Fitzroy Harbour – Carp River Erosion Control Class Environmental Assessment

FINAL ENVIRONMENTAL ASSESSMENT STUDY REPORT

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City of Ottawa

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION AND LOCATION

This Environmental Assessment Study (EA) Report addresses the Carp River Slope Stabilization near the Fitzroy Harbour Community Center. The site is located on the Carp River approximately 2.5 kilometres upstream of its confluence with the Ottawa River (refer to **Figure 1-1**). The Fitzroy Harbour Community Center is located in the Village of Fitzroy Harbour, a village in the northwest portion of the City of Ottawa.

Concern with the receding river bank along the north east boundary of the Fitzroy Harbour Community Centre property has been documented for a number of years. **Figure** 1-2 illustrates the progression of the loss of property since 1991. It is estimated that as much as 10m of adjacent table land has been lost to erosion. This loss has reduced the distance from the baseball diamond fence to the river bank edge from 18 m to approximately 7 m at the nearest point in 2011.

The erosion is due to the movement of the main channel of the Carp River to the base of the river bank. The cause of the erosion is related to the geology of the site which is affecting the river flow patterns. Site observations and aerial photography show that the main channel (thalweg) for the Carp River has become well defined at the foot of the river bank in comparison to 1999 and 2002 at which time the main channel was less defined. Bedrock has provided resistance in the rest of the channel with a local low spot at the foot of the river bank. With the change in flow path, the associated change in scour and deposition has resulted in increasing flow and velocities at the foot of the river bank with associated increased erosion of the river bank and increasing deposition of materials along and on the islands across the channel from the river bank. The increased deposition on the islands further focuses the flow into the main channel and further exacerbates the erosion of the river bank.

1.2 CLASS EA PLANNING AND DESIGN PROCESS

The Class EA process for Municipal Road, Water, and Wastewater Projects is an approved *provincial planning and design procedure designed to protect the environment and meet the* requirements of the Ontario Environmental Assessment Act. The process provides the necessary framework to ensure that the potential social, economic, and natural environment effects are considered in undertaking certain projects. The Class EA process is designed to address various aspects of municipal wastewater projects, including:

- Normal and/or emergency maintenance and operational activities;
- Expansion, reconstruction, and/or modification of existing facilities; and,
- Construction of new facilities.

November 2011
1634-01089

Primary Site

Secondary Site

1:750

0 12.5 25 50 75 100 Meters

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Client/Project
CITY OF OTTAWA
CARP RIVER SLOPE STABILITY NEAR
FITZROY HARBOUR COMMUNITY CENTER
ENVIRONMENTAL ASSESSMENT STUDY REPORT

Figure No.
1

Title
Study Area

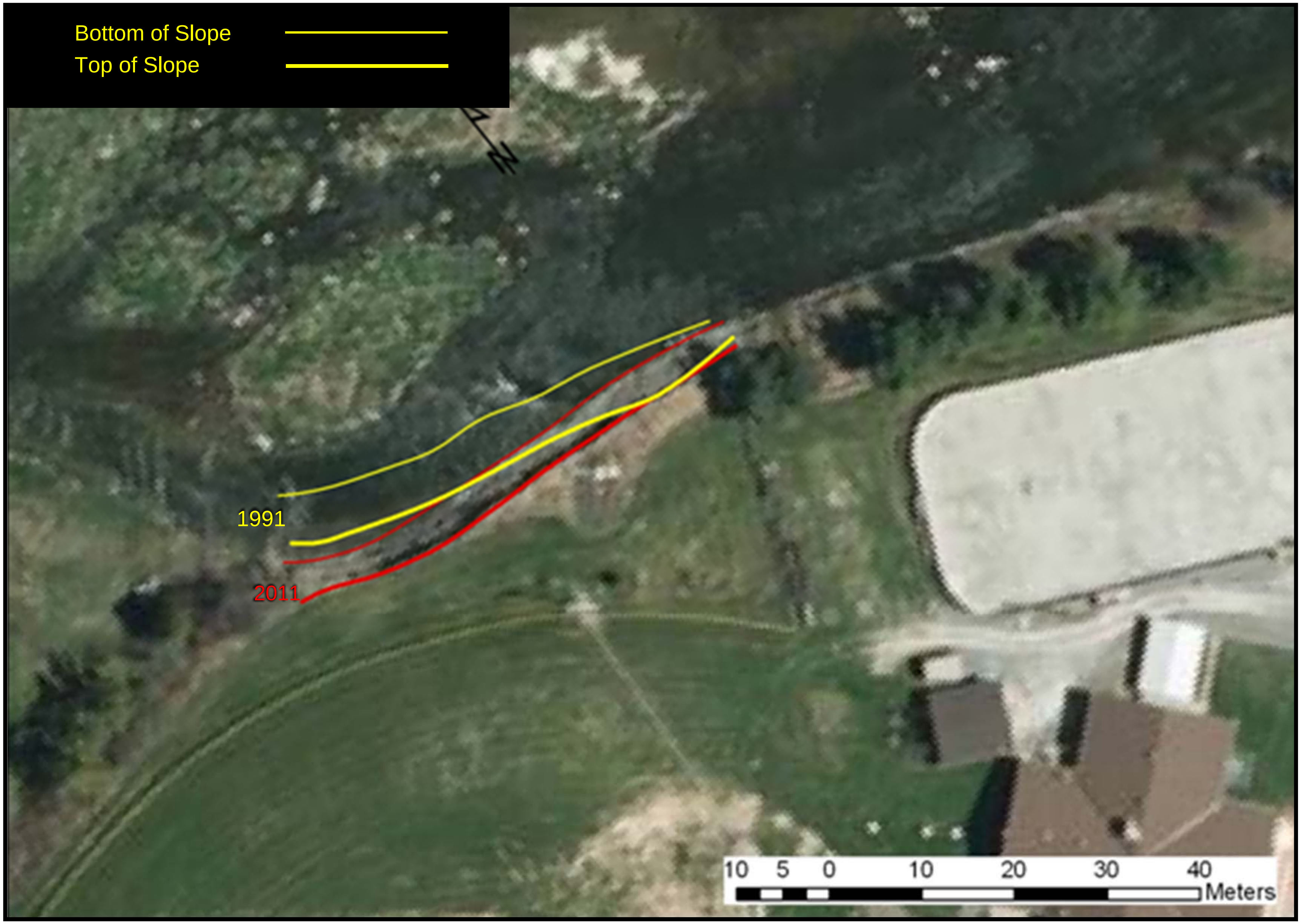

Figure 1-2: Loss of Property along Primary Erosion Site

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The Class EA process is self-directed, representing an alternative for municipalities to carry out individual assessments for most municipal wastewater projects in Ontario. The Class EA process recognizes that most projects will share similarities and can follow the same general EA planning framework.

Since projects undertaken by municipalities vary in the complexity and their environmental impacts, projects are further classified in terms of the following schedules:

- Schedule A projects are limited in scale and have minimal adverse effects. Typical projects include municipal infrastructure maintenance and operational activities. These projects are approved and may proceed to implementation without following the full Class EA planning process.
- Schedule B projects have the potential for some adverse environmental effects. The proponent is required to undertake a screening process of alternatives, involving mandatory contacts with affected public and relevant government agencies to ensure that they are aware of the project and that their concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation; however, if the screening process raises a concern that cannot be easily resolved, then the Part II Order procedure may be invoked. Alternatively, the proponent may voluntarily elect to plan the project as a Schedule C undertaking.
- Schedule C projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the Class EA document. Schedule C projects require that an Environmental Study Report be prepared and submitted for review by the public. If concerns are raised that cannot be resolved, the Part II Order procedure may be invoked.

If invoked, the Part II order would require that the proponent carry out an individual assessment for the project. The selection of the applicable schedule is determined at the completion of the first phase of the process (Definition of the Problem or Opportunity) and confirmed in the second phase (Alternative Solutions).

The Class EA process stipulates a Schedule B classification for a "works undertaken in a watercourse for the purpose of flood control or erosion control, which may include: bank or slope regrading, deepening of the watercourse, relocation, realignment or channelization of watercourse, revetment including soil bio-engineering techniques and construction of a weir or dam." The Fitzroy Harbour Community Center Slope Stability Project is anticipated to be a Schedule B project, as it seeks to stabilize and eroding riverbank and will likely involve work within a watercourse.

1.3 PROJECT ORGANIZATION

In September 2011 Stantec Consulting Ltd. was retained by the City of Ottawa to undertake the Fitzroy Harbour Community Center Slope Stability and Geomorphology Study and Class EA. The key personnel involved in the project are:

Kevin Cover, P. Eng.
Project Manager, City of Ottawa

Stéphane D’Aoust, P.Eng.
Project Manager, Stantec

1.4 PUBLIC STAKEHOLDER AND REVIEW AGENCY CONSULTATION

A Public Open House was held on October 26, 2011, at the Fitzroy Harbour Community Center from 6 – 8 pm where a poster presentation was set up and Project Team members were on hand to field public inquiries. The Public Open House was advertised in the EMC West Carleton and the West Carleton Review on October 20, 2011. Posters were also put up at the Fitzroy Harbour Community Centre, the local branch of the Library, the general store in the village and emails notices were sent out to the Community Association's mailing list.

A total of 5 people attended the Public Open House. The Mississippi Valley Conservation Authority was also in attendance at the meeting. Copies of the notice, presentation boards, and sign in sheet from the Open House are provided in **Appendix A**.

The Ministry of Natural Resources (MNR) suggested that no Algonquin consultation is necessary based on the fact that a Stage 1 archaeological assessment (with the Stage 1 expected to lead to a Stage 2 due to proximity to river) and that any findings of interest would be communicated to them. This project is an improvement to the environment of the Carp River and not subject to any asserted aboriginal right as there would likely be more positive benefits than any negative effects.

MNR also provided some comments on the draft EA document. Their comments were addressed and changes were incorporated in this final EA report. Please refer to **Appendix A** for correspondence.

Upon completion of the planning process, this report will be finalized and placed on the public record and a Notice of Completion will be published. Subsequent to publication of the Notice, a final 30 day review period will transpire. This will be the last opportunity to make a request of the Minister for a Part II Order. If no request is made, the project will proceed to design and construction.

2.0 PROBLEM DESCRIPTION

2.1 PROBLEM IDENTIFICATION

A shift of the Carp River's main channel has resulted in ongoing erosion of the river bank that borders the Fitzroy Harbour Community Center. Erosion at the base of the bank has resulted in the repeated collapse of the top of the bank. Consequently, the bank face has become near vertical in some places.

This situation presents a two-fold problem. First, the over-steepened bank is nearly vertical and is a safety issue for the public. Second, the erosion, albeit a natural process, is resulting in a loss of property. The eroding bank is approaching the built infrastructure (i.e. the outfield fence of the ball diamond and light standards). The intent of this report is to study the options available to address these two issues and to ensure that the preferred solution does not increase risk to other neighboring properties.

2.2 STUDY AREA

For the purposes of this EA Report, the study area is defined as the Community Center site and any area that could reasonably be expected to be impacted by the work contemplated in this document (length of concern approximately 250 m). The study area is not limited to land area, but is inclusive of water bodies and the atmosphere as well as areas defined by social and economic boundaries. **Section 3.0** "Study Area and Existing Conditions" provides a complete catalogue of the environments considered in the course of this study.

3.0 STUDY AREA AND EXISTING CONDITIONS

A variety of materials were searched to gather information on the environment of the project location and nearby areas. This included a desktop review of publicly available databases, agency consultation and review of aerial imagery, topographic mapping and relevant available reports and photos taken during a site visit by Stantec personnel in September 2011. The detailed inventory may be found in **Appendix D**.

3.1 SOCIO-ECONOMIC ENVIRONMENT

3.1.1 Existing Land Use

The project location is situated on the Carp River within the town of Fitzroy Harbour. The Fitzroy Harbour Community Centre and Campbell Bicentennial Park are located immediately adjacent to the project location. The project location is zoned as flood plain while the Community Centre is zoned as rural institutional (City of Ottawa, 2003).

The following community characterization was obtained from the City's website:

Community Characterization

Facilities	Events
Fitzroy Harbour Community Centre	Fitzroy Harbour Winter Carnival
Fitzroy Provincial Park	"Harbour Days" Summer Festival
Penny's Fudge Factory	
Ottawa Public Library (Fitzroy Harbour Branch)	
Fire station	
Fitzroy Harbour Public School (closed)	
St. Andrew's United Church	
St. Michaels Roman Catholic Church	
St. Michael Catholic School	
Post Office (at The Harbour Store)	
Fitzroy Harbour Boat Launch	
St George's Anglican Church	
Baird Park	
River Park	

The following village profile was also sourced from the City website:

> *"Fitzroy Harbour has a population of 637 people with a potential to grow. There is a large amount land within the village boundary that is undeveloped. The 46.22 ha of vacant residential land has a potential to accommodate another 178 dwelling units in the village. However growth in the village has been very slow, only 30 new dwelling units have been built in Fitzroy Harbour since 2001. Also the elementary school in the village has recently closed which is a concern to the community."*

3.1.2 Cultural Heritage

The project location falls within an area of elevated archaeological potential, as delineated by the City of Ottawa's Archaeological Potential Mapping (City of Ottawa, 2009). This elevated potential is a result of the project location's proximity to the Carp River. In general it has been demonstrated that areas within 200 to 300 m of watercourses, or other significant bodies of water, and in particular those areas with multiple water sources, are considered to be of elevated archaeological potential for prehistoric period resources. Given the project location's proximity to the historic town of Fitzroy Harbour there is also a possibility for impacts on historic period archaeological resources and heritage resources, although no legally designated buildings or landscapes are within or adjacent to the project location.

3.1.3 Recreation

The project location is immediately adjacent to the Fitzroy Harbour Community Centre which provides five sports fields, a basketball court, two baseball diamonds, a skateboard park and an outdoor rink for recreation (City of Ottawa, 2009). Approximately 1 km downstream the Carp River there is Fitzroy Harbour Provincial Park and River Park, another small community recreation area approximately 500 m northwest of the project location (MNR, 2011). The Carp River is a popular fishing spot in the Fitzroy Harbour area and would be considered a navigable waterway.

The City of Ottawa has also proposed construction of a recreational pathway system that follows the Carp River from the Kanata urban area to the rural areas of Fitzroy Harbour (Robinson Consultants Inc., 2004). It is uncertain what stage this project is at currently.

3.1.4 Transportation Routes

There are no transportation routes within the project area. The routes that would likely be used to access the site for the contemplated works would be Harbour Street (RR-5) and Clifford Campbell Street. The site is located behind the Fitzroy Harbour Community Center at 100 Clifford Campbell Street.

3.1.5 Utilities

There are no known utilities in the project area. The adjacent Fitzroy Harbour Community Center does have utilities in the vicinity. The village of Fitzroy Harbour is serviced via individual wells and septic systems.

3.2 NATURAL ENVIRONMENT

3.2.1 Subsurface Conditions

The Fitzroy Harbour / Carp River Bank Erosion Assessment and Remediation Geomorphology Assessment Final Report (JTB Environmental Systems Inc. 2011) included in **Appendix B** describes the following subsurface conditions. Banks along the lower Carp River have a layer of varved clay (deposited during the recession of the Wisconsinian Glaciation 8000 – 10000 YBP). As this area was under water as part of Lake Champlain, settling of clay particles at the bottom of the lake created bedding plains which are points of weakness in the clay matrix. Along some of the upper sections of the bank there is also the addition of fine sands into the clay matrix. This results in a bank which is comprised of variable-sized materials, which prevents strong electrochemical bonds from forming. The result is a weaker bank whose internal structure which can be fractured relatively easily by flowing water adjacent to the bank, as well as by infiltrating water from rain events.

The eroded bank was reviewed in a Slope Stability Assessment (Stantec, 2011) included as **Appendix C**. This assessment concluded the following:

> *"The slope is overly steep and is being eroded by water flowing in the adjacent Carp River. Our site observations and slope stability analysis indicate that the slope is unstable, and will likely continue to erode. The baseball field is within the Limit of Hazard Loads. The slope should be stabilized to protect the health and safety of the Community Center patrons."*

3.2.2 Surface Hydrology and Drainage

The Fitzroy Harbour / Carp River Bank Erosion Assessment and Remediation Geomorphology Assessment Final Report (JTB Environmental Systems Inc., 2011) describes the surface hydrology and drainage as follows:

1. A low-gradient reach with historical deposition of fluvial sediment;
2. Bankfull widths ranging from an average of about 20m upstream and downstream of the site to approximately 60 metres at the study location;
3. Meander wavelengths of approximately 360 metres and amplitudes averaging approximately 135 m;

4. Moderate to high sediment loading from upstream;
5. Multiple stable islands/bars resulting in a braiding path for the main flow of the river;
6. Banks comprised of varved clays with fine sand;
7. Bed comprised of transported alluvial materials from upstream as well as outcrops of bedrock in the vicinity of the study site; and
8. A trending of flow (meander) to the south as a result of the deposition bars in the center of the river.

3.2.3 Natural Vegetation and Wildlife

3.2.3.1 Aquatic Environment

The Carp River has a total drainage area of 305 km^2 in the City of Ottawa (City of Ottawa, 2011). It discharges to the Ottawa River near Fitzroy Harbour. Forty (40) fish species are said to occur within the Carp watershed which include both stream resident fish and fish that migrate from the Ottawa River on a seasonal basis (Robinson Consultants Inc., 2004). The lower Carp River supports a diverse, warm water fish community (Robinson Consultants Inc., 2004). Longnose Dace, Rock Bass, Smallmouth Bass, Johnny Darter, Tesselated Darter and Yellow Walleye have been captured in the Fitzroy Harbour area (Robinson Consultants Inc., 2004).

The Ontario Geological Survey's surficial geology (2009) has identified the project location as being composed of Precambrian Bedrock (shield) with some glaciomarine deposits. Stantec confirmed that the riverbed at the project location is primarily composed of exposed bedrock with clay. The project location is not within the Carp Ridges Area of Natural or Scientific Interest (ANSI) Life Science Site, however, the bedrock in the riverbed at the project location is part of the shield bedrock corridor that extends to Kanata to form the Carp Ridges (Robinson Consultants Inc., 2004). The unique upland habitat created from the bedrock ridge is a key natural habitat feature for the river (Robinson Consultants Inc., 2004).

3.2.3.2 Terrestrial Environment

As mentioned, the terrestrial environment of the project location is primarily composed of non-native and planted species on the southern bank of the Carp River. Tree species found on this bank include White Pine, Scots Pine, Manitoba Maple, Ash and Willow Species. Composing the ground and shrub layers are mostly wasteland species including Wild Parsnip, Common Milkweed, Sumac, Birdsfoot Trefoil and Goldenrod species with some grass species.

The woodland on the northern bank of the Carp River appears to be primarily composed of coniferous tree species including Eastern White Cedar and White Spruce The City of Ottawa has identified this as a significant woodland (Annex 14, Official Plan Amendment 76 2009). By definition, a significant woodland is a contiguous woodland patch that contains mature woodlands greater than 80 years old, forest interior greater than 100 m from the edge and within 5 m of any type of permanent water (Annex 14, Official Plan Amendment 76 2009).

There are no significant valleylands in or near the project location, the closest is several kilometres northeast (City of Ottawa 2011). There are no provincially significant wetlands in or near the project location, the closest is Kilmaurs Marsh, 3.2 km southeast (MNR 2011). The wetlands mapped within the project location have not been evaluated using the Ontario Wetland Evaluation System (MNR 2011). There are no ANSI in the project location: the closest is the Carp River Stromatolites approximately 1 km upstream; 900 m southwest is the Mississippi Snye Wetland; and 7.5 km southeast is the previously mentioned Carp Ridge (MNR 2011). There are no deer wintering areas or other known areas of significant wildlife habitat in the project location, the closest is a Deer Yard approximately 1.2 km to the southwest (MNR 2011).

3.2.3.3 SAR and SAR Habitat

A search of the NHIC database indicates the potential for and/or historical record of the following species protected under the *Endangered Species Act, 2007* (ESA), within 1 km of the project location:

- Lake Sturgeon (threatened)
- Butternut (endangered)

The NHIC search also identified potential for and/or historical record of the following species that are not protected under the ESA but are listed provincially as special concern:

- Short-eared Owl
- Eastern Ribbonsnake
- Northern Map Turtle
- Milksnake

A search of the provincial databases for SAR identified a total of 35 species. A high-level assessment of SAR with potential to occur in the project location was undertaken and only species that require specialized habitat were removed from consideration if their specialized habitat requirements do not occur in the project location. A list of species not likely to be found near the project location because there is no suitable habitat can be found below in **Table 3-1**. **Appendix D** provides more details on the rationale for establishing this list.

Comments received by MNR requested further explanation for Spiny Softshell and Eastern Musk Turtle’s absence from the list of species with potential to occur in the project location. Spiny Softshells inhabit aquatic environments that include some aquatic vegetation and soft bottoms to bury in (COSEWIC 2003). The Eastern Musk Turtle inhabit aquatic environments that have a very slow current and soft bottom (ROM 2009). The substrate of the Carp River in the project location is entirely composed of bedrock, little to no soft substrate with steep near vertical river banks and the water moves at a high velocity. It is because of these natural environment characteristics that it is not anticipated that either Spiny Softshell or Eastern Musk turtle would be found within the project location. In addition, other species have been omitted from consideration because it is anticipated that project activities will be primarily isolated to within the Carp River, therefore, aquatic, semi-aquatic SAR have been presumed to have more chance to occur in the project location.

Table 3-1: Species at Risk not likely to be encountered in project area

Taxon	Common Name	Taxon	Common Name
Plant	Eastern Prairie Fringed-Orchid	Bird	Peregrine Falcon
Reptile	Eastern Musk Turtle	Bird	Henslow's Sparrow
Reptile	Spiny Softshell	Bird	Short-eared Owl
Reptile	Spotted Turtle	Bird	Yellow Rail
Bird	Black Tern	Bird	Olive-sided Flycatcher
Bird	Least Bittern	Animal	Grey Fox
Bird	Loggerhead Shrike		
Bird	Cerulean Warbler		

There could be suitable habitat for some avian, reptile, fish, animal and plant species listed below.

Table 3-2: Species at Risk with suitable habitat in project area

Taxon	Common Name	Taxon	Common Name
Fish	American Eel	Reptile	Milk **S**nake
Fish	Lake Sturgeon	Insect	West Virginia White
Fish	River Redhorse	Insect	Monarch
Plant	Butternut	Bird	Whip-poor-will
Plant	Ginseng	Bird	Golden-winged Warbler
Plant	Flooded Jellyskin	Bird	Chimney Swift
Reptile	Snapping Turtle	Bird	Red-headed Woodpecker
Reptile	Eastern Ribbonsnake	Bird	Canada Warbler
Reptile	Northern Map Turtle	Bird	Common Nighthawk
Reptile	Blanding's Turtle	Animal	Eastern Cougar

Conservation Ontario and DFO mapping (2011) indicates that there is presence of American Eel (provincially endangered) and River Redhorse (provincially special concern) in the Carp River within the project location.

4.0 Development of Alternative Solutions

Numerous methods and measures are may be used to provide riverbank erosion protection. Some of the most common include:

- Removal of In-river Obstructions and retraining of the watercourse – may involve the removal of log and/or debris jams or alteration of river bend features to prevent impinging flow;
- Bank Sloping/Flattening – re-grading or flattening of over-steepened banks to achieve a more gradual stable slope and allow vegetation to establish itself;
- Bank Revetments – placement of a cover over the bank to protect from further erosion from flowing water;
  - Rock/Rip rap
  - Interlocking Concrete Blocks
  - Mats/Fabrics
  - Large Woody Debris
  - Vegetation (bioengineering)
- Retaining Walls – to retain eroding bank and protect from flowing water;
  - Log Cribbing
  - Gabions
  - Precast concrete blocks
  - Cast in place concrete
- Deflectors (spurs/vanes/barbs/groynes/jetties) - to reduce near shore velocities;
  - Rock
  - Earth + Rock
  - Large woody Debris

4.1 STRATEGIES FOR THE DEVELOPMENT OF ALTERNATIVES

With the exception of the “Do-Nothing Alternative” (Alternative No. 1) which will be used as the reference alternative, two main strategies were used to develop alternative solutions:

- Erosion Reduction
- River Re-Training

Erosion Reduction: This strategy focuses on the eroding riverbank and promotes traditional solutions that provide more resistance to the flow's erosive forces. These approaches are appropriate where the major issue is low resistance to erosion with relatively low forces acting on the banks. The ensuing solutions typically do not redirect the flow energy away from the affected river bank:

- Alternative 2: Re-grade & Re-vegetate Slope
- Alternative 3: Reconstruct & Riprap Riverbank
- Alternative 4: Gabion Basket Retaining Wall

River Re-Training: In the Fitzroy Harbour situation, the major factor is the direction of flow towards the bank, driven by the new route of the main channel and alignment of the bedrock. A long term solution relies on the understanding of these fluvial processes and requires the re-direction of the flows to reduce the energy imparted into the bank. The following solutions attempt to redirect the flow energy away from the affected river bank:

- Alternative 5: Re-grade Slope & Rock Deflectors
- Alternative 6: Partial River Channel Re-training
- Alternative 7: Full River Channel Re-training

The seven alternative solutions to address the riverbank erosion and slope stability problem next to the Fitzroy Harbour Community Center are described in more detail below:

4.1.1 Alternative 1: Do Nothing

For comparative purposes, Alternative 1 is the do nothing alternative. The Carp River will be allowed to move at will, with the clay bank providing its own protection against excessive toe erosion and sloughing. Eventually, the main flow channel will move away from the eroding bank and the bank will re-vegetate and stabilize itself on its own. Hopefully this will happen before much more bank retrogression has taken place.

While this is the least expensive alternative, it does not achieve our goal of reducing the risk of losing more property or improving public safety (current limit of hazard lands is within ball diamond fence line).

4.1.2 Alternative 2: Re-grade & Re-vegetate Slope

This alternative would involve re-grading of the slope by cutting the top of the slope and using this material to fill in the base of the vertical slope in order to provide a stable bank (2H:1V) with the goal of achieving a balanced cut and fill. The bank would be re-vegetated using bioengineering methods such as brush layering up to the estimated 1:100-yr water level to provide better resistance to flowing water compared to a simple native grass cover.

With the proposed configuration, some of the table land would be sacrificed in order to avoid importing fill material. The use of more "natural" bioengineering methods, which may not be as robust compared to traditional structural means, is prescribed considering that slope regrading will eliminate the immediate threat to loss of land and public safety and that the adjacent land use is a park. The low flow in the river would be diverted away from the re-vegetated bank by re-arranging some bars within the river.

As part of this alternative, consideration could be given to providing buried rip rap up to the 1:100-yr water level as a means of armouring the slope should the bioengineering treatment fail. This would add significant cost to the alternative and could compromise the viability of the bioengineering treatment if insufficient fill material is provided to allow vigorous growth.

4.1.3 Alternative 3: Reconstruct & Rip Rap Riverbank

This alternative attempts to regain lost ground by moving the base of the riverbank back to its 1991 location. This is achieved by importing fill material and grading the bank at a 2H:1V slope or flatter. The new riverbank would be hardened through the use of a riprap revetment up to the estimated 1:100-yr water level and the top of the bank would be re-vegetated using native grasses, trees (reforestation beds) and live/dormant cuttings. The low flow in the river would be diverted away from the riprap bank by re-arranging some bars within the river. While more expensive than Alternative 2, the rock revetment is expected to provide better long-term erosion protection when compared to bioengineering methods alone.

4.1.4 Alternative 4: Gabion Basket Retaining Wall

Alternative 4 is based on providing a gabion basket retaining wall to support the near vertical face of the riverbank that has developed over time. The retaining wall would extend up approximately 2 to 3m from the bedrock surface and the top of the bank would be re-graded to a 2H:1V slope and re-vegetated. Gabion baskets are made of galvanized steel wire mesh and filled with rock. The low flow in the river would be diverted away from the retaining wall by re-arranging the bars within the river.

4.1.5 Alternative 5: Re-grade Slope + Rock Deflectors

This alternative entails the provision of deflectors in the form of rock groynes located at the base of the eroded slope. A groyne is a rigid hydraulic structure that extends out from the shore into a body of water to interrupt water flow and limit the movement of sediment. These would extend into the channel and would drastically reduce near-shore velocities, thus limiting the erosion.

The vertical slope would then be re-graded by cutting the top of the slope and using this material to fill in the base of the vertical slope in order to provide a stable bank (2H:1V) at the base of the groynes. The goal is to achieve a balanced cut and fill with respect to the existing riverbank in order to keep capital costs down. The face of the re-graded bank would simply be seeded with native grasses and planted with live/dormant cuttings. Over time the area between the groynes would recruit additional sediment and plant material.

The use of engineered log jams (also known engineered woody debris or large woody debris structures) to act as a deflector was not considered as a viable option for this project due to concerns with durability. The wood in the structure will decay over time and therefore the long-term success of the solution would rely on the early recruitment of sediment and establishment of plant material between the structures. Rock deflectors do not decay and would provide a base structure for long-term recruitment and retention of sediments. The construction of log deflectors may be a bit less costly than rock reflectors, however they are labor intensive (anchoring) and the supply of good quality wood of adequate diameter (30 to 50cm diameter for some durability) is also considerable. We deem such wood-based structures to be more experimental in nature and more suitable for natural systems with some flexibility in meeting the targeted objectives. In this case, the City is addressing two objectives 1) loss of land and 2) public safety and does not have much flexibility in achieving these objectives and does not want to face a recurring problem at this site in the future.

4.1.6 Alternative 6: Partial River Channel Retraining

This alternative would involve the placement of a significant amount of fill within the river, at the base of the eroded riverbank, in order to shift the path of the river away from the eroding bank. The fill would be terraced in order to provide some limited floodplain and protected along the outer edges using large stone rip rap. Compared to Alternatives 2 to 4, more emphasis would be placed on re-arranging bars within the river to divert low flows away from the restored bank.

4.1.7 Alternative 7: Full River Channel Re-training

This alternative entails more extensive changes to the riverbed and banks than in the previous alternatives. This would likely involve some rock excavation of the riverbed and the placement of a significant amount of fill at the base of the eroded riverbank in order to shift the path of the river away from the eroding bank.

4.2 OTHER CONSIDERATIONS

To improve the success of the alternatives described above, all of the alternatives (with the exception of Alternative 1: Do Nothing) will include some minor movement of in-stream materials at the head of bars to re-instate flows in the eastern flow channels and remove the direct impingement of flows against the west riverbank. This is relatively minor work considering that the channel invert in the area of interest is composed primarily of smooth uniform bedrock which is easily accessible.

Likewise, the alternatives relying on structural measures (Alternatives 3, 4 and 5) for erosion protection would likely benefit from roughening of the smooth bedrock invert or even keying in of the proposed treatment to ensure their long term stability. This is considered a design detail which will be specified once a preferred alternative is selected.

During the detailed assessment and field investigations, a short section (+/- 30m) of river bank was also observed to be over steepened and devoid of any vegetation. This site is located approximately 150m upstream (south) of the Community Center on the west bank of the river. Since this site is located further away from City infrastructure it is not as high a priority. However, the City is considering addressing this location as part of the main slope stabilization project. Alternatives 1 to 5 would be applicable to this site.

5.0 Evaluation of Alternative Solutions

5.1 EVALUATION METHODOLOGY

A qualitative evaluation methodology was selected for the Carp River Slope Stabilization Project. This methodology relies on the rating of 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 are retained and undergo further evaluation as necessary until a preferred alternative solution is selected.

5.2 CRITERIA – DESCRIPTIONS

The 13 criteria used to evaluate the alternatives fall into 6 main categories as summarized below. A description of each criterion is provided further on in this section.

Table 5-1 - Evaluation Criteria

Category	Criteria
Technical Feasibility	
	Can we use it here per this specific application?
	How well has it worked elsewhere?
	How easy/difficult would it be to implement?
Regulatory Feasibility	
	Current regulatory constraints
Health and Safety	
	Public safety
Social Acceptance	
	Construction impacts
	Visual appearance
	Recreational use of site
Environmental Protection	
	River water quality & fluvial processes
	Local ecosystem
Economics	
	Capital costs
	Maintenance Costs

5.2.1 Technical Feasibility

Technical efficacy: Evaluates the degree to which a process has been technically tested and proven. This criterion will address the ability of the alternative to improve the stability of the riverbank and to mitigate future erosion concerns which threaten the community centre lands, buildings, and infrastructure.

Track record and performance: This criterion evaluates the historical performance of the alternative under consideration. Alternatives with less operating experience, particularly in this type of setting and that are more complex to operate are considered to have a higher degree of technical risk and are less desirable. This criterion includes system reliability under varying operating conditions and regulatory compliance record.

5.2.2 Regulatory Feasibility

Regulatory constraints: Federal, Provincial and Municipal Regulations govern lands adjacent to water courses and regulate impacts of any modifications to land and water. Is the solution constrained by any current regulation? Does the solution help meet existing regulations?

5.2.3 Health and Safety

Public safety: Evaluates the hazards to city employees or the general public once the proposed erosion mitigation and slope stabilization measure is in place.

5.2.4 Social Acceptance

Construction impacts: Evaluates the net impacts of construction including noise, dust, sedimentation, vibration and temporary loss of use or disruption to the public.

Visual appearance: Evaluates the net aesthetic qualities of the alternative post construction.

Recreational use of site: is the use of the property enhanced once the alternative is implemented?

5.2.5 Environmental Protection/Fish habitat

River water quality & fluvial processes: maintenance of natural riverbank form for the Carp River through natural river flow and sediment transport processes.

Local ecosystem: Net impact on terrestrial and/or aquatic ecosystem functions over the operational life of the alternative.

5.2.6 Economics

The economic criterion is gauged as a relative comparison of capital (construction costs) and on-going maintenance costs for each alternative. An opinion of probable costs is provided for the recommended alternative (refer to **Section 6.0**).

5.3 RATING SCHEME

The following rating scheme was used for the evaluation of the alternatives.

Color	Rating
Red	Low Preference or Negative impact (i.e. has comparative disadvantage over other alternatives) Economics: costs are above average for group.
Yellow	Medium Preference or No impact (i.e. comparable to other alternatives) Economics: costs are average for group.
Green	High Preference or Beneficial impact (i.e. has comparative advantage over other alternatives), Economics: costs are below average for group.

5.4 EVALUATION OF ALTERNATIVES

The following section provides a series of tables (**Tables 5-2** to **5-8**) summarizing the qualitative evaluation of each of alternative while providing some rationale for the given rating. Table 5-9 provides an overall summary of the evaluation reporting a rating per criteria category. Note that the detailed evaluation and its summary were updated after the public open house based on comments received at the open house and the receipt of the final geomorphology assessment report (JTB Environmental, 2011).

5.4.1 Alternative 1: Do Nothing

Table 5-2 – Evaluation for Do Nothing

Category	Rating	Justification/Explanation
Technical Feasibility		
Technical efficacy		• Does not address erosion concerns
Track record		• Historical records show erosion has progressively worsened since 1991. No indication the process will stop or improve on its own.
Ease of implementation		• May need to restrict access to ball field
Regulatory Feasibility		• Ball field is currently within Municipally defined limit of hazard lands
Health and Safety		• Erosion affected area will continue to recede the bank. The closer this approaches the community centre facilities, the higher the risk to the general public.
Social Acceptance		
Construction impacts		• None
Visual appearance		• The existing slope is fairly steep and bare
Recreational use		• Continued erosion and loss of land may impact use of ball field
Environmental Protection/Fish habitat		
River water quality & fluvial processes		• Excessive erosion will impact water quality and accelerate fluvial processes
Local ecosystem		• Aquatic habitat at risk if erosion continues unchecked
Economics		
Capital costs		• Lowest cost in the short term
Maintenance Costs		• Unknown, could be high if erosion persists

5.4.2 Alternative 2: Re-Grade & Re-Vegetate Slope

Table 5-3 – Evaluation for Re-Grade & Re-Vegetate Slopes

Category	Rating	Justification/Explanation
Technical Feasibility		
Technical efficacy		• Flattening of bank will improve slope stability. • Re-vegetation is meant to reinforce bank and prevent erosion – may not be adequate at base of slope.
Track record		• Bioengineering methods have proven quite effective in low energy environments, mixed results in high energy environments. • Need rapid establishment of vegetation to get erosion protection
Ease of implementation		• Good access to site
Regulatory Feasibility		• MVCA/DFO approval required (not considered an issue)
Health and Safety		• Flattening of bank will reduce public safety risks.
Social Acceptance		
Construction impacts		• Minimal, short-term effects on Community Centre activities
Visual appearance		• Vegetation will provide natural looking riverbank
Recreational use		• Ball field protected from future erosion
Environmental Protection/Fish habitat		
River water quality & fluvial processes		• Approach may improve water quality locally by controlling eroded material inputs. • Retains high potential for downstream impacts and alteration to natural flow.
Local ecosystem		• Re-vegetated bank will improve riparian habitat
Economics		
Capital costs		• Average costs if balance cut and fill is achieved. Bioengineering costs are not negligible.
Maintenance Costs		• Average, could be high if erosion persists at base of slope

5.4.3 Alternative 3: Reconstruct & Rip Rap

Table 5-4 – Evaluation for Reconstruct & Rip Rap

Category	Rating	Justification/Explanation
Technical Feasibility		
Technical efficacy		• Buttressing toe of slope with fill and flattening of bank will improve slope stability
Track record		• Riprap revetment is a proven method in high energy environments • Does not rely on rapid establishment of vegetation
Ease of implementation		• Good site access
Regulatory Feasibility		• MVCA/DFO approval required (not considered an issue)
Health and Safety		• Flattening of bank will reduce public safety risks
Social Acceptance		
Construction impacts		• Minimal, short-term effects on Community Centre activities
Visual appearance		• Riprap may not be considered as aesthetically pleasing as vegetation
Recreational use		• Ball field protected from future erosion
Environmental Protection/Fish habitat		
River water quality & fluvial processes		• Approach may improve water quality locally by controlling eroded material inputs. • Solution does not address natural (historical) flow paths.
Local ecosystem		• Riprap bank and re-vegetated upper bank will improve riparian ad aquatic habitat
Economics		
Capital costs		• High due to imported fill and rock
Maintenance Costs		• Low, some maintenance of vegetation necessary

5.4.4 Alternative 4: Gabion Basket Retaining Wall

Table 5-5 – Evaluation for Gabion Basket Retaining Wall

Category	Rating	Justification/Explanation
Technical Feasibility		
Technical efficacy		• Flattening of bank will improve slope stability • Strict quality control required during construction of gabion basket retaining wall
Track record		• When properly built gabion basket walls are a proven method in high energy environments. • They have a limited lifespan and will break down over time.
Ease of implementation		• Good site access
Regulatory Feasibility		• MVCA/DFO approval required – such measures are typically not the preferred choice in such natural environments.
Health and Safety		• Near vertical wall may remain a public safety risks - may be mitigated with guard rails
Social Acceptance		
Construction impacts		• Minimal, short-term effects on Community Centre activities
Visual appearance		• Gabion wall may not be considered as aesthetically pleasing as vegetation
Recreational use		• Ball field protected from future erosion
Environmental Protection/Fish habitat		
River water quality & fluvial processes		• Approach may improve water quality locally by controlling eroded material inputs. • Solution may simply more erosion downstream.
Local ecosystem		• Limited improvement to riparian/aquatic habitat
Economics		
Capital costs		• High due to imported rock and extensive labour
Maintenance Costs		• Some maintenance of gabions expected

5.4.5 Alternative 5: Re-Grade & Rock Deflectors

Table 5-6 – Evaluation for Re-Grade & Rock Deflectors

Category	Rating	Justification/Explanation
Technical Feasibility		
Technical efficacy		• Flattening of bank will improve slope stability. • Re-vegetation between deflectors will also reinforce bank and prevent erosion
Track record		• Deflectors are a proven method in high energy environments • Long-term stability of rock deflectors built on smooth bedrock is unknown – some movement expected
Ease of implementation		• Good site access
Regulatory Feasibility		• MVCA/DFO approval required (not considered an issue)
Health and Safety		• Flattening of bank will reduce public safety risks
Social Acceptance		
Construction impacts		• Minimal, short-term effects on Community Centre activities
Visual appearance		• Deflectors may not be considered as aesthetically pleasing as vegetation since they are not a natural river feature.
Recreational use		• Ball field protected from future erosion
Environmental Protection/Fish habitat		
River water quality & fluvial processes		• Approach will improve water quality by limiting downstream sedimentation. • Groynes may have a negative impact on fluvial processes by robbing sediment that would be destined for downstream reaches
Local ecosystem		• Rock deflectors and re-vegetated upper bank will improve riparian and aquatic habitat
Economics		
Capital costs		• High due to imported rock
Maintenance Costs		• Low, some maintenance of deflectors and vegetation may be necessary

5.4.6 Alternative 6: Partial River Channel Retraining

Table 5-7 – Evaluation for Channel Retraining

Category	Rating	**Justification/Explanation**
Technical Feasibility		
Technical efficacy		• Considered effective as long as river equilibrium is maintained
Track record		• Method relies on ability to predict river's morphological evolution
Ease of implementation		• Good site access during low river flow
Regulatory Feasibility		• MVCA/DFO approval required
Health and Safety		• Filling and flattening of bank will reduce public safety risks
Social Acceptance		
Construction impacts		• Second most extensive disruptions when compared to other alternatives
Visual appearance		• Natural looking river section
Recreational use		• Ball field protected from future erosion
Environmental Protection/Fish habitat		
River water quality & fluvial processes		• Approach aims to restore fluvial processes which will benefit water quality
Local ecosystem		• Improvements expected to riparian and aquatic habitat
Economics		
Capital costs		• High due to extensive fill/earthworks
Maintenance Costs		• Low, some maintenance expected

5.4.7 Alternative 7: Full River Channel Retraining

Table 5-8 – Evaluation for Channel Retraining

Category	Rating	Justification/Explanation
Technical Feasibility		
Technical efficacy	[green]	• Considered effective as long as river equilibrium is maintained
Track record	[yellow]	• Method relies on ability to predict river's morphological evolution
Ease of implementation	[green]	• Good site access during low river flow
Regulatory Feasibility	[yellow]	• MVCA/DFO approval required
Health and Safety	[green]	• Filling and flattening of bank will reduce public safety risks
Social Acceptance		
Construction impacts	[red]	• Most extensive disruptions when compared to other alternatives
Visual appearance	[green]	• Natural looking river section
Recreational use	[green]	• Ball field protected from future erosion
Environmental Protection/Fish habitat		
River water quality & fluvial processes	[green]	• Approach aims to restore fluvial processes which will benefit water quality
Local ecosystem	[green]	• Improvements expected to riparian and aquatic habitat
Economics		
Capital costs	[red]	• High due to extensive earthworks and possibly in-river rock excavation
Maintenance Costs	[green]	• Low, some maintenance expected

Table 5-9 – Evaluation for Summary Results

Alternatives	Technical Feasibility	Regulatory Feasibility	Health & Safety	Social Acceptance	Environmental Protection	Economics
Alternative 1 - Do Nothing						
Alternative 2 – Re-Grade & Re-Vegetate						
Alternative 3 – Reconstruct & Rip Rap						
Alternative 4 – Gabion Basket Retaining Wall						
Alternative 5 – Rock Deflectors + Re-Grade						
Alternative 6 – Partial Channel Retraining						
Alternative 7 – Full River Channel Retraining						

5.4.8 Recommended Solution

Traditional erosion reduction measures to protect the bank from erosion (Alts 2 to 4) are not effective at the primary erosion location as they do not address the main cause of the erosion – the energy of the river directed towards the bank. Such measures are expected to translate to problems downstream, effectively introducing disequilibrium over a longer spatial distance in the reach of interest.

The rock deflectors (Alternative 5) are not natural features and are expected to be difficult to maintain given the bedrock conditions at this site.

Based on the preceding evaluation of alternatives, and as summarized in **Table 5-9**, the recommended solution for the primary erosion area is the re-establishment of the general form of the river to previous (1991) patterns through Alternative 6: Partial River Channel Retraining. While this alternative is among the most expensive to implement, it is considered to be a longer lasting and therefore more sustainable solution. This solution will reverse the local tendency of the river to widen and deposit materials which ultimately puts further erosive pressures on the riverbanks. The intent is to re-establish historical flow paths in order to increase the river's competency through the reach under low-flows and to maintain this equilibrium for a lasting solution. This alternative will result in less disruption to the active river channel when compared to Alternative 7: Full River Channel Retraining and therefore will likely be more readily approved by regulatory agencies.

As for the secondary erosion site, this area of the river is not as susceptible to impinging flows and therefore may be addressed through the implementation of the measures described in Alternatives 2 or 3.

6.0 PREFERRED ALTERNATIVE

6.1 DESCRIPTION OF PREFERRED ALTERNATIVE

6.1.1 Primary Erosion Site

As described briefly under **Section 4.1.6**, the preferred alternative to mitigate against ongoing erosion and associated public safety issues entails the partial retraining of the river channel. As illustrated in **Figure 3 and 4,** the solution involves importing fill and placing it at the base of the eroded bank in order to build some floodplain terraces out into the river and to re-instate the river bank with more gentle and stable slopes (minimum 2 horizontal to 1 vertical). The outer edge of the fill would be armoured with riprap to prevent erosion while the terraces and the upper slope would be re-vegetated. Opportunities to incorporate bioengineering into the channel re-training will be explored further during detailed design.

The in-stream work would also include the removal and/or movement of some rock and sediment that have accumulated at the head of bars located adjacent and a short distance upstream of the eroded bank. The removal/movement of these materials will ease the re-establishment of flow to side channels that have been less active in the last decade.

6.1.2 Secondary Erosion Site

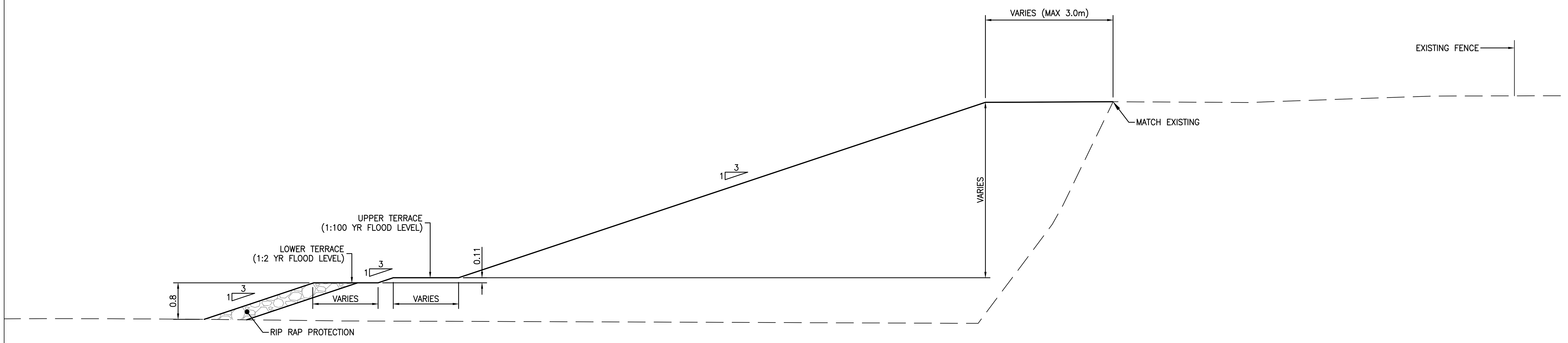
As for the secondary erosion site, the recommended prescription involves the simple re-grading of the over-steepened slope (minimum 2 horizontal to 1 vertical) with the need for little to no imported fill material. The base of the re-graded slope would be armoured with either riprap or bioengineering techniques such as brush layering to prevent erosion and the upper slope would be re-vegetated.

6.1.3 Conceptual Planting Plan

Conceptual planting plans have been prepared for both the primary and secondary erosion sites (illustrated in **Figure 5 and 6**). The development of the plan was inspired from the existing vegetation found across the river. Three types of treatments are proposed including:

- Lower floodplain terraces - planted with native, water-tolerant shrubs species;
- Slope (primary site) – reforestation bed composed primarily of native conifers;
- Slope (secondary site) - reforestation bed composed primarily of native deciduous shrubs; and,
- Table land – a mix of larger native conifers (2.4m high) and deciduous (70mm d.b.h.) species.

PLAN VIEW
N.T.S.



TYPICAL SECTION
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Permit-Seal

Client/Project
City of Ottawa

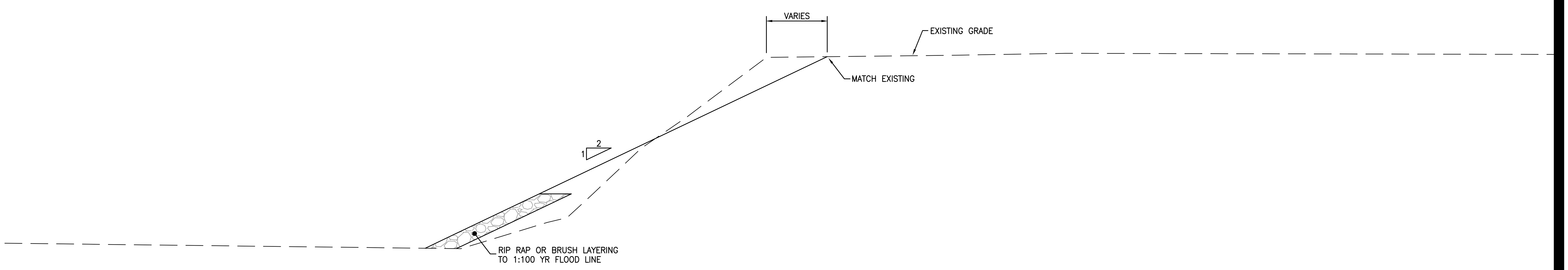
FITZROY HARBOUR
SLOPE STABILITY
Ottawa ON Canada

Title
PLAN VIEW AND
TYPICAL SECTION
PRIMARY SITE

Project No. 163401089
Scale AS SHOWN

Figure No. 6-1
Sheet of
Revision 0

PLAN VIEW
N.T.S.



TYPICAL SECTION
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Client/Project
City of Ottawa

FITZROY HARBOUR
SLOPE STABILITY
Ottawa ON Canada

Title
PLAN VIEW AND
TYPICAL SECTION
SECONDARY SITE

Project No. 163401089
Scale AS SHOWN

Drawing No. 6-2
Sheet of
Revision 0

FITZROY HARBOUR
SLOPE STABILITY

PLAN VIEW AND TYPICAL SECTION PRIMARY SITE

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Manager - Division	*Project Manager*

Contract No. 000	Dwg. No. 000
Sheet _ of _	
Asset No. 00	
Asset Group 00	
Des. 00	Chk'd. 00
Dwn. E.C.	Chk'd. 00
Utility Circ. No. 00	Index No. 00
Const. Inspector 00	
Scale: AS SHOWN	

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The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

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REVISIONS

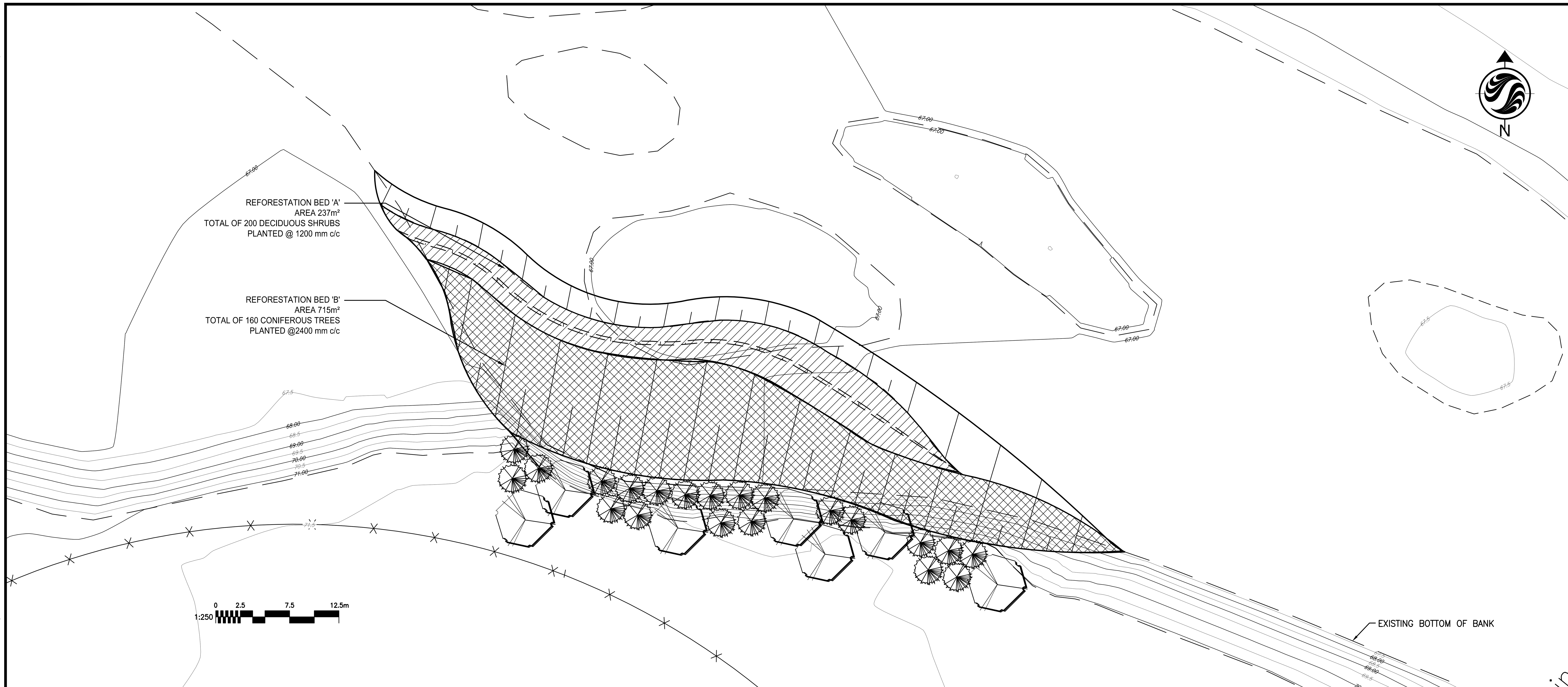
No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR DISCUSSION	C.G.	17/11/2011

LEGEND

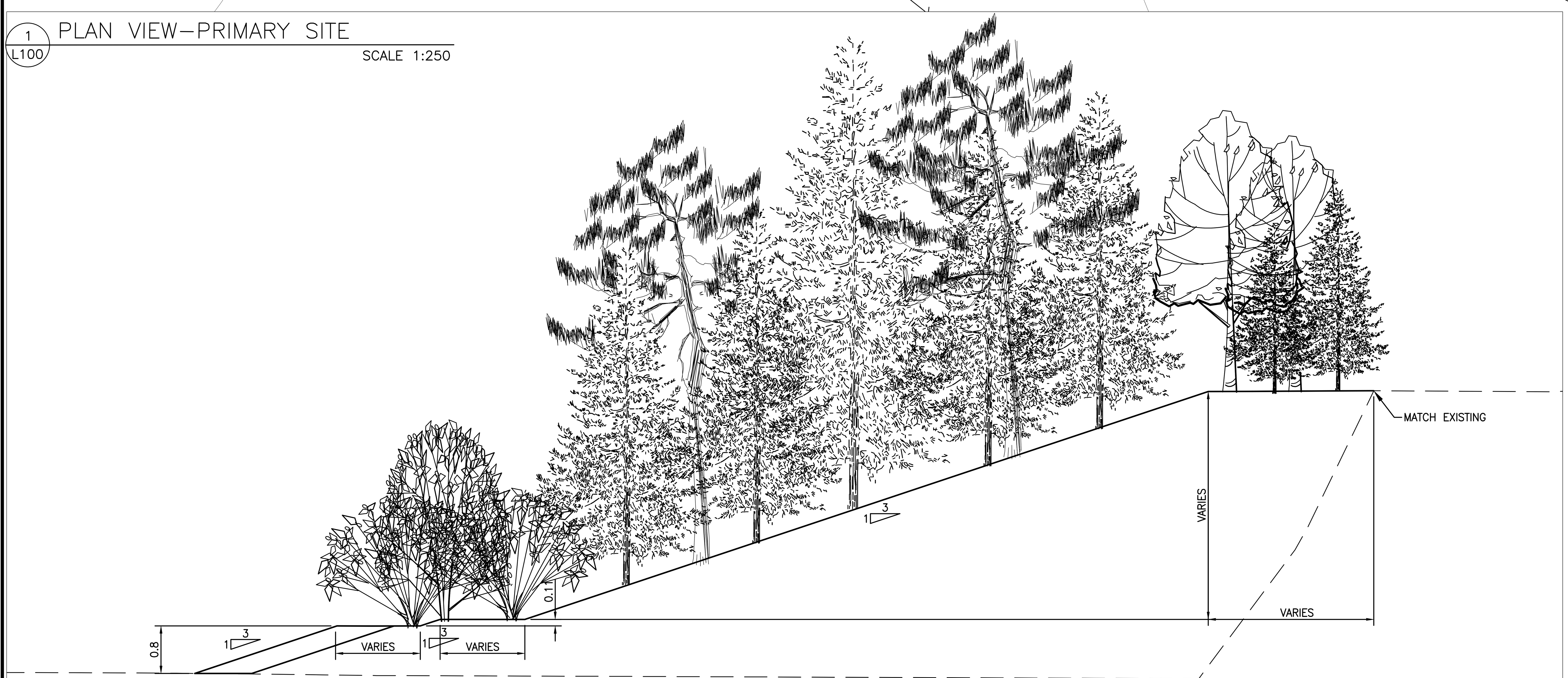
PROPOSED DECIDUOUS TREE REFER TO DETAIL 1/L300

PROPOSED CONIFEROUS TREE REFER TO DETAIL 1/L300

PROPOSED SHRUB PLANTING BED REFER TO DETAIL 3/L300



1 L100 PLAN VIEW–PRIMARY SITE
SCALE 1:250



1 L100 SECTION– STATION 2+340
SCALE 1:50

Plant Material

SYM	QTY	Botanical Name	Common Name	Size	Remarks
DECIDUOUS TREES:					
AS		Acer saccharum	Sugar Maple		
QR		Quercus rubra	Red Oak		
CONIFEROUS TREES:					
PG		Picea glauca	White Spruce		
PS		Pinus strobus	Eastern White Pine		
TO		Thuja occidentalis	White Cedar		

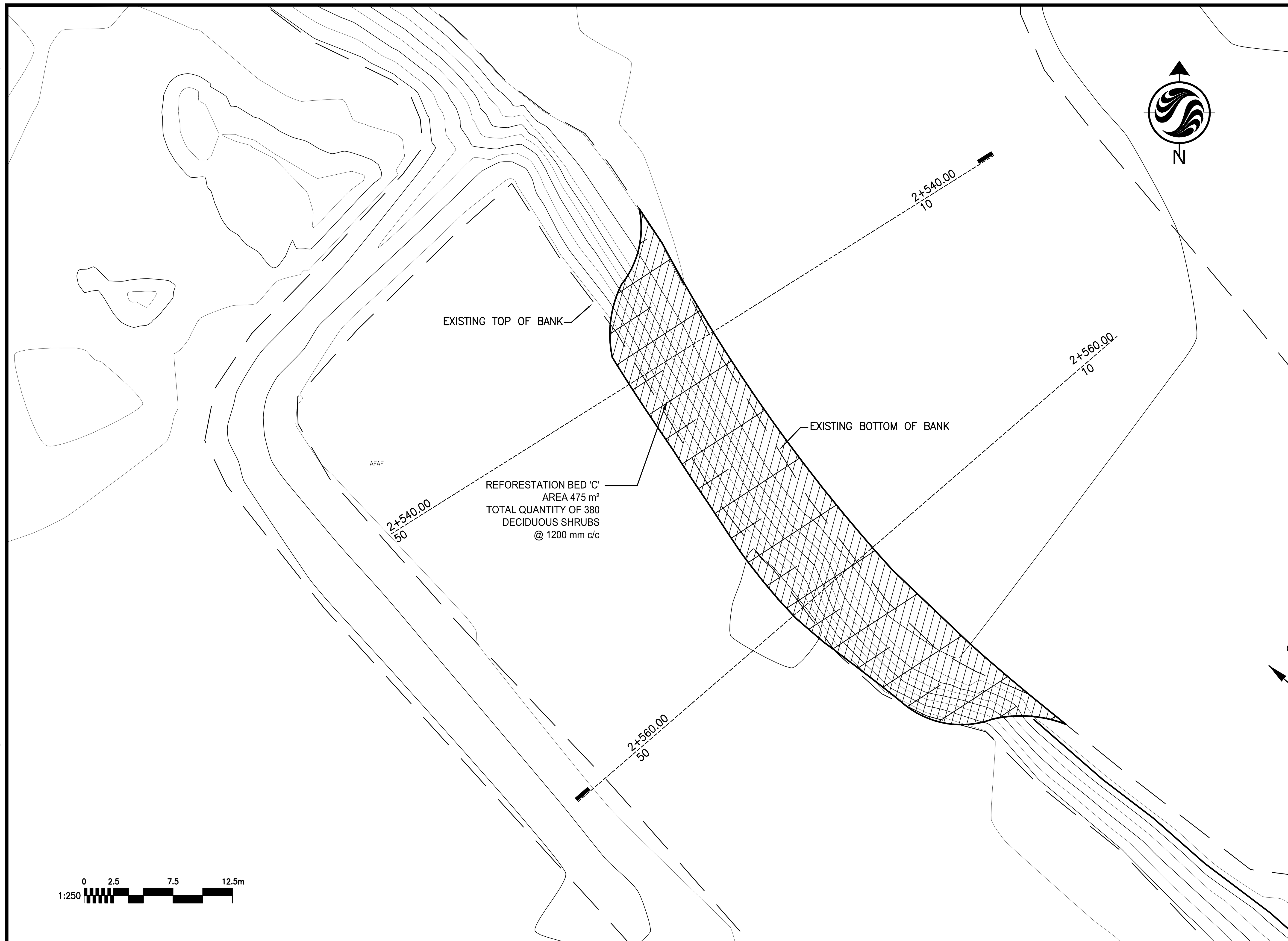
PLANT MATERIAL - REFORESTATION BED A (237 m²)

SYM	QTY	Botanical Name	Common Name	Size	Remarks
DECIDUOUS SHRUBS:					
AMC		Amelanchier canadensis	Downy Serviceberry		
CFO		Cornus racemosa	Gray Dogwood		
COR		Cornus sericea	Red Osier Dogwood		
SAC		Salix candida	Hoary Willow		
SAD		Salix discolor	Pussy Willow		
SAE		Salix exigua	Sandbar Willow		
VC		Viburnum cassinoides	Witherod		

PLANT MATERIAL - REFORESTATION BED B (715 m²)

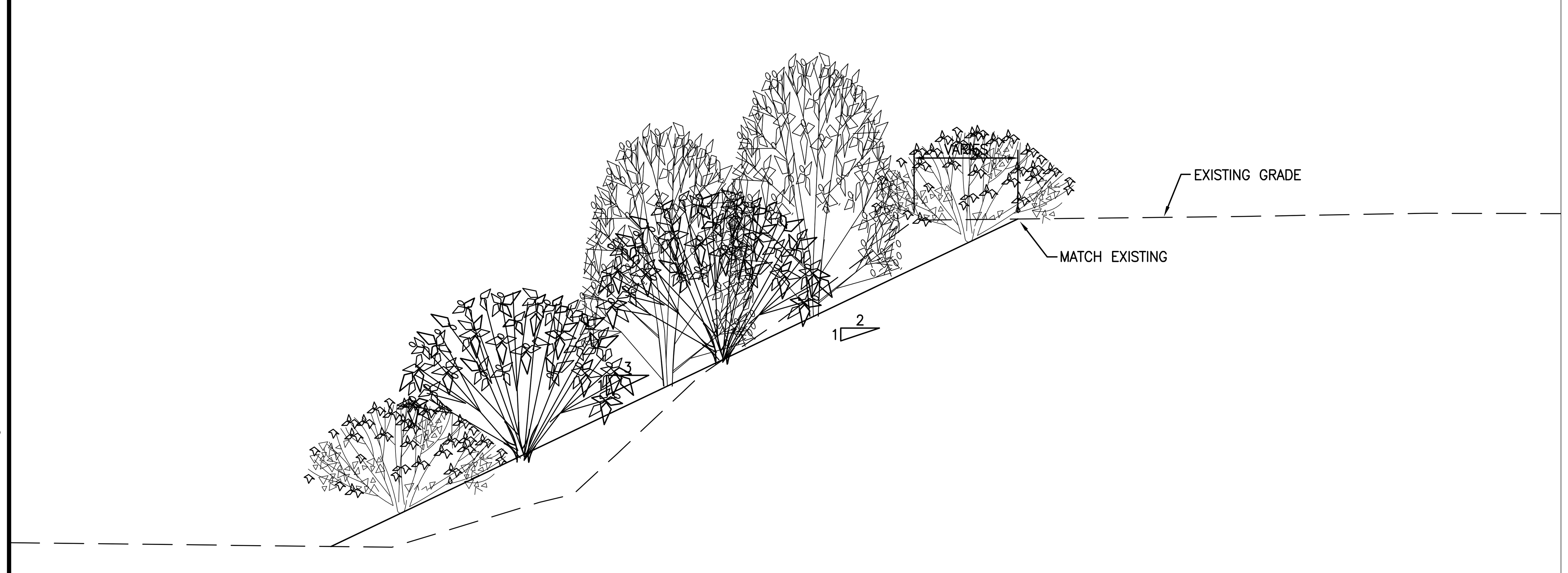
SYM	QTY	Botanical Name	Common Name	Size	Remarks
CONIFEROUS TREES:					
PG		Picea glauca	White Spruce		
PS		Pinus strobus	Eastern White Pine		
TO		Thuja occidentalis	White Cedar		

Consultant Drawing Number



1 L200 PLAN VIEW– SECONDARY SITE

SCALE 1:250



2 L200 SECTION– SECONDARY SITE (STATION 2+560)

SCALE 1:50

FITZROY HARBOUR
SLOPE STABILITY

Ottawa

PLAN VIEW AND
TYPICAL SECTION
SECONDARY SITE

-- Manager - Division	-- Project Manager

Contract No. 000	Dwg. No. 000
Sheet _ of _	
Asset No. 00	
Asset Group 00	
Des. 00	Chk'd. 00
Dwn. E.C.	Chk'd. 00
Utility Circ. No. 00	Index No. 00
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REVISIONS

No.	Description	By	Date (dd/mm/yy)
	XXX	XX	XXX

LEGEND

PROPOSED SHRUB PLANTING BED
REFER TO DETAIL 3/L300

PLANT MATERIAL - REFORESTATION BED A (475 m²)

SYM	QTY	Botanical Name	Common Name	Size	Remarks
DECIDUOUS SHRUBS:					
CFO		Cornus racemosa	Gray Dogwood		
COR		Cornus sericea	Red Osier Dogwood		
SAC		Salix candida	Hoary Willow		
SAD		Salix discolor	Pussy Willow		
SAE		Salix exigua	Sandbar Willow		
VC		Viburnum cassinoides	Witherod		

6.2 OPINION OF PROBABLE COSTS

A planning level opinion of probable costs was prepared for the preferred alternative as described above. Details of the opinion are provided in **Appendix F**. The total estimated cost for the works including a 20% contingency is $256,000.

6.3 DETAILED DESIGN

The following is a listing of issues that were raised as part of the conceptual design and consultation process and that will need to be addressed as part of the detailed design:

- MNR concerns with encroachment on crown land and others landowners. There may be a need for a work permit under section 14 of the Public Lands Act;
- Detailed implementation plan will be developed during the detailed design phase to mitigate any impacts on fish habitat;
- Access to the river bed with the working assumption that it is crown land and permitting will be required. City maintains ongoing communications with MNR;
- Public access and liability associated with restored slope and new easier access to the river. The detailed design will need to address integration of works with existing fences, new signage and any necessary deterrents; and,
- Ensure construction activities are done in coordination with the Community Centre to avoid impacts to significant events planned for the Centre. Contact the president of the Fitzroy Harbour Community Centre and City Rural Affairs.

7.0 IMPACTS, MITIGATION MEASURES AND MONITORS

7.1 CONSTRUCTION IMPACTS, MITIGATION, AND MONITORING

7.1.1 Noise and Vibration

Nuisance impacts may occur over the short-term during the construction phase of the project. The adjacent land owners will be informed of the construction schedule. With proper care and staging of construction, the noise and vibration impacts are expected to be modest in intensity and duration. The impacts will be mitigated through the inclusion of specific mitigation measures in the contract documents when the work is tendered for construction. The implementation of these measures will also need to be monitored by the Owner's representative during construction. Measures that will be included to address noise and vibration include:

- Limiting the hours of work to the standard construction work hours set out in the current City of Ottawa by-law,
- Limiting the speed of construction traffic to posted speed limits on all roads, or to reduced speeds if construction conditions warrant, and
- All construction vehicles and equipment are to be equipped with effective muffling devices and operated in a fashion to minimize noise/vibration levels.

7.1.2 Traffic Control

The expected impacts of the proposed work on the traffic in the village are expected to be minimal and will be contained to the short-tern construction phase. There will be increased truck traffic and movement of workers and equipment to and from the site. Pedestrian movement around the site, as well as access and parking at the Community Centre are likely to be affected. The mitigation measures that will be incorporated into contract documents and monitored during construction by the Owner's representative are as follows:

- Designated construction access routes,
- Contractor will provide a traffic plan to be approved by the City detailing signage and barriers where required for changes to the flow of traffic,
- Pedestrian access will be provided for all facilities affected by construction,
- Notification of the public in advance of any road closures, and
- Ensure access for emergency response vehicles and personnel.

7.1.3 Waste and/or Contaminated Materials Handling

The possibility of the Contractor excavating contaminated materials is remote for this work, however the contract will specify that any materials identified as contaminated must be disposed of according to all applicable regulations. The design of the works is such that a minimal amount of waste material from the excavation will be transported from the site. The Contractor will be required to dispose of any and all construction waste in a designated waste handling facility.

7.1.4 Erosion and Sediment Control

This project involves extensive in-stream works. As such, extensive planning for proper erosion and sediment control by the Contractor will need to be clearly defined and communicated in the contract documents. Mitigation measures that will need to be implemented and monitored will include:

- Limit disturbance of in-stream sediment to that which is required by the contract,
- Provide silt fences and other erosion and sediment control measures as necessary, and
- Employ stream diversion away from construction activity where appropriate.

7.2 ENVIRONMENTAL IMPACTS, MITIGATION, AND MONITORING

7.2.1 Aesthetics/Vegetation

The impact to aesthetics/vegetation will be positive due to the incorporation of re-vegetating work that will be included in the design. Native species of plants will be established in the re-graded slope for both structural and aesthetic reasons. The plantings will need to be monitored on an annual basis with the rest of the upgrades to ensure that they are prospering. Monitoring will identify any areas where the desired results of the design are not being achieved.

7.2.2 Waterway Flow Regime

Potential impacts to the Carp River flow regime have been examined by hydraulic modeling and a memo entitled *Fitzroy Harbour Community Centre Slope Stability Study Hydraulic Assessment of Recommended Solution* (Stantec, 2011) has been included in **Appendix E**. The conclusions of the modeling are provided below.

> A comparison of the hydraulic modeling results indicates that the expected impacts from the proposed channel modifications are limited to a section of approximately 80m upstream of the project (Sections 2+340 to 2+420 inclusive).
>
> Additionally, the maximum difference in depths between the preferred solution and existing conditions is approximately 17cm under the 1:100 year flood conditions. This

difference in elevations occurs about 40m upstream of the cross-section where the most severe erosion has occurred (Section 2+380).

The expected impact on the average flow velocities of the implementation of the preferred alternative will vary from a decrease of 0.31m/s (seen at Section 2+400) to an increase of 0.55m/s (seen at Section 2+360). The average velocities under both the existing and the preferred alternative conditions ranged from 1.76m/s to 3.13m/s under the 1:100 year conditions.

The model results show that the suggested modifications to the channel can be implemented with minimal impacts to the flow characteristics of the Carp River.

In an effort to monitor the erosion/land loss from this project, a physical monitoring plan using aerial photography would be implemented. Control points would be established along the bank and future rates of erosion would be compared to historical rates in order to ensure the expected positive effects of the project are being achieved.

7.2.3 Fish, Aquatic Wildlife and Vegetation

Some potential impacts common to all of the proposed alternatives include the modification of aquatic habitat, reduced water quality and the disruption of spawning, nesting or breeding periods for various species, some of which may be species at risk. Consultation has begun with MVCA, MNR and DFO regarding this project (refer to **Appendix A**). It is expected that this consultation will result in the establishment of certain required mitigation and monitoring measures, based on the alternative selected and the subsequent detailed design.

Some expected mitigation measures include:

- Windows of time during which in-stream works are not allowed, to protect fish and other aquatic species during sensitive life cycles (e.g. March 15 to June 30 for warmwater fish spawning, or broader periods to protect turtles during hibernation or nesting);
- Implementation of appropriate sediment and erosion control measures, which can also be used to exclude wildlife such as fish, snakes and turtles from the work area;
- Thorough searches of the work area prior to commencing project activities, with specific emphasis on potential species at risk snakes and turtles using MNR-approved methodologies, to encourage any local wildlife to move away from the work site and to determine whether any additional mitigation measures are needed (should species at risk be located);
- Searches for bank swallow or other species that may be using the river banks and associated habitat for nesting;
- Installation of specific structures on the stream bed to replace or improve the aquatic habitat; and,

- Monitoring of habitat by sampling before construction and then annually for two years after construction.

At this point, it is anticipated that the project will not commence until late summer 2012 when the water in the Carp River is lowest. This will eliminate concern for potential over-wintering turtles in the area, spring spawning fish species, and most breeding birds. This also allows time for a site-specific fish and fish habitat assessment to be conducted prior to any project activities to identify the sensitivity of the fish species and habitat present, and determine the scale of negative effect of the proposed work. This assessment will determine if any further mitigation is required for species at risk that could potentially be present (e.g., American eel, lake sturgeon and river redhorse). Searches for potential species at risk such as milksnake, eastern ribbonsnake, snapping turtle, northern map turtle and Blanding's turtle can also be conducted during the spring and summer of 2012 prior to the commencement of project activities.

Although suitable habitat may exists within 120 m of the project site for other terrestrial species at risk such as, Ginseng, Butternut, Flooded Jellyskin, West Virginia White, Monarch, Whip-poor-will, Golden-winged Warbler, Chimney Swift, Red-headed Woodpecker, Canada Warbler and Common Nighthawk, the likelihood of such species being impacted will depending on the which alternative is chosen and on the detailed design that is developed. It is not known at this time whether there will be any potential impacts to these listed species. Once the details of the design are finalized, further mitigation for these species may be recommended. Any further mitigation will be developed in consultation with the MNR.

7.3 SOCIAL/COMMUNITY IMPACTS, MITIGATION, AND MONITORING

7.3.1 Recreation / Social Impact

The expected recreation / social impacts would primarily be related to access during construction and safety issues. Access during construction has been addressed in Section 6.2.2 Traffic Control. The safety issues could be divided into short-term and long-term. The short-term impacts would be the potential for hazards during construction. Signage and fencing will be employed by the Contractor during construction to minimize these hazards. Long-term safety impacts will be positive as the hazard of an unstable bank will be removed by this work.

7.3.2 Economic Impact

The economic impact of the contemplated work would primarily be related to the cost of construction. Standard contractual language will be employed to protect the City as much as possible from the potential economic impact of construction risks. A positive economic impact is the reduction of litigation risk that is achieved by addressing a known safety hazard at a public recreation facility.

7.3.3 Archaeological Effects

The anticipated potential archaeological effects would be the disturbance, destruction and/or loss of archaeological artifacts. The mitigation measures that will be incorporated into the detailed design phase of the project would include a Stage 1 Archaeological Assessment of the site. It is also expected that a Stage 2 Archaeological Assessment of the site would be required prior to construction. These measures would ensure that any potential impacts are mitigated.

8.0 REFERENCES

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APPENDIX A
Public Stakeholder and Review Agency Consultation

September 2011

The Fitzroy Peeper

The newsletter of the Fitzroy Harbour Community Association

www.fitzroyharbour.com

FHCA est. 1976
Volume xiii – Issue IX

Yoga in Fitzroy

from the City of Ottawa

Fall Yoga sessions at the Fitzroy Harbour Community Centre. Relax your body and mind. Various stretching postures to help tone your muscles, improve circulation and get a boost of energy.
Barcode 676824; Mondays Sept 19 - Dec 5 from 7-8pm
Barcode 676833; Saturdays Sept 24 - Dec 10 from 10-11am
For more information contact **Adam O'Rourke, Program Coordinator** , adam.orourke@ottawa.ca or (613) 580-2424 x 33527

City of Ottawa Well Water Testing

Pick up your testing bottle and drop off a sample for well water testing on Sunday, October 11 at the Harbour Store 7 am to 9 pm.

A Thank You From Bill and Amy Newell

We wish to thank the many people of the community of Fitzroy Harbour for their generous support of St. George's Corn Roast and BBQ on August 13. The turnout was very gratifying. We also want to thank our friends at St. George's for designating the proceeds this year as a benefit for us to help meet some of the expenses from the storm damage to our home. The music provided by Bill and Kelly Ann Wilson was a wonderful addition to the whole event. We have known for over 40 years that Fitzroy Harbour is a great place to live and your support has proved that once again.
With grateful hearts, Bill and Amy Newell.

Youth Connexion Lounge

Youth Connexion of the City of Ottawa along with some local youth from Fitzroy Harbour this summer will be creating a youth room called The Connexion Lounge. This room will be located in the old playgroup room in the basement of the community centre. Youth Connexion is looking for donations to help out with room; gently used furniture, electronics, games etc. If you have any items that you are willing to donate contact Sarah Hanniman at (613)580-2424 ext 43306 or sarah.hanniman@ottawa.ca

Library Nook

From the Ottawa Public Library – Fitzroy Harbour branch

New arrivals in Express DVD's – these are recently released movies – come in and select a great movie to watch – 3 day loan. Also check out some wonderful suggestions by your local librarian, Valerie, for your next book. You'll find them in Junior Fiction: "Valerie Recommends" complete with book synopsis and reviews of many titles. Thanks to all the children who participated in the Summer Reading Club - if you haven't picked up your seashell, visit the library and choose one soon!

Norma Dixon's September Poem

Frankie boy sang
'it's a long long way from May to December
but the days grow short when they reach September'
shortened days may be the theme
while coloured leaves surround the scene
falling leaves in the Carp or Snye
favourite camera shots to please the eye
texts and book buying tweets and twitters
gives many of our websites the bank balance jitters
so as Labour Day passes quickly by
hunting fans follow gees on the fly
take a break now in less humid air
or a joyous Ferris ride at our
popular September's nearby Carp Fair.

City of Ottawa Seniors Summit

The Mayor's Seniors Summit is an opportunity for seniors to come together to ask questions and get answers about what the City is doing for seniors and to provide ideas about ways to improve services. This Summit is part of a larger project that will culminate in a new older adult action plan for the City of Ottawa in 2012. Everyone is invited to participate, but registration is limited. For more information visit www.ottawa.ca/seniors or call 3-1-1.
When: Monday, October 3, 2011
Time: 8 a.m. to 3:30 p.m. - Lunch provided
Location: City Hall, 110 Laurier Avenue West, Jean Pigott Place and Andrew Haydon Hall

West Carleton Electric Fastball

West Carleton Electric Men's Fastball is over for another year. Thanks to our sponsors and supporters this year and see you back for another season in 2012.

Email thepeeper@fitzroyharbour.com or call 613-623-8867 to get in the next edition

Visit our website: www.fitzroyharbour.com

Rural Roots Theatre news

Auditions will be held in the Arnprior Library on Sept 6th and 8th at 7:00pm, and Sept 10th at 2:00pm. Looking for two women to play "best friends since high-school", and two men to play their husbands. These will be cold reads for "The Long Weekend" by Norm Foster to be performed Nov 11th, 12th, 18th and 19th, 2011. We are also looking for people to work "behind the scenes" in a wide variety of roles, experience welcomed but not necessary. For additional information call 613 623 3836 or email priorplayers@gmail.com.

Harbour Days Silent Auction Sponsors

The FHCA would like to thank the following sponsors of the Harbour Days Silent Auction in 2011, in no particular order: Monique & Neil Findlay, Norma Dixon, Dunrobin Meat & Grocery, Harbour Garage, Delores Penney, Niki Farmer, Emcon, Filtran, Ben & Tracey Jardine, Sherry Krahn, WC Kids Korner, Eli El-Chantiry, Rick Langford, Sandra Coker, Stephanie Wilson, Ted Devine, Harbour Store, Harbour Pizza, Wendy Mayhew, Madawaska Golf Course, Mount Pakenham, Arnprior Pool, Carp Fair, Joey Sawyer, Accolade, Mike Beach, Margaret Ann Davis, Capital Ice Management, Perry Mason & Astrid Neuland, Penny's Fudge Factory and Mark D'arcy.

Badminton Club seeks players

The West Carleton Adult Recreational Badminton Club welcomes new members of all skill levels each Wednesday, 6-10 p.m. Season starts Wednesday, September 21at Stonecrest Elementary School , corner of Stonecrest Rd. and Kinburn Side Rd. Cost: $50 from September to May. Register September 21 or get more information by phoning: 613-297-1707.

Fall dates for disposal of household hazardous waste

If it's corrosive, flammable or poisonous it's hazardous waste. These types of products contaminate water and landfills and should never be poured down the drain or put out with your regular garbage. The City of Ottawa is hosting hazardous waste depots for residents of Ottawa. To find out what products are considered household hazardous waste, or for additional information, visit ottawa.ca.

Sunday, September 25, Waste Management at 254 Westbrook Road, off Carp Road, south of Highway 417 from 9am to 4pm.

Interested in booking the Fitzroy Harbour Community Centre for an event? Call the FHCA at 613-623-5241 or email hallrental@fitzroyharbour.com for rates and available dates

Did you know that the Fitzroy Harbour Community Association has an electronic e-mailing list to keep residents up to date on the latest news and distribute the "E-Peeper"? If you would like to join, please email peeper@fitzroyharbour.com

Fitzroy Harbour Fundraiser – The Fabulous BelAirs

Dance, fun, entertaining, an unforgettable experience of memories, harmonies that create an authentic atmosphere from the past, and proceeds benefit improvements to the Fitzroy Harbour Community Centre. Entertainment by the Fabulous BelAirs. **Saturday, October 22**, doors open at 8pm, Show starts at 9pm. Pay at the door $20 per person. Must be willing to go back in time and re-live the Fabulous 50's. So come as you are, or put on your pedal pushers or poodle skirts ladies; grease back your hair gentlemen; and we guarantee you'll have a fabulous evening.

NOTICE OF STUDY COMMENCEMENT
Schedule "B" Class EA for the
Fitzroy Harbour Community Centre Slope Stability and Geomorphology Study

THE STUDY

The City of Ottawa has initiated this Class Environmental Assessment (EA) to develop and recommend alternative solutions and mitigation measures to address the ongoing erosion problem near the Fitzroy Harbour Community Centre. The study area has been identified as approximately 175m of the Carp River adjacent to the Fitzroy Harbour Community Centre.

PROBLEM STATEMENT

The City of Ottawa is developing alternative solutions to address the ongoing erosion concerns adjacent to the Fitzroy Harbour Community Centre. Approximately 8 metres of land has been lost over the nine year period from 1999-2008. This loss is attributed to a shift in the main channel of the Carp River near the Community Centre. Alternative solutions on the Carp River will be considered for in-stream flow redirection with the goal of mitigating the erosion concerns with the understanding that there can be no increase in risk to other properties in the area.

THE PROCESS

This project follows the planning and design process as defined in the Municipal Engineers Association Municipal Class Environmental Assessment document (2007). The project is being planned under Schedule "B" of the Municipal Class EA and as such the public and appropriate agencies will be consulted once alternatives are developed and evaluated. Subject to comments received, the City intends to proceed with the implementation of the mitigation measures commencing in the spring of 2012. A Notice of Completion will be issued and the Project File will be made available for public review and comment.

PUBLIC COMMENTS INVITED

Public input and comment are invited for incorporation into the planning and design of this project. If you have any questions, comments, or wish to be added to the study mailing list, please contact:

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Infrastructure Services & Community Sustainability
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1505 Laperriere Avenue
Ottawa, ON, K1Z 7T1
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Info session planned over erosion issue in Fitzroy

Posted Oct 20, 2011 By EMC News

EMC News - Fitzroy Harbour Community Centre will be the site of the Slope Stability and Geomorphology Study, Schedule "B" Class Environmental Assessment open house Wednesday, Oct. 26 6-8 p.m.

The City of Ottawa has initiated this Class Environmental Assessment (EA) to develop and recommend alternative solutions and mitigation measures to address the ongoing erosion problem near the Fitzroy Harbour Community Centre. A shift in the main channel of the Carp River near the Community Centre has resulted in eight metres of eroded land over the last decade. Alternative solutions on the Carp River will be considered to relieve the erosion concerns without increasing risk to other properties in the area. The study area has been identified as approximately 175 metres of the Carp River adjacent to the Fitzroy Harbour Community Centre.

The project is being planned under Schedule "B" of the Municipal Class Environmental Assessment Process. At the Open House you will be able to review the proposed alternative solutions and provide your input. City staff and consultants will be available to discuss the project and answer your questions. Your feedback is an important part of the consultation process.

For further information and/or to submit comments, please contact:

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Infrastructure Services &
Community Sustainability
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Fitzroy Harbour Community Centre Slope Stability and Geomorphology Study
Étude de stabilité et de géomorphologie des berges au centre communautaire de Fitzroy Harbour

Schedule "B" Class Environmental Assessment / Évaluation environnementale de portée générale – Annexe B
Open House Wednesday, October 26, 2011 / Séance portes ouvertes, mercredi 26 octobre 2011

ATTENDANCE SHEET

Print Name	Mailing Address	Postal Code	Telephone No	E-mail Address
Courtney Symons	311 Bell St. S. Ottawa	K1S 4K2	613·700·1810	courtney.symons@metroland.c
Kerry Bourgaize	City of Ottawa.	K0A 3M0	580-2424 x-32256	Kerry.Bourgaize@ottawa.ca
Kevin Mayhew	84 Creek Dr.	K0A 1X0	6136230673	kwwen@sympatico.ca
Adam Brown	260 Frome St	K0A 1X0	6136230867	Adam.Brown@ottawa.ca
Karen Taylor	126 Snye Crt	K0A 1X0	613-623-6171	K.Taylor613@sympatico.ca

Welcome to the City of Ottawa Fitzroy Harbour Community Centre Slope Stability and Geomorphology Study

Open House

October 26th 2011 - 6 to 8 pm

Please sign in

Take a comment sheet to record your thoughts as you review the display materials. City Staff and the Study Team are available to answer your questions.

Your input is important!

Public input will influence this study; please take the time to fill out a comment sheet and return it to the registration table

Stantec

Bienvenue à l'étude de stabilité et de géomorphologie des berges au centre communautaire de Fitzroy Harbour de la Ville d'Ottawa

Séance portes ouvertes

Le 26 octobre 2011, de 18 h à 20 h

Inscrivez-vous!

Prenez une fiche de commentaires pour écrire vos pensées pendant que vous examinez le matériel présenté. Des membres du personnel de la Ville et l'équipe d'étude sont disponibles pour répondre à vos questions.

Votre opinion compte!

Les commentaires du public influeront sur l'étude; nous vous prions donc de prendre un moment pour remplir une fiche de commentaires, puis de la remettre à la table d'inscription.

Ottawa

Introduction

Problem Statement

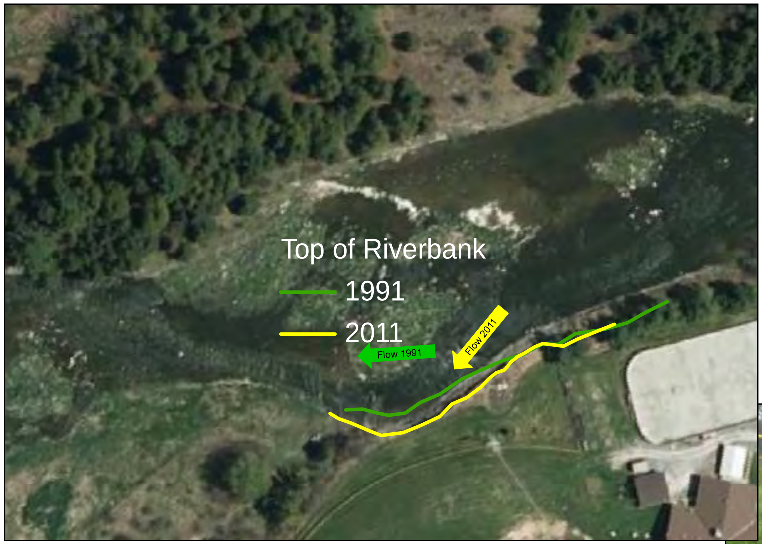
Approximately 8 metres of land has been lost near the Fitzroy Harbour Community Centre over the last decade. This loss is attributed to a shift in the main flow channel of the Carp River and the flow striking the riverbank resulting in bank erosion. Portions of the stream bank is vertical and poses a public safety hazard.

Énoncé du problème

Environ huit mètres de terrain ont été perdus près du Centre communautaire de Fitzroy Harbour au cours de la dernière décennie. Cette perte est due au déplacement du chenal principal de la rivière Carp et au fait que l'eau frappe la berge et l'érode. La berge est verticale par endroits et pose un danger pour la sécurité publique.

Opportunity

The City of Ottawa has initiated a Class Environmental Assessment (EA) to develop and recommend alternative solutions and mitigation measures to address the ongoing erosion problem and public safety concerns for a section of the Carp River near the Fitzroy Harbour Community Centre.



Possibilité

La Ville d'Ottawa s'est engagée dans une procédure d'évaluation environnementale (EE) de portée générale en vue d'élaborer et de recommander différentes solutions et des mesures d'atténuation pour régler le problème d'érosion et dissiper les craintes pour la sécurité publique sur une section de la rivière Carp près du Centre communautaire de Fitzroy Harbour.

Photo: John Beebe

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Municipal Class Environmental Assessment Process

Processus d'évaluation environnementale de portée générale pour les projets municipaux

Phase 1

- Identify Problem or Opportunity
  Identifier le problème ou la possibilité

Phase 2

- Identify and Evaluate Alternative Solutions
  Déterminer et évaluer des solutions de rechange
- Consult Review Agencies and Public
  Consulter les organismes examinateurs et le public
- Select Preferred Solution
  Choisir une solution préférée
- Confirm Schedule
  Confirmer le choix de l'annexe
- Notice of Completion
  Avis d'achèvement

We are here!
On est ici!

Phase 3

- Identify and Evaluate Alternative Design Concepts
  Déterminer et évaluer des études conceptuelles
- Consult Review Agencies and Public
  Consulter les organismes examinateurs et le public
- Select Preferred Design
  Choisir la conception préférée

Phase 4

- Environmental Study Report
  Rapport d'étude environnementale
- Notice of Completion
  Avis d'achèvement

Phase 5

- Detailed Design
  Conception détaillée
- Construction
  Procéder à la construction

Schedule / Annexe B

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Alternative Solutions / Solutions de rechange

Alternative 1: Do Nothing

The exposed riverbank would continue to provide its own protection against excessive erosion and sloughing. This alternative does not achieve our goals of reducing the loss of land or improving public safety.

Photo: City of Ottawa

Photo: John Beebe

Solution n° 1 : ne rien faire

La berge exposée continuerait de se protéger elle-même contre l'érosion excessive et la solifluxion. Cette solution ne permettrait pas d'atteindre les objectifs de réduire la perte de terrain et d'améliorer la sécurité publique.

Strategies for the development of alternatives

Two strategies were used to develop alternative solutions:

A.Focus on the eroding riverbank and provide a traditional solution using various approaches to riverbank revetments:

- Alternative 2: Re-grade & Re-vegetate Slope
- Alternative 3: Reconstruct & Riprap Riverbank
- Alternative 4: Gabion Basket Retaining Wall

B.Understand and work with the fluvial processes within this reach of the Crap River in order to develop longer lasting solutions:

- Alternative 5: Re-grade Slope & Rock Deflectors
- Alternative 6: Partial Channel Re-training
- Alternative 7: Full Channel Re-training

Stratégies d'élaboration de solutions de rechange

On a recouru à deux stratégies pour élaborer des solutions de rechange :

A.Se concentrer sur la berge subissant l'érosion et présenter une solution classique en recourant aux différentes techniques de revêtement des berges :

Solution n° 2 : adoucir la pente et la remettre en végétation
Solution n° 3 : reconstruire la berge et l'enrocher
Solution n° 4 : construire un mur de soutènement en gabions

B.Comprendre les processus fluviaux et travailler avec eux dans la section visée de la rivière Carp afin d'élaborer des solutions plus durables :

Solution n° 5 : adoucir la pente et construire des déflecteurs rocheux
Solution n° 6 : redresser partiellement le chenal
Solution n° 7 : redresser entièrement le chenal

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Alternative Solutions / Solutions de rechange

Alternative 2: Re-Grade & Re-Vegetate Slope

This alternative involves flattening of the riverbank by cutting the top of the slope and using this material to fill in the base of the vertical bank to provide a more stable bank. The bank would be re-vegetated using bio-engineering methods such as brush layering to provide erosion protection. The low flow in the river would be diverted away from the re-vegetated bank by re-arranging bars within the river.

Photo: Brinkman Associates

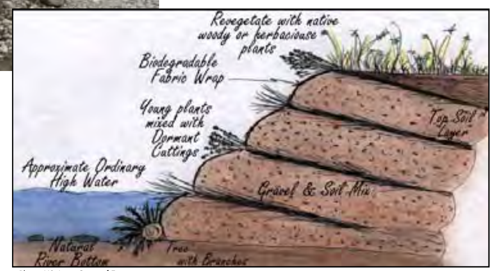

Photo: US Army Corps of Engineers

Solution n° 2 : adoucir la pente et la remettre en végétation

Cette solution comporte l'adoucissement de la pente de la berge en coupant son sommet et en utilisant le matériel pour remblayer le pied de la pente verticale et créer une berge plus stable. On remettrait la berge en végétation à l'aide des techniques de la bioingénierie, comme les couches de broussailles, pour contrer l'érosion. On éloignerait le faible débit de la rivière de la berge remise en végétation en redisposant les barres fluviales.

Alternative 3: Reconstruct & Rip Rap Stream Bank

This alternative would import fill material and rebuild the riverbank to its 1991 location and flatten the bank to improve its stability. The base of the new riverbank would be protected with a rock riprap revetment and the top of the bank would be re-vegetated with grasses, shrubs and trees.

The low flow in the river would be diverted away from the riprap bank by re-arranging bars within the river.

Photo: Stantec

Solution n° 3 : reconstruire la berge et l'enrocher

Cette solution prévoit l'importation de matériaux de remblai, la reconstruction de la berge à son emplacement de 1991 et son adoucissement pour la rendre plus stable. On protégerait le pied de la nouvelle berge par un perré et on garnirait le sommet d'herbes, d'arbustes et d'arbres.

On éloignerait le faible débit de la rivière du perré en redisposant les barres fluviales.

Alternative Solutions / Solutions de rechange

Alternative 4: Gabion Basket Retaining Wall

Alternative 4 is based on providing a gabion basket retaining wall to support the base of the riverbank. Gabion baskets are made of galvanized steel wire mesh which are filled with rock. The top of the riverbank would be flattened and re-vegetated. The low flow in the river would be diverted away from the retaining wall by re-arranging bars within the river.

Solution n° 4 : construire un mur de gabions

Cette solution consiste à construire un mur de gabions pour protéger le pied de la berge. Les gabions seraient faits de treillis de fil d'acier galvanisé retenant des roches. On aplanirait le sommet de la berge et on le regarnirait de végétation. On éloignerait le faible débit de la rivière du mur de soutènement en redisposant les barres fluviales.

Alternative 5: Re-grade Slope + Rock Deflectors

Flow deflectors in the form of rock groynes would be provided at the base of the eroded riverbank. These would extend into the channel and reduce near-shore velocities responsible for the erosion. The riverbank would also be flattened and re-vegetated with grasses, shurbs and trees.

Over time the area between the groynes would recruit sediment and plant material.

Photo: Salix Applied Earthcare

Solution n° 5 : adoucir la pente et construire des déflecteurs rocheux

On construirait des déflecteurs de courant sous la forme d'épis de roches au pied de la berge érodée. Ces épis se projetteraient dans le chenal et réduiraient le débit près du rivage, qui est responsable de l'érosion. On adoucirait la pente de la berge et on la regarnirait d'herbes, d'arbustes et d'arbres.

Avec le temps, l'espace entre les épis s'emplirait de sédiments et de plantes.

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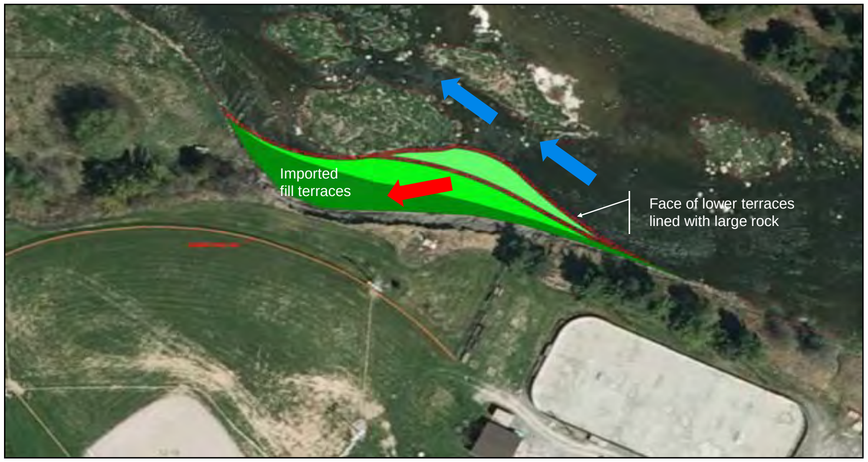
Alternative Solutions / Solutions de rechange

Alternative 6: Partial River Channel Re-training

This alternative would involve the placement of a significant amount of fill within the river, at the base of the eroded riverbank, in order to shift the path of the river away from the eroding bank. The fill would be terraced and protected along the outer edges using large stone. The low flow in the river would be diverted away from restored bank by re-arranging bars within the river.

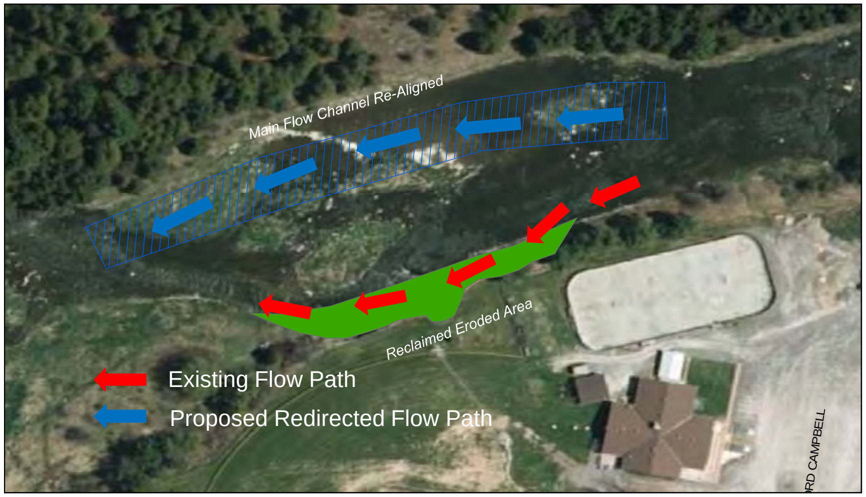


Solution n° 6 : redresser partiellement le chenal

Cette solution comporte la mise en place d'un important remblai dans la rivière, au pied de la berge érodée, afin d'en éloigner le cours. On façonnerait le remblai en terrasses, dont on protégerait les rebords par de grosses pierres. On détournerait le faible débit de la rivière de la berge restaurée en redisposant les barres fluviales.

Alternative 7: Full River Channel Re-training

This alternative entails more extensive changes to the riverbed and banks than in the previous alternatives. This would involve some rock excavation of the riverbed and the placement of a significant amount of fill at the base of the eroded riverbank in order to shift the path of the river away from the eroding bank.



Solution n° 7 : redresser entièrement le chenal

Cette solution comporte davantage de modifications du lit et des berges de la rivière que les solutions précédentes. Elle supposerait une excavation du lit de la rivière et la mise en place d'un important remblai au pied de la berge érodée, afin d'en éloigner le cours de la rivière.

Stantec

Ottawa

Evaluation Methodology

The following evaluation criteria and ratings were developed and applied to assist in identifying the preferred alternative.

Evaluation Criteria	
Technical Feasibility	Can alternative be used here? How well has it worked elsewhere? How easy/difficult would it be to implement?
Regulatory Feasibility	Are there any current regulatory constraints?
Health and Safety	Will alternative address public safety concerns?
Social Acceptance	What are the construction impacts, visual appearance and will it affect the recreational use of the site?
Environmental Protection	What impacts will the alternative have on the river water quality and the local ecosystem?
Economics	What are the capital and operational costs?

Méthode d'évaluation

On a élaboré puis appliqué les critères d'évaluation et les cotes suivantes pour faciliter la détermination de la solution privilégiée.

Critères d'évaluation	
Faisabilité technique	Peut-on utiliser la solution sur les lieux? A-t-elle bien ou mal fonctionné ailleurs? Serait-elle facile ou difficile à mettre en œuvre?
Faisabilité règlementaire	Existe-t-il des contraintes règlementaires?
Santé et sécurité	La solution dissipe-t-elle les craintes pour la sécurité du public?
Acceptation sociale	Quelles seraient les incidences de la construction sur l'aspect visuel et sur l'utilisation récréative de l'endroit?
Protection de l'environnement	Quelles incidences la solution aurait-elle sur la qualité de l'eau de la rivière et sur l'écosystème local?
Économie	Quelles sont les dépenses en immobilisations et quels sont les couts opérationnels?

Rating	Color/ Couleur	Cotes
Low preference or negative impact. Costs are above average for group.	(red)	Intérêt faible ou incidences néfastes. Couts supérieurs à la moyenne du groupe.
Medium preference or no impact. Costs are average for group.	(yellow)	Intérêt moyen ou absence d'incidences. Couts près de la moyenne du groupe.
High preference or beneficial impact. Costs are below average for group.	(green)	Intérêt élevé ou incidences bénéfiques. Couts inférieurs à la moyenne du groupe.

Stantec

Ottawa

Evaluation of Alternative Solutions
Évaluation des solutions de rechange

These are the draft evaluation results. You are invited to review the ratings and provide feedback to the project team.

Voici l'ébauche de l'évaluation. Vous êtes invités à examiner les cotes attribuées et à faire parvenir vos commentaires à l'équipe d'étude.

	Technical Feasibility / Faisabilité technique	Regulatory Feasibility / Faisabilité règlementaire	Health & Safety / Santé et sécurité	Social Acceptance / Acceptation sociale	Environmental Protection / Protection de l'environnement	Economics / Économie
Alternative 1: Do Nothing Solution n° 1 : ne rien faire						
Alternative 2: Re-Grade & Re-Vegetate Slope Solution n° 2 : adoucir la pente et la remettre en végétation						
Alternative 3: Reconstruct & Rip Rap River Bank Solution n° 3 : reconstruire la berge et l'enrocher						
Alternative 4: Gabion Basket Retaining Wall Solution n° 4 : construire un mur de gabions						
Alternative 5: Re-Grade Slope + Rock Deflectors Solution n° 5 : adoucir la pente et construire des déflecteurs rocheux						
Alternative 6: Partial Channel Re-training Solution n° 6 : redresser partiellement le chenal						
Alternative 7: Full Channel Re-training Solution n° 7 : redresser entièrement le chenal						

Next Steps

- Receive and incorporate public comments
- Confirm recommended solution
- Study Report – end of November 2011
- Detailed design – winter 2012
- Construction – summer 2012

- Upcoming public contacts
  - Issue Notice of Completion
  - Thirty (30) Day Review Period (December 2011)

Prochaines étapes

- Réception et intégration des commentaires du public
- Confirmation de la solution privilégiée
- Rapport d'étude – fin novembre 2011
- Conception détaillée – hiver 2012
- Construction – été 2012

- Prochaines interactions avec le public
  - Émission de l'avis d'achèvement
  - Période d'examen de 30 jours (décembre 2011)

Stantec

Ottawa

From: Mcwatters, Ken (MNR) [mailto:ken.mcwatters@ontario.ca]
Sent: December 14, 2011 1:26 PM
To: Cover, Kevin
Cc: Allemang, Bryan (MNR)
Subject: City of Ottawa Draft EA - Carp River

Thanks for talking to me today Kevin about the City of Ottawa Carp River Project. I have reviewed the Draft EA and see that Alternative 6 is the preferred option. With the details provided, I am suggesting that no Algonquin consultation is required and I base this on the following:

- the project includes a Stage 1 archaeological assessment with the Stage 1 expected to lead to a Stage 2 due to the projects proximity to the river. Should anything be found in this process, Ontario may wish to discuss this more (Ministry of Tourism and Culture) It has been made known to me on other projects, that the Algonquins of Ontario do want to be made aware of Algonquin artefacts that may be found in the workings of any project

- Alternative 6 is a long lasting solution to mitigate ongoing erosion. The prevention of erosion normally would make for a better environment for aquatic species and be supported by the Algonquins of Ontario

- the necessary work also addresses a safety concern with continued erosion

I see this project as an improvement to the environment of the Carp River and not subject to any asserted aboriginal right as there would likely be more positive benefits than any negative effects. My comments are specific to the need for any Algonquin of Ontario consultation and is not an approval to proceed. Through the normal approval process within MNR, the formal approval will come to you after a detailed review allows for such approval.

I trust this addresses the current questions. Should any more questions come forward related to Algonquin consultation, please contact me. Thanks again.

Ken McWatters
Resource Liaison Specialist
Algonquin Land Claim Area
Districts of Bancroft, Kemptville and Pembroke
Ministry of Natural Resources

Direct Line: 613-732-5572

c: Bryan Allemang

MNR Comments on Draft EA Carp River Slope Stabilization

Tuesday November 29, 2011

Ontario Parks

Due to the location of the proposed work being directly upstream of Fitzroy Provincial Park, Ontario Parks staff have been notified and will be commenting directly to the City.

Kemptville District

Lands, Planning and Species at Risk staff have reviewed the Draft EA. Fisheries staff will have time to review it by the end of this week.

In terms of the individual slope stabilization alternatives described, MNR policy would not limit our support of the project regardless of which alternative is chosen. With that said, MNR will also support modifications that place a high priority on ecological improvements. This project is an opportunity to profile erosion control methods using bioengineering.

Our role from a permitting perspective is still unknown at this time. It will be dependent on whether the bed of the river is provincial crown land. The answer is expected to be yes, but that final decision will need to be based on original crown patents. These patents have been requested from the Ontario Crown Land Registry but could take up to 6 months to receive.

Should a permit be required it is a work permit under section 14 of the Public Lands Act. This is a form of disposition and is subject to Aboriginal consultation as well as EA requirements under MNR's RSFD Class EA. We will need to ensure that the municipal EA addresses all of the MNR EA requirements.

Specific Comments on the Draft EA

Species at Risk:

There is not sufficient justification (besides the comment "there is no habitat") for the species listed on top of page 3.6. Please explain why this area of the Carp River is not appropriate habitat for Eastern Musk turtles and Spiny Softshell.

Please explain how species listed in the 2nd table on page 3.6 (and continued) on page 3.7 will not be affected by the work proposed. What avoidance measures are proposed to have no impacts of turtle, fish and snake species? The timing window (March 15th to June 30th) protects fish but does not protect snake species or over-wintering turtles. A more thorough assessment of the work site may be needed to assess the impacts on these species.

MNR Comments on Draft EA Carp River Slope Stabilization

General comments:

In table 5.7 where the preferred alternative is evaluated there are some uncertainties acknowledged by the report author.

Technical efficacy - Considered effective as long as river equilibrium is maintained

Track record - Method relies on ability to predict river's morphological evolution

Where did the author describe

i) the river's equilibrium and how it is anticipated to be maintained?

ii) the predicted morphological evolution of the River?

There is a definition of both the river's equilibrium and morphological evolution in Appendix B, but they are not addressed specifically in the report as they relate to the preferred alternative.

ALTERNATIVE 5: RE - GRADE SLOPE AND ROCK DEFLECTORS.

The issues associated with alternative 5 appear to be the following:

i) difficulty in anchoring to the bedrock

ii) high cost of rock material

iii) not aesthetically pleasing

iv) potential for downstream impacts

To the first point, would the site's low slope environment and ability to anchor into bedrock not provide a very suitable location for anchoring a deflector? Appendix B states that there is the opportunity on low-elevation features to trap coarse woody debris as well as ice jamming in the spring, which also acts to deflect flow. The trick would be to provide suitable anchoring to ensure it stays put long term. In terms of issues ii and iii, they would be resolved by a simple modification; using Engineered Woody Debris (EWD). EWD is a more natural approach that is cheaper and has additional benefits for the fishery. The potential for downstream impacts could be argued if EWD is used, but then again it comes down to how well the logs are anchored. With respect to sediment transport, the Carp River has no shortage of sediment (acknowledged in Appendix B), nor does this reach of the Ottawa River.

An EWD deflector would create a deposition area immediately downstream using nothing more than the energy and sediment of the river. The preferred alternative appears to use imported material and rock to do the same thing.

The preferred alternative has a budget of $256K; more than half of which ($138K) is for imported fill, grading and rip rap rock. Using alternative 5 with EWD would significantly reduce these costs, create a natural feature, provide additional benefits to the fishery, and use the energy of the river to our advantage.

D'Aoust, Stephane

Subject: FW: MNR comments of draft EA
Attachments: MNR Comments on Draft EA Carp River Slope Stabilization.doc

From: Cover, Kevin [mailto:Kevin.Cover@ottawa.ca]
Sent: Wednesday, December 21, 2011 12:26 PM
To: Allemang, Bryan (MNR)
Cc: D'Aoust, Stephane; Robinson, Anne
Subject: FW: MNR comments of draft EA

Hello Bryan:

1. Provided below is an outline of how your comments are being addressed in the Fitzroy Harbour – Carp River Erosion Control Environmental Assessment Study Report. As discussed, we understand that all of the issues are ones that are matters to be addressed during detailed design and construction of the preferred solution and that there is agreement with the selected preferred solution.
2. The report is going forward to the City's Agriculture and Rural Affairs Committee 2012 January 13. The Committee meeting starts at 9:30.
3. Any progress on the crown land determination?
4. I am out of the office Dec 23 through Jan 6 inclusive.
5. Thanks for all your efforts on this file

Wishing you and yours all the best over the Christmas season and through the New Year
Regards

Kevin A. Cover, M.A.Sc., P. Eng.
Environmental Information, Environmental Sustainability Branch, Community Sustainability Department, Infrastructure Services and Community Sustainability
110 Laurier Avenue West 3rd Floor East, Ottawa, ON, K1P 1J1
kevin.cover@ottawa.ca
Phone: (613) 580-2424, ext. 22830 Fax: (613) 560-6028
Mail Code 01-12

Kemptville District Comments

We agree that this is project may provide an opportunity to profile bioengineering. The potential use of bioengineering will be determined during detailed design when site specific opportunities will be reviewed while considering expected shear stresses, moisture conditions and long term maintenance requirements.

MNR has suggested no consultation with Algonquins is necessary at this time. Refer to email from Ken McWatters (Dec 14, 2011).

Draft EA Comments

Species at risk –

Please explain why this area of the Carp River is not appropriate habitat for Eastern Musk turtles and Spiny Softshell.
Spiny Softshells inhabit aquatic environments that include some aquatic vegetation and soft bottoms to bury in (COSEWIC 2003). The Eastern Musk Turtle inhabit aquatic environments that have a very slow current and soft bottom (ROM 2009). The substrate of the Carp River in the project location is entirely composed of bedrock, little to no soft substrate with steep near vertical river banks and the water moves at a high velocity. It is because of these natural environment characteristics that it is not anticipated that either Spiny Softshell or Eastern Musk turtle would be found within the project location.

We will provide additional justification for the species listed as not likely present in Section 3.2.3.3.

What avoidance measures are proposed to have no impacts of turtle, fish and snake species?

We will provide additional details in terms of avoidance measures for SAR in Section 7.2.3.

Some expected measures include:

- Windows of time during which in-stream works are not allowed, to protect fish and other aquatic species during sensitive life cycles (i.ee.g., March 15 to June 30 for warmwater fish spawning, or broader periods to protect turtles during hibernation or nesting),
- Implementation of appropriate sediment and erosion control measures, which can also be used to exclude wildlife such as fish, snakes and turtles from the work area,
- Thorough searches of the work area prior to commencing project activities, with specific emphasis on potential species at risk snakes and turtles using MNR-approved methodologies, to encourage any local wildlife to move away from the work site and to determine whether any additional mitigation measures are needed (should species at risk be located)
- Searches for bank swallow or other species that may be using the river banks and associated habitat for nesting.
- Installation of specific structures on the stream bed to replace or improve the aquatic habitat, and
- Monitoring of habitat by sampling before construction and then annually for two years after construction.

At this point, It is anticipated that the project will not commence until late summer 2012 when the water in the Carp River is lowest. This will eliminate concern for potential over-wintering turtles in the area, spring spawning fish species, and most breeding birds. This also allows time for a site-specific fish and fish habitat assessment to be conducted prior to any project activities to identify the sensitivity of the fish species and habitat present, and determine the scale of negative effect of the proposed work. This assessment will determine if any further mitigation is required for species at risk that could potentially be present (e.g., American eel, lake sturgeon and river redhorse). Searches for potential species at risk such as milksnake, eastern ribbonsnake, snapping turtle, northern map turtle and Blanding's turtle can also be conducted during the spring and summer of 2012 prior to the commencement of project activities.

Although suitable habitat may exists within 120 m of the project site for other terrestrial species at risk such as, Ginseng, Butternut, Flooded Jellyskin, West Virginia White, Monarch, Whip-poor-will, Golden-winged Warbler, Chimney Swift, Red-headed Woodpecker, Canada Warbler and Common Nighthawk, the likelihood of such species being impacted will depending on thewhich alternative is chosen and on the detailed design that is developed. for the project it is not known at this time whether there will be any potential impacts to these listed species. Once the details of the design are finalized, further mitigation for these species can be recommended if needed. Any further mitigation will be developed in consultation with the MNR.

We offer the following on River equilibrium and morphological evolution:

River Equilibrium and Long-term maintenance – This was a short-term specific study that looked at the possible alternatives relating to the eroding bank. Interpretation of the natural processes and form of the river was completed at a coarse level because of the time and spatial scales of the project. That said, the preferred alternative suggested in the geomorphology report places the river in its previous location. The reason the river did not stay in this position is not factually known but anecdotal evidence indicates that contact with the bedrock surface altered the ability of the river to downcut to pick up sediment, resulting in lateral movement. The unfortunate consequence of this lateral movement, which is natural, is there is infrastructure in the way which precludes allowing it to continue. Returning to its previous path (as opposed to training to another path) incorporates some sense of equilibrium as the river can retrain back to that path. Alternatively, shoring the bank and leaving the main thread of flow at the toe will throw the river out of sync with what it wants to do and will translate problems downstream, effectively introducing disequilibrium over a longer spatial distance.

Predicted Morphological Evolution – Based on review of historical air photos it appears that the river has wandered across the corridor over time, and has shifted its main thread to the south then north and back again in response primarily to temporary blockages (ice, wood debris). It is anticipated that this behavior will continue, and implementation of the preferred alternative will not prevent that natural variability from occurring over time.

The discussion in Section 5.4.8 will be supplemented to address equilibrium and morphology w/r to preferred alternative.

Use of EWD –

Anchoring – The use of deflectors would require the need for anchoring of some sort (especially for the tip of the deflectors) to ensure long-term stability. The original though was that some roughening or key would be required in the bedrock if a rock deflector was used. Anchoring of EWD structures is usually achieved through the use of galvanized steel cables epoxied into rock anchors or bedrock. With EWD, the concern would not be stability but rather durability. The wood in the structure will decay over time and therefore the long-term success of the solution would rely on the early recruitment of sediment and establishment of plant material between the structures. Rock does not decay and would provide a base structure for long-term recruitment and retention of sediments.

Cost – While the cost of rock is not cheap, the overall solution (even with EWD) would still require some imported fill to provide some slope regarding for stability. Furthermore, the construction of EWD structure is labor intensive (anchoring) and the supply of good quality wood of adequate diameter (30 to 50cm diameter for durability) is also considerable. Given that the recruitment of woody debris is not expected to be high in this area of the river, the structures would have to be "pre-loaded" with a significant amount of wood.

Aesthetics – From a visual impact point of view, EWD may appear more natural to an experience watershed restoration practitioner. The common layperson would likely consider these to be as much an eyesore as the rock deflectors.

Sediment Transport – While the river may not have a shortage of sediment, the intended use of deflectors is to "rob" the river of sediments to recreate a stable bar behind the structures. This will impact the sediment regime of the river for years to come.

We consider EWD to be more experimental in nature and more suitable for natural systems with some flexibility in the targeted objectives. In this case, the City is addressing two objectives 1) loss of land and 2) public safety and does not have much flexibility in achieving these objectives and does not want to face a recurring problem at this site in the future.

We will provide additional discussion in Section 4.1.5 with respect to EWD and why we did not consider it further.

Fisheries Risk Assessment

as completed by Mississippi Valley Conservation Authority

Project Name	**Carp River Bank Restoration – Fitzroy Harbor**
Project Description	Reconstruct failing river bank, village of Fitzroy Harbour Create new channel, armour slope, shoreline plantings
As presented	Excavate new channel, fill existing channel, stabilize bank
Pathways of Effects	Placement of material, dredging, cleaning/maintenance
Matrix result	Ellipse crosses well into 'brown'
Mitigation Suggested	Improve channel elsewhere
Pathways of Effects	(same), but with flow diversion, habitat quality is maintained
Matrix result	Ellipse wholly within 'green'
Accepted changes	
Pathways of Effects	
Matrix result	
Referral required to DFO?	No

Scale of Negative Effect				Construction	Operation
Extent	Refers to the direct 'Footprint', as well as areas indirectly affected, such as downstream or down-current areas	Site or segment - localized effect Channel Reach or lake Region Entire watershed or lake	low Med High	1	1
Duration	amount of time that a residual effect will persist	Days weeks to months Permanent	Low Med High	1	1
Intensity	expected change in baseline condition	habitat still suitable habitat quality significantly reduced habitat quality unusable	Low Med High	1	1
Summary			Low Med High	2 1 0	2 1 0

Sensitivity			Sensitivity	Immediate location	Likely range of effects
Species	Sensitivity of species to change in environmental conditions	Cyprinids	Low		
		pike, walleye, bass	Med	1	1
		Salmonidae	High		
Dependence on Habitat	Use of habitat by fish species	Not used by species	Low	1	1
		Migratory corridor, feeding	Med		
		Spawning habitat	High		
Rarity	Relative strength of a fish population	Common	Low	1	1
		Limited distribution	Med		
		SARA listed	High		
Habitat rarity	Prevalence of habitat	Common	Low	1	1
		Limited in area	Med		
		Unique	High		
Habitat Resiliency: Ability of an aquatic ecosystem to recover from change	thermal regime	warm water	Low	1	1
		cool water/cold water that can buffer temperature change	Med		
		Cold water that can not buffer temperature change	High		
	Physical characteristics	system is stable and resilient	Low	1	1
			Med		
		system is unstable and delicate	High		
	Flow regime	Ephemeral	Low		
		Intermittent	Med		
		Permanent	High	1	1
Summary	Low			5	5
	Medium			1	1
	High			1	1

Solution as Presented

		Sensitivity						Totals	
		SAR	High	Medium	Low	None		Construction	Operation
Impact	High							1	2
	Medium							1	0
	Low							1	1
	None							0	0
Totals	Location	0	1	1	5	0			
	Area	0	1	1	5	0			

Solution as Revised

		Sensitivity						Totals	
		SAR	High	Medium	Low	None		Construction	Operation
Impact	High							0	0
	Medium							1	1
	Low							2	2
	None							0	0
Totals	Location	0	1	1	5	0			
	Area	0	1	1	5	0			

Notes:

Yellow is construction

Purple is operation

APPENDIX B
Geomorphology Assessment

FITZROY HARBOUR / CARP RIVER BANK EROSION

ASSESSMENT AND REMEDIATION

GEOMORPHOLOGY ASSESSMENT

FINAL REPORT

JTB Environmental Systems Inc

Cambridge, Ontario

November, 2011

JTB Environmental Systems Inc.

Fluvial Geomorphology Natural Channel Design Coastal Processes Erosion Control

INTRODUCTION

For a number of years there has been an ongoing erosion problem along a receding bluff adjacent to the ball diamond fence at the Fitzroy Harbour Community Centre, to the point that there has been approximately 8 metres of top land lost over the nine-year period from 1999 to 2008. The apparent cause of the loss of top land is attributed to a shift in channel position of the Carp River at the base of the bluff, to the point where direct impingement against the toe of the slope is resulting in oversteepening of the slope. This results in failure of the upper sections of the slope, and the process then repeats itself.

The cause of the excessive erosion is related to the movement of the main channel of the Carp River to the base of the bluff. Site observations and aerial photography show that the main channel (thalweg) for the Carp river has become well defined at the foot of the bluff in comparison to 1999 and 2002 at which time the main channel was less defined. Bedrock surfaces have provided resistance to downward erosion in the rest of the channel with a local low spot at the foot of the bluff. With the change in flow path, the associated change in scour and deposition has resulted in increasing flow and velocities at the foot of the bluff with associated increased erosion of the bluff and increasing deposition of materials along and on the islands across the channel from the bluff. The increased deposition on the islands further focuses the flow into the main channel and further exacerbates the erosion of the bluff.

Erosion of the bluff is occurring at a rapid rate and as time progresses the rate of erosion is going to increase. This creates risk to the Community Centre property (in particular the ball diamond) but also creates a risk to persons who may use the upper bank as a walking trail, as instability of the upper bank could result in a failure at any particular time. Elimination of risk at this at this site is a high priority.

EXISTING CONDITIONS

The site is located on the Carp River approximately 2.5 kilometres upstream of the confluence with the Ottawa River in the Village of Fitzroy Harbour.

Channel widths in the area upstream of the Study Site range from 25-30 metres (immediately upstream, narrowing to approximately 20 metres further upstream near Galetta Side Road). Downstream of the site the widths range between 17-25m (upstream of Fitzroy Street). At the study site the width is approximately 65m +/-. Meander belt is approx. 135m and meander wavelength is approx. 360m.

Figure 1 shows a tracing of the approximate location of the top of bank line within the study area.

In the area where the river is widening there are outcrops of bedrock at the bed of the river. Bedrock is very resistant to erosion by flow and when a river has a chance to erode material, under these conditions bank materials are less resistant to erosion and are therefore affected. The result of this combination of site conditions is a widening of the river at the bedrock outcrop sites.

Under higher flows the Carp River has trended to the bank at the Community Centre as the river is pushed in that direction by sediment bars and vegetated islands. This is evident in Photo Plate 1. In addition, it appears that the bedrock outcrop dips slightly in the direction of the eroding bank, further pushing flow in that direction.

Figure 1: Tracing showing the approximate location of widening of the Carp River in the vicinity of the Study Site.

Photo Plate 1: View looking downstream at flow in contact with eroding bank under moderate flow conditions.

In association with this shift in channel position to the toe of slope is the fact that the Carp River in this area is a depositional environment: review of air photos show that multiple side-channel bars occur in the lower reaches of the river as the gradient flattens out to meet the elevation of the Ottawa River. This decrease in slope, which appears to be more pronounced in the study area, results in decreased flow competence and larger sediment being transported down the river gets deposited along the channel margins (and in some cases within the main channel itself). This high sediment loading to the reach creates flow obstructions under certain conditions which deflects the main channel, resulting in a 'new' potential erosion condition.

In addition to sediment loading from upstream, sediment loading from the slope failures contributes to the problem. While the Carp River may over time have the ability to re-work the deposited material from upstream, the addition of large volumes of sediment from the slope may tip the sediment budget over the edge, resulting in a condition where flow competence will not be able to keep up. When this happens, the channel shifts along a number of paths over short temporal and spatial distances, and this flow splitting further decreases the flow competence and ability of the river to re-work sediment. In short, this is how braided rivers are developed (high sediment loading, low gradient, variable hydrologic regime); review of the site using Google Earth clearly shows that the river is braiding around stable bars in the vicinity of the ball diamond and Community Centre.

The Carp River in this location is adjusting to a change in gradient (slope) from a somewhat steeper gradient to a flatter one. When a river slope decreases abruptly the ability of the river to transport sediment is diminished, and large-scale deposition can occur. The Carp River is considered a relatively high-sediment load river, meaning that under higher flows it can be expected that the volume of sediment in transport by river flow is significant. This provides a large sediment supply with which to create deposition zones (islands and bars).

Bar/Island evolution contributes to the erosion of the toe of the bluff. Vegetated bars or low elevation islands are efficient at trapping sediment in transport, resulting in a buildup of the feature. As the feature builds (this occurs with minor storm events), frequent flows are diverted around the excess form of the feature and if deflected properly, could affect the toe of the slope. While it is expected that high-energy flows would act to remove more material from a slope toe than frequent events of longer duration, it is in fact those frequent events which act to slowly wear away the toe so that the higher-energy events can do their work.

Appendix 1 shows a tracing showing the talweg in 1991 and 2001. The main flow path in 2011 is directed at the base of the eroding bank; note the formation of islands in 2011 is more developed than in 1991.

Under higher flows (those flows which inundate the bar/island to a certain degree) the feature then loses the material which built up under smaller events, resulting in a decrease in the area and impact of the feature. What results is a bar/island feature that grows and shrinks according to flow activity around the feature. If the feature has trapped a large volume of sediment in a late spring event and there are no high flows to re-work that material, the seed bank inherent in the sediment has time to take root and when that happens, the feature tends to grow and remain stable. This exacerbates the deflection problem and can make toe and bluff erosion worse.

In addition to sediment trapping and deflection there is the opportunity on low-elevation features to trap coarse woody debris as well as ice jamming in the spring, which also acts to deflect flow. The debris may or may not remain in position for a long period of time; however when it is in contact with flow it is an effective deflector of flow energy; the ice jamming and subsequent impacts are diminished with melt.

The bank material is also a factor in the rate of recession of the bank. Banks along the lower Carp River have a layer of varved clay (deposited during the recession of the Wisconsinan Glaciation 8000-10000 YBP. As this area was under water as part of Lake Champlain, settling of clay particles at the bottom of the lake created bedding planes which are points of weakness in the clay matrix. Photo Plate 2 shows the varves (horizontal layering) within the clay at the base of the eroding slope.

Photo Plate 2: View of the base of the bank showing horizontal bedding planes in the varved clay.

Along some of the upper sections of the bank there is also an addition of fine sands into the clay matrix. This results in a bank which is comprised of variable-sized materials, which prevents strong electro-chemical bonds from forming. The result is a weaker bank whose internal structure can be fractured relatively easily by flowing water adjacent to the bank, as well as by infiltrating water from rain events.

The presence of clay in the bank affects stability through the process of wetting and drying. It is well held that clay banks that are allowed to stay wet (do not dry out) remain relatively strong; however banks with clay that go through repeated wetting and drying cycles weaken to the point where internal structure is eliminated and the bank is subject to failure.

During drying periods the banks suffer from desiccation of the clay materials, which leaves small fractures which are acted upon by water action. This allows for clump erosion as these small blocks of clay are worn away as bulk units. Photo Plate 3 shows a close up of the desiccation and fractures in the clay at the time of the stream assessment.

Photo Plate 3: View showing desiccation of the clay surface and bulk erosion collecting at the toe of the slope.

To summarize, the lower Carp River at the study site can be characterized by the following:

1. A low-gradient reach with historical deposition of fluvial sediment;
2. Bankfull widths ranging from an average of about 20m upstream and downstream of the site to approximately 60 metres at the study location;
3. Meander wavelengths or approximately 360 metres and amplitudes averaging approximately 135 metres;
4. Moderate to high sediment loading from upstream;
5. Multiple stable islands/bars resulting in a braiding path for the main flow of the river;
6. Banks comprised of varved clays with fine sands;
7. Bed comprised of transported alluvial materials from upstream as well as outcrops of bedrock in the vicinity of the study site; and
8. A trending to flow (meander) to the south as a result of deposition bars in the centre of the river.

CAUSE OF EROSION AT THE SITE

The assessment of existing conditions and a review of the historical conditions allows for the determination of cause and effect at the site. Figure 2 is a flow diagram showing the progression of cause at the site:

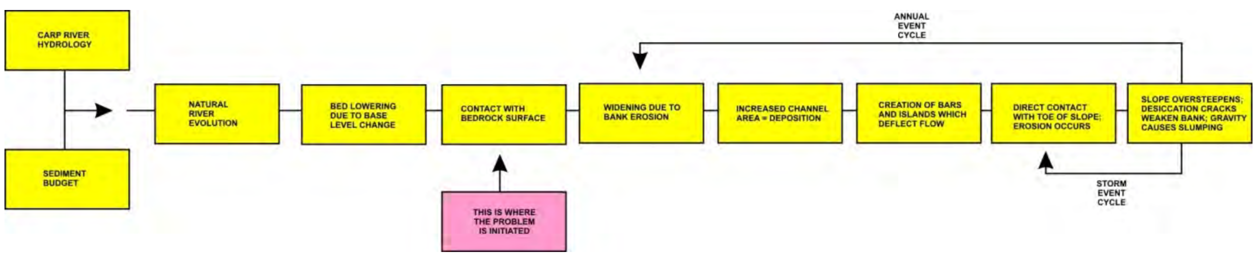


Figure 2: Flow chart depicting the progression of cause resulting in bank erosion at the Community Centre site.

Initially the Carp River was operating under what could be considered normal fluvial conditions: the average annual flow and sediment budgets were operating in equilibrium to create the form of the channel as it was seen in historic air photos. This is referred to as natural river evolution.

Over time, and perhaps in response to a lowering of water levels in the Ottawa River (which acts as a local base level for the lower Carp River), downcutting (bed erosion) on the Carp River resulted in a contact with the bedrock surface. Since this surface is non-erodible over short time periods, the river adjusted and started eroding the banks as a means of dissipating energy. This bank erosion caused a widening of the river, which in turn increased the channel area active under certain flows.

When channel area is increased and there is not a corresponding increase in flow volume (discharge), the result is a loss of flow competence to transport sediment of certain sizes. This causes the river to deposit sediment in locations where widening occurs. Over time this results in the creation of bars and ultimately islands, which stabilize with additional sediment and vegetation.

These islands result in flow redirection. In this case flow was directed to the south where the eroding bank is located. Direct flow in contact with the slope erodes the toe of the slope; oversteepening it to the point where the upper slope fails under the force of gravity. Material that is deposited at the toe of the slope is then washed away during storm events, resulting in continual oversteepening. As time progresses the process accelerates as a positive feedback loop system, which is why erosion rates have now advanced to the rate of over a metre per year.

As more material is brought to the system from upstream and is deposited, the bars/islands will continue to grow and deflection will continue. As the bars/islands raise in elevation, the periodicity of inundation gets less frequent, meaning flow acting at the toe of the eroding bank is doing more work to erode the material over the course of an average year.

The feedback loops exacerbating the problem act on two distinct time intervals. The rapid loop, referred to as the Storm Event Cycle, cycles many times per year and prevents eroded material from accumulating at the toe (which could add erosion protection). The slower loop, referred to as the Annual Event Cycle, repeats on an annual basis and is responsible for erosion of larger quantities of materials. Acting together, these event cycles create a continual erosion/removal process and this results in the condition that occurs today.

MITIGATION OF THE PROBLEM

The problem in and of itself is mitigable however the strategies to alleviate the bank erosion problem must address the cause of the problem as opposed to simply dealing with the effect (the erosion).

Development of Alternative Solutions

Numerous methods and measures have been used to provide stream bank erosion protection. Some of the most common include:

- Removal of In-stream Obstructions – involves the removal of log and/or debris jams or alteration of stream bend features to prevent impinging flow;
- Bank Sloping/Flattening – re-grading or flattening of over-steepened banks to achieve a more gradual stable slope and allow vegetation to establish itself;
- Bank Revetments – placement of a cover over the bank to protect from further erosion from flowing water;
    - Rock/Rip rap
    - Interlocking Concrete Blocks
    - Mats/Fabrics
    - Large Woody Debris
    - Vegetation (bioengineering)
- Retaining Walls – to retain eroding bank and protect from flowing water;
    - Log Cribbing
    - Gabions
    - Precast concrete blocks
    - Cast in place concrete
- Deflectors (spurs/vanes/barbs/groynes/jetties) - to reduce nearshore velocities;
    - Rock
    - Earth + Rock
    - Large woody Debris

A series of seven (7) possible actions in response to the problem have been identified. Two strategies were used to develop alternative solutions:

1. ***Focus on the eroding riverbank and provide a traditional solution using various approaches to riverbank revetments:***

Alternative 2: Re-grade & Re-vegetate Slope

Alternative 3: Reconstruct & Riprap Riverbank

Alternative 4: Gabion Basket Retaining Wall

2. ***Understand and work with the fluvial processes within this reach of the Crap River in order to develop longer lasting solutions:***

Alternative 5: Re-grade Slope & Rock Deflectors

Alternative 6: Partial Channel Re-training

Alternative 7: Full Channel Re-training

ALTERNATIVES

ALTERNATIVE 1: DO NOTHING

The exposed riverbank would continue to provide its own protection against excessive erosion and sloughing. This alternative does not achieve our goals of reducing the loss of land or improving public safety.

ALTERNATIVE 2: RE-GRADE & RE-VEGETATE SLOPE

This alternative would involve flattening of the riverbank by cutting the top of the slope and using this material to fill in the base of the vertical slope to provide a more stable bank. The bank would be re-vegetated using bioengineering methods such as brush layering to provide erosion protection. The low flow in the river would be diverted away from the re-vegetated bank by re-arranging bars within the river.

ALTERNATIVE 3: RECONSTRUCT & RIP RAP STREAM BANK

This alternative would import fill material and rebuild the riverbank to its 1991 location and flatten the bank to improve its stability. The base of the new riverbank would be protected with a rock riprap revetment and the top of the bank would be re-vegetated with grasses, shrubs and trees.

The low flow in the river would be diverted away from the riprap bank by re-arranging bars within the river.

ALTERNATIVE 4: GABION BASKET AND RETAINING WALL

Alternative 4 is based on providing a gabion basket retaining wall to support the base of the riverbank. Gabion baskets are made of galvanized steel wire mesh which are filled with rock. The top of the riverbank would be flattened and re-vegetated. The low flow in the river would be diverted away from the retaining wall by re-arranging bars within the river.

ALTERNATIVE 5: RE-GRADE SLOPE AND ROCK DEFLECTORS

Flow deflectors in the form of rock groynes would be provided at the base of the eroded riverbank. These would extend into the channel and reduce near-shore velocities responsible for the erosion. The riverbank would also be flattened and re-vegetated with grasses, shurbs and trees.

Over time the area between the groynes would recruit sediment and plant material.

ALTERNATIVE 6: PARTIAL RIVER CHANNEL RE-TRAINING

This alternative would involve the placement of a significant amount of fill within the river, at the base of the eroded riverbank, in order to shift the path of the river away from the eroding bank. The fill would be terraced and protected along the outer edges using large stone. The low flow in the river would be diverted away from restored bank by re-arranging bars within the river.

ALTERNATIVE 7: FULL RIVER RE-TRAINING

This alternative entails more extensive changes to the riverbed and banks than in the previous alternatives. This would involve some rock excavation of the riverbed and the placement of a significant amount of fill at the base of the eroded riverbank in order to shift the path of the river away from the eroding bank.

PRESENTATION OF ALTERNATIVES AT THE PUBLIC OPEN HOUSE

The seven alternatives were presented at a Public Open House held in the evening of 26 October 2011. The public were be able to present their ideas with respect to the alternatives and more importantly, provide information of which the Study Team may not be aware.

EVALUATION OF THE ALTERNATIVES

Evaluation of the alternatives is completed based on a prescribed evaluation methodology. Criteria for determining the preferred alternative is based on practical EA components such as technical and regulatory feasibility, health and safety, social acceptance, environmental protection and economics; in addition the alternatives are evaluated based on their appropriateness with respect to fluvial functioning in the Carp River at that location and in the upstream and downstream directions.

From the perspective of fluvial geomorphology the evaluation matrix table consists of the following components:

1. Does the Alternative solve the problem over the short and long term?

Some solutions may be effective at solving the immediate problem but may not be sustainable even if proper maintenance is performed. This is scored on a YES/NO basis.

2. What is the potential for Downstream Impacts if the Alternative is implemented?

If the alternative is selected and constructed properly is there a potential that the solution will have an impact on downstream areas. This is based on a high-level assessment and is scored as HIGH/MODERATE/LOW with HIGH being a negative response and LOW a positive response.

3. Does the Alternative create or maintain an alteration to natural flow regimes/processes?

Given the nature of the Carp River prior to the accelerated erosion (it's natural path and processes), will the alternative create some alteration to natural process if implemented? Will the alternative allow for the restoration of the flow pathways back to their positions prior to the erosion occurring? This is scored on a HIGH/MODERATE/LOW basis with HIGH being a negative response.

4. What is the ease of implementation of the Alternative from a fluvial geomorphology perspective?

Ease of implementation considers access and potential damage/requirement for additional rehabilitation due to the construction of the alternative, and considers the complexity of the alternative and whether there are a large number of potential contractors who could perform the work. This is scored on a HIGH/MODERATE/LOW basis where HIGH is a positive response.

5. What is the potential maintenance requirement over the long term?

This is based on fluvial maintenance as well as potential structural maintenance (ie replacement of gabion wire baskets) and the potential for the maintenance to have its own impact that needs mitigation. This is scored on a HIGH/MODERATE/LOW basis where HIGH is a negative response.

6. Based on design and construction costs for fluvial rehabilitation projects, what is the relative cost of the Alternative?

This factors in costs for design and construction as well as monitoring of the alternative. It does NOT include maintenance costs and is scored on a HIGH/MODERATE/LOW basis where LOW is a positive response.

The response matrix is provided in the following table.

Alternative	Solves Problem		Potential for Downstream Impacts	Alteration to Natural Flow	Ease of Implementation	Maintenance Requirement	Relative Cost
	Short-Term	Long - Term					
1	NO	NO	HIGH	YES	HIGH	HIGH	LOW
2	YES	NO	HIGH	YES	HIGH	MODERATE	LOW
3	YES	YES	MOD-HIGH	YES	MODERATE	LOW	MODERATE
4	YES	NO	HIGH	YES	MODERATE	MODERATE	MODERATE
5	YES	NO	MOD-HIGH	YES	MODERATE	LOW	MODERATE
6	YES	YES	LOW	NO	MODERATE	LOW	MODERATE
7	YES	YES	LOW	NO	LOW	LOW	HIGH

SUMMARY OF THE ALTERNATIVES

Alternative 1 is not a practical alternative because it does not solve the problem and continues to have negative impacts on the Carp River.

Alternative 2 retains high potential for downstream impacts and alterations to natural flow. Rearranging bars in the river does not address the cause of the problem and will not result in a long-term positive outcome.

Alternative 3 lessens the impact downstream but continues to affect natural (historical) flow paths. Rearranging bars in the river still does not address the cause of the problem though through armouring (using large rip-rap which is not a natural component of the river sediment system) the potential for long-term success is strong.

Alternative 4 requires installation of gabion baskets which are artificial and wear down over time and have to be replaced. Gabion baskets are a hard surface and installation of these structures creates a deflection which then impinges on other areas of the river, causing reverberation erosion. This results in a HIGH designation for downstream impacts. When the baskets fail (the wire component breaks down) and they have to be replaced there is an additional impact on the river every time they are replaced.

Alternative 5 requires rock groynes which are not natural features in the Carp River. These structures affect flow and sediment transport and as a result create both an impact at the site as well as a downstream impact. Given the bedrock surface on the bed it may be difficult to maintain the positioning of the groynes over time and they can be dislodged by ice and debris.

Alternative 6 requires reconstruction of the failing bank to historical locations and creating a buffer to erosion through the use of terracing at critical flow levels to minimize erosive power on the bank. This can be done with minimal use of large stone backfilled and vegetated, which will stabilize the feature. The alternative also requires a minor clean-up of existing low-flow channels around existing bars and islands which re-introduces flow to historical pathways.

Alternative 7 requires significant in-channel works which are sensitive as well as costly and would require short-term disturbance to a large section of the river, which is subject to variable flow regimes. That said, the alternative would provide a total solution to the problem; however the complexity of a natural channel design solution in a large river system such as the Carp River at Fitzroy Harbour makes ease of implementation significantly lower and the relative cost of the solution significantly higher than the other possible solutions.

PREFERRED ALTERNATIVE

Based on the analysis of the alternatives and consideration of the factors listed in the above table, Alternative 6 (Partial River Re-Training) is the preferred alternative.

The rationale behind selection of this alternative is based on the fact that it addresses the problem and re-creates the historical path of the Carp River at the failure site. Through addressing other components of the alternative it is possible to protect from the problem recurring in the future; and through the use of natural channel design principles the final design of the alternative will be able to build in natural resilience and recreate a functioning system at the site while having no impact on downstream reaches.

IMPLEMENTATION OF THE PREFERRED ALTERNATIVE

There are a number of ways the preferred alternative can be implemented and these will be fully discussed in the detailed design of the alternative. However, there are a number of components of the solution that should be incorporated into the design in order for it to be successful. These include:

1. Consideration of leaving the existing bank line at the present location or extending the top of the bank creekward by 2-3 metres and extending the new bank slope from those points;
2. Consideration of having the slope of the new bank at 3:1 to facilitate successful landscape planning; this may be altered to a 2:1 slope depending on the location of the final toe of slope;
3. Having the slope contain two terraces (shelves) at the 2-year flow and the 100-year flow elevations. These terraces will become small floodplain features and will be used by the river to dissipate energy;
4. If there is no room for two terraces then one terrace at the 2-year flow level should be used to manage flow energy;
5. Removal of accumulated cobbles and boulders at the inlets of side-channels around the bars (see Photo Plate 4) to facilitate entrance to these side channels under low flow conditions

Photo Plate 4: View looking downstream through a side channel which is currently blocked to low flow by accumulated cobbles. Removal of these cobbles will allow for access to this channel under lower flow conditions.

SUMMARY

From the perspective of fluvial geomorphology the erosion issue at the Fitzroy Harbour Community Centre is a culmination of a series of natural processes which unfortunately are operating at a location where local infrastructure is at risk. As a result of this risk, resolution of the erosion problem is required; this resolution must satisfy not only the effect of the problem (the erosion), but also the cause of the problem (or the problem will reoccur and will require intervention at some point in the future).

This report summarizes the existing conditions at the Study Site on the Carp River at Fitzroy Harbour and delineates the probable cause of the problem. Identification of the seven alternative solutions is reported upon; selection of the preferred alternative based on fluvial principles has been made. Finally, recommendations as to the implementation of the preferred alternative are provided, to be considered at the detailed design stage of the project as it moves forward.

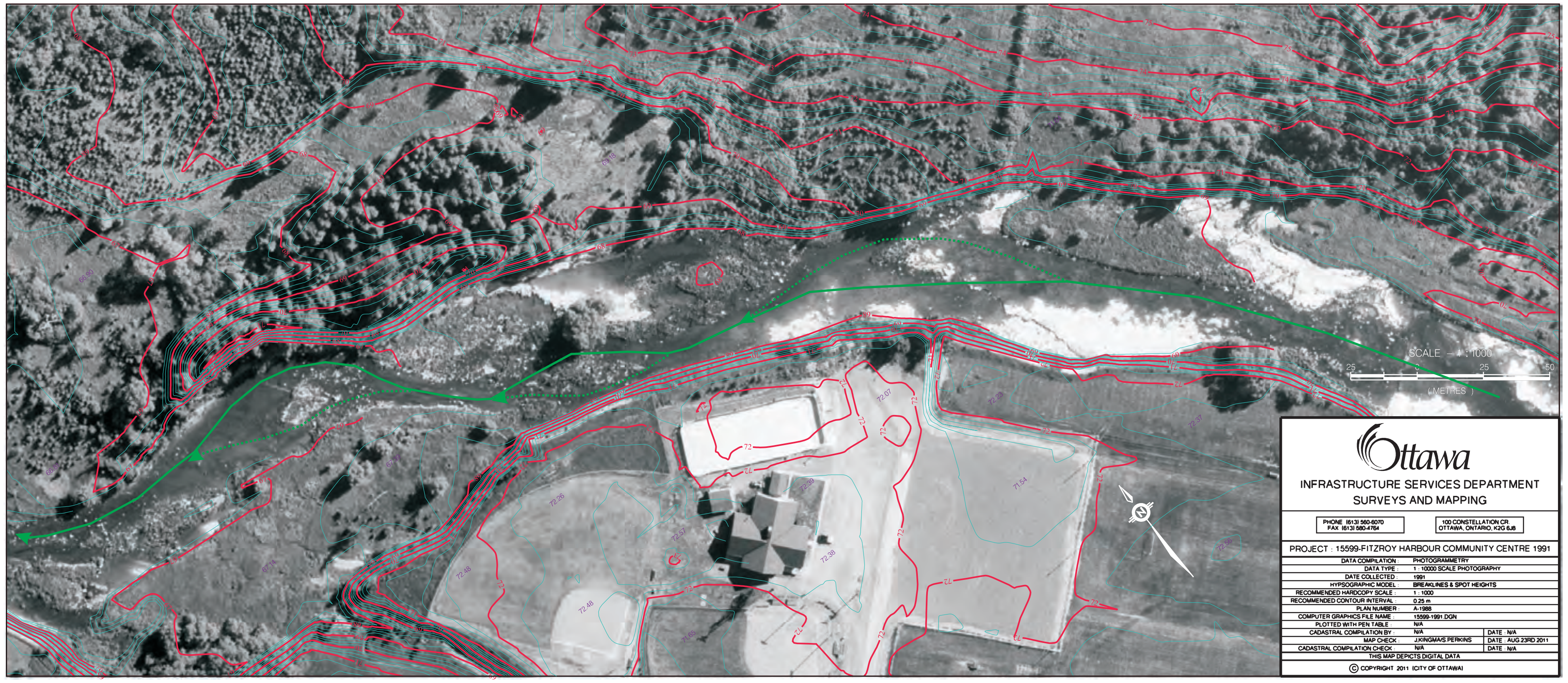
It is my judgement that the implementation of Alternative 6 (Partial River Re-Training) will create a long-term and lasting solution to the bank erosion problem at the Fitzroy Harbour Community Center property, provided proper design and construction of the alternative results.

Respectfully Submitted;

Dr. J. Beebe, JTB Environmental Systems Inc.; Cambridge, Ontario

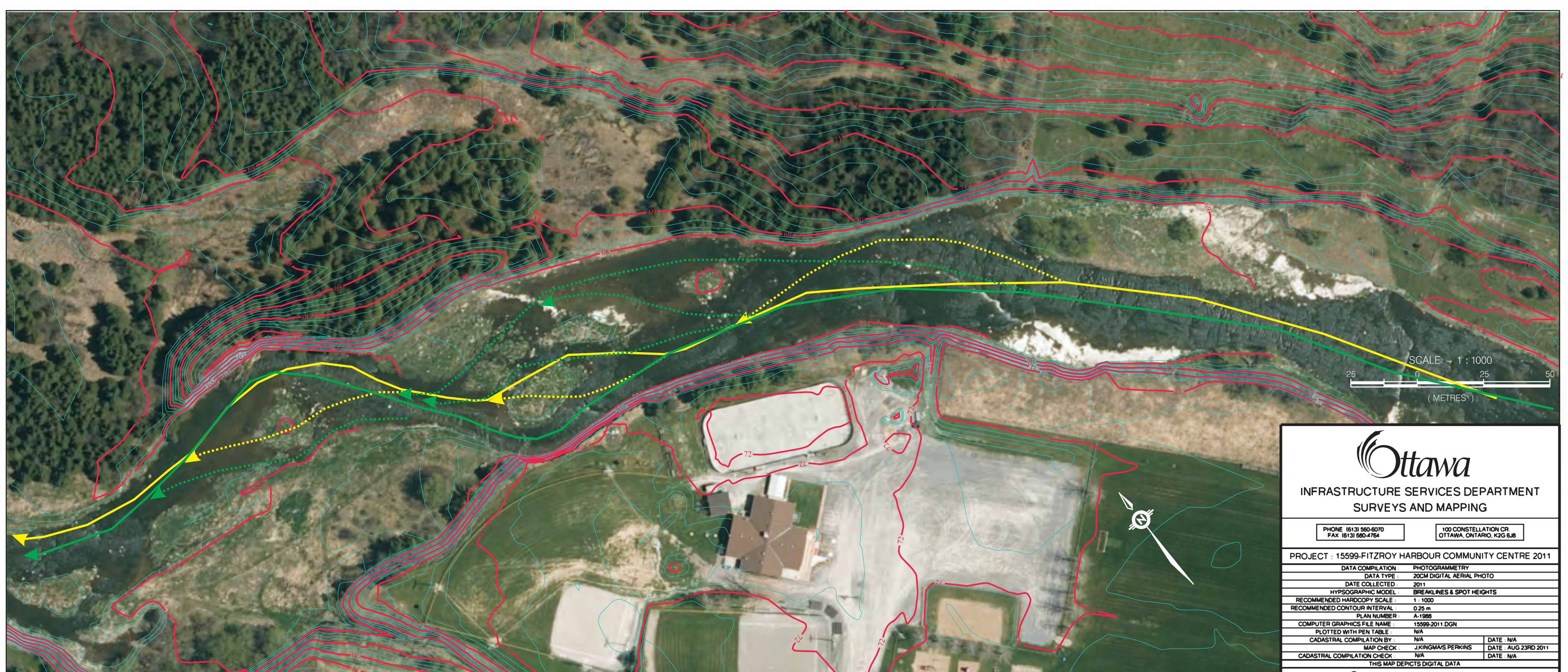
Appendix 1:

Graphic showing the major and minor flow pathways in 1991 and 2011-11-14



Tracing of 1991 Talweg

Major Flow Path
Minor Flow Paths



Tracing of 2011 Talweg

Major Flow Path
Minor Flow Paths
1991 Flow Path

APPENDIX C

Slope Stability Assessment

Slope Stability Assessment
Fitzroy Harbour Community Centre
Ottawa, ON

Prepared for:
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Project No. 163401089

November 2011

Table of Contents

List of Tables

Table of Contents

List of Appendices

1.0 Introduction

This report presents the results of the Slope Stability Assessment for a slope located adjacent to the Fitzroy Harbour Community Center, located in the Fitzroy Harbour community of Ottawa, Ontario. The location of the site is shown on the Key Plan in Appendix B. The work was carried out to assess the stability of the slopes to the Carp River in the vicinity of the community centre and to provide geotechnical engineering recommendations to the design team to evaluate stabilization treatments.

The work was carried out in general accordance with the Stantec Consulting Ltd. (Stantec) proposal to the City of Ottawa under our Standing Offer Agreement RFSO No. 01911-92517-01.

2.0 Background

The subject slope is located next to the Fitzroy Harbour Community Center, and is located on the site's north-northeast boundary, directly adjacent to one of the site's baseball diamonds. The total length of this side of the property is roughly 175 m, although the length of the critical slope section is approximately 60 m.

It is understood that the Carp River, which is located at the base of the slope, has been progressively eroding away the soil. Exposed bedrock is located at the base of the slope, and it is theorized that this bedrock is providing resistance to the river, causing the flow path to change and the amount of scour and erosion in the area to increase. Aerial photography of the top of the slope provided by the City suggests that the bank receded approximately 1.5 m between 1999 and 2002, increasing to over 2.5 m between 2005 and 2008. The RFP document indicates the distance from the baseball diamond fence to the top of the slope has decreased from 18 m to 10 m between 1999 and 2008.

Stantec recently completed a geotechnical investigation at this site for the proposed construction of new light standards for the baseball diamond adjacent to the slope. The results are documented in the October 2009 Report titled "Geotechnical Investigation Report, Fitzroy Community Centre, Light Standards, Fitzroy, ON". At the time of the investigation, the slope distresses were noted. Boreholes records from this investigation, which are included in Appendix C, indicate that the site soils consist of a thin layer of topsoil with occasional layers of fill, over a deposit of stiff to very stiff lean clay.

3.0 Scope of Work

The scope of work for this Slope Stability Assessment included the following:

- Review boreholes logs from the 2009 field investigation;
- Carry out a site reconnaissance by a Geotechnical Engineer-in-Training (EIT) to observe the condition of the slope;
- Obtain samples by hand from the face of the slope;
- Complete a geotechnical laboratory testing program to characterize the soil;
- Prepare a Geotechnical Investigation Report for the project. The report will incorporate the elements outlined in the City of Ottawa document "Minimum Requirements for Slope Stability Assessment Reports", and will include the following:
  - Soil and bedrock condition;
  - Assessment of the stability of the existing slope;
  - Determination of the Limit of Hazard Lands;
  - Geotechnical recommendations to stabilize the slope.

4.0 Method of Investigation

A site reconnaissance was carried out by a Geotechnical Engineer-in-Training (EIT) on August 30, 2011, to observe the condition of the slope and to obtain samples for laboratory testing. Three samples were manually obtained from the face of the slope, at the approximate locations shown on the Site Plan (Drawing No. 2 in Appendix B). Samples were obtained from varying heights on the slope.

The flow velocity in the Carp River was estimated by measuring the time required for a floating object to travel a set distance.

All recovered soil samples were stored in moisture-proof bags and returned to the Stantec Ottawa Laboratory for visual classification and testing.

4.1 LABORATORY TESTING

All samples returned to the laboratory were subjected to detailed visual examination and classification by a geotechnical engineer. Selected samples were tested for moisture content, gradation and Atterberg Limits; results of the testing are shown in Appendix D.

Samples will be stored for a period of one (1) month after issuance of this report unless we are otherwise directed by the client.

5.0 Results of Investigation

5.1 SITE RECONNAISSANCE

A site visit was carried out by Ms. Laura Bostwick, EIT, on August 30, 2011 to observe the condition of the slope.

Site photographs are presented in Appendix C and the site observations are summarized below.

- The critical slope failure, which is shown on the Site Plan in Appendix B, was approximately 60 m long, and extended from the fence near the rink enclosure westward to roughly in line with second base on the nearby baseball diamond.
- The slope surface ranged from near vertical at the west end of the slope, to roughly 1H:2V at the east end of the slope. The height of the slope was measured to be approximately 4.9 m.
- No tension cracks were observed at the top of slope, and grass and vegetation were present.
- Exposed bedrock was noted directly beneath the slope and within the river channel.
- At the west side of the failure, the clay was noted to be desiccated and blocky.
- A possible historical slope failure was noted east of the fence line, behind the rink enclosure. The flow velocity in the Carp River, directly beneath the critical slope failure, was measured to be approximately 0.6 m/s at the time of the site visit.

5.2 SUBSURFACE INFORMATION

The slope face consisted primarily of clay, with a thin veneer of topsoil at the top of slope. Exposed bedrock was noted at the bottom of slope, or at approximately 4.9 meters below ground surface.

The clay was brown, and was noted to be desiccated and blocky at the west side of the failure, which had near-vertical slopes.

The moisture contents of the tested samples ranged from 7% to 28%. Atterberg Limit tests carried out on select samples of the clay indicated Liquid Limits of 51 and 57 with a Plastic Limit of 20, which indicates high plasticity clay. A gradation analysis performed on the clay material shows it to contain 30% silt-sized particles and 70% clay-sized particles. The Atterberg Limits and gradation test results are presented in Figures 1 and 2 in Appendix D.

5.3 GROUNDWATER

No seepage was noted from the face of the slope. Water in the adjacent Carp River was noted to be moving at a velocity of approximately 0.6 m/s, at a distance of approximately 5 m from the base of the slope.

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

6.0 Slope Stability Analyses

The stability analysis was carried out in general accordance with the "City of Ottawa Slope Stability Guidelines for Development Applications in the City of Ottawa" and included both static and seismic loading conditions.

The analysis was carried out using the GeoStudio 2007 SLOPE/W computer modeling software. The Morgenstern-Price method as presented in the SLOPE/W software was used for the stability modeling.

6.1 GEOMETRY & SOIL STRATIGRAPHY

A cross-section, labeled A-A, was generated through the west side of the critical slope failure, where the current slopes are almost vertical. The cross-sections were developed based on the aerial photographs provided by the City of Ottawa, as well as measurements obtained during the site visit. The location of this section is shown on Drawing No. 2 in Appendix B. The cross-section profile is provided on the Slope/W stability models, in Appendix E.

6.2 SOIL PARAMETERS

The soil parameters used in the stability models are shown in Table 6.1. The unit weight of the various soils was established based on in-situ tests and laboratory tests.

Table 6.1: Soil Parameters

Soil	Unit Weight (kN/m^3)	Angle of Friction (°)	Effective Cohesion c' (kPa)	Cohesion c (kPa)
Clay	18.5	28	10	100

6.3 SEISMIC LOADING

A seismic coefficient of 0.2g was used in the models to determine the factor of safety under seismic loading.

6.4 GROUNDWATER REGIME

The phreatic surface (groundwater) was estimated based on our site observations and measurements. The estimated phreatic surface is shown as a blue dashed line on the Slope/W output in Appendix E.

For Figures 3, 5, 6 and 8 the phreatic surface was assumed to be at the ground surface. For Figures 4 and 7 the phreatic surface was assumed to be between 3 m and 4 m below ground surface.

6.5 SLOPE STABILITY RESULTS

For permanent structures or valuable infrastructure a factor of safety of 1.5 for static conditions and a factor of safety of 1.1 for seismic conditions are appropriate. A factor of safety of 1.3 can also be considered for passive land use such as pathways or parkland. For this project a factor of safety of 1.3 is appropriate for static conditions.

6.5.1 Existing Slopes

The results of the slope stability analysis for the existing slope are presented in Appendix E and summarized in Table 6.2.

Table 6.2: Summary of Slope Stability Analysis – Existing Slopes

Figure/Section	Factor of Safety Static Analysis Target 1.3	Factor of Safety Seismic Analysis Target 1.1	Conclusion
Figures 3/4, Section A-A	0.75	3.81	Unstable

The results of the analysis indicate that the slopes are unstable.

6.5.2 Limit of Hazard Lands

The City of Ottawa “Minimum Requirements for Slope Stability Assessment Reports” defines the Limit of Hazard Lands as the land which is located between the face of the slope and the safe setback distance, which has the potential to be adversely impacted by natural geologic processes and includes requirements to maintain accessibility of the slope. The land which does not have an adequate factor of safety (in this case, 1.3 for static and 1.1 for seismic loading) against being affected by a slope failure triggers the requirement to establish a Limit of Harzard Lands.

An analysis was carried out to determine the safe setback distance that provides a factor of safety greater than 1.3 for static and 1.1 for seismic conditions. The results are presented in Appendix E and summarized in Table 6.3. Static analysis was analyzed as it was determined to be the critical condition in the above analysis.

Table 6.3: Summary of Hazard Lands Analysis

Figure/Section	Factor of Safety Static Analysis Target 1.3	Setback Distance – Limit of Hazard Lands
Figure 5, Section A-A	1.32	12.5 m (safe slope set back allowance) + 6 m (erosion allowance)

Typically, the Limit of Hazard Lands considers toe erosion allowances and erosion access allowances, as described in the Ministry of Natural Resources’ Technical Guide – River and Stream Systems: Erosion Hazard Limit. At this site, no development, apart from the existing baseball field, is planned for the area above the slope. Access issues are not anticipated due to the current land use as a baseball field/parkland. Therefore, the erosion access allowance was not added to the Limit of Hazard Lands calculation.

The existing baseball field is within the Limit of Hazard Lands for the present slope.

6.5.3 Flattened Slopes

An analysis was carried out to determine the safe side slope that provides a factor of safety greater than 1.3 for static and 1.1 for seismic conditions. The results are presented in Appendix E and summarized in Table 6.4.

Table 6.4: Summary of Slope Stability Analysis – Flattened Slopes

Figure/Section	Side Slope	Factor of Safety Static Analysis Target 1.3	Factor of Safety Seismic Analysis Target 1.1	Conclusion
Figure 6/7, Section A-A	2H:1V	1.39	5.39	Stable

The results indicate that for this site a side slope of 2H:1V will provide a factor of safety of greater than 1.3 for static and 1.1 for seismic conditions.

6.5.4 Retained Slope

A slope stability analysis was carried out for a retaining wall at the base of the slope with a 2H:1V backslope. The Factor of Safety is 4.44 against global failure at the wall. The results of the analysis are presented on Figure 8 in Appendix E.

7.0 Conclusion

The slope is overly steep and is being eroded by water flowing in the adjacent Carp River. Our site observations and slope stability analysis indicate that the slope is unstable, and will likely continue to erode. The baseball field is within the Limit of Hazard Loads. The slope should be stabilized to protect the health and safety of the Community Center patrons.

8.0 Recommendations

Two options could be considered to stabilize the slope: Option A -flatten the slope or Option B - install a retaining wall to support the embankment. The proposed improvements may involve reducing the distance between the top of slope and the baseball field, to allow for flatter slopes.

8.1 OPTION A – FLATTEN SLOPES

The existing slopes could be flattened to 2H:1V at this site. This can be accomplished by means of cutting the slope back, by filling in the slope at the base, or by a combination of the two methods. If the slope is to be reinstated with fill to 2H:1V, it should be benched as per City of Ottawa "Benching of Earth Slopes" drawing R18. New embankment fill should consist of OPSS Select Subgrade Material (SSM) placed in 300 thick lifts and compacted to 95 % Standard Proctor Maximum Dry Density (SPMDD).

8.2 OPTION B – RETAINING WALLS

The slope could be supported with a retaining wall. The retaining wall could consist of a gabion basket wall, concrete structure/block wall, or armor stone wall. We have prepared a summary of the pros and cons of the three wall types:

Table 8.1: Comparison of Retaining Wall Options

Retaining Wall Type	Pros	Cons
Gabion Basket Wall	• Lower comparative cost to concrete • Provides erosion protection at toe • Near vertical face	• Poor aesthetics • Base layer of baskets will require excavation into the existing slope
Concrete Retaining Wall/Block System	• Vertical face • Capable of resisting large horizontal forces • Provides erosion protection at toe	• Generally the most expensive option
Armor Stone Wall	• Aesthetics • Lowest comparative cost	• Wall cannot be constructed vertical for significant fill heights; wall needs to be constructed with incline • Potential for toe erosion; rip rap protection will be required • Will require bedding material behind the stones • Not suitable for large horizontal loads

We have also considered the use of a Retained Soil System (RSS) and Steel Sheet Pile walls. Due to the risk of erosion and excavation required for the embedment of the RSS we do not recommend this option. A steel sheet pile wall is not feasible due to the presence of exposed bedrock at the base of slope.

8.2.1 FOUNDATIONS

The existing bedrock will provide a suitable bearing surface for a retaining wall. Foundations can be designed with the resistances outlined in Table 8.2.

Table 8.2: Bearing Resistances for Shallow Foundations

Footing Width (m)	Geotechnical Resistances (kPa)	
	ULS	SLS
1.0 to 2.0	1000 kPa	1000 kPa

The factored bearing resistance at Ultimate Limit States (ULS) includes a resistance factor of 0.5. The bearing resistance at Serviceability Limit States (SLS) corresponds to the load that is expected to result in no greater than 25 mm of post-construction settlement. As the bearing surface at this site is bedrock, no settlement is expected, thus the ULS resistance governs.

Typically, footings will require an equivalent minimum soil cover of 1.8 m for protection against frost action. This requirement may be waived provided the footing is placed on clean, sound bedrock which is not frost-susceptible. The bedrock at this site is not anticipated to be frost-susceptible.

The base of all footing excavations should be inspected by a geotechnical inspector prior to placing concrete to confirm the above design pressure and to ensure there is no loose material present at the footing level. Any loose or disturbed material identified during the inspection will require removal or recompaction to the satisfaction of the geotechnical inspector. Where construction is undertaken during winter conditions, footing subgrades should be protected from freezing and foundation walls and columns should be protected against heave due to soil adfreeze.

8.2.2 Seismic Design Considerations

The Peak Ground Acceleration (PGA) for the Fitzroy Harbour (Ottawa) area is 0.42 (based on Table 4.1.8.4.A. of the Ontario Building Code [OBC]). The ground conditions correspond to a site class C in accordance with Table 4.1.8.4.A. of the OBC.

8.2.3 Earth Pressure Design

For retaining structures total active and passive thrusts under earthquake conditions can be calculated using the following equations:

$P_{AE} = ½ K_{AE} \gamma H^2 (1 - k_V)$

$P_{PE} = ½ K_{PE} \gamma H^2 (1 - k_V)$

where;

K_{AE} = active earth pressure coefficient (combined static and seismic)

K_{PE} = passive earth pressure coefficient (combined static and seismic)

H = height of wall

k_h = horizontal acceleration coefficient

k_v = vertical acceleration coefficient

γ = total unit weight

For this site, the following design parameters were used to develop the recommended K_{AE} and K_{PE} values (assumes Horizontal Backslope to retaining wall).

Zonal Acceleration Ratio, A	0.2
Horizontal Acceleration Coefficient, k_h	0.1
Vertical Acceleration Coefficient, k_v	0.067

The above k_h value corresponds to ½ of the A value, and the k_v value corresponds to 0.67 of the k_h value. The angle of friction between the soil and the wall has been set at 0° to provide a conservative estimate.

Table 8.3: Combined Coefficients of Static and Seismic Earth Pressure

Parameter	SSM Fill	Retaining Wall Backfill: OPSS Granular A or Granular B, Type II	Native Clay
Bulk Unit Weight, γ (kN/m^3)	20	21	18.5
Effective Friction Angle (°)	32	35	28
Angle of Internal Friction between wall and backfill (°)	0	0	0
Yielding Wall, Horizontal Backfill			
Active Earth Pressure, K_{AE}	0.37	0.33	0.43
Height of Application of P_{AE} from base as a ratio of wall height, H	0.364	0.367	0.361
Passive Earth Pressure, K_{PE}	3.06	3.48	2.58
Height of Application of P_{PE} from base as a ratio of wall height, H	0.296	0.297	0.294
Ka	0.31	0.27	0.36

Parameter	SSM Fill	Retaining Wall Backfill: OPSS Granular A or Granular B, Type II	Native Clay
Kp	3.25	3.69	2.77
Yielding Wall, Backfill Sloped at 2.5H:1V (21.8 degrees)			
Active Earth Pressure, K_{AE}	0.57	0.48	0.83
Height of Application of P_{AE} from base as a ratio of wall height, H	0.391	0.387	0.423
Passive Earth Pressure, K_{PE}	6.74	8.24	5.25
Height of Application of P_{PE} from base as a ratio of wall height, H	0.305	0.305	0.304
Ka	0.41	0.35	0.51
Kp	6.96	8.50	5.44

Sliding resistance between concrete and the native soil should be calculated using an unfactored friction coefficient of 0.35. The unfactored friction coefficient may be increased to 0.45 for concrete placed on Granular Fill or 0.70 for concrete placed on bedrock. A Resistance Factor of 0.8 should be used for design.

8.3 EROSION PROTECTION

The Wischmeier Nomograph has been utilized to assess the erodibility of the site soils. The soil erodibility factor, K, for the native clay was found to be between 0.1 and 0.2. This material can therefore be considered to be relatively non-erodible from surface run-off. The result suggests that the erosion of the slope is a result of the overly steep slope and a high flow velocity in the river.

Erosion protection should be provided at the base of the slope to prevent the erosion of the embankment slopes.

Erosion protection should consist of rip rap material with rough angular rock particles, well-graded, ranging from 120 to 550 mm nominal size. The rip rap material should extend a minimum of 500 mm above the high water level and should be placed over a non-woven geotextile such as Terrafix 360R or equivalent. The rip rap layer should be at least 300 mm thick.

9.0 Closure

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of the City of Ottawa, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

This report has been prepared by Laura Bostwick and reviewed by Christopher McGrath, P.Eng.

Respectfully submitted,

STANTEC CONSULTING LTD.

Laura Bostwick, M.Sc.(eng.), EIT

Christopher McGrath, P.Eng.
Associate – Geotechnical Engineering

v:\01224\active\other_pc_projects\163401089\report\fitzroy_slope_november_2011.doc

APPENDIX A

Statement of General Conditions

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

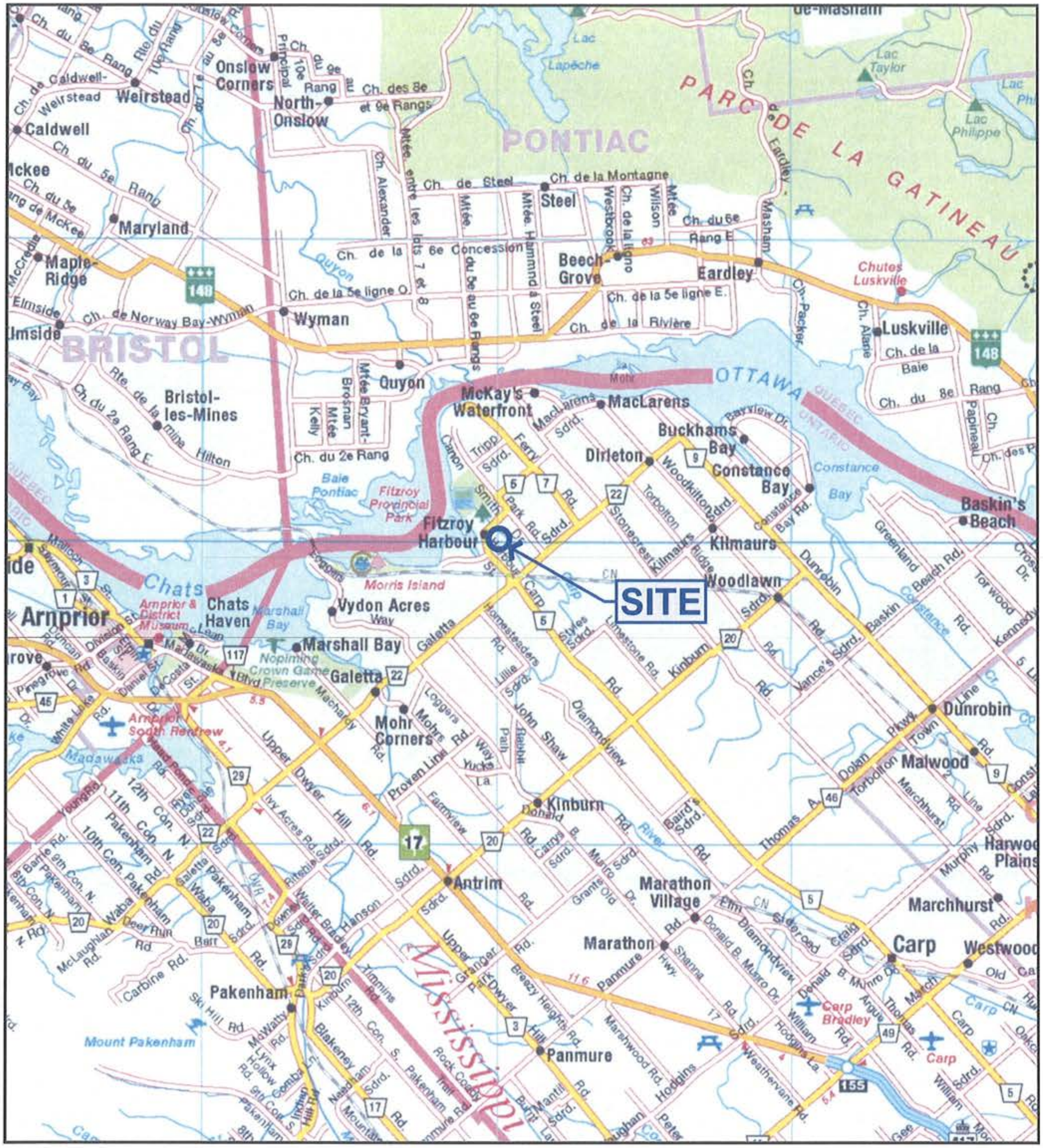
PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

Drawing No. 1 – Key Plan

Drawing No. 2 – Site Plan

Aerial Photography Comparison of 1999 & 2008 Carp Slopes



GRAPHIC SCALE

2000 0 2000 4000 6000 8000 m

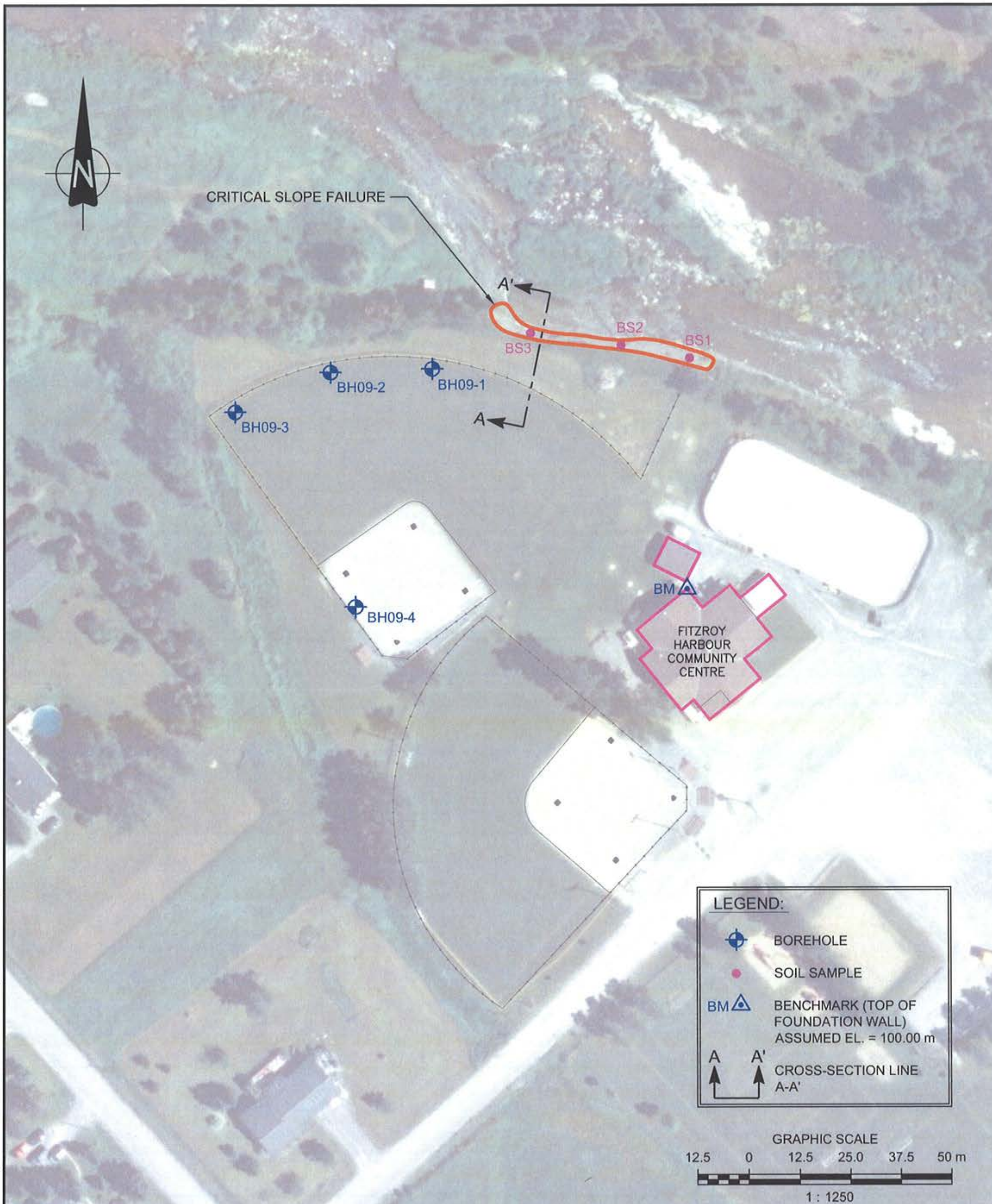
1 : 200 000

REFERENCE: MAPART

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

KEY PLAN SLOPE STABILITY ASSESSMENT FITZROY HARBOUR COMMUNITY CENTER, OTTAWA, ONTARIO	Job No.:	163401089	Dwg. No.: 1
	Scale:	1 : 200 000	
	Date:	11/09/07	
	Dwn. By:	GBB	
Client: CITY OF OTTAWA	App'd By:		Stantec

T:\Autocad\Drawings\Project Drawings\2011\163401089\163401089-1.dwg PRINTED: Sep 07, 2011



NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

SITE PLAN SLOPE STABILITY ASSESSMENT FITZROY HARBOUR COMMUNITY CENTER, OTTAWA, ONTARIO	Job No.: 163401089 Scale: 1 : 1250 Date: 11/09/19 Dwn. By: GBB App'd By:	Dwg. No.: 2	Stantec
Client: CITY OF OTTAWA			

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Legend
Reference Lines: 1999
Reference Lines: 2008
2008 20cm Aerial Photography
0 5 10 20 30 40
Meters
25 12.5 0 25 50 75 100
Meters

APPENDIX C

Symbols and Terms Used on Borehole and Test Pit Records

Borehole Records

Site Photos

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
Very Soft	<0.25	<12.5
Soft	0.25 - 0.5	12.5 - 25
Firm	0.5 - 1.0	25 - 50
Stiff	1.0 - 2.0	50 – 100
Very Stiff	2.0 - 4.0	100 - 200
Hard	>4.0	>200

ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor*
25-50	*Poor*
50-75	*Fair*
75-90	*Good*
90-100	*Excellent*

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

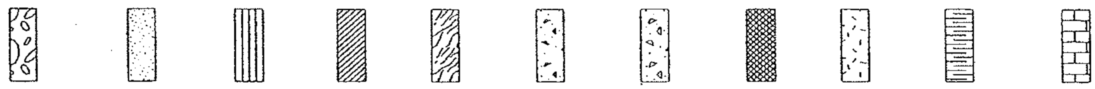
Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.
Completely Weathered	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

▼ measured in standpipe, piezometer, or well

▽ inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

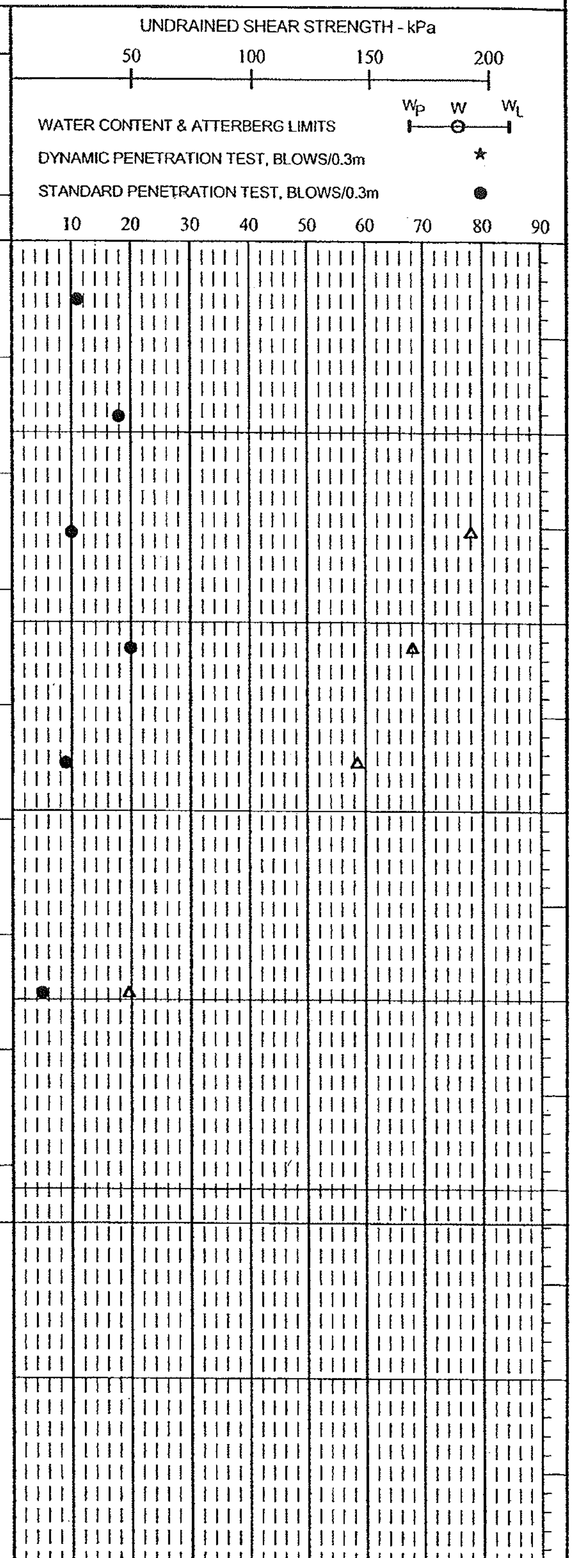
	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

Stantec BOREHOLE RECORD

BH09-1

CLIENT: Stantec Consulting Limited
BOREHOLE No.: BH09-1
LOCATION: Fitzroy Harbor Community Centre, Fitzroy Harbor, ON
PROJECT No.: 1056022
DATES: BORING October 9, 2009
WATER LEVEL:
DATUM: Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	98.99	Stiff to very stiff brown lean CLAY (CL)	SS	1	410	11
			SS	2	460	18
1			SS	3	520	10
2			SS	4	565	20
			SS	5	600	9
3		- S_u > 108 kPa (> than vane capacity)				
4			SS	6	600	5
		- S_u > 108 kPa (> than vane capacity)				
5	93.9		SS	7	275	50/3
	93.8	Compact brown silty sand (SM) with gravel TILL				
		End of Borehole at 5.2 m				
		Auger Refusal				
6						
7						



∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd ______
Date ______

STAN-GEO 1056022 FITZROY HARBOR.GPJ SMART.GDT 10/26/09

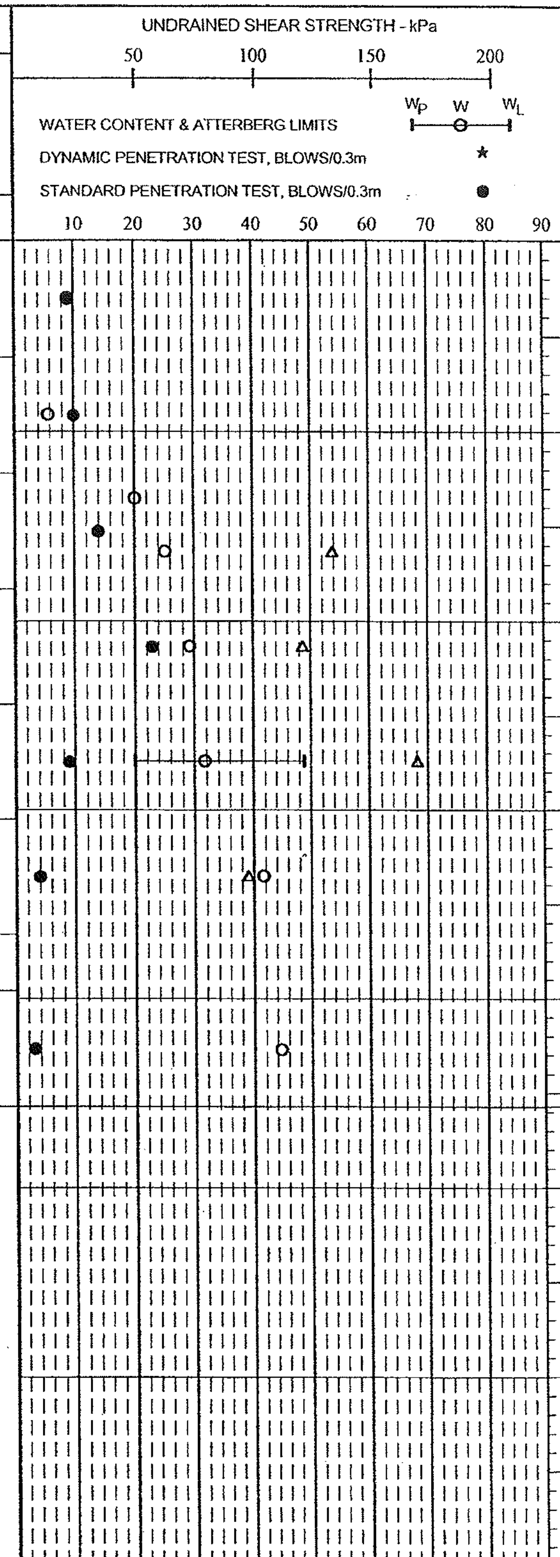
Stantec BOREHOLE RECORD BH09-2

CLIENT Stantec Consulting Limited — BOREHOLE No. BH09-2

LOCATION Fitzroy Harbor Community Centre, Fitzroy Harbor, ON — PROJECT No. 1056022

DATES: BORING October 9, 2009 WATER LEVEL — DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	98.72					
	98.6	100 mm TOPSOIL				
		FILL: brown sandy gravel trace silt trace clay	SS	1	360	9
1			SS	2	30	10
	97.5	Stiff to very stiff brown lean CLAY (CL)	SS	3	500	14
2			SS	4	560	23
			SS	5	500	9
3			SS	6	600	4
4		- S_u > 108 kPa (> than vane capacity)				
			SS	7	610	3
	94.3	Compact brownish grey silty sand (SM) TILL				
	94.2	End of Borehole at 4.6 m				
5						
6						
7						



∇ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ______

Date ______

STAN-GEO 1056022 FITZROY HARBOR.GPJ SMART.GDT 10/26/09

Stantec BOREHOLE RECORD

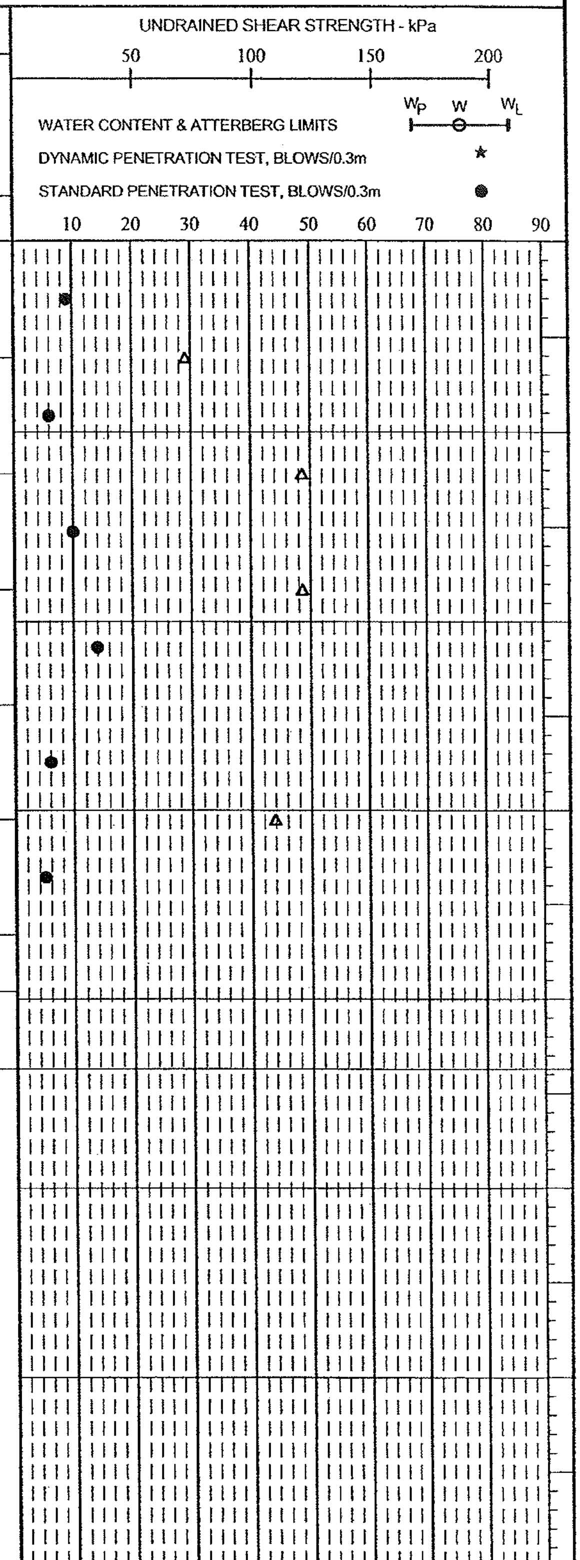
BH09-3

CLIENT: Stantec Consulting Limited | BOREHOLE No.: BH09-3

LOCATION: Fitzroy Harbor Community Centre, Fitzroy Harbor, ON | PROJECT No.: 1056022

DATES: BORING: October 9, 2009 | WATER LEVEL: | DATUM: Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	98.56							
	98.4	115 mm TOPSOIL						
		FILL: brown sandy gravel			SS	1	545	9
1					SS	2	610	6
	97.3	Stiff to very stiff brown lean CLAY (CL)			SS	3	610	10
2					SS	4	610	14
					SS	5	610	6
3					SS	6	610	5
		- S_u > 108 kPa (> than vane capacity)						
4	94.3				SS	7	410	
	94.2	Compact brownish grey silty sand (SM) trace gravel TILL						
		End of Borehole at 4.4 m						
5		Auger Refusal						
6								
7								



▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ______

Date ______

STAN-GEO 1056022 FITZROY HARBOR.GPJ SMART.GDT 10/26/09

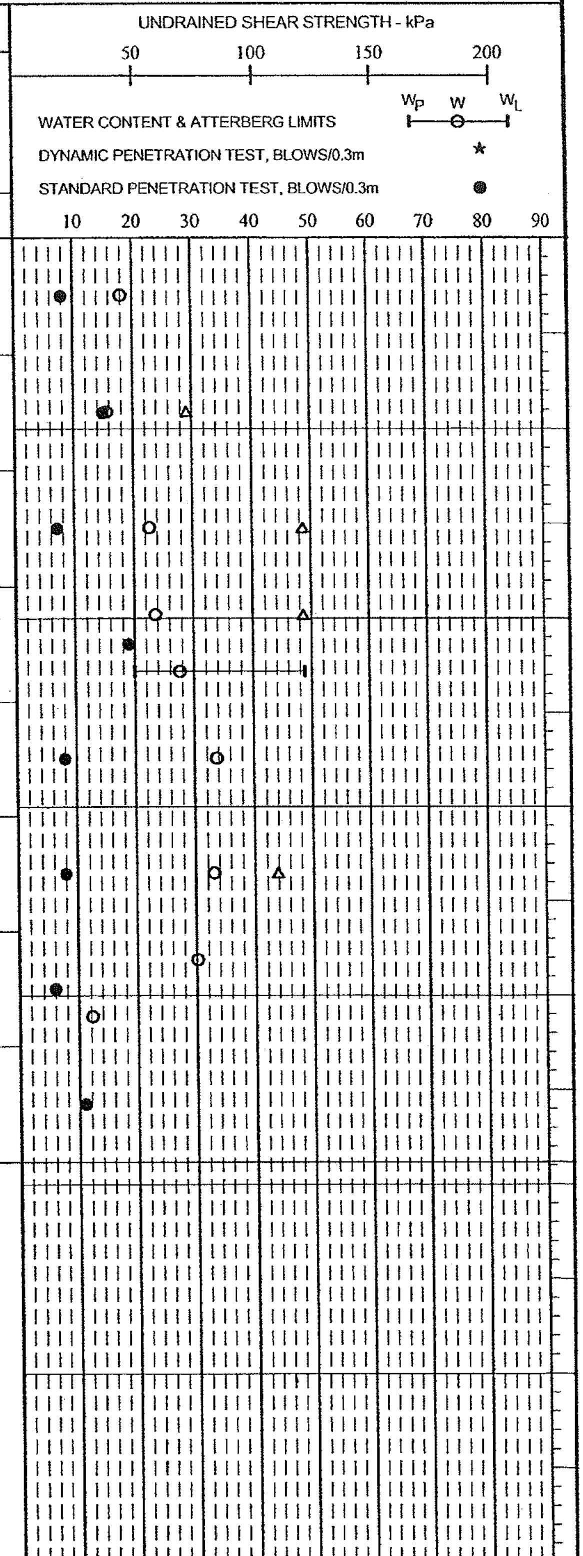
Stantec

BOREHOLE RECORD

BH09-4

CLIENT Stantec Consulting Limited
BOREHOLE No. BH09-4
LOCATION Fitzroy Harbor Community Centre, Fitzroy Harbor, ON
PROJECT No. 1056022
DATES: BORING October 9, 2009 WATER LEVEL
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.38							
	99.2	FILL: grey sandy gravel						
		Stiff to very stiff brown lean CLAY (CL) trace gravel			SS	1	420	8
1					SS	2	280	15
					SS	3	360	7
2					SS	4	490	19
					SS	5	600	8
3					SS	6	600	8
	95.5	Compact brown silty sand (SM) trace gravel TILL			SS	7	500	6
4					SS	8	210	11
	94.5	End of Borehole at 4.9 m						
5								
6								
7								



∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd ______
Date ______

STAN-GEO 1056022 FITZROY HARBOR.GPJ SMART.GDT 10/26/09

Photo No. 1: Critical slope surface (east side)

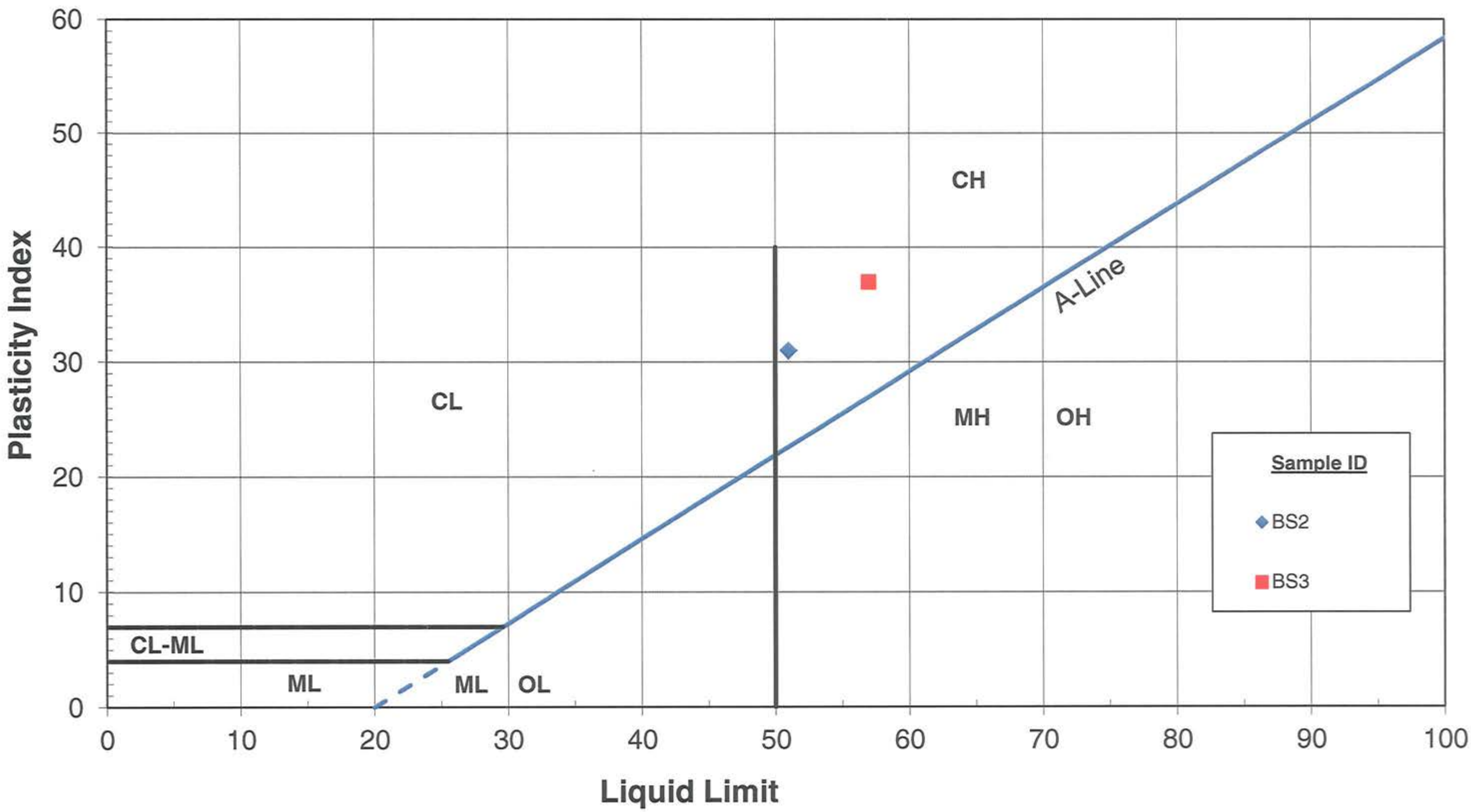
Photo No. 2: Exposed fence post foundation at east end of critical slope

Photo No. 3: Critical slope surface, looking northwest. Exposed bedrock visible at base.

Photo No. 4: Desiccated and blocky clay on vertical slope face (west end).

APPENDIX D

Laboratory Test Results

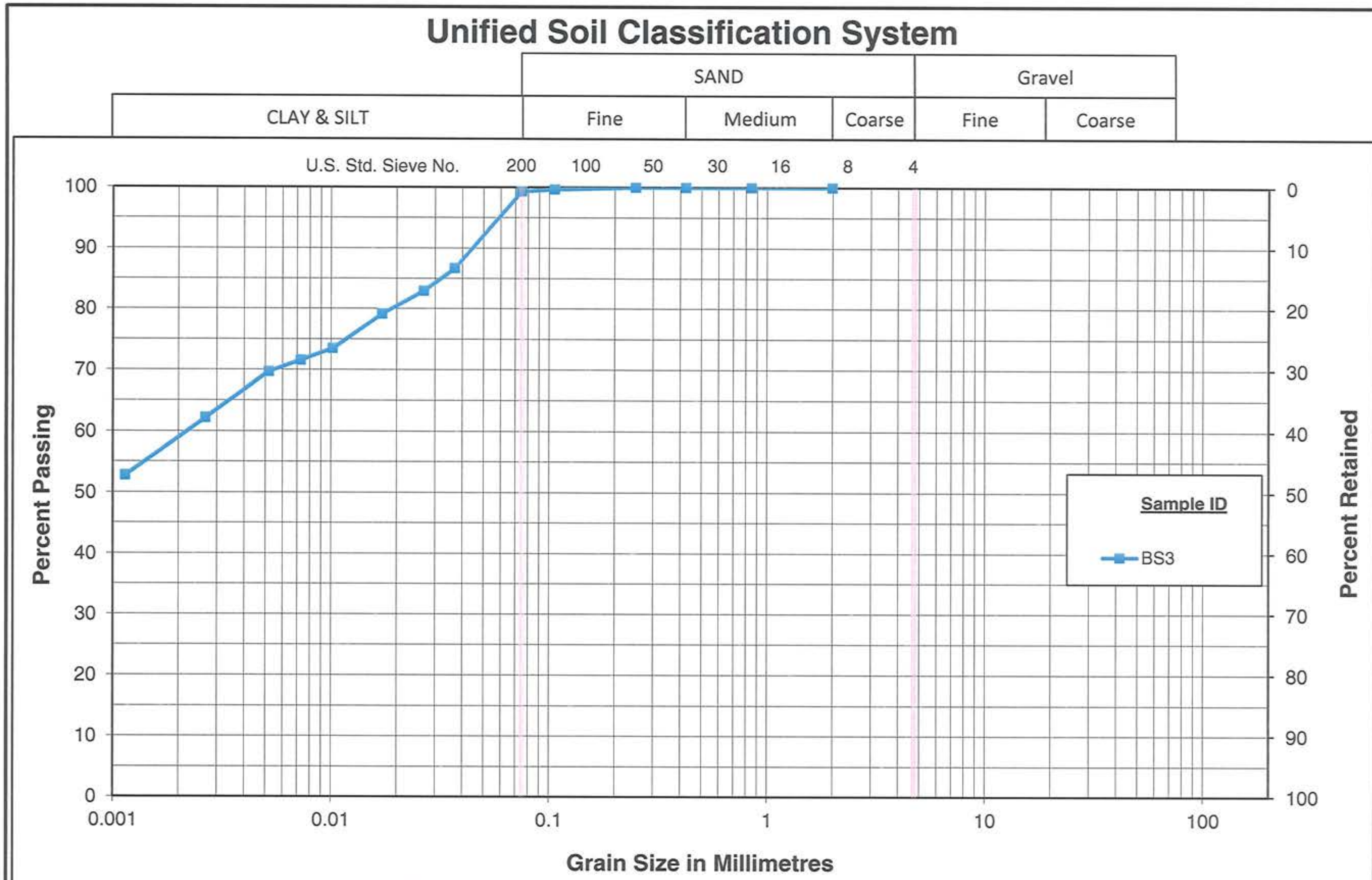


Stantec

PLASTICITY CHART

Figure No. 1

Project No. 163401089



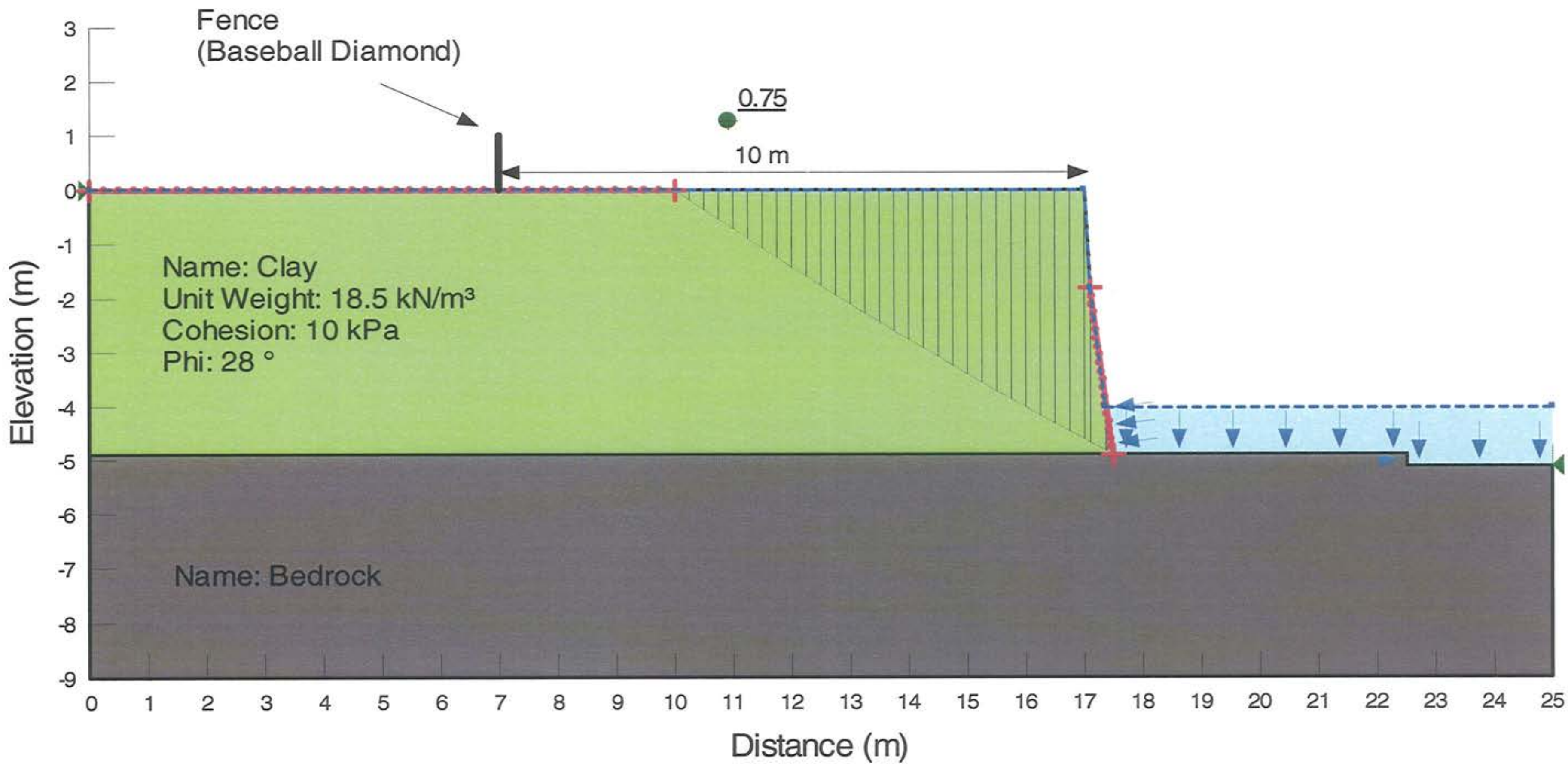
GRAIN SIZE DISTRIBUTION

Figure No. 2

Project No. 163401089

APPENDIX E

Output from Slope Stability Analyses



Stantec

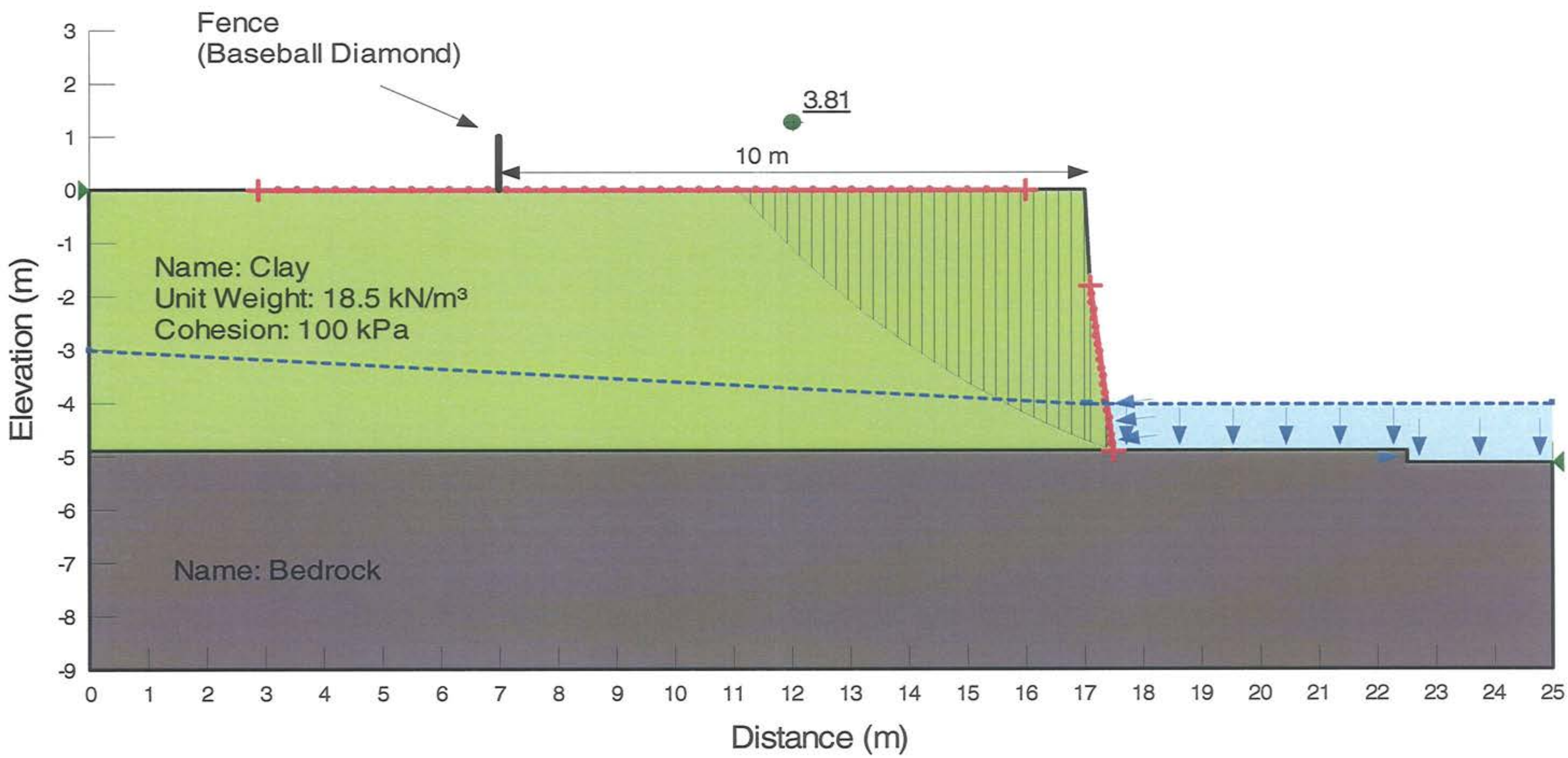
Static Slope Stability Analysis

Fitzroy Harbour Community Centre

Existing Slope

Figure 3

Project No. 163401089



Stantec

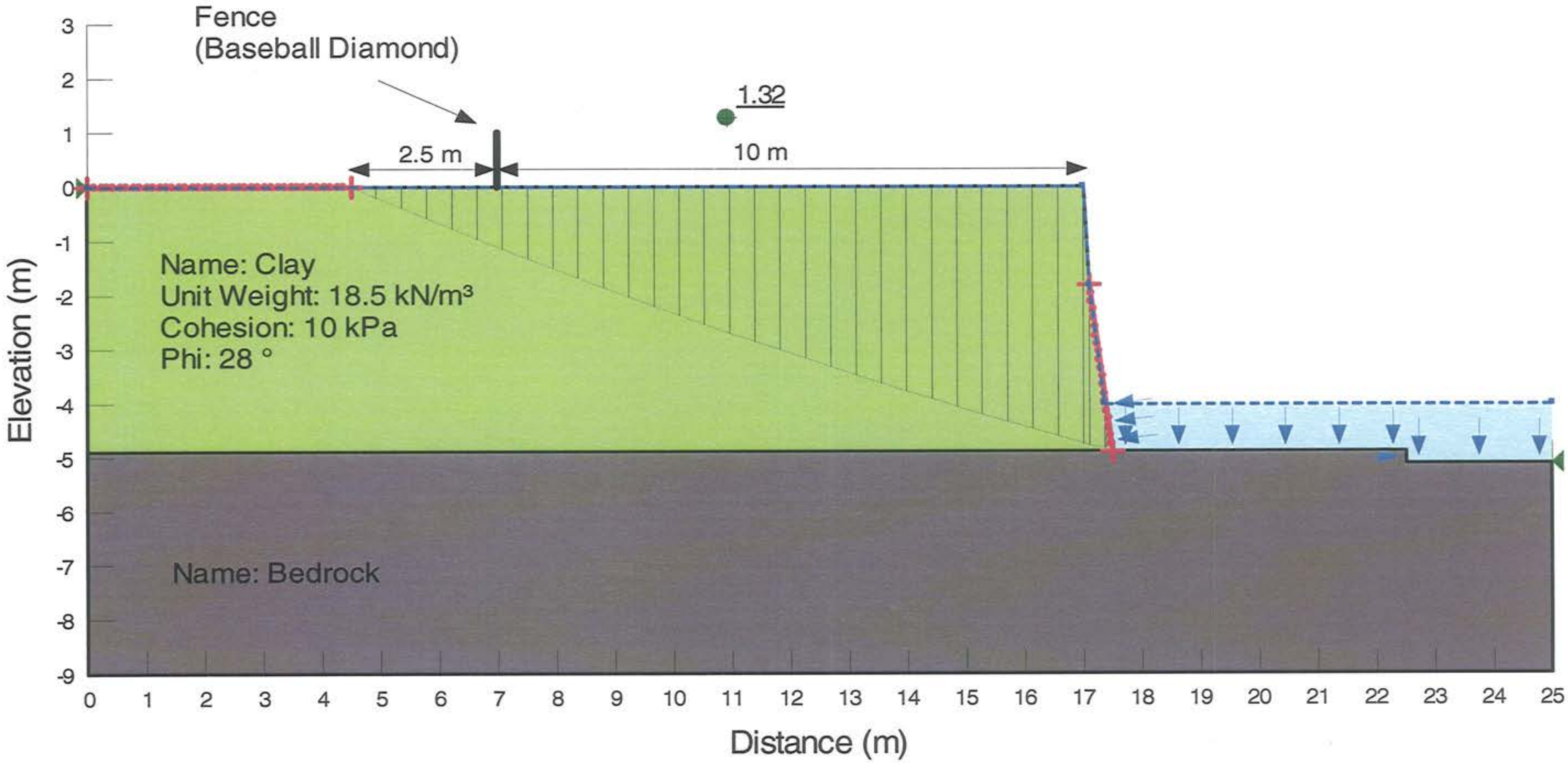
Seismic Slope Stability Analysis

Fitzroy Harbour Community Centre

Existing Slope

Figure 4

Project No. 163401089



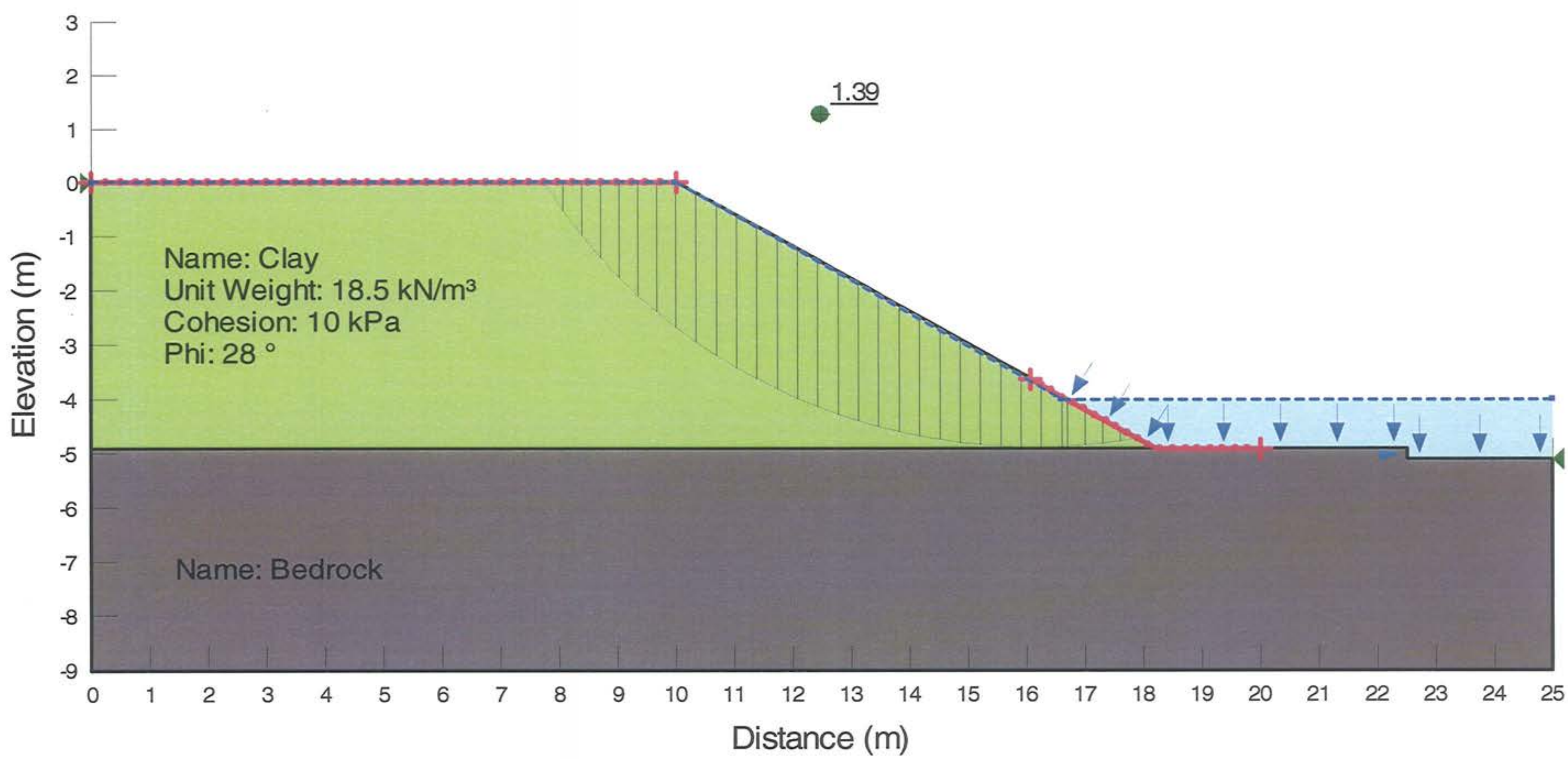
Stantec

Static Slope Stability Analysis

Fitzroy Harbour Community Centre
Limit of Hazard Lands

Figure 5

Project No. 163401089



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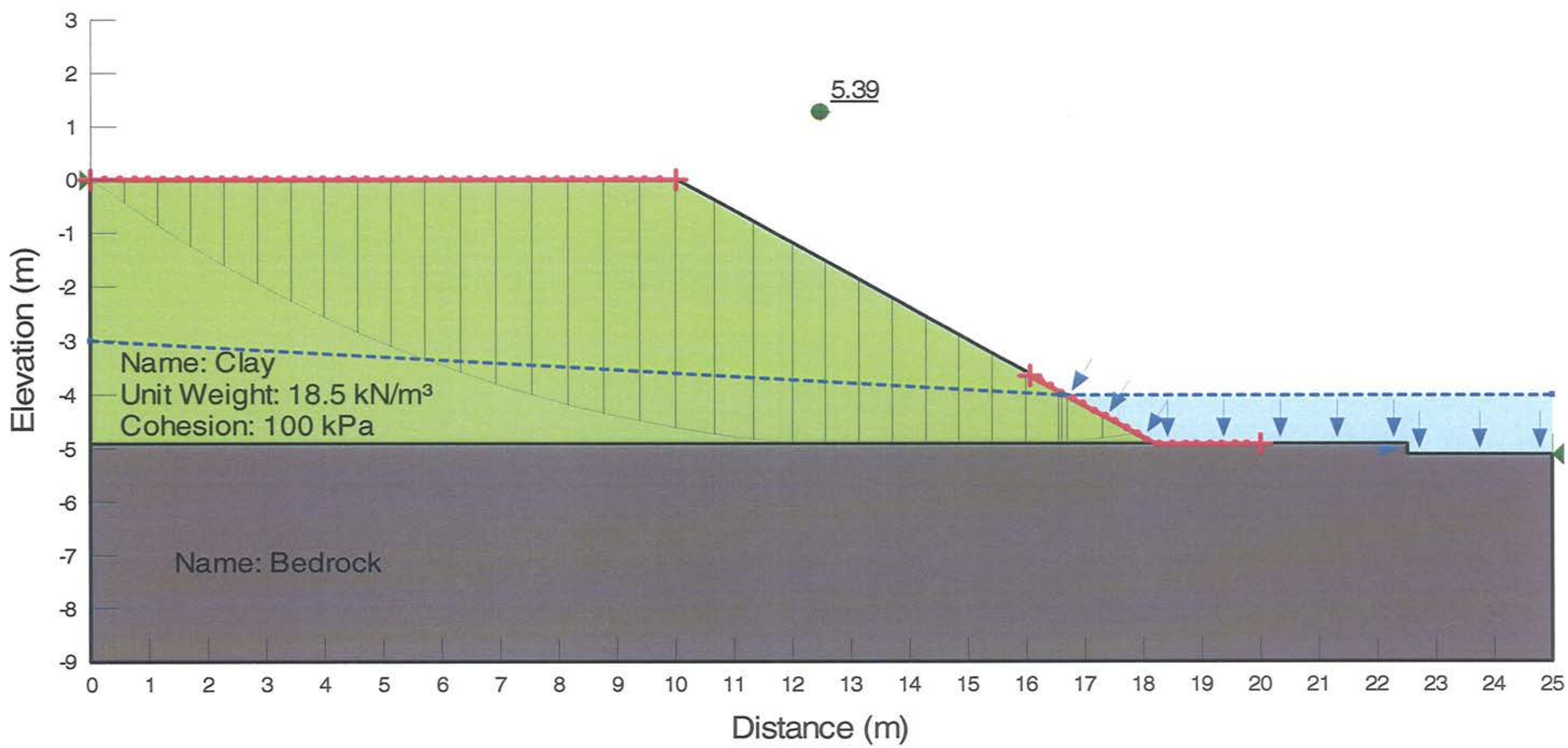
Static Slope Stability Analysis

Fitzroy Harbour Community Centre

2H:1V Slope

Figure 6

Project No. 163401089



Stantec

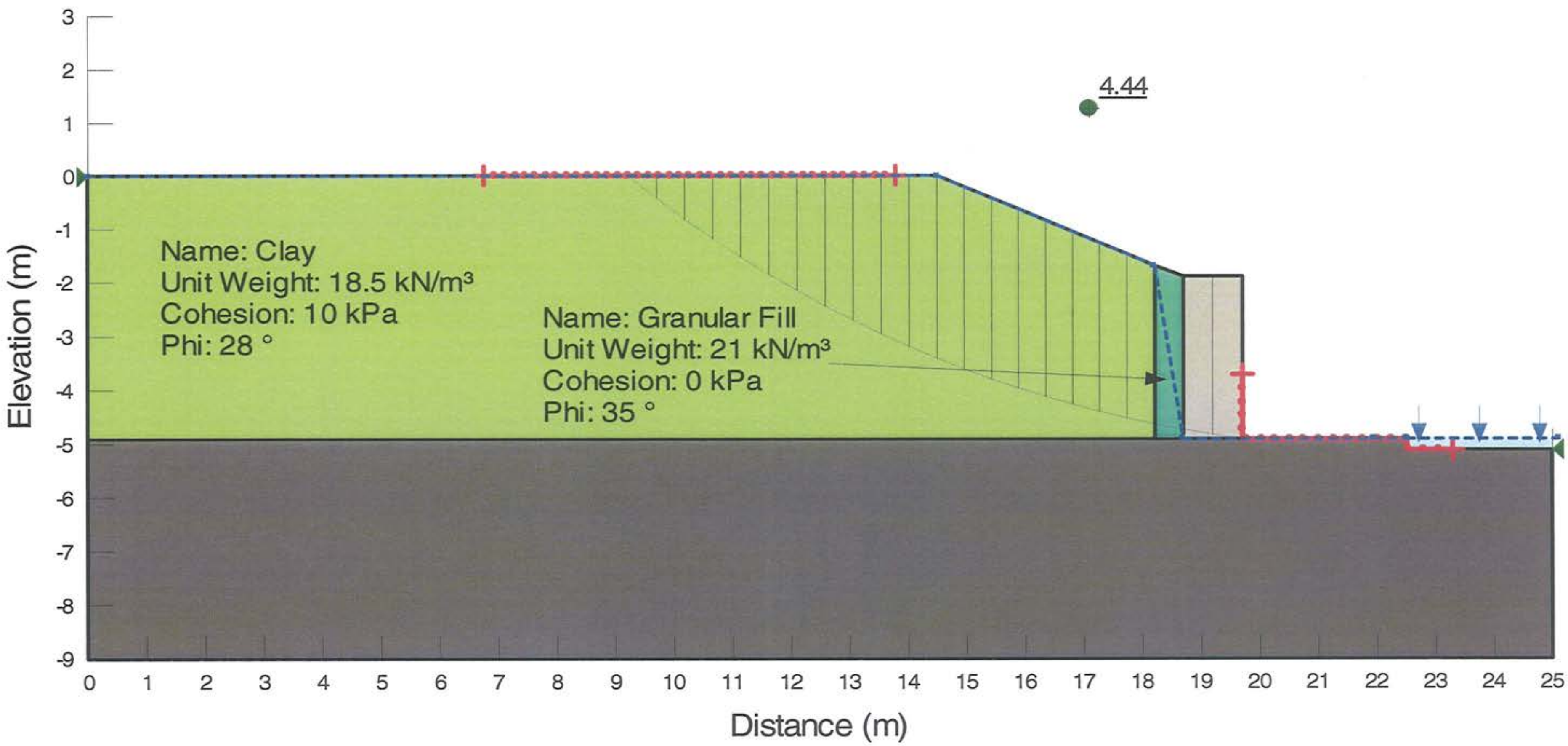
Seismic Slope Stability Analysis

Fitzroy Harbour Community Centre

2H:1V Slope

Figure 7

Project No. 163401089



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Seismic Slope Stability Analysis

Fitzroy Harbour Community Centre

Retaining Wall with 2H:1V Slope

Figure 8

Project No. 163401089

APPENDIX D
Environmental Inventory

Internal Technical Memo

Stantec

To:	Stéphane D'Aoust Ottawa (Laperriere Ave) ON Office	From:	Sarah Rogers Ottawa (Lancaster Rd) ON Office
File:	163404089	Date:	December 20, 2011

Reference: City of Ottawa Fitzroy Harbour – Environmental Inventory

INTRODUCTION

The project location is situated in the Carp River within the town of Fitzroy Harbour (Appendix A). The Fitzroy Harbour Community Centre and Campbell Bicentennial Park are located immediately adjacent to the project location.

Plant species found on the southern bank of the Carp River in the project location consist of non-native and planted species, likely a combined result of the proximity to cultural influences and park land use. The northern bank is composed of mature forest, recognized as significant woodland in Annex 14, Official Plan Amendment 76 (City of Ottawa 2009). The topography is subtle, overall sloping gently towards the Ottawa River just over 1 km to the north (Appendix A). According to the Ministry of Natural Resources (MNR 2011) the physiography of the project location consists exclusively of Clay Plains (Appendix A). The project location is zoned as flood plain, where the Community Centre is located is zoned as rural institutional (City of Ottawa 2003).

METHODOLOGY

A variety of materials were searched to gather information on the environment of the project location and nearby areas. Desktop review included publicly available databases, agency consultation and review of aerial imagery, topographic mapping and relevant available reports and photos taken during a site visit by Stantec personnel in September 2011. Desktop review included

- City of Ottawa eMAP website
- Natural Resources Canada Toporama web-based database
- MNR's Land Information Ontario (LIO) geospatial databases including areas of natural or scientific interest, important bird areas, provincially significant wetlands, wildlife corridors and nesting sites
- Conservation Ontario & the Department of Fisheries and Oceans (DFO) Aquatic Species at Risk (SAR) mapping

- Natural Heritage Information Centre's (NHIC) data provided information on historic and potential for SAR and rare species occurrences within 1 km of the project location
- Royal Ontario Museum's SAR website on all provincially listed SAR
- MNR's SAR website on all provincially listed SAR
- Friends of the Carp River website

Consultation included

- Mississippi Valley Conservation Authority (MVC) – contacted for information on the Carp River, aquatics and any other relevant information
- Kemptville District MNR office - contacted for information on SAR presence or habitat within the project location or within 1 km
- Amy MacPherson, Natural Systems Planner City of Ottawa

Publicly available documents reviewed included

- Robinson Consultants Inc., prepared for the City of Ottawa. 2004. Carp River Watershed/Subwatershed Study Volume I – Main Report
- Summary Natural Area Reports for the former Regional Municipality of Ottawa-Carleton (RMOC 1997)
- City of Ottawa Official Plan (2007)
- City of Ottawa Greenspace Masterplan (2006)
- Urban Natural Areas Environmental Evaluation Study and Appendices 2002

AQUATIC ENVIRONMENT

The Carp River is a large watercourse in the City of Ottawa that drains into the Ottawa River near Fitzroy Harbour. Forty fish species are said to occur within the Carp watershed which include both stream resident fish and fish that migrate from the Ottawa River on a seasonal basis (Robinson Consultants Inc. 2004). The lower Carp River supports a diverse, warm water fish community (Robinson Consultants Inc. 2004). Longnose Dace, Rock Bass, Smallmouth Bass, Johnny Darter, Tesselated Darter and Yellow Walleye have been captured in the Fitzroy Harbour area (Robinson Consultants Inc. 2004).

The Ontario Geological Survey's surficial geology (2009) has identified the project location as being composed of Precambrian Bedrock (shield) with some glaciomarine deposits (Appendix A). Photos from the site visit in September 2011 by Stantec confirmed that the riverbed at the project location is primarily composed of exposed bedrock with clay. The project location is not within the Carp Ridges Area of Natural or Scientific Interest (ANSI) Life Science Site, however, the bedrock in the riverbed at the project location is part of the shield bedrock corridor that extends to Kanata to form the Carp Ridges (Robinson Consultants Inc. 2004) (Appendix A). The unique upland habitat created from the bedrock ridge is a key natural habitat feature for the river (Robinson Consultants Inc. 2004).

TERRESTRIAL ENVIRONMENT

As mentioned, the terrestrial environment of the project location is primarily composed of non-native and planted species on the southern bank of the Carp River. Tree species found on this bank include White Pine, Scots Pine, Manitoba Maple, Ash and Willow Species. Composing the ground and shrub layers are mostly wasteland species including Wild Parsnip, Common Milkweed, Sumac, Birdsfoot Trefoil and Goldenrod species with some grass species.

The woodland on the northern bank of the Carp River appears to be primarily composed of coniferous tree species including Eastern White Cedar and White Spruce. The City of Ottawa has identified this as a significant woodland (Annex 14, Official Plan Amendment 76 2009). By definition, a significant woodland is a contiguous woodland patch that contains mature woodlands greater than 80 years old, forest interior greater than 100 m from the edge and within 5 m of any type of permanent water (Annex 14, Official Plan Amendment 76 2009).

There are no significant valleylands in or near the project location, the closest is several kilometres northeast (City of Ottawa 2011). There are no provincially significant wetlands in or near the project location, the closest is Kilmaurs Marsh, 3.2 km southeast (Appendix A) (MNR 2011). The wetlands mapped within the project location have not been evaluated using the Ontario Wetland Evaluation System (MNR 2011). There are no ANSI in the project location: the closest is the Carp River Stromatolites approximately 1 km upstream; 900 m southwest is the Mississippi Snye Wetland; and 7.5 km southeast is the previously mentioned Carp Ridge (Appendix A) (MNR 2011). There are no deer wintering areas or other known areas of significant wildlife habitat in the project location, the closest is a Deer Yard approximately 1.2 km to the southwest (Appendix A) (MNR 2011).

SAR AND SAR HABITAT

A search of the NHIC database indicates the potential for and/or historical record of the following species protected under the *Endangered Species Act, 2007* (ESA), within 1 km of the project location:

- Lake Sturgeon (threatened)
- Butternut (endangered)

The NHIC search also identified potential for and/or historical record of the following species that are not protected under the ESA but are listed provincially as special concern:

- Short-eared Owl
- Eastern Ribbonsnake
- Northern Map Turtle
- Milksnake

A search of the provincial databases for SAR identified a total of 35 species. If habitat for a SAR could exist up or downstream of the project location, or even if the area could serve as a travel corridor a SAR species was considered to have potential to be present. The assessment of SAR with potential to occur in the project location was high level, and only species that require specialized habitat were removed from consideration if their specialized habitat requirements do not occur in the project location. A list of species that are not likely to be found near the project location because there is no suitable habitat can be found below in Table 1.

Table 1 – SAR not likely to be found near the Project Location

Taxon	Common Name	Latin Name	SARO	Rationale
Reptile	Spiny Softshell	*Apalone spinifera*	THR	Found in waterbodies with soft bottoms to hide in waiting to ambush prey. The substrate in the project location is bedrock.
Reptile	Spotted Turtle	*Clemmys guttata*	END	Specialized to ponds, marshes and bogs with an abundant supply of aquatic vegetation. Vegetation is limited in and near the project location. Spotted Turtles are almost always found in densely vegetated areas. Further, there are no marshes, fens or bogs present.
Reptile	Eastern Musk Turtle	*Sternotherus odoratus*	THR	Shallow, slow-moving water where it typically walks along the bottom rather than swimming. The Carp River moves quite swiftly in the vicinity of the project location and this species is very habitat specific, requiring soft bottoms to bury in.
Bird	Black Tern	*Chlidonias niger*	SC	Nests in shallow, coastal marshes especially with cattails. There are no coastal marshes in the project location.
Bird	Least Bittern	*Ixobrychus exilis*	THR	Found in marshes and swamps, requires cattails. The project location does not contain marshes or swamps.

Reference: City of Ottawa Fitzroy Harbour – Environmental Inventory

Table 1 – SAR not likely to be found near the Project Location

Taxon	Common Name	Latin Name	SARO	Rationale
Bird	Loggerhead Shrike	*Lanius ludovicianus migrans*	END	The MNR has no confirmed nests reported since 2002, they perch near barbed wire fences where they impale their prey. Hawthorn and Prickly Ash trees could also indicate preferred habitat. They like a mixture of pasture/grassland with scattered low trees and shrubs. There is no grassland/pasture in the project location.
Bird	Cerulean Warbler	*Dendroica cerulea*	SC	Forest interior birds that typically require large, undisturbed mature deciduous forest. The nearby forest is in close proximity to human disturbance.
Bird	Olive-sided Flycatcher	*Contopus cooperi*	SC	Typically found at forest edges, high up in the trees waiting for prey. They commonly nest in large tracts of Boreal Forest. The project location lacks the contiguous conifer forest this species requires.
Bird	Peregrine Falcon	*Falco peregrinus*	THR	Nest on tall, steep cliff ledges near waterbodies and in urban downtown environments with tall buildings. There are no steep cliff ledges in the project location and the town of Fitzroy Harbour is not an urban downtown area as it lacks numerous tall buildings this species requires.
Bird	Henslow's Sparrow	*Ammodramus henslowii*	END	Rarely reported in the Ottawa area. Ground nester, found in tall dense grasses and thatch. There is no tall dense grass and thatch in the project location.
Bird	Short-eared Owl	*Asio flammeus*	SC	Requires open habitats and nests on the ground in fields and marshes. There are no fields or marshes in the project location, project activities will likely be isolated to within the Carp River.
Bird	Yellow Rail	*Coturnicops noveboracensis*	SC	Nests in sedge meadows and marshes. There are no sedge meadows or marshes in the project location.
Mammal	Grey Fox	*Urocyon cinereoargenteus*	THR	Deciduous forests, especially swampy areas. Only known breeding pair is found on Pelee Island. Project activities will likely be isolated to within the Carp River limiting potential for disturbance to this species.
Plant	Eastern Prairie Fringed-Orchid	*Platanthera leucophaea*	END	Several noted sites in the Ottawa area, all being found in fens. There are no fens in the project location.

Comments received on the draft by MNR requested further explanation for Spiny Softshell and Eastern Musk Turtle's absence from the list of species with potential to occur in the project location. Spiny Softshells inhabit aquatic environments that include some aquatic vegetation and soft bottoms to bury in (COSEWIC 2003). The Eastern Musk Turtle inhabit aquatic environments that have a very slow current and soft bottom (ROM 2009). The substrate of the Carp River in the project location is entirely composed of bedrock, little to no soft substrate with steep near vertical river banks and the water moves at a high velocity. It is because of these natural environment characteristics that it is not anticipated that either Spiny Softshell or Eastern Musk turtle would be found within the project location. In addition, other species have been omitted from consideration because it is anticipated that project activities will be primarily isolated to within the Carp River, therefore, aquatic, semi-aquatic SAR have been presumed to have more chance to occur in the project location.

There could be suitable habitat for some species listed below in Table 2.

Table 2 - SAR that could be found near the Project Location

Taxon	Common Name	Latin Name	SARO	Rationale
Fish	American Eel	*Anguilla Rostrata*	END	Occurs mainly along the St. Lawrence River and Lake Ontario and their tributaries. Historically, it was present throughout the Ottawa River drainage system. Identified by the Conservation Ontario and DFO SAR mapping.
Fish	Lake Sturgeon	*Acipenser fulvenscens*	THR	Found in all the Great Lakes, and in all drainages of the Great Lakes and of Hudson Bay. Identified by the NHIC as occurring in the project location and the Carp River could be potential habitat.
Fish	River Redhorse	*Moxostoma carinatum*	SC	Lives in pools and riffle areas of large streams and rivers. Lays eggs directly on gravel. Identified by the Conservation Ontario and DFO SAR mapping.
Reptile	Snapping Turtle	*Chelydra serpentina*	SC	They prefer shallow waters so they can hide under the soft mud and leaf litter, with only their noses exposed to the surface to breathe. This species is not as specialized to specific habitats and could use the project location as a travel corridor.
Reptile	Blanding's Turtle	*Emydoidea blandingii*	THR	Inhabits a network of lakes, streams, and wetlands, preferring shallow wetland areas with abundant vegetation. It can also spend significant portions of time in upland areas moving between wetlands. This species could use the project location as a travel corridor.
Reptile	Eastern Ribbonsnake	*Thamnophis sauritus*	SC	Identified by NHIC. Usually found close to water, especially in marshes where it hunts for frogs and small fish. A good swimmer, it will occasionally dive in shallow water. A few have been reported near Morris Island, nearby. The Carp River could be potential habitat.

Table 2 - SAR that could be found near the Project Location

Taxon	Common Name	Latin Name	SARO	Rationale
Reptile	Milksnake	*Lampropeltis triangulum*	SC	Identified by NHIC. Lives in a wide range of habitats, especially old fields and farm buildings where rodents are common. Nearby areas could be potential habitat.
Reptile	Northern Map Turtle	*Graptemys geographica*	SC	Identified by NHIC. Lives in large rivers and lakes, and individuals from a wide area will often congregate at favoured sites to bask together. The Carp River is large, and could be potential habitat.
Bird	Golden-winged Warbler	*Vermivora chrysoptera*	SC	Typically found on the edge of woodlands in open areas such as hydro right-of-ways. The nearby forest could be potential habitat.
Bird	Canada Warbler	*Wilsonia canadensis*	SC	Found in a range of deciduous and coniferous forest, usually wet forest types with a well-developed, dense shrub layer. Nests are usually located on or near the ground on mossy logs or roots, along stream banks or on hummocks. The nearby forest could be potential habitat.
Bird	Chimney Swift	*Chaetura pelagica*	THR	Cannot perch, but cling to walls of chimneys and tree cavities. They roost in hollow trees but are most often seen on man-made structures, preferably chimneys. The nearby forest could be potential habitat.
Bird	Common Nighthawk	*Chordeiles minor*	SC	Can be found in a variety of habitats, preferably open areas, including urban rooftops. The nearby forest could be potential habitat.
Bird	Red-headed Woodpecker	*Melanerpes erythrocephalus*	SC	Lives in woodlands and on the edges of woodlands especially in oak savannahs and those with a higher density of trees in general. The nearby forest could be potential habitat.
Bird	Whip-poor-will	*Caprimlugus vociferus*	THR	Found in a mix of open and forested areas typically with more mature trees for nesting and roosting. The nearby forest could be potential habitat.
Mammal	Eastern Cougar	*Puma concolor*	END	Found in large undisturbed forested areas. The nearby forest could be potential habitat.
Plant	Butternut	*Juglans cinerea*	END	Low density forests, several sites identified in Ottawa area particularly in bottomlands. The project location has some bottomland area and depending on which alternative is chosen, some areas beyond the immediate in-water areas could be affected.
Plant	American Ginseng	*Panax quinquefolius*	END	Found in rich, moist, mature deciduous forest, and commonly under Butternut trees. The project location has bottomland areas which are favoured by Butternut trees and therefore there is potential habitat for Ginseng.

Table 2 - SAR that could be found near the Project Location

Taxon	Common Name	Latin Name	SARO	Rationale
Plant	Flooded Jellyskin	*Leptogium rivulare*	THR	Grows in wetted areas at the base of trees. The project location includes areas with vernal pooling so there is potential for this species to be present perhaps along the river banks.
Insect	Monarch	*Danaus plexippus*	SC	Along roadsides, city gardens and parks. The larvae feed on milkweed plants. The banks of the Carp River in the project location could be potential habitat.
Insect	West Virginia White	*Pieris virginiensis*	SC	Requires moist, deciduous forests, preferential to the plant Toothwort. Nearby areas could provide habitat, especially if Toothwort is present.

Conservation Ontario and DFO mapping (2011) indicates that there is presence of American Eel (provincially endangered) and River Redhorse (provincially special concern) in the Carp River within the project location (Appendix A).

It is anticipated that the project will not commence until late summer 2012 when the water in the Carp River is lowest. This will eliminate concern for potential over-wintering turtles in the area.

With respect to fish:

In addition to the timing window that will be respected with regards to project construction, a fish and fish habitat assessment will be conducted prior to any project activities to identify the sensitivity of the fish species and habitat present, and determine the scale of negative effect of the proposed work. This assessment will determine if any further mitigation is required for the following species that might occur in the project location because suitable habitat exists: American Eel, Lake Sturgeon and River Redhorse.

With respect to snakes:

A thorough search of the area will take place before commencing project activities. Temperature and weather conditions will drive their behaviour and they are much more visible on warm summer days when basking or moving more frequently. Snakes may use open areas to bask, but avoid these areas when it is too hot. Searches could include trees, logs, ground, stumps, rock outcrops and ledges. Skin sheds can be a good indication of presence. If hibernacula and ovipostion sites are suspected or known they will not be destroyed and if encountered the project area will be fenced off to prevent any snakes from entering the work project area (the project area will be enclosed by silt-fencing anyway). The suggested search will determine whether further mitigation is required for the following species that might occur in the project location because suitable habitat exists: Eastern Ribbonsnake and Milksnake. Any further mitigation will be developed in consultation with the MNR.

With respect to turtles:

A thorough sweep of the aquatic area will take place before any in water work occurs. A sweep of the area will encourage any turtles possibly utilizing the site to move away before any equipment or work which could impact the species occurs. In addition, if the project extends into late October, the project area will be fenced off to prevent any turtles from hibernating within the area (the project area will be enclosed by silt-fencing anyway). The suggested sweep will determine whether further mitigation is required for the following species that might occur in the project location because suitable habitat exists: Snapping Turtle, Northern Map Turtle and Blanding's Turtle. Any further mitigation will be developed in consultation with the MNR.

Although suitable habitat exists for, Ginseng, Butternut, Flooded Jellyskin, West Virginia White, Monarch, Whip-poor-will, Golden-winged Warbler, Chimney Swift, Red-headed Woodpecker, Canada Warbler and Common Nighthawk, depending on the alternative chosen for the project it is not known at this time whether there will be any potential impacts to these listed species. Once the details of the design are finalized, further mitigation can be recommended if needed. Any further mitigation will be developed in consultation with the MNR.

SOCIO-ECONOMIC ENVIRONMENT

The project location is immediately adjacent to the Fitzroy Harbour Community Centre which provides five sports fields, a basketball court, two baseball diamonds, a skateboard park and an outdoor rink for recreation (Appendix A) (City of Ottawa 2009). Approximately 1 km downstream the Carp River there is Fitzroy Harbour Provincial Park and River Park, another small community recreation area approximately 500 m northwest of the project location (Appendix A) (MNR 2011). The Carp River is a popular fishing spot in the Fitzroy Harbour area.

The City of Ottawa has also proposed construction of a recreational pathway system that follows the Carp River from the Kanata urban area to the rural areas of Fitzroy Harbour (Robinson Consultants Inc. 2004). It is uncertain what stage this project is at currently.

CULTURAL HERITAGE

The project location falls within an area of elevated archaeological potential, as delineated by the City of Ottawa's Archaeological Potential Mapping (City of Ottawa 2009). This elevated potential is a result of the project location's proximity to the Carp River. In general it has been demonstrated that areas within 200 to 300 m of watercourses, or other significant bodies of water, and in particular those areas with multiple water sources, are considered to be of elevated archaeological potential for prehistoric period resources. Given the project location’s proximity to the historic town of Fitzroy Harbour there is also a possibility for impacts on historic period archaeological resources and heritage resources, although no legally designated buildings or landscapes are within or adjacent to the project location.

STANTEC CONSULTING LTD.

Sarah Rogers
Environmental Scientist
sarah.rogers@stantec.com

Attachment: Appendix A

RESOURCES

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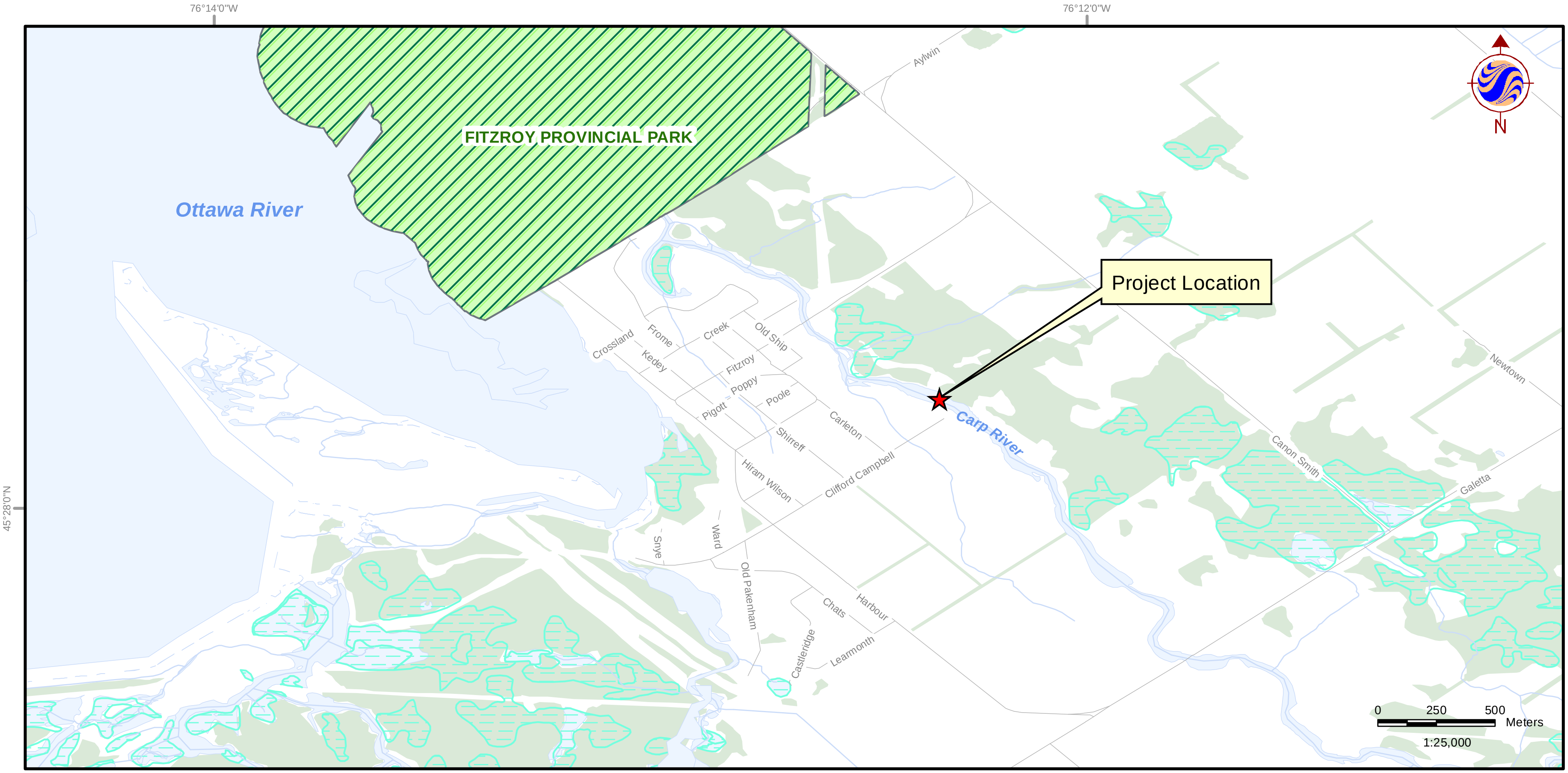
APPENDIX A

Figures



December 2011
Project No. 163401089

Legend

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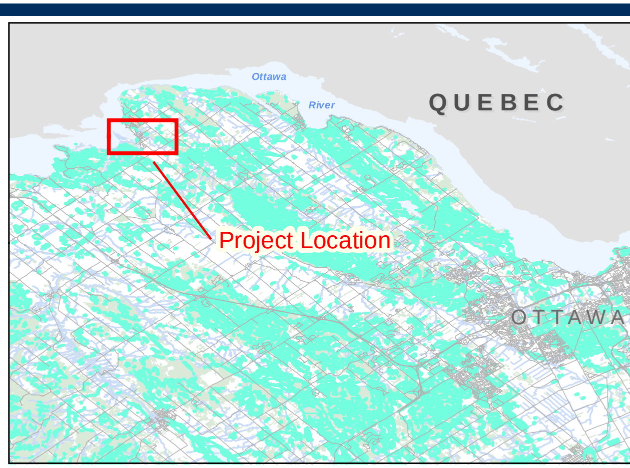
- Provincial Park
- Provincially Significant Wetland
- Wetland
- Waterbody
- Wooded Area



Notes

1. Coordinate System: GCS_North_American_1983.
2. Data Source: Ontario Ministry of Natural Resources
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Client

City of Ottawa

Figure No.

1

Title

Project Location

Stantec

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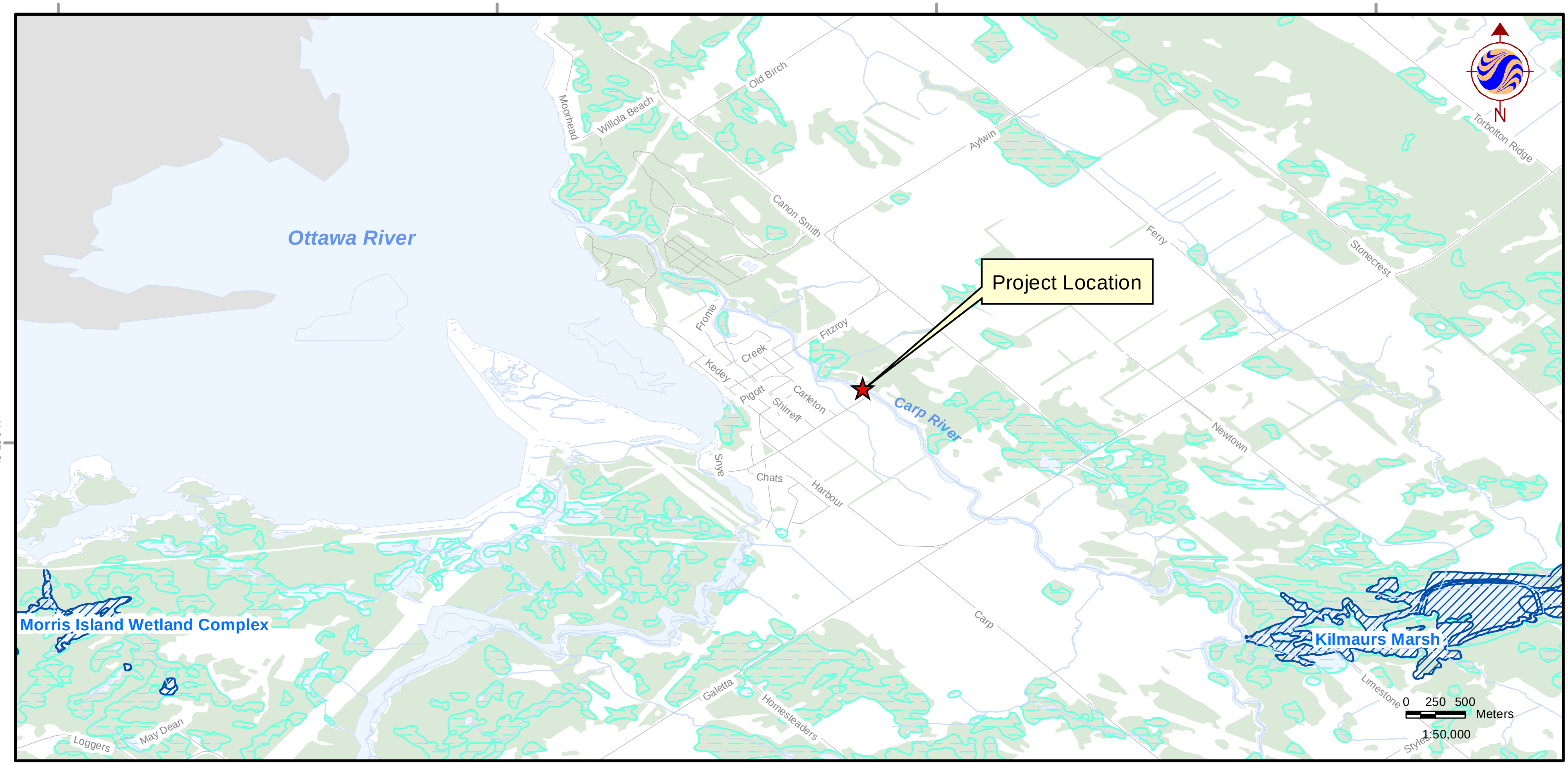

December 2011
Project No. 163401089

Legend

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- Provincially Significant Wetland
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- Waterbody
- Wooded Area

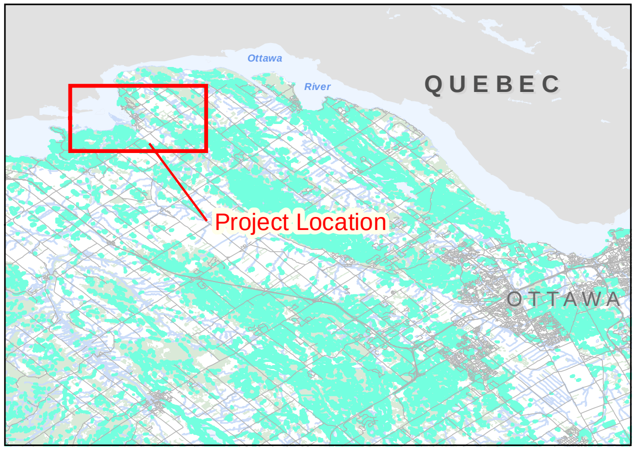

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Figure No.

2

Title

Location of Provincially Significant Wetlands

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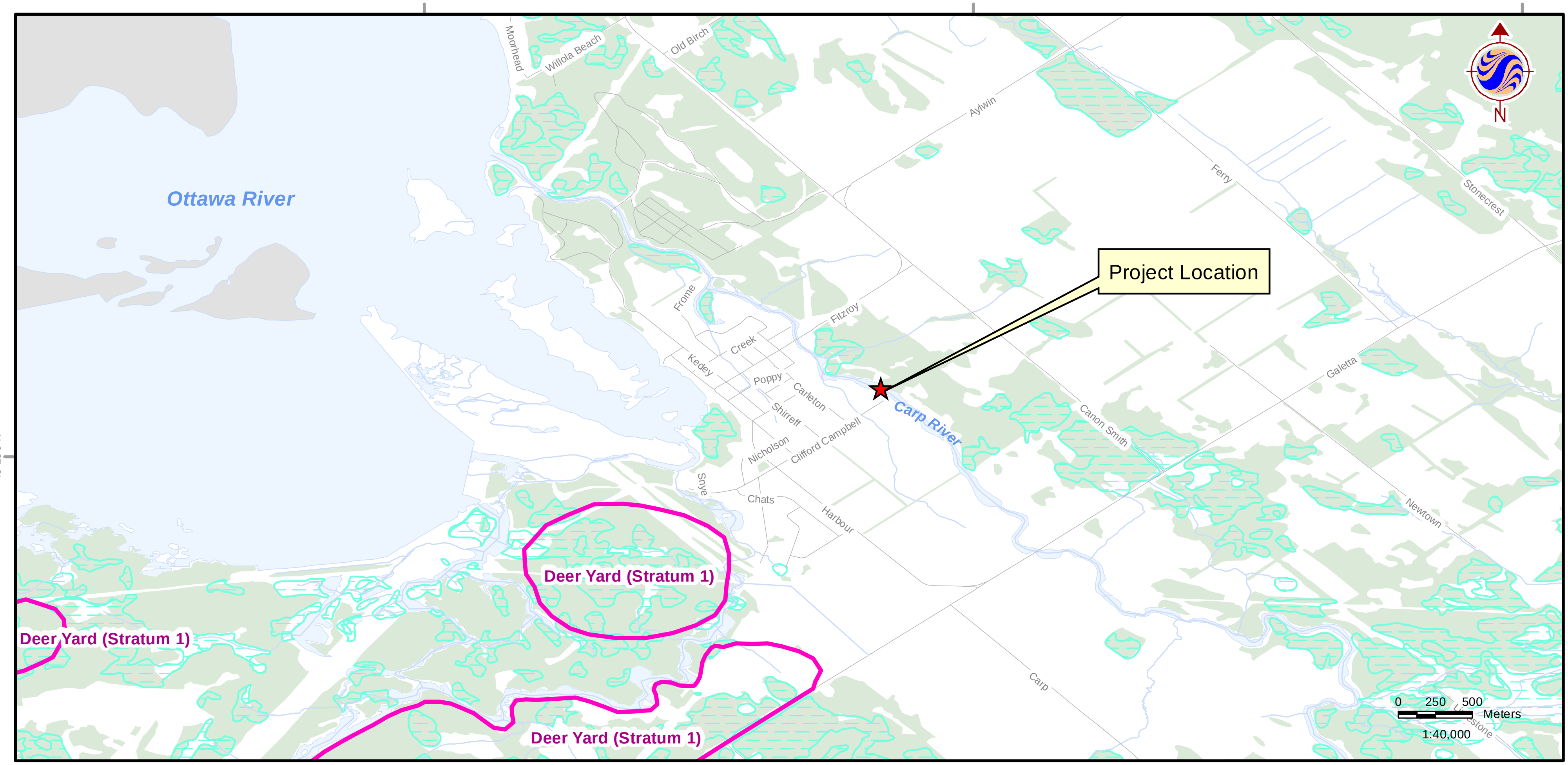

December 2011
Project No. 163401089

Legend

- Wintering Area
- Road
- Watercourse
- Wetland
- Waterbody
- Wooded Area

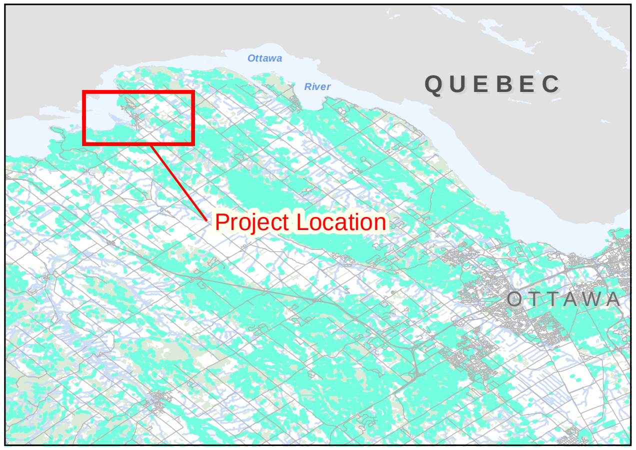

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Figure No.

3

Title

Location of Wintering Areas

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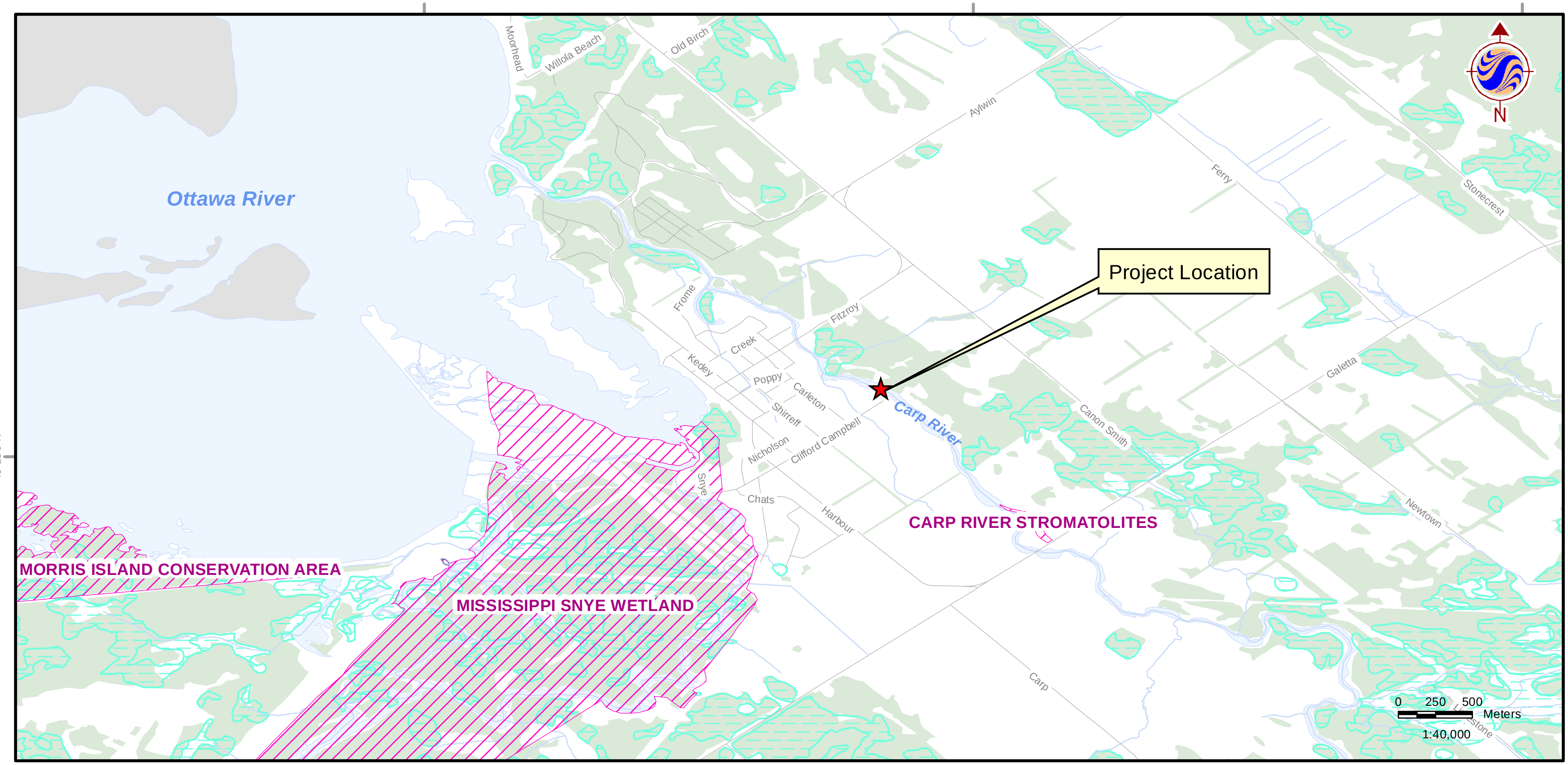

December 2011
Project No. 163401089

Legend

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- Waterbody
- Wooded Area

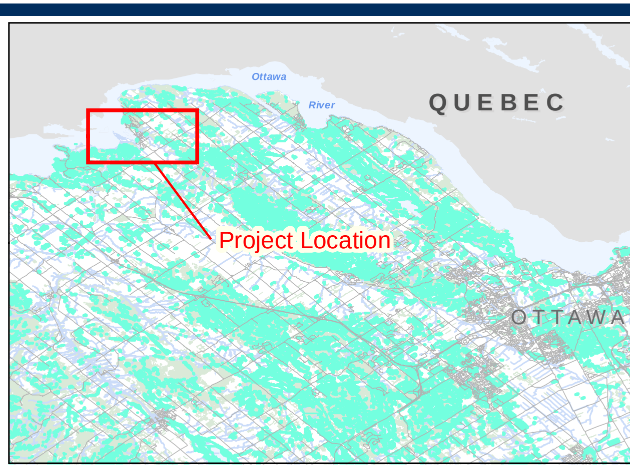

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Figure No.

4

Title

Location of Areas of Natural or Scientific Interest

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December 2011
Project No. 163401089

Legend

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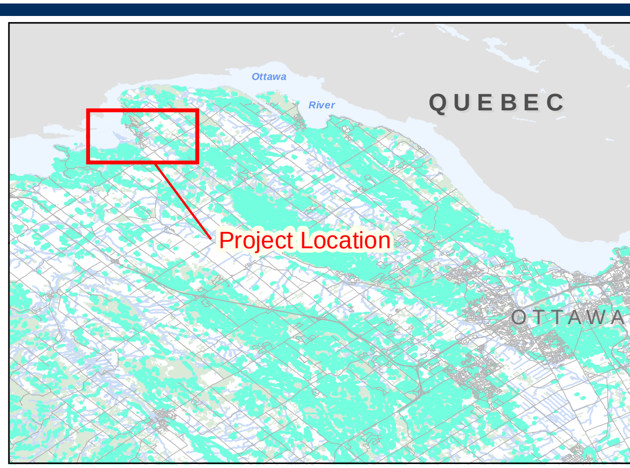
- Wetland
- Waterbody
- Wooded Area



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Client
City of Ottawa

Figure No.
5

Title
Physiography

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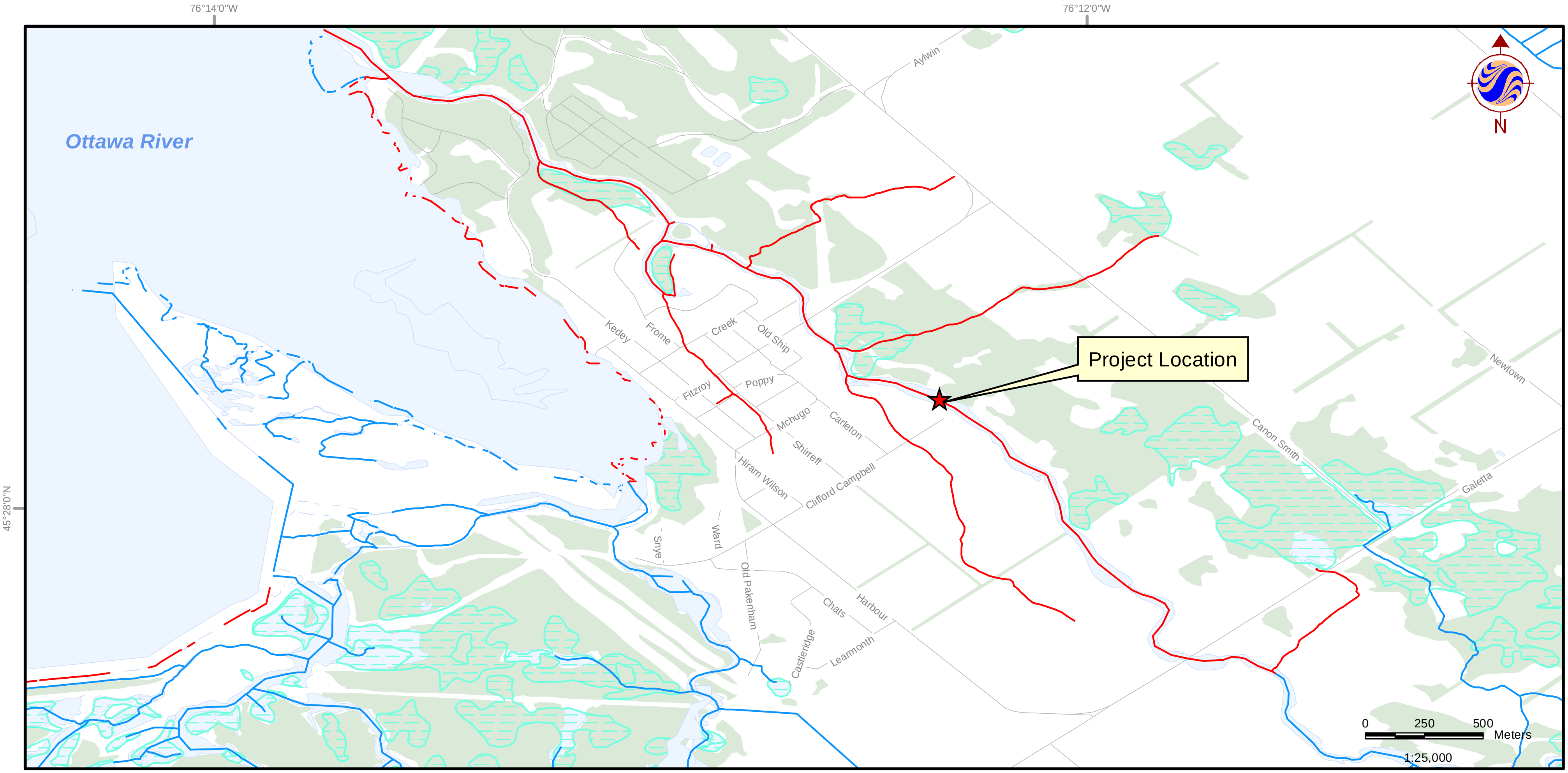

December 2011
Project No. 163401089

Legend

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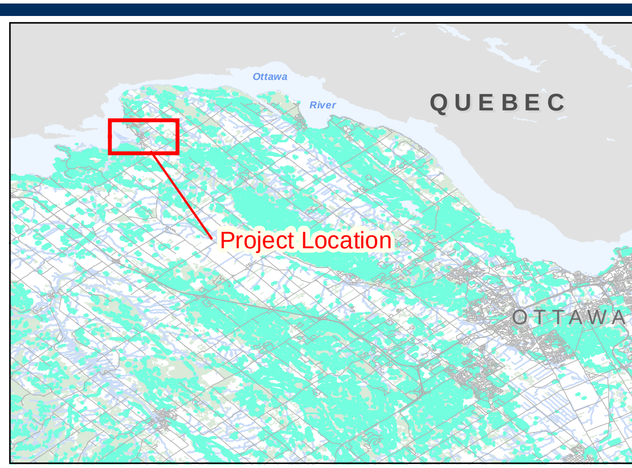
- Wetland
- Waterbody
- Wooded Area



Notes

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Figure No.

6

Title

Presence/Absence of SAR in Watercourses

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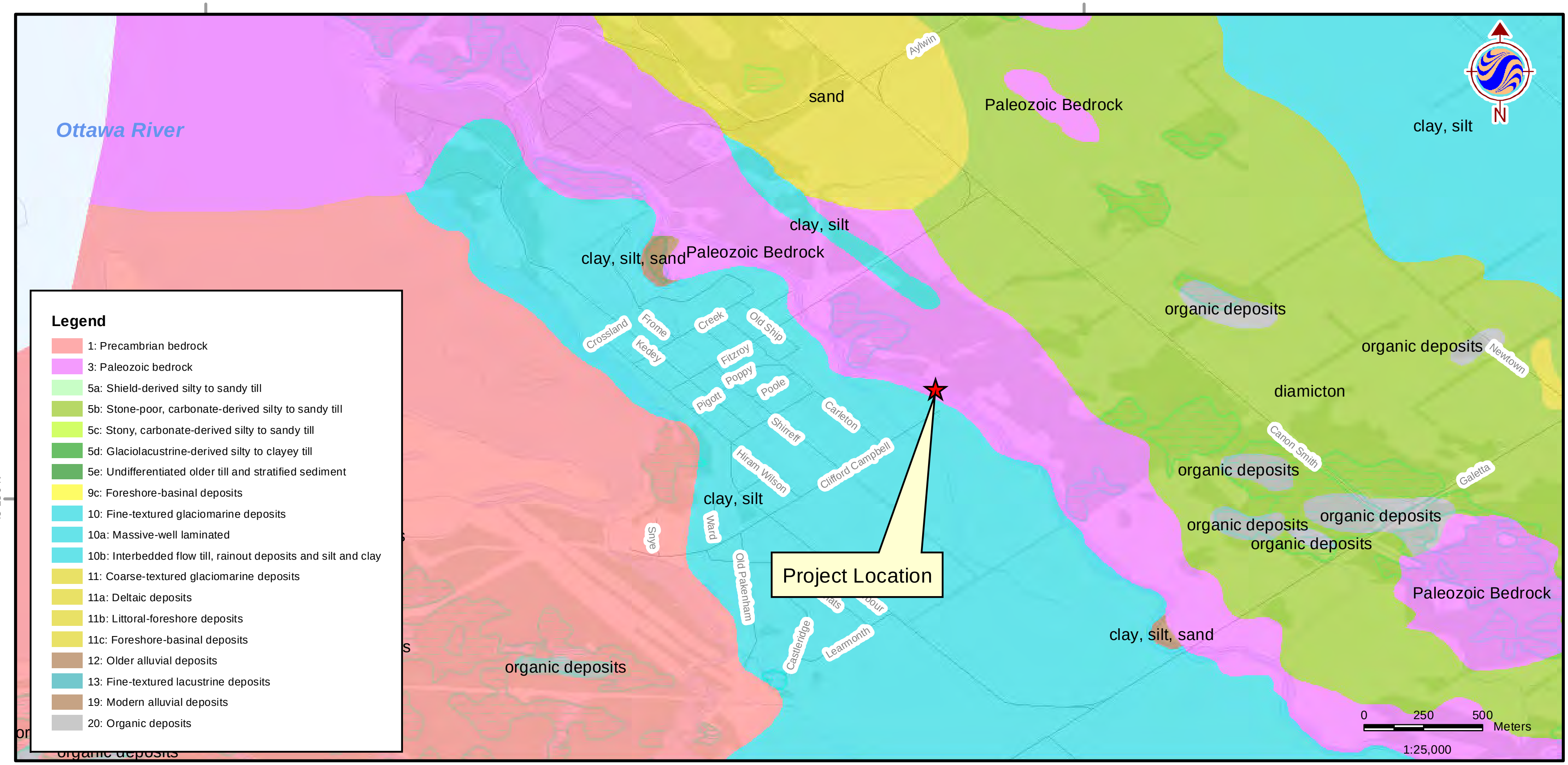

December 2011
Project No. 163401089

Legend

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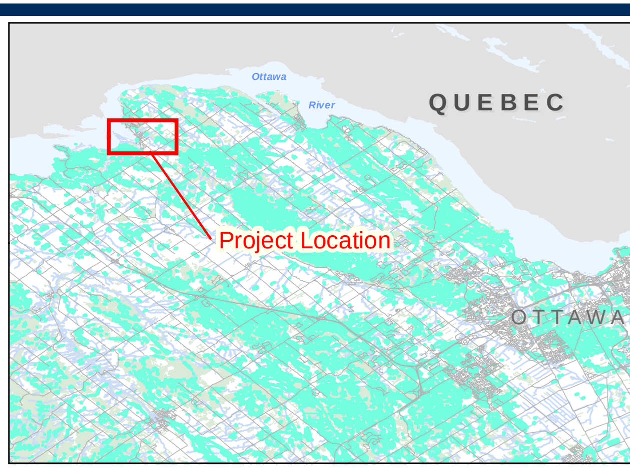
- Wetland
- Waterbody
- Wooded Area



Notes

1. Coordinate System: GCS_North_American_1983.
2. Data Source: Ontario Ministry of Natural Resources
   © Queens Printer Ontario, 2011.
   OGS Surficial Geology © 2009.

Client
City of Ottawa

Figure No.
7

Title
Surficial Geology

Stantec

Revised: 2011-12-19 By: sarogers
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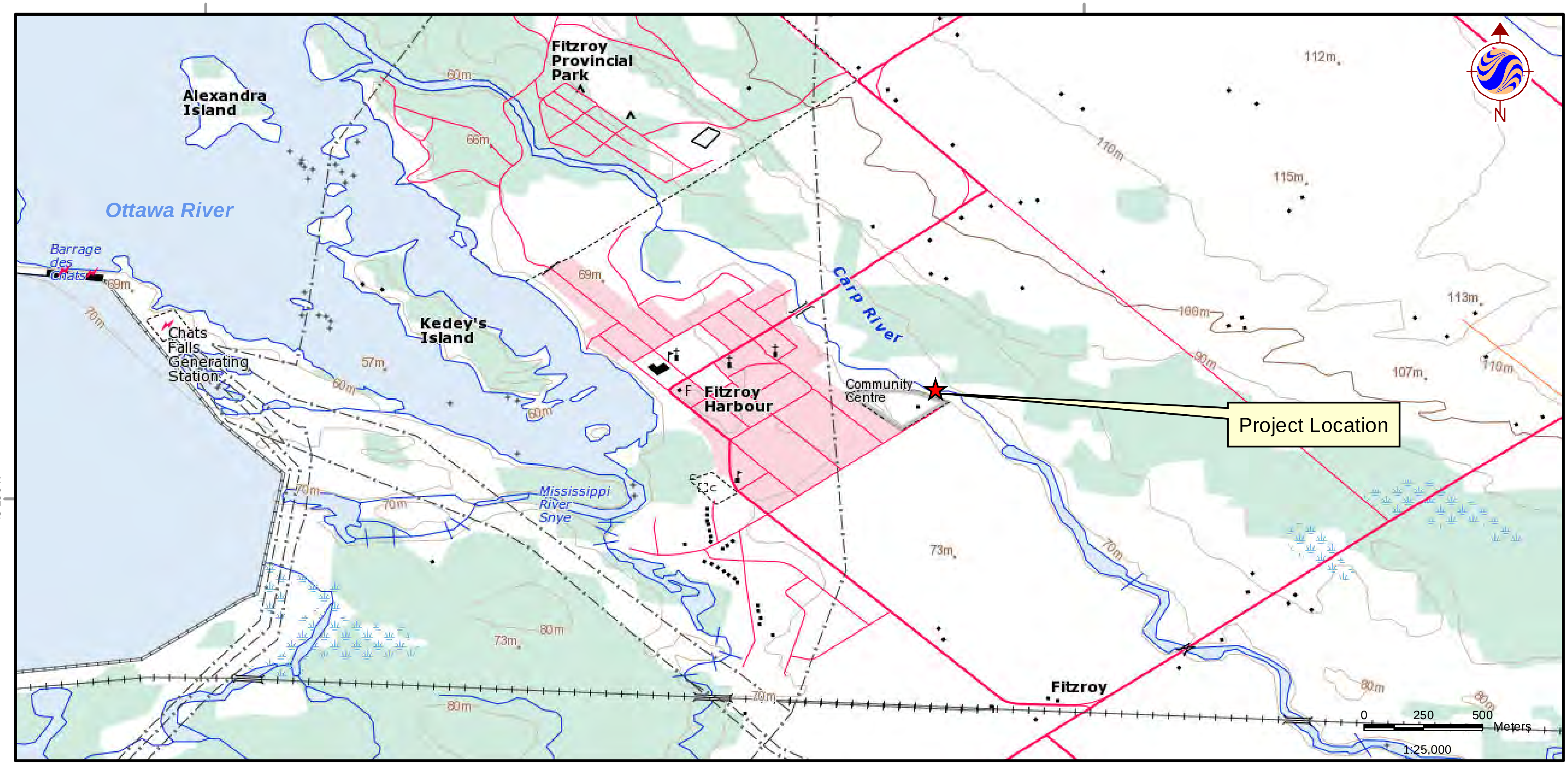
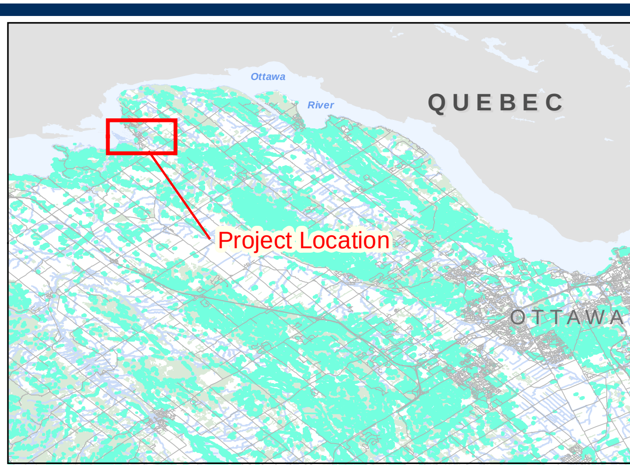


December 2011
Project No. 163401089



Notes

1. Coordinate System: GCS_North_American_1983.
2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2011. NRCAN Toporama © 2011

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Figure No.
8

Title
Topography of Project Location

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Stantec

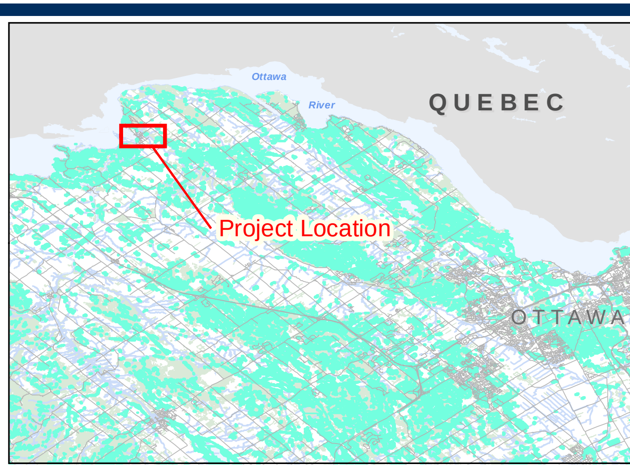
76°12'0"W

45°28'0"N

December 2011
Project No. 163401089

Legend

- Sports Field
- Skateboard Park
- Outdoor Rink
- Park
- Basketball Court
- Baseball Diamond
- Large Building
- Railway
- Watercourse
- Waterbody



Notes

1. Coordinate System: GCS_North_American_1983.
2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2011. City of Ottawa Open Data © 2011.

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Figure No.
9

Title
Socio-Economic Setting

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APPENDIX E
Hydraulic Assessment of Recommended Solution

Memo

Stantec

To:	Kevin Cover	From:	Marc Telmosse
	City of Ottawa		Ottawa (Laperriere Ave) ON Office
File:	1634-01089	Date:	December 12, 2011

Reference: Fitzroy Harbour Community Centre Slope Stability Study
Hydraulic Assessment of Recommended Solution

INTRODUCTION

Over the past 10 years the riverbanks located near the Fitzroy Harbour Community Centre have eroded approximately 8-10 metres. As such, mitigation measures are required to halt the progression and reclaim the lost bank.

The area of interest is a stretch of approximately 100m which runs near the rear of the baseball diamond adjacent to the community centre.

A steady state hydraulic model was used to assess existing hydraulic conditions within the reach, as well as to assess the recommended solution.

MODEL DEVELOPMENT

An existing HEC-2 model was provided by the City of Ottawa for this assignment. This model was developed as part of the Floodplain Mapping Study of the Mississippi River and Tributaries and Watts Creek (Cuming-Cockburn & Associates Ltd., December 1983) undertaken for the Mississippi Valley Conservation Authority (MVCA).

The model developed as part of the 1983 assignment included HEC-2 modeling of the Carp River that included our area of interest in Fitzroy Harbour. As such, the existing HEC-2 model was used as a starting point for this assignment.

MODEL UPDATES

The original HEC-2 model was updated to the HEC-RAS modeling environment.

ASSUMPTIONS

The original HEC-2 model was developed based on a 1:5,000 and 1:2,000 mapping, and field topographic surveys. The depictions of the reaches, cross-sections, and inline-structures (as developed in the 1983 HEC-2 model) have been assumed representative and adequate for the purposes of this assignment.

**Reference: Fitzroy Harbour Community Centre Slope Stability Study
Hydraulic Assessment of Recommended Solution**

FITZROY HARBOUR MODEL REFINEMENTS

REACHES OF INTEREST

The original HEC-2 model included reaches of the Carp River from the mouth at the Ottawa River to the Glen Cairn area in Kanata. This model covers approximately 40-50km of river and far exceeds our requirements.

The section of the Carp River of interest is located approximately 2.3km upstream of the conjunction with the Ottawa River. As such, only the lower portion of the updated HEC-RAS model (approximately 3.5km upstream from the Ottawa River) was utilized.

The updated HEC-RAS model was supplemented with additional cross-sections based on 2011 topographic elevations provided by the City. The modeled sections through the area of interest are presented in plan-view in **Figure 1**.

Elevation Confirmation

Topographic information was also provided by the City for the reach for 1999, 2001, and 2011 conditions. These elevations were used to generate additional cross-sections near the area of interest. The difference in the sections between 1999 and 2011 provided guidance as to how much of the existing channel had been lost and what portion of the eroded bank section should be targeted for reclamation.

It should be noted that the elevations associated with these cross-sections were found to be approximately 0.50 m higher than those corresponding to the same areas from the 1983 HEC-2 model. As such, additional surveying was requested to establish which elevations were correct.

The survey confirmed that the elevations from the 1983 HEC-2 model were more accurate. As a result, the elevations obtained from the topographic mapping provided by the City were lowered by 0.50 m.

BOUNDARY CONDITIONS

Development of a hydraulic model requires the establishment of appropriate boundary conditions. The original report that accompanied the 1983 HEC-2 model provided boundary conditions to be used as a starting point for backwater computations. For the Carp River, this level was identified as 59.3m at the conjunction with the Ottawa River for all storm events. This boundary condition has been carried forward to this analysis and was used for all flow scenarios.

**Reference: Fitzroy Harbour Community Centre Slope Stability Study
Hydraulic Assessment of Recommended Solution**

Figure 1. Sections of Interest.

SIMULATED FLOWS

The original development of the HEC-2 model included a hydrologic analysis to establish flow rates through the area of interest. This assessment considered various approaches involving both rainfall event and snowmelt event responses. The flows resulting from the original assessment for our area of interest were carried forward and are presented in **Table 1**. Stantec undertook a flood frequency analysis based on the Water Survey of Canada peak instantaneous flow records (1972 – 2010) at the gauging station near Kinburn (Station 02KF011 – drainage area of 269 km^2). The results were then factored by 1.1 (300 km^2/269 km^2) to represent the conditions at the site of interest. The results of this analysis are also summarized in **Table 1**. The factored flood frequency analysis values were used for the hydraulic modeling

**Reference: Fitzroy Harbour Community Centre Slope Stability Study
Hydraulic Assessment of Recommended Solution**

Table 1. Peak Flow Rates (m^3/s).

Return Period	Floodplain Study[a]	Flood Frequency Analysis[b]
April mean monthly flow	n/a	14
May mean monthly flow	n/a	3.5
2 Year	n/a	53
5 Year	81.6	70
10 Year	88.4	n/a
25 Year	97.8	n/a
50 Year	102.8	103
100 Year	109.3	112

[a] Sourced from Floodplain Mapping Study of the Mississippi River and Tributaries and Watts Creek. (CCL, 1983).

[b] Flood Frequency Analysis, 1972 to 2010 records from Water Survey of Canada Station 02KF011

MODEL RESULTS

The hydraulic model was run for existing conditions (2011) and for the preferred alternative configuration as described in the Carp River Slope Stability Near Fitzroy Harbour Community Centre Environmental Assessment Study Report (Stantec, November 2011). The preferred alternative has been identified as a partial channel re-alignment approach. This approach includes terraces corresponding to the 5 and 100 year flood depths, as well as re-sloping of the banks to 3:1 side slopes.

The reach of interest spans from approximately Stations 2+300 to 2+450. The results for each of these cross-sections under both model runs are provided in **Tables 2** through **10**. A profile for the reach of interest for the 100 year event is provided in **Figure 4**.

DISCUSSION

The progression of the slope erosion issues near the Fitzroy Harbour Community Centre has reached approximately 8m over the past 10 years. Alternative solutions have been developed through discussion with the City to mitigate any further erosion problems and stabilize the slope.

A hydraulic model was used to assess potential impacts on the River water levels and flow characteristics following the implementation of the preferred alternative.

A comparison of the results from the HEC-RAS model indicates that the expected impacts from the proposed channel modifications under the 1:100-year flood are limited to a section of approximately 80m upstream of the project (Sections 2+340 to 2+380 inclusive). Additionally, the maximum difference in depths between the preferred solution and existing conditions under this flood condition is approximately 17cm. This difference in elevations occurs about 40m upstream of the cross-section where the most severe erosion has occurred (Section 2+340).

**Reference: Fitzroy Harbour Community Centre Slope Stability Study
Hydraulic Assessment of Recommended Solution**

Table 2. Hydraulic Modeling Results

Return Period	Station	Depth (m)			Velocity (m/s)		
		Existing	Preferred Solution	Difference	Existing	Preferred Solution	Difference
100-yr	2+300	1.00	1.00	0.00	1.76	1.76	0.00
	2+320	0.90	0.95	0.05	2.49	2.51	0.02
	2+340	1.05	1.09	0.04	1.89	2.10	0.21
	2+360	1.07	1.09	0.02	1.76	2.31	0.55
	2+380	1.00	1.17	0.17	2.38	2.18	-0.20
	2+400	1.05	1.19	0.14	2.19	1.88	-0.31
	2+420	1.04	1.11	0.07	2.30	2.11	-0.19
	2+450	1.10	1.10	0.00	3.12	3.13	0.01
50-yr	2+300	0.97	0.97	0.00	1.69	1.69	0.00
	2+320	0.87	0.92	0.05	2.40	2.44	0.04
	2+340	1.00	1.05	0.05	1.82	2.00	0.18
	2+360	1.02	1.05	0.03	1.70	2.22	0.52
	2+380	0.96	1.12	0.16	2.30	2.11	-0.19
	2+400	1.00	1.13	0.13	2.13	1.84	-0.29
	2+420	0.99	1.06	0.07	2.24	2.06	-0.18
	2+450	1.05	1.05	0.00	3.05	3.05	0.00
5-yr	2+300	0.85	0.85	0.00	1.38	1.38	0.00
	2+320	0.75	0.69	-0.06	2.01	2.45	0.44
	2+340	0.83	0.88	0.05	1.52	1.65	0.13
	2+360	0.83	0.87	0.04	1.46	1.91	0.45
	2+380	0.78	0.92	0.14	2.01	1.82	-0.19
	2+400	0.82	0.91	0.09	1.85	1.62	-0.23
	2+420	0.80	0.84	0.04	1.96	1.85	-0.11
	2+450	0.83	0.83	0.00	2.68	2.69	0.01
2-yr	2+300	0.77	0.77	0.00	1.21	1.21	0.00
	2+320	0.66	0.63	-0.03	1.80	2.06	0.26
	2+340	0.71	0.74	0.03	1.36	1.51	0.15
	2+360	0.70	0.73	0.03	1.31	1.75	0.44
	2+380	0.67	0.79	0.12	1.83	1.68	-0.15
	2+400	0.71	0.78	0.07	1.65	1.48	-0.17
	2+420	0.70	0.72	0.02	1.76	1.69	-0.07
	2+450	0.74	0.74	0.00	2.33	2.34	0.01
Mean Monthly April	2+300	0.49	0.49	0.00	0.66	0.66	0.00
	2+320	0.40	0.39	-0.01	0.89	0.96	0.07
	2+340	0.34	0.35	0.01	0.82	0.91	0.09
	2+360	0.34	0.37	0.03	0.82	1.05	0.23
	2+380	0.36	0.42	0.06	1.16	1.05	-0.11
	2+400	0.39	0.40	0.01	0.96	0.92	-0.04
	2+420	0.38	0.38	0.00	1.06	1.07	0.01
	2+450	0.41	0.41	0.00	1.22	1.21	-0.01
Mean Monthly May	2+300	0.30	0.30	0.00	0.44	0.44	0.00
	2+320	0.21	0.20	-0.01	0.53	0.56	0.03
	2+340	0.16	0.17	0.01	0.50	0.56	0.06
	2+360	0.18	0.20	0.02	0.48	0.61	0.13
	2+380	0.20	0.24	0.04	0.71	0.63	-0.08
	2+400	0.22	0.21	-0.01	0.60	0.61	0.01
	2+420	0.22	0.22	0.00	0.65	0.64	-0.01
	2+450	0.21	0.21	0.00	0.64	0.64	0.00

**Reference: Fitzroy Harbour Community Centre Slope Stability Study
Hydraulic Assessment of Recommended Solution**

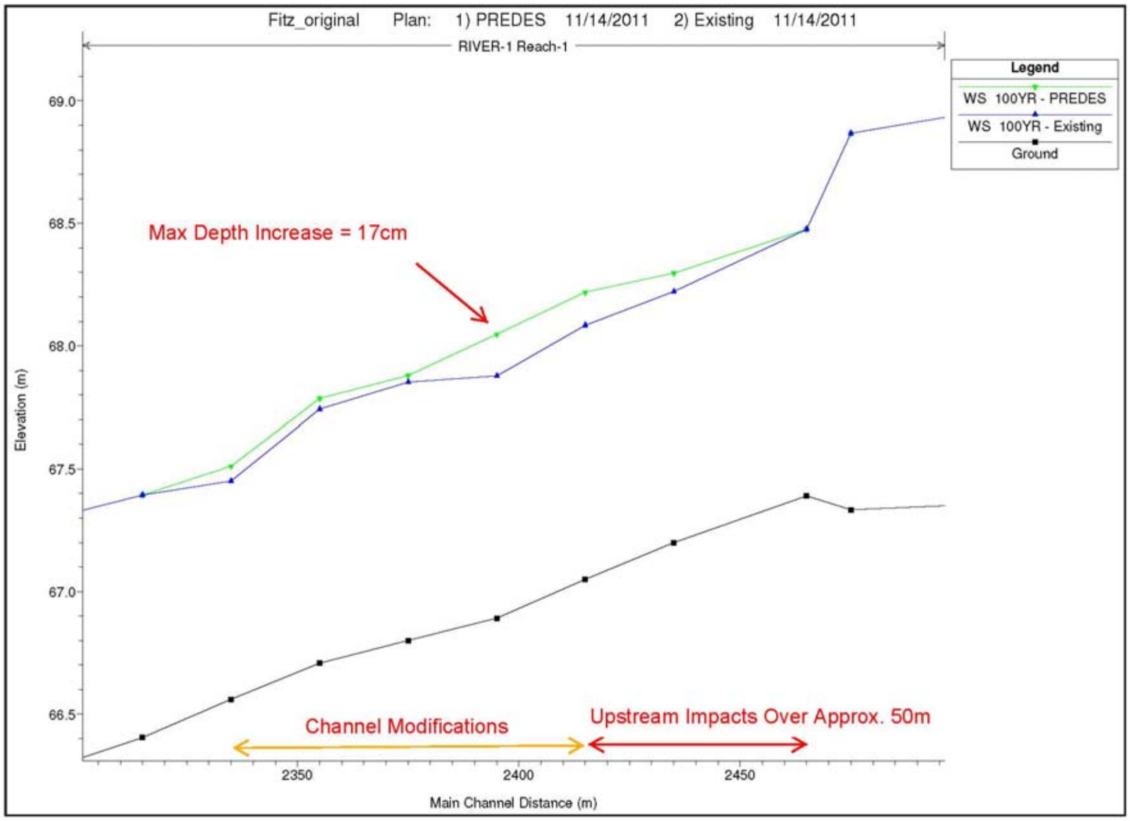

Figure 1. Results - Hydraulic Grade Line Comparison.

Figure 3 illustrates the outline, in plan, of the estimated flood levels for the existing and proposed works under mean monthly discharge for the month of April.

**Reference: Fitzroy Harbour Community Centre Slope Stability Study
Hydraulic Assessment of Recommended Solution**

The model results show that the suggested modifications to the channel can be implemented with minimal impacts to the flow characteristics of the Carp River.

STANTEC CONSULTING LTD.

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Water Resources Engineer, Water
Marc.Telmosse@stantec.com

Attachment:

c. D'Aoust, Stephane

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Consultants

Legend

MEAN MONTHLY WATER LEVEL – APRIL
EXISTING
PROPOSED

Notes

Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

File Name:	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

City of Ottawa

FITZROY HARBOUR
SLOPE STABILITY

Ottawa ON Canada

Title

PLAN VIEW
MEAN MONTHLY WATER LEVEL-
APRIL

Project No.
163401089

Scale 0 5 15 25m

Figure No. 3

Sheet of

Revision 0

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2011/12/22 3:03 PM By: Nichol, James

ORIGINAL SHEET – ISO A1

APPENDIX F
Opinion of Probable Costs

Fitzroy Harbour Community Centre Slope Stability Study
Opinion of Probable Costs - Preferred Alternative

Item #	Description	Unit of Payment	Estimated Quantity	Unit Price	Total
1.00	**GENERAL REQUUIREMENTS (DIVISION 1)**				
1.01	Mobilization and demobilization at the job site of site office, equipment, conveniences, other temporary facilities and other items not required to form part of the permanent works	LS	1	$ 5,000.00	$ 5,000.00
1.02	Erosion and Sediment Control	LS	1	$ 5,000.00	$ 5,000.00
1.03	Preservation and Protection	LS	1	$ 1,500.00	$ 1,500.00
1.04	Lump Sum for Other Requirements in Division 1	LS	1	$ 2,000.00	$ 2,000.00
	SUBTOTAL FOR DIVISION 1				*$ 13,500.00*
2.00	**SITE WORK (DIVISION 2)**				
2.01	02072 - Geotextile	m^2	525	$ 10.00	$ 5,250.00
2.02	02222 – Demolition and Removal (Chain link fence)	LS	1	$ 250.00	$ 250.00
2.03	02231 – Clearing and Grubbing	LS	1	$ 2,500.00	$ 2,500.00
2.04	02250 – Compaction control	LS	1	$ 1,000.00	$ 1,000.00
2.05	02300 – Imported fill & Site grading	m^3	2500	$ 30.00	$ 75,000.00
2.06	02371 - Rip-rap Treatment	m^3	315	$ 200.00	$ 63,000.00
2.07	Reforestation Bed Area A - Deciduous Shrubs	ea.	250	$ 15.00	$ 3,750.00
2.08	Reforestation Bed Area B - Conifers	ea.	200	$ 20.00	$ 4,000.00
2.09	Reforestation Bed Area C - Deciduous Shrubs	ea.	400	$ 15.00	$ 6,000.00
2.10	Deciduous Trees - 70mm DBH	ea.	10	$ 600.00	$ 6,000.00
2.11	Coniferous Trees - 2.4m ht	ea.	25	$ 500.00	$ 12,500.00
2.12	Erosion Control Blanket or Coir Fabric	m^2	500	$ 5.00	$ 2,500.00
2.13	Seed + Mulch	m^2	1000	$ 5.00	$ 5,000.00
2.14	02922 - Naturalized Wetland Seed Mix	m^2	250	$ 6.00	$ 1,500.00
2.15	02821 - Galvanized chain link fence post	lm	1	$ 150.00	$ 150.00
2.16	02934 - Brush layering	m^2	100	$ 55.00	$ 5,500.00
2.17	Lump Sum for Other Requirements in Division 2	LS	1	$ 1,500.00	$ 1,500.00
	SUBTOTAL FOR DIVISION 2				*$ 195,400.00*
3.00	**CONCRETE (DIVISION 3)**				
3.01	Lump Sum for all requirements in Division 3	LS	1	$ 250.00	$ 250.00
	SUBTOTAL FOR DIVISION 3				*$ 250.00*
4.00	***BONDS, INSURANCE AND CONTINGENCY***				
4.01	Cost of 100% Performance & 100% of Labour and Material Payment Bonds	LS	1	$ 1,500.00	$ 1,500.00
4.02	INSURANCE	LS	1	$ 500.00	$ 500.00
4.03	CONTINGENCY ALLOWANCE	LS	1	$ 45,000.00	$ 45,000.00
	SUBTOTAL FOR BONDS, INSURANCE AND CONTINGENCY				*$ 47,000.00*
5.00	**TOTAL COST (Items 1.0 to 4.0, Rounded, Excl. H.S.T.)**				**$ 256,000.00**