CARP CREEK EMBANKMENT RESTORATION CONSERVATION ONTARIO CLASS ENVIRONMENTAL ASSESSMENT ADDENDUM - PROJECT PLAN REPORT

Project No.: CM-17-0429-02

Prepared for:

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January 2020

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1.0 INTRODUCTION

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1.1 Project Background

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1.1.1 Study Area

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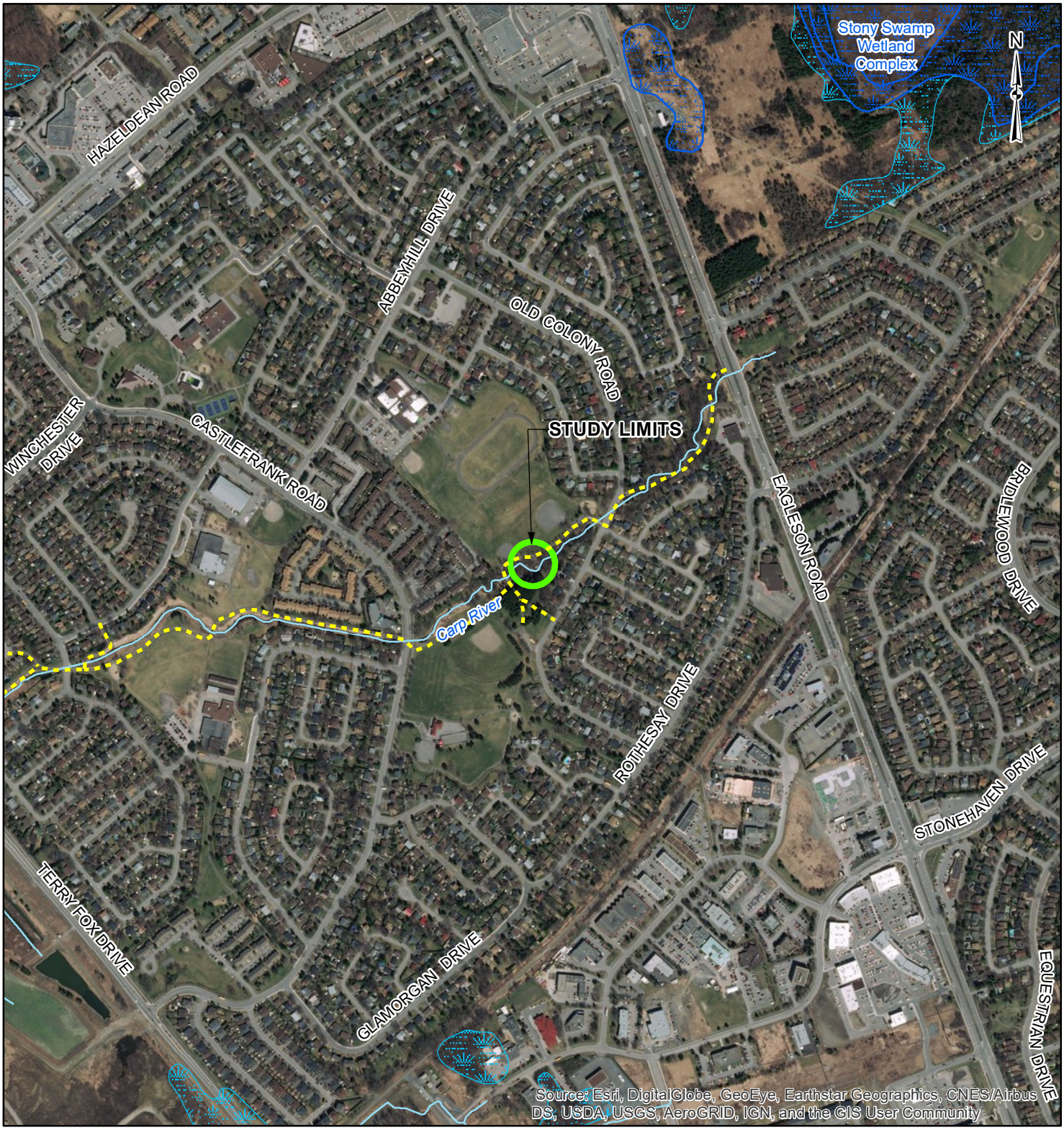

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Scale 1:10,000 Metres

LEGEND

- Recreational Path
- Study Area
- Watercourse
- Waterbody
- Provincially Significant Wetland
- Wetland

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2017.

CLIENT: MISSISSIPPI VALLEY CONSERVATION AUTHORITY

PROJECT: CARP CREEK EMBANKMENT RESTORATION

TITLE: KEY PLAN

McINTOSH PERRY
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www.mcintoshperry.com

PROJECT NO: CM-17-0429	FIGURE:
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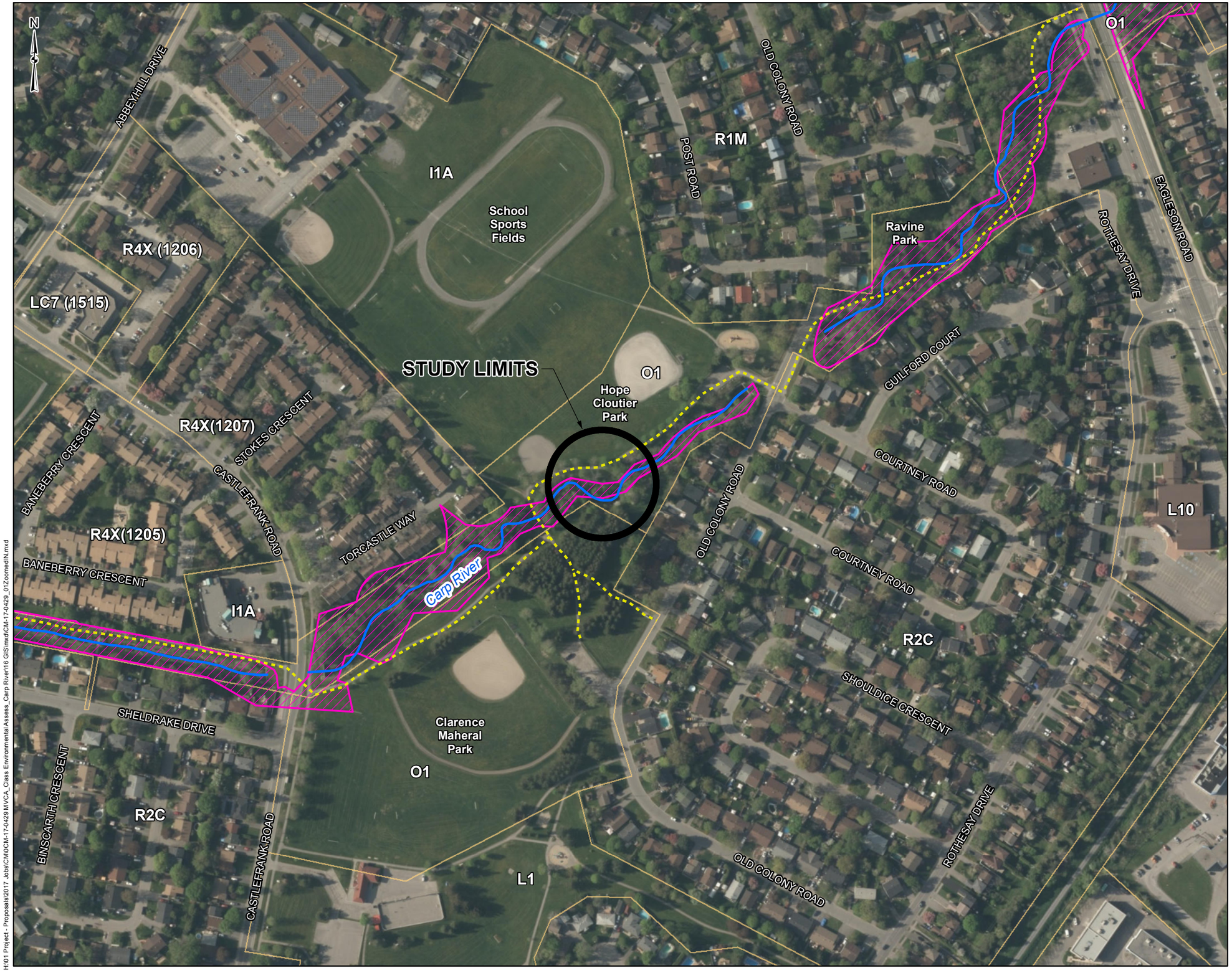

LEGEND

- Study Area
- FloodPlain
- Zoning
- Carp Creek
- Recreational Path

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

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Scale 1:2,802 Metres

CLIENT: MISSISSIPPI VALLEY CONSERVATION AUTHORITY

PROJECT: CARP CREEK EMBANKMENT RESTORATION

TITLE: KEY PLAN

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PROJECT NO: CM-17-0429	
Date	Sep., 19, 2018
GIS	SK
Checked By	LM

FIGURE: 1-2

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1.1.2 Overview of 2017/2018 Conservation Ontario Class Environmental Assessment

In 2017, McIntosh Perry was retained by MVCA to complete a Class Environmental Assessment (Class EA), preliminary and detailed design and prepare tender documents for the Carp Creek Embankment Restoration Project. The Carp Creek Embankment restoration study area is located along the Carp Creek within Glen Cairn community, between Terry Fox Drive and Eagleson Road. The portion of the creek under investigation runs perpendicular between Castlefrank Road, and Old Colony Road, and is adjacent to the Hope Cloutier Park and A.Y. Jackson High School, City of Ottawa.

During the original Class EA in 2017/2018, a range of alternative solutions were identified and evaluated to address the problem/opportunity statement prepared for this assignment. To determine the best approach to provide erosion protection along the reach of Carp Creek, McIntosh Perry identified the following embankment restoration alternative solutions:

- Alternative 1: “Do Nothing”;
- Alternative 2: Solider Piles and Wood Lagging;
- Alternative 3: Mechanically Stabilized Earth;
- Alternative 4: Partial Realignment with live bank treatment (i.e. live crib wall, coir fibre logs, planting/Rip-Rap combinations, live stakes, wattle fence, etc.);
- Alternative 5: Partial Realignment with hard bank treatment (i.e. Stacked/Terraced Stone Revetment, gabion basket, rip-rap revetment, etc.), and
- Alternative 6: Full Realignment.

Through consultation with agencies, stakeholders and the public, it was determined that the Technically Preferred Alternative was a partial realignment of the creek with the installation of a live crib wall, as well as plantings and Rip Rap strategically placed to protect the toe of slope and at transition points along the creek.

Following the 30-day public review period, no Part II Orders were received and therefore the assignment proceeded to the detail design phase. McIntosh Perry prepared a detailed design for the embankment restoration and a full draft tender package. Prior to finalizing the tender package, the City of Ottawa requested that an alternative solution be considered, and the tendering of the Crib Wall be put on hold.

1.1.3 Rationale for Addendum

On May 22, 2019, McIntosh Perry met with MVCA and City of Ottawa representatives to discuss the TPA for the Carp Creek embankment restoration project. During the meeting, the City of Ottawa requested that an additional alternative solution/design concept be considered beyond just which would require re-grading the eroded embankment within the study area (south bank) to provide more floodplain storage and potentially dissipate energy. The City indicated that based on the City' draft Official Plan Policy, Section 4.9.2 states "Natural watercourses shall be kept in their natural condition. Where an alteration is assessed as being environmentally appropriate and consistent with a Council-approved study, watercourse alterations shall follow natural channel design".

On December 4, 2019, McIntosh Perry prepared a conceptual design which included re-grading the eroded embankment within the study area (south bank) to provide more floodplain storage and potentially dissipate energy. At that time, it was determined that further hydraulic analysis was required to determine the impacts of the proposed design concept within the study area, as well as to determine the impact downstream where the channel

returns to existing conditions. Furthermore, based on recommendations from the Fluvial Geomorphologist, re-grading of banks further upstream and downstream of the apex of the eroded bank was recommended to promote more efficient floodplain connection and better flow patterns during high flow events.

In accordance with the guidance document for Conservation Ontario Class Environmental Assessment, January 2002, as amended June 2013, Section 3.8, an addendum should be undertaken should a "change in an environmental setting, or other unforeseen circumstances may necessitate a change to the proposed undertaking". Therefore, MVCA and City of Ottawa have elected to prepare an addendum to the original Class EA to review the planning, provide an opportunity for governing agencies, stakeholders and the public to provide comment and ensure mitigation measures are still valid for the proposed additional alternative solution/design concept.

In addition, to support the Class EA addendum and detailed design phase, technical investigations were completed to provide additional supporting information, as well as determine if any significant changes have occurred to the existing within the study area since the initial field investigations were completed in 2017.

1.2 Problem Statement/ Purpose of the Undertaking

For the purpose of this Class EA Addendum, the original problem statement is being carried forward. The original problem statement was as follows:

The Carp Creek embankment has become unstable due to various flooding events and severe erosion. The severe erosion is primarily along the southeast embankment. If erosion of the embankment is to continue, it will deposit high levels of sediment into the watercourse, as well as extending into the green space (i.e. forest, parkland, manicured lawns, etc.) along the Carp Creek which is immediately adjacent to residential dwellings. Therefore, the purpose of this undertaking is to identify and deliver an innovative design that will mitigate the erosion of the Carp Creek embankment within the above noted study area.

2.0 ENVIRONMENTAL ASSESSMENT PROCESS

Recognizing that common elements exist in addressing flood and erosion problems, a coordinated approach to environmental assessments was developed by Conservation Ontario for all Conservation Authorities (CAs), known as the Class Environmental Assessment for Remedial and Erosion Control Projects (Class EA). According to the Class EA document:

> *"Remedial Flood and Erosion Control Projects refer to those projects undertaken by Conservation Authorities, which are required to protect human life and property, in previously developed areas, from an impending flood or erosion problem. Such projects do not include works which facilitate or anticipate development. Major flood and erosion control undertakings which do not suit this definition, such as multipurpose projects, lie outside the limits of this Class and require an Individual Environmental Assessment" (Conservation Ontario, 2002, amended in 2013)."*

The Conservation Ontario Class Environmental Assessment (Class EA), January 2002, as amended in June 2013, documents an approved process under the Ontario EA Act. The Class EA document applies to remedial flood and erosion control projects. The Class EA document (Section 3.0) provides a planning and design process to describe

how potential projects are identified, and a specific planning process that needs to be followed once a project is identified to need remedial flood or erosion control.

The complexity of a project is based on many components, including environmental effects, public and agency input and technical consideration, and how they are interrelated. The planning process for the Conservation Ontario Class EA is outlined in Figure 2-1 below.

2.1 Addendum Process

In accordance with the guidance document for Conservation Ontario Class Environmental Assessment, January 2002, as amended June 2013, Section 3.8, an addendum should be undertaken should a "change in an environmental setting, or other unforeseen circumstances may necessitate a change to the proposed undertaking".

The addendum shall describe the circumstances necessitating the change, the environmental implications of the change and what mitigation methods will be employed to mitigate the negative environmental effects of the change. The addendum shall be filed with the Project Plan and a Notice of Filing of Addendum shall be issued in the same manner as the Notice of Filing for the Project Plan prepared for the original Class EA undertaking.

A period of 15 days following the issuance of a Notice of Filing of Addendum shall be provided by the proponent for public and agency review of the addendum. During these 15-day period, it may be requested that the undertaking, as documented in the addendum, be subject to a Part II Order.

In the event that a person or party has concerns or objections to the information provided, the proponent and the person or party raising the concern shall endeavour to come to a resolution. If the issue cannot be resolved, the person or party raising the objection may write to the Minister of the Environment, Conservation and Parks or delegate to request a Part II Order. A request for a Part II Order must be copied by the requester to the proponent at the same time that it is submitted to the Minister or delegate.

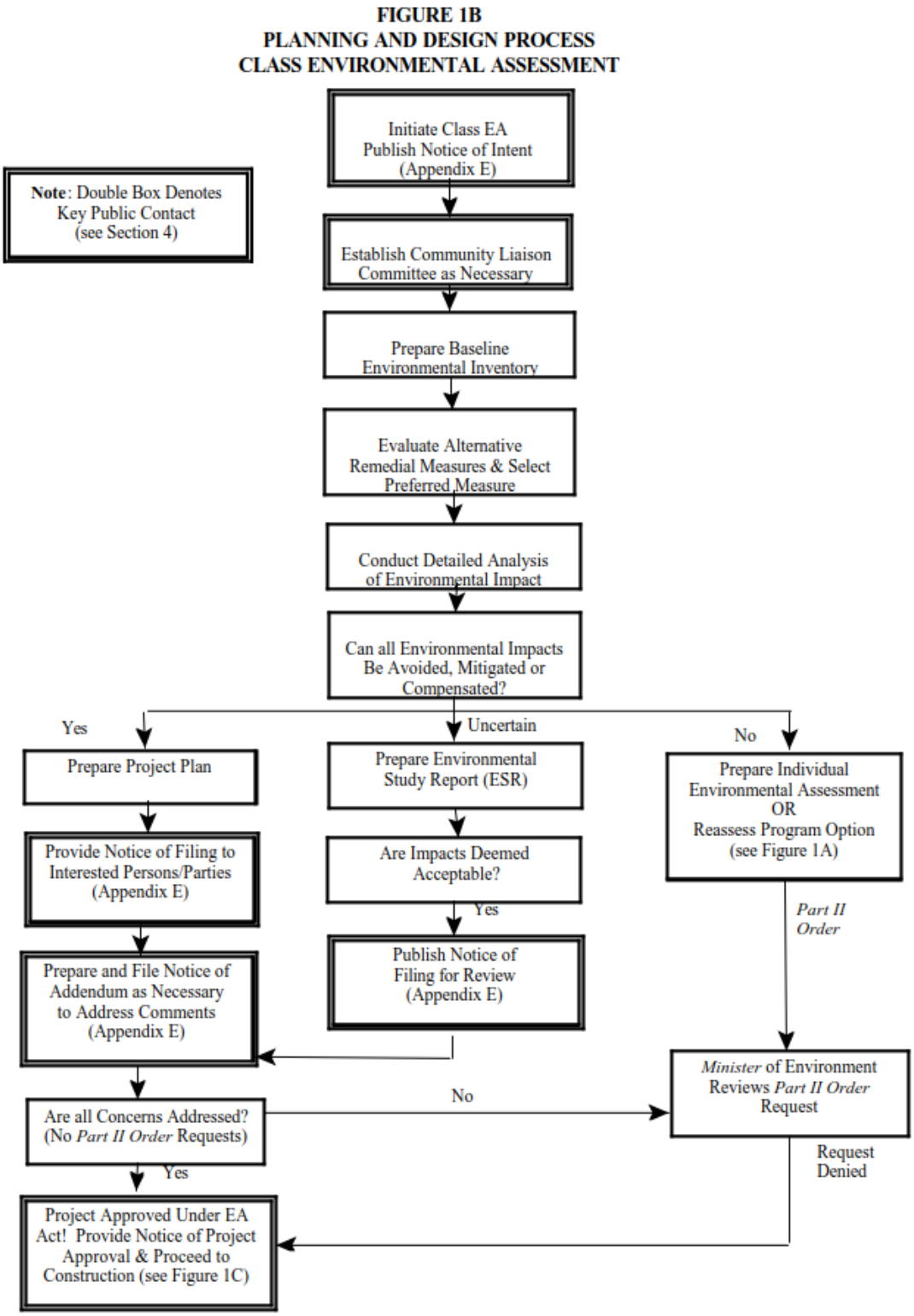


Figure 2-1: Conservation Ontario Class EA Planning and Design Process

3.0 BASELINE ENVIRONMENTAL INVENTORY

An integral part of the Class EA process is the review and inventory of the environmental features to support the evaluation of potential project effects.

The baseline environmental information is documented in the original Carp Creek Embankment Restoration Class Environmental Assessment Project Plan Report (McIntosh Perry, November 2018) and should be read in conjunction with the following sections.

Additional technical investigations were also completed in June/July 2020 to support the Class EA addendum, as well as update supporting documentation to determine if any significant changes have occurred within the study area since the initial field investigations completed in 2017. Site-specific information was obtained through field investigations which included a new topographic survey, geotechnical investigation and an environmental exiting condition survey. The following sections provide key highlights from these field investigations

3.1 Natural Environment Conditions

The environmental site reconnaissance was carried out to ground-truth findings of the desktop investigation, and to assess communities and look for habitat that could be used by rare species, as well as confirm data collected in 2017 is still valid. The visit also focused more on the south embankment and surrounding landscape to assist with the environmental impact assessment of the proposed alternative solution/design concept and identify any new mitigation measures that should be implemented during the preliminary and detailed design.

For further details pertaining to the environmental site reconnaissance, please refer to the Carp Creek Environmental Inventory/Existing Condition Report (dated October 2020) enclosed in Appendix B.

3.1.1 Eroding Embankment

The creek embankment at the above noted property is excessively eroding (south embankment) which has produced approximately 3.3 m of close to vertical cut through the existing topsoil and clay. The clay at the exposed surface was observed weathered. The eroded area is located at a sharp creek meander, which is exposed to excessive erosion forces at the time of high flood level and high velocity.

The top of the slope is vegetated with mature trees. A few trees were observed to have fallen into the creek once undermined by erosion. The area beyond mature trees consists of manicured lawns, residential dwellings, a walking trail and recreational fields (i.e. soccer and baseball).

The opposite embankment (north) is relatively lower than the south embankment with a gentle slope and is expected to be overtopped during lower return periods.

Site photographs are enclosed in Appendix A.

3.1.2 Vegetation

The vegetation community present within the study area was identified as a Fresh – Moist Lowland Deciduous Forest Ecosite. For a specific list of vegetation species observed within the study area, please refer to the updated Environmental Inventory/Existing Conditions Report in Appendix B. A high concentration of non-native and invasive

species was observed within the study area (e.g. Himalayan balsam, common buckthorn, garlic mustard, wild parsnip, etc.). The presence of such species is indicative of the highly disturbed nature of the study area. Japanese knotweed was identified within the study area in 2017 and again in 2019 by City of Ottawa staff along the north bank in the east end of the study area, however, it was not present during the 2020 field investigation. No rare or uncommon vegetation or vegetative communities were identified within the study area, during the field investigations.

3.1.3 Wildlife

The following species of wildlife were observed within the study area during the 2017 and 202 field investigations: White-breasted Nuthatch (*Sitta carolinensis*), Black-capped Chickadee (*Poecile atricapillus*), American Robin (*Turdus migratorius*), American Crow (*Corvus brachyrhynchos*), Eastern kingbird (Tyrannus tyrannus), Blue Jay *(Cyanocitta cristata*), Green Frog (Rana clamitans), eastern chipmunk (*Tamias striatus*), eastern grey squirrel (*Sciurus carolinensis*), and American red squirrel (*Tamiasciurus hudsonicus*). The forested habitat within the study area would provide habitat for breeding migratory birds.

3.1.4 Fish and Fish Habitat

The Carp Creek is known to have a warm water thermal regime with the following species of fish present: Brown Bullhead (*Ameiurus nebulosus*), Northern Pike (*Esox lucius*), Pumpkinseed (*Lepomis gibbosus*), White Sucker (*Catostomus commersonii*), and Yellow Perch (*Perca flavescens*). Although a fish survey was not conducted during the 2017 and 2020 field investigations, multiple unidentified species of minnows (Cyprinidae spp.) were observed to be present within the pool portion of the watercourse within the study area.

During the field investigations, the section of the Carp Creek included in the study area was an average depth of 15 to 30 cm with substrate consisting of clay, sand, gravel and cobble which create riffle/pool/run sequences. The average wetted which throughout the study area was approximately 2 m during the 2020 field investigation. The watercourse meanders through the study area creating steep, eroded banks at two (2) bends. The banks opposite of the thalweg at these bends are low, flat, and vegetated which are most likely seasonally flooded.

3.1.5 Species at Risk

During the 2017 and 2020 field investigations, no SAR were observed within the study area. However, given background information and the habitat observed to be present during the field investigation, there is the potential for species at risk turtles [i.e. Blanding's Turtle (*Emydoidea blandingii*), threatened; Eastern Musk Turtle (*Sternotherus odoratus*), special concern; and Common Snapping Turtle (*Chelydra serpentina*), special concern], to utilize the watercourse as a travel corridor. In addition, the forested habitat adjacent to the watercourse could be utilized by Canada Warbler (*Cardellina canadensis*), special concern; Eastern Wood-pewee (*Contopus virens*), special concern; and Red-headed Woodpecker (*Melanerpes erythrocephalus*), special concern; for breeding and nesting purposes.

3.1.6 Surface Water

Surface water within the study area is a tributary of the Carp Creek Depths within the study area were an average of 15 to 30 cm.

Based on the Carp River in Glen Cairn Bank Failure Assessment Report and Hec-Ras model prepared by JFSA Water Resources and Environmental Consultants (November 2011), the 100-year floodwater elevation is 102.23 m and has velocities ranging from 2.52 - 3.58 m/s for the 2-year to 100-year return periods.

3.1.7 Topography

The original topographic survey was completed in 2017. McIntosh Perry completed a new topographic survey in July 2020 to confirm how much the existing bank had eroded since 2017 survey and obtain property information of residential dwellings. Additional survey information was also picked up adjacent to the top of slope (i.e. green space) to properly assess the tie-in point, as well as to assess the potential environmental impacts (i.e. tree removal). The survey crew also surveyed the location and measured the diameter of individual trees that are larger than 10 cm in diameter at breast height (DBH) within the study area. Where trees were clumped together, the outline of these groups of trees was measured along with their approximate diameters.

McIntosh Perry determined that there has been some minor horizontal movement of the low flow channel within the creek alignment and some minor changes in elevations within the creek bed and along the eroding bank since the previous topographic survey completed in 2017. The trend of erosion is in line with what was previously observed in 2017 and is not indicative of any new trend.

3.1.8 Geotechnical Investigation

Based on published physiography maps of the area (Ontario Geological Survey) the site is located within the Ottawa Valley Clay Plains. Surficial geology maps of southern Ontario identify the site on gleaciomarine fine grain deposits of silt and clay.

In general, the site stratigraphy, as encountered in boreholes, consists of clay topping till. Topsoil was observed at the eroded surface. The soils encountered at this site can be divided into three different zones; Topsoil, Clay and Till.

The first site investigation was carried in October 2017 consisted of two boreholes drilled at the toe of the slope. Initially, the scope of work included the design of a retaining wall to mitigate the risk of erosion and localized slope failure. The boreholes were advanced to a maximum depth of 3.7 m below the ground surface.

Upon receiving the request to further investigate an alternative concept design for the Carp Creek embankment restoration, the staff of McIntosh Perry conducted a more detailed second site investigation included drilling two boreholes at the top of the slope in July 2020. The boreholes were advanced to a maximum depth of 7.0 m below the existing ground level (El. 104.0 m) to obtain necessary soil stratigraphy, groundwater, and mechanical properties information for slope stability analysis. Herein a summary of the site investigation, slope stability analysis, and geotechnical design recommendations is provided:

- The site stratigraphy consists of topsoil, clay/silty clay layer, followed by a till layer, which extends to the maximum depth of investigation in both boreholes. It was also observed that there is an alluvial deposit (a mix of variable portions of gravel, sand, silt, and clay) of variable thickness that is interbedded with a clay/silty clay layer. The clay/silty clay was observed to be desiccated above the groundwater table and very soft below the water table.

- The groundwater table was last monitored on July 8, 2020, which was a relatively very hot and dry season time. The groundwater depth was observed at 4.3 m (El. 100.0 m) from the existing ground surface. The groundwater level suppressed gradually to the level of water in the creek which is approximately at El. 99.0 m. The groundwater level may be expected to fluctuate due to seasonal changes.

- Slope stability analyses were performed to evaluate the current slope condition, to provide a suitable backslope gradient and to estimate the factor of safety (FOS) against failure. Slope stability analyses for Long-term condition under sustained loads and short-term condition under seismic loading were performed using SoilVision's limit equilibrium software, SVSlope, and finite element software, SVFlux GT coupled analysis. The model was developed based on existing site topography and soil stratigraphy. Tension cracks due to the presence of a desiccated clay layer was considered in the analyses.

- The soil mechanical parameters for the slope stability analyses were estimated based on SPT and vane shear field tests and were compared against typical shear strength values of each soil layer. Since typical site investigation can explore only 1% of the subsurface conditions, the numerical slope stability analyses were performed with conservative soil mechanical parameters to accommodate the associated uncertainty.

- Three slope cut ratios were investigated (2H:1V, 2.5H:1V and 3H:1V). The minimum global and local factor of safety (FOS) is presented in Table 1. The global FOS of safety is for the whole slope while the local FOS is for specific zones in the slope. The soil profile at Carp Creek constituted of three soil layers, clay, sand and till. The local slope failures were observed under seismic loading within the sand (alluvial) deposit. Under certain circumstances, sand is known to exhibit liquefaction behavior when subjects to seismic loads which could be a possible reason to trigger local slop failure. Therefore, slope cut of 2.5H:1V ratio is recommended. Also, any steeper slope is not recommended from a surface erosion perspective.

Table 3-1: Minimum Values of Factor of Safety for the Suggested Slope Cuts

Analysis	Slope Cuts		
	2H:1V	2.5H:1V (Recommended)	3H:1V
Global FOS for Long-term Analysis	1.4	1.6	1.8
Global FOS for Short-term Analysis	3.1	3.3	3.6
Local FOS for Short-term Analysis	--	2.4	0.3

- The toe of the 2.5H:1V slope needs to be protected by Rip Rap. Rip Rap shall be designed by an environmental engineer based on the maximum current velocity. The Rip Rap shall be separated from the clay bank by a layer of non-woven geotextile. It is necessary to use non-woven geotextile below the Rip Rap, especially when Rip Rap is to protect fine-grained soil.

- Proper selection of Rip Rap size should be considered to mitigate the risk of displacement and geotextile exposure. The Rip Rap shall be extended on the riverbed to mitigate the scour. The top of Rip Rap shall be covered by erosion protection and growth medium blanket.

- Above the Rip Rap, the surface of the cut shall be protected with Terrafirm slope stabilization system (or an equivalent product). This system will provide an anchored mesh supporting a vegetation mat over the slope. Using this anchored mesh is necessary due to the presence of the sandy alluvial layer, which is prone to erosion more than other layers. It is preferred to grow bush size vegetation, which can develop deeper roots than typical grassy vegetation.

- The slope shall be protected as soon as possible upon excavation against any surface water run-off.

For further details, please refer to the Carp Creek Geotechnical Report (dated October 2020) enclosed in Appendix C, as well as the Carp Creek Embankment Restoration Geotechnical Investigation Report (McIntosh Perry, 2017) under separate cover.

4.0 DEVELOPMENT OF ALTERNATIVE SOLUTIONS

One of the steps of the Conservation Ontario Class EA is the evaluation of the alternative methods for carrying out a remedial project. Key criteria for alternative solutions are long-term stability and appropriate channel functions.

To develop alternative designs that would be appropriate for the unique characteristics of the Carp Creek Embankment, it was necessary to review all background documents available, discuss with MVCA and City staff, and solicit feedback from local residents and stakeholders.

MVCA and the City of Ottawa have identified that a more naturalized alternative solution to prevent further erosion and restore the embankment (i.e. live-crib walls, plantings, etc.) is preferred from an environmental perspective. Although through the Class EA process all feasible alternative solutions such as hard surface treatments (i.e. armour stone wall, Rip Rap, etc.) are to be evaluated as well.

4.1 Original Class EA - Alternative Solutions to Problem/Opportunity Statement

4.1.1 Alternative Solutions

During the original Class EA in 2017/2018, a range of alternative solutions were identified and evaluated to address the problem/opportunity statement prepared for this assignment. To determine the best approach to provide erosion protection along the reach of Carp Creek, McIntosh Perry identified the following embankment restoration alternative solutions:

Alternative 1: "Do Nothing"

The Conservation Ontario Class EA process requires the evaluation of a "Do Nothing" alternative solution. Under the "Do Nothing" Approach, the unprotected reach of the Carp Creek will continue to erode, which will eventually extend to the surrounding green area and communities.

The "Do Nothing" approach does not address the objective of the Carp Creek Embankment Restoration project. The financial cost of leaving the embankment unprotected has not been established.

Alternative 2: Soldier Piles and Wood Lagging

The use of soldier piles and wood lagging. Soldier piles are typically steel beams, which are driven into the bed of the streambank, with wood lagging between the beams. Soil is then backfilled between the soldier piles and wood lagging wall, and the point of erosion.

Alternative 3: Mechanically Stabilized Earth

Proposed use of a mechanically stabilized earth wall. Mechanically stabilized earth is backfilling the eroded area with soil/earth and reinforcing the earth with a retaining wall structure made up of a tensile material, such as a geo-synthetic material, which increases the strength of the soil.

Alternative 4: Partial Channel Realignment with Live Bank/Bio-Engineering Treatment

Partial realignment of the channel to the north and stabilize the eroded embankment using a live bank/bio-engineering treatment. This option would require grading the banks back to a stable slope and construction a live bank. Bio-Engineered Treatments are a combination of engineering techniques using natural materials and structures to stabilize soil. It is often used as a means of repairing or remediating embankments from the effects of erosion with the intent of minimizing the overall impact to the environment. Live bank/Bio-Engineered treatments could consist of live crib wall, coir fibre logs, planting/Rip-Rap combinations, live stakes, wattle fence, etc. Live bank treatments use a combination of log walls, soil and vegetation to stabilize the streambank.

Alternative 5: Partial Channel Realignment with hard bank treatment

Partial realignment of the channel to the north and stabilize the eroded embankment using a hard surface treatment such as stacked/terraced stone revetment, gabion basket, rip-rap revetment, etc. This design would provide a relatively steep slope, which matches or exceeds the slope along the majority of the embankment length within the project area. This alternative allows for a more efficient use of the existing embankment shape and will minimize encroachment of the revetment into the creek.

Alternative 6: Full Channel Realignment

Full channel realigning which would consist of a full adjustment of the creek location and cross-section to redirect the flow away from the point of erosion. This would provide an opportunity to design a system appropriate for existing flow regimes while moving the watercourse away from the erosion site and residential dwellings, as well has the potential to improve aquatic habitat conditions.

4.1.2 Evaluation of Alternative Solutions

As per the Class EA process, the above noted list of original alternative solutions problem/opportunity were considered to ensure that there is reasonable justification to proceed with the project proposal.

The alternative solutions were subject to the following evaluation:

- Long-List Evaluation – Alternatives were evaluated for suitability based on their advantages and disadvantages.

- Short-List Evaluation – Alternative solutions deemed as a potential solution during the long-list evaluation were furthered evaluated based on pre-determined screening criteria. A qualitative evaluation methodology was selected for the Carp Creek Embankment Restoration Project. This methodology consisted of rating a number of criteria with a simple high, medium or low rating and substantiating the rating with a brief explanation. Subsequently, the alternative(s) with the most preferable ratings was deemed the Technically Preferred Alternative (TPA).

Of the six (6) alternatives considered for the embankment restoration, two (2) were carried forward after completion of the long-list evaluation. The two (2) alternative solutions selected for the embankment restoration to be carried forward for detailed evaluation by the Project Team were: Alternative 4 - partial channel realignment with live bank /Bio-Engineered treatment (i.e. live crib wall, coir fibre logs, planting/Rip-Rap combinations, live stakes, wattle fence, etc.) and Alternative 6 – full channel realignment. Based on discussion with MVCA, the City of Ottawa, governing agencies, and the public, alternatives were evaluated based on their effectiveness to further protect and restore the embankment, reduce the impact on the natural environment and socio-economic environment, and cost.

Through the shortlist evaluation process and consultation with agencies, stakeholders and the public, it was determined that the TPA was a partial realignment of the creek with the installation of a live crib wall, as well as plantings and Rip Rap strategically placed to protect the toe of slope and at transition points along the creek.

4.2 Class EA Addendum

As previously stated in Section 1.1.3, in 2019 MVCA and the City of Ottawa requested that an additional alternative solution/design concept be considered for the Carp Creek Embankment Restoration study area. The additional alternative consists of re-grading the eroded embankment within the study area (south bank) to provide more floodplain storage and potentially dissipate energy. The City indicated that based on the City' draft Official Plan Policy, Section 4.9.2 states "Natural watercourses shall be kept in their natural condition. Where an alteration is assessed as being environmentally appropriate and consistent with a Council-approved study, watercourse alterations shall follow natural channel design".

In order for this addendum to determine the best approach to provide erosion protection along the reach of Carp Creek, McIntosh Perry carried forwarded the two (2) alternative solutions from the previous Class EA selected during the Long Evaluation process: Alternative 4 - partial channel realignment with live bank /Bio-Engineered treatment (i.e. live crib wall, coir fibre logs, planting/Rip-Rap combinations, live stakes, wattle fence, etc.) and Alternative 6 – full channel realignment, as well as identified the following additional alternative solutions to restore the Cark Creek Embankment:

Alternative 7: Partial Channel Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments

Partial realignment of the channel to the north and re-grading the eroded embankment within the study area (south bank) back to a stable slope. The re-graded slope would then be stabilized using natural material such as live bank/Bio-Engineered treatments including planting, live stakes, Rip Rap, etc. Slight re-grading of banks upstream and downstream of apex of eroded bank will be required to tie back into the existing embankment.

5.0 EVALUATION OF ALTERNATIVES

The evaluation process undertaken for this Class EA addendum used similar criteria as was adopted in the original Class EA. The following evaluation of Alternative Solutions was undertaken to address the problem and opportunity statement identified for this project (Section 1.2), considering all aspects of the Class EA study. The overall assessment and evaluation process followed two basic concepts:

1. Assessment of Alternatives: the potential benefits of each alternative are assessed against a comprehensive set of criteria for Function, Biological/Natural Environment, Socio-Economic and Cultural Environment and Implementation.

2. Evaluation of Alternatives: A comparative evaluation of alternatives to identify a preliminary technically preferred design alternative.

An evaluation framework was developed by the Project Team, including technical considerations and environmental components that address the broad definition of the environment as described in the EAA and those based on comments received from relevant agencies. The evaluation of alternatives was carried out using the Reasoned Argument method of comparing differences in impacts and providing a clear rationale for the selection of the technically preferred alternative. **Table 5-1** identifies the evaluation criteria and rationale, as well as the criteria measures and corresponding descriptions.

The evaluation of Alternative Solutions considers the positive and negative potential impacts associated with each of the design alternatives in consideration of the criteria listed in **Table 5-1.** This evaluation is a relative comparison to be used to determine which alternative is technically preferred.

As illustrated in **Figure 5-1**, each criterion was given a score on a scale from least preferred (empty circle) to most preferred (solid circle).

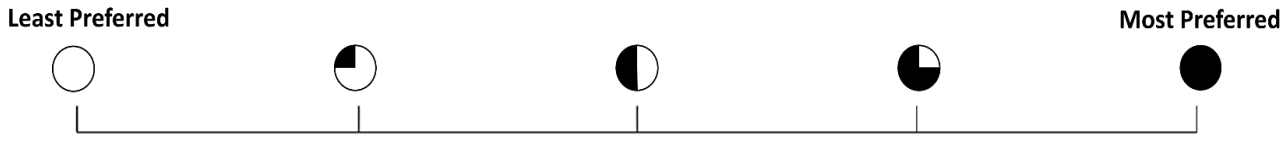
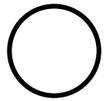


Figure 5-1: Evaluation of Alternative Solutions Scale of Preference

Table 5-1: Preliminary Evaluation of Short List of Alternative Solutions

Evaluation Criteria	Description of Criteria	Criteria Measures	Description of Criteria Measures	Alternative 4 Partial Creek Realignment with Live Crib Wall and Planting/Rip Rap	Alternative 6 Full Creek Realignment	Alternative 7 Partial Creek Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments
Function Environment	Criteria to evaluate whether the alternative Solution addresses the problem and opportunities; as well as, evaluate the operational suitability and engineering characteristics of the Solution.	Infrastructure Plans and Policies	Compatibility with MVA and City of Ottawa guidelines, standards and policies (i.e. City of Ottawa Draft Official Plan).	 - Incorporates natural stream features but not to the full extent as Alternative 6 & 7. Does not fully conform to the Draft Official Plan. - Crib walls provides both embankment and toe protection. - Mitigates erosion of embankment but doesn't provide any additional floodplain storage and/or energy dissipation. - If properly constructed and allowed enough time to effectively vegetate, the wall is an effective erosion mitigation measure. - Crib walls require monitoring and maintenance to ensure no shifting or materials have become displaced.	 - Highly effective as new channel would be designed to be stable within the existing flow regime. - Potential to increase the capacity of the watercourse. - Natural channel would be designed to require minimal maintenance.	 - Conforms to the City of Ottawa Draft Official Plan that "Natural watercourses shall be kept in their natural condition" - Incorporates natural stream design. - Realignment require minor reclaiming of additional lands, however, won't result in impacts to residential lands, MUP or existing recreational facility. - Effective mitigation measure once vegetation establishes and Rip Rap protection properly sized at toe of slope. - Natural channel design requires minimal maintenance.
		Effectiveness of Erosion Mitigation and Embankment Stabilization	The ability to address the existing erosion condition within the study area both long and short term.			
		Durability	The ability to withstand wear, pressure or further erosion.			
		Maintenance	Minimal maintenance and is self-sustaining.			

Evaluation Criteria	Description of Criteria	Criteria Measures	Description of Criteria Measures	Alternative 4 Partial Creek Realignment with Live Crib Wall and Planting/Rip Rap	Alternative 6 Full Creek Realignment	Alternative 7 Partial Creek Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments
Biological/ Physical/ Natural Environment	Criteria to evaluate the alternative Solution's effects on the natural heritage systems, natural environment and habitats, and water quality.	Fish/Aquatic Habitat	Presence of fish communities and aquatic habitats; and potential impacts, including to water quality.	 - Within the portion of the realigned creek, there will be opportunities to improve fish/aquatic habitat. - Duration of in-water works likely to be short. - Short-term impacts such as minor loss of mature trees and short-term impacts to riparian species. Post-construction site restoration will ensure no long-term adverse effects or changes to terrestrial habitat affected. - If terrestrial habitat is to be removed during construction, mitigation measures are to be implemented to protect SAR. - The design includes a low flow channel to maintain a natural process of sediment transport. - Mitigation measures (i.e. Rip Rap) will be provided to minimize the impact of directing flows at downstream bank. - This alternative does not provide as much opportunity to allow larger flows to have additional room for energy dissipation on the floodplain as is provided for Alternative 7 and potentially alternative 6.	 - Opportunity to improve fish/aquatic habitat in new channel. However, an extensive realignment would be required through the study area and adjacent lands, including areas that are currently not exhibiting any problems. - Greater short-term and long-term impacts due to the loss of significantly more greenspace and verequired to adequately realign the creek to be stable within the existing flow regime. - Extensive terrestrial habitat is to be removed during construction, mitigation measures are to be implemented to protect SAR. - In the short-term, this alternative will have the most impact to adjacent landscaping and will not be aesthetic pleasing. However, in the long-term, the new channel designed would include aesthetically pleasing enhancement features such as plantings, walking paths, etc. - New channel would be designed to be stable within the existing flow regime but does run the risk of negatively impacting upstream and downstream.	 - Opportunities to improve fish/aquatic habitat in realigned channel. - Short-term impacts such as minor loss of mature trees and short-term impacts to riparian species. Post-construction site restoration would ensure no long-term adverse effects or changes to terrestrial habitat affected. - More vegetation removal will be required with this alternative in comparison to alternative 4 due to the regrading of the embankments at 2.5H:1V and additional staging area. - Slightly shorter duration of in-water works likely compared to atlernative 4. - If terrestrial habitat is to be removed during construction, mitigation measures are to be implemented to protect SAR. - Incorporation of a bankfull bench allows the low flow channel to maintain a natural process of sediment transport while also allowing larger flows to have additional room for energy dissipation on the floodplain. - Channel realignment minimizes the impact of directing flows at downstream bank.
		Terrestrial Habitat (wildlife, habitat, and vegetation)	Presence of terrestrial wildlife habitat areas and potential impacts			
		Species-at-Risk	Presence of SAR and potential Impacts/ opportunities for mitigation.			
		Geomorphology	The ability to mitigate any short- and long-term impacts to the watercourse. Channel formation must consider fluvial and hydraulic properties of stream flow.			

Evaluation Criteria	Description of Criteria	Criteria Measures	Description of Criteria Measures	Alternative 4 Partial Creek Realignment with Live Crib Wall and Planting/Rip Rap	Alternative 6 Full Creek Realignment	Alternative 7 Partial Creek Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments
Social and Cultural Environment	Criteria to evaluate the alternative Solution's effects on community and social features, and properties within the study area.	Public Safety	Protect, maintain and enhance the watercourse through naturalization and improved stability of the the embankment.	 - Eroding embankment will be stabilized and regraded to a safer slope. - The new crib will stay within the existing creek valley and improves the stability of the embankment. However, less of a natural channel design than alternative 6 & 7. - Minor pedestrian and residential impacts during construction - Moderate disturbance – typically requires larger machinery during construction for placement of logs. - Smallest construction area.	 - Longer construction period leads to a higher risk to public safety. - The new realignment will not stay within the existing creek valley. Additional land would be required for the full realignment, which would extend into the adjacent recreational faculties. - Significantly long construction period which will have an impact on residences, recreational activities and schools. Extensive staging requirements. - Difficult to construct due to current landuses. - Largest construction area and extensive staging requirements.	 - Eroding embankment will be stabilized and regraded to a safer slope. - Provides a natural channel design and improves the stability of the embankment for residence to enjoy. - Minor pedestrian and residential impacts during construction. - Moderate disturbance – typically requires larger machinery during construction for re-grading purposes and placement of Rip Rap and planting.
		Land Use/Socio Conditions	Potential to impact residences, community, public parks, institutions or recreation within or adjacent to the study area.			
		Construction Impacts	Duration of construction, staging options and potential for construction-related impacts on public, access, noise and dust.			
Implementation	Criteria to evaluate the financial implications and implementation opportunities of the alternative Solution.	Capital Costs	Capital cost of proposed improvement	 - Lower development and labour cost over other alternatives. - Long term sustainability and therefore reduced maintenance costs but will still require monitoring and maintenance. - Construction duration is anticipated to be approximately 8 weeks	 - High development and labour cost over other alternatives. - Natural channel design requires minimal maintenance costs. - Dependent on design, construction duration could be anywhere from 6-18+ months	 - Lower/moderate development and labour cost over other alternatives. - Natural channel design requires minimal maintenance costs. - Construction duration is anticipated to be approximately 8 weeks
		Operational and Maintenance Costs	Operational and maintenance costs of proposed improvement over life-cycle.			
		Estimated Construction Duration	Duration of construction anticipated for implementation of design alternative.			

5.1 Preliminary Technically Preferred Alternative

Based on the above evaluation, MVCA, City of Ottawa, City Councillor and initial public input, the preliminary Technically Preferred Alternative is Alternative 7 – partial realignment of the channel to the north and re-grading the eroded embankment within the study area (south bank) back to a stable slope. The re-graded slope will then be stabilized using natural material such as live bank (planting, live stakes, etc.) and Rip Rap Treatment. Slight re-grading of banks upstream and downstream of apex of eroded bank will be required to tie back into the existing embankment. The preliminary TPA creates a stable alignment with stable bank slopes through the placement of stone protection at the toes of slope for immediate erosion protection and plantings for long-term stability along the embankments, top of bank and proposed bench within the floodplain. The preliminary TPA also provides more floodplain storage and potential for energy dissipation within study area, as well as provides a natural embankment which will support various terrestrial, fish, aquatic and SAR habitat.

In comparison to the original Class EA selected TPA, this preliminary TPA conforms to the City' draft Official Plan Policy 4.9.2, "*Natural watercourses shall be kept in their natural condition. Where an alteration is assessed as being environmentally appropriate and consistent with a Council-approved study, watercourse alterations shall follow natural channel design*". This design will provide a more natural channel design, as well as provides additional flow capacity and reduces flow velocities within the immediate channel section. The hydraulic and geomorphic assessment of the preliminary TPA is further discussed in Sections 5.2.1 and 5.2.2, as well as the environmental impacts.

Confirmation of the TPA will be completed following the Public Information Centre to be held in January 2021. Consultation with the affected/interested members of the public, governing agencies, and stakeholders is further outlined in Section 8.0.

5.1.1 Conceptual Design Criteria

The proposed embankment restoration will consist of shift the creek to the north and regrading the south and north embankments, along with the use of Rip Rap and vegetation protection to provide long-term slope stability. Based on recent site investigations (i.e. geotechnical and topographic survey) and consultation with Water's Edge (Geomorphologist), the following design criteria have been implemented into the conceptual design plans (Figure 5-1 and Figure 5-2):

- The alignment of the creek has been shifted to the north by approximately one bankfull width (4.5-5.0 m) to achieve a better sinuosity within the creek and to reduce impact to natural heritage features on the south embankment.
    - Low-flow channel with design depth of 0.37m (average depth of existing low-flow channel).
    - 2.5:1 slope on south bank of low-flow channel.
- A 1.0-4.0 m bankfull bench has been established on both the south and north side of Carp Creek along study area to allow flows to spill onto the floodplain and reduce shear stress on the channel.
    - Width of bankfull bench varies to transition back into existing grades and proposed channel.
    - 1-2% slope on bankfull bench draining to low-flow channel.

  - Slight re-grading of banks upstream and downstream of apex of eroded bank has been incorporated to into the conceptual design to tie back into the existing embankment and achieve better flow patterns during high flows. Less regrading has been proposed upstream to ensure the existing natural rock weir and Willow tree remain in place.

- Based on the slope stability analysis, it was determined that the eroded embankment can be cut back at a 2.5H:1V slope. The site is located within the MVCA regulation limit which MVCA guidelines specify a minimum stable slope allowance of 3H:1V. However, upon further discussion with MVCA, they indicated that a 2.5H:1V slope can be supported as long as a suitable slope stabilization system has been designed to support the steeper slope.

  - South Slope - Top of 2.5H:1V slope along south bank encroaches closer to nearest neighbouring residential properties to the south by approximately 2.57 meters (+/-) compared to existing conditions but still provides approximately 24 meters (+/-) setback to the nearest residential property line.

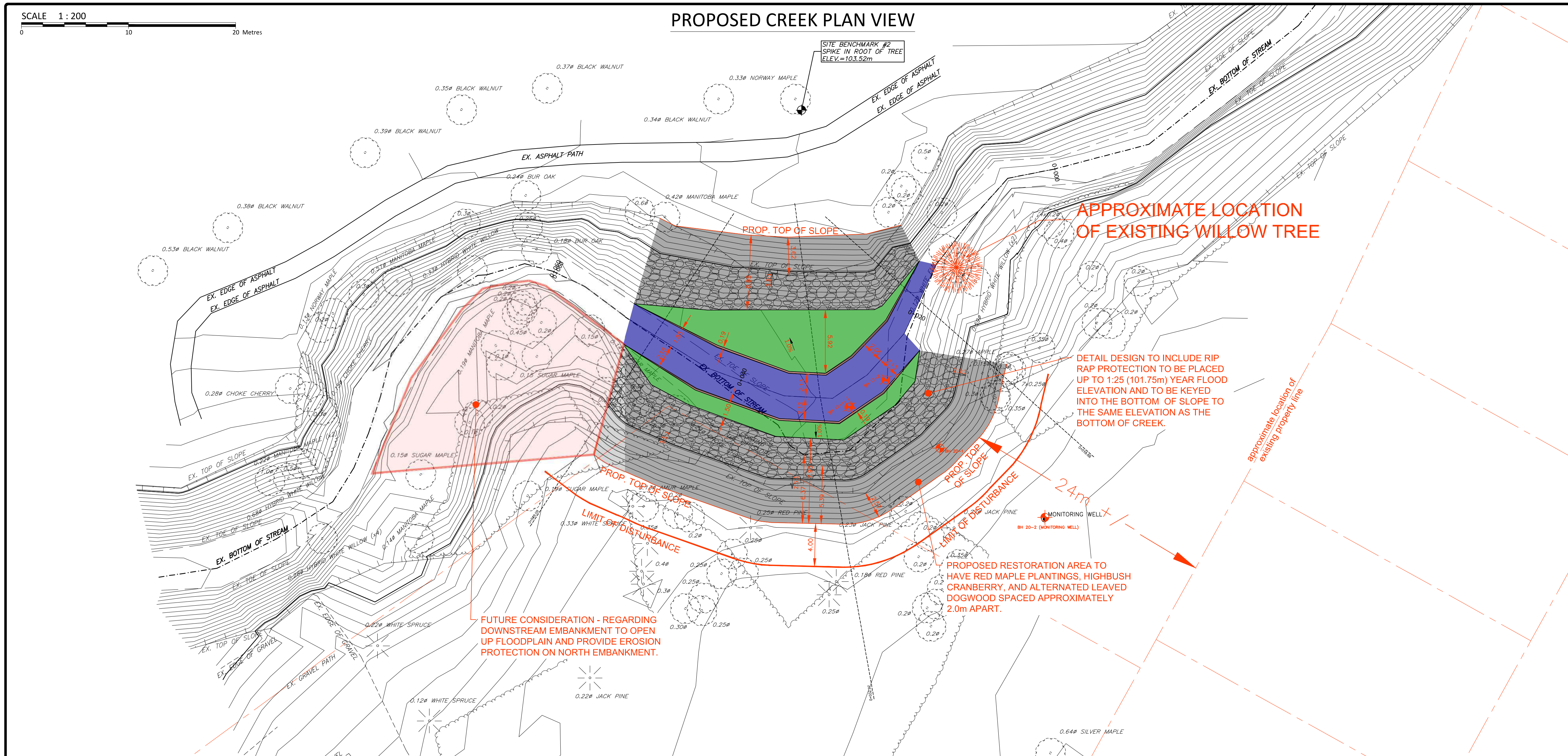
  - North Embankment – Top of 2.5H:1V slope along north bank encroaches closer to existing asphalt pathway by 3.62 (+/-) compared to existing condition top of slope but still provides approximately 6 to 9 meters (+/-) setback from the pathway within the study area.

- Potted plants shall be installed to re-vegetating the top of embankment with tress/shrubs/ grass. Rip Rap will also be strategically placed to protect top of slopes and transition points along the creek.

- The in-stream work would also include the removal and/or movement of some fallen trees, rocks and sediment that has accumulated at the bend and a short distance upstream of the eroded bank.

The proposed TPA will follow a natural channel design principle in accordance with MVCA guidelines and City's draft Official Plan Policy.

PROPOSED CREEK PLAN VIEW



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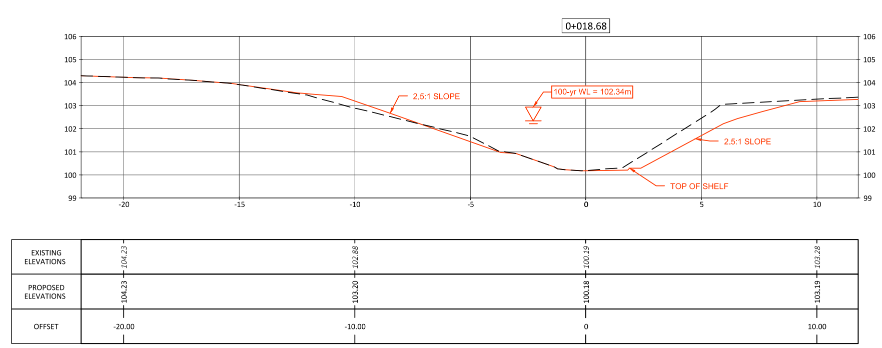

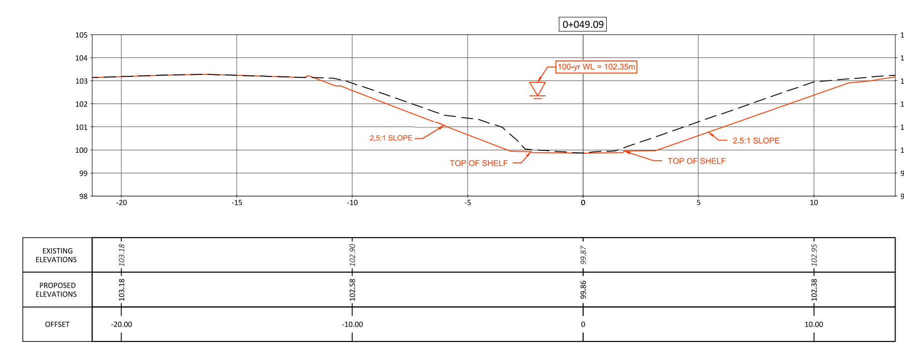

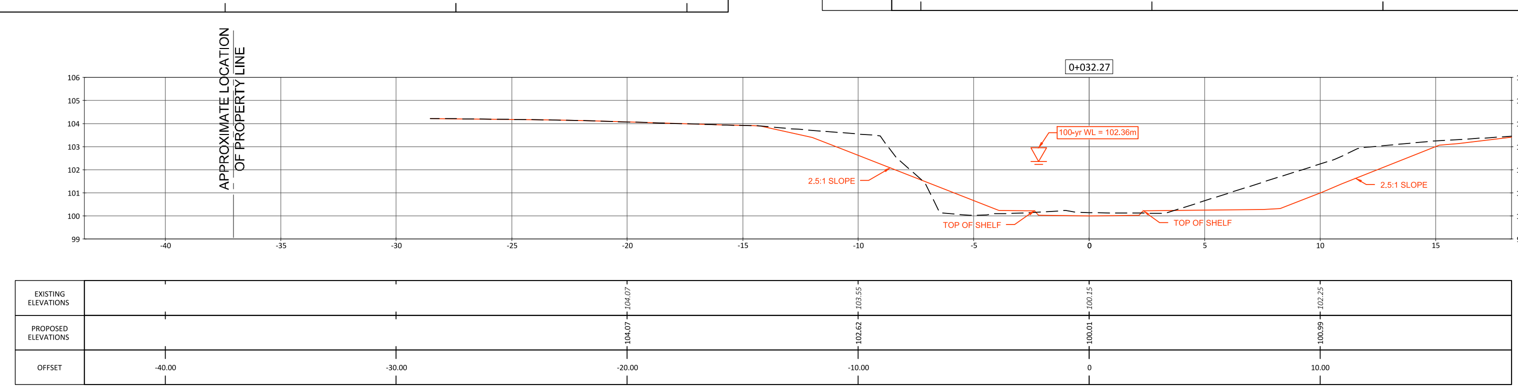

GENERAL NOTES:

1. ALL DIMENSIONS AND ELEVATIONS MUST BE VERIFIED PRIOR TO CONSTRUCTION, IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
2. ORIGINAL TOPOGRAPHY, GROUND ELEVATION AND SURVEY DATA SHOWN ARE PROVIDED BY OTHERS AND SUPPLIED FOR INFORMATION PURPOSES ONLY AND IMPLY NO GUARANTEE OF ACCURACY. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL INFORMATION OBTAINED FROM THEM.
3. THIS PLAN IS TO BE READ IN CONJUNCTION WITH ALL LANDSCAPING PLANS, DETAILS AND ANY OTHERS WHICH MAY APPLY.
4. CONTRACTOR TO OBTAIN AND PAY FOR ALL NECESSARY PERMITS AND APPROVALS BEFORE COMMENCING CONSTRUCTION.
5. THE CONTRACTOR IS RESPONSIBLE FOR ALL LAYOUT.
6. THE CONTRACTOR IS TO DETERMINE THE EXACT LOCATION, SIZE, MATERIAL AND ELEVATION OF ALL EXISTING UTILITIES PRIOR TO COMMENCING CONSTRUCTION. PROTECT AND ASSUME ALL RESPONSIBILITY FOR EXISTING UTILITIES WHETHER OR NOT SHOWN ON THESE DRAWINGS. IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
7. RESTORE ALL TRENCHES AND SURFACES OF PUBLIC ROAD ALLOWANCES TO CONDITION EQUAL OR BETTER THAN ORIGINAL CONDITION AND TO THE SATISFACTION OF THE CITY OF OTTAWA AUTHORITIES.
8. EXCAVATE AND DISPOSE OF ALL EXCESS EXCAVATED MATERIAL, SUCH AS ASPHALT, CURBING AND DEBRIS, OFF SITE AS DIRECTED BY THE ENGINEER AND THE CITY OF OTTAWA.
9. TOPSOIL TO BE STRIPPED AND STOCKPILED FOR REHABILITATION. CLEAN FILL TO BE PLACED IN FILL AREAS AND COMPACTED TO 95% STANDARD PROCTOR DENSITY.
10. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER UNLESS OTHERWISE SPECIFIED.
11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC CONTROL AND SAFETY MEASURES DURING THE CONSTRUCTION PERIOD, INCLUDING THE SUPPLY, INSTALLATION, AND REMOVAL OF ALL NECESSARY SIGNAGE, DELINEATORS, MARKERS AND BARRIERS.
12. DO NOT ALTER GRADING OF THE SITE WITHOUT PRIOR APPROVAL OF THE CITY OF OTTAWA
13. THE SITE GRADING CONTRACTOR IS RESPONSIBLE FOR ENSURING INSTALLATION OF EROSION AND SEDIMENT CONTROLS PRIOR TO COMMENCING CONSTRUCTION. CARE SHALL BE TAKEN AT THE REMOVAL STAGE TO ENSURE THAT ANY SILT THAT HAS ACCUMULATED IS PROPERLY HANDLED AND DISPOSED OF.

BENCHMARK INFORMATION:

TBM - OBVERT AT DOWNSTREAM END OF EXISTING BOX CULVERT APPROXIMATELY 100m UPSTREAM OF WORK ZONE
APPROXIMATE GEODETIC ELEVATION = 102.22m

No.	Revision/Issue	Date
2	REVISED CONCEPT DESIGN	OCT 26/20
1	CONCEPTUAL DESIGN	SEPT 18/20

Check and verify all dimensions before proceeding with the work

Do not scale drawings

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N

Stamp:

Client:
MISSISSIPPI VALLEY CONSERVATION AUTHORITY
10970 ON-7, CARLETON PLACE
ON K7C 3P1

Project:
CARP CREEK EMBANKEMENT RESTORATION

Drawing Title:
PROPOSED ALIGNMENT CROSS SECTIONS

Scale:	AS SHOWN
Drawn by:	R.F.
Checked By:	L.M.
Designed By:	B.A., R.F.
Date:	09/18/20
Project Number:	CM-17-0429-02
Drawing Number:	C101A
SHEET	1 of 1

No.	Revision/Issue	Date
2	REVISED CONCEPT DESIGN	OCT 26/20
1	CONCEPT PLAN	SEPT 18/20

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Client:
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10970 ON-7, CARLETON PLACE
ON K7C 3P1

Project:
CARP CREEK EMBANKMENT RESTORATION

Drawing Title:
PROPOSED EXTENTS OF WORKS

Scale:	N.T.S.
Drawn by:	R.F.
Checked By:	L.M.
Designed By:	B.A., R.F.
Date:	SEPT/18/20
Project Number:	CM-17-0429-02
Drawing Number:	Figure 5-2

5.2 Impact Assessment

5.2.1 Hydrology and Hydraulic Assessment

MVCA and the City of Ottawa provided supporting hydrology and hydraulic information which included the Carp River in Glen Cairn Bank Failure Assessment Report prepared by JFSA (2011), as well as corresponding CarpRiver_Glen Cairn Hec-Ras Model used for the hydraulic analysis in this study.

As was completed in the initial assignment in 2017, the Hec-Ras model provided by the City of Ottawa was used to perform hydraulic and geomorphic analyses of the study reach. As previously indicated this model was updated in 2011 by JFSA for the Carp River in Glen Cairn Bank Failure Assessment. MVCA and the City of Ottawa are continuously working on updating existing hydraulic and hydrological studies (i.e. floodplain mapping) to take into consideration land use changes, as well as climate change.

In 2020, an additional topographic survey was obtained to determine if further erosion had occurred since 2017 and to update the model accordingly within the study area. The survey data was used to generate additional cross-sections within the study area. Manning's roughness coefficients were updated to reflect the main channel and overbanks within the study area reach. The modeled sections through the study area are presented in a figure enclosed in Appendix D.

5.2.1.1 Hydrological

For this study, McIntosh Perry's has been directed to use the hydrological data provided within the provided Hec-Ras model as it represents the most current.

For further details pertaining to the hydrological assessment, refer to *Carp River in Glen Cairn Bank Failure Assessment Report (JFSA, 2011) and Glen Cairn Community Carp River Flood Mitigation Environmental Study Report and Pre-Design (CCL, 2003) and the original Carp Creek Embankment Restoration Class Environmental Assessment Project Plan Report (McIntosh Perry, November 2018).*

5.2.1.2 Hydraulic

The purpose of this hydraulic analysis is to determine whether the existing condition and proposed the embankment remediation alternative will have the capacity to convey the design flow and regulatory storm without causing adverse impacts to the channel, and the surrounding lands. The hydraulic analysis also assess that the creek can withstand the check flow for scour without endangering the integrity of the embankments and without overtopping or causing embankment failure.

The Hec-Ras model was used to analyse the hydraulics performance of the creek for all storm events from the 2-year to the 100-year flow for the existing condition and the proposed conceptual design, which consisted of re-graded the eroded embankment within the study area (south and north bank) to provide more floodplain storage and energy dissipation. The shaving of the point bar directly across from the eroding bank was also incorporated into the design to provide additional flow capacity and assist with reducing flow velocities within the immediate channel section.

5.2.1.3 Modeling Results

The Hec-Ras model was used to analyze the hydraulics performance of the creek for all storm events from the 2-year to the 100-year flow for the existing condition and the proposed conceptual design, which consisted of re-graded the eroded embankment within the study area (south bank) to provide more floodplain storage and energy dissipation. The shaving of the point bar directly across from the eroding bank was also incorporated into the design to provide additional flow capacity and assist with reducing flow velocities within the immediate channel section.

The expected impacts from the proposed channel realignment and regrading of the embankment are limited to the Carp Creek study area for an approximate reach of 32 m (cross-section 46564 to 46533). A hydraulic comparison table for all storm events has been enclosed in Appendix D. A summary of the flood elevation for key storm events (2 yr., 25 yr. and 100 yr.) and locations within the proposed study area are illustrated in Table 5-1.

Table 1-2: Summary of Flood Elevations for Key Return Periods

Hec_Ras Cross-Section	Return Period (m)		
	2 Year	25 Year	100 Year
46582	101.77	102.02	102.57
46564	101.47	101.74	102.34
46552	101.48	101.75	102.36
46515	101.48	101.74	102.35
46533	101.41	101.67	102.26
56527	101.0	101.55	102.12

As illustrated in the hydraulic comparison table (Appendix D), the proposed water elevations and flow area increases at the downstream cross-section 46533 compared to existing conditions which allows the velocity to decrease while conveying the same flow. The increase in flood elevation at 46533 negligible (0.08 m) and most likely can be attributed to a change in roughness over the wider cross-sectional area, as well due to the downstream converging back into existing condition. This however will be further reviewed in the detailed design and mitigated. The same result is seen throughout the study area where the floodplain has been regraded (cross-section 46552 to 46533) which allows larger flow events additional flow area in the floodplain to convey flow and dissipate energy. In comparison to the existing condition, there is a decrease in channel velocity of 0.15 to 0.50 m/s from cross-section 46552 to 46533, as well as with similar or lower velocities in the left and right overbank areas. However, with a relatively uniform cross-section for the entire reach, the flow has to now transition from a wider cross-section back to the narrow existing cross-section and therefore the proposed water elevations and flow area begin to decrease as the velocities begin to increase. This change is especially evident since the Hec Ras model, simulated in the steady-state model, calculates water elevations and velocities from downstream to upstream.

At cross-section 46564 there is a slight increase in velocity (0.12 to 0.15 m/s) as a result of the decrease in flood elevation, which is a limited 10% increase. Throughout the study area, velocity ranges from 1.00 to 1.96 m/s and an average overbank velocity of 0.40 to 0.87 m/s for the 2-year to 100-year event. The highest flow velocity for the 25-year event within the study area is 1.65 m/s (cross-section 46533). According to the MTO Drainage Management Manual, Design Chart 2.17, the maximum permissible velocity for soils representative of alluvial silts for water carrying fine silt is 1.50 m/s. Therefore, the flow increase for proposed condition is not expected to result in

increased erosion. However, since the velocity is great than 1.5 m/s, erosion mitigation measures (i.e. Rip Rap and plantings) will be strategically incorporated into the design to protect the toe of slope and embankments.

Therefore, the model results illustrate that the suggested modifications to the channel can be implemented with minimal impacts to the Carp Creek within the study area. However as stated above, the Hec Ras model calculates water elevations and flow velocities from downstream to upstream. The model is primarily designed to calculate water elevations but is limited in its ability to generate accurate detailed velocity distributions. As a result, the proposed channel alignment within the study area has been optimized, as analyzed within the limitations of the Hec Ras model, to minimize the impact of directing flows at the downstream bank which is further discussed below.

5.2.2 Geomorphic Assessment

The proposed design has considered geomorphic properties and tendencies of natural channel systems. It is proposed that the local, eroding slope be regraded to a stable slope and, in doing so, the low flow channel also be shifted slight northward to a recent historical alignment (as the channel has eroded southerly over time to its current position). The proposed conceptual design also incorporates a bankfull bench which allows the low flow channel to maintain a natural process of sediment transport while also allowing larger flows to have additional room for energy dissipation on the floodplain. The proposed channel alignment also minimizes the impact of directing flows at downstream bank (since the very acute angle of the exiting channel tends to direct flows at the immediately downstream banks). As such, the proposed conceptual design creates a stable alignment with stable bank slopes through the placement of stone toe protection for immediate protection and plantings for long term stability. The shaving of the point bar directly across from the eroding bank also provides for additional flow capacity and reduces flow velocities within the immediate channel section.

Channel formation must consider fluvial and hydraulic properties of stream flow. Historically the channel has been straightened but natural systems want to meander. The proposed conceptual design maintains the geomorphic properties that natural channels require however; large flows need to be addressed as well. Currently with the larger channel beginning to erode against the banks, as well the larger flows also are meandering where historically the channel was straight and hydraulically efficient. Over time the channel has also slightly entrenched itself and so larger events are not able to spill onto the floodplain as quickly. As such, and just as we are doing with the channel at the eroded bend (study area), it is expedient to create the flow path required for larger events by shaving the local floodplain. We recommend that consideration be given to some limited floodplain shaving immediately downstream of the eroding bank (second meander) to allow for additional flow capacity and energy dissipation on the floodplain. In addition, and in order to protect the trail located at the top of the steep slope, we also recommend that the downstream outside bend be treated with stone toe protection to fill in gaps between existing, randomly placed large stone.

5.2.3 Vegetation

During the July 2020 topographic survey, the location and diameter of individual trees that are larger than 0.10 m in diameter at breast height (DBH) were surveyed within the study area. Where trees are clumped together, an outline of these trees was provided, and approximate measurement was taken.

As stated above, a 2.5H:1V slope has been proposed for the conceptual design which will limit the number of trees and vegetation being removed along the south and north banks. However, this will still have a socio impact to the existing residential dwellings. Based on the Conceptual Design, approximately 20-30 Sugar Maple, Manitoba Maple

Red Pine and Jack Pine with a DBH greater than 0.10 m will need to be removed, however, this number will be confirmed during the detailed design phase. The proposed top of slope and limits of disturbance have been identified in Figures 5-1 and 5-2.

Therefore, restoration of the re-graded embankment will be required as part of the detailed design. Type of vegetation to take on a 2.5H:1V slope will be recommended such as Red Maple plantings, highbush Cranberry and leaved Dogwood. As part of the Detailed Design, the number of trees larger than 0.10 m in diameter at breast height (DBH) required to be removed will be confirmed and illustrated on a Tree Removal and Restoration Plan. The proposed Tree Removal and Restoration Plan will identify the location and type of trees/shrubs to be removed and planted. Consultation with the City of Ottawa Forestry will be ongoing during the detailed design process to obtain approval for tree removal, as well as determine the number of trees that need to be replanted.

Site access for construction is expected to be required from both the north and south side of Carp Creek, with access for the majority of works likely now being from south bank. Access from north of Carp Creek likely be required to construct the north bench, proposed channel and re-grading of the embankment. The south embankment will be constructed via the south side of Carp Creek through the available grassy parkland located south-west of the work area. Existing grassy parkland in that area is expected to be generally sufficient to allow for equipment access and required laydown area with minimal disturbances to existing trees. All areas required for access and staging during construction will be reinstated following construction to previous condition or better.

5.3 Preliminary/Detail Design

The following will need to be considered and addressed during the detailed design process:

- Continue to work with MVCA and the City to ensure compliance with environmental regulations, to restore the eroded embankment and prevent long-term adverse impacts on the environment.
- Continued consultation with Ministry of Natural Resources and Forestry (MNRF) and Department of Fisheries and Oceans (DFO) to complete the embankment restoration design and obtain any required permits. Approval anticipated at this time for the preliminary TPA:
    - MNRF Work Permit to work on Shorelands and within a Waterbody
    - DFO Request for Review
    - MECP - determined if a Permit to Take Water (greater than 400,000 L/day) or an Environmental Activity Sector Registry (50,000 L/day to 400,000 L/day.) will be required during construction.
- Detailed implementation plan will be developed during the detailed design phase to mitigate any impacts on fish habitat;
- Prepare a detail Planting Plan to ensure re-vegetation of embankments, top of bank and proposed bench within the floodplain. Vegetation planting on the 2.5H:1V slope to consist vegetative native to the Carp Creek study area such as red maple, highbush cranberry and alternate-leaved dogwood. Plantings will be spaced approximately 2.0 m apart within the proposed Terrafirm slope stabilization system (or an equivalent product) to assist the slope stabilization and prevent future erosion.
- Update hydraulic model to ensure that final design to verify and confirm no negative impacts upstream and downstream of the study area, as well as prepare sheer stress calculation to confirm

the size Rip-Rap material require at the toe of slope and determine depth of embedment to prevent undermining.

- Further discuss the geotechnical recommend for the placement non-woven geotextile between the riprap and clay bank. It states that it is necessary to use non-woven geotextile below the Rip Rap, especially when Rip Rap is to protect fine-grained soil. We acknowledge that geotextile has a tendency to allow Rip Rap to be easily displaced during larger storm events and leave geotextile exposed.
- As per geotechnical recommendation, the surface of the cut shall be protected with Terrafirm slope stabilization system (or an equivalent product) above Rip Rap. This system will provide an anchored mesh supporting a vegetation mat over the slope. Using this anchored mesh is necessary due to the presence of the sandy alluvial layer, which is prone to erosion more than other layers.
- Incorporate live stakes within the voids of the Rip rap protection for additional stability. The use of strictly a mix of willows and dogwoods is recommended.
- Ensure construction activities are done to limit and/or avoid impacts to the environment and surrounding lands and with the least disruption to the public.

5.3.1 Cost Estimate

A planning level opinion of probable cost was prepared for the preliminary technically preferred alternative as described above in Section 5.1. The preliminary cost estimate for the proposed embankment restoration is $202,498 which includes contingencies as per a Class C estimate. The cost estimate has been enclosed in Appendix E.

5.4 Future Considerations

Based on-site observations, the immediately downstream bend is also showing signs of erosion but is slightly more protected by larger stones. In its current state, the very acute angle of the exiting channel tends to direct flows at the immediately downstream banks which is evident of the erosion. At the immediately downstream bend of the study area, the existing velocities range from 2.13 to 2.74 m/s for the 2-year to 100-year rainfall events. Based on fluvial and hydraulic properties of streamflow, it is recommended that future consideration be given to some limited floodplain shaving immediately downstream of the eroding bank (second meander) to allow for additional flow capacity and energy dissipation on the floodplain. In addition, and in order to protect the trail located at the top of the steep slope, we also recommend that the downstream outside bend be treated with stone toe protection to fill in gaps between existing, randomly placed large stone. However, this will result in additional tree removal along the south embankment and potentially a few on the north bank.

6.0 DETAILED ENVIRONMENTAL SCREENING OF PREFERRED ALTERNATIVE

To complete the detailed environmental analysis of the preliminary TPA, the information collected for the baseline environmental inventory as well as alternatives evaluation was examined in greater detail to confirm potential impacts, refine mitigation and/or compensation measures, and identify any unforeseen impacts.

Screening criteria used were consistent with the criteria provided in the Conservation Ontario Class Environmental Assessment (2011) guidelines. The criteria represented impacts to physical, biological, cultural and socio-economic environments and included engineering/technical considerations.

The environmental components where potential positive, negative or neutral effects are likely were identified. The detailed consideration included potential effect ranking as Negative High (-H), Negative Medium (-M), Negative Low (-L), Neutral or None (N), Positive Low (+L), Positive Medium (+M) or Positive High (+H) based on the magnitude, geographic extent, duration, frequency, the permanence of reversibility, and ecological context of the effect in question. Proposed mitigation and/or compensation measures and any residual effects were documented as well.

The results of the detailed environmental analysis of the preliminary TPA are presented in Appendix F. The criteria determined as not applicable and environmental components where no impacts are likely were omitted from further discussion. The potential effects and proposed mitigation measures are further discussed in Sections 7.0.

7.0 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

This section describes the potential impacts to existing environmental conditions and mitigation measures that are associated with the **preliminary TPA.** Once the final TPA has been selected following consultation, the below mitigation measures will be confirmed and carried forward into the detail design package. Proposed mitigation measures are recommended that minimize or prevent negative impacts from the project works.

In order to mitigate the potential impacts to the physical, biological, cultural/socio-economic and engineering/technical environment, the Contractor is responsible for implementing conditions of referenced special provisions and Ontario Provincial Standard Specifications (OPSS) which will be identified during the detail design and incorporated in the tender Package. In general, the Contractor is responsible for the protection of people, property and the natural environment from environmental impacts and damage that may result from this contract.

7.1.1 Physical Environment

7.1.1.1 Designated Areas

There are no designated areas within the study area and all project works are currently planned to take place within the Carp Creek and along embankment. As such, it is not anticipated that construction activities will impact any designated areas. Refer to Section 7.1.1.5 for recommendation on preventing impacts to surface water and around the study area.

7.1.1.2 Air Quality

Generation of dust, fumes, and odours may be created during construction by machinery working within the study area.

Odour and fume impacts will be minimized by ensuring that all equipment is proper maintained and that all pollution control devices on the equipment are operational and properly maintained.

Dust shall be controlled as per OPSS 506 - Construction Specifications for Dust Suppressants.

7.1.1.3 Noise Levels and Vibration

The potential negative effects on noise levels and vibration are anticipated to be minimal and contained to areas within close proximity to the construction site with the local study area. The impact is attributed to the construction

equipment operation and a possible increase in truck traffic during peak traffic hours. Mitigation measures may include:

- Carrying out construction Monday to Friday during normal working hours;
- Enforcement of the city of Ottawa Noise By-Law; and
- Regular equipment inspections and operation (e.g., restrict swinging of truck tailgates to dislodge material during filling operations) to ensure noise levels are kept to a minimum

Potential negative effect on noise and vibration levels within the local study area and surrounding lands is expected to last for the duration of the project construction phase only. No long-term impacts would occur.

7.1.1.4 Existing Surface Drainage and Groundwater Seepage

There are no impacts on existing surface drainage and groundwater seepage expected in the regional study area. The potential negative effects on existing surface drainage are expected to be minor and within the construction access and staging areas in the local study area. Where existing drainage paths cannot be maintained, mitigation may include the following:

- Minimizing vegetation removal and soil exposure during site preparation; and
- Sediment and erosion control measures (e.g., installing and maintaining a sediment fence along the construction access and/or staging area boundaries) as per the MVCA's erosion and sediment control requirements during construction.

Post-implementation restoration of disturbed areas to pre-construction condition is expected to fully mitigate the impact. No Permanent adverse effects are anticipated.

7.1.1.5 Surface Water

- Proper mitigation measures should be employed to limit the impacts of sediment movement into surface waters within the vicinity of the study area during construction.
- As watercourses are home to many species including SAR, the following recommendations are listed to mitigate the impacts of work in the vicinity of watercourse associated with the study area:
    - Mobile equipment refuelling should take place no closer than 30 m from any waterbody, watercourse or wetland in order to prevent water contamination due to accidental fuel spills. For non-mobile equipment, refuelling should be carried out in a controlled manner so as to prevent fuel spillage, and drip pans should be located under parked equipment at all times;
    - Equipment operating near any watercourse, waterbody or wetland should be in good working condition, properly maintained and free of excess oil/grease to reduce the risk of contaminant leakage. In the event that a spill occurs, proper containment, clean up, and reporting, in accordance with federal and provincial requirements, must be completed;
    - The Contractor should take all necessary precautions to prevent the accumulation of litter and construction debris;
    - Construction equipment should not enter watercourses unless access to a watercourse is approved and delineated in the Contract Drawings;

- Appropriate ESC measures should be installed prior to construction to prevent siltation into watercourses and wetland areas; and
- OPSS 182 – General Specification for Environmental Protection for Construction in Waterbodies and on Waterbody Banks.

7.1.1.6 Groundwater

Construction activities, such as refueling, can increase the potential for accidental spillage and subsequent contamination of groundwater sources. In order to prevent groundwater contamination, the Contractor shall:

- Take special care to avoid accidental spillage or discharge of chemical contaminants;
- Proper containment, clean up and reporting, in accordance with provincial requirements, shall be completed immediately if a spill occurs; and
- During detail design, it will be determined if a Permit to Take Water (greater than 400,000 L/day) or an Environmental Activity Sector Registry (50,000 L/day to 400,000 L/day.) will be required during construction.

7.1.2 Biological Environment

7.1.2.1 Wildlife and Migratory Birds

Due to the presence of appropriate habitat and observation of multiple species, migratory birds may be encountered nesting within vegetation present in the vicinity of the Carp Creek. As such, the migratory bird nesting window is from May 1st to August 31st, of any year. A screening of the study area for the presence of migratory birds or their nests should be undertaken by an avian specialist prior to disturbance or removal of vegetation during the bird nesting window. May 1st to August 31st represents the core bird breeding period when most bird species would be nesting. If migratory birds or their nests are encountered at any time of the year, works should not continue in the location of the nest until:

- After it has been determined by an avian specialist that the young have fledged and vacated the nest and work area; or
- An avian specialist determines a suitable buffer distance at which work may continue to prevent disturbance of the bird(s), and,
- Where a buffer distance has been implemented, an avian specialist must undertake monitoring during construction to ensure migratory birds and their eggs are not disturbed, destroyed or taken.

The removal of vegetation during the proposed restoration works may temporarily disturb wildlife habitat. However, this type of habitat is well represented outside of the study area. Impacts to at-risk wildlife species listed on the Species at Risk in Ontario List (Ontario Regulation 230/08), (i.e. turtles, birds, etc.), are discussed below in Section 7.1.2.4.

7.1.2.2 Vegetation

To mitigate the disturbance of vegetation, avoid erosion and sediment transport, and reduce the potential impact of invasive species, the following principles should be implemented during the project design:

- Disturbance of riparian vegetation should be minimized where possible;

- Embankments disturbed as a result of construction shall be restored to their pre-construction condition or better (i.e. enhanced);
- Replacement of disturbed vegetative cover with native species to the Carp Creek study area. Areas of exposed soils shall be revegetated as soon as possible following disturbance as per OPSS 805. If there is insufficient time in the growing season for seed to sprout, the site shall be stabilized with temporary erosion and sediment control measures and seeded in the following spring.

7.1.2.3 Fish and Fish Habitat

The watercourse associated with the study area is known as the Carp Creek. The Carp Creek is known to have a warm water thermal regime with the following species of fish present: Brown Bullhead (*Ameiurus nebulosus*), Northern Pike (*Esox lucius*), Pumpkinseed (*Lepomis gibbosus*), White Sucker (*Catostomus commersonii*) and Yellow Perch (*Perca flavescens*). Although a fish survey was not conducted during the field investigation, multiple unidentified species of minnows (*Cyprinidae spp.)* were observed to be present within the pool portion of the watercourse within the study area.

It is not anticipated that the proposed restoration works will impact the fish and fish habitat of the watercourse provided the proper mitigation measures are utilized.

The following general mitigation measures will be applied during construction:

- In-water works will be conducted during the in-water work timing window (in water works not permitted from March 15 to June 30 of any given year) to avoid impacts to fish species found within the watercourses;
- OPSS 182, April 2017-Timing In-Water Work will be included in the Contract Package; and
- The Contractor shall follow OPSS -182- General Specification for Environmental Protection for Construction in Waterbodies.

In addition to adhering to the in-water timing window the following mitigation measures shall be followed:

Protection of Fish and Fish Habitat

- Minimize duration of in-water work;
- When possible, schedule work to avoid wet and rainy periods that may increase the risk of erosion and sedimentation;
- Plan access points to minimize the amount of riparian vegetation lost or disturbed;
- All in-water work shall be conducted in the dry to avoid introducing suspended sediment into the watercourse;
- Downstream flow will be maintained at all times;
- Dewatering shall be carried out as per OPSS 185 – *General Specification for Temporary Flow Control for Construction in Waterbodies*. Flows will be maintained at all times; and,
- Develop a spill response plan that is to be implemented immediately in the event of a sediment release or spill of a deleterious substance. An emergency spill kit shall be kept on site at all times.

Fish Removal

If fish rescue is required, the work areas will be isolated and will be de-fished by a qualified fisheries specialist as per the requirements in OPSS 182 – General Specification for Environmental Protection for Construction in Waterbodies and on Waterbody Banks and a signed License to Collect Fish for Scientific Purposes is attained from Kemptville MNRF District. The work areas will be isolated from the rest of the watercourse. The fisheries specialist will rescue the fish from these areas and relocate them into the same watercourse downstream of the work area prior to the embankment restoration or other in-water work activities. Upon catching any fish, they will be identified and promptly removed from the work area and released. Species and numbers of fish will be recorded and submitted to the MNRF.

Erosion and Sediment Control

- An Erosion and Sediment (ESC) Control Plan shall be prepared by the Contractor and discussed with the Contract Administrator to prevent sediment leaving the work zone and entering the watercourses;
- ESC measures shall be installed prior to starting work to prevent sediment from entering the watercourse and will be removed at the completion of construction;
- ESC measures shall be inspected for effectiveness regularly throughout construction and deficiencies corrected; and
- The installation, monitoring, maintenance, and removal of temporary ESC measures shall be according to OPSS 805 – *Construction Specification for Temporary Erosion and Sediment Control Measures*.

Aquatic Vegetation Clearing

Vegetation removal will be required as part of the proposed works. Any aquatic vegetation that is removed, must be disposed of on dry land in a manner that prevents the aquatic vegetation from entering any waterbody as per OPSS 182 – General Specification for Environmental Protection for Construction in Waterbodies and on Waterbody Banks.

7.1.2.4 Species at Risk

During the 2017 and 2020 field investigations, no SAR were observed within the study area. However, given background information and the habitat observed to be present during the field investigation, there is the potential for species at risk turtles [i.e., Blanding's Turtle (*Emydoidea blandingii*), threatened; Eastern Musk Turtle (*Sternotherus odoratus*), special concern; and Common Snapping Turtle (*Chelydra serpentina*), special concern], to utilize the watercourse as a travel corridor. In addition, the forested habitat adjacent to the watercourse could be utilized by Canada Warbler (*Cardellina canadensis*), special concern; Eastern Wood-pewee (*Contopus virens*), special concern; and Red-headed Woodpecker (*Melanerpes erythrocephalus*), special concern; for breeding and nesting purposes.

Post-construction site restoration will ensure that no long-term adverse effects occur. The proposed design concept is not expected to have any long-term effect on SAR. The following additional mitigation measures should be implemented in order to ensure the protection of all SAR and their habitat potentially present within the study area, and to ensure compliance with the ESA:

- **SAR Awareness Training:** The Contractor shall provide fact sheets and identification training to all onsite personnel for the identification of species at risk which may be encountered within or directly adjacent to

the work area (MNRF Fact Sheets for Blanding Turtles, Snapping Turtle: https://www.ontario.ca/page/snapping-turtle)

- **Daily site inspections/sweeps:** are recommended prior to commencing work activities to ensure no SAR have entered or nested in the proposed works area. Site inspections should be undertaken during the workday to determine if SAR have entered the work area.
    - **Temporary Work Stoppage during SAR Encounter:** If any SAR or their nest is observed during the site inspection or at any other time, avoid the area, temporarily suspend all work in the area and contact the Contract Administrator. SAR that are encountered within the work zone should be allowed a reasonable amount of time to leave the work area. If a turtle or snake is encountered appears to be moving through the area, the species shall be allowed to move out of the work area on their own, and
    - **Report SAR Observations within the Work Area to the MNRF:** The Contractor will contact Contract Administration to notify them of SAR observations within the work area. All SAR observations shall be documented and reported to the Contract Administrator in writing within 24 hours of the observation. SAR should only be handled by qualified professionals who have knowledge of the species and the correct approvals to undertake SAR handling.

- All stockpiled topsoil, sand, and gravel must be covered with geotextile or encircled with light duty silt fence to prevent turtles from nesting in the materials from June 1 to July 15 of any year. All silt fence or geotextile must be removed after the work has been completed; and
- Where turtles are encountered nesting or have already nested, construction activities shall stop and MNRF notified.

SAR Birds - Although suitable habitat appears to be present within the study area for SAR, based on the nature of the proposed works, it is not anticipated that there will be as significant impacts to the species. Mitigations measures outlined in Section 7.1.2.1 for Migratory Birds are anticipated to provide suitable mitigation for these SAR birds. It is not anticipated that the proposed construction will have negative impacts to these species.

SAR Turtles - The Snapping Turtle and Blanding Turtle may be found within the Carp Creek and may use terrestrial habitats adjacent to the river for their life processes. SAR turtles may utilize the Creek as a traveling corridor. During the field investigations, no evidence of turtle nesting activity was observed. As a result, these species are not anticipated to be impacted by the proposed embankment restoration.

SAR Insects - The Monarch was not observed within the study area during the 2017 and 2020 field investigations but may be found in the open habitats adjacent to the study area. It is not anticipated that the proposed construction will have negative impacts to the Monarch or other insects.

SAR Bats - There is the potential to encounter all SAR bats which may utilize the forested area along the Carp Creek as maternity colony habitat (i.e., snags, cavity trees etc.). Though the Eastern Small-footed Myotis, Little Brown Myotis, Northern Myotis, and Tri-colored Bat may be found within the general area of the study site, no evidence was observed during the 2017 and 2020 field investigations to suggest that bats are using the embankment as a maternity colony site. As a result, these species are not anticipated to be impacted by the proposed embankment restoration works.

7.1.3 Cultural and Socioeconomic Environment

7.1.3.1 Recreational or Tourist Uses of Existing Shoreline Access, Body of Water and/or Adjacent Lands

There are no long-term anticipated impacts to recreation or tourism within the study area. The potential negative effects on adjacent multi-use/pedestrian trail and parklands surrounding the study area may be temporarily closed during construction. The installation of a temporary alternative path, fencing or the implementation of a pedestrian detour route may limit the impacts to the adjacent recreational facilities.

Post-implementation restoration of disturbed areas to pre-construction condition is expected to fully mitigate the impact. No Permanent adverse effects are anticipated.

7.1.3.2 Built Heritage and Cultural Heritage Landscapes

No other built heritage and cultural heritage landscape resources are within the study area.

7.1.3.3 Cultural Heritage - Archaeology

An archaeological assessment was required for the Carp Creek Embankment Restoration. A Stage 1 and 2 Archaeological Assessment was conducted in 2017, by Past Recovery Archaeological Services Inc. No artifacts, features, or other cultural deposits of archaeological concern were noted during the Stage 2 assessment. No further investigations are required for the study area.

During construction there is always the chance of encountering buried archaeological material. If this occurs, the Contractor shall immediately stop all construction activities in the area and contact the Heritage Advisor at the office of the Heritage Program Unit, Ministry of Tourism, Culture and Sport (416-314-7159). If unmarked human remains are uncovered, the provisions of the Ontario Cemeteries Act apply. The Contractor shall immediately stop all construction activities in the area and contact the office of the Heritage Operations Unit, Ministry of Tourism, Culture and Sport, the Cemeteries Regulation Unit (416-326-8393), the local OPP, the local Coroner and the MVCA.

7.1.3.4 Surrounding Land Use

Due to the general nature of the project works being restricted to the Carp Creek embankment, the project works will cause minimal change to the existing landscape composition.

Impacts of the project works on the study area land uses were assessed against the scope of the assignment. Adjacent land use consists of watercourses, greenspace, residential dwellings, and recreational areas (i.e. parks). In general, it is not anticipated that the proposed construction activities will have any long-term negative impact on adjacent land uses.

Impacts of the project works in the short-term are mainly related to traffic and noise disruption during construction. The short-term traffic impacts will be mitigated through appropriate measures and staging to minimize traffic disruption. Area used for staging areas during construction are to be restored to pre-construction condition.

7.2 Engineering/Technical Environment

7.2.1.1 Erosion and Sediment Control

Project works may lead to the suspension of sediment in the watercourses. Also, exposed or stockpiled soils adjacent to the watercourses can lead to sedimentation during rain events. In order to prevent the entrainment of sediment in the watercourses, the contract package should include the following mitigation measures:

- An Erosion and Sediment (ESC) Control Plan shall be prepared by the Contractor and discussed with the Contract Administrator to prevent sediment leaving the work zone and entering the watercourses associated with Carp Creek;
- ESC measures shall be installed prior to starting work to prevent sediment from entering the watercourse and will be removed at the completion of construction;
- ESC measures shall be inspected for effectiveness regularly throughout construction and deficiencies corrected;
- The installation, monitoring, maintenance, and removal of temporary ESC measures shall be according to OPSS 805 – Construction Specification for Temporary Erosion and Sediment Control Measures;

7.2.1.2 Management of Excess Materials

Stockpiled construction materials such as aggregate, and earth may potentially contaminate the study area without proper containment and environmental protection measures.

In order to mitigate the potential impacts associated with excess material storage, no stockpiles shall be located closer than 30 m from the watercourse in accordance with OPSS 180 – General Specification for the Management of Excess Material.

All excess materials may be reused or recycled. Materials may also be temporarily stockpiled in preparation for these uses. Management of excess materials outside of the study area, stockpiling and wood management will depend upon local circumstances and will be subject to the requirements of OPSS 180.

Site protection is provided by the imposition of constraints and by mitigation measures suggested to protect water and air quality adapted from existing legislation. The constraint on the management of these materials also involves discussions and written agreements with landowners and may involve consultation with MECP and other authorities. Where an excess material management option cannot meet constraints, another option must be pursued, or the material must be disposed of as waste. Waste generated on-site which requires off-site removal will be in accordance with Ontario Regulation 347 under the Environmental Protection Act, which provides for the transportation and processing of hazardous and non-hazardous waste.

Operational Constraint (Environmental) - Areas used for the Management of Excess Materials shall be included in the Contract Documents.

7.2.1.3 Emergency Spill Response

The Contractor is required have a spill kit available on site in the event of a spill. All spills (i.e. accidental discharges of sediment or other contaminating material) that may have a negative impact on the environment should be reported to the MECP Spills Action Centre (1-800-268-6060).

7.2.1.4 Equipment Use

- All equipment shall be used in accordance with OPSS 182;
- Equipment shall arrive on site in clean condition free of fluid leaks and invasive plant species;
- Equipment shall not enter the watercourse. Equipment shall be operated on dry land in a way that minimizes the disturbance of waterbody banks and riparian vegetation;
- Ensure machinery is not leaking fuels or lubricants;
- When possible, equipment refueling, and maintenance shall take place at least 30 m away from the watercourse. In circumstances where it is not possible, fueling and maintenance shall be carried out in a way that prevents deleterious materials from contaminating soil or the watercourse;
- Develop a spill response plan that is to be implemented immediately in the event of a sediment release or spill of a deleterious substance;
- An emergency spill kit shall be kept on site at all times; and
- Monitoring will occur throughout construction and placement of materials to ensure proper procedures.

8.0 CONSULTATION PROCESS

Consultation is a key component of the Class EA process. Consultation occurs throughout the planning of the project and is carried out in conjunction with environmental protection principles, as well as the documentation and Part II Order principles set out in the Class EA. Consultation early and throughout the Class EA process attempts to meet the growing expectation on the part of the public that they will be consulted regarding decisions made by public decision-making bodies.

As part of the original Class EA study, a Notice of Intent, Notice of Public of Information and Notice of Filling of Document for Review were all circulated to governing agencies, stakeholders and the public to provide an opportunity to comment on the planning and design process.

8.1 External Agency and Public Notification for Addendum

The Carp Creek Embankment Restoration Class EA Addendum followed the consultation process set out in the Conservation Ontario Class Environmental Assessment. The Class EA Addendum involves notifying all potentially affected/interested members of the public, governing agencies and stakeholders. The following notifications will be undertaken for this Class EA Addendum (Appendix G).

8.1.1 Notice of Site Meeting

In advance of revising the Class EA, MVCA and City wanted to meet with directly impact property owners on-site to present the new proposed alternative solution and receive feedback. The Notice of Site Meeting was hand delivered (English and French) to eight property owners directly adjacent to the eroding embankment (South Bank) inviting

them to attend a site meeting on November 26, 2020 at 3:00 pm on the north side of the creek across from the eroded slope, in Hope Cloutier Park.

Of the eight property owners, two residence attended the site meeting.

8.1.2 Notice of Public Information

A Notice of Public Information will be published in the Kanata Voice and Stittsville-Richmond Voice on January 28, 2021, as well as a letter circulated to governing agencies, stakeholders and members of the public that have shown interested in this project.

Public, governing agencies and stakeholders are being given an opportunity to provide input and review the background information and assist with the selection of technically preferred alternative. A preliminary Project Plan Addendum report will be posted on the MVCA website (mvc.on.ca/carp-creek) on January 28, 2021 for viewing, along with a public information presentation which can be viewed at anytime. Comments will be received until February 11, 2021. At that time, the study team will review all comments and respond to any concerns or questions before the Class EA report is completed.

Public Information presentation has been enclosed in n Appendix H.

8.1.3 Notice of Filing of an Addendum for Review

A Notice of Filing of an Addendum for Review will be circulated to governing agencies, stakeholders and members of public who expressed interest in the project. It will inform the public that the Project Plan Addendum Report will be available for a 15-day public review period and will be under review by agencies, ministries and local government. If no concerns are raised by the conclusion of the 15-day review period, a letter will be prepared and submitted to MVCA indicating the successful completion of the Class EA Addendum and identifying that this project is eligible to proceed to detail design phase and implementation.

The Notice will identify the change in the preferred solution and identify where the Addendum Report will be available for public review. Comments from the public, stakeholders and agencies will be solicited in the Notice.

The Notice of Filling of an Addendum will be posted on the MVCA website (mvc.on.ca/carp-creek) following the completion of the Public Information period and finalization of the Project Plan Report.

8.2 Consultation Response

A summary of consultation responses will be provided in Table 8-1 and will be updated as the assignment progresses. Comments received throughout the Addendum process are provided in Appendix I.

Table 8-1: Stakeholder Responses

Contact Type	Concern Raised

Contact Type	Concern Raised

9.0 ENVIRONMENTAL MONITORING

Environmental monitoring is essential to characterize and monitor the quality of the surrounding environment, identify potential negative effects and refine mitigation measures, ensure compliance with environmental regulations, and prevent long-term adverse impacts on the environment.

This section provides an overview of the key environmental monitoring efforts that will be undertaken for the Preferred Alternative. A comprehensive monitoring program will be developed in the detailed design phase for the Carp Creek embankment restoration. This program will be designed to monitor impacts to the environment during the various stages of construction and following construction completion. This will allow for an inclusive assessment of cumulative impacts. The key elements of the comprehensive monitoring program will include, but are not limited to, the following, described below:

- Constructed Works monitoring
- Environmental compliance monitoring

9.1 Constructed Works monitoring

The objective of Constructed Works monitoring is to assess the structural integrity of the construction and their effectiveness with respect to controlling environmental impacts during construction (i.e. erosion and sediment control, etc.).

Construction-phase and post-construction monitoring may include recording of water levels, photographic record of the constructed works, and a review of constructed works by a qualified engineer. Construction-phase monitoring may also include ongoing monitoring of turbidity upstream and downstream of the construction. Post-construction monitoring may also be undertaken to monitor and maintain the proposed restoration including a geomorphological follow site investigation to confirm no negative impacts are occurring upstream and downstream of the restoration.

10.0 REFERENCES

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Glen Cairn Community Carp River Flood Mitigation Phase 2 – Carp River Channel Drawings Issued for Construction, Cumming Cockburn Limited, October 2005.

Carp River Tributary (Eagleson Road to Castlefrank Road) Sediment Loading Impact Assessment (JTB Environmental Systems Inc, 2011-2013)

Carp River in Glen Cairn Bank Failure Assessment Final Interim Report (JFSA, Water Resources and Environmental Systems Inc., 2011)

Carp Creek Embankment Restoration Geotechnical Investigation Report (McIntosh Perry, 2017)

Carp Creek Embankment Restoration Geotechnical Investigation Report (McIntosh Perry, 2020)

Carp Creek Environmental Inventory/Existing Condition Report (McIntosh Perry, 2017)

Carp Creek Environmental Inventory/Existing Condition Report (McIntosh Perry, 2020)

Carp Creek Fluvial Geomorphology Investigations (Water's Edge, 2017 and 2018)

APPENDIX A – SITE PHOTOGRAPHS

Photo 1: Carp Creek study area, watercourse and embankment scour downstream of riffle and pool, facing southwest (downstream)

Photo 2: Study area is highly disturbed, adjacent to watercourse, facing northeast (upstream – south bank)

Photo 3: Eroded embankment, facing southwest

Photo 4: Eroded embankment, facing southwest

Photo 5: Vegetation present on bank opposite from scour site/eroded embankment, facing west

APPENDIX B – CARP CREEK ENVIRONMENTAL INVENTORY/EXISTING CONDITION REPORT (UPDATED OCTOBER 2020)

ENVIRONMENTAL INVENTORY / EXISTING CONDITIONS REPORT

Carp Creek Embankment Restoration

Project No.: CM-17-0429

Prepared for:

Mississippi Valley Conservation Authority
10970 Highway 7
Carleton Place, Ontario
K7C 3P1

Prepared by:

McIntosh Perry Consulting Engineers Ltd.
115 Walgreen Road
R.R. 3 Carp, Ontario
K0A 1L0

McINTOSH PERRY

ENVIRONMENTAL INVENTORY / EXISTING CONDITIONS REPORT
CARP CREEK EMBANKMENT RESTORATION

Prepared for:

Mississippi Valley Conservation Authority
10970 Highway 7
Carleton Place, Ontario
K7C 3P1

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1.0 INTRODUCTION

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) was retained by the Mississippi Valley Conservation Authority (MVCA) for the purpose of conducting a Conservation Ontario *Class Environmental Assessment* (Class EA) for the Carp Creek Erosion Control Project. An area of erosion concern has been identified along a reach of the Carp Creek, within Glen Cairn at Castlefrank Road and Old Colony Road, adjacent to the Hope Cloutier Park and A. Y. Jackson High School, City of Ottawa (**Figure 1**). The key objective of the project is to deliver an innovative detail design for erosion restoration and protection of the Carp Creek, at the location identified on **Figure 1**. This *Environmental Inventory / Existing Conditions Report* has been prepared to summarize environmental information and sensitivities that will be taken into consideration during the detail design for the erosion restoration.

The project is being carried out as a Conservation Ontario Class EA. Documentation will include a summary of existing conditions and noted sensitivities of the study area. The environmental assessment was carried out to determine the existing biological and physical characteristics of the study area, and to identify potential issues/concerns that may arise as a result of the proposed project works.

The following report includes an overview of the existing terrestrial vegetation communities, fish and fish habitat, wildlife communities, including migratory birds and species at risk, and environmentally significant areas found within the project limits.

This *Environmental Inventory / Existing Conditions Report* has been prepared to provide a summary of methodology for collecting data and the existing environmental conditions of the study area. Environmental information used in the production of this report has been assembled from existing natural heritage information, agency correspondence, and field data collected specifically for this project. This report has been updated from the initial 2017 existing conditions to include observations from a 2020 field investigation.

2.0 PROJECT SUMMARY

Working under the Conservation Authorities Act of Ontario (1990), the MVCA follows an integrated watershed management approach to balance human, environmental and economic needs. The MVCA is most concerned with protecting people and property from the dangers of flooding and natural hazards, keeping drinking water sources clean, and fostering the protection of wildlife habitats and significant natural features (i.e., wetland and forested habitat) (MVCA, 2017). Due to various flooding events and severe erosion, the southeast embankment present within the Carp Creek study area has become unstable. Flows are directed around the outside bend of the tributary, causing the toe of slope to erode, which in turn causes the embankment to steepen due to sloughing. If erosion of the embankment is allowed to continue, it will deposit high levels of sediment into the tributary, as well as eventually extend into green space along the Carp Creek, which is situated immediately adjacent to residential properties and recreational facilities (i.e., walking trail and park). Therefore, the key issues associated with the proposed project are that the erosion is impacting the natural environment.

2.1 Study Area

The study area is located along a reach of the Carp Creek where an area of erosion concern has been identified, within Glen Cairn at Castlefrank Road and Old Colony Road, adjacent to the Hope Cloutier Park and A. Y. Jackson High School, City of Ottawa (**Figure 1**). The environmental inventory included the land area within 120 m of the watercourse. The study area is located within the Ministry of Natural Resources and Forestry – Kemptville District.

2.2 Project Design

McIntosh Perry is currently investigating and evaluating all potential opportunities to address and mitigate the existing eroding embankment on the Carp Creek. The final detail design will provide erosion control and restore the embankments, as well as ensuring that proposed measures will not impact the adjacent slope. The final detail design will also be one that is environmentally-friendly and complies with directions provided in the City's draft Official Plan Policy to keep watercourses in a natural state while managing erosion, slope stability and flooding concerns.

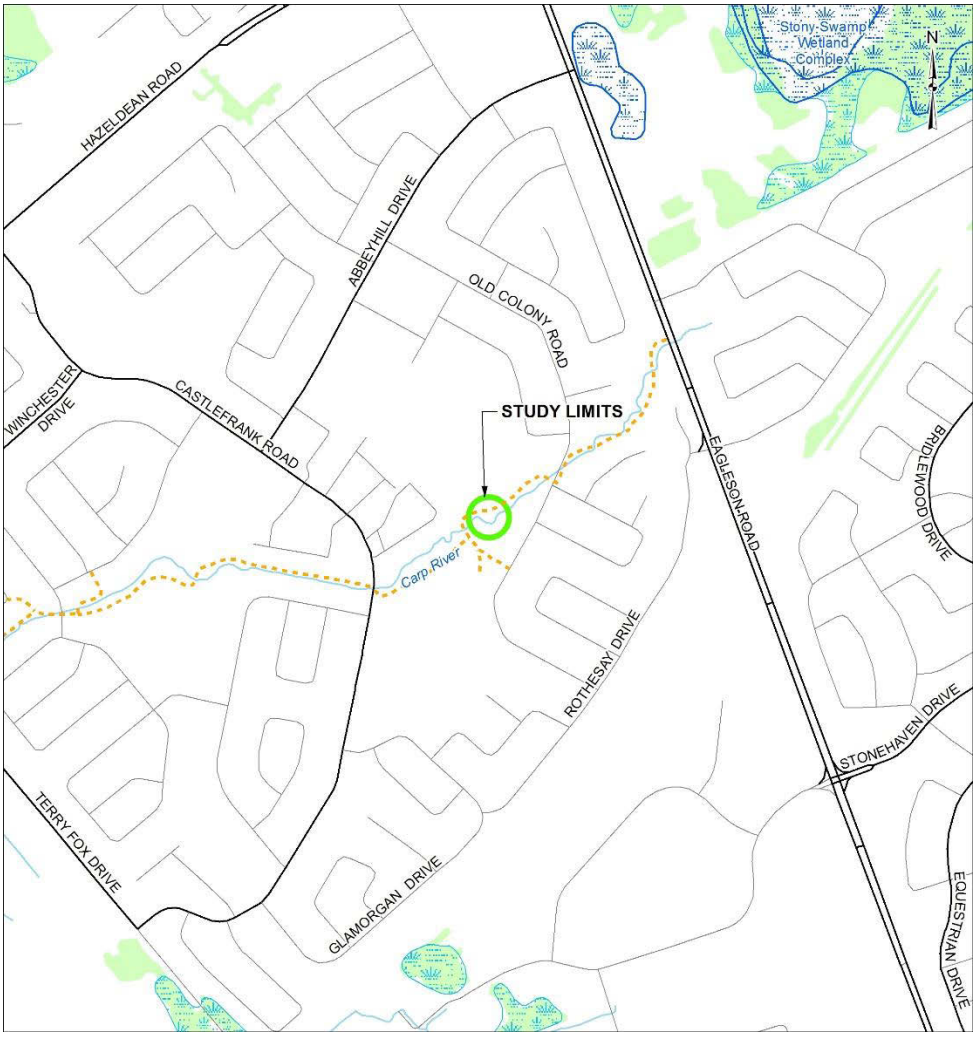

Figure 1: Study Area Key Map

3.0 METHODOLOGY

3.1 Background Data Collection

At project initiation background information related to vegetation, soils, fisheries, wildlife, species at risk (SAR), as well as associated habitat, were obtained from a variety of sources, including:

- Discussions with local District Ministry of Natural Resources and Forestry (MNRF) – Kemptville District;
- The Atlas of the Breeding Birds of Ontario (OBBA) (Bird Studies Canada et al., 2008);
- The Ontario Reptile and Amphibian Atlas (ORAA) (Ontario Nature, 2017);
- The Land Information Ontario (LIO) Metadata Management Tool (LIO, 2017);
- The MNRF Natural Heritage Information Centre (NHIC) database (MNRF, 2017); and,

The background information collected was verified through field investigation observations.

3.2 Field Investigations

Field investigations to collect current information related to fisheries habitat and terrestrial ecosystem conditions within the study area were carried out by McIntosh Perry staff on the following dates:

- September 27, 2017;
- June 24, 2020, and
- June 25, 2020.

The investigations included identification and mapping of the following, where applicable:

- Existing vegetation communities;
- Existing wetland areas;
- Aquatic habitat;
- SAR and their habitat;
- Resident or migrant bird and wildlife species;
- Critical habitat areas, and
- Current land uses surrounding the study area.

Wildlife species noted during the investigations were identified by signs, visual observations, and vocalizations. All wildlife observed within and adjacent to the study area were recorded and considered to be residents or visitors of the area for the purpose of this assessment.

A photographic record of the study area can be found in **Appendix A.**

4.0 EXISTING CONDITIONS

Determining the existing environmental conditions of the study area is required in order to accurately assess the impacts that may be associated with planned improvements to the embankment. The following sections

summarize the existing physical and biological conditions within the study area and surrounding lands (**Photos 1-4**).

4.1 Terrestrial Ecosystems

4.1.1 Vegetation

The study area is located within Ecoregion 5E (Georgian Bay Ecoregion). The Georgian Bay Ecoregion is located in south central Ontario and extends from Lake Superior in the north western portion of the region to the central portion of the Ottawa Creek valley in the east. The ecoregion is dominated by mixed forests, and lakes and Creeks cover over 10% of the ecoregion. Vegetation representative of the Georgian Bay Ecoregion is characterized by a mixture of northern and southern species, such as sugar maple (*Acer saccharum*), eastern hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*) and black spruce (*Picea mariana*) (Crins et al., 2009).

The vegetation community present within the study area was identified as a Fresh – Moist Lowland Deciduous Forest Ecosite. The following vegetation species were observed within the study area: Amur maple (*Acer ginnala*), apple (*Malus* sp.), balsam fir (*Abies balsamea*), black cherry (*Prunus serotina*), black walnut (*Juglans nigra*), bur oak (*Quercus macrocarpa*), common hackberry (*Celtis occidentalis*), green ash (*Fraxinus pennsylvanica*), Jack pine (*Pinus banksiana*), Manitoba maple (*Acer negundo*), Norway maple (*Acer platanoides*), red maple (*Acer rubrum*), red pine (*Pinus resinosa*), silver maple (*Acer saccharinum*), small-leaved linden (*Tilia cordata*), sugar maple (*Acer saccharum*), white elm (*Ulmus americana*), white spruce (*Picea glauca*), white willow (*Salix alba*), alternate-leaved dogwood (*Cornus alternifolia*), common buckthorn (*Rhamnus cathartica*), elderberry (*Sambucus* sp.), hawthorn (*Crataegus* sp.), glossy buckthorn (*Frangula alnus*), gray dogwood (*Cornus racemosa*), high-bush cranberry (*Viburnum trilobum*), mountain-ash (*Sorbus* sp.), red-osier dogwood (*Cornus sericea*), Creekbank grape (*Vitis riparia*), serviceberry (*Amelanchier* sp.), staghorn sumac (*Rhus typhina*), Tatarian honeysuckle (*Lonicera tatarica*), thicket creeper (*Parthenocissus inserta*), wayfaring shrub (*Viburnum lantana*), wild prickly gooseberry (*Ribes cynosbati*), wild red raspberry (*Rubus strigosus*), aster sp. (Asteraceae), bittersweet nightshade (*Solanum dulcamara*), black medick (*Medicago lupulina*), Canada anemone (*Anemone canadensis*), Canada thistle (*Cirsium arvense*), Canadian honewort (*Cryptotaenia canadensis*), cattail (*Typha* sp.), common burdock (*Arctium minus*), common dandelion (*Taraxacum officinale*), common gromwell (*Lithospermum officinale*), common plantain (*Plantago major*), common water-plantain (*Alisma plantago-aquatica*), common yarrow (*Achillea millefolium*), coneflower (*Rudbeckia* sp.) cow vetch (*Vicia cracca*), curled dock (*Rumex crispus*), currant (*Ribes* sp.), dotted loosestrife (*Lysimachia punctata*), hay-scented fern (*Dennstaedtia punctilobula*), hedge bindweed (*Calystegia sepium*), garlic mustard (*Alliaria petiolata*), goldenrod (*Solidago* sp.), grass sp. (Poaceae), ground-ivy (*Clechoma hederacea*), Himalayan balsam (*Impatiens glandulifera*), Japanese knotweed (*Reynoutria japonica*), lemon balm (*Melissa officinalis*), milkweed (*Asclepias* sp.), motherwort (*Leonurus cardiaca*), orange hawkweed (*Pilosella aurantiaca*), Philadelphia fleabane (*Erigeron philadelphicus*), purple loosestrife (*Lythrum salicaria*), red clover (*Trifolium pratense*), reed canary grass (*Phalaris arundinacea*), spotted jewelweed (*Impatiens capensis*), spotted Joe-Pyeweed (*Eutrochium maculatum*), spotted water-hemlock (*Cicuta maculata*), stinging nettle (*Urtica dioica*), tall buttercup (*Ranunculus acris*), violets (*Viola* spp.), white avens (*Geum canadense*), white clover (*Trifolium repens*), wild parsnip (*Pastinaca sativa*), wild strawberry (*Fragaria virginiana*), wood avens (*Geum urbanum*),

and wood nettle (*Laportea canadensis*). A high concentration of non-native and invasive species was observed within the study area (e.g. Himalayan balsam, common buckthorn, garlic mustard, wild parsnip, etc.). The presence of such species is indicative of the highly disturbed nature of the study area. Japanese knotweed was identified within the study area in 2017 and again in 2019 by City of Ottawa staff along the north bank in the east end of the study area, however, it was not observed during the 2020 field investigation. Non-native and invasive species of plants are widespread throughout the study area and removal or control is likely to result in high disturbance of the entire study area. No rare or uncommon vegetation or vegetative communities were identified within the study area, during the field investigations.

4.1.2 Wetland Habitat

Background information indicated there was no wetland habitat present within 120 m of the study area. This was confirmed during the 2017 and 2020 field investigations.

4.1.3 Wildlife

Characteristic wildlife found in the Georgian Bay Ecoregion include: fisher (*Martes pennanti*), black bear (*Ursus americanus*), moose (*Alces alces*), beaver (*Castor canadensis*) Creek otter (*Lontra canadensis*) white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*) and striped skunk (*Mephitis mephitis*). Common bird species found within the ecoregion include: Common Loon (*Gavia immer*), Ruffed Grouse (*Bonasa umbellus*) and Common Raven (*Corvus corax*) (Crins et al., 2009).

The following species of wildlife were observed within the study area during the 2017 and 2020 field investigations: American Crow (*Corvus brachyrhynchos*), American Goldfinch (*Spinus tristis*), American Robin (*Turdus migratorius*), Black-capped Chickadee (*Poecile atricapillus*), Blue Jay (*Cyanocitta cristata*), Chipping Sparrow (*Spizella passerina*), Common Grackle (*Quiscalus quiscula*), Eastern Kingbird (*Tyrannus tyrannus*), Eastern Phoebe (*Sayornis phoebe*), Hairy Woodpecker (*Leuconotopicus villosus*), Northern Cardinal (*Cardinalis cardinalis*), Red-breasted Nuthatch (*Sitta canadensis*), Red-eyed Vireo (*Vireo olivaceus*), Ring-billed Gull (*Larus delawarensis*), Song Sparrow (*Melospiza melodia*), White-breasted Nuthatch (*Sitta carolinensis*), Green Frog (*Lithobates clamitans*), American red squirrel (*Tamiasciurus hudsonicus*), eastern chipmunk (*Tamias striatus*), eastern gray squirrel (*Sciurus carolinensis*), and raccoon (*Procyon lotor*). The forested habitat within the study area would provide habitat for breeding migratory birds.

4.2 Fish and Fish Habitat

The Carp Creek is known to have a warm water thermal regime with the following species of fish present: Brown Bullhead (*Ameiurus nebulosus*), Northern Pike (*Esox lucius*), Pumpkinseed (*Lepomis gibbosus*), White Sucker (*Catostomus commersonii*), and Yellow Perch (*Perca flavescens*). Although a fish survey was not conducted during the 2017 and 2020 field investigations, multiple unidentified species of minnows (Cyprinidae spp.) were observed to be present within the pool portion of the watercourse within the study area.

During the field investigations, the section of the Carp Creek included in the study area was an average depth of 15 to 30 cm with substrate consisting of clay, sand, gravel and cobble which create riffle/pool/run sequences. The average wetted witch throughout the study area was approximately 2 m during the 2020 field investigation. The watercourse meanders through the study area creating steep, eroded banks at two (2)

bends. The banks opposite of the thalweg at these bends are low, flat, and vegetated which are most likely seasonally flooded.

4.3 Species at Risk

During the 2017 and 2020 field investigations, no SAR were observed within the study area. However, given background information and the habitat observed to be present during the field investigation, there is the potential for species at risk turtles [i.e. Blanding's Turtle (*Emydoidea blandingii*), threatened; Eastern Musk Turtle (*Sternotherus odoratus*), special concern; and Common Snapping Turtle (*Chelydra serpentina*), special concern], to utilize the watercourse as a travel corridor. In addition, the forested habitat adjacent to the watercourse could be utilized by Canada Warbler (*Cardellina canadensis*), special concern; Eastern Wood-pewee (*Contopus virens*), special concern; and Red-headed Woodpecker (*Melanerpes erythrocephalus*), special concern; for breeding and nesting purposes.

4.4 Surface Water

Surface water within the study area is a tributary of the Carp Creek. Depths within the study area were an average of 15 to 30 cm.

4.5 Physiography and Soils

Within the Georgian Bay Ecoregion Precambrian bedrock is frequently exposed, creating a rugged landscape, characteristic of the region. Where bedrock is not exposed, ground moraine (till) of variable depth dominates the landscape. Soils present within the study area of North Gower soils, comprised of silt loam, loam, silty clay loam or clay loam, with imperfect drainage (Schut et al., 1987).

5.0 REFERENCES

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APPENDIX A – STUDY AREA PHOTOGRAPHS

Photo 1: Carp Creek study area, watercourse and embankment scour downstream of riffle and pool, facing southwest (downstream) (considered the east bend). 27 September 2017.

Photo 2: Study area is highly disturbed, adjacent to watercourse, facing northeast (upstream – south bank). 27 September 2017.

Photo 3: Eroded embankment at east bend, facing southwest. 27 September 2017.

Photo 4: Vegetation present on bank opposite from scour site/eroded embankment, facing west. 27 September 2017.

Photo 5: Eroded embankment at west bend, facing north. 24 June 2020.

APPENDIX C – CARP CREEK GEOTECHNICAL REPORT (UPDATED OCTOBER 2020)

CARP CREEK - GEOTECHNICAL INVESTIGATION AND SLOPE SAFETY ANALYSIS

Project No.: 0CM-17-0429-02

Prepared for:

Mississippi Valley Conservation Authority
10970 Hwy. 7
Carleton Place, ON
K7C 3P1

Prepared by:

McIntosh Perry
104-215 Menten Place
Ottawa, ON K2H 9C1

October 2020

McINTOSH PERRY

TABLE OF CONTENTS

APPENDICES

GEOTECHNICAL INVESTIGATION and
ENGINEERING RECOMMENDATION REPORT
Carp Creek, Ottawa, Ontario

1.0 INTRODUCTION

This report presents the factual findings obtained from a geotechnical investigation performed near the eroded stream bank of the Carp Creek at the Castlefrank Road and Old Colony Road adjacent to the Hope Cloutier Park and A. Y. Jackson High School. The fieldwork was carried out on July 02, 2020, and comprised of two boreholes advanced to a maximum depth of 7.0 m below the existing ground surface. Previously two boreholes were drilled at the toe of the slope (at the creek level) in October 2017.

The purpose of the investigation was to explore the subsurface conditions at this site and to provide borehole location plans, records of borehole logs, description of subsurface conditions, to evaluate the stability of Carp Creekbank at various slope angles, and to provide engineering recommendations for slope corrections, and erosion protection.

McIntosh Perry Consulting Engineers Ltd (McIntosh Perry) carried out the investigation at the request of the Mississippi Valley Conservation Authority.

2.0 SITE DESCRIPTION

2.1 Existing Site Conditions

The creek bank at the above-noted location was excessively eroded (south bank), which has produced approximately 3.3 m of close to vertical cut through the existing topsoil and clay. The clay at the exposed surface was observed to be weathered above the creek level. The eroded area is located at a sharp creek meander, and the slope walls can be exposed to excessive erosion forces at the time of high flood level and high velocity.

The top of the slope is vegetated with mature trees. A few trees were observed fallen into the creek once undermined by erosion.

The opposite bank (north bank) is relatively lower than the south bank with a gentle slope and is expected to be overtopped at its toe at flooding events.

2.2 Site Geology

Based on published physiography maps of the area (Ontario Geological Survey) the site is located within the Ottawa Valley Clay Plains. Surficial geology maps of southern Ontario identify the site on glaciomarine fine-grain deposits of silt and clay.

The Ottawa Valley between Pembroke and Hawkesbury, Ontario, consists of clay plains interrupted by ridges of rock or sand. It is naturally divided into two parts, above and below Ottawa, Ontario. Within the valley, the bedrock is further faulted so that some of the uplifted blocks appear above the clay beds. The sediments themselves in the valley are deep silty clay. Although the clay deposits are grey in color like the limestones that underlie them in part, they are only mildly calcareous and likely derived from the more acidic rock of the Canadian Shield.

3.0 FIELD PROCEDURES

The staff of McIntosh Perry visited the site before the drilling investigation to mark out the proposed borehole locations. Utility clearance was carried out by USL-1 Scanning on behalf of McIntosh Perry. Public and private utility authorities were informed, and all utility clearance documents were obtained before the commencement of drilling work. The equipment used for drilling was owned and operated by CCC Geotechnical & Environmental Drilling Ltd. of Ottawa, Ontario. Boreholes were advanced using CME 850 track mounted drill.

Field investigation included drilling two boreholes on July 02, 2020. Boreholes were advanced to a maximum depth of 7.0 m below the existing ground level (El. 104.0 m) using hollow stem augers. Soil samples were obtained at 0.75 m intervals using a 51 mm outside diameter split spoon sampler in accordance with the ASTM D1586 Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils procedure. SPT testing alternated with in-situ measurement of the undrained shear strength of cohesive soils using the filed vane as per ASTM D2573. A monitoring well was installed in borehole BH20-2, and its assembly is shown on the borehole log. Boreholes were backfilled with auger cuttings. The borehole locations are shown in Figure 2, included in Appendix B.

ASTM D1586 – Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D2573 – Field Vane Shear Test in Saturated Fine-Grained Soils

Field investigation, including drilling and sampling, were supervised on a full-time basis by McIntosh Perry technical staff. All boreholes were logged during the drilling progress. All samples were labeled by waterproof paper one by one as they were retrieved. All soil samples were preserved in double plastic bags to mitigate the risk of moisture loss during transportation to the geotechnical laboratory.

Previous site investigation carried in October 2017 consisted of two boreholes drilled at the toe of the slope. Both boreholes were laid out at the toe of the erosion, close to the water level at the time of investigation, and approximately 20 m apart. Boreholes were advanced to a maximum depth of 3.7 m below the ground surface. Boreholes were drilled with continuous sampling and in-situ testing. Soil samples were obtained using a 50 mm outside diameter split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. In-situ shear tests were performed using MTO N-Size vane. Both boreholes were backfilled with bentonite. Borehole locations are shown in Figure 2, included in Appendix B.

4.0 IDENTIFICATION AND TEST PROCEDURES

All samples were logged as retrieved, and visual description and soil type identification were added to the logs. Subsequently, soil descriptions were confirmed by additional tactile examination of the soils in the laboratory. Laboratory testing on representative SPT samples was performed at McIntosh Perry geotechnical lab and included moisture content, grain-size distribution, and Atterberg Limit tests. The laboratory tests to determine index properties were performed in accordance with the American Society for Testing Materials (ASTM) test procedures.

Test procedures are listed below;

ASTM C117 (LS-601) –Materials Finer than 75 µm (No. 200) Sieve by Washing
ASTM C136 (LS-602) – Sieve Analysis of Fine and Coarse Aggregates
LS-702 – Determination of Particle Size Analysis of Soils
ASTM D2216 – Laboratory Determination of Water Content of Soil and Rock by Mass
ASTM D4318 (LS-703/704) – Liquid Limit, Plastic Limit, and Plasticity Index of Soils

The rest of the soil samples recovered will be stored in McIntosh Perry storage facility for a period of one month after submission of the final report. Samples will be disposed of after this time unless otherwise requested in writing by the Client.

5.0 SUBSURFACE CONDITIONS

In general, the site stratigraphy consists of topsoil, clay/silty clay layer, followed by a till layer, which extends to the maximum depth of investigation in both boreholes. It was also observed that there is an alluvial deposit (a mix of variable portions of gravel, sand, silt, and clay) of variable thickness that is intervene the clay/silty clay layer. For classification purposes, the soils encountered at this site can be divided into four zones.

a) Topsoil
b) Clay/Silty Clay
c) Sand/Clayey and Silty Sand (Alluvial deposit)
d) Till

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets included in Appendix C. Description of the strata encountered are given below.

5.1.1 Topsoil

The creek banks on both sides were not eroded, are vegetated and therefore covered with topsoil. The topsoil thickness was observed on average 0.6 m.

5.1.2 Clay/Silty Clay

Clay/silty clay deposit was encountered in both boreholes. The clay/silty clay deposit extended to the depth of 5.9 m in borehole BH20-1 and 6.5 m in borehole BH20-2. The clay/silty clay was observed to be desiccated above the groundwater table and very soft below the water table. Two plasticity tests were completed on clay samples which indicated liquid limit of 41 and 42 and plastic limit of 18 and 23 and it is classified as clay of low plasticity (Lean Clay). Water content of clay ranged between 52% and 59%. In-situ shear strength of the clay ranged between 71 kPa and 112 kPa the sensitivity was between 3 and 9. Based on the undrained shear strength measurements, the clay is classified as low sensitive stiff clay. The clay layer is interbedded by coarser alluvial or river deposit approximately between levels 102.5 m and 101.3 m.

5.1.3 Sand/Clayey and Silty Sand (Alluvial Deposit)

Alluvial deposit constituted of a mix of variable portions of gravel, sand, silt and clay, which could be flood plain deposit, was encountered in both boreholes. The depth of the alluvial deposit in BH20-1 ranges between 1.5 m to 2.1 m (El. 102.5 m to 101.9 m) and in BH20-2 between 1.7 m to 3.0 m (El. 102.6 m to 101.3 m). The deposit was observed to be brown, moist, and loose to compact. SPT 'N' values ranged between 5 and 11 within the alluvial layer. Two samples were subject to gradation which indicated the existence of approximately 1% Gravel, 72 to 38% Sand, 12 to 33% Silt and 12 to 29% clay size particles. Gradation test result of the alluvial deposit is shown in Table 5-1.

Table 5-1: Gradation Test Results - Sand/Clayey and Silty Sand

Borehole	Sample	Percentage of Soil Constituents			
		Gravel	Sand	Silt	Clay
BH20-1	SS-03	0	38	33	29
BH20-2	SS-04	1	75	12	12

5.1.4 Till

The till encountered immediately below clay in both boreholes at 5.9 m and 6.5 m in boreholes BH20-1 and BH20-2, respectively. The till is a mix of variable portions of gravel, sand, silt and clay which is the predominant grain size particles. In-situ shear strength of the till ranged between 112 kPa and 127 kPa, the sensitivity was between 5 and 7 within the till layer.

Boreholes BH20-1 and BH20-2 were extended within the till layer to 7.0 m and 6.7 m.

5.2 Groundwater

A monitoring well was installed in borehole BH20-2 on July 2, 2020, and its assembly is shown on the borehole log. The groundwater table was monitored on July 8, 2020, which was a relatively very hot and dry season time. The groundwater depth was also measured in open BH20-1. Groundwater level may be expected to fluctuate due to seasonal changes. The measured levels in both boreholes are presented in Table 5-2.

Table 5-2 Groundwater Depth and Elevation

Borehole	Observation Method	Monitoring Date	Surface El. (m)	Groundwater Depth (m)	Water Table El. (m)
BH20-1	Open borehole	2020-07-02	104.0	3.5	100.5
BH20-2	Monitoring well	2020-07-08	104.3	4.3	100.0

5.3 Seismic Performance for Seismic Site Response

Selected spectral responses in the general vicinity of the site for 2% chance of exceedance in 50 years (2500 years return period) are as indicated in Table 5-3, shown below and in Appendix E;

Table 5-3: Selected Seismic Spectral Responses (2% in 50 Yrs) – NRCan 2010

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.621	0.300	0.134	0.045	0.317

6.0 SLOPE STABILITY ANALYSIS

Computer analysis was completed using SoilVision's limit equilibrium software, SVSlope and finite element software, SVFlux GT. The model was developed based on existing site topography as well as the subsurface information which was obtained from the geotechnical field investigation.

Since typical site investigation can explore only 1% of the subsurface conditions, there is always uncertainty associated with predicting the soil mechanical properties, including shear strength parameters, hydraulic conductivity and the extent of different soil strata. Therefore, the slope stability analyses were performed with conservative soil mechanical parameters to accommodate the associated uncertainty.

The soil profile consists of a deep silty clay soil layer that is topped by approximately 0.6 m of topsoil. The silty clay layer is desiccated and stiff above the groundwater level and soft below the groundwater level. The soil profile and soil stratigraphy were presented earlier and described in the appendix. The topsoil has no significant mechanical influence on the slop stability. The alluvial deposit was assumed to be diminished before reaching the existing slope face. This assumption was made based on the field observations and change of the alluvial deposit thickness between BH20-1 and 20-2. The till layer was assumed to extend well below the excavation depth. The mechanical properties of the silty clay, alluvial, and till layers were derived from in-situ standard penetration test (SPT) and vane shear tests. The groundwater information was obtained from the installed well in BH20-2 and from groundwater measurement in open BH20-1. It was assumed that the groundwater level suppressed gradually to the level of water in the creek.

SVSlope-SVFlux coupled analysis was performed considering Long-term and short-term (seismic loading) slope stability. The soil mechanical parameters, effective cohesion and effective angle of internal friction, for long-

term stability analysis were estimated from vane shear test results following McEniry (1978) recommendations. The undrained shear strength parameters were derived from vane shear test in both boreholes. The soil mechanical parameters are presented in Table 5-4. The required information for the seismic spectral responses in the general vicinity of the site was obtained from Natural Resources Canada website – Seismic Hazard Calculator. Selected values are listed in Table 5-3 and Appendix D.

Table 5-4: Soil and Engineered Material Properties

Borehole	Silty Clay	Alluvial (Sand)	Till
Effective Internal Friction Angle, ϕ'	18°	28°	25°
Effective Cohesion, c'(kPa)	8	1	10
Average undrained Cohesion, c_u (kPa)	65	-	100
Unit Weight, Υ (kN/m^3)	17.5	18.5	18.0

The purpose of the analysis was to evaluate the current slope condition, to provide suitable backslope gradient and to estimate the factor of safety (FOS) against failure. Three backslope gradient ratios were considered; 2H:1V, 2.5H:1V and 3H:1V. Since the silty clay layer above the groundwater level is desiccated, tension cracks are very likely and therefore, they were considered in the slope stability analysis. Discussion on the slope stability analysis will be introduced in the following sections.

7.0 DISCUSSIONS AND RECOMMENDATIONS

7.1 General

This section of the report provides recommendations for the minimum backslope gradient and design of an erosion protection. The recommendations are based on interpretation of the factual information obtained from the boreholes advanced during the subsurface investigation and the numerical slope stability analyses. The discussions and recommendations presented are intended to provide sufficient information to the designer of the embankment restoration and potential creek realignment to select the suitable type of solution.

The comments made on the construction are intended to highlight aspects which could have impact or affect the detailed design of the embankment restoration, for which special provisions may be required in the Contract Documents. Those who require information on construction aspects should make their own interpretation of the factual data presented in the report. Interpretation of the data presented may affect equipment selection, proposed construction methods, and scheduling of construction activities.

7.2 Slope Stability

Slope stability analysis for Long-term condition under sustained loads and short-term condition under seismic loading were performed using SoilVision's limit equilibrium software, SVSlope, and finite element software, SVFlux GT coupled analysis.

Several slip surfaces were anticipated. The minimum estimated FOS against slope failure for long term stability at the current slope condition is approximately (1.1) which does not meet the minimum requirement criteria as outlined in the City of Ottawa slope stability guidelines for development applications (2012). The guidelines suggest a minimum factor of safety for slopes within residential areas should be: i) FOS ≥ 1.5 for long-term stability, and ii) FOS ≥ 1.1 for earthquake load. Also, the current embankment slope angle which is close to vertical, cannot support installation of erosion protection.

Based on slope stability analyses, the minimum values of FOS for long- and short-term analyses for the suggested slope cuts, 2H:1V, 2.5H:1V and 3H:1V are presented in Table 6-1. The estimated FOS values meet or exceed the recommended FOS by the City of Ottawa's guidelines for long-term and short-term slope stability for the slope cut 2.5H:1V. The low value of FOS for the slope cut of 3H:1V is possibly attributed to local sand liquefaction.

Many parameters affect the slope stability analysis under dynamic loading, including slope gradient, seismic load intensity, soil type, and constitutive model. It is reasonable to expect higher FOS for flatter slope (i.e. FOS for 2H:1V < 2.5H:1V < 3H:1V). Such a scenario is true for a homogeneous soil profile.

However, the soil profile at Carp Creek constituted of three soil layers, clay, sand and till. The sand layer was observed to become thinner in BH20-2 or as moving towards the Creek. The 2.5H:1V and 3H:1V backslope cuts at some point intersect with this layer. Under certain circumstances, sand is known to exhibit liquefaction behavior.

Soil liquefaction occurs when the soil subjects to dynamic or seismic loading. The pore water pressure increases significantly bringing the effective stress to zero. At this stage, the soil loses its shear strength and becomes unable to support any load. The liquefaction process depends on seismic load intensity, soil type and degree of saturation. For soils of low fine-grain percentage such as coarse-grained uniform sand, and high water content (saturated), liquefaction is likely. For fine-grained soils such as clay and silt, significant seismic loading intensity is required to trigger liquefaction.

The FOS values for the short-term analysis for the 2.5H:1V and 3H:1V backslope cuts are for local slip failures that run through the sand layer. The global FOS for 2.5H:1V = 3.3 which is higher than 2H:1V = 3.1. Same thing for the flatter slope 3H:1V.

Therefore, we recommend using slope cut of 2.5H:1V as a backslope for the Carp Creek south bank. Having said that, erosion protection measurements will be required to protect the toe of the slope. Results of the analyses are presented in Appendix F.

Table 6-1: Minimum Values of Factor of Safety for the Suggested Slope Cuts

Analysis	Slope Cuts		
	2H:1V	2.5H:1V	3H:1V
Global FOS for Long-term Analysis	1.4	1.6	1.8
Global FOS for Short-term Analysis	3.1	3.3	3.6
Local FOS for Short-term Analysis	--	2.4	0.3

7.3 Design Approach for Erosion Protection

The existing slope shall be cut back to 2.5H:1V slope. The toe of the slope needs to be protected by riprap. Riprap shall be designed by an environmental engineer based on the maximum current velocity. The riprap shall be separated from the clay bank by a layer of non-woven geotextile. Proper selection of riprap size should be considered to mitigate risk of geotextile exposure. The riprap shall be extended on the riverbed to mitigate the scour. Also, to extend on the slope a minimum of 1 m above the maximum flood level.

If there are ecological concerns about riprap installations, other environmentally appealing options can be selected by the designers. With a 2.5H:1V slope cut, a retaining mechanism is not expected from the erosion protection system.

Above the, riprap, the surface of the cut shall be protected with Terrafirm slope stabilization system (or an equivalent product). This system will provide an anchored mesh supporting a vegetation mat over the slope. Using this anchored mesh is necessary due to the presence of the sandy alluvial layer, which is prone to erosion more than other layers.

7.4 Construction Considerations

The slope shall be protected as soon as possible upon excavation against any surface water run-off.

Authors of this report shall be informed if subsurface conditions encountered during construction differ from those presented in this report.

8.0 CLOSURE

We trust this geotechnical investigation and design recommendation report meets the requirements of your project. The "Limitations of Report" presented in Appendix A are an integral part of this report. Please contact the undersigned should you have any questions or concerns.

McIntosh Perry Consulting Engineers Ltd.

Mohammed Al-Khazaali, Ph.D., P.Eng.
Geotechnical Engineer

N'eem Tavakkoli, M.Eng., P.Eng.
Senior Geotechnical Engineer

REFERENCES

1) ASTM D1586, “Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils," 2018.

2) ASTM D2573-01, “Standard Test Method for Field Vane Shear Test in Cohesive Soil," 2002.

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14) The City of Ottawa, “Slope Stability Guidelines for Development Applications in the City of Ottawa” (online), 2012, Original by Golder Associates, 2004.

SLOPE STABILITY OF CARP RIVER, OTTAWA, ONTARIO

APPENDIX A
LIMITATIONS OF REPORT

McINTOSH PERRY

LIMITATIONS OF REPORT

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) carried out the field work and prepared the report. This document is an integral part of the Foundation Investigation and Design report presented.

The conclusions and recommendations provided in this report are based on the information obtained at the borehole locations where the tests were conducted. Subsurface and groundwater conditions between and beyond the boreholes may differ from those encountered at the specific locations where tests were conducted and conditions may become apparent during construction, which were not detected and could not be anticipated at the time of the site investigation. The benchmark level used and borehole elevations presented in this report are primarily to establish relative differenced in elevations between the borehole locations and should not be used for other purposes such as to establish elevations for grading, depth of excavations or for planning construction.

The recommendations presented in this report for design are applicable only to the intended structure and the project described in the scope of the work, and if constructed in accordance with the details outlined in the report. Unless otherwise noted, the information contained in this report does not reflect on any environmental aspects of either the site or the subsurface conditions.

The comments or recommendation provided in this report on potential construction problems and possible construction methods are intended only to guide the designer. The number of boreholes advanced at this site may not be sufficient or adequate to reveal all the subsurface information or factors that may affect the method and cost of construction. The contractors who are undertaking the construction shall make their own interpretation of the factual data presented in this report and make their conclusions, as to how the subsurface conditions of the site may affect their construction work.

The boundaries between soil strata presented in the report are based on information obtained at the borehole locations. The boundaries of the soil strata between borehole locations are assumed from geological evidences. If differing site conditions are encountered, or if the Client becomes aware of any additional information that differs from or is relevant to the McIntosh Perry findings, the Client agrees to immediately advise McIntosh Perry so that the conclusions presented in this report may be re-evaluated.

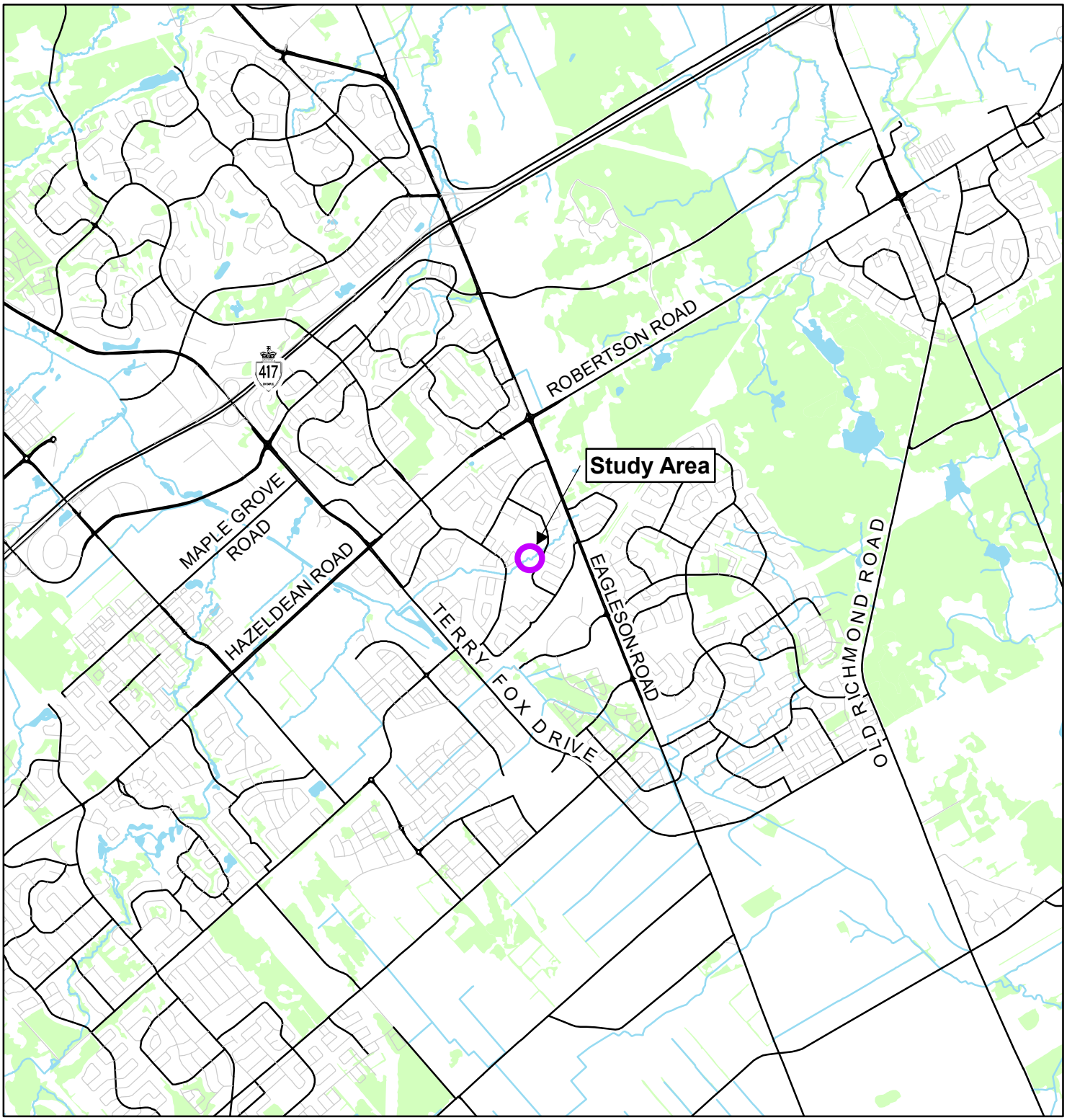
Under no circumstances shall the liability of McIntosh Perry for any claim in contract or in tort, related to the services provided and/or the content and recommendations in this report, exceed the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify McIntosh Perry. Such errors and omissions policies are available for inspection by the Client at all times upon request, and if the Client desires to obtain further insurance to protect it against any risks beyond the coverage provided by such policies, McIntosh Perry will co-operate with the Client to obtain such insurance.

McIntosh Perry prepared this report for the exclusive use of the Client. Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibility of such third parties. McIntosh Perry accepts no responsibility and will not be liable for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

SLOPE STABILITY OF CARP RIVER, OTTAWA, ONTARIO

APPENDIX B
FIGURES

McINTOSH PERRY



LEGEND

- Study Area
- Local Road
- Major Road

0 30 60 120

Scale 1:2,500 Metres

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2020.

CLIENT: MISSISSIPPI VALLEY CONSERVATION AUTHORITY

PROJECT: CARP CREEK RESTORATION

TITLE: SITE LOCATION

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

PROJECT NO:CM-17-0429-02		FIGURE:
Date	Jul., 24, 2020	1
GIS	LC	
Checked By	AL	

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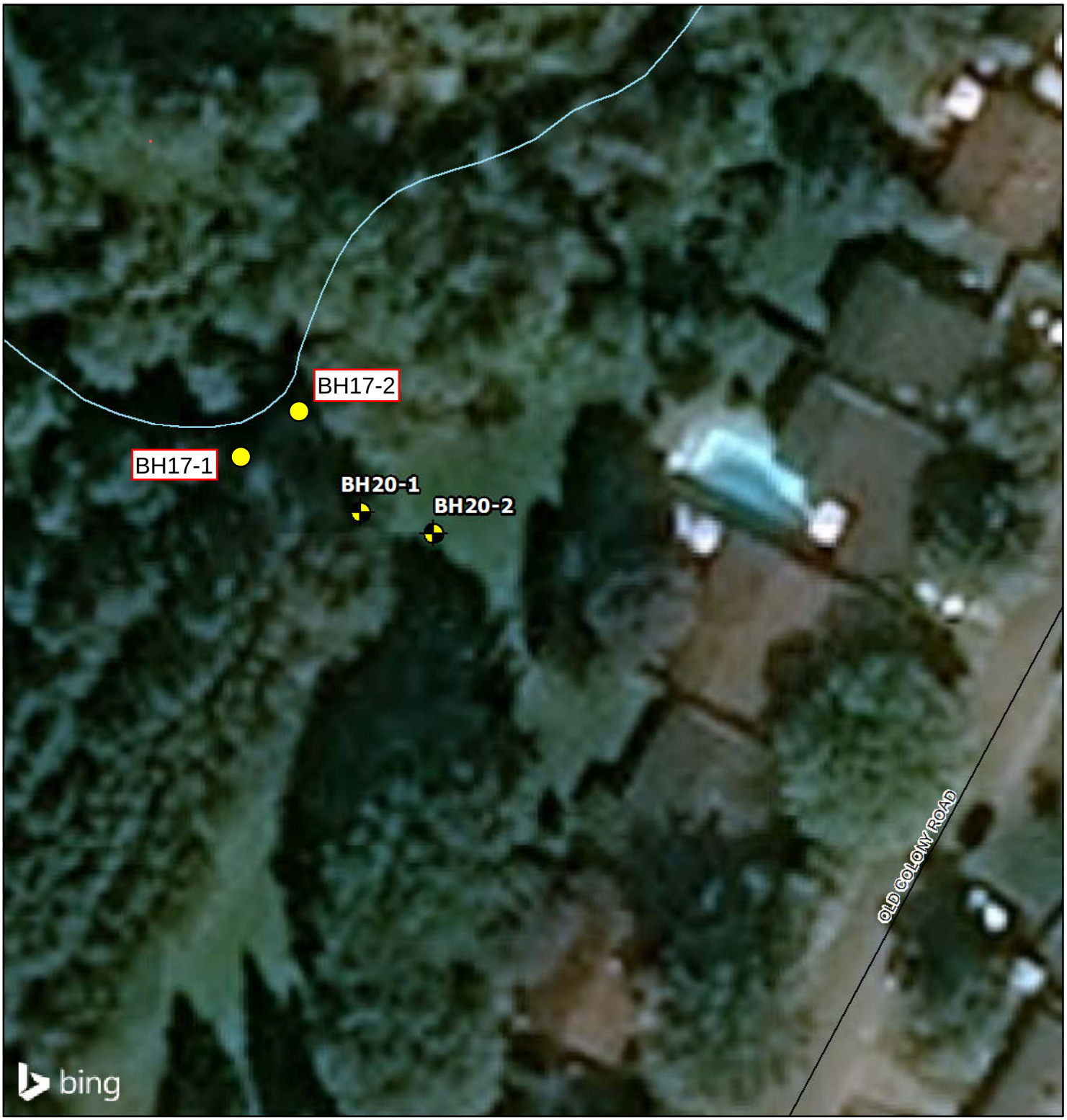

0 30 60 120

Scale 1:2,500 Metres

LEGEND

- Borehole Location drilled in July 2020
- Borehole Location drilled in October 2017

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2020.

CLIENT:	MISSISSIPPI VALLEY CONSERVATION AUTHORITY
PROJECT:	CARP CREEK RESTORATION
TITLE:	BOREHOLE LOCATIONS

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

PROJECT NO:	CM-17-0429-02
Date	Jul., 27, 2020
GIS	LC
Checked By	AL

FIGURE: 2

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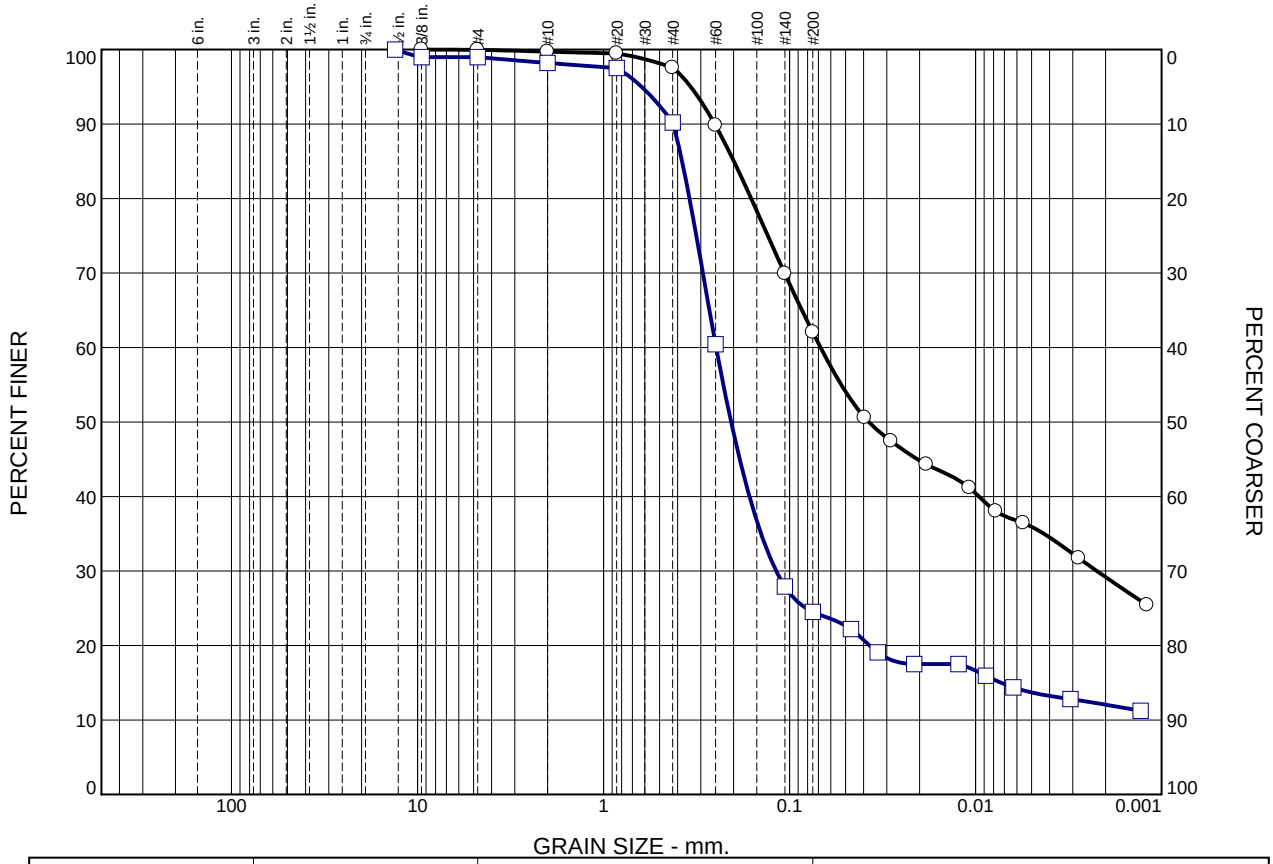
Particle Size Distribution Report



	% +75mm	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.1	0.2	2.1	35.6	32.8	29.2
□	0.0	0.0	1.0	0.8	8.0	65.7	12.4	12.1

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Carp Creek	BH2001SS03	5.0-7.0'	Clayey Silty Sand	
□	Carp Creek	BH2002SS04	7.5-9.5'	Sand some Silt some Clay trace Gravel	

McINTOSH PERRY

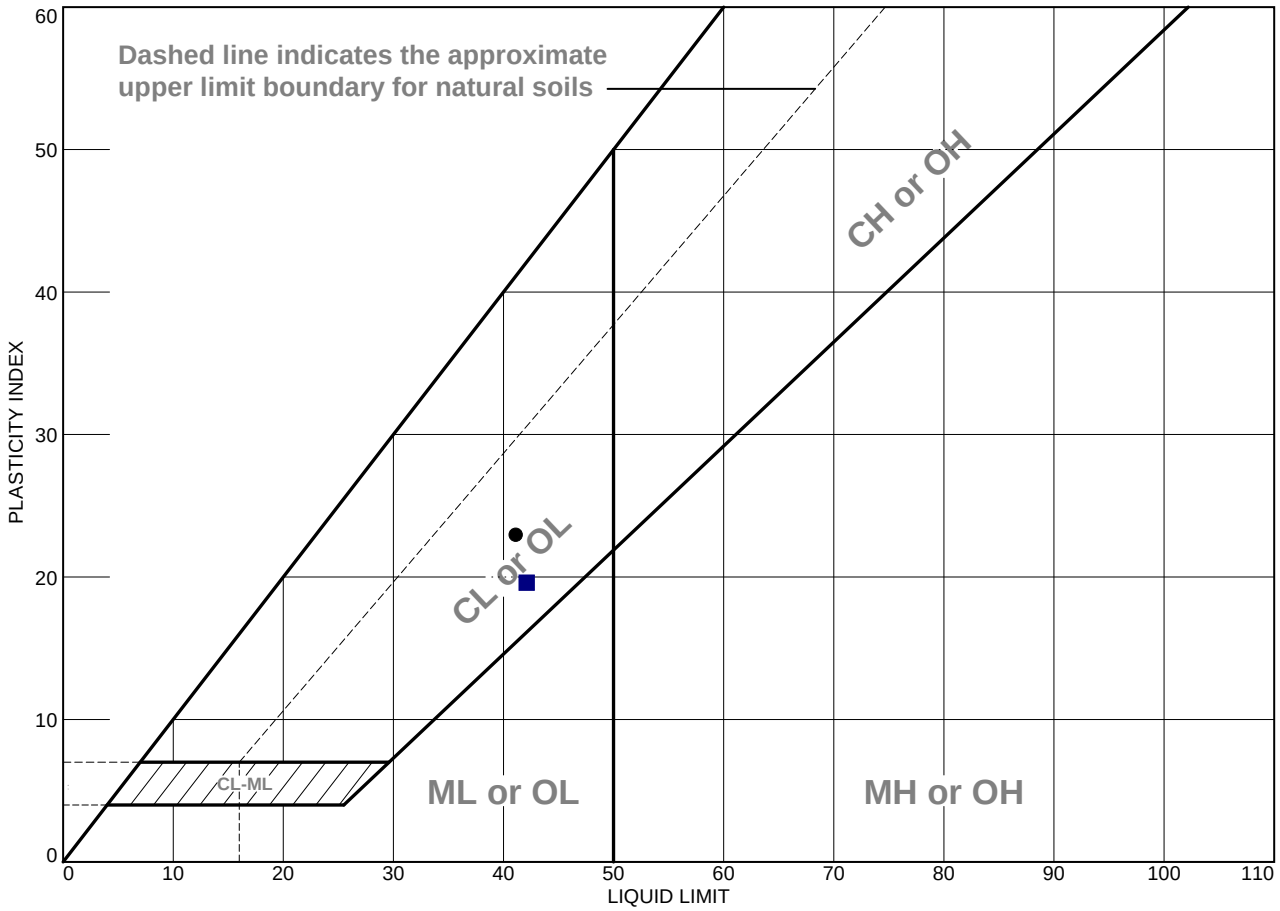
Client: City of Ottawa

Project: Geotech Investigation - Carp Creek Embankment Restoration

Project No.: CM17-0429-02 **Figure** 3

Checked By: H.Smith

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Clay Low Plasticity	41.2	18.3	22.9			
■	Clay Low Plasticity	42.1	22.5	19.6			

Project No. CM17-0429- **Client:** City of Ottawa

Project: Geotech Investigation - Carp Creek Embankment Restoration

●**Location:** BH20-01 SS05 **Depth:** 12.5-14.5' **Sample Number:** BH2010SS05

■**Location:** BH20-02 SS05 **Depth:** 10.0-12.0' **Sample Number:** BH2002SS05

Remarks:

McINTOSH PERRY

Figure 4

Checked By: H.Smtih

SLOPE STABILITY OF CARP RIVER, OTTAWA, ONTARIO

APPENDIX C
BOREHOLE LOGS

McINTOSH PERRY

EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

C_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSION AND STRUCUTRAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINT AND BEDDING:

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ε	%	LINEAR STRAIN
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICALL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
c_c	1	COMPRESSION INDEX
c_s	1	SWELLING INDEX
c_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
Φ'	$^{-o}$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
Φ_u	$^{-o}$	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1,%	VOID RATIO	e_{min}	1,%	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1,%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1,%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT – DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_P	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_P	%	PLASTICITY INDEX = $(W_L - W_L)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(W - W_P)/ I_P$	i	1	HYDAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $(W_L - W) / 1_P$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERED SOIL	$e_{,max}$	1,%	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

McINTOSH PERRY

BOREHOLE No 20-1

DATE:	02/07/2020 - 02/07/2020	**LOCATION:**	Carp Creek, Ottawa	**ORIGINATED BY:**	J.H.J.
PROJECT:	0CM-17-0429-02_CARP	**COORDINATES:**	Lat: 45.29231182 , Lon: -75.87656011	**COMPILED BY:**	A.L.
CLIENT:	Mississippi Valley Conservation	**DATUM:**	Geodetic	**CHECKED BY:**	N.T.
ELEVATION:	104.03 m	**REMARK:**		**REPORT DATE:**	26/08/2020

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	STATE	RECOVERY	"N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		104.0	Natural ground surface									
		0.0 / 104.0	Topsoil (25 mm).									
		0.0 / 103.4	Clayey silt, brown.		SS-01		12	11				
	1	0.6 / 102.5	Silty clay, grey brown, dense.		SS-02		100	9				
5		1.5 / 102.2	Clayey and silty sand, traces of gravel, grey brown.		SS-03		62	10				Could not push vane 0 38 33 29
	2	1.8 / 101.9	Clayey and silty sand, brown.									
		2.1	Clay, grey, moist, soft.		SS-04		67	2				
10	3								3.5 m	16.0, 78.0, 27.0, 71.0		
	4				SS-05		100	WOH		11.0, 71.0		
15	5									16.0, 89.0		
					SS-06		100	WOH				
		98.1										
20	6	5.9	Silty and sandy clay, traces of gravel.							16.0, 112.0, 27.0, 127.		Till observed to have started at 5.9 m.
		97.0										
	7	7.0	**END OF BROEHOLE.** **Water level measured in open borehole.**									
25	8											
	9											DCP refusal at 8.8 m.
30												

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH (kPa): Vane test (◇ Intact, ◆ Remolded) Lab vane (□ Intact, ■ Remolded); 20 40 60 80 100

WATER CONTENT and LIMITS (%): W_P W W_L; 25 50 75

REMARKS & GRAIN SIZE DISTRIBUTION (%): G S M C

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McINTOSH PERRY

BOREHOLE No 20-2

DATE:	02/07/2020 - 02/07/2020	**LOCATION:**	Carp Creek, Ottawa	**ORIGINATED BY:**	J.H.J.
PROJECT:	0CM-17-0429-02_CARP	**COORDINATES:**	Lat: 45.29229377 , Lon: -75.87647543	**COMPILED BY:**	A.L.
CLIENT:	Mississippi Valley Conservation	**DATUM:**	Geodetic	**CHECKED BY:**	N.T.
ELEVATION:	104.30 m	**REMARK:**		**REPORT DATE:**	26/08/2020

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	SOIL PROFILE: DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: STATE	SAMPLES: RECOVERY	SAMPLES: "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		104.3	Natural ground surface							Vane test: ◇ Intact, ◆ Remolded; Lab vane: □ Intact, ■ Remolded	W_P W W_L	G S M C
		0.0 / 104.3	Topsoil (40 mm).									
		0.0 / 103.7	Silty and gravelly clay, brown, stiff.		SS-01		17	15				
		0.6	Clay, grey brown, stiff.									
5	1				SS-02		100	6				
		102.6										
		1.7	Sand, some clay and silt, traces of gravel, wet.		SS-03		50	5				Su > 200kPa at 1.7m
	2				SS-04		25	11				1 75 12 12
		101.3										
10	3	3.0	Clay, traces of silt, grey, moist, soft.		SS-05		100	WOH	EL. 100.0 m on 2020-07-08	11.0, 100.0		
	4									16.0, 89.0		
15					SS-06		100	WOH				
	5									11.0, 100.0, 27.0, 112.0		
20	6	97.8			SS-07		100	WOH				
		6.5 / 97.6	Sandy clay, traces of gravel, grey.									
		6.7	**END OF BOREHOLE**									
25	7											
	8											
30	9											

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McINTOSH PERRY

BOREHOLE No 17-1

DATE:	19/10/2017 -	**LOCATION:**	Carp River, Ottawa	**ORIGINATED BY:**	
ID:	CM-17-0429	**COORDINATES:**	Lat: 45.292395 , Lon: -75.8766885	**COMPILED BY:**	
CLIENT:	City of Ottawa	**DATUM:**	Local	**CHECKED BY:**	
ELEVATION:	100.0 m	**REMARK:**		**REPORT DATE:**	28/11/2017

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	STATE	RECOVERY	"N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		100.0	Natural ground surface							DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80; SHEAR STRENGTH (kPa) Vane test: ◇ Intact, ◆ Remolded; Lab vane: □ Intact, ■ Remolded; 20 40 60 80 100	W_P W W_L; 25 50 75	G S M C
		0.0	CLAY, firm, wet, blue grey, desiccated		SS-01		100	1		◆3.0 ◇38.0		
5	1									◆6.0 ◇34.0		
	2	97.7			SS-02		100	2		◆8.0 ◇42.0		
		2.3	Silty sand, some gravel, traces to some clay, grey, wet, loose (TILL).		SS-03		100	7			○	
10	3				SS-04		100	4			○	
		96.3										
	4	3.7	**END OF BOREHOLE**									
15	5											
	6											
20												

McINTOSH PERRY

BOREHOLE No 17-2

DATE:	19/10/2017 -	**LOCATION:**	Carp River, Ottawa	**ORIGINATED BY:**	
ID:	CM-17-0429	**COORDINATES:**	Lat: 45.292395 , Lon: -75.8766885	**COMPILED BY:**	
CLIENT:	City of Ottawa	**DATUM:**	Local	**CHECKED BY:**	
ELEVATION:	100.0 m	**REMARK:**		**REPORT DATE:**	28/11/2017

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	SOIL PROFILE: DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: STATE	SAMPLES: RECOVERY	SAMPLES: "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		100.0 / 0.0	Natural ground surface							DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80; SHEAR STRENGTH (kPa) Vane test: Intact ◇, Remolded ◆; Lab vane: Intact □, Remolded ■; 20 40 60 80 100	W_P W W_L; 25 50 75	G S M C
		0.0	Clay, blue grey, wet, firm, desiccated.		SS-01		100	1		1.0 ◆ 30.0 ◇		
5	1									5.0 ◆ 38.0 ◇; 4.0 ◆ 40.0 ◇; 10.0 ◆ 44.0 ◇		
		98.2 / 1.8	Silty sand, some gravel, traces of clay, grey, wet, loose to compact (TILL).		SS-02		100	3				
					SS-03		100	20				
10	3	96.9 / 3.1	**END OF BOREHOLE** **SPT sampler refusal on probable bedrock.**									
	4											
15	5											
	6											
20												

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SLOPE STABILITY OF CARP RIVER, OTTAWA, ONTARIO

APPENDIX D
SEISMIC HAZARD CALCULATION

McINTOSH PERRY

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.292N 75.877W **User File Reference:** Carp River 2020-07-23 20:25 UT

Requested by: McIntosh Perry

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.411	0.222	0.132	0.039
Sa (0.1)	0.483	0.272	0.168	0.055
Sa (0.2)	0.406	0.233	0.147	0.051
Sa (0.3)	0.309	0.180	0.115	0.041
Sa (0.5)	0.220	0.129	0.082	0.029
Sa (1.0)	0.111	0.066	0.042	0.015
Sa (2.0)	0.053	0.031	0.020	0.006
Sa (5.0)	0.014	0.008	0.005	0.001
Sa (10.0)	0.005	0.003	0.002	0.001
PGA (g)	0.260	0.149	0.092	0.030
PGV (m/s)	0.183	0.103	0.063	0.020

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

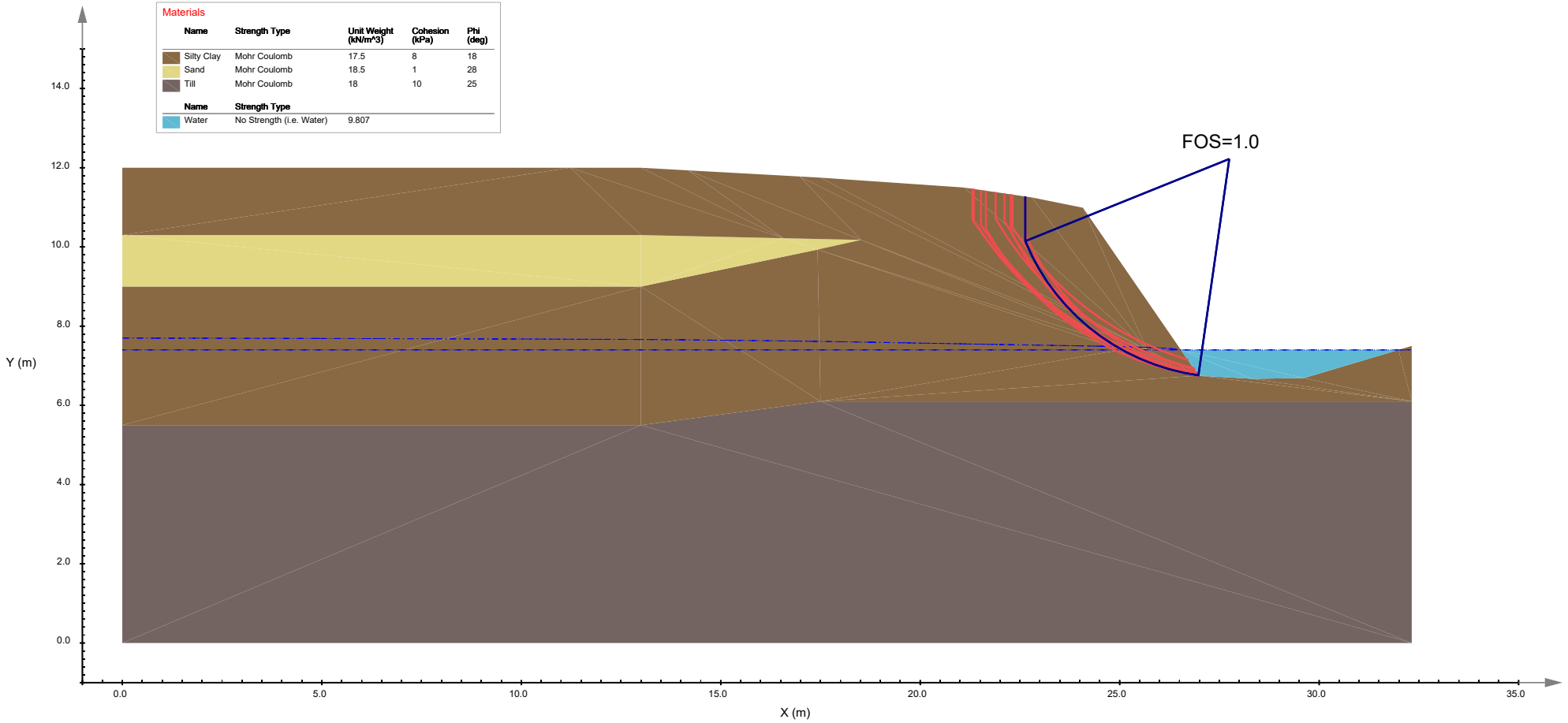
Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

SLOPE STABILITY OF CARP RIVER, OTTAWA, ONTARIO

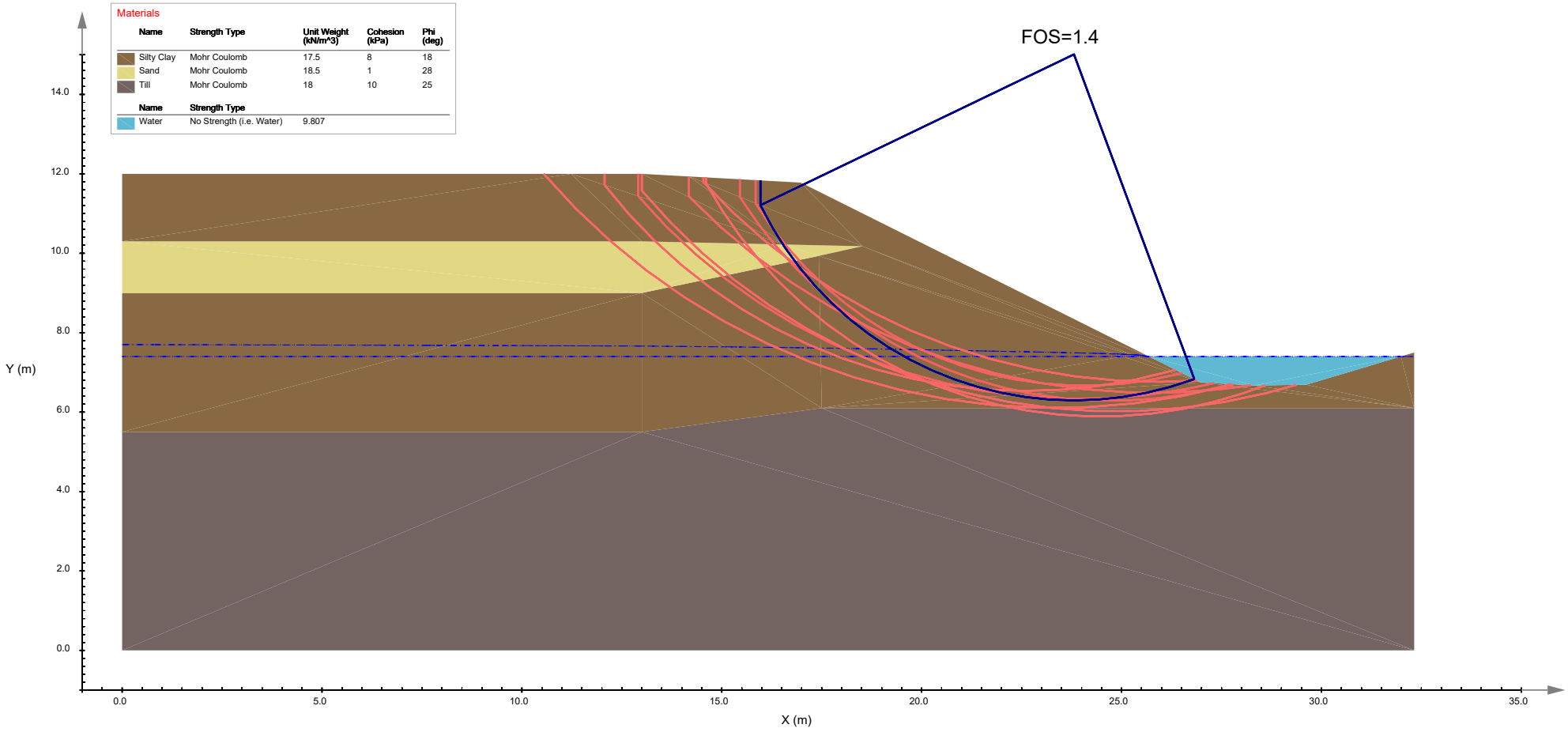
APPENDIX E
SLOPE STABILITY ANALYSES

McINTOSH PERRY



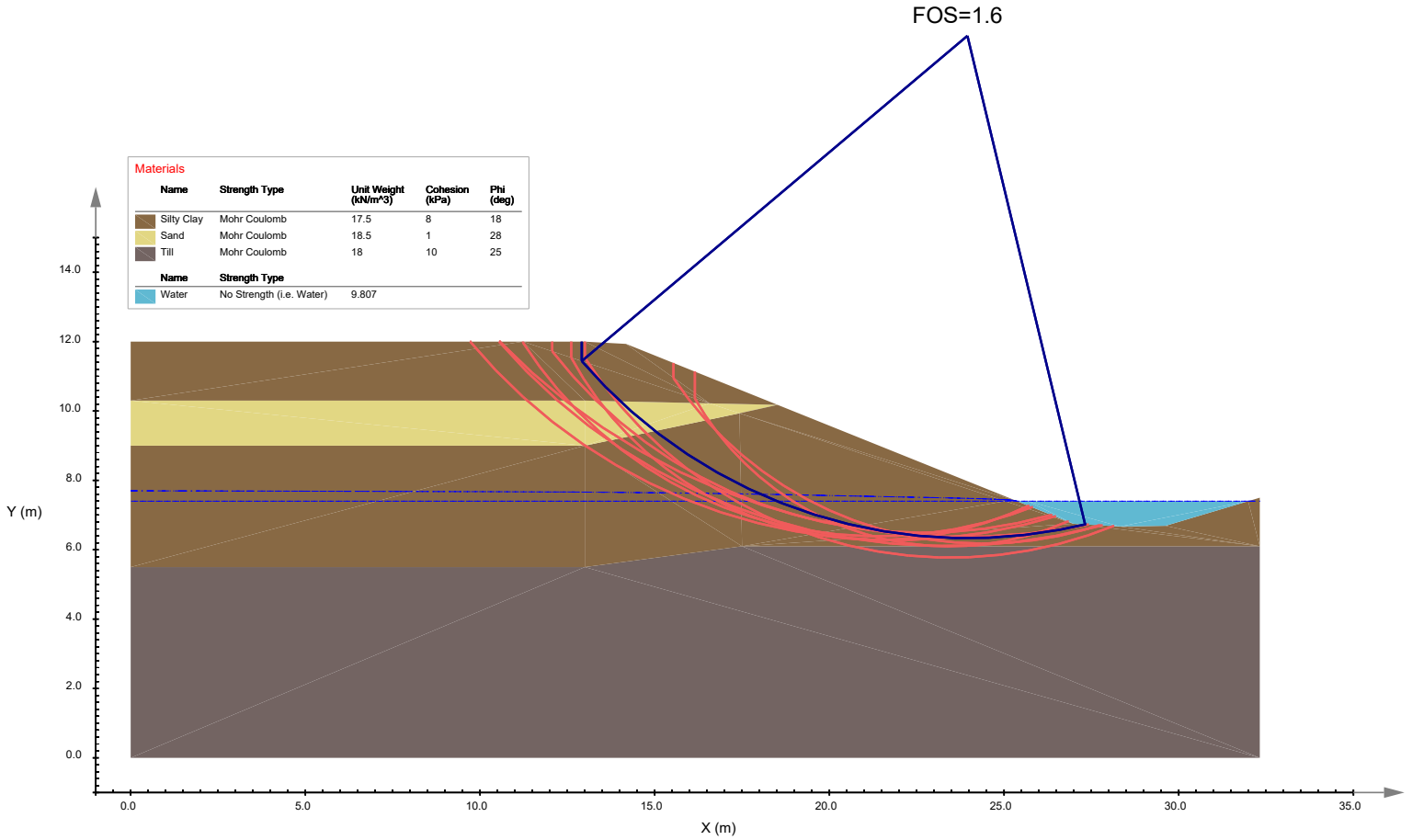
SVOFFICE 5
NEXT GEN GEOTECHNICAL SOFTWARE SUITE

PROJECT	Carp Creek Restoration	
TITLE	Slope Stability Analysis	
McINTOSH PERRY	PROJECT No. 0CM-17-429-	File No.
	Author	FIGURE 1
	Date 2020-08-12	



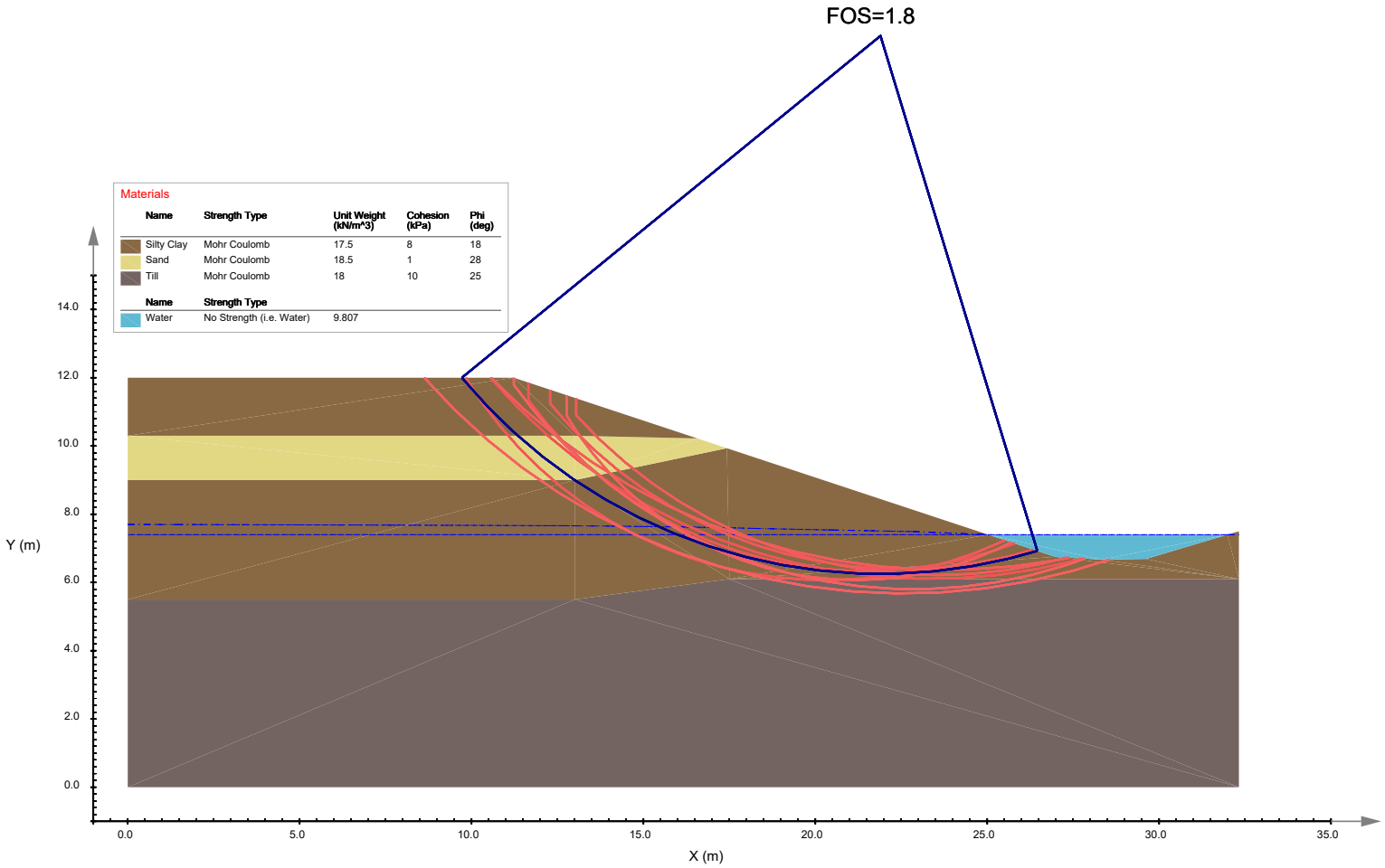
SVOFFICE 5
NEXT GEN GEOTECHNICAL SOFTWARE SUITE

PROJECT	Carp Creek Restoration	
TITLE	Long-term Slope Stability Analysis (2H:1V)	
McINTOSH PERRY	PROJECT No. 0CM-17-429-	File No.
	Author	FIGURE 2
	Date 2020-08-24	



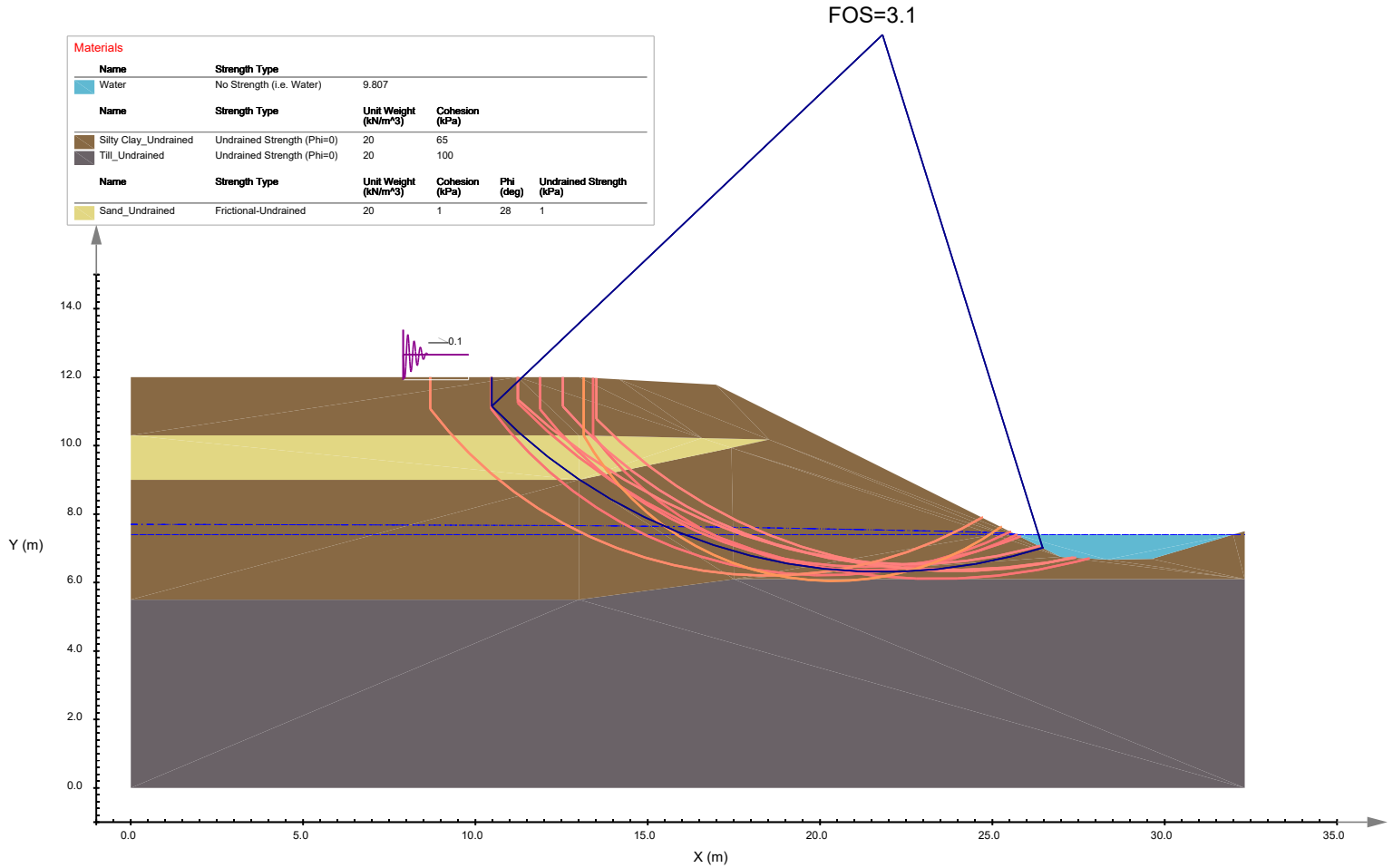
PROJECT	Carp Creek Restoration	
TITLE	Long-term Slope Stability Analysis (2.5H:1V)	
McINTOSH PERRY	PROJECT No. 0CM-17-429-	File No.
	Author	FIGURE 3
	Date 2020-08-24	

SVOFFICE 5
NEXT GEN GEOTECHNICAL SOFTWARE SUITE



SVOFFICE 5
NEXT GEN GEOTECHNICAL SOFTWARE SUITE

PROJECT	Carp Creek Restoration	
TITLE	Long-term Slope Stability Analysis (3H:1V)	
McINTOSH PERRY	PROJECT No. 0CM-17-429-	File No.
	Author	FIGURE 4
	Date 2020-08-24	



PROJECT: Carp Creek Restoration

TITLE: Short-term Slope Stability Analysis (2H:1V)

McINTOSH PERRY

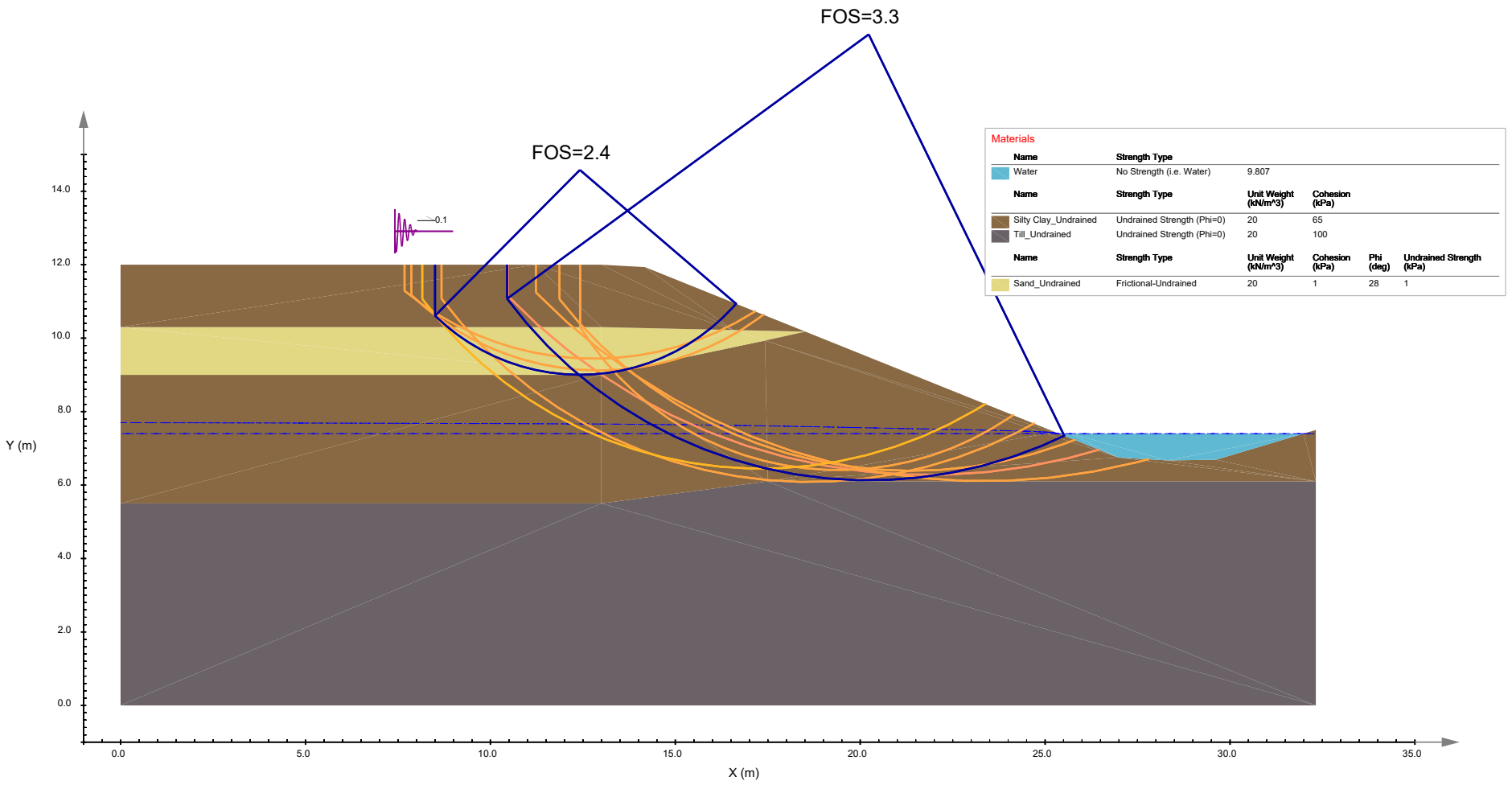
PROJECT No. 0CM-17-429- | File No.

Author

Date 2020-08-24

FIGURE 5

SVOFFICE 5
NEXT GEN GEOTECHNICAL SOFTWARE SUITE



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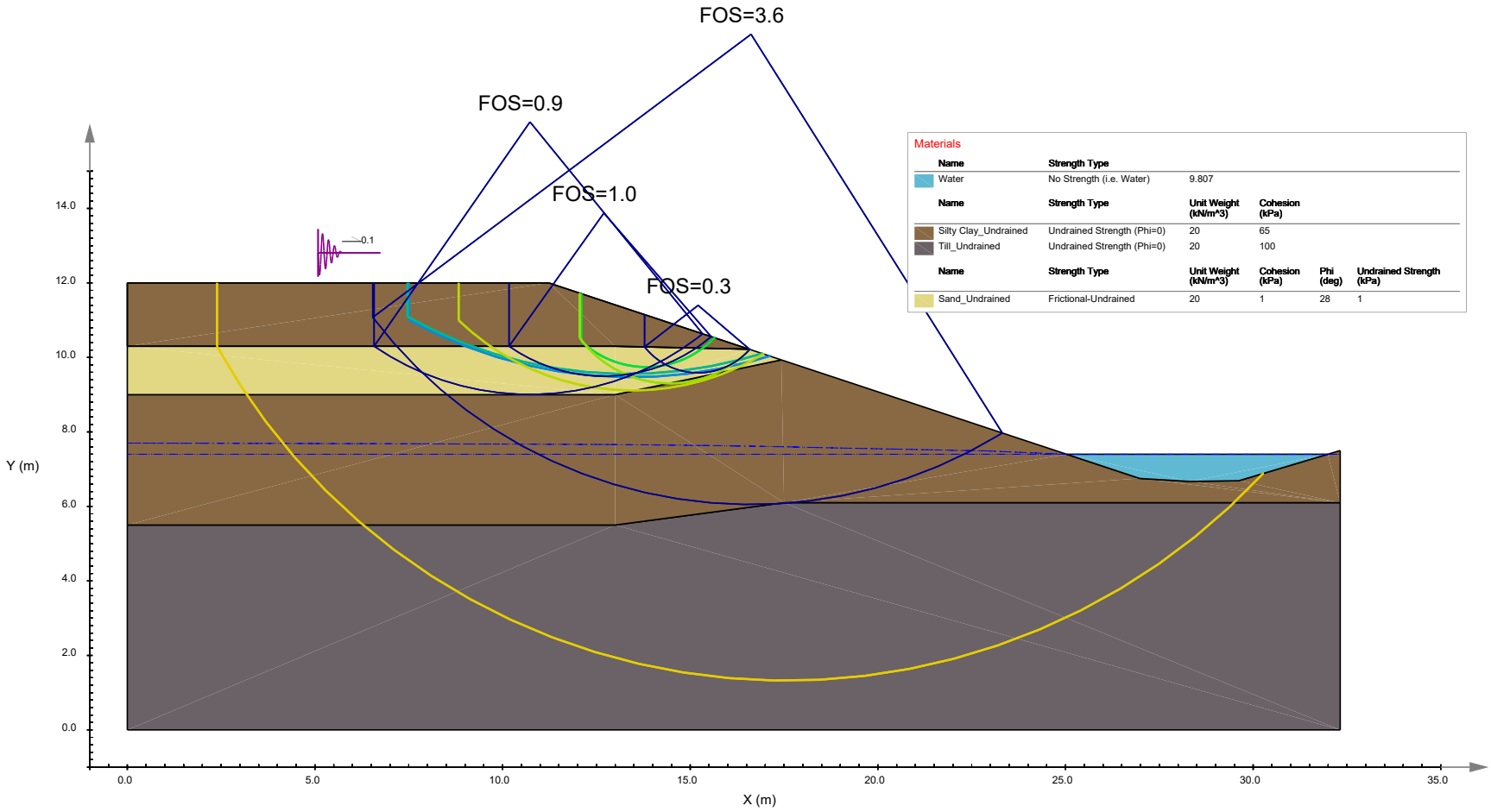
NEXT GEN GEOTECHNICAL SOFTWARE SUITE

PROJECT	Carp Creek Restoration	
TITLE	Short-term Slope Stability Analysis (2.5H:1V)	
McINTOSH PERRY	PROJECT No. 0CM-17-429-	File No.
	Author	FIGURE 6
	Date 2020-08-24	



PROJECT	Carp Creek Restoration	
TITLE	Short-term Slope Stability Analysis (3H:1V)	
McINTOSH PERRY	PROJECT No. 0CM-17-429-	File No.
	Author	FIGURE 7
	Date 2020-08-24	

SVOFFICE 5
NEXT GEN GEOTECHNICAL SOFTWARE SUITE

APPENDIX D – HEC-RAS MODELING RESULTS

LEGEND

- Carp Creek
- HecRAS Section

0 25 50 100

Scale 1:2,000 Metres

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT: MISSISSIPPI VALLEY CONSERVATION AUTHORITY

PROJECT: CARP CREEK RESTORATION

TITLE: HecRAS SECTIONS

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

PROJECT NO: CM-17-0429	
Date	Jun., 20, 2018
GIS	SK
Checked By	LM

FIGURE: 1

H:\01 Project - Proposals\2017 Jobs\CM\0CM-17-0429 MVCA_Class Environmental Assess_Carp River\GIS\mxd\CM-17-0429_HecRasSections.mxd

XS	Return Period	Flow Rate	Headwater Comparison			Velocity		
			Existing Condition	Proposed Condition	Difference	Existing Condition	Proposed Condition	Difference
Old Colony Road Culvert								
46705	100 yr.	23.39	103.43	103.43	0.00	1.33	1.33	0.00
	50 yr.	21.7	102.90	102.90	0.00	1.62	1.62	0.00
	25 yr.	18.6	102.75	102.75	0.00	1.52	1.52	0.00
	10 yr.	14.2	102.51	102.51	0.00	1.37	1.37	0.00
	5 yr.	12.78	102.80	102.80	0.00	1.01	1.01	0.00
	2 yr.	9.4	102.52	102.52	0.00	0.90	0.90	0.00
46699	100 yr.	32.72	103.35	103.35	0.00	1.70	1.70	0.00
	50 yr.	21.7	102.90	102.90	0.00	1.45	1.45	0.00
	25 yr.	18.6	102.75	102.75	0.00	1.38	1.38	0.00
	10 yr.	14.2	102.50	102.50	0.00	1.28	1.28	0.00
	5 yr.	18.39	102.74	102.74	0.00	1.38	1.38	0.00
	2 yr.	13.52	102.46	102.46	0.00	1.26	1.26	0.00
46655	100 yr.	32.72	103.15	103.15	0.00	2.52	2.52	0.00
	50 yr.	21.7	102.72	102.72	0.00	2.18	2.18	0.00
	25 yr.	18.6	102.56	102.56	0.00	2.08	2.08	0.00
	10 yr.	14.2	102.32	102.32	0.00	1.93	1.93	0.00
	5 yr.	18.39	102.55	102.55	0.00	2.07	2.07	0.00
	2 yr.	13.52	102.28	102.28	0.00	1.89	1.89	0.00
46630	100 yr.	32.72	103.10	103.10	0.00	2.39	2.39	0.00
	50 yr.	21.7	102.68	102.68	0.00	1.98	1.98	0.00
	25 yr.	18.6	102.53	102.53	0.00	1.85	1.85	0.00
	10 yr.	14.2	102.30	102.30	0.00	1.65	1.65	0.00
	5 yr.	18.39	102.52	102.52	0.00	1.85	1.85	0.00
	2 yr.	13.52	102.25	102.25	0.00	1.62	1.62	0.00
46600	100 yr.	32.72	102.99	102.99	0.00	2.81	2.81	0.00
	50 yr.	21.7	102.55	102.55	0.00	2.45	2.45	0.00
	25 yr.	18.6	102.40	102.40	0.00	2.34	2.34	0.00
	10 yr.	14.2	102.16	102.16	0.00	2.14	2.14	0.00
	5 yr.	18.39	102.39	102.39	0.00	2.33	2.33	0.00
	2 yr.	13.52	102.12	102.12	0.00	2.12	2.12	0.00
Carp Creek Embankment Restoration Study Area - Commences								
46582	100 yr.	32.72	102.57	102.57	0.00	4.06	4.06	0.00
	50 yr.	21.7	102.15	102.15	0.00	3.70	3.70	0.00
	25 yr.	18.6	102.02	102.02	0.00	3.54	3.54	0.00
	10 yr.	14.2	101.82	101.82	0.00	3.24	3.24	0.00
	5 yr.	18.39	102.01	102.01	0.00	3.52	3.52	0.00
	2 yr.	13.52	101.77	101.77	0.00	3.24	3.24	0.00
46564	100 yr.	32.72	102.36	102.34	-0.02	1.49	1.64	0.15
	50 yr.	21.7	101.90	101.89	-0.01	1.32	1.45	0.13
	25 yr.	18.6	101.76	101.74	-0.02	1.25	1.39	0.14
	10 yr.	14.2	101.53	101.51	-0.02	1.15	1.27	0.12
	5 yr.	18.39	101.75	101.73	-0.02	1.25	1.38	0.13
	2 yr.	13.52	101.50	101.47	-0.03	1.13	1.25	0.12
46552	100 yr.	32.72	102.35	102.36	0.01	1.57	1.34	-0.23
	50 yr.	21.7	101.90	101.90	0.00	1.36	1.17	-0.19
	25 yr.	18.6	101.76	101.75	-0.01	1.29	1.11	-0.18
	10 yr.	14.2	101.53	101.52	-0.01	1.17	1.01	-0.16
	5 yr.	18.39	101.75	101.74	-0.01	1.28	1.10	-0.18
	2 yr.	13.52	101.49	101.48	-0.01	1.15	1.00	-0.15
46545	100 yr.	32.72	102.29	102.35	0.06	1.76	1.38	-0.38
	50 yr.	21.7	101.84	101.89	0.05	1.56	1.20	-0.36
	25 yr.	18.6	101.70	101.74	0.04	1.48	1.14	-0.34
	10 yr.	14.2	101.48	101.52	0.04	1.36	1.03	-0.33
	5 yr.	18.39	101.69	101.73	0.04	1.48	1.13	-0.35
	2 yr.	13.52	101.44	101.48	0.04	1.34	1.02	-0.32
46533	100 yr.	32.72	102.18	102.26	0.08	2.43	1.96	-0.47
	50 yr.	21.7	101.73	101.81	0.08	2.23	1.73	-0.50
	25 yr.	18.6	101.59	101.67	0.08	2.14	1.65	-0.49
	10 yr.	14.2	101.37	101.45	0.08	1.99	1.51	-0.48
	5 yr.	18.39	101.58	101.66	0.08	2.14	1.65	-0.49
	2 yr.	13.52	101.33	101.41	0.08	1.96	1.49	-0.47
46527	100 yr.	32.72	102.12	102.12	0.00	2.74	2.74	0.00
	50 yr.	21.7	101.69	101.69	0.00	2.44	2.44	0.00
	25 yr.	18.6	101.55	101.55	0.00	2.34	2.34	0.00
	10 yr.	14.2	101.34	101.34	0.00	2.16	2.16	0.00
	5 yr.	18.39	101.54	101.54	0.00	2.33	2.33	0.00
	2 yr.	13.52	101.30	101.30	0.00	2.13	2.13	0.00

XS	Return Period	Flow Rate	Headwater Comparison			Velocity		
			Existing Condition	Proposed Condition	Difference	Existing Condition	Proposed Condition	Difference
Carp Creek Embank Restoration Study Area - Ends								
46518	100 yr.	32.72	102.13	102.13	0.00	2.47	2.47	0.00
	50 yr.	21.7	101.70	101.70	0.00	2.19	2.19	0.00
	25 yr.	18.6	101.55	101.55	0.00	2.09	2.09	0.00
	10 yr.	14.2	101.34	101.34	0.00	1.93	1.93	0.00
	5 yr.	18.39	101.54	101.54	0.00	2.09	2.09	0.00
	2 yr.	13.52	101.30	101.30	0.00	1.90	1.90	0.00
46513	100 yr.	32.72	101.52	101.52	0.00	3.67	3.67	0.00
	50 yr.	21.7	101.17	101.17	0.00	3.26	3.26	0.00
	25 yr.	18.6	101.07	101.07	0.00	3.10	3.10	0.00
	10 yr.	14.2	100.89	100.89	0.00	2.88	2.88	0.00
	5 yr.	18.39	101.06	101.06	0.00	3.09	3.09	0.00
	2 yr.	13.52	100.87	100.87	0.00	2.84	2.84	0.00
46508	100 yr.	32.72	101.26	101.26	0.00	3.53	3.53	0.00
	50 yr.	21.7	100.97	100.97	0.00	3.06	3.06	0.00
	25 yr.	18.6	100.85	100.85	0.00	3.00	3.00	0.00
	10 yr.	14.2	100.71	100.71	0.00	2.70	2.70	0.00
	5 yr.	18.39	100.85	100.85	0.00	2.97	2.97	0.00
	2 yr.	13.52	100.69	100.69	0.00	2.66	2.66	0.00
46505	100 yr.	32.72	101.17	101.17	0.00	2.35	2.35	0.00
	50 yr.	21.7	100.65	100.65	0.00	2.66	2.66	0.00
	25 yr.	18.6	100.51	100.51	0.00	2.76	2.76	0.00
	10 yr.	14.2	100.44	100.44	0.00	2.31	2.31	0.00
	5 yr.	18.39	100.50	100.50	0.00	2.75	2.75	0.00
	2 yr.	13.52	100.45	100.45	0.00	2.18	2.18	0.00
46500	100 yr.	32.72	101.17	101.17	0.00	1.46	1.46	0.00
	50 yr.	21.7	100.62	100.62	0.00	1.57	1.57	0.00
	25 yr.	18.6	100.33	100.33	0.00	1.85	1.85	0.00
	10 yr.	14.2	100.01	100.01	0.00	2.22	2.22	0.00
	5 yr.	18.39	100.32	100.32	0.00	1.86	1.86	0.00
	2 yr.	13.52	99.96	99.96	0.00	2.30	2.30	0.00
					0.00			
46400	100 yr.	32.72	101.14	101.14		0.89	0.89	0.00
	50 yr.	21.7	100.46	100.46	0.00	1.23	1.23	0.00
	25 yr.	18.6	100.22	100.22	0.00	1.21	1.21	0.00
	10 yr.	14.2	99.90	99.90	0.00	1.11	1.11	0.00
	5 yr.	18.39	100.20	100.20	0.00	1.21	1.21	0.00
	2 yr.	13.52	99.86	99.86	0.00	1.09	1.09	0.00
Castlefrank Road Culvert								

HEC-RAS Plan: Ex Cond. River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Left	Vel Right
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)	(m/s)
Reach-1	46724	2-Year (est.)	9.40	102.15	102.87	102.67	103.01	0.006326	5.75	8.00	0.61	1.63		
Old Colony Road Culvert														
Reach-1	46723		Culvert											
Reach-1	46705	100-Year	23.39	101.13	103.43		103.52	0.000730	18.50	12.42	0.28	1.33	0.33	
Reach-1	46705	50-Year	21.70	101.13	102.90		103.03	0.001532	14.10	11.84	0.39	1.62	0.37	
Reach-1	46705	25-Year	18.60	101.13	102.75		102.86	0.001531	12.83	11.68	0.39	1.52	0.34	
Reach-1	46705	10-Year	14.20	101.13	102.51		102.60	0.001554	10.82	11.42	0.38	1.37	0.29	
Reach-1	46705	5-Year	12.78	101.13	102.80		102.85	0.000647	13.27	11.74	0.25	1.01	0.23	
Reach-1	46705	2-Year (est.)	9.40	101.13	102.52		102.56	0.000664	10.90	11.43	0.25	0.90	0.19	
Reach-1	46699	100-Year	32.72	101.04	103.35		103.49	0.001405	21.57	11.69	0.38	1.70	0.32	0.32
Reach-1	46699	50-Year	21.70	101.04	102.90		103.01	0.001423	16.45	11.20	0.37	1.45	0.28	0.27
Reach-1	46699	25-Year	18.60	101.04	102.75		102.84	0.001477	14.73	11.03	0.37	1.38	0.27	0.26
Reach-1	46699	10-Year	14.20	101.04	102.50		102.58	0.001620	12.05	10.76	0.37	1.28	0.25	0.25
Reach-1	46699	5-Year	18.39	101.04	102.74		102.83	0.001482	14.61	11.02	0.37	1.38	0.26	0.26
Reach-1	46699	2-Year (est.)	13.52	101.04	102.46		102.54	0.001667	11.57	10.71	0.38	1.26	0.25	0.25
Reach-1	46655	100-Year	32.72	100.60	103.15		103.40	0.002485	21.89	14.88	0.52	2.52	0.51	0.66
Reach-1	46655	50-Year	21.70	100.60	102.72		102.92	0.002419	15.77	13.49	0.50	2.18	0.43	0.52
Reach-1	46655	25-Year	18.60	100.60	102.56		102.75	0.002469	13.72	12.99	0.49	2.08	0.41	0.47
Reach-1	46655	10-Year	14.20	100.60	102.32		102.49	0.002568	10.63	12.00	0.49	1.93	0.38	0.39
Reach-1	46655	5-Year	18.39	100.60	102.55		102.74	0.002474	13.57	12.96	0.49	2.07	0.41	0.47
Reach-1	46655	2-Year (est.)	13.52	100.60	102.28		102.44	0.002577	10.13	11.46	0.49	1.89	0.37	0.39
Reach-1	46630	100-Year	32.72	100.48	103.10		103.35	0.002270	20.47	13.19	0.48	2.39	0.58	0.56
Reach-1	46630	50-Year	21.70	100.48	102.68		102.86	0.001980	15.36	11.50	0.44	1.98	0.47	0.45
Reach-1	46630	25-Year	18.60	100.48	102.53		102.69	0.001921	13.69	10.88	0.43	1.85	0.43	0.42
Reach-1	46630	10-Year	14.20	100.48	102.30		102.42	0.001818	11.22	9.91	0.41	1.65	0.38	0.36
Reach-1	46630	5-Year	18.39	100.48	102.52		102.68	0.001917	13.57	10.84	0.43	1.85	0.43	0.41
Reach-1	46630	2-Year (est.)	13.52	100.48	102.25		102.38	0.001809	10.80	9.73	0.40	1.62	0.37	0.35
Reach-1	46600	100-Year	32.72	100.53	102.99		103.26	0.003233	22.77	16.87	0.58	2.81	0.73	0.71
Reach-1	46600	50-Year	21.70	100.53	102.55		102.78	0.003218	16.08	14.16	0.56	2.45	0.63	0.62
Reach-1	46600	25-Year	18.60	100.53	102.40		102.61	0.003268	14.00	13.09	0.56	2.34	0.61	0.59
Reach-1	46600	10-Year	14.20	100.53	102.16		102.35	0.003317	11.07	11.53	0.55	2.14	0.56	0.54
Reach-1	46600	5-Year	18.39	100.53	102.39		102.60	0.003271	13.86	13.02	0.56	2.33	0.60	0.59
Reach-1	46600	2-Year (est.)	13.52	100.53	102.12		102.30	0.003370	10.56	11.29	0.55	2.12	0.55	0.53
Reach-1	46582	100-Year	32.72	100.35	102.57	102.57	103.20	0.007717	15.31	13.76	0.90	4.06	0.95	0.89
Reach-1	46582	50-Year	21.70	100.35	102.15	102.15	102.71	0.008647	10.02	11.05	0.91	3.70	0.82	0.80
Reach-1	46582	25-Year	18.60	100.35	102.02	102.02	102.55	0.008830	8.62	10.11	0.91	3.54	0.77	0.76
Reach-1	46582	10-Year	14.20	100.35	101.82	101.82	102.28	0.008940	6.72	8.94	0.89	3.24	0.67	0.70
Reach-1	46582	5-Year	18.39	100.35	102.01	102.01	102.54	0.008841	8.53	10.05	0.91	3.52	0.77	0.76
Reach-1	46582	2-Year (est.)	13.52	100.35	101.77	101.77	102.24	0.009395	6.28	8.60	0.91	3.24	0.66	0.70
Reach-1	46580.9*	100-Year	32.72	100.33	102.61		103.01	0.005179	15.75	13.90	0.74	3.39	1.47	0.79
Reach-1	46580.9*	50-Year	21.70	100.33	102.09	102.06	102.58	0.008061	9.43	10.35	0.88	3.52	1.34	0.80
Reach-1	46580.9*	25-Year	18.60	100.33	101.98	101.96	102.43	0.008159	8.24	9.64	0.87	3.37	1.26	0.77
Reach-1	46580.9*	10-Year	14.20	100.33	101.77	101.76	102.19	0.008756	6.38	8.48	0.88	3.17	1.11	0.72
Reach-1	46580.9*	5-Year	18.39	100.33	101.97	101.95	102.42	0.008166	8.16	9.60	0.87	3.36	1.25	0.76
Reach-1	46580.9*	2-Year (est.)	13.52	100.33	101.75	101.73	102.15	0.008586	6.17	8.33	0.87	3.10	1.08	0.70
Reach-1	46579.8*	100-Year	32.72	100.32	102.59	102.44	103.00	0.005294	15.47	13.78	0.75	3.43	1.54	0.84
Reach-1	46579.8*	50-Year	21.70	100.32	102.08	102.06	102.56	0.008050	9.36	10.14	0.88	3.53	1.41	0.85
Reach-1	46579.8*	25-Year	18.60	100.32	101.96	101.96	102.42	0.008218	8.18	9.52	0.88	3.39	1.31	0.81
Reach-1	46579.8*	10-Year	14.20	100.32	101.75	101.75	102.18	0.008740	6.36	8.34	0.88	3.17	1.18	0.75
Reach-1	46579.8*	5-Year	18.39	100.32	101.95	101.95	102.41	0.008226	8.10	9.48	0.88	3.38	1.31	0.81
Reach-1	46579.8*	2-Year (est.)	13.52	100.32	101.73	101.71	102.14	0.008556	6.15	8.19	0.87	3.10	1.14	0.74
Reach-1	46578.8*	100-Year	32.72	100.30	102.43	102.43	102.98	0.007556	13.45	12.33	0.88	3.92	1.72	0.98
Reach-1	46578.8*	50-Year	21.70	100.30	102.06	102.05	102.55	0.008153	9.33	10.07	0.89	3.56	1.45	0.88
Reach-1	46578.8*	25-Year	18.60	100.30	101.93	101.92	102.40	0.008411	8.11	9.40	0.89	3.42	1.37	0.84
Reach-1	46578.8*	10-Year	14.20	100.30	101.74	101.73	102.16	0.008768	6.36	8.27	0.89	3.19	1.22	0.78
Reach-1	46578.8*	5-Year	18.39	100.30	101.92	101.91	102.39	0.008465	8.01	9.34	0.89	3.42	1.36	0.84
Reach-1	46578.8*	2-Year (est.)	13.52	100.30	101.71	101.69	102.12	0.008554	6.17	8.13	0.87	3.11	1.18	0.76
Reach-1	46577.7*	100-Year	32.72	100.28	102.39	102.39	102.97	0.008083	13.19	11.95	0.91	4.03	1.76	1.06
Reach-1	46577.7*	50-Year	21.70	100.28	102.03	102.03	102.53	0.008333	9.30	10.07	0.90	3.59	1.49	0.93
Reach-1	46577.7*	25-Year	18.60	100.28	101.91	101.91	102.38	0.008637	8.06	9.35	0.90	3.46	1.42	0.89
Reach-1	46577.7*	10-Year	14.20	100.28	101.70	101.70	102.14	0.009173	6.28	8.19	0.90	3.24	1.28	0.83
Reach-1	46577.7*	5-Year	18.39	100.28	101.90	101.90	102.37	0.008645	7.98	9.30	0.90	3.45	1.41	0.89
Reach-1	46577.7*	2-Year (est.)	13.52	100.28	101.70	101.67	102.10	0.008409	6.25	8.16	0.87	3.10	1.22	0.79
Reach-1	46576.7*	100-Year	32.72	100.26	102.37	102.37	102.92	0.007846	13.31	11.96	0.90	3.97	1.83	1.14
Reach-1	46576.7*	50-Year	21.70	100.26	102.00	102.00	102.50	0.008442	9.29	10.12	0.90	3.60	1.58	0.97
Reach-1	46576.7*	25-Year	18.60	100.26	101.88	101.88	102.35	0.008737	8.06	9.40	0.90	3.47	1.49	0.93
Reach-1	46576.7*	10-Year	14.20	100.26	101.68	101.68	102.11	0.009185	6.31	8.24	0.91	3.24	1.35	0.86
Reach-1	46576.7*	5-Year	18.39	100.26	101.87	101.87	102.34	0.008747	7.98	9.35	0.90	3.46	1.49	0.93
Reach-1	46576.7*	2-Year (est.)	13.52	100.26	101.65	101.65	102.07	0.009265	6.04	8.05	0.91	3.20	1.32	0.85
Reach-1	46575.6*	100-Year	32.72	100.25	102.32	102.32	102.87	0.008016	13.28	12.18	0.91	3.99	1.88	1.23
Reach-1	46575.6*	50-Year	21.70	100.25	101.96	101.96	102.46	0.008934	9.18	10.17	0.92	3.67	1.64	1.03
Reach-1	46575.6*	25-Year	18.60	100.25	101.85	101.85	102.32	0.008730	8.17	9.58	0.90	3.47	1.53	0.97
Reach-1	46575.6*	10-Year	14.20	100.25	101.66	101.66	102.08	0.009228	6.38	8.39	0.91	3.24	1.39	0.90
Reach-1	46575.6*	5-Year	18.39	100.25	101.85	101.85	102.31	0.008757	8.08	9.53	0.90	3.46	1.52	0.97
Reach-1	46575.6*	2-Year (est.)	13.52	100.25	101.62	101.62	102.04	0.009305	6.11	8.20	0.91	3.20	1.36	0.88

HEC-RAS Plan: Ex Cond. River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Left	Vel Right
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)	(m/s)
Reach-1	46574.5*	100-Year	32.72	100.23	102.28	102.28	102.82	0.008191	13.34	12.53	0.91	4.00	1.92	1.30
Reach-1	46574.5*	50-Year	21.70	100.23	101.96	101.96	102.42	0.008124	9.70	10.58	0.88	3.54	1.63	1.05
Reach-1	46574.5*	25-Year	18.60	100.23	101.82	101.82	102.28	0.009038	8.21	9.79	0.92	3.50	1.59	1.00
Reach-1	46574.5*	10-Year	14.20	100.23	101.63	101.63	102.05	0.009279	6.49	8.64	0.91	3.25	1.43	0.92
Reach-1	46574.5*	5-Year	18.39	100.23	101.81	101.81	102.27	0.008913	8.18	9.77	0.91	3.47	1.57	1.00
Reach-1	46574.5*	2-Year (est.)	13.52	100.23	101.60	101.60	102.01	0.009345	6.21	8.44	0.91	3.20	1.41	0.91
Reach-1	46573.5*	100-Year	32.72	100.21	102.22	102.22	102.75	0.008331	13.38	12.68	0.92	3.98	2.00	1.38
Reach-1	46573.5*	50-Year	21.70	100.21	101.91	101.91	102.35	0.008301	9.71	10.68	0.89	3.53	1.71	1.14
Reach-1	46573.5*	25-Year	18.60	100.21	101.80	101.80	102.22	0.008442	8.56	10.15	0.89	3.39	1.63	1.05
Reach-1	46573.5*	10-Year	14.20	100.21	101.59	101.59	102.00	0.009485	6.56	8.94	0.92	3.25	1.52	0.96
Reach-1	46573.5*	5-Year	18.39	100.21	101.79	101.79	102.21	0.008439	8.48	10.12	0.89	3.38	1.62	1.04
Reach-1	46573.5*	2-Year (est.)	13.52	100.21	101.56	101.56	101.96	0.009382	6.33	8.77	0.91	3.19	1.48	0.94
Reach-1	46572.4*	100-Year	32.72	100.20	102.15	102.15	102.67	0.008794	13.28	12.70	0.94	4.02	2.06	1.48
Reach-1	46572.4*	50-Year	21.70	100.20	101.85	101.85	102.28	0.008687	9.69	10.98	0.91	3.55	1.76	1.24
Reach-1	46572.4*	25-Year	18.60	100.20	101.74	101.74	102.16	0.008752	8.58	10.28	0.90	3.40	1.67	1.15
Reach-1	46572.4*	10-Year	14.20	100.20	101.59	101.59	101.95	0.008523	7.04	9.55	0.87	3.11	1.50	0.97
Reach-1	46572.4*	5-Year	18.39	100.20	101.73	101.73	102.15	0.008752	8.50	10.24	0.90	3.39	1.66	1.14
Reach-1	46572.4*	2-Year (est.)	13.52	100.20	101.56	101.56	101.92	0.008490	6.78	9.43	0.87	3.07	1.47	0.94
Reach-1	46571.4*	100-Year	32.72	100.18	102.14	102.07	102.59	0.007627	14.15	13.09	0.88	3.77	2.04	1.48
Reach-1	46571.4*	50-Year	21.70	100.18	101.78	101.78	102.20	0.009049	9.68	11.23	0.92	3.55	1.86	1.32
Reach-1	46571.4*	25-Year	18.60	100.18	101.67	101.67	102.08	0.009157	8.56	10.58	0.92	3.41	1.77	1.24
Reach-1	46571.4*	10-Year	14.20	100.18	101.53	101.53	101.88	0.008834	7.07	9.73	0.88	3.11	1.58	1.07
Reach-1	46571.4*	5-Year	18.39	100.18	101.67	101.67	102.07	0.009161	8.49	10.53	0.92	3.40	1.76	1.23
Reach-1	46571.4*	2-Year (est.)	13.52	100.18	101.49	101.49	101.84	0.008969	6.77	9.58	0.89	3.08	1.56	1.04
Reach-1	46570.3*	100-Year	32.72	100.16	102.21		102.54	0.005664	16.07	13.82	0.76	3.35	1.88	1.39
Reach-1	46570.3*	50-Year	21.70	100.16	101.71	101.70	102.12	0.009349	9.79	11.39	0.93	3.54	1.90	1.39
Reach-1	46570.3*	25-Year	18.60	100.16	101.60	101.60	102.00	0.009644	8.61	10.86	0.94	3.42	1.82	1.31
Reach-1	46570.3*	10-Year	14.20	100.16	101.46	101.46	101.80	0.009343	7.10	10.00	0.90	3.12	1.63	1.15
Reach-1	46570.3*	5-Year	18.39	100.16	101.60	101.60	101.99	0.009644	8.53	10.82	0.94	3.41	1.81	1.31
Reach-1	46570.3*	2-Year (est.)	13.52	100.16	101.43	101.43	101.77	0.009365	6.84	9.84	0.90	3.08	1.60	1.12
Reach-1	46569.2*	100-Year	32.72	100.15	102.25		102.51	0.004336	17.87	14.39	0.67	3.00	1.73	1.33
Reach-1	46569.2*	50-Year	21.70	100.15	101.78		102.06	0.006216	11.58	12.18	0.77	3.01	1.68	1.29
Reach-1	46569.2*	25-Year	18.60	100.15	101.62		101.92	0.007332	9.73	11.47	0.82	3.04	1.68	1.28
Reach-1	46569.2*	10-Year	14.20	100.15	101.38	101.38	101.71	0.010030	7.09	10.27	0.93	3.13	1.68	1.25
Reach-1	46569.2*	5-Year	18.39	100.15	101.61		101.91	0.007428	9.60	11.42	0.82	3.04	1.68	1.28
Reach-1	46569.2*	2-Year (est.)	13.52	100.15	101.36	101.36	101.68	0.010053	6.83	10.12	0.93	3.09	1.65	1.22
Reach-1	46568.2*	100-Year	32.72	100.13	102.29		102.49	0.003356	19.61	14.87	0.59	2.68	1.65	1.27
Reach-1	46568.2*	50-Year	21.70	100.13	101.83		102.02	0.004399	13.24	12.83	0.65	2.60	1.56	1.21
Reach-1	46568.2*	25-Year	18.60	100.13	101.68		101.88	0.004913	11.39	12.17	0.68	2.58	1.52	1.19
Reach-1	46568.2*	10-Year	14.20	100.13	101.44		101.65	0.006133	8.66	11.16	0.74	2.57	1.49	1.14
Reach-1	46568.2*	5-Year	18.39	100.13	101.67		101.87	0.004954	11.26	12.12	0.68	2.58	1.52	1.18
Reach-1	46568.2*	2-Year (est.)	13.52	100.13	101.40		101.61	0.006425	8.22	10.98	0.75	2.57	1.48	1.14
Reach-1	46567.1*	100-Year	32.72	100.11	102.31		102.47	0.002661	21.33	15.30	0.53	2.42	1.54	1.22
Reach-1	46567.1*	50-Year	21.70	100.11	101.85		102.00	0.003275	14.80	13.37	0.57	2.29	1.42	1.15
Reach-1	46567.1*	25-Year	18.60	100.11	101.71		101.85	0.003549	12.91	12.74	0.58	2.25	1.38	1.12
Reach-1	46567.1*	10-Year	14.20	100.11	101.48		101.62	0.004129	10.12	11.78	0.61	2.18	1.31	1.06
Reach-1	46567.1*	5-Year	18.39	100.11	101.70		101.84	0.003569	12.78	12.70	0.58	2.24	1.37	1.11
Reach-1	46567.1*	2-Year (est.)	13.52	100.11	101.44		101.58	0.004256	9.68	11.63	0.62	2.17	1.30	1.05
Reach-1	46566.1*	100-Year	32.72	100.10	102.32		102.46	0.002171	23.02	15.67	0.48	2.22	1.45	1.17
Reach-1	46566.1*	50-Year	21.70	100.10	101.87		101.99	0.002540	16.34	13.84	0.50	2.05	1.31	1.08
Reach-1	46566.1*	25-Year	18.60	100.10	101.73		101.84	0.002692	14.39	13.24	0.51	1.99	1.26	1.05
Reach-1	46566.1*	10-Year	14.20	100.10	101.50		101.61	0.002991	11.51	12.32	0.52	1.89	1.18	0.99
Reach-1	46566.1*	5-Year	18.39	100.10	101.72		101.83	0.002703	14.25	13.20	0.51	1.99	1.26	1.05
Reach-1	46566.1*	2-Year (est.)	13.52	100.10	101.47		101.57	0.003053	11.05	12.16	0.52	1.88	1.17	0.98
Reach-1	46565.0*	100-Year	32.72	100.08	102.34		102.45	0.001720	24.77	16.03	0.43	2.00	1.40	1.12
Reach-1	46565.0*	50-Year	21.70	100.08	101.89		101.98	0.001928	17.92	14.27	0.44	1.81	1.25	1.03
Reach-1	46565.0*	25-Year	18.60	100.08	101.74		101.83	0.002006	15.90	13.70	0.44	1.75	1.19	0.99
Reach-1	46565.0*	10-Year	14.20	100.08	101.52		101.59	0.002149	12.92	12.82	0.44	1.63	1.10	0.92
Reach-1	46565.0*	5-Year	18.39	100.08	101.73		101.82	0.002011	15.76	13.66	0.44	1.74	1.19	0.99
Reach-1	46565.0*	2-Year (est.)	13.52	100.08	101.48		101.55	0.002177	12.44	12.67	0.44	1.62	1.08	0.91
Carp Creek Embankment Restoration Study Area														
Reach-1	46564	100-Year	32.72	100.06	102.36		102.44	0.000932	26.69	16.40	0.32	1.49	1.08	1.19
Reach-1	46564	50-Year	21.70	100.06	101.90		101.97	0.000985	19.64	14.71	0.31	1.32	0.94	1.07
Reach-1	46564	25-Year	18.60	100.06	101.76		101.82	0.001002	17.55	14.16	0.31	1.25	0.89	1.03
Reach-1	46564	10-Year	14.20	100.06	101.53		101.58	0.001029	14.45	13.30	0.31	1.15	0.80	0.95
Reach-1	46564	5-Year	18.39	100.06	101.75		101.81	0.001003	17.41	14.12	0.31	1.25	0.88	1.03
Reach-1	46564	2-Year (est.)	13.52	100.06	101.50		101.54	0.001034	13.95	13.16	0.31	1.13	0.79	0.94
Reach-1	46552	100-Year	32.72	99.97	102.35		102.42	0.000999	32.06	18.92	0.33	1.57	1.11	0.84
Reach-1	46552	50-Year	21.70	99.97	101.90		101.95	0.001002	23.91	17.06	0.32	1.36	0.96	0.75
Reach-1	46552	25-Year	18.60	99.97	101.76		101.80	0.000999	21.48	16.46	0.31	1.29	0.91	0.71
Reach-1	46552	10-Year	14.20	99.97	101.53		101.57	0.000988	17.86	15.53	0.31	1.17	0.83	0.65
Reach-1	46552	5-Year	18.39	99.97	101.75		101.79	0.000998	21.31	16.42	0.31	1.28	0.91	0.71
Reach-1	46552	2-Year (est.)	13.52	99.97	101.49		101.53	0.000986	17.28	15.38	0.30	1.15	0.82	0.64
Reach-1	46545	100-Year	32.72	99.84	102.29		102.41	0.001276	22.51	15.04	0.37	1.76	1.14	1.11
Reach-1	46545	50-Year	21.70	99.84	101.84		101.94	0.001342	16.26	12.97	0.37	1.56	1.01	1.02

HEC-RAS Plan: Ex Cond. River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Left	Vel Right
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)	(m/s)
Reach-1	46545	25-Year	18.60	99.84	101.70		101.79	0.001357	14.47	12.31	0.36	1.48	0.96	0.98
Reach-1	46545	10-Year	14.20	99.84	101.48		101.56	0.001371	11.87	11.29	0.36	1.36	0.87	0.91
Reach-1	46545	5-Year	18.39	99.84	101.69		101.78	0.001357	14.34	12.26	0.36	1.48	0.95	0.98
Reach-1	46545	2-Year (est.)	13.52	99.84	101.44		101.52	0.001373	11.46	11.12	0.36	1.34	0.86	0.89
Reach-1	46533	100-Year	32.72	99.84	102.18		102.38	0.002414	21.20	16.15	0.51	2.43	0.88	1.03
Reach-1	46533	50-Year	21.70	99.84	101.73		101.91	0.002718	14.47	13.66	0.53	2.23	0.76	0.95
Reach-1	46533	25-Year	18.60	99.84	101.59		101.76	0.002807	12.59	12.88	0.53	2.14	0.70	0.91
Reach-1	46533	10-Year	14.20	99.84	101.37		101.53	0.002905	9.94	11.52	0.52	1.99	0.59	0.85
Reach-1	46533	5-Year	18.39	99.84	101.58		101.75	0.002812	12.47	12.83	0.53	2.14	0.70	0.91
Reach-1	46533	2-Year (est.)	13.52	99.84	101.33		101.49	0.002914	9.53	11.18	0.52	1.96	0.56	0.83
Reach-1	46527	100-Year	32.72	99.84	102.12		102.36	0.003106	23.65	17.32	0.58	2.74	0.85	0.71
Reach-1	46527	50-Year	21.70	99.84	101.69		101.90	0.003261	16.65	15.13	0.57	2.44	0.74	0.63
Reach-1	46527	25-Year	18.60	99.84	101.55		101.75	0.003323	14.59	14.51	0.57	2.34	0.70	0.61
Reach-1	46527	10-Year	14.20	99.84	101.34		101.51	0.003402	11.59	13.54	0.57	2.16	0.63	0.56
Reach-1	46527	5-Year	18.39	99.84	101.54		101.74	0.003326	14.45	14.46	0.57	2.33	0.70	0.61
Reach-1	46527	2-Year (est.)	13.52	99.84	101.30		101.47	0.003413	11.11	13.38	0.57	2.13	0.61	0.55
Reach-1	46518	100-Year	32.72	99.49	102.13		102.33	0.002222	27.92	18.99	0.50	2.47	0.68	0.56
Reach-1	46518	50-Year	21.70	99.49	101.70		101.86	0.002255	19.98	17.27	0.48	2.19	0.56	0.49
Reach-1	46518	25-Year	18.60	99.49	101.55		101.71	0.002265	17.57	16.71	0.48	2.09	0.52	0.47
Reach-1	46518	10-Year	14.20	99.49	101.34		101.48	0.002257	14.01	15.87	0.47	1.93	0.44	0.43
Reach-1	46518	5-Year	18.39	99.49	101.54		101.70	0.002265	17.41	16.67	0.48	2.09	0.52	0.47
Reach-1	46518	2-Year (est.)	13.52	99.49	101.30		101.44	0.002253	13.44	15.74	0.47	1.90	0.43	0.42
Reach-1	46513	100-Year	32.72	99.80	101.52	101.52	102.15	0.010318	11.44	10.62	0.95	3.67	0.69	0.92
Reach-1	46513	50-Year	21.70	99.80	101.17	101.17	101.68	0.011404	8.01	9.38	0.96	3.26	0.52	0.78
Reach-1	46513	25-Year	18.60	99.80	101.07	101.07	101.53	0.011717	7.04	8.98	0.96	3.10	0.43	0.73
Reach-1	46513	10-Year	14.20	99.80	100.89	100.89	101.30	0.012826	5.54	8.10	0.97	2.88	0.25	0.65
Reach-1	46513	5-Year	18.39	99.80	101.06	101.06	101.52	0.011758	6.97	8.95	0.96	3.09	0.43	0.73
Reach-1	46513	2-Year (est.)	13.52	99.80	100.87	100.87	101.26	0.013013	5.31	7.91	0.98	2.84	0.22	0.64
Reach-1	46508	100-Year	32.72	99.78	101.26	101.26	101.85	0.010897	11.12	10.29	0.98	3.53	0.69	0.91
Reach-1	46508	50-Year	21.70	99.78	100.97	100.97	101.43	0.011356	8.19	10.12	0.96	3.06	0.58	0.68
Reach-1	46508	25-Year	18.60	99.78	100.85	100.85	101.29	0.012855	6.99	9.30	1.00	3.00	0.54	0.72
Reach-1	46508	10-Year	14.20	99.78	100.71	100.71	101.08	0.012906	5.77	8.93	0.98	2.70	0.44	0.62
Reach-1	46508	5-Year	18.39	99.78	100.85	100.85	101.28	0.012657	6.97	9.30	0.99	2.97	0.54	0.71
Reach-1	46508	2-Year (est.)	13.52	99.78	100.69	100.69	101.04	0.013079	5.55	8.86	0.98	2.66	0.41	0.60
Reach-1	46505	100-Year	32.72	99.42	101.17		101.37	0.004057	25.85	33.07	0.59	2.35	0.43	0.77
Reach-1	46505	50-Year	21.70	99.42	100.65	100.59	100.95	0.008630	12.50	20.50	0.80	2.66	0.39	0.80
Reach-1	46505	25-Year	18.60	99.42	100.51	100.51	100.84	0.011104	9.70	18.08	0.89	2.76	0.30	0.78
Reach-1	46505	10-Year	14.20	99.42	100.44	100.36	100.68	0.008561	8.54	16.97	0.77	2.31	0.18	0.62
Reach-1	46505	5-Year	18.39	99.42	100.50	100.50	100.83	0.011144	9.58	17.97	0.89	2.75	0.29	0.77
Reach-1	46505	2-Year (est.)	13.52	99.42	100.45	100.34	100.66	0.007527	8.66	17.09	0.73	2.18	0.18	0.59
Reach-1	46500	100-Year	32.72	98.97	101.17		101.25	0.001110	45.03	44.65	0.34	1.46	0.33	0.40
Reach-1	46500	50-Year	21.70	98.97	100.62		100.71	0.002005	24.14	31.58	0.43	1.57	0.38	0.39
Reach-1	46500	25-Year	18.60	98.97	100.33		100.48	0.003771	15.92	26.38	0.56	1.85	0.42	0.42
Reach-1	46500	10-Year	14.20	98.97	100.01	99.95	100.24	0.008722	8.54	19.44	0.81	2.22	0.47	0.41
Reach-1	46500	5-Year	18.39	98.97	100.32		100.47	0.003897	15.52	25.96	0.57	1.86	0.42	0.42
Reach-1	46500	2-Year (est.)	13.52	98.97	99.96	99.93	100.21	0.010276	7.57	18.03	0.87	2.30	0.47	0.41
Reach-1	46400	100-Year	32.72	98.37	101.14	99.53	101.17	0.000368	78.90	93.55	0.20	0.89	0.18	0.18
Reach-1	46400	50-Year	21.70	98.37	100.46	99.25	100.54	0.001189	20.13	78.38	0.33	1.23	0.05	0.05
Reach-1	46400	25-Year	18.60	98.37	100.22	99.17	100.29	0.000795	15.35	59.04	0.28	1.21		
Reach-1	46400	10-Year	14.20	98.37	99.90	99.04	99.97	0.000864	12.74	40.07	0.29	1.11		
Reach-1	46400	5-Year	18.39	98.37	100.20	99.16	100.28	0.000800	15.22	57.59	0.29	1.21		
Reach-1	46400	2-Year (est.)	13.52	98.37	99.86	99.02	99.92	0.000867	12.35	39.16	0.29	1.09		
Reach-1	46350		Culvert											
Reach-1	46349	100-Year	32.72	98.37	100.97	99.56	101.09	0.004262	21.07	8.32	0.31	1.55		
Reach-1	46349	50-Year	21.70	98.37	100.31	99.28	100.41	0.005078	15.62	8.32	0.32	1.39		
Reach-1	46349	25-Year	18.60	98.37	100.11	99.19	100.20	0.005467	13.93	8.32	0.32	1.34		
Reach-1	46349	10-Year	14.20	98.37	99.82	99.05	99.90	0.001681	11.62	8.00	0.32	1.22		
Reach-1	46349	5-Year	18.39	98.37	100.10	99.19	100.19	0.005489	13.82	8.32	0.32	1.33		
Reach-1	46349	2-Year (est.)	13.52	98.37	99.78	99.03	99.85	0.001670	11.27	8.00	0.32	1.20		
Reach-1	46348		Culvert											
Reach-1	46287	100-Year	32.72	97.92	100.69		100.83	0.000977	20.43	13.31	0.33	1.61	1.37	1.57
Reach-1	46287	50-Year	21.70	97.92	100.24		100.32	0.000854	16.62	11.66	0.30	1.31	1.11	1.29
Reach-1	46287	25-Year	18.60	97.92	100.08		100.15	0.000832	15.27	10.36	0.29	1.22	1.03	1.21
Reach-1	46287	10-Year	14.20	97.92	99.82		99.88	0.000795	13.17	10.05	0.27	1.08	0.90	1.08
Reach-1	46287	5-Year	18.39	97.92	100.06		100.14	0.000830	15.18	10.34	0.29	1.22	1.02	1.21
Reach-1	46287	2-Year (est.)	13.52	97.92	99.78		99.84	0.000790	12.81	10.00	0.27	1.06	0.88	1.06
Reach-1	46284	100-Year	32.72	97.91	100.53		100.78	0.003229	27.45	22.04	0.61	3.09	0.82	0.69
Reach-1	46284	50-Year	21.70	97.91	100.05		100.28	0.003433	18.05	15.74	0.61	2.78	0.74	0.68
Reach-1	46284	25-Year	18.60	97.91	99.91		100.11	0.003258	15.98	13.99	0.58	2.59	0.69	0.69
Reach-1	46284	10-Year	14.20	97.91	99.66		99.84	0.003289	12.73	12.52	0.57	2.38	0.63	0.63
Reach-1	46284	5-Year	18.39	97.91	99.90		100.10	0.003259	15.83	13.93	0.58	2.58	0.69	0.69
Reach-1	46284	2-Year (est.)	13.52	97.91	99.62		99.80	0.003294	12.21	12.27	0.57	2.35	0.62	0.62
Reach-1	46264	100-Year	32.72	97.90	100.45		100.72	0.003498	24.86	17.45	0.63	3.15	0.84	0.84

HEC-RAS Plan: Proposed Rev3 River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Left	Vel Right
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)	(m/s)
Reach-1	46724	2-Year (est.)	9.40	102.15	102.87	102.67	103.01	0.006326	5.75	8.00	0.61	1.63		
Old Colony Road Culvert														
Reach-1	46723		Culvert											
Reach-1	46705	100-Year	23.39	101.13	103.43		103.52	0.000730	18.50	12.42	0.28	1.33	0.33	
Reach-1	46705	50-Year	21.70	101.13	102.90		103.03	0.001532	14.10	11.84	0.39	1.62	0.37	
Reach-1	46705	25-Year	18.60	101.13	102.75		102.86	0.001531	12.83	11.68	0.39	1.52	0.34	
Reach-1	46705	10-Year	14.20	101.13	102.51		102.60	0.001554	10.82	11.42	0.38	1.37	0.29	
Reach-1	46705	5-Year	12.78	101.13	102.80		102.85	0.000647	13.27	11.74	0.25	1.01	0.23	
Reach-1	46705	2-Year (est.)	9.40	101.13	102.52		102.56	0.000664	10.90	11.43	0.25	0.90	0.19	
Reach-1	46699	100-Year	32.72	101.04	103.35		103.49	0.001405	21.57	11.69	0.38	1.70	0.32	0.32
Reach-1	46699	50-Year	21.70	101.04	102.90		103.01	0.001423	16.45	11.20	0.37	1.45	0.28	0.27
Reach-1	46699	25-Year	18.60	101.04	102.75		102.84	0.001477	14.73	11.03	0.37	1.38	0.27	0.26
Reach-1	46699	10-Year	14.20	101.04	102.50		102.58	0.001620	12.05	10.76	0.37	1.28	0.25	0.25
Reach-1	46699	5-Year	18.39	101.04	102.74		102.83	0.001482	14.61	11.02	0.37	1.38	0.26	0.26
Reach-1	46699	2-Year (est.)	13.52	101.04	102.46		102.54	0.001667	11.57	10.71	0.38	1.26	0.25	0.25
Reach-1	46655	100-Year	32.72	100.60	103.15		103.40	0.002485	21.89	14.88	0.52	2.52	0.51	0.66
Reach-1	46655	50-Year	21.70	100.60	102.72		102.92	0.002419	15.77	13.49	0.50	2.18	0.43	0.52
Reach-1	46655	25-Year	18.60	100.60	102.56		102.75	0.002469	13.72	12.99	0.49	2.08	0.41	0.47
Reach-1	46655	10-Year	14.20	100.60	102.32		102.49	0.002568	10.63	12.00	0.49	1.93	0.38	0.39
Reach-1	46655	5-Year	18.39	100.60	102.55		102.74	0.002474	13.57	12.96	0.49	2.07	0.41	0.47
Reach-1	46655	2-Year (est.)	13.52	100.60	102.28		102.44	0.002577	10.13	11.46	0.49	1.89	0.37	0.39
Reach-1	46630	100-Year	32.72	100.48	103.10		103.35	0.002270	20.47	13.19	0.48	2.39	0.58	0.56
Reach-1	46630	50-Year	21.70	100.48	102.68		102.86	0.001980	15.36	11.50	0.44	1.98	0.47	0.45
Reach-1	46630	25-Year	18.60	100.48	102.53		102.69	0.001921	13.69	10.88	0.43	1.85	0.43	0.42
Reach-1	46630	10-Year	14.20	100.48	102.30		102.42	0.001818	11.22	9.91	0.41	1.65	0.38	0.36
Reach-1	46630	5-Year	18.39	100.48	102.52		102.68	0.001917	13.57	10.84	0.43	1.85	0.43	0.41
Reach-1	46630	2-Year (est.)	13.52	100.48	102.25		102.38	0.001809	10.80	9.73	0.40	1.62	0.37	0.35
Reach-1	46600	100-Year	32.72	100.53	102.99		103.26	0.003233	22.77	16.87	0.58	2.81	0.73	0.71
Reach-1	46600	50-Year	21.70	100.53	102.55		102.78	0.003218	16.08	14.16	0.56	2.45	0.63	0.62
Reach-1	46600	25-Year	18.60	100.53	102.40		102.61	0.003268	14.00	13.09	0.56	2.34	0.61	0.59
Reach-1	46600	10-Year	14.20	100.53	102.16		102.35	0.003317	11.07	11.53	0.55	2.14	0.56	0.54
Reach-1	46600	5-Year	18.39	100.53	102.39		102.60	0.003271	13.86	13.02	0.56	2.33	0.60	0.59
Reach-1	46600	2-Year (est.)	13.52	100.53	102.12		102.30	0.003370	10.56	11.29	0.55	2.12	0.55	0.53
Reach-1	46582	100-Year	32.72	100.35	102.57	102.57	103.20	0.007717	15.31	13.76	0.90	4.06	0.95	0.89
Reach-1	46582	50-Year	21.70	100.35	102.15	102.15	102.71	0.008647	10.02	11.05	0.91	3.70	0.82	0.80
Reach-1	46582	25-Year	18.60	100.35	102.02	102.02	102.55	0.008830	8.62	10.11	0.91	3.54	0.77	0.76
Reach-1	46582	10-Year	14.20	100.35	101.82	101.82	102.28	0.008940	6.72	8.94	0.89	3.24	0.67	0.70
Reach-1	46582	5-Year	18.39	100.35	102.01	102.01	102.54	0.008841	8.53	10.05	0.91	3.52	0.77	0.76
Reach-1	46582	2-Year (est.)	13.52	100.35	101.77	101.77	102.24	0.009395	6.28	8.60	0.91	3.24	0.66	0.70
Reach-1	46580.8*	100-Year	32.72	100.33	102.46	102.46	103.03	0.007734	14.57	13.52	0.89	3.95	1.17	0.91
Reach-1	46580.8*	50-Year	21.70	100.33	102.05	102.05	102.58	0.008730	9.64	10.78	0.91	3.61	1.03	0.82
Reach-1	46580.8*	25-Year	18.60	100.33	101.93	101.93	102.42	0.008857	8.38	9.99	0.91	3.45	0.97	0.78
Reach-1	46580.8*	10-Year	14.20	100.33	101.73	101.73	102.17	0.009286	6.50	8.82	0.91	3.20	0.85	0.72
Reach-1	46580.8*	5-Year	18.39	100.33	101.92	101.92	102.41	0.008883	8.29	9.93	0.91	3.44	0.97	0.78
Reach-1	46580.8*	2-Year (est.)	13.52	100.33	101.68	101.68	102.13	0.009742	6.10	8.52	0.92	3.20	0.84	0.72
Reach-1	46579.6*	100-Year	32.72	100.31	102.33	102.33	102.95	0.008587	13.84	13.09	0.93	4.03	1.23	0.98
Reach-1	46579.6*	50-Year	21.70	100.31	101.97	101.97	102.49	0.008974	9.54	10.74	0.92	3.58	1.07	0.85
Reach-1	46579.6*	25-Year	18.60	100.31	101.85	101.85	102.34	0.009142	8.29	9.99	0.92	3.43	1.00	0.81
Reach-1	46579.6*	10-Year	14.20	100.31	101.66	101.66	102.10	0.009663	6.43	8.84	0.92	3.19	0.89	0.75
Reach-1	46579.6*	5-Year	18.39	100.31	101.84	101.84	102.33	0.009176	8.20	9.94	0.92	3.42	1.00	0.80
Reach-1	46579.6*	2-Year (est.)	13.52	100.31	101.63	101.63	102.06	0.009462	6.22	8.69	0.91	3.12	0.86	0.73
Reach-1	46578.4*	100-Year	32.72	100.30	102.26	102.26	102.86	0.008695	13.72	12.99	0.93	3.99	1.26	1.02
Reach-1	46578.4*	50-Year	21.70	100.30	101.90	101.90	102.41	0.009099	9.51	10.80	0.92	3.54	1.09	0.88
Reach-1	46578.4*	25-Year	18.60	100.30	101.79	101.79	102.26	0.009259	8.30	10.12	0.92	3.38	1.03	0.83
Reach-1	46578.4*	10-Year	14.20	100.30	101.60	101.60	102.02	0.009618	6.50	9.00	0.91	3.13	0.91	0.76
Reach-1	46578.4*	5-Year	18.39	100.30	101.78	101.78	102.25	0.009242	8.22	10.08	0.92	3.37	1.02	0.83
Reach-1	46578.4*	2-Year (est.)	13.52	100.30	101.57	101.57	101.98	0.009690	6.22	8.80	0.91	3.09	0.89	0.75
Reach-1	46577.2*	100-Year	32.72	100.28	102.18	102.18	102.77	0.008878	13.59	12.93	0.94	3.95	1.30	1.06
Reach-1	46577.2*	50-Year	21.70	100.28	101.84	101.84	102.33	0.009242	9.50	10.88	0.93	3.50	1.12	0.91
Reach-1	46577.2*	25-Year	18.60	100.28	101.73	101.73	102.19	0.009290	8.35	10.29	0.92	3.33	1.05	0.85
Reach-1	46577.2*	10-Year	14.20	100.28	101.54	101.54	101.95	0.009774	6.53	9.16	0.92	3.09	0.94	0.78
Reach-1	46577.2*	5-Year	18.39	100.28	101.72	101.72	102.18	0.009265	8.28	10.26	0.91	3.32	1.04	0.85
Reach-1	46577.2*	2-Year (est.)	13.52	100.28	101.51	101.51	101.91	0.009932	6.22	8.94	0.92	3.06	0.92	0.77
Reach-1	46576.*	100-Year	32.72	100.26	102.10	102.10	102.68	0.009122	13.45	12.90	0.95	3.92	1.34	1.11
Reach-1	46576.*	50-Year	21.70	100.26	101.76	101.76	102.25	0.009512	9.45	10.95	0.93	3.47	1.16	0.95
Reach-1	46576.*	25-Year	18.60	100.26	101.66	101.66	102.11	0.009407	8.37	10.44	0.92	3.29	1.08	0.88
Reach-1	46576.*	10-Year	14.20	100.26	101.47	101.47	101.88	0.010198	6.49	9.30	0.93	3.08	0.97	0.81
Reach-1	46576.*	5-Year	18.39	100.26	101.65	101.65	102.10	0.009417	8.29	10.40	0.92	3.28	1.07	0.88
Reach-1	46576.*	2-Year (est.)	13.52	100.26	101.44	101.44	101.84	0.010232	6.22	9.11	0.93	3.04	0.95	0.80
Reach-1	46574.8*	100-Year	32.72	100.24	102.12	102.02	102.60	0.007405	14.67	13.48	0.86	3.60	1.27	1.07
Reach-1	46574.8*	50-Year	21.70	100.24	101.69	101.69	102.17	0.009724	9.44	11.09	0.94	3.44	1.19	0.99
Reach-1	46574.8*	25-Year	18.60	100.24	101.60	101.60	102.03	0.009556	8.40	10.61	0.92	3.25	1.10	0.92
Reach-1	46574.8*	10-Year	14.20	100.24	101.42	101.42	101.81	0.010222	6.57	9.57	0.93	3.03	1.00	0.83
Reach-1	46574.8*	5-Year	18.39	100.24	101.59	101.59	102.02	0.009566	8.32	10.58	0.92	3.24	1.10	0.92
Reach-1	46574.8*	2-Year (est.)	13.52	100.24	101.38	101.38	101.77	0.010439	6.26	9.35	0.93	3.00	0.99	0.82

HEC-RAS Plan: Proposed Rev3 River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Left	Vel Right
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)	(m/s)
Reach-1	46573.6*	100-Year	32.72	100.22	102.18		102.55	0.005493	16.57	14.30	0.74	3.20	1.18	1.01
Reach-1	46573.6*	50-Year	21.70	100.22	101.72	101.63	102.10	0.007470	10.57	11.76	0.83	3.09	1.12	0.95
Reach-1	46573.6*	25-Year	18.60	100.22	101.57	101.53	101.96	0.008603	8.86	10.99	0.87	3.08	1.10	0.93
Reach-1	46573.6*	10-Year	14.20	100.22	101.36	101.36	101.74	0.010360	6.64	9.82	0.93	2.99	1.04	0.85
Reach-1	46573.6*	5-Year	18.39	100.22	101.56	101.52	101.95	0.008698	8.74	10.93	0.88	3.08	1.10	0.93
Reach-1	46573.6*	2-Year (est.)	13.52	100.22	101.33	101.33	101.70	0.010370	6.38	9.68	0.92	2.94	1.01	0.83
Reach-1	46572.4*	100-Year	32.72	100.20	102.22		102.52	0.004322	18.25	15.03	0.66	2.90	1.11	0.97
Reach-1	46572.4*	50-Year	21.70	100.20	101.77		102.06	0.005485	12.03	12.54	0.71	2.74	1.04	0.90
Reach-1	46572.4*	25-Year	18.60	100.20	101.63		101.91	0.006054	10.26	11.77	0.74	2.69	1.01	0.87
Reach-1	46572.4*	10-Year	14.20	100.20	101.40	101.30	101.68	0.007336	7.71	10.60	0.79	2.62	0.96	0.81
Reach-1	46572.4*	5-Year	18.39	100.20	101.62		101.90	0.006099	10.14	11.72	0.74	2.69	1.01	0.87
Reach-1	46572.4*	2-Year (est.)	13.52	100.20	101.36	101.27	101.64	0.007609	7.32	10.39	0.80	2.61	0.95	0.80
Reach-1	46571.2*	100-Year	32.72	100.19	102.25		102.50	0.003555	19.84	15.88	0.60	2.68	1.04	0.93
Reach-1	46571.2*	50-Year	21.70	100.19	101.80		102.03	0.004289	13.36	13.22	0.64	2.48	0.96	0.87
Reach-1	46571.2*	25-Year	18.60	100.19	101.66		101.88	0.004641	11.50	12.46	0.65	2.42	0.94	0.84
Reach-1	46571.2*	10-Year	14.20	100.19	101.43		101.65	0.005386	8.83	11.33	0.68	2.32	0.88	0.78
Reach-1	46571.2*	5-Year	18.39	100.19	101.65		101.87	0.004667	11.38	12.41	0.65	2.41	0.93	0.84
Reach-1	46571.2*	2-Year (est.)	13.52	100.19	101.40		101.61	0.005539	8.41	11.13	0.69	2.30	0.87	0.77
Reach-1	46570.*	100-Year	32.72	100.17	102.27		102.48	0.002908	21.51	16.63	0.55	2.46	0.99	0.89
Reach-1	46570.*	50-Year	21.70	100.17	101.83		102.01	0.003400	14.69	13.88	0.57	2.25	0.91	0.84
Reach-1	46570.*	25-Year	18.60	100.17	101.68		101.86	0.003629	12.74	13.13	0.58	2.19	0.88	0.81
Reach-1	46570.*	10-Year	14.20	100.17	101.46		101.63	0.004089	9.92	12.00	0.60	2.08	0.83	0.75
Reach-1	46570.*	5-Year	18.39	100.17	101.67		101.85	0.003646	12.61	13.08	0.58	2.18	0.88	0.81
Reach-1	46570.*	2-Year (est.)	13.52	100.17	101.42		101.59	0.004185	9.48	11.81	0.60	2.06	0.82	0.74
Reach-1	46568.8*	100-Year	32.72	100.15	102.29		102.47	0.002396	23.19	17.28	0.50	2.26	0.94	0.87
Reach-1	46568.8*	50-Year	21.70	100.15	101.84		102.00	0.002744	16.03	14.57	0.51	2.06	0.86	0.81
Reach-1	46568.8*	25-Year	18.60	100.15	101.70		101.84	0.002890	13.98	13.77	0.52	1.99	0.83	0.79
Reach-1	46568.8*	10-Year	14.20	100.15	101.48		101.61	0.003183	11.02	12.63	0.53	1.87	0.78	0.73
Reach-1	46568.8*	5-Year	18.39	100.15	101.69		101.83	0.002901	13.84	13.72	0.52	1.98	0.83	0.78
Reach-1	46568.8*	2-Year (est.)	13.52	100.15	101.44		101.57	0.003243	10.55	12.45	0.53	1.85	0.77	0.72
Reach-1	46567.6*	100-Year	32.72	100.13	102.31		102.45	0.001986	24.89	17.86	0.46	2.08	0.90	0.86
Reach-1	46567.6*	50-Year	21.70	100.13	101.86		101.98	0.002236	17.41	15.28	0.46	1.89	0.82	0.79
Reach-1	46567.6*	25-Year	18.60	100.13	101.71		101.83	0.002330	15.26	14.44	0.47	1.82	0.79	0.76
Reach-1	46567.6*	10-Year	14.20	100.13	101.49		101.59	0.002514	12.14	13.27	0.47	1.70	0.74	0.71
Reach-1	46567.6*	5-Year	18.39	100.13	101.70		101.82	0.002337	15.11	14.39	0.47	1.81	0.79	0.76
Reach-1	46567.6*	2-Year (est.)	13.52	100.13	101.45		101.56	0.002552	11.64	13.08	0.47	1.68	0.73	0.70
Reach-1	46566.4*	100-Year	32.72	100.11	102.32		102.44	0.001655	26.60	18.39	0.42	1.92	0.85	0.84
Reach-1	46566.4*	50-Year	21.70	100.11	101.87		101.97	0.001826	18.83	15.92	0.42	1.73	0.78	0.77
Reach-1	46566.4*	25-Year	18.60	100.11	101.72		101.82	0.001891	16.57	15.12	0.42	1.66	0.75	0.74
Reach-1	46566.4*	10-Year	14.20	100.11	101.50		101.58	0.002003	13.30	13.90	0.42	1.54	0.70	0.69
Reach-1	46566.4*	5-Year	18.39	100.11	101.71		101.81	0.001896	16.42	15.07	0.42	1.65	0.75	0.74
Reach-1	46566.4*	2-Year (est.)	13.52	100.11	101.46		101.54	0.002026	12.78	13.71	0.42	1.52	0.69	0.68
Reach-1	46565.2*	100-Year	32.72	100.10	102.33		102.44	0.001383	28.33	18.88	0.38	1.78	0.81	0.83
Reach-1	46565.2*	50-Year	21.70	100.10	101.88		101.96	0.001496	20.30	16.51	0.38	1.59	0.74	0.75
Reach-1	46565.2*	25-Year	18.60	100.10	101.73		101.81	0.001537	17.95	15.75	0.38	1.52	0.71	0.72
Reach-1	46565.2*	10-Year	14.20	100.10	101.51		101.58	0.001606	14.51	14.56	0.38	1.40	0.66	0.67
Reach-1	46565.2*	5-Year	18.39	100.10	101.72		101.80	0.001540	17.79	15.69	0.38	1.51	0.71	0.72
Reach-1	46565.2*	2-Year (est.)	13.52	100.10	101.47		101.54	0.001619	13.96	14.37	0.38	1.38	0.65	0.66
Carp Creek Embankment Restoration Study Area														
Reach-1	46564	100-Year	32.72	100.08	102.34		102.43	0.001158	30.08	19.34	0.35	1.64	0.78	0.82
Reach-1	46564	50-Year	21.70	100.08	101.89		101.96	0.001227	21.81	17.06	0.35	1.45	0.70	0.74
Reach-1	46564	25-Year	18.60	100.08	101.74		101.81	0.001251	19.36	16.33	0.34	1.39	0.67	0.71
Reach-1	46564	10-Year	14.20	100.08	101.51		101.57	0.001289	15.78	15.19	0.34	1.27	0.62	0.65
Reach-1	46564	5-Year	18.39	100.08	101.73		101.80	0.001253	19.20	16.28	0.34	1.38	0.67	0.70
Reach-1	46564	2-Year (est.)	13.52	100.08	101.47		101.53	0.001296	15.21	15.00	0.34	1.25	0.61	0.64
Reach-1	46552	100-Year	32.72	99.99	102.36		102.41	0.000732	37.29	22.38	0.28	1.34	0.62	0.72
Reach-1	46552	50-Year	21.70	99.99	101.90		101.94	0.000748	27.56	20.09	0.27	1.17	0.55	0.64
Reach-1	46552	25-Year	18.60	99.99	101.75		101.79	0.000752	24.65	19.35	0.27	1.11	0.52	0.61
Reach-1	46552	10-Year	14.20	99.99	101.52		101.56	0.000756	20.34	18.20	0.26	1.01	0.48	0.56
Reach-1	46552	5-Year	18.39	99.99	101.74		101.78	0.000752	24.45	19.30	0.27	1.10	0.52	0.61
Reach-1	46552	2-Year (est.)	13.52	99.99	101.48		101.52	0.000756	19.64	18.01	0.26	1.00	0.47	0.55
Reach-1	46545	100-Year	32.72	99.95	102.35		102.41	0.000768	36.01	21.53	0.29	1.38	0.64	0.73
Reach-1	46545	50-Year	21.70	99.95	101.89		101.94	0.000772	26.70	19.26	0.28	1.20	0.57	0.65
Reach-1	46545	25-Year	18.60	99.95	101.74		101.79	0.000771	23.92	18.53	0.27	1.14	0.54	0.62
Reach-1	46545	10-Year	14.20	99.95	101.52		101.55	0.000762	19.81	17.39	0.26	1.03	0.49	0.56
Reach-1	46545	5-Year	18.39	99.95	101.73		101.78	0.000770	23.73	18.48	0.27	1.13	0.54	0.61
Reach-1	46545	2-Year (est.)	13.52	99.95	101.48		101.51	0.000760	19.15	17.20	0.26	1.02	0.48	0.55
Reach-1	46533	100-Year	32.72	99.84	102.26		102.39	0.001470	25.87	17.66	0.40	1.96	0.87	0.86
Reach-1	46533	50-Year	21.70	99.84	101.81		101.92	0.001510	18.61	15.02	0.39	1.73	0.77	0.77
Reach-1	46533	25-Year	18.60	99.84	101.67		101.77	0.001517	16.51	14.28	0.39	1.65	0.72	0.73
Reach-1	46533	10-Year	14.20	99.84	101.45		101.53	0.001511	13.47	13.13	0.38	1.51	0.64	0.68
Reach-1	46533	5-Year	18.39	99.84	101.66		101.76	0.001517	16.37	14.23	0.39	1.65	0.72	0.73
Reach-1	46533	2-Year (est.)	13.52	99.84	101.41		101.49	0.001508	12.99	12.94	0.38	1.49	0.62	0.67
Reach-1	46527	100-Year	32.72	99.84	102.12		102.36	0.003106	23.65	17.32	0.58	2.74	0.85	0.71
Reach-1	46527	50-Year	21.70	99.84	101.69		101.90	0.003261	16.65	15.13	0.57	2.44	0.74	0.63

HEC-RAS Plan: Proposed Rev3 River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Left	Vel Right
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)	(m/s)
Reach-1	46527	25-Year	18.60	99.84	101.55		101.75	0.003323	14.59	14.51	0.57	2.34	0.70	0.61
Reach-1	46527	10-Year	14.20	99.84	101.34		101.51	0.003402	11.59	13.54	0.57	2.16	0.63	0.56
Reach-1	46527	5-Year	18.39	99.84	101.54		101.74	0.003326	14.45	14.46	0.57	2.33	0.70	0.61
Reach-1	46527	2-Year (est.)	13.52	99.84	101.30		101.47	0.003413	11.11	13.38	0.57	2.13	0.61	0.55
Reach-1	46518	100-Year	32.72	99.49	102.13		102.33	0.002222	27.92	18.99	0.50	2.47	0.68	0.56
Reach-1	46518	50-Year	21.70	99.49	101.70		101.86	0.002255	19.98	17.27	0.48	2.19	0.56	0.49
Reach-1	46518	25-Year	18.60	99.49	101.55		101.71	0.002265	17.57	16.71	0.48	2.09	0.52	0.47
Reach-1	46518	10-Year	14.20	99.49	101.34		101.48	0.002257	14.01	15.87	0.47	1.93	0.44	0.43
Reach-1	46518	5-Year	18.39	99.49	101.54		101.70	0.002265	17.41	16.67	0.48	2.09	0.52	0.47
Reach-1	46518	2-Year (est.)	13.52	99.49	101.30		101.44	0.002253	13.44	15.74	0.47	1.90	0.43	0.42
Reach-1	46513	100-Year	32.72	99.80	101.52	101.52	102.15	0.010318	11.44	10.62	0.95	3.67	0.69	0.92
Reach-1	46513	50-Year	21.70	99.80	101.17	101.17	101.68	0.011404	8.01	9.38	0.96	3.26	0.52	0.78
Reach-1	46513	25-Year	18.60	99.80	101.07	101.07	101.53	0.011717	7.04	8.98	0.96	3.10	0.43	0.73
Reach-1	46513	10-Year	14.20	99.80	100.89	100.89	101.30	0.012826	5.54	8.10	0.97	2.88	0.25	0.65
Reach-1	46513	5-Year	18.39	99.80	101.06	101.06	101.52	0.011758	6.97	8.95	0.96	3.09	0.43	0.73
Reach-1	46513	2-Year (est.)	13.52	99.80	100.87	100.87	101.26	0.013013	5.31	7.91	0.98	2.84	0.22	0.64
Reach-1	46508	100-Year	32.72	99.78	101.26	101.26	101.85	0.010897	11.12	10.29	0.98	3.53	0.69	0.91
Reach-1	46508	50-Year	21.70	99.78	100.97	100.97	101.43	0.011356	8.19	10.12	0.96	3.06	0.58	0.68
Reach-1	46508	25-Year	18.60	99.78	100.85	100.85	101.29	0.012855	6.99	9.30	1.00	3.00	0.54	0.72
Reach-1	46508	10-Year	14.20	99.78	100.71	100.71	101.08	0.012906	5.77	8.93	0.98	2.70	0.44	0.62
Reach-1	46508	5-Year	18.39	99.78	100.85	100.85	101.28	0.012657	6.97	9.30	0.99	2.97	0.54	0.71
Reach-1	46508	2-Year (est.)	13.52	99.78	100.69	100.69	101.04	0.013079	5.55	8.86	0.98	2.66	0.41	0.60
Reach-1	46505	100-Year	32.72	99.42	101.17		101.37	0.004057	25.85	33.07	0.59	2.35	0.43	0.77
Reach-1	46505	50-Year	21.70	99.42	100.65	100.59	100.95	0.008630	12.50	20.50	0.80	2.66	0.39	0.80
Reach-1	46505	25-Year	18.60	99.42	100.51	100.51	100.84	0.011104	9.70	18.08	0.89	2.76	0.30	0.78
Reach-1	46505	10-Year	14.20	99.42	100.44	100.36	100.68	0.008561	8.54	16.97	0.77	2.31	0.18	0.62
Reach-1	46505	5-Year	18.39	99.42	100.50	100.50	100.83	0.011144	9.58	17.97	0.89	2.75	0.29	0.77
Reach-1	46505	2-Year (est.)	13.52	99.42	100.45	100.34	100.66	0.007527	8.66	17.09	0.73	2.18	0.18	0.59
Reach-1	46500	100-Year	32.72	98.97	101.17		101.25	0.001110	45.03	44.65	0.34	1.46	0.33	0.40
Reach-1	46500	50-Year	21.70	98.97	100.62		100.71	0.002005	24.14	31.58	0.43	1.57	0.38	0.39
Reach-1	46500	25-Year	18.60	98.97	100.33		100.48	0.003771	15.92	26.38	0.56	1.85	0.42	0.42
Reach-1	46500	10-Year	14.20	98.97	100.01	99.95	100.24	0.008722	8.54	19.44	0.81	2.22	0.47	0.41
Reach-1	46500	5-Year	18.39	98.97	100.32		100.47	0.003897	15.52	25.96	0.57	1.86	0.42	0.42
Reach-1	46500	2-Year (est.)	13.52	98.97	99.96	99.93	100.21	0.010276	7.57	18.03	0.87	2.30	0.47	0.41
Reach-1	46400	100-Year	32.72	98.37	101.14	99.53	101.17	0.000368	78.90	93.55	0.20	0.89	0.18	0.18
Reach-1	46400	50-Year	21.70	98.37	100.46	99.25	100.54	0.001189	20.13	78.38	0.33	1.23	0.05	0.05
Reach-1	46400	25-Year	18.60	98.37	100.22	99.17	100.29	0.000795	15.35	59.04	0.28	1.21		
Reach-1	46400	10-Year	14.20	98.37	99.90	99.04	99.97	0.000864	12.74	40.07	0.29	1.11		
Reach-1	46400	5-Year	18.39	98.37	100.20	99.16	100.28	0.000800	15.22	57.59	0.29	1.21		
Reach-1	46400	2-Year (est.)	13.52	98.37	99.86	99.02	99.92	0.000867	12.35	39.16	0.29	1.09		
Reach-1	46350		Culvert											
Reach-1	46349	100-Year	32.72	98.37	100.97	99.56	101.09	0.004262	21.07	8.32	0.31	1.55		
Reach-1	46349	50-Year	21.70	98.37	100.31	99.28	100.41	0.005078	15.62	8.32	0.32	1.39		
Reach-1	46349	25-Year	18.60	98.37	100.11	99.19	100.20	0.005467	13.93	8.32	0.32	1.34		
Reach-1	46349	10-Year	14.20	98.37	99.82	99.05	99.90	0.001681	11.62	8.00	0.32	1.22		
Reach-1	46349	5-Year	18.39	98.37	100.10	99.19	100.19	0.005489	13.82	8.32	0.32	1.33		
Reach-1	46349	2-Year (est.)	13.52	98.37	99.78	99.03	99.85	0.001670	11.27	8.00	0.32	1.20		
Reach-1	46348		Culvert											
Reach-1	46287	100-Year	32.72	97.92	100.69		100.83	0.000977	20.43	13.31	0.33	1.61	1.37	1.57
Reach-1	46287	50-Year	21.70	97.92	100.24		100.32	0.000854	16.62	11.66	0.30	1.31	1.11	1.29
Reach-1	46287	25-Year	18.60	97.92	100.08		100.15	0.000832	15.27	10.36	0.29	1.22	1.03	1.21
Reach-1	46287	10-Year	14.20	97.92	99.82		99.88	0.000795	13.17	10.05	0.27	1.08	0.90	1.08
Reach-1	46287	5-Year	18.39	97.92	100.06		100.14	0.000830	15.18	10.34	0.29	1.22	1.02	1.21
Reach-1	46287	2-Year (est.)	13.52	97.92	99.78		99.84	0.000790	12.81	10.00	0.27	1.06	0.88	1.06
Reach-1	46284	100-Year	32.72	97.91	100.53		100.78	0.003229	27.45	22.04	0.61	3.09	0.82	0.69
Reach-1	46284	50-Year	21.70	97.91	100.05		100.28	0.003433	18.05	15.74	0.61	2.78	0.74	0.68
Reach-1	46284	25-Year	18.60	97.91	99.91		100.11	0.003258	15.98	13.99	0.58	2.59	0.69	0.69
Reach-1	46284	10-Year	14.20	97.91	99.66		99.84	0.003289	12.73	12.52	0.57	2.38	0.63	0.63
Reach-1	46284	5-Year	18.39	97.91	99.90		100.10	0.003259	15.83	13.93	0.58	2.58	0.69	0.69
Reach-1	46284	2-Year (est.)	13.52	97.91	99.62		99.80	0.003294	12.21	12.27	0.57	2.35	0.62	0.62
Reach-1	46264	100-Year	32.72	97.90	100.45		100.72	0.003498	24.86	17.45	0.63	3.15	0.84	0.84
Reach-1	46264	50-Year	21.70	97.90	99.96		100.21	0.003825	17.07	14.53	0.64	2.86	0.76	0.76
Reach-1	46264	25-Year	18.60	97.90	99.80		100.03	0.003956	14.82	13.57	0.64	2.76	0.73	0.74
Reach-1	46264	10-Year	14.20	97.90	99.55		99.76	0.004153	11.61	12.04	0.64	2.57	0.68	0.69
Reach-1	46264	5-Year	18.39	97.90	99.79		100.02	0.003963	14.67	13.50	0.64	2.75	0.73	0.73
Reach-1	46264	2-Year (est.)	13.52	97.90	99.51		99.72	0.004191	11.10	11.79	0.64	2.54	0.68	0.68
Reach-1	46244	100-Year	32.72	97.70	100.34		100.64	0.003589	23.41	15.94	0.64	3.27	0.86	0.85
Reach-1	46244	50-Year	21.70	97.70	99.88		100.13	0.003502	16.76	13.36	0.61	2.84	0.75	0.75
Reach-1	46244	25-Year	18.60	97.70	99.73		99.96	0.003482	14.78	12.57	0.61	2.70	0.71	0.71
Reach-1	46244	10-Year	14.20	97.70	99.49		99.69	0.003441	11.87	11.30	0.59	2.47	0.65	0.65
Reach-1	46244	5-Year	18.39	97.70	99.72		99.95	0.003480	14.65	12.51	0.60	2.69	0.71	0.71
Reach-1	46244	2-Year (est.)	13.52	97.70	99.44		99.64	0.003433	11.41	11.08	0.59	2.43	0.64	0.64
Reach-1	46224	100-Year	32.72	97.65	100.28		100.57	0.003470	23.53	15.39	0.63	3.21	0.89	0.85

APPENDIX E – COST ESTIMATE

CARP CREEK - COST ESTIMATE

COST PROVIDED BY :	McIntosh Perry Consulting Engineers
PROJECT NAME:	CARP CREEK
PROJECT NUMBER:	CM-17-0429-02

BANK STABILIZATION

DESCRIPTION	QTY.	UNIT	UNIT COST	TOTAL
Traffic Control	1.00	LS	$5,000.00	$5,000.00
Pedestrian Traffic Control	1.00	LS	$3,000.00	$3,000.00
Erosion and Sediment Control Plan & Monitoring	1.00	LS	$3,000.00	$3,000.00
Erosion and Sediment Control measures	1.00	LS	$5,000.00	$5,000.00
Fish Removal Plan and Implementation	1.00	LS	$5,000.00	$5,000.00
Clearing and Grubbing	1.00	LS	$3,000.00	$3,000.00
Remove/Replace existing Asphalt Pathway	1.00	LS	$5,000.00	$5,000.00
Access to work Area and Site Restoration	1.00	LS	$10,000.00	$10,000.00
Earth Excavation - Grading	500.00	m^3	$48.00	$24,000.00
Temporary Flow Passage System - Dewatering	1.00	LS	$15,000.00	$15,000.00
Rip Rap	260.00	m^2	$75.00	$19,500.00
Geotextile for rip rap and rock Protection	260.00	m^2	$12.00	$3,120.00
Plantings	1	LS	15%	$15,093.00
LANDSCAPING	1	LS	15%	$17,356.95
MOBILIZATION/DEMOBILIZATION	1	LS	15%	$17,356.95
UTILITIES	1	LS	15%	$17,356.95
MISC. SOFT COSTS	2	LS	5%	$5,785.65
CONTINGENCY	3	LS	25%	$28,928.25
			SUB-TOTAL	**$202,497.75**

APPENDIX F – DETAILED ENVIRONMENTAL ANALYSIS TABLE

Screening Criteria	Rating of Potential Effect								Comments
	-H	-M	-L	NIL	+L	+M	+H	NA	
Physical									
Unique Landforms								•	No unique landforms were identified within the study area.
Existing Mineral/Aggregate Resources Extraction Industries								•	No extraction industry operations have been identified in the study area.
Earth Science - Areas of Natural and Scientific Interest (ANSI)								•	There are no Earth Science ANSIs in the local study area.
Specialty Crop Areas								•	No specialty crop areas were identified in the study area.
Agricultural Lands or Production								•	No agricultural lands or production were identified in the study area.
Niagara Escarpment								•	The study area is outside of the Niagara Escarpment.
Oak Ridges Moraine								•	The study area is outside of the Oak Ridges Moraine.
Environmentally Sensitive/Significant Areas (physical)								•	No environmentally sensitive/significant areas have been identified in the study area. See Section 7.1.1.1 for more information.
Air Quality			•						The air quality in the project area is determined by the air quality in the City of Ottawa, where the sources are primarily regional and international. Temporary negative effects associated with construction activities are possible within the study area, and the lands immediately surrounding it. Mitigation measures will be in place to minimize the impact. See Section 7.1.1.2 for more information.
Agricultural Tile or Surface Drains								•	No agricultural drains were found within the study area. Any drains in the surrounding area are not expected to be impacted.
Noise Levels and Vibration			•						Noise and vibration levels in the study area and lands immediately surrounding it may be affected during the proposed construction. Mitigation measures will be in place to minimize the impact. See Section 7.1.1.3 for more information.
High/Storm Water Flow Regime				•					The project activities are not expected to affect the water level regime in Carp Creek. Flow from Carp Creek will be redirected around the study area during the construction activities. The proposed alternative will have minimal disruptions to the flow regime.
Low/Base Water Flow Regime				•					The project activities are not expected to affect the water level regime in Carp Creek. Flow from Carp Creek will be redirected around the study area during the construction activities. The proposed alternative will have minimal disruptions to the flow regime.
Existing Surface Drainage and Groundwater Seepage			•						Minor negative effects on the existing surface drainage path may occur within the study area as a result of construction activities. A number of mitigation measures will be used to minimize disturbance to existing surface drainage paths during construction. Post- construction site restoration is anticipated to minimize the impacts to ensure that there are no long-term adverse effects on surface drainage and groundwater seepage. See Section 7.1.1.4 for more information.
Groundwater Recharge/Discharge Zones				•					The project activities are not expected to affect the groundwater recharge and discharge zones within the study area.
Falls within a vulnerable area as defined by the Clean Water Act								•	The study area does not fall within a vulnerable area as defined by the Clean Water Act. The study area is not within Ottawa's source water protection areas.
Littoral Drift				•					The preferred alternative's effect on sediment transport in the littoral zone in the study area is anticipated to be neutral. While the proposed works are expected to stabilize the embankment and prevent sediment deposition in Carp Creek, sediment deposition in areas outside of the live bank/bio-engineered treatment area would continue, and no disruptions in the overall sediment transport pattern are anticipated.
Other Coastal Processes								•	N/A
Water Quality		•							Negative impacts on water quality may include increases in turbidity during construction. However, the preferred alternative is predicted to prevent further erosion on the embankment, which will decrease the amount of sediment deposition in the watercourse. Overall, construction-related negative effects on water quality have been deemed acceptable as the preferred alternative offers the potential for improved water quality in the long term. See Section 7.1.1.5, 7.1.1.6, 7.2.1.1 and 7.2.1.2 for more information.
Soil/Fill Quality				•					Shore infilling is required on the embankment to backfill the erosion in concurrence with the installation of the preferred alternative. Appropriate guidelines, such as MECP Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario, will be followed to ensure that the proposed works do not result in negative impacts.

Screening Criteria	Rating of Potential Effect								Comments
	-H	-M	-L	NIL	+L	+M	+H	NA	
Contaminated Soils/Sediments/Seeps				•					No known contaminated soils, sediments or seeps occur within the study area. MECP Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario, will be followed to ensure no negative impacts occur. See Section 7.2.1.3 for more information.
Existing Transportation Routes			•						In the lands surrounding the study area, there is a potential for increase in truck traffic, and temporary multi-use/pedestrian trail closures that may occur during the construction phase. Mitigation measures, such as alternative routes, are anticipated to minimize the impacts. In the long term, the preferred alternative is not expected to have any effects on the surrounding multi-use/pedestrian trail surrounding the study area. See Section 7.1.3.4 for more information.
Constructed Crossings (e.g. bridges, culverts)				•					There is a pedestrian bridge crossing the Carp Creek, adjacent to the study area. It is anticipated that this bridge will not be affected during construction activities or effected by the preferred alternative.
Geomorphology							•		The study area is within the Ottawa Valley Clay Plains, which leads to poor infiltration and flooding. This leads to shallow interflow and overland flow, resulting in accelerated erosion. The preferred alternative is expected to reduce the impacts from the shallow interflow and overland flow, thereby preventing erosion on the embankment.
Other								•	N/A
Biological									
Wildlife Habitat			•						Within the study area, wildlife habitat is expected to be affected during the proposed construction activities. Habitat disturbances, such as vegetation removal during site preparation and construction-related increase in noise and disruption, are anticipated to be reduced through conscientious site design, and conforming to breeding and migratory bird timing windows and post-construction site restoration regulations. See Section 7.1.2.1 for more information.
Habitat Linkages or Corridors				•					The proposed works are not anticipated to have any impacts on the existing habitat linkages or corridors in the study area.
Significant Vegetation Communities			•						Potential negative impacts associated with construction activities may occur within the study area. These impacts included vegetation removal during access to the river embankment. Impacts are anticipated to be mitigated through minimizing vegetation loss and post-construction site restoration for vegetation reestablishment. See Section 7.1.2.2 for more information.
Environmentally Sensitive/Significant Areas (biological)								•	No environmentally sensitive/significant areas have been identified in the study area.
Fish Habitat			•						Fish are anticipated to be displaced as a result of increases in noise and vibration as well as localized increases in turbidity associated with construction within the study area. Best environmental management practices will be followed to minimize the impacts to fish habitat. In the long-term, the preferred alternative will provide opportunities to improve fish/aquatic habitat within the study area. See Section 7.1.2.3 for more information.
Species of Concern (e.g. species at risk, vulnerable/threatened/endangered species, conservation priorities - either flora or fauna)			•						There is the potential for certain species at risk habitat to be present within the study area. Mitigation measures will be put in place during construction to avoid impacts to the species of concern and their habitat. Post-construction site restoration will ensure that no long-term adverse effects occur. The preferred alternative is not expected to have any long-term effects on species of concern. See Section 7.1.2.4 for more information.
Exotic/Alien and Invasive Species				•					The potential impacts associated with exotic/alien and invasive species are not anticipated, as the proposed works would involve small amount of soil used to backfill the eroded embankment, which is not likely to introduce exotic invasive plant species. The post-construction site restoration would involve site appropriate native species to minimize the establishment of non-native and/or invasive species.
Wildlife/Bird Migration Patterns			•						Since the project activities are localized to the study area, and the study area does not play a significant role in conveying wildlife movement, bird migration patterns are not expected to be affected. See Section 7.1.2.1 for more information.
Wildlife Population			•						Impacts on wildlife within the study area, as well as adjacent lands, are likely a result of displacement during construction. Mitigation measures minimizing negative impacts on existing habitat, and post-construction site restoration, are anticipated to reduce the impacts.
Wetlands								•	No wetlands have been identified in the study area, or in the immediate surrounding area.

Screening Criteria	Rating of Potential Effect								Comments
	-H	-M	-L	NIL	+L	+M	+H	NA	
Microclimate				•					While highly localized changes in the study area water temperature may occur during construction, the overall impacts on the study area microclimate are expected to be neutral.
Life Science ANSIs								•	No life science ANSIs have been identified in the study area, or in the immediate surrounding area.
Unique Habitats								•	No unique habitats were identified within the study area.
Other								•	N/A
Cultural									
Traditional Land Uses				•					No impacts on the Traditional Land Uses are expected as no concerns have been raised by the Aboriginal Communities during consultation.
Aboriginal Community or Reserve				•					No impacts on the Aboriginal Community or Reserve are expected as no concerns have been raised by the Aboriginal Communities during consultation.
Outstanding Native Land Claim as identified by the Aboriginal Community				•					No impacts on Outstanding Native Land Claim are expected as no concerns have been raised by the Aboriginal Communities during consultation.
Transboundary Water Management Issues								•	No Transboundary Water Management issues concerning the study area have been identified.
Riparian Uses			•						The riparian area within the study area will be temporarily disrupted during construction (i.e. vegetation removal, site access, etc.). Mitigation measures during construction, and post-construction restoration is anticipated to reduce the impacts. See Section 7.1.2.2 for more information.
Recreational or Tourist Uses of a Water Body and/or Adjacent Lands			•						The recreational parks that are adjacent to the study area may be temporarily disrupted from construction activities (i.e. from an increase in noise). However, the construction will be of a short-term duration, and the preferred alternative will have no long-term impacts on the recreational parks. See Section 7.1.3.1 for more information.
Recreational or Tourist Uses of Existing Shoreline Access			•						The multi-use/pedestrian trail surrounding the study area may be temporarily closed during construction. Mitigation measures, such as an alternative path, will be put in place to limit the impacts to recreational or tourist use of the pathway surrounding Carp Creek. See Section 7.1.3.1 for more information.
Aesthetic or Scenic Landscapes or Views					•				In the study area, temporary aesthetic negative effects may be associated with construction activities. However, in the long-term, the preferred alternative will be aesthetically pleasing (as compared to the continuously eroding embankment).
Archaeological Resources				•					The Stage 1 and Stage 2 Archaeological assessment that was conducted for the study area determined that there were no archaeological resources within the study area. Therefore, it is expected that there will be no impacts on Archaeological Resources associated with the proposed works. See Section 7.1.3.3 for more information.
Built Heritage Resources				•					There are no significant heritage features within the study area. Therefore, it is expected that there will be no impacts on built heritage resources associated with the proposed works. See Section 7.1.3.2 for more information.
Cultural Heritage Landscapes				•					There are no significant heritage features within the study area. Therefore, it is expected that there will be no impacts on cultural heritage landscapes associated with the proposed works. See Section 7.1.3.2 for more information.
Historic Canals								•	There are no historic canals within or immediately surrounding the study area.
Federal Property								•	There is no federal property within or immediately surrounding the study area.
Heritage River System					•				The Carp River discharges into the Ottawa River, which is part of the Heritage River System. Mitigation measures will be put in place during construction to limit the disturbance in Carp Creek, subsequently limiting the disturbance in the Ottawa River. In the long-term, the preferred alternative will be beneficial for Carp Creek, subsequently benefiting the Ottawa River.
Other								•	N/A
Socioeconomic									

Screening Criteria	Rating of Potential Effect								Comments
	-H	-M	-L	NIL	+L	+M	+H	NA	
Surrounding Neighbourhood or Community				•					Within the surrounding area of the study area, the proposed construction works may affect residents closest to the study area as a result of an increase in noise levels, potential trail closures, and potential increase in truck traffic. These temporary impacts are anticipated to be minimized by appropriate measures such as noise by-law enforcement, alternative routes for pedestrians, and traffic management plans. In the long term, the preferred alternative will prevent the embankment from eroding further towards the surrounding community.
Surrounding Land Uses or Growth Pressure				•					The surrounding land use consists of residences, A.Y. Jackson Secondary School, Hope Cloutier Park, and the Frank MacDonald Ball Park. The surrounding land use is not anticipated to be affected by the proposed works.
Existing Infrastructure, Support Services, Facilities				•					The facilities surrounding the study area (A.Y. Jackson Secondary School, Hope Cloutier Park and Frank MacDonald Park) are not anticipated to be affected by the proposed works. Mitigation measures will be put in place to ensure that the Construction access and staging areas are located away from the facilities.
Pedestrian Traffic Routes			•						In the lands surrounding the study area, there is a potential for temporary multi-use/pedestrian trail closures that may occur during the construction phase. Mitigation measures, such as alternative routes, are anticipated to minimize the impacts. In the long term, the preferred alternative is not expected to have any effects on the multi-use/pedestrian trail surrounding the study area. See Section 7.1.3.4 for more information.
Property Values or Ownership				•					No effects on property values or ownership are expected in the area surrounding the study area.
Existing Tourism Operations				•					No impacts area expected on existing tourism operations within the study area, and surrounding area.
Property /Farm Accessibility				•					No impacts on property accessibility is anticipated in the local area surrounding the study area.
Other								•	N/A
Engineering/Technical									
Rate of Erosion in Ecosystem							•		The rate of erosion in the ecosystem in the study area will be reduced as a result of the proposed works. By stabilizing the embankment with the preferred alternative, the rate of the erosion on the embankment will drastically decrease, which will prevent sediment deposition within Carp Creek.
Sediment Deposition Zones in Ecosystem				•					See Littoral Drift criterion.
Flood Risk in Ecosystem				•					It is anticipated that the preferred alternative will not have an effect on the flood risk in the ecosystem in the study area.
Slope Stability							•		The slope of the embankment in the study area is eroding away. The preferred alternative includes backfilling and grading the eroded area back to a stable slope and stabilizing the embankment with a live bank/bio-engineered treatment. These proposed works will help to stabilize the slope and soil of the embankment.
Existing Structures				•					No impact on existing structures in the area surrounding the study area is expected. There is a pedestrian bridge crossing the Carp Creek, adjacent to the study area. It is anticipated that this bridge will not be affected during construction activities or effected by the preferred alternative. There are no existing structures in the immediate study area.
Hazardous Lands								•	No impacts on hazardous lands within the surrounding area is expected to occur as the project activities are localized to the study area. The study area does not contain hazardous lands.
Hazardous Sites								•	No impacts on hazardous sites within the surrounding area is expected to occur as the project activities are localized to the study area. No hazardous sites were identified in the local study area.
Other								•	N/A

(-H) = highly negative; (-M) = moderately negative; (-L) = minor negative; (NIL) = neutral or none; (+L) = minor positive; (+M) = moderately positive; (+H) = highly positive; (NA) = not applicable.

APPENDIX G – CONTACT LIST, NOTICES AND LETTERS

Re: Site Meeting Invitation for the Carp Creek Embankment Restoration Project

Dear Resident,

A portion of the south embankment of Carp Creek is excessively eroding, resulting in a steep cut or “scarp” that will continue to erode adjacent public property if no action is taken.

A Class Environmental Assessment (Class EA) was initially completed for the Carp Creek Embankment Restoration from September 2017 to December 2018. Through the EA process, it was determined that the Technically Preferred Alternative was to partially realign Carp Creek, install a live crib wall, and provide plantings and erosion protection to protect the toe of slope and other points along the creek. However, upon further consultation during the detail design phase, the City requested that an alternative design concept be considered. The new alternative, based on natural channel principles, is intended to provide more room for the creek’s natural functions and will reduce the amount of infrastructure requiring long-term maintenance.

In advance of revising the Class EA, we would like to meet with you on-site to present the new alternative and receive your feedback. Shortly after this meeting, an addendum to the Class EA will be prepared, and a public information session will be held on-line to present the results to the general public.

The site visit will be held on **November 26, 2020 at 3:00 pm** on the north side of the creek across from the eroded slope, in Hope Cloutier Park. The attached figure shows the meeting location. Staff from the City of Ottawa, Mississippi Valley Conservation Authority, and study consultant team will be on-site to answer your questions. Please note that this invitation has been sent to homes between 163 and 177 Old Colony Road only, to limit attendance.

To comply with COVID-19 safety guidelines, we ask that you perform a self-assessment (attached) before attending the session, and when on-site wear a cloth mask, maintain a physical distance of 2 metres from others and exercise good hand hygiene to reduce risks associated with transmission. Please note that these measures may change based on regulatory updates that may be made between today and November 26.

If you have any questions, or need more information, please contact Laurent Jolliet, Project Specialist, Stormwater Management, Public Works and Environmental Services, by phone at 613-809-8540 or by e-mail at Laurent.Jolliet@ottawa.ca.

Looking forward to meeting you,

Laurent Jolliet
Project Specialist, Stormwater
City of Ottawa

Location Plan

STOP COVID-19

Do you have any of the following new or worsening symptoms?

Fever/Chills

Cough

Difficulty breathing/ Shortness of breath

Sore throat/ Difficulty swallowing

Runny nose (unrelated to seasonal allergies)

Loss of taste or smell

Not feeling well, headache, unexplained tiredness and muscle aches

Nausea, vomiting, diarrhea, abdominal pain

In the last 14 days, have you had close physical contact with a person who:

- was sick with a respiratory illness (had a new or worsening cough, fever or difficulty breathing)?
- has returned from travel outside of Canada in the last 14 days?
- was a confirmed or probable case of COVID-19?

In the last 14 days, have you travelled outside of Canada?

If you answered **YES** to any of these questions, **please return home and self-isolate.**
Visit **OttawaPublicHealth.ca/COVIDCentre** for more information about getting tested.

If you are feeling unwell, contact your health care provider or call **Telehealth Ontario** at **1-866-797-0000** to speak to a registered nurse.

Adapted with permission from Toronto Public Health

17/06/2020

Objet : Projet de restauration de la berge du ruisseau Carp - Invitation à la réunion sur les lieux

Madame, Monsieur,

Une partie de la berge sud du ruisseau Carp est excessivement érodée, ce qui donne lieu à une berge abrupte ou à un « escarpement » qui continuera d'éroder la propriété publique adjacente si aucune mesure n'est prise.

Une évaluation environnementale de portée générale a d'abord été réalisée pour la restauration de la berge du ruisseau Carp, de septembre 2017 à décembre 2018. Dans le cadre de ce processus d'évaluation, il a été déterminé que la solution privilégiée sur le plan technique consistait à réaligner partiellement le ruisseau Carp, à installer un mur de soutènement, et à fournir une protection des plantations et une protection contre l'érosion pour protéger la base de la pente et d'autres points le long du ruisseau. Toutefois, après d'autres consultations au cours de l'étape de conception détaillée, la Ville a demandé qu'un autre plan conceptuel soit envisagé. La nouvelle solution, fondée sur les principes du lit naturel du cours d'eau, vise à donner plus de place aux fonctions naturelles du ruisseau et à réduire la quantité d'infrastructures exigeant un entretien à long terme.

Avant la révision de l'évaluation environnementale de portée générale, nous aimerions vous rencontrer sur place pour vous présenter la nouvelle solution et recevoir vos commentaires. Peu après cette réunion, un addenda sera préparé et une séance d'information publique sera tenue en ligne pour présenter les résultats au grand public.

La visite aura lieu le **26 novembre 2020, à 15 h**, au parc Hope-Cloutier, du côté nord du ruisseau, en face de la pente érodée. L'image ci-dessous indique le lieu de la réunion. Des membres du personnel de la Ville d'Ottawa, de l'Office de protection de la nature de la vallée du Mississippi et de l'équipe de conseillers chargée de l'étude seront sur place pour répondre à vos questions. Veuillez noter que cette invitation a uniquement été envoyée aux résidences situées entre le 163 et le 177, chemin Old Colony, afin de limiter le nombre de participants.

Afin de respecter les directives en matière de sécurité liées à la COVID-19, nous vous demandons de procéder à une autoévaluation (ci-jointe) avant de participer à la rencontre et, lorsque vous serez sur place, de porter un masque en tissu, de maintenir une distance physique de deux mètres avec les autres personnes et de bien vous désinfecter les mains pour réduire les risques associés à la transmission du virus. Veuillez noter que ces mesures pourraient être modifiées en fonction des mises à jour réglementaires qui pourraient avoir lieu d'ici le 26 novembre.

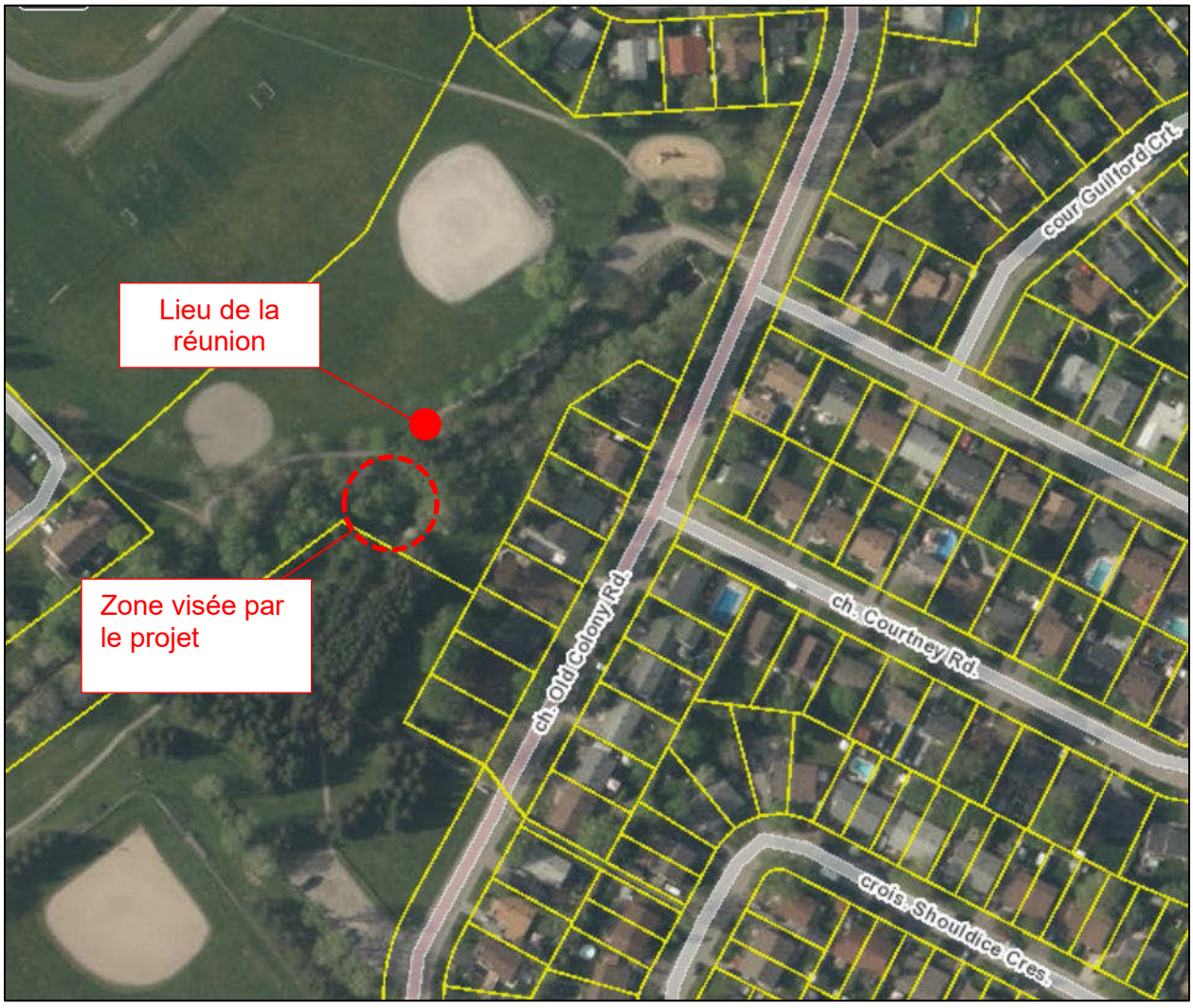
Si vous avez des questions ou si vous souhaitez obtenir de plus amples renseignements, veuillez communiquer avec Laurent Jolliet, spécialiste de projet, Gestion des eaux pluviales, Direction générale des travaux publics et de

l’environnement, en composant le 613-809-8540 ou en envoyant un message à l'adresse suivante : laurent.jolliet@ottawa.ca.

Au plaisir de vous rencontrer,

Laurent Jolliet
Spécialiste de projet, Gestion des eaux pluviales
Ville d’Ottawa

Plan du site



ARRÊT COVID-19

Présentez-vous l'un de ces nouveaux symptômes ou une aggravation de ceux-ci?

Fièvre / frissons

Toux

Essoufflement / difficulté à respirer

Mal de gorge / Difficulté à avaler

Écoulement nasal (sans lien avec les allergies saisonnières)

Perte du sens du goût ou de l'odorat

Malaise / mal de tête / fatigue inexpliquée et douleurs musculaires

Nausée / vomissement / diarrhée / douleur abdominale

Au cours des 14 derniers jours, avez-vous été en contact physique proche avec une personne qui :

- avait une maladie respiratoire (présentait une nouvelle toux ou une aggravation de la toux, de la fièvre ou des difficultés respiratoires)?
- est revenue d'un séjour à l'extérieur du Canada au cours des derniers 14 jours?
- était un cas confirmé ou présumé de la COVID-19?

Au cours des 14 derniers jours, avez-vous voyagé à l'extérieur du Canada?

Si vous avez répondu **OUI** à l'une de ces questions, **veuillez rentrer à la maison ou y rester, puis vous isoler**. Rendez-vous sur **SantePubliqueOttawa.ca/CliniqueCOVID** pour en savoir plus sur le dépistage.

Si vous ne vous sentez pas bien, appelez votre fournisseur de soins de santé ou encore **Télésanté Ontario** au **1-866-797-0000** pour parler à une infirmière autorisée.

Adapté avec permission de Toronto Public Health

17/06/2020

SantePubliqueOttawa.ca/CoronavirusFR

Ottawa | Santé publique Public Health

McINTOSH PERRY

January 28, 2021

Enter Name and Title
Enter Address
Enter City, Province
Enter Postal Code

Dear Name:

Re: Notice of Public Information - Carp Creek Embankment Restoration
Class Environmental Assessment Addendum

The Mississippi Valley Conservation Authority (MVCA) has retained McIntosh Perry Consulting Engineers to complete a study regarding the Carp Creek Embankment Restoration located within Glen Cairn community between Terry Fox Drive and Eagleson Road (see attached key plan). This project is being considered in order to provide protection to the Carp Creek embankment which is currently unstable due to flooding and severe erosion occurring primarily along the southeast embankment. This study was initiated to solely address embankment erosion within the study area limits and will not address and/or rectify any recent flooding issues.

In accordance with the guidance document for Conservation Ontario Class Environmental Assessment, January 2002, as amended June 2013, an addendum should be undertaken should a "change in an environmental setting, or other unforeseen circumstances may necessitate a change to the proposed undertaking". In December 2019, the City of Ottawa requested that an alternate solution consisting of regrading of the embankment be considered to provide more floodplain storage and energy dissipation. Therefore, an addendum to the original Class EA was prepared to provide an opportunity for governing agencies, stakeholders and the public to provide comments, evaluate the proposed alternative solution and ensure that the mitigation measures are still valid for the Technically Preferred Alternative.

The study team invites you to participate in the study addendum. A preliminary Project Plan Addendum report is currently available for viewing on the MVCA website (mvc.on.ca/carp-creek) along with a public information presentation which can be viewed at anytime. **Please email us your comments by February 11, 2021.** The study team will review all comments and respond to any concerns or questions before the Class EA report is completed.

For further information on this project please contact the following:

Juraj Cunderlik, Ph.D., P.Eng.
Director, Water Resources Engineering
Mississippi Valley Conservation Authority
Phone: 613-253-0006 Ext. 233
jcunderlik@mvc.on.ca

Lisa Marshall, P.Eng.
Project Manager/Environmental Engineer
McIntosh Perry Consulting Engineers Ltd.
Phone: 613-714-0815
l.marshall@mcintoshperry.com

Laurent Jolliet, Project Specialist
Public Works and Environmental Services
Phone: 613-809-8540
Laurent.Jolliet@ottawa.ca

Thank you for your anticipated assistance and cooperation.

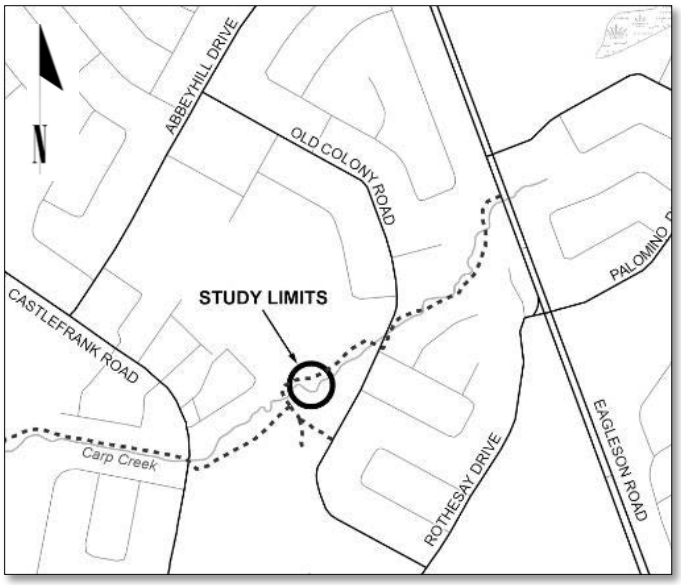
Sincerely,
McIntosh Perry Consulting Engineers

Lisa Marshall, P.Eng.
Project Manager

Pour des renseignements en français au sujet de ce projet, veuillez rejoindre Laurent Jolliet en composant le 613-809-8540 ou par courriel au Laurent.Jolliet@ottawa.ca

NOTICE OF PUBLIC INFORMATION
CARP CREEK EMBANKMENT RESTORATION
CLASS ENVIRONMENTAL ASSESSMENT ADDENDUM

The Mississippi Valley Conservation Authority (MVCA) has retained McIntosh Perry Consulting Engineers to complete a study regarding the Carp Creek Embankment Restoration located within Glen Cairn community between Terry Fox Drive and Eagleson Road. This project is being considered in order to provide protection to the Carp Creek embankment which is currently unstable due to flooding and severe erosion occurring primarily along the southeast embankment. This study was initiated to solely address embankment erosion within the study area limits and will not address and/or rectify any recent flooding issues.



In accordance with the guidance document for Conservation Ontario Class Environmental Assessment, January 2002, as amended June 2013, an addendum should be undertaken should a "change in an environmental setting, or other unforeseen circumstances may necessitate a change to the proposed undertaking". In December 2019, the City of Ottawa requested that an alternate solution consisting of regrading of the embankment be considere d to provide more floodplain storage and energy dissipation. Therefore, an addendum to the original Class EA was prepared to provide an opportunity for governing agencies, stakeholders and the public to provide comments, evaluate the proposed alternative solution and ensure that the mitigation measures are still valid for the Technically Preferred Alternative.

The study team invites you to participate in the study addendum. A preliminary Project Plan Addendum report is currently available for viewing on the MVCA website (mvc.on.ca/carp-creek), along with a public information presentation which can be viewed at anytime. **Please email us your comments by February 11, 2021**. The study team will review all comments and respond to any concerns or questions before the Class EA report is completed.

For further information on this project please contact:

Juraj Cunderlik, Ph.D., P.Eng.
Director, Water Resources Engineering
Mississippi Valley Conservation Authority
Phone: 613-253-0006 Ext. 233
jcunderlik@mvc.on.ca

Lisa Marshall, P.Eng.
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McIntosh Perry Consulting Engineers Ltd.
Phone: 613-714-0815
l.marshall@mcintoshperry.com

Laurent Jolliet, Project Specialist
Public Works and Environmental Services
Phone: 613-809-8540
Laurent.Jolliet@ottawa.ca

This notice issued **January 28, 2021.**

McINTOSH PERRY

February 15, 2021

Enter Name and Title
Enter Address
Enter City, Province
Enter Postal Code

Dear Name:

Re: Notice of Filing of an Addendum Document for Review - Carp Creek Embankment Restoration Class Environmental Assessment

The Mississippi Valley Conservation Authority (MVCA) has retained McIntosh Perry Consulting Engineers to complete a study regarding the Carp Creek Embankment Restoration located within Glen Cairn community between Terry Fox Drive and Eagleson Road. The portion of the creek under investigation runs perpendicular between Castlefrank Road, and Old Colony Road, and is adjacent to the Hope Cloutier Park and A.Y. Jackson High School, City of Ottawa (Figure 1). This project is being considered in order to provide protection to the Carp Creek embankment which is currently unstable due to flooding and severe erosion occurring primarily along the southeast embankment. This study was initiated to solely address embankment erosion within the study area limits and will not address and/or rectify any recent flooding issues.

In 2017/2018, a Project Plan Report was prepared in accordance with the *Class Environmental Assessment for Remedial Flood and Erosion Control Projects*, approved for projects of this type.

As described in the 2017/2018 Project Plan Report, through consultation with agencies, stakeholders and the public, MVCA in cooperation with the City of Ottawa, determined that the Technically Preferred Alternative was a partial realignment of the creek with the installation of a live crib wall, as well as plantings and Rip Rap strategically placed to protect the toe of slope and at transition points along the creek. However, during review of the final detailed design plans and tender, the City of Ottawa requested that an alternate solution consisting of regrading of the embankment be considered to provide more floodplain storage and energy dissipation.

In accordance with the guidance document for Conservation Ontario Class Environmental Assessment, January 2002, as amended June 2013, an addendum should be undertaken should a “change in an environmental setting, or other unforeseen circumstances may necessitate a change to the proposed undertaking”. Therefore, MVCA and City of Ottawa elected to prepare an addendum to the original Class EA to review the planning, provide an opportunity for governing agencies, stakeholders and the public to provide comment and ensure mitigation measures are still valid for the proposed additional alternative solution.

Through the addendum process, it was determined that the Technically Preferred Alternative (TPA) is a partial realignment of the channel to the north and re-grading the eroded embankment within the study area (south bank) back to a stable slope. The re-graded slope will then be stabilized using natural material such as live bank (planting, live stakes, etc.) and Rip Rap Treatment. Slight re-grading of banks upstream and downstream of apex of eroded bank will be required to tie back into the existing embankment. The TPA creates a stable alignment with stable bank

slopes through the placement of stone protection at the toes of slope for immediate erosion protection and plantings for long-term stability along the embankments, top of bank and proposed bench within the floodplain. The TPA also provides more floodplain storage and energy dissipation within study area, as well as provides a natural embankment which will support various terrestrial, fish, aquatic and SAR habitat.

Changes have been outlined in an Addendum to the Project Plan Report. Interested persons are invited to review this addendum document on the Conservation Authority's website at: https://mvc.on.ca/carp-creek or request an electronic copy be emailed to your attention.

You may provide comments via email, within 15 calendar days from the date of this notice to:

Juraj Cunderlik, Ph.D., P.Eng.
Director, Water Resources Engineering
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Subject to comments received as a result of this review and the receipt of necessary approvals and funding, MVCA and the City intends to proceed with the design and construction of this project. If any individual feels that serious environmental concerns remain unresolved after consulting with Conservation Authority staff, it is their right to request that the project be subject to a Part II Order by the Minister of the Environment. Part II Order requests must be received by the Minister, with a copy to the Conservation Authority, at the following address within 15 calendar days (**March 1st, 2021**) following the date of this Notice:

Minister of the Environment
135 St. Clair Avenue West, 15th Floor
Toronto, Ontario
M4V 1P5

Thank you for your anticipated assistance and cooperation.

Sincerely,
McIntosh Perry Consulting Engineers

Lisa Marshall, P.Eng.
Project Manager

Pour des renseignements en français au sujet de ce projet, veuillez rejoindre Laurent Jolliet en composant le 613-809-8540 ou par courriel au Laurent.Jolliet@ottawa.ca

APPENDIX H – PUBLIC INFORMATION PRESENTATION

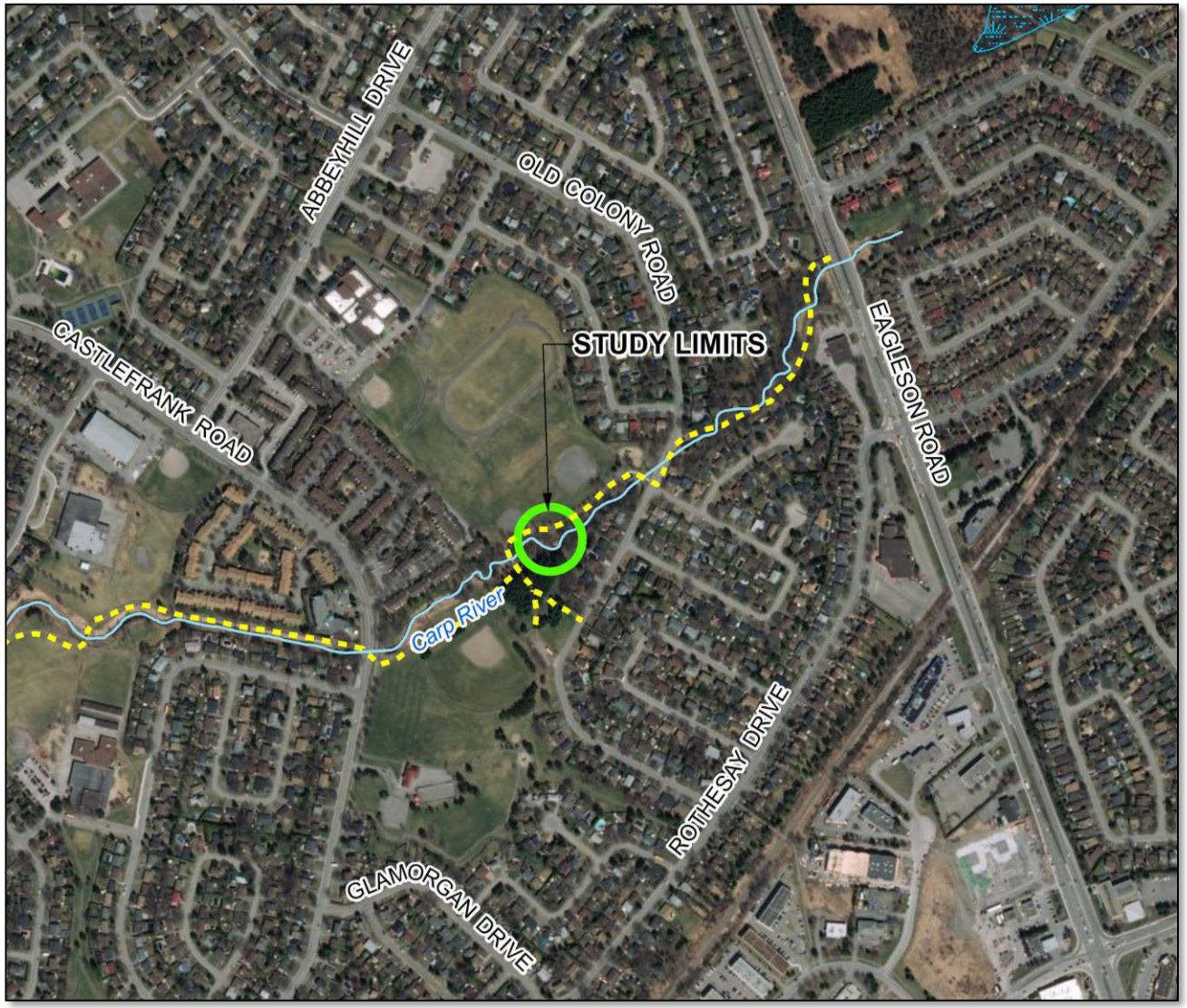
CARP CREEK EMBANKMENT RESTORATION
CONSERVATION ONTARIO CLASS ENVIRONMENTAL ASSESSMENT

PUBLIC INFORMATION CENTRE
JANUARY 2021

CARP CREEK STUDY AREA

The Carp Creek Embankment Restoration study area is located along the Carp Creek within Glen Cairn community, between Terry Fox Drive and Eagleson Road. The portion of creek under investigation runs perpendicular between Castlefrank Road, and Old Colony Road, and is adjacent to the Hope Cloutier Park and A.Y. Jackson High School, within the City of Ottawa.

This Class EA is solely to remediate the severe erosion occurring within the study area limits and will not address and/or deal with recent flooding issues along the Carp Creek/River.



PROJECT BACKGROUND

2011-2013

The City of Ottawa retained the services of JTB Environmental Systems Inc. to assess the existing conditions along the Carp Creek from upstream of the Castlefrank crossing through to Eagleson Road. The Assessment Report identify an area of potential concern east of Castlefrank Road and upstream of the pedestrian bridge crossing.

2017-2018

McIntosh Perry was retained by MVCA to complete a Conservation Ontario Class Environmental Assessment (Class EA), preliminary and detailed design and prepare tender documents for the Carp Creek embankment restoration within the specified study area.

Fall 2019

In fall 2019, McIntosh Perry met with MVCA and City of Ottawa to discuss the selected Technically Preferred Alternative (TPA) for the Carp Creek embankment restoration. At that time, MVCA and the City requested that an additional alternative solution be considered and tendering of the TPA be put on hold.

Winter 2019/Spring 2020

McIntosh Perry further investigated the additional alternative solution which included re-grading the eroded embankment within the study area (south bank) to provide more floodplain storage and dissipate energy. In Spring 2020, MVCA and City of Ottawa decided to undertake a Class EA Addendum to re-evaluate and confirm the TPA.

CONSERVATION ONTARIO CLASS ENVIRONMENTAL ASSESSMENT

Class EA Process

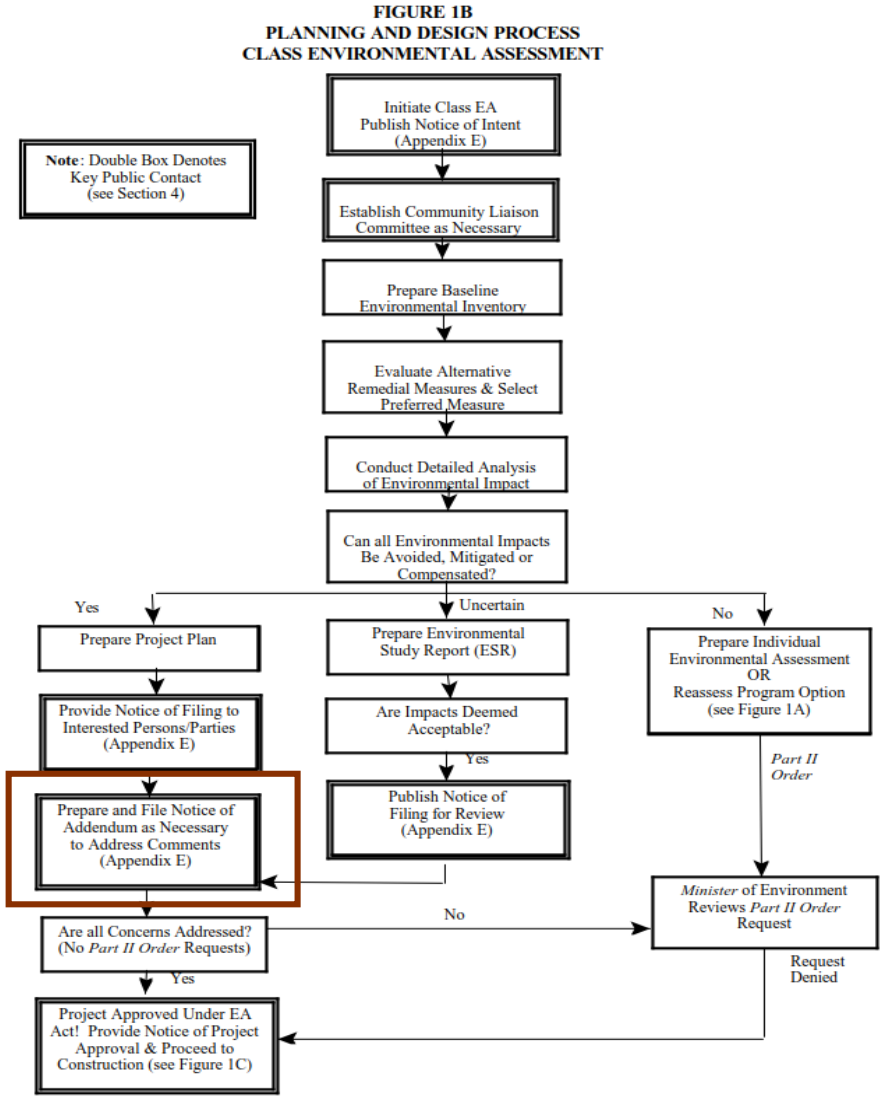
The Carp Creek Embankment Restoration project is following the process outlined in the Conservation Ontario's Class Environmental Assessment for Remedial Flood and Erosion Control Projects.

The process provides a project planning and design framework for proponents (conservation authorities like Mississippi Valley Conservation Authority) to ensure they meet the requirements of the Provincial Environmental Assessment Act.

As part of the process, consultation is required with all stakeholders including the public and agency partners at all stages.

An addendum should be undertaken should a “change in an environmental setting, or other unforeseen circumstances may necessitate a change to the proposed undertaking”.

A Notice of Filing of Addendum should be circulated, and a 15-day review period be provided for public and agency to review the addendum.



We are here

RATIONALE FOR ADDENDUM

Project Objectives

In 2019, MVCA and the City of Ottawa re-evaluated the project and identified the following objectives for this assignment:

- Stabilize the Carp Creek embankment within the study area and prevent any further erosion;
- TPA to be in compliance with the City' draft Official Plan Policy, Section 4.9.2 states "Natural watercourses shall be kept in their natural condition. Where an alteration is assessed as being environmentally appropriate and consistent with a Council-approved study, watercourse alterations shall follow natural channel design". To restore the embankment back to a natural and functional feature of the watercourse.”; and
- To the extent possible, provide more floodplain storage and energy dissipation within study area, while minimizing impacts to the natural environment.

Addendum Process

In accordance with the guidance document for Conservation Ontario Class Environmental Assessment, January 2002, as amended June 2013, Section 3.8, an addendum should be undertaken should a “change in an environmental setting, or other unforeseen circumstances may necessitate a change to the proposed undertaking”. The addendum shall describe the circumstances necessitating the change, the environmental implications of the change and what mitigation methods will be employed to mitigate the negative environmental effects of the change.

PROBLEM STATEMENT/ PURPOSE OF THE UNDERTAKING

The Carp Creek embankment has become unstable due to flooding and severe erosion. The severe erosion is primarily along the southeast embankment. If erosion of the embankment is to continue, it will deposit high levels of sediment into the watercourse, as well as extending into the green space (i.e. forest, parkland, manicured lawns, etc.) along the Carp Creek which is immediately adjacent to residential dwellings. Therefore, the purpose of this undertaking is to identify and deliver an innovative design that will mitigate the erosion of the Carp Creek embankment within the above noted study area.

BASELINE ENVIRONMENTAL INVENTORY

Study Area Description

- Carp Creek is part of the headwater area of the Carp River watershed.
- The creek is located within a forested valley and surrounded by the Glen Cairn community, A.Y. Jackson Secondary School, Hope Cloutier Park, and the Frank MacDonald Ball Park.
- Top of the slope is vegetated with mature trees. A few trees were observed fallen into the creek once undermined by erosion.
- Area beyond mature trees consists of manicured lawns, residential dwellings, a walking trail and recreational fields.

Natural Science

- Carp Creek is known to have a warm water thermal regime and include a wide range of fish communities.
- The forested habitat within the study area would provide habitat for breeding migratory birds and various wildlife species.
- During the 2017 and 2020 field investigations, no Species at Risk (SAR) were observed within the study area.
- Potential SAR within the general vicinity of the study area, as well as their status and habitat protection are stated in below table. Potential impacts to the surrounding natural environment will be considered during the evaluation of alternative solutions, and potential mitigation measures will be identified.

Species at Risk			
Common Name	**Scientific Name**	**Provincial Status**	**Federal Status**
Blanding's Turtle	*Emydoidea blandingii*	Threatened	Threatened
Eastern Musk Turtle	*Sternotherus odoratus*	Special Concern	Threatened
Common Snapping Turtle	*Chelydra serpentina*	Special Concern	Special Concern
Canada Warbler	*Cardellina canadensis*	Threatened	Threatened
Eastern Wood-pewee	*Contopus virens*	No Status	Special Concern
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Threatened	Threatened

BASELINE ENVIRONMENTAL INVENTORY

Geotechnical

- The site stratigraphy consists of topsoil, clay/silty clay layer, followed by a till layer.
- It was also observed that there is an alluvial deposit (a mix of variable portions of gravel, sand, silt, and clay) of variable thickness that is interbedded with a clay/silty clay layer.
- The clay/silty clay layer was observed to be desiccated above the groundwater table and very soft below the water table.
- A slope stability analyses was performed to evaluate the current slope condition, to determine a suitable backslope gradient and to estimate the factor of safety (FOS) against failure.
- Three slope cut ratios were investigated (2H:1V, 2.5H:1V and 3H:1V).
- A slope cut of 2.5H:1V ratio was recommended, steeper slopes are not recommended from a surface erosion perspective.

Hydraulic and Fluvial Geomorphology

- The average bankfull widths and depths through this reach are 5.25 m and 0.57 m, respectively.
- Depth of water within the study area average from 15 to 30 cm.
- The 100-year floodwater elevation is approximately 102.23 m throughout the study area with velocities ranging from 2.52 - 3.58 m/s for the 2-year to 100-year return periods.
- The study reach of the Carp Creek is within the Ottawa Valley Clay Plains, which leads to poor infiltration and flooding.

ISSUES RELATED TO EROSION

The eroded area is located at a sharp creek meander which is exposed to excessive erosive forces and high velocities during flood events.

The existing bank is failing due to the creek being out of alignment which is causing toe erosion and mass washout of the existing slopes.

The southeast embankment is relatively steep and remains susceptible to high discharge events that will eventually lead to further erosion.

The sites geotechnical stratigraphy consists of clay material topping till with a low bearing capacity.

Very acute angle of the exiting channel tends to direct flows at the immediately downstream banks causing additional erosion concerns.

OVERVIEW OF 2017/2018 CLASS ENVIRONMENTAL ASSESSMENT

A range of alternative solutions were identified and evaluated to address the problem/opportunity statement prepared for the 2017/2018 Class EA. Six Alternative Solutions were evaluated.

Through consultation with agencies, stakeholders and the public, and the Class EA evaluation process, a Technically Preferred Alternative was selected and carried forward to the detailed design and tendering stage.

Technical Preferred Alternative #4 - partial realignment of the creek with the installation of a live crib wall, as well as plantings and Rip Rap strategically placed to protect the toe of slope and at transition points along the creek.

ALTERNATIVE SOLUTIONS

1. "Do Nothing"
2. Solider Piles and Wood Lagging
3. Mechanically Stabilized Earth
4. Partial Realignment with live bank treatment (i.e. live crib wall, coir fibre logs, planting/Rip-Rap combinations, live stakes, wattle fence, etc.)
5. Partial Realignment with hard bank treatment (i.e. Stacked/Terraced Stone Revetment, gabion basket, rip-rap revetment, etc.),
6. Full Realignment

CLASS EA ADDENDUM ALTERNATIVE SOLUTIONS

Alternatives carried forward from the long list in 2017/2018 Class EA: **Alternative 4** – partial channel realignment with live bank /Bio-Engineered treatment (live crib wall, planting/Rip-Rap combinations and live stakes) and **Alternative 6** – full channel realignment, as well as the new alternative solution:

Alternative 7 - Partial Channel Realignment with Revegetation: partial realignment of the channel and re-grading the eroded embankment within the study area back to a stable slope. The re-graded slope would be stabilized using natural material such as live bank (planting, live stakes, etc) and Rip Rap treatments.

Long List of Alternatives

Alternative 1:	"Do Nothing"
Alternative 2:	Solider Piles and Wood Lagging
Alternative 3:	Mechanically Stabilized Earth
Alternative 4:	Partial Realignment with Live Bank/Bio-Engineering Treatment
Alternative 5:	Partial Realignment with Hard Bank Treatment
Alternative 6:	Full Realignment

Short List of Alternatives

Alternative 4:	Partial Realignment with Live Bank/Bio-Engineering Treatment
Alternative 6:	Full Realignment
Alternative 7:	Partial Creek Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments

Alternatives have been evaluated considering four environmental categories and various evaluation criteria specifically relevant to the study area, objectives and stakeholders.

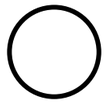
PRELIMINARY EVALUATION OF ALTERNATIVE SOLUTIONS

Evaluation Criteria	Description of Criteria	Criteria Measures	Description of Criteria Measures	Alternative 4 Partial Creek Realignment with Live Crib Wall and Planting/Rip Rap	Alternative 6 Full Creek Realignment	Alternative 7 Partial Creek Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments
Function Environment	Criteria to evaluate whether the alternative Solution addresses the problem and opportunities; as well as, evaluate the operational suitability and engineering characteristics of the Solution.	Infrastructure Plans and Policies	Compatibility with MVA and City of Ottawa guidelines, standards and policies (i.e. City of Ottawa Draft Official Plan).	 - Incorporates natural stream features but not to the full extent as Alternative 6 & 7. Does not fully conform to the Draft Official Plan. - Crib walls provides both embankment and toe protection. - Mitigates erosion of embankment but doesn't provide any additional floodplain storage and/or energy dissipation. - If properly constructed and allowed enough time to effectively vegetate, the wall is an effective erosion mitigation measure. - Crib walls require monitoring and maintenance to ensure no shifting or materials have become displaced.	 - Highly effective as new channel would be designed to be stable within the existing flow regime. - Potential to increase the capacity of the watercourse. - Natural channel would be designed to require minimal maintenance.	 - Conforms to the City of Ottawa Draft Official Plan that "Natural watercourses shall be kept in their natural condition" - Incorporates natural stream design. - Realignment require minor reclaiming of additional lands, however, won't result in impacts to residential lands, MUP or existing recreational facility. - Effective mitigation measure once vegetation establishes and Rip Rap protection properly sized at toe of slope. - Natural channel design requires minimal maintenance.
		Effectiveness of Erosion Mitigation and Embankment Stabilization	The ability to address the existing erosion condition within the study area both long and short term.			
		Durability	The ability to withstand wear, pressure or further erosion.			
		Maintenance	Minimal maintenance and is self-sustaining.			

PRELIMINARY EVALUATION OF ALTERNATIVE SOLUTIONS

Evaluation Criteria	Description of Criteria	Criteria Measures	Description of Criteria Measures	Alternative 4 Partial Creek Realignment with Live Crib Wall and Planting/Rip Rap	Alternative 6 Full Creek Realignment	Alternative 7 Partial Creek Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments
Biological/ Physical/ Natural Environment	Criteria to evaluate the alternative Solution's effects on the natural heritage systems, natural environment and habitats, and water quality.	Fish/Aquatic Habitat	Presence of fish communities and aquatic habitats; and potential impacts, including to water quality.	 - Within the portion of the realigned creek, there will be opportunities to improve fish/aquatic habitat. - Duration of in-water works likely to be short. - Short-term impacts such as minor loss of mature trees and short-term impacts to riparian species. Post-construction site restoration will ensure no long-term adverse effects or changes to terrestrial habitat affected. - If terrestrial habitat is to be removed during construction, mitigation measures are to be implemented to protect SAR. - The design includes a low flow channel to maintain a natural process of sediment transport. - Mitigation measures (i.e. Rip Rap) will be provided to minimize the impact of directing flows at downstream bank. - This alternative does not provide as much opportunity to allow larger flows to have additional room for energy dissipation on the floodplain as is provided for Alternative 7 and potentially alternative 6.	 - Opportunity to improve fish/aquatic habitat in new channel. However, an extensive realignment would be required through the study area and adjacent lands, including areas that are currently not exhibiting any problems. - Greater short-term and long-term impacts due to the loss of significantly more greenspace and verequired to adequately realign the creek to be stable within the existing flow regime. - Extensive terrestrial habitat is to be removed during construction, mitigation measures are to be implemented to protect SAR. - In the short-term, this alternative will have the most impact to adjacent landscaping and will not be aesthetic pleasing. However, in the long-term, the new channel designed would include aesthetically pleasing enhancement features such as plantings, walking paths, etc. - New channel would be designed to be stable within the existing flow regime but does run the risk of negatively impacting upstream and downstream.	 - Opportunities to improve fish/aquatic habitat in realigned channel. - Short-term impacts such as minor loss of mature trees and short-term impacts to riparian species. Post-construction site restoration would ensure no long-term adverse effects or changes to terrestrial habitat affected. - More vegetation removal will be required with this alternative in comparison to alternative 4 due to the regrading of the embankments at 2.5H:1V and additional staging area. - Slightly shorter duration of in-water works likely compared to atlernative 4. - If terrestrial habitat is to be removed during construction, mitigation measures are to be implemented to protect SAR. - Incorporation of a bankfull bench allows the low flow channel to maintain a natural process of sediment transport while also allowing larger flows to have additional room for energy dissipation on the floodplain. - Channel realignment minimizes the impact of directing flows at downstream bank.
		Terrestrial Habitat (wildlife, habitat, and vegetation)	Presence of terrestrial wildlife habitat areas and potential impacts			
		Species-at-Risk	Presence of SAR and potential Impacts/ opportunities for mitigation.			
		Geomorphology	The ability to mitigate any short- and long-term impacts to the watercourse. Channel formation must consider fluvial and hydraulic properties of stream flow.			

PRELIMINARY EVALUATION OF ALTERNATIVE SOLUTIONS

Evaluation Criteria	Description of Criteria	Criteria Measures	Description of Criteria Measures	Alternative 4 Partial Creek Realignment with Live Crib Wall and Planting/Rip Rap	Alternative 6 Full Creek Realignment	Alternative 7 Partial Creek Realignment with Re-grading of Embankment and Stabilization using Live Bank/Rip Rap Treatments
Social and Cultural Environment	Criteria to evaluate the alternative Solution's effects on community and social features, and properties within the study area.	Public Safety	Protect, maintain and enhance the watercourse through naturalization and improved stability of the the embankment.	 - Eroding embankment will be stabilized and regraded to a safer slope. - The new crib will stay within the existing creek valley and improves the stability of the embankment. However, less of a natural channel design than alternative 6 & 7. - Minor pedestrian and residential impacts during construction - Moderate disturbance – typically requires larger machinery during construction for placement of logs. - Smallest construction area.	 - Longer construction period leads to a higher risk to public safety. - The new realignment will not stay within the existing creek valley. Additional land would be required for the full realignment, which would extend into the adjacent recreational faculties. - Significantly long construction period which will have an impact on residences, recreational activities and schools. Extensive staging requirements. - Difficult to construct due to current landuses. - Largest construction area and extensive staging requirements.	 - Eroding embankment will be stabilized and regraded to a safer slope. - Provides a natural channel design and improves the stability of the embankment for residence to enjoy. - Minor pedestrian and residential impacts during construction. - Moderate disturbance – typically requires larger machinery during construction for re-grading purposes and placement of Rip Rap and planting.
		Land Use/Socio Conditions	Potential to impact residences, community, public parks, institutions or recreation within or adjacent to the study area.			
		Construction Impacts	Duration of construction, staging options and potential for construction-related impacts on public, access, noise and dust.			
Implementation	Criteria to evaluate the financial implications and implementation opportunities of the alternative Solution.	Capital Costs	Capital cost of proposed improvement	 - Lower development and labour cost over other alternatives. - Long term sustainability and therefore reduced maintenance costs but will still require monitoring and maintenance. - Construction duration is anticipated to be approximately 8 weeks	 - High development and labour cost over other alternatives. - Natural channel design requires minimal maintenance costs. - Dependent on design, construction duration could be anywhere from 6-18+ months	 - Lower/moderate development and labour cost over other alternatives. - Natural channel design requires minimal maintenance costs. - Construction duration is anticipated to be approximately 8 weeks
		Operational and Maintenance Costs	Operational and maintenance costs of proposed improvement over life-cycle.			
		Estimated Construction Duration	Duration of construction anticipated for implementation of design alternative.			

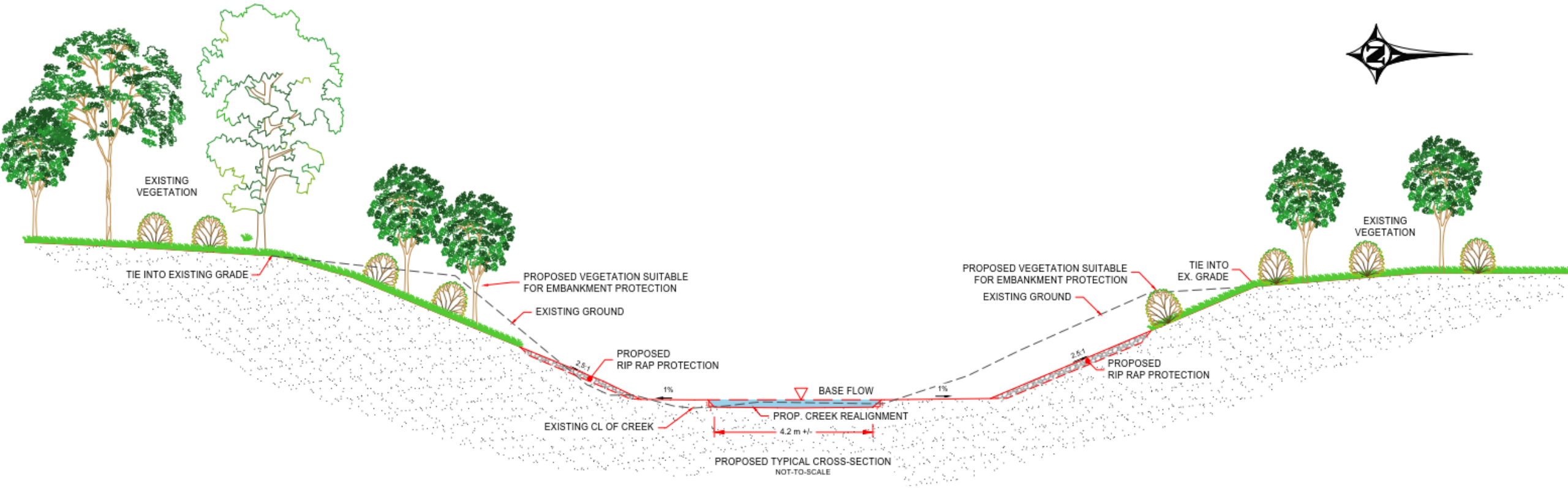
PRELIMINARY TECHNICALLY PREFERRED ALTERNATIVE

Alternative 7: Partial Realignment with Re-grading of Embankments and Stabilization using Live Bank/Rip Rap Treatments. In accordance with preliminary discussion and evaluation, the preliminary TPA consist of a partial realignment of the channel to the north and re-grading the eroded embankment within the study area (south bank) back to a stable slope. The re-graded slopes will be stabilized using natural material such as live bank (planting, live stakes, etc.) and Rip Rap treatments. Slight re-grading of banks upstream and downstream of apex of eroded bank will be required to tie back into the existing embankment.

Applications and Effectiveness:

- Stabilize the Carp Creek embankment within the study area and provides erosion control;
- Complies with the City' draft Official Plan Policy, Section 4.9.2 which states "Natural watercourses shall follow natural channel design to restore the embankment. Where an alteration is assessed as being environmentally appropriate and consistent with a Council-approved study, watercourse alterations shall follow natural channel design". To restore the embankment back to a natural and functional feature of the watercourse.";
- Provides more floodplain storage and potential for energy dissipation within study area;
- Creates a stable alignment with stable bank slopes through the placement of stone protection at the toes of slope for immediate protection and plantings for long-term stability along the embankments, top of bank and proposed bench within the floodplain, and
- Maintains a natural embankment which will support various terrestrial, fish, aquatic and SAR habitat.

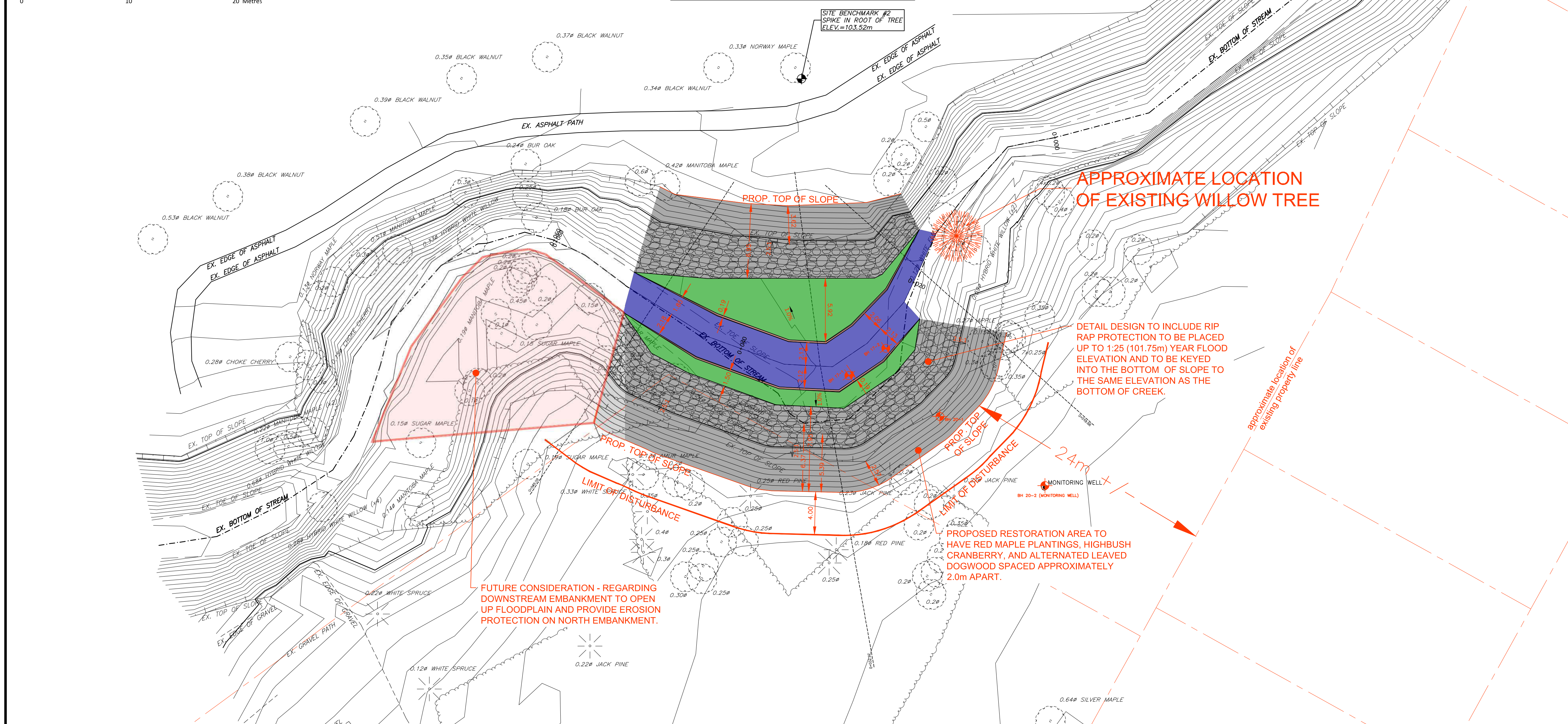
PRELIMINARY TECHNICALLY PREFERRED ALTERNATIVE TYPICAL CROSS-SECTION



PROPOSED CREEK PLAN VIEW

SCALE 1 : 200

0 10 20 Metres



GENERAL NOTES:

1. ALL DIMENSIONS AND ELEVATIONS MUST BE VERIFIED PRIOR TO CONSTRUCTION, IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
2. ORIGINAL TOPOGRAPHY, GROUND ELEVATION AND SURVEY DATA SHOWN ARE PROVIDED BY OTHERS AND SUPPLIED FOR INFORMATION PURPOSES ONLY AND IMPLY NO GUARANTEE OF ACCURACY. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL INFORMATION OBTAINED FROM THEM.
3. THIS PLAN IS TO BE READ IN CONJUNCTION WITH ALL LANDSCAPING PLANS, DETAILS AND ANY OTHERS WHICH MAY APPLY.
4. CONTRACTOR TO OBTAIN AND PAY FOR ALL NECESSARY PERMITS AND APPROVALS BEFORE COMMENCING CONSTRUCTION.
5. THE CONTRACTOR IS RESPONSIBLE FOR ALL LAYOUT.
6. THE CONTRACTOR IS TO DETERMINE THE EXACT LOCATION, SIZE, MATERIAL AND ELEVATION OF ALL EXISTING UTILITIES PRIOR TO COMMENCING CONSTRUCTION. PROTECT AND ASSUME ALL RESPONSIBILITY FOR EXISTING UTILITIES WHETHER OR NOT SHOWN ON THESE DRAWINGS. IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
7. RESTORE ALL TRENCHES AND SURFACES OF PUBLIC ROAD ALLOWANCES TO CONDITION EQUAL OR BETTER THAN ORIGINAL CONDITION AND TO THE SATISFACTION OF THE CITY OF OTTAWA AUTHORITIES.
8. EXCAVATE AND DISPOSE OF ALL EXCESS EXCAVATED MATERIAL, SUCH AS ASPHALT, CURBING AND DEBRIS, OFF SITE AS DIRECTED BY THE ENGINEER AND THE CITY OF OTTAWA.
9. TOPSOIL TO BE STRIPPED AND STOCKPILED FOR REHABILITATION. CLEAN FILL TO BE PLACED IN FILL AREAS AND COMPACTED TO 95% STANDARD PROCTOR DENSITY.
10. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER UNLESS OTHERWISE SPECIFIED.
11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC CONTROL AND SAFETY MEASURES DURING THE CONSTRUCTION PERIOD, INCLUDING THE SUPPLY, INSTALLATION, AND REMOVAL OF ALL NECESSARY SIGNAGE, DELINEATORS, MARKERS AND BARRIERS.
12. DO NOT ALTER GRADING OF THE SITE WITHOUT PRIOR APPROVAL OF THE CITY OF OTTAWA
13. THE SITE GRADING CONTRACTOR IS RESPONSIBLE FOR ENSURING INSTALLATION OF EROSION AND SEDIMENT CONTROLS PRIOR TO COMMENCING CONSTRUCTION. CARE SHALL BE TAKEN AT THE REMOVAL STAGE TO ENSURE THAT ANY SILT THAT HAS ACCUMULATED IS PROPERLY HANDLED AND DISPOSED OF.

BENCHMARK INFORMATION:

TBM - OBVERT AT DOWNSTREAM END OF EXISTING BOX CULVERT APPROXIMATELY 100m UPSTREAM OF WORK ZONE
APPROXIMATE GEODETIC ELEVATION = 102.22m

No.	Revision/Issue	Date
2	REVISED CONCEPT DESIGN	OCT 26/20
1	CONCEPTUAL DESIGN	SEPT 18/20

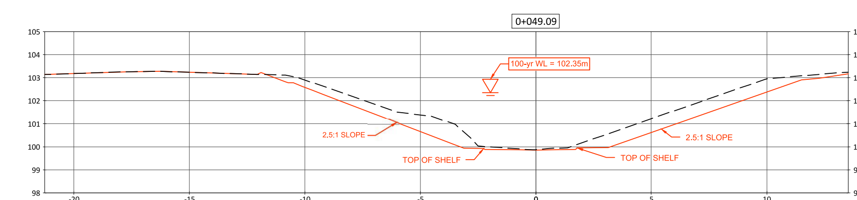
Check and verify all dimensions before proceeding with the work — Do not scale drawings

H = 1:150

0+018.68

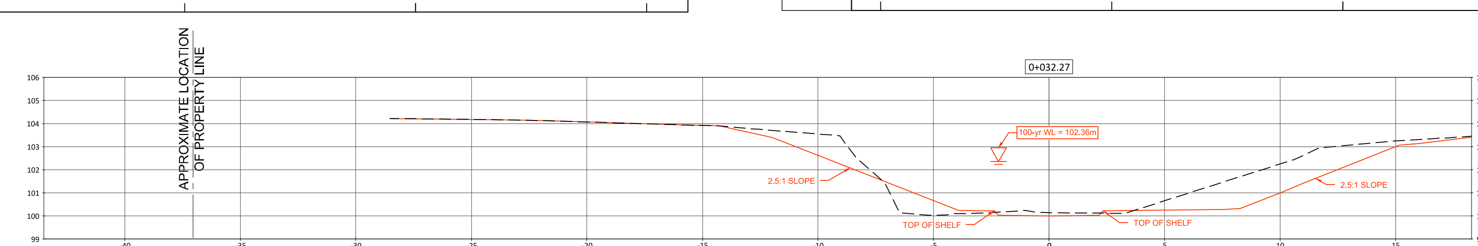
EXISTING ELEVATIONS	104.23	102.88	100.19	103.28
PROPOSED ELEVATIONS	104.23	103.20	100.18	103.19
OFFSET	-20.00	-10.00	0	10.00

0+049.09



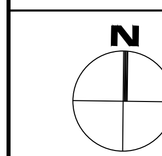
EXISTING ELEVATIONS	103.18	102.90	99.87	102.95
PROPOSED ELEVATIONS	103.18	102.58	99.86	102.38
OFFSET	-20.00	-10.00	0	10.00

0+032.27



EXISTING ELEVATIONS			104.07	103.55	100.15	102.25
PROPOSED ELEVATIONS			104.07	102.62	100.01	100.99
OFFSET	-40.00	-30.00	-20.00	-10.00	0	10.00

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A 1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com



Stamp:

Client:
MISSISSIPPI VALLEY CONSERVATION AUTHORITY
10970 ON-7, CARLETON PLACE
ON K7C 3P1

Project:
CARP CREEK EMBANKEMENT
RESTORATION

Drawing Title:
PROPOSED ALIGNMENT
CROSS SECTIONS

Scale:	AS SHOWN	Project Number:	CM-17-0429-02
Drawn by:	R.F.		
Checked By:	L.M.	Drawing Number:	
Designed By:	B.A., R.F.		
Date:	09/18/20	SHEET 1 of 1	C101A

NEXT STEPS & SCHEDULE

Milestone	Deadline
Notice of Public Information	January 28, 2021
Public Information Review Period Expires	February 11, 2021
Select Technically Preferred Alternative	February 15, 2021
Prepare Project Plan Report and Preliminary Design	February 19, 2021
Mandatory Consultation - Notice of Filing to an Addendum for Review (15-day period)	February 2021
Deadline for Comments and Part II Orders	March 2021

For further information on the Carp Creek Embankment Restoration Project, please contact:

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Phone: 613-714-0815
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The Preliminary Project Plan Addendum Report is currently available for viewing on MVCA website's (https://mvc.on.ca/carp-creek)

APPENDIX I – COMMENTS RECEIVED