follow-up inspection was carried out in May 2018, a time of year when algae is not present. The follow up inspection involved a close visual inspection of the north stop log structure, and a visual inspection of the entire dam from the adjacent rail bridge. Inspectors could not walk along the concrete apron safely due to the very high-water flow. Physical touch-based observations

were difficult to confirm by photographs during the first inspection due to the turbulent flow obscuring most of the details and defects. It is noted that nearly all the significant details/defects were found in the turbulent flow areas ('white-water"). Photographs taken during the follow up inspection, confirmed the observations with clearer algae-free pictures.

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 bottom of the dam wall and sections of the concrete apron nearest the wall (toe of the dam) have eroded, to a maximum depth of 150mm. The underwater investigation in July 2018 found that the downstream face of the apron was in fair condition with light to medium scaling.

Two exposed rebars were found on the northern portion of the spillway (at the interface between the stop log structure).

A Structural Inspection Drawing originating from the 2014 inspection report titled "*14-12-23 Cambridge-BRobinson*" has been updated and attached in Appendix 'C' addressing any additional changes to the condition of the dam.

4.0 Conclusions & Recommendations

The following summarizes the conclusions of the investigation:

1. The 2017 & 2018 inspections have established that the dam remains in **poor condition.**
2. The 2017 & 2018 inspections have determined that the dam has **continued to deteriorate since the 2014 inspection.** Concrete blocks have popped out of place on the North Stop Log Structure. More concrete erosion and deterioration has been observed on the spillway and other elements.
3. 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.
4. Based on the advancing deterioration for the past decade, it is estimated that within two (2) to ten (10) years, the risk of concrete pop-out (separation of the dam in two) would be high, and with a significant local failure, the integrity of the dam would be compromised. On this basis, it is recommended that inspection of the dam continue to be carried out annually in the spring, at minimum, with consideration for inspection every six (6) months, to monitor the dam's condition and assess short-term risk.

5.0 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:

Wood Environment & Infrastructure Solutions
A Division of Wood Canada Limited

Prepared by: *Dante Shawil, EIT*
Structural Designer

Signature: 

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

Signature: 

Reviewed by: *Karam Albazi, P.Eng.*
Senior Bridge Lead Engineer

Signature: 

APPENDIX A:
SITE INSPECTION PHOTOGRAPHS

Photo 13 – Top of South Stop Log Structure

Photo 14 – Vegetation on or near South Stop Log Structure

Photo 21 – North Spillway – Note Erosion and Debris Blockage

Photo 22 – North Spillway