APPENDIX A

Flood Photos During Hurricane Igor

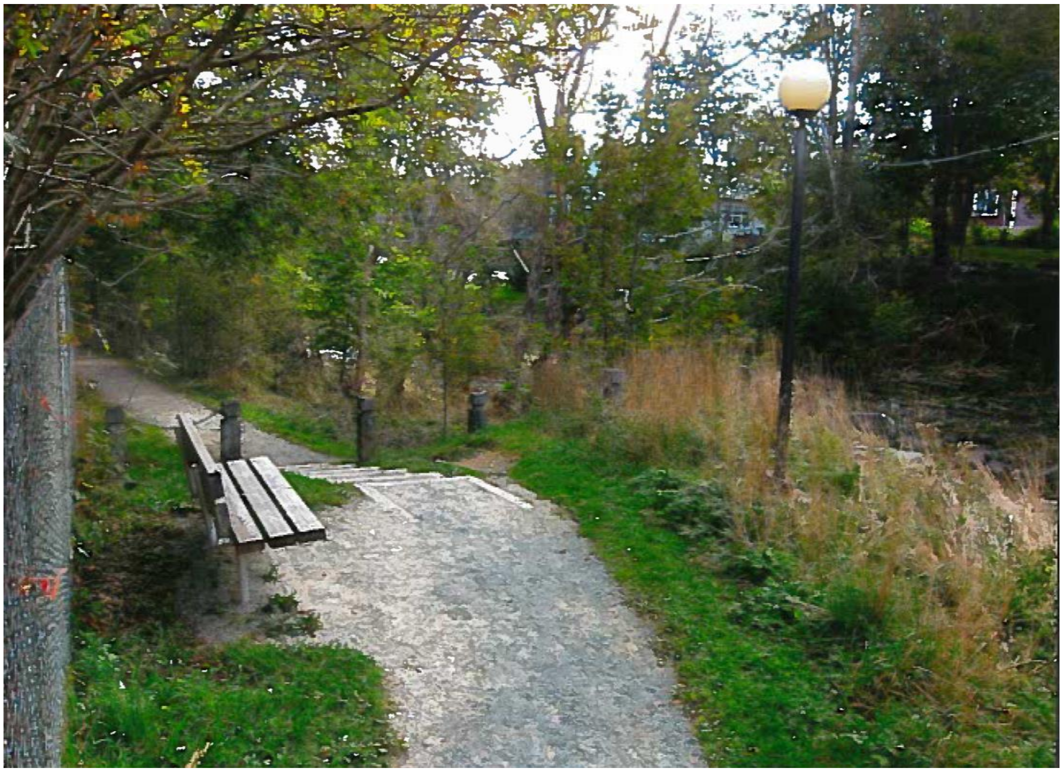


Photo 1: View of Rennies River From Rear of Pringle Place Property

Photo 2: Same View as Photo 1 During Hurricane Igor

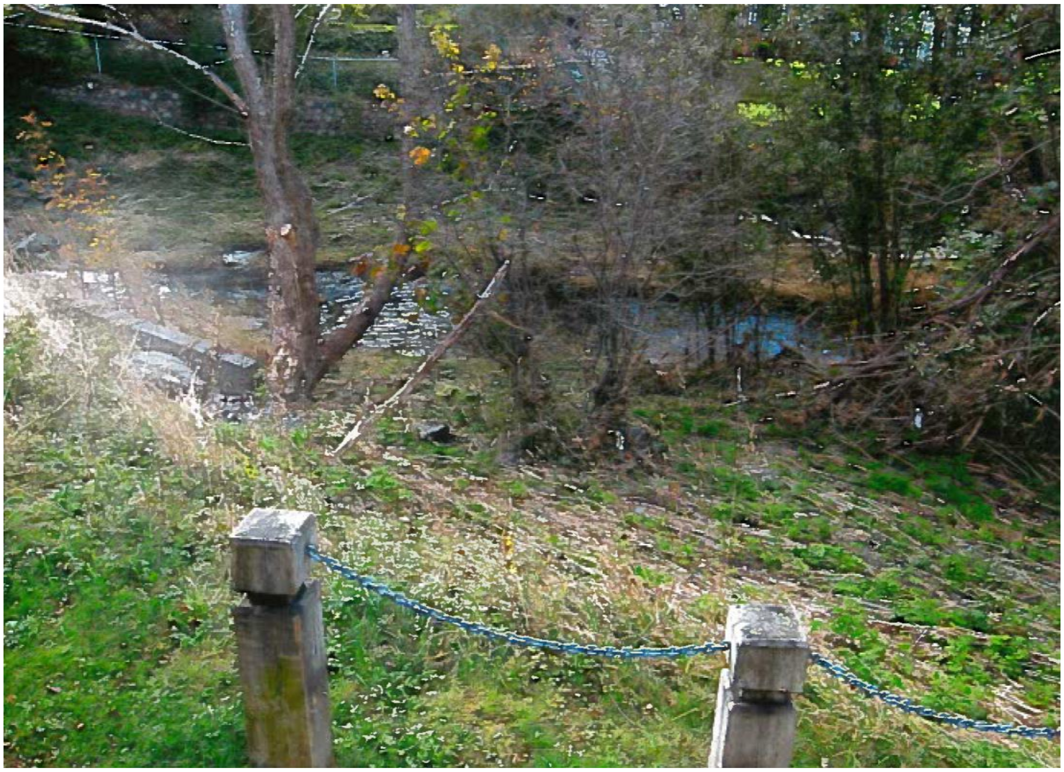


Photo 3: View across Rennies River Taken From Walking Trail

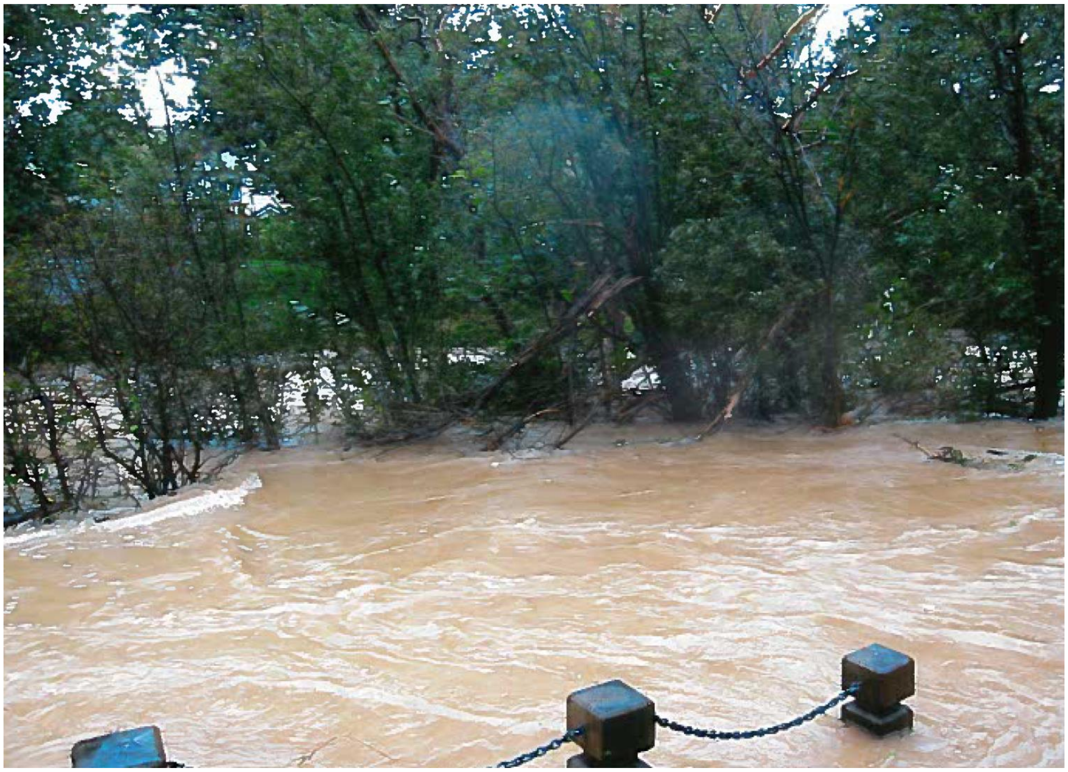


Photo 4: Same View as Photo 3 During Hurricane Igor
Note: Normal route of river is behind the treeline.

Photo 5: Trail Looking West
Note the location of the guy wires.

Photo 6: Same View as Photo 5 During Hurricane Igor

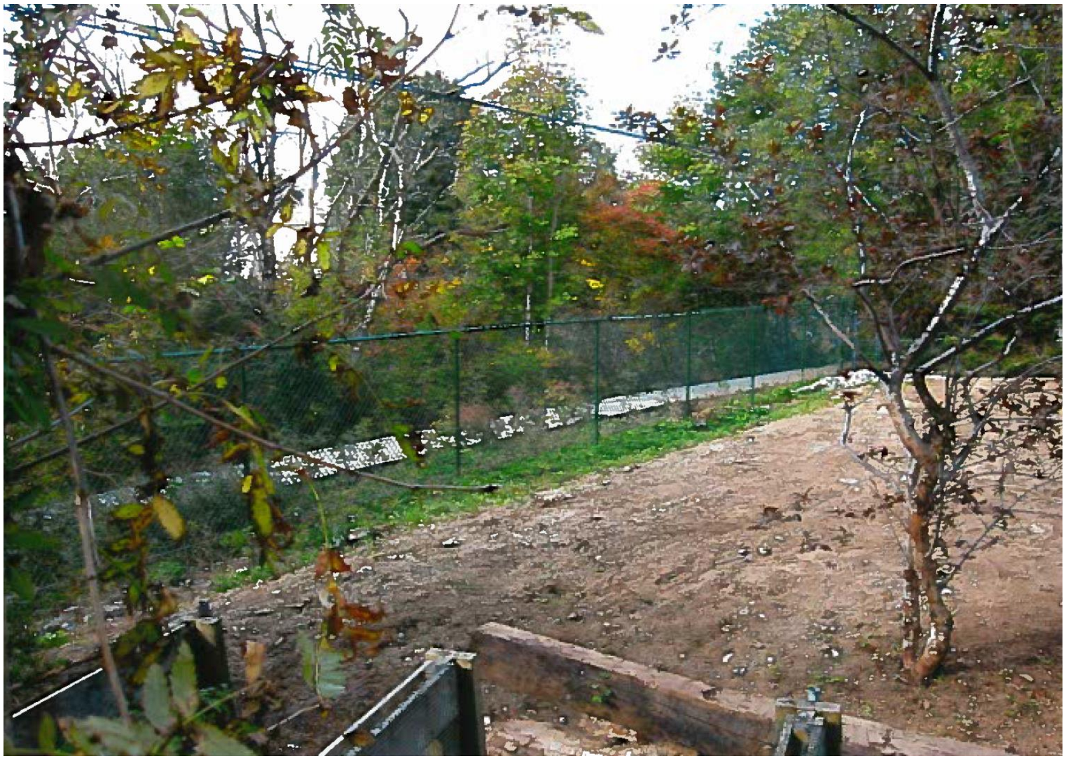


Photo 7: Rear of Property on Pringle Place
Note the location of the fence.

Photo 8: Same View as Photo 7 During Hurricane Igor

APPENDIX B

Comparison of Pre- and Post-Weir Construction Floodplain Maps

ST. JOHN'S
NEWFOUNDLAND AND LABRADOR, CANADA

Model Calibration
Igor

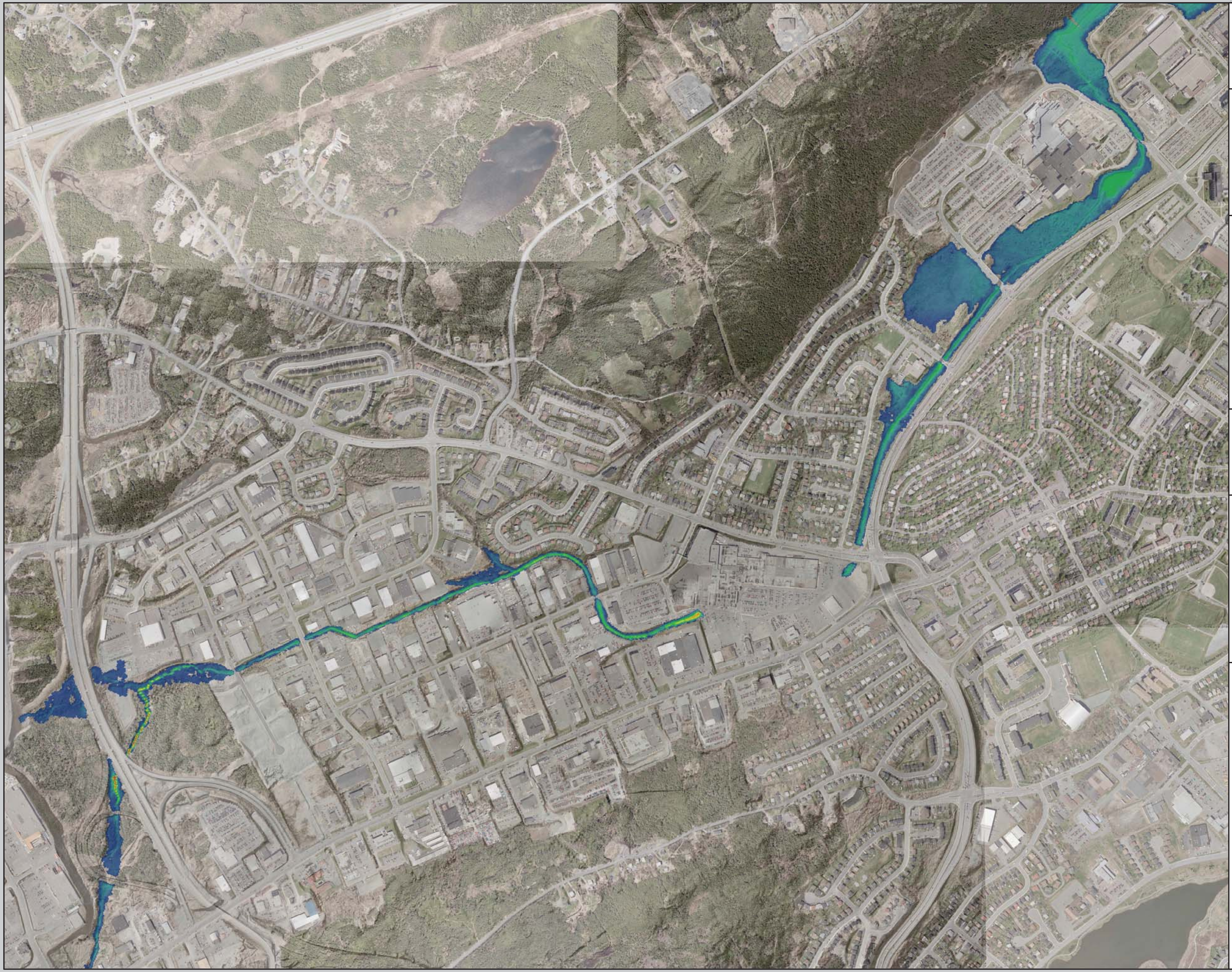
Rennies River Catchment
Stormwater Management Study

Water Depth (m)
High : 9
Low : 0

Map 2

CBCL LIMITED
Consulting Engineers

Coordinate System:
NAD_1983_MTM_1
Units:Metre
Scale:1:10,000



ST. JOHN'S
NEWFOUNDLAND AND LABRADOR, CANADA

Flood Control Measures
1:100 AEP Floodplain

Rennies River Catchment
Stormwater Management Study

Water Depth (m)
High : 9
Low : 0

Map 2

CBCL
CBCL LIMITED
Consulting Engineers

Coordinate System:
NAD_1983_MTM_1
Units:Metre
Scale:1:10,000

APPENDIX C

Environmental Preview Report Guidelines and Clarifications

GUIDELINES

for an

Environmental Preview Report

for the

Long Pond Weir

Honourable Dan Crummell
Minister
Department of Environment and Conservation

June 9, 2015

ENVIRONMENTAL PREVIEW REPORT GUIDELINES

The following guidelines are intended to assist the proponent, the City of St. John's, with the preparation of the Environmental Preview Report (EPR) for the proposed Long Pond Weir. The EPR is a report that presents the results of an investigation based on readily available information that supplements the information already provided by the proponent upon registration of the undertaking. The purpose of the information in the EPR is to assist the Minister of Environment and Conservation in making a determination as to whether an Environmental Impact Statement (EIS) will be required for the proposed undertaking. The EPR is expected to be as concise as possible while presenting the comprehensive information necessary to make an informed decision.

The EPR should include and update the information provided in the original registration and focus on the information gaps identified during the government and public review of the registration. The EPR should address the information gaps in sufficient detail to enable the Minister of Environment and Conservation to make an informed decision as to the potential for significant environmental effects from the undertaking.

The contents of the EPR should be organized according to the following format:

1. NAME OF UNDERTAKING:

The undertaking should be assigned a name that clearly identifies the proposed project. The undertaking has been assigned the name, "Long Pond Weir." In every respect, the proposed weir at Long Pond will act and behave as a dam. The proposed structure meets the Canadian Dam Association (CDA) definition of a dam. If the structure fails, there will be an uncontrolled release of the water being impounded, as per the failure of a dam.

2. PROPONENT:

Name the proponent and the corporate body, if any, and state the mailing address and the E-mail address.

Name the chief executive officer if a corporate body, telephone number and E-mail address.

Name the principal contact person for purposes of environmental assessment and state the official title, mailing address, telephone number and E-mail address.

3. THE UNDERTAKING:

State the purpose/rationale/need for the Long Pond Weir Project (the Project) from the perspective of the City of St. John's.

If the proposal is in response to an established need, this should be clearly stated. Identify needs that are immediate as well as potential future needs. Identify any broader private or public sector policies, plans or programs to which the objectives of the Project contribute, i.e. the Rennies River Catchment Stormwater Management Plan, the City's Subdivision Design Manual, the City's Stormwater Detention Policy and the provincial Climate Change Action Plan 2011.

If the project has changed from the original project description, as presented in the Environmental Assessment (EA) registration document dated February 6, 2015, clearly identify the proposed change(s) and state the rationale for the change(s).

4. DESCRIPTION OF THE UNDERTAKING:

Provide complete information concerning the preferred choice of location, design, construction and maintenance standards. (Section 1.1)

The type of material used in the construction of the dam can have a significant impact on the design of the structure. Justification for the type of dam material must be provided, considering the expected useful life of the structure and design requirements. (section 1.1)

Classify the proposed structure as per the Canadian Dam Association (CDA) *Dam Safety Guidelines (2013)*. This classification will have bearing on the annual exceedance probability (AEP) design flood and other dam safety measures that may be required. Supporting information is required to justify the dam classification. 4.0 Weir Classification

Undertake a sensitivity analysis of the flow of the Rennie's River catchment using the 100 yr Climate Change AEP flow plus 30 per cent, which is the province's standard sensitivity range for flood risk studies. Find the flow which ensures that a minimum elevation difference of 1.45 m is always maintained between the water level in Long Pond and the entrance to the Health Science Centre (HSC) Utility Tunnel located at Clinch Crescent East (57.15 m elevation). This will be the limiting flow. The elevation gradient of 1.45m is the difference between the elevation at the entrance to the HSC Utility Tunnel and the projected peak water level in Long Pond during the 1:100 AEP flow. section 3.2 & Sect 3.3

Design the dam to ensure that water levels in Long Pond do not exceed those associated with the limiting flow. Any flows that would reduce the elevation gradient of 1.45 m, from the water level in Long Pond to the entrance of the HSC Utility Tunnel, must pass through the dam without dam failure. sect 3.2

Design the dam to ensure that no structure impedes the flow of water through and/or above the spillway, e.g. a pedestrian walkway. sect 3.2

Install an automated real-time water level monitoring system in Long Pond, under the federal-provincial Hydrometric Agreement, and describe an Alert Plan that will be implemented by the City to inform property owners including the Health Sciences Centre, Memorial University of Newfoundland, the Elaine Dobbin Centre, the Pippy Park Commission and private property owners of increasing water levels in Long Pond. The Water Resources Management Division of the Department of Environment and Conservation can provide details on establishing the water level monitoring station under the Hydrometric Agreement.

section 7.1

If the design of the dam cannot meet the flood annual exceedance probability recommendations of the CDA *Dam Safety Guidelines (2013)* based on the identified dam classification, acknowledge this fact and implement a more extensive dam safety risk management approach as outlined in Section 6.

section 4

Given that the proposed project will be sensitive to climate and weather, particularly extreme precipitation events and ice damage, mitigative measures should be factored into the design to ensure that the risk of infrastructure and environmental damage and other accidents is minimized. Climate data, historical data, local area knowledge and increasing ranges of weather events should be taken into account in determining the adequacy of the structural design.

section 5 and 3.3

4.1 Geographical Location/Physical Components/Existing Environment

Provide an accurate physical description of the dam, including the location, composition, width, length, height and slopes associated with the structure. Provide illustrations and/or drawings of the proposed structure clearly indicating the above-noted dimensions.

section 2

Provide hydro technical and geotechnical analysis for the dam as appropriate including freeboard analysis, stage-discharge analysis, slope stability analysis and spillway erosion analysis etc., for the dam as per the CDA Dam Safety Guidelines (2013).

sections 3.4 and 5

Ensure that the spillway capacity of the structure is adequate to the design flood AEP and/or water limitation in Long Pond.

section 3.2

Submit an elevation profile of the land surrounding Long Pond, extending southwest to the Clinch Crescent West Bridge, both pre and post dam construction.

section 2

Using sensitivity analysis and various AEP flows, including the 1:5, 1:20, 1:50, 1:100 AEP and 1:100yr Climate Change AEP flow plus 30 per cent, clearly identify adjacent land uses, structures, wetlands, public and private property that may be impacted by increased water levels during precipitation events, both pre and post dam construction.

section 3.3

Provide information regarding ownership and/or zoning of the land upon

section 2

which the Project is to be located and any restrictions imposed by that ownership or zoning, i.e. the Pippy Park Commission.

4.2 Construction:

State the total project construction period (if staged, list each stage and its approximate duration) and proposed date of first physical construction-related activity.

sec 6.1

Provide details, materials, methods, schedule, and location of all planned construction activities.

sec 6.2

Provide details on site construction methods including the operation of a cofferdam and the management of flow during construction.

sec 6.2/
sec6.3

Identify the construction design flow that will be implemented to manage the risk of construction site inundation during the work period.

sec 6.3

Describe the potential sources of pollutants during the construction period(s) including soil erosion, sedimentation and siltation. All available construction materials should be considered including pre-cast concrete, corrosive resistant steel, and those materials best suited to the conditions and intended use of the structure. Selection of the preferred construction material should include a consideration of the full life-cycle of the material (ease of use, design factors associated with the construction material and maintenance requirements). Environmental implications (i.e. storm and ice damage) should also be considered.

sec 6.4/
sec 6.2

Describe measures that will be undertaken to ensure that activities associated with the construction of the Long Pond dam are conducted in compliance with the *Occupational Health and Safety Act, O.C. 2012-005* and its Regulations. This includes the responsibility for ensuring that contractors hired to perform work also comply with this legislation, as per *OHS Act s.10.*

sec 6.5

Identify potential causes of resource conflicts during the construction phase(s) including temporary disruption of vehicular and pedestrian traffic and disruption of fish habitat.

sec 6.6

4.3 Operation and Maintenance:

All aspects of the operation of the proposed Long Pond dam shall be presented in detail.

sect 7-

Predict the duration of water retention in Long Pond after the dam is constructed for the following return period flows: 1:5, 1:20, 1:50, 1:100 AEP and 1:100yr Climate change AEP flow plus 30 per cent.

sec7.2

Describe the potential effects the increased water levels will have on property adjacent to Long Pond, including the HSC, the Elaine Dobbin Centre, Memorial University of Newfoundland, the East Coast/Pippy Park Walking Trail and associated structures, as well as wetlands around the perimeter of Long Pond.

Describe how the dam will be operated to ensure that a minimum 1.45 m elevation gradient is maintained between the maximum water level in Long Pond (as per the 1:100yr Climate change AEP flow plus 30 per cent) and the entrance to the HSC Utility Tunnel at Clinch Crescent East. sect 3.5

5. ALTERNATIVES

The EPR must identify and describe alternative means for carrying out the Project that are technically and economically feasible, to meet the stated purpose and rationale. The following steps for addressing alternatives are recommended:

sect 8
all of it

- Identify alternative means, designs and locations to carry out the Project, and provide reasons for the rejection of alternatives;
- Describe the advantages and disadvantages of constructing the dam using earthen materials versus using concrete and demonstrate the rationale for the selected material of construction;
- Explain why the installation of a dam at the outlet of Long Pond was selected as the first priority amongst a number of flood protection improvements that were recommended as part of a related study, the *Rennies River Catchment Stormwater Management Plan;*
- Explain why earth berms and concrete walls, recommended in the above-noted study, are not being constructed in the vicinity of Clinch Crescent East to Clinch Crescent West prior to the installation of the dam to manage potential backwater effects;
- Explain why a fixed flow control structure is preferred, as opposed to a structure with operable parts that may be used to manage the release of water out of Long Pond.

6. POTENTIAL ENVIRONMENTAL EFFECTS and MITIGATION:

Provide detailed information regarding the potential effects of the proposed Project on the environment and details of proposed mitigations.

The following dam risk management measures should be included in the EPR:

- Dam break analysis and flood inundation mapping downstream of the dam; sect 3.4
- An Emergency Preparedness and Response Plan (EPRP), including plans for public notification of residents downstream of the dam;
- A dam Operation, Maintenance and Surveillance Manual (OMS Manual); sect 7.5
- An inspection program including inspection form, frequency and procedures for corrective action; sect 7.6

section 9 the four points below

- A Dam Safety Review (DSR) schedule;
- A testing schedule for the EPRP;
- A self-assessment tool for the City to assess its state of readiness in the event of dam failure;
- Complete Hazard Identification and Risk Assessment (HIRA) covering dam safety emergencies.

Criteria for completion of the above-noted measures are described in the CDA Dam Safety Guidelines (2013) and Associated Bulletins.

Provide a contingency plan for flow control equipment and/or structure failure during the construction phase(s).

Using sensitivity analysis for various AEP flows, including the 1:5, 1:20, 1:50, 1:100 yr and 1:100yr Climate Change AEP flow plus 30 per cent, identify mitigative measures that will be implemented prior to dam construction to protect adjacent land uses, structures, wetlands, public and private property that may be impacted by increased water levels during precipitation events after the dam is installed. sect 9.1

Describe measures that will be undertaken to ensure that a zero net run-off policy will be maintained for all future development in the Rennie's River watershed. N/A

Describe methods that will be used to prevent discharges from project work involving concrete, cement, mortars and other lime-containing construction materials from entering the aquatic environment. 6.4

Provide information on erosion prevention and drainage control measures, such as filter fabrics, sediment traps and/or settling ponds that will be installed prior to any land disturbance, to minimize the effects of dam construction and operation on fish and migratory birds and their habitat. Describe regular monitoring and repair activities that will be undertaken to ensure the continued effectiveness of such control devices. 6.4

The Department of Fisheries and Oceans Canada (DFO) has conducted an independent assessment of the Project. The EPR shall describe measures that will be undertaken to uphold the conditions, requirements and recommendations given by DFO to protect fish habitat and facilitate fish passage during construction and operation of the weir. 6.4/7.7

Explain methods that will be used to avoid or minimize the impacts of the Project on wetlands. 6.4

Provide information on best practices that will be undertaken with regard to fuelling and servicing equipment, using biodegradable fluids, fuel spills and environmental emergency plans to protect fish, migratory birds and their habitats. 6.4

Define plans to ensure that a quick and effective response to a spill event is possible, and that spill response equipment is readily available on-site. Response equipment, such as absorbents and open-ended barrels for collection of clean-up debris, should be stored in an accessible location on-site. Personnel working on the project should be knowledgeable about response procedures. Develop, test and implement an environmental emergency contingency plan which includes information regarding the location of on-site spill response equipment and a trained contractor, in the event of a spill. sect 6.5

Describe strategies and best available control technologies that will be used to minimize the project's impact on climate change with respect to greenhouse gas emissions, i.e. indicate plans to operate all heavy equipment used during construction in a manner that will maximize fuel efficiency, thereby reducing greenhouse gas emissions that could contribute to climate change issues. sect 6.4

Identify methods that will be used to minimize interference with vehicular and pedestrian traffic during construction and maintenance of the dam; sect 6.6

Indicate measures that will be undertaken to resolve potential land use conflicts with the Pippy Park Commission during construction and operation and the dam. N/A

7. PROJECT- RELATED DOCUMENTS:

Provide a bibliography of all project-related documents already generated by or for the proponent (i.e. the *Rennies River Catchment Stormwater Management Plan*, the *Regional Stormwater Detention Feasibility Study*, *Ken Brook and Leary's Brook Floodplain Delineation Study*, *Report on Proposed Weir Structure–Long Pond St. John's NL*, and the *Report on Fish Passage at the Proposed Long Pond Weir*). Provide access to information contained in previous studies specific to this project, i.e. web links.

8. APPROVAL OF THE UNDERTAKING:

List the main permits, licences, approvals, and other forms of authorization required for the undertaking, together with the names of the authorities responsible for issuing them (e.g., federal government departments, provincial government departments, municipal councils, etc.).

Water Resources Management Division advises that the proponent must apply for and obtain a permit under the *Water Resources Act*, 2002, specifically Section 48 http://assembly.nl.ca/Legislation/sr/statutes/w04-01.htm for any work in any body of water (including wetland) prior to the start of construction. It should be pointed out that more than one permit may be required in relation to this Project within Long Pond and its watershed area.

The Department of Fisheries and Oceans Canada (DFO) has assessed this project and has given approval subject to conditions. The conditions outlined by DFO for this project must be adhered to by the City of St. John's.

9. PUBLIC INFORMATION MEETING:

An Open House Public Information Session is required to be held in a centralized location within the City of St. John's to present the information gathered to fulfill the requirements of Section 5 of these guidelines. You are required to notify the Minister and the public of the scheduled meeting not fewer than 7 days before that meeting. Public concerns should be addressed in a separate section of the EPR. Protocol for these public sessions will comply with Section 10 of the Environmental Assessment Regulations, 2003. Public notification specifications are outlined in Appendix A.

A minimum of 8 paper copies of the EPR and an electronic version for posting to the Environmental Assessment website should be forwarded, together with a covering letter, to:

Minister
Environment and Conservation
P.O. Box 8700
St. John's NL A1B 4J6
Attention: Director of Environmental Assessment

APPENDIX A

Public Notices

Under the provisions of the Environmental Assessment Regulations 2003, Section 10, and where the approved Guidelines require public information session(s), the following specified public notification requirements must be met by the proponent prior to each meeting.

Minimum information content of public advertisement - (Proponent to substitute appropriate information for italicized items):

PUBLIC NOTICE

Public Information Session on the Proposed

Name of undertaking
Location of undertaking

shall be held at
Date and Time
Location

This session shall be conducted by the Proponent,
Proponent name and contact phone number,
as part of the environmental assessment for this Project.
The purpose of this session is to describe all aspects of the proposed Project,
to describe the activities associated with it, and to provide an opportunity for all interested
persons to request information or state their concerns.

ALL ARE WELCOME

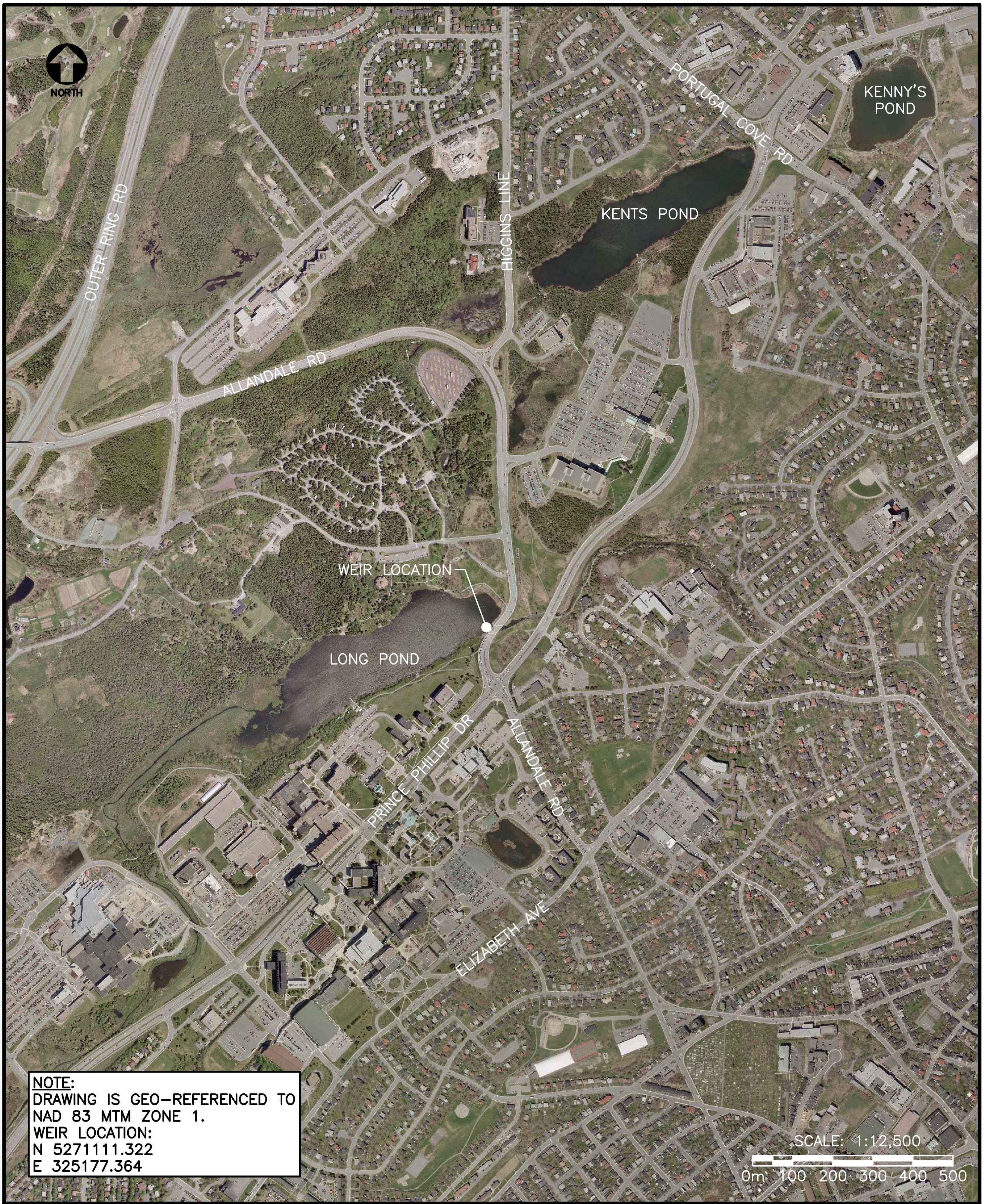
Minimum newspaper ad size: 2 column widths; Minimum posted ad size: 7" x 5"

Minimum newspaper ad coverage: Weekend preceding meeting and 3 consecutive days prior to meeting date; to be run in newspaper locally distributed within meeting area or newspaper with closest local distribution area.

Minimum posted ad coverage: Local Town or City Hall or Office, and local Post Office, within town or city where meeting is held, to be posted continually for 1 full week prior to meeting date.

APPENDIX D

Location Drawing



NOTE:
DRAWING IS GEO-REFERENCED TO
NAD 83 MTM ZONE 1.
WEIR LOCATION:
N 5271111.322
E 325177.364

CBCL LIMITED
Consulting Engineers

187 KENMOUNT ROAD
ST. JOHN'S, NL, A1B 3P9

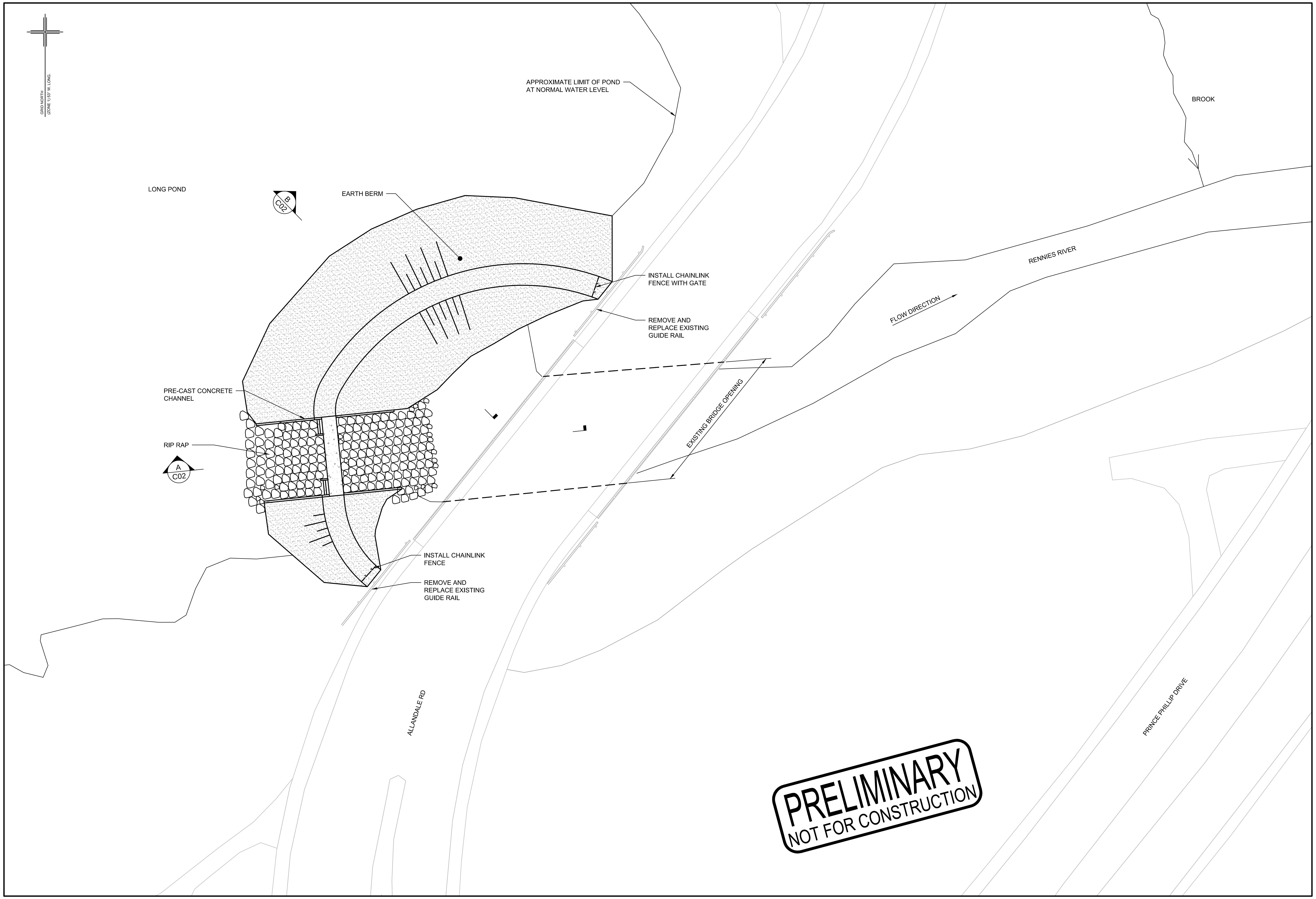
Phone: (709) 364-8623
Fax: (709) 364-8627

PROPOSED LONG POND WEIR

LOCATION PLAN

APPENDIX E

Preliminary Drawings and Control Gates Product Literature



PRELIMINARY
NOT FOR CONSTRUCTION

SITE PLAN
1:250
0 5.0 10.0 15.0 20.0 25.0m
1:250

DO NOT SCALE FROM PRINT

NOTES

1. CONTRACTOR TO VERIFY ALL DIMENSIONS PRIOR TO PROCEEDING WITH THE WORK. ALL WORK SHALL CONFORM TO THE CITY OF ST. JOHN'S SPECIFICATIONS BOOK.
2. DO NOT SCALE FROM DRAWINGS.
3. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
4. ALL SOUNDINGS AND ELEVATIONS ARE IN METRES TO NAD83.
5. GRADES AT PROJECT LIMITS TO MATCH EXISTING GRADES.
6. CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL REQUIRED PERMITS AND INSURANCES TO CARRY OUT THE WORK.
7. CONTRACTOR TO PROVIDE RED-LINED AS-BUILT DRAWINGS TO OWNER AT PROJECT COMPLETION.
8. CONTRACTOR TO SCHEDULE AND PERFORM WORK TO MITIGATE DISRUPTIONS TO DAILY OPERATIONS.
9. ALL AREAS DISTURBED DURING CONSTRUCTION TO BE REINSTATED TO THEIR ORIGINAL CONDITIONS.
10. LOCATION OF ALL EXISTING UNDERGROUND AND ABOVE GROUND UTILITIES, PIPES AND ELECTRICAL CONDUITS ARE APPROXIMATE AND ARE TO BE VERIFIED BY THE CONTRACTOR; REPORT ANY DISCREPANCIES TO OWNER'S REPRESENTATIVE BEFORE COMMENCEMENT OF WORK.
11. ALL IN-WATER WORK TO BE DONE IN THE DRY.
12. DUE TO THE NATURE OF THE IN SITU POND BOTTOM MATERIAL, THE USE OF SAND BAGS FOR COFFERDAMMING IN AREAS WHERE THE NORMAL WATER DEPTH EXCEEDS 1 METRE IS NOT PERMITTED.
13. CONTRACTOR TO STRICTLY ADHERE TO ALL FEDERAL, PROVINCIAL AND MUNICIPAL POLICIES AND REGULATIONS REGARDING ENVIRONMENTAL PROTECTION.

CONSULTANT

STAMP

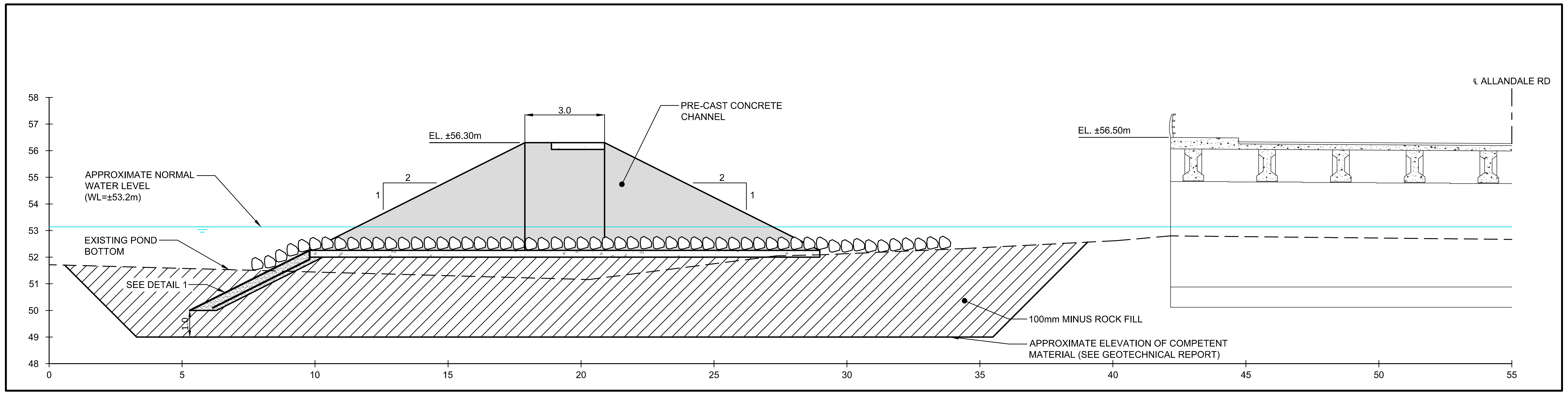
16/03/03	ISSUED FOR EPR	A
DATE	REVISION	NO.

PROJECT
CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE
SITE PLAN

AUTHORITY
ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: 1 OF -
CHECKED BY: JB
DRAWING NUMBER: C01
APPROVED BY: GS
PROJECT NUMBER: 143063.02



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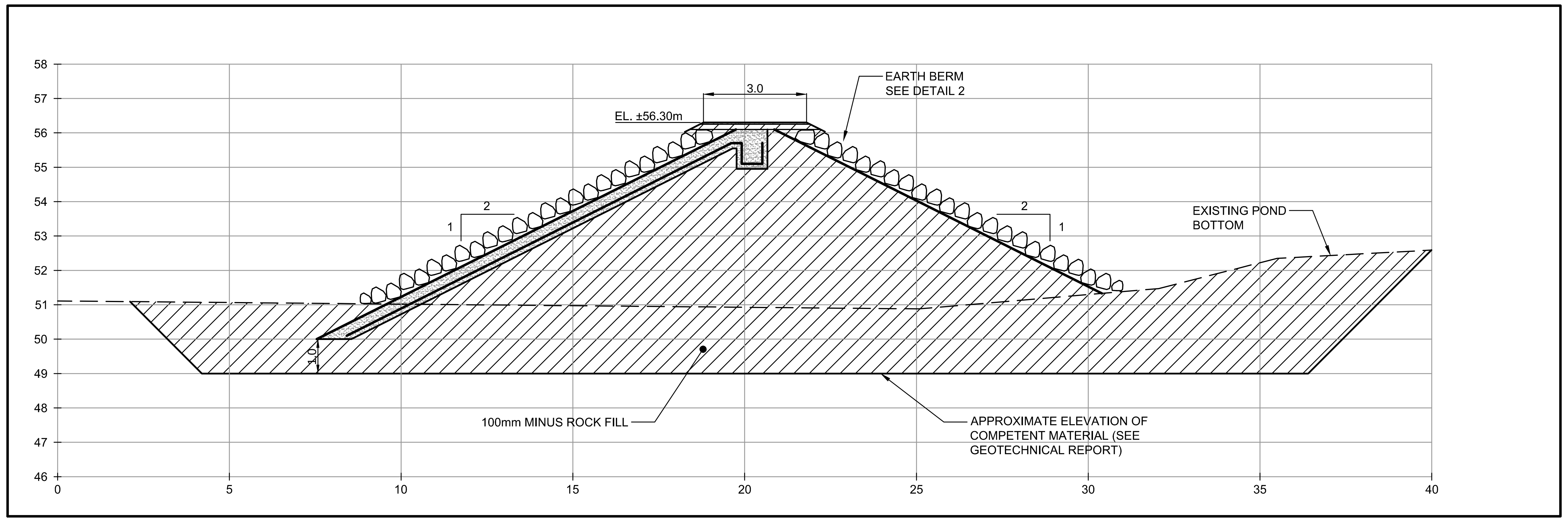
1:100



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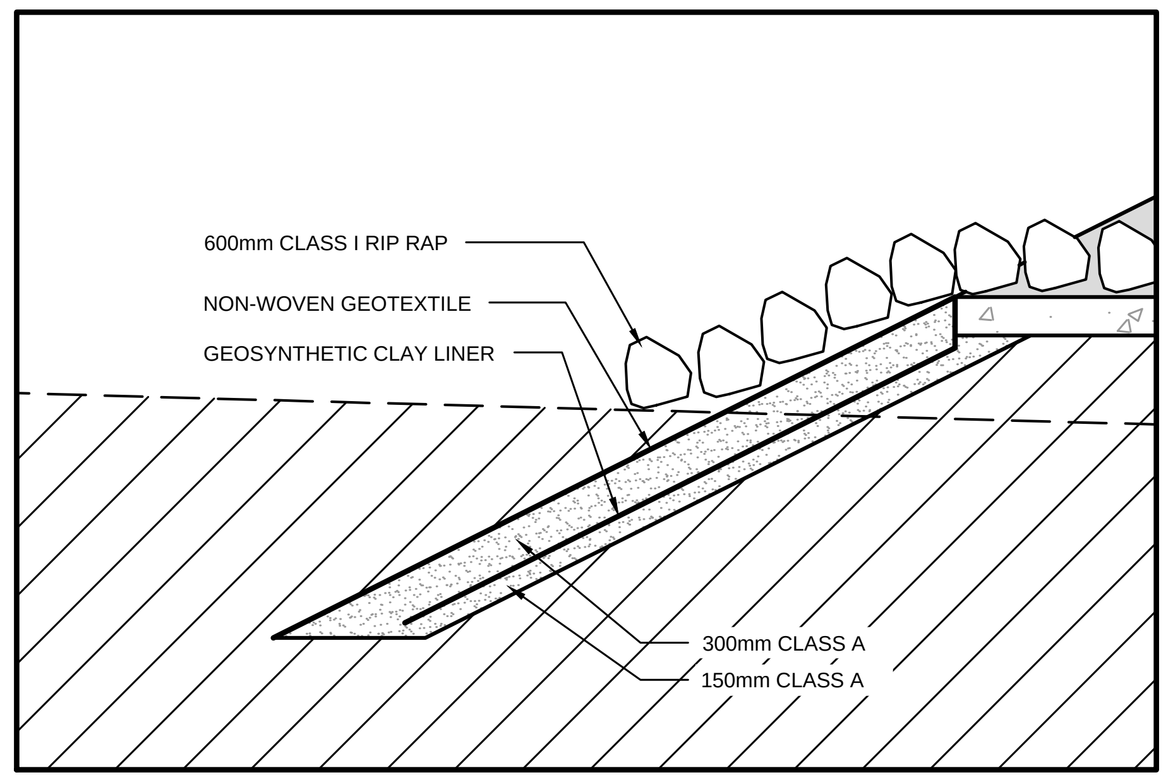
1:100



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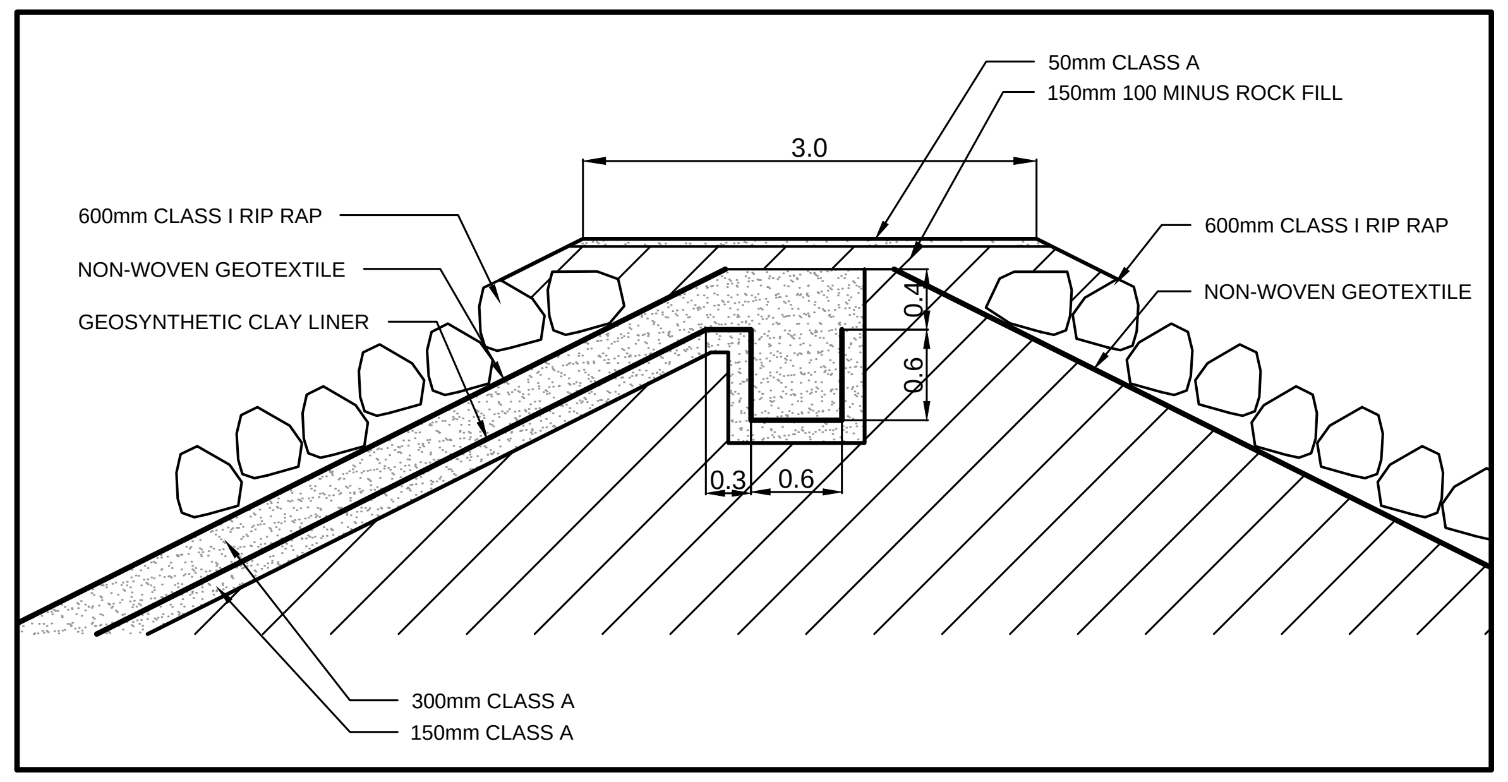

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1:50

PRELIMINARY
NOT FOR CONSTRUCTION

DO NOT SCALE FROM PRINT

NOTES

1. SEE DRAWING C01 FOR GENERAL NOTES.

CONSULTANT

STAMP

16/03/03	ISSUED FOR EPR	A
DATE	REVISION	NO.

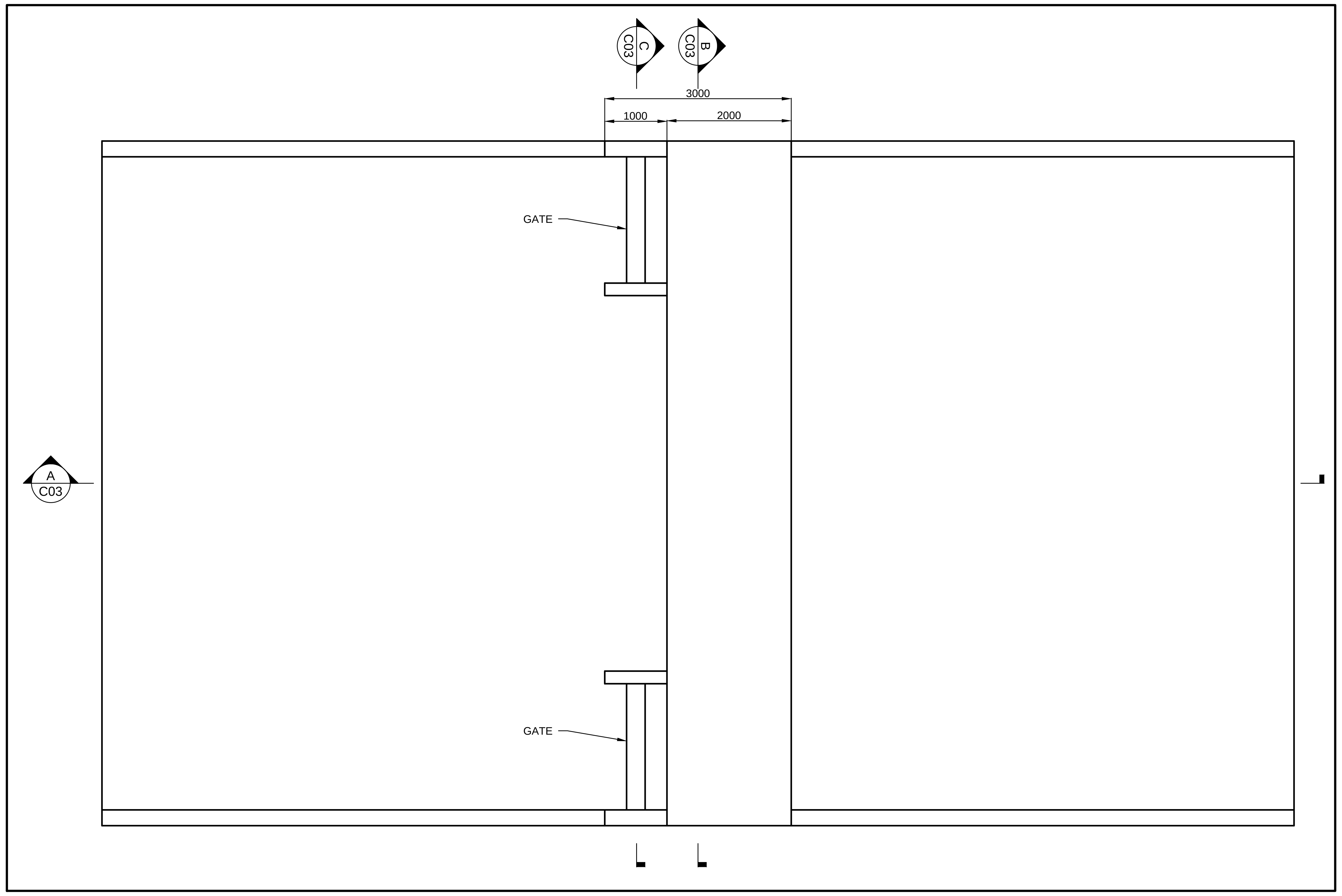
PROJECT
CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE
SECTIONS

AUTHORITY
ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: - OF -
CHECKED BY: JB
DRAWING NUMBER: C02
APPROVED BY: GS
PROJECT NUMBER: 143063.02

PRELIMINARY
NOT FOR CONSTRUCTION



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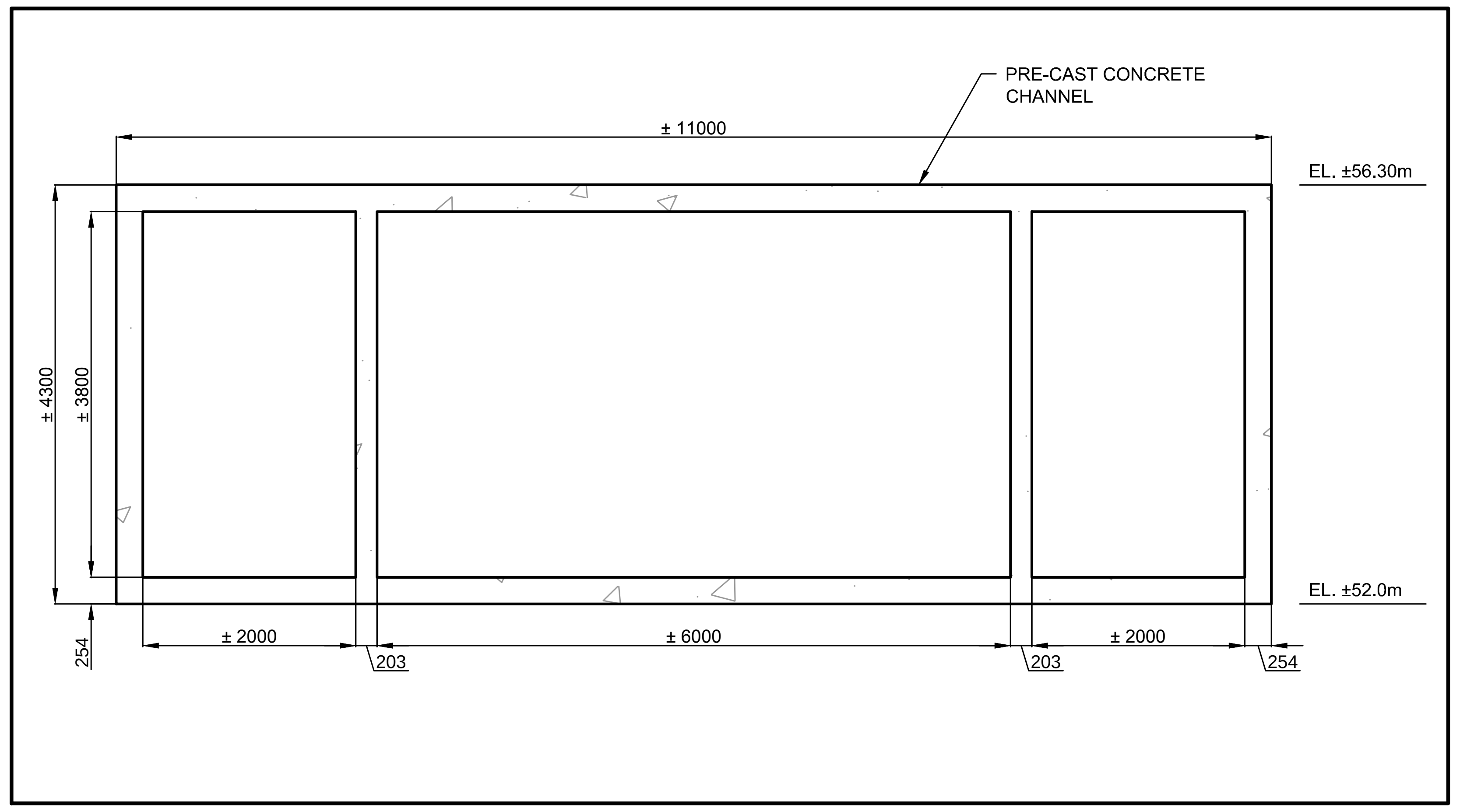

CONCRETE CHANNEL - SECTION B
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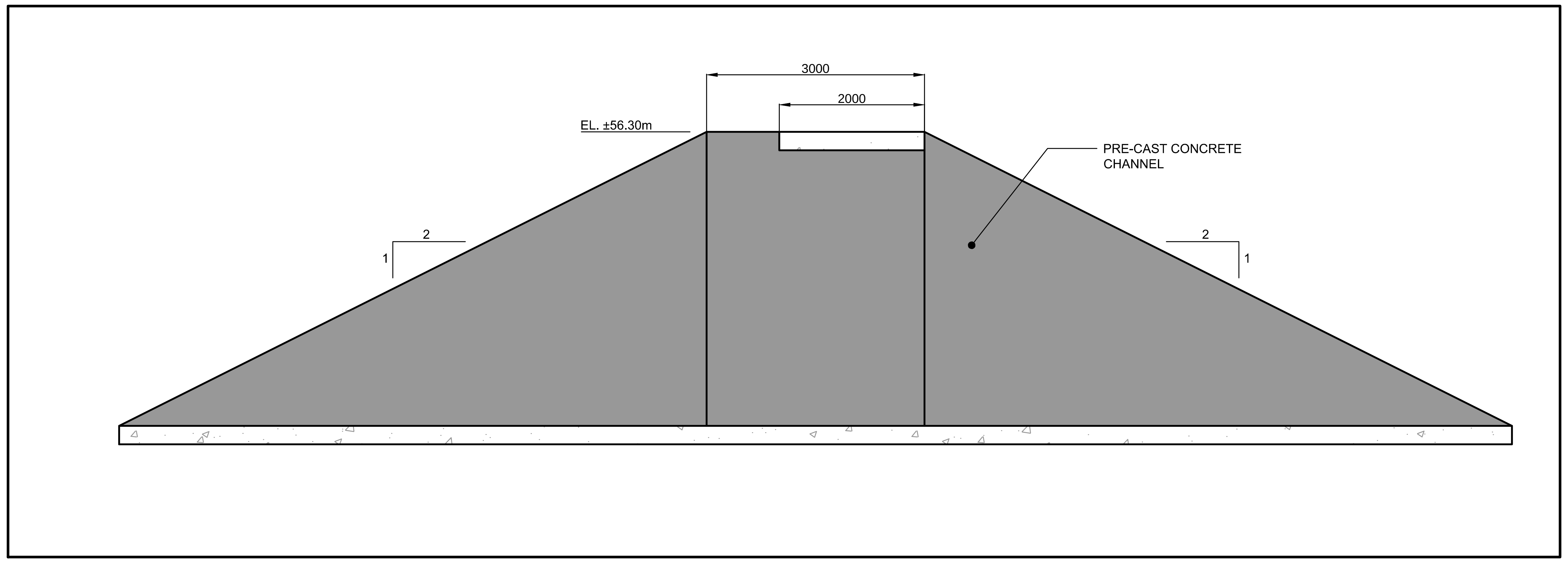
1:50



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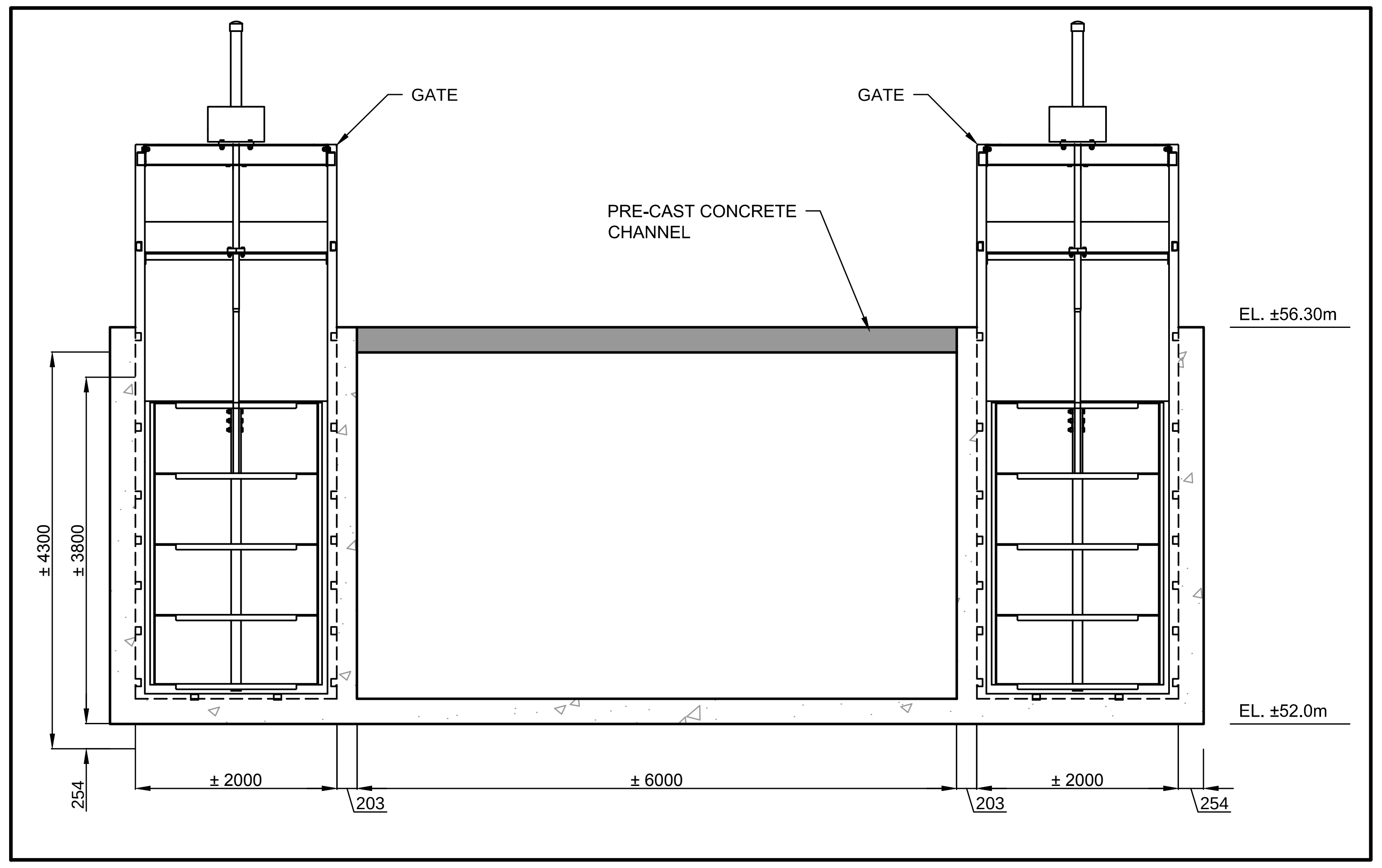

CONCRETE CHANNEL - SECTION C
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1:50

DO NOT SCALE FROM PRINT

NOTES

1. SEE DRAWING C01 FOR GENERAL NOTES.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

CONSULTANT

STAMP

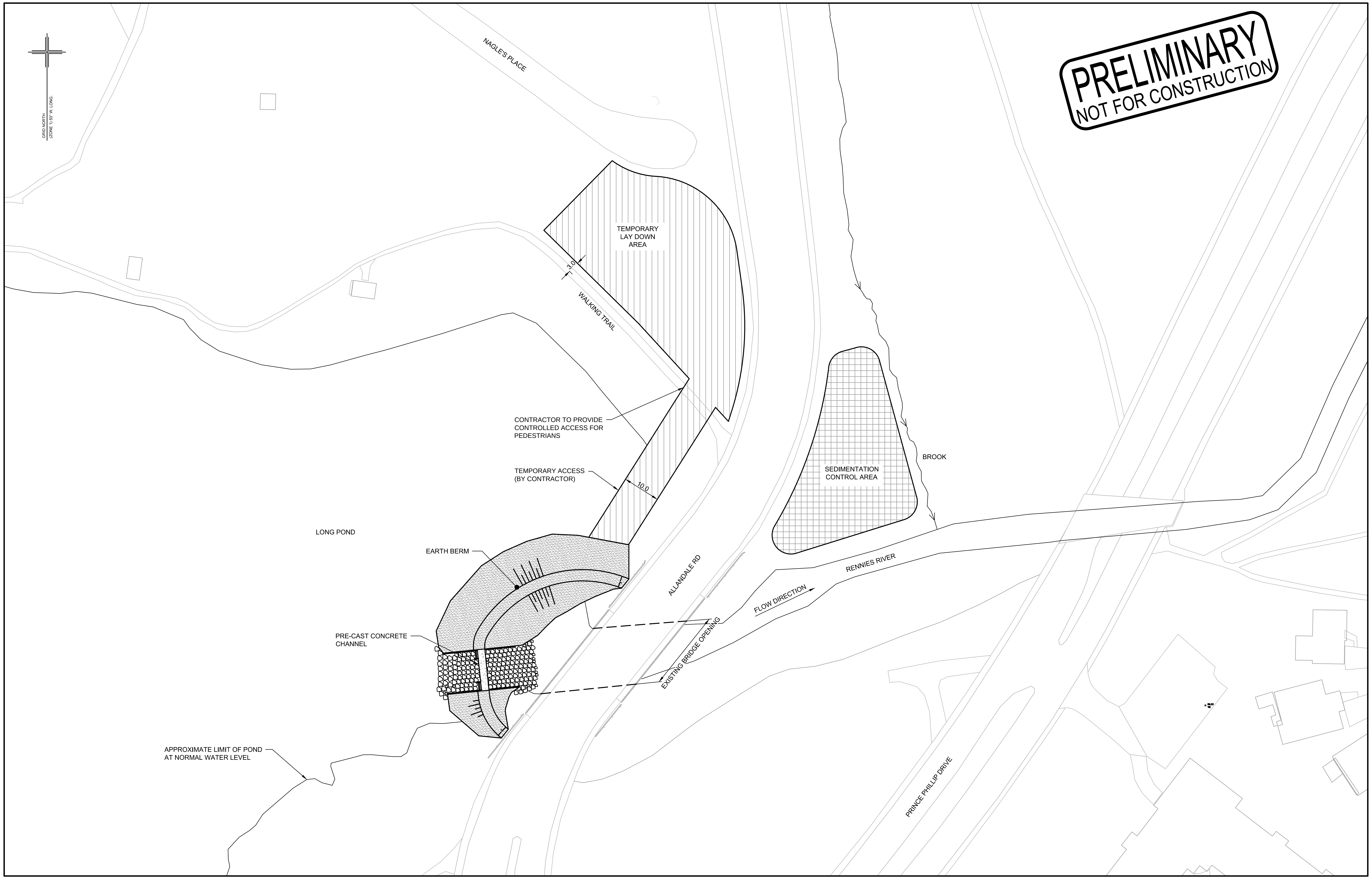
16/03/03	ISSUED FOR EPR	A
DATE	REVISION	NO.

PROJECT
CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE
DETAILS

AUTHORITY
ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: - OF -
CHECKED BY: JB
DRAWING NUMBER: C03
APPROVED BY: GS
PROJECT NUMBER: 143063.02



PRELIMINARY
NOT FOR CONSTRUCTION

PLAN
1:500

0 10.0 20.0 30.0 40.0 50.0m
1:500

DO NOT SCALE FROM PRINT

NOTES

1. CONTRACTOR TO VERIFY ALL DIMENSIONS PRIOR TO PROCEEDING WITH THE WORK. ALL WORK SHALL CONFORM TO THE CITY OF ST. JOHN'S SPECIFICATIONS BOOK.

LEGEND:

▥	TEMPORARY LAY DOWN AREAS
▦	SEDIMENTATION CONTROL AREA

CONSULTANT

STAMP

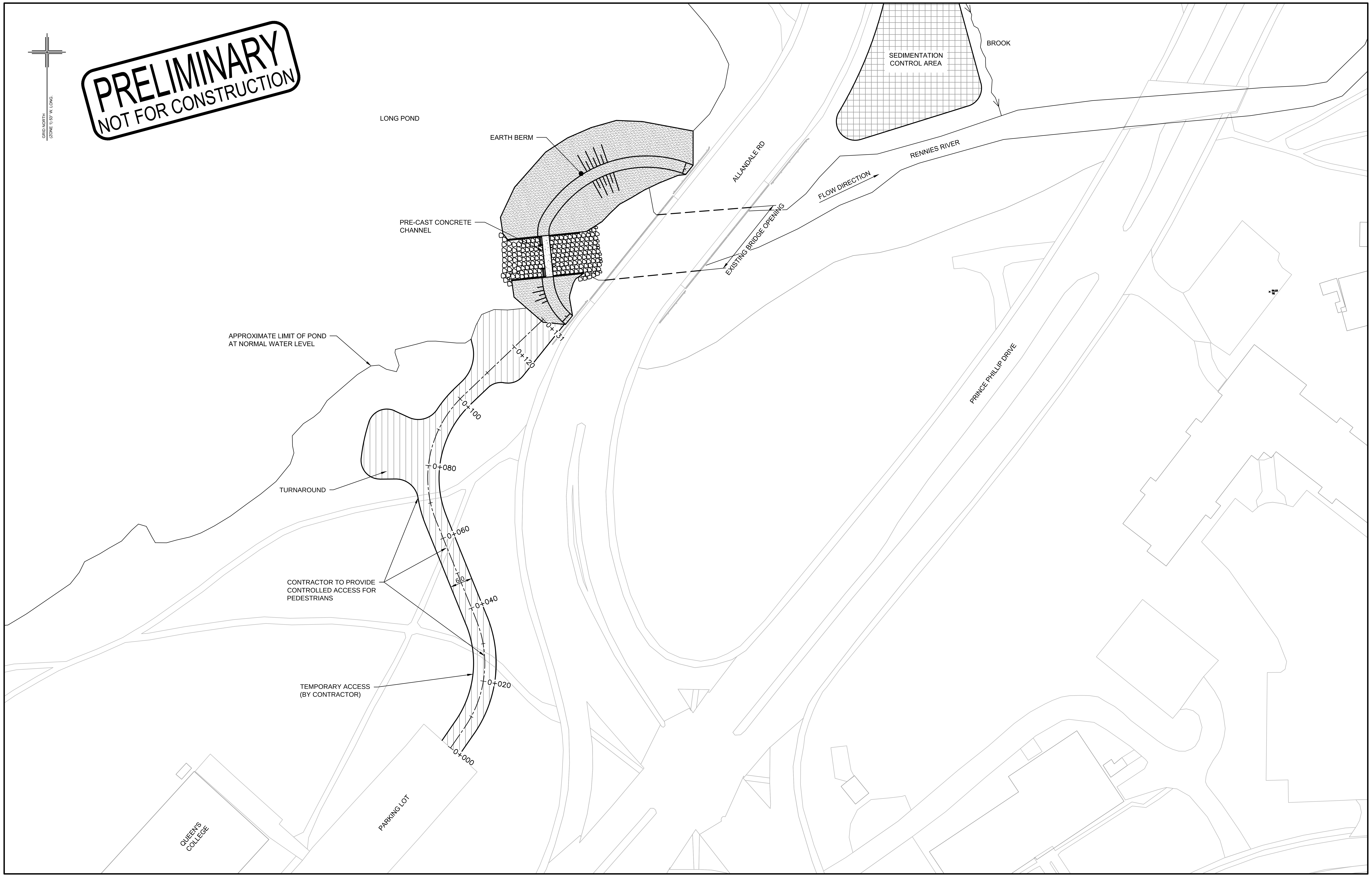
DATE	REVISION	NO.
16/03/03	ISSUED FOR EPR	A

PROJECT
CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE
SITE ACCESS 1
PLAN

AUTHORITY
ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: - OF -
CHECKED BY: JB
DRAWING NUMBER: -
APPROVED BY: GS
PROJECT NUMBER: 143063.02



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DO NOT SCALE FROM PRINT

NOTES

1. CONTRACTOR TO VERIFY ALL DIMENSIONS PRIOR TO PROCEEDING WITH THE WORK. ALL WORK SHALL CONFORM TO THE CITY OF ST. JOHN'S SPECIFICATIONS BOOK.

LEGEND:

▥	TEMPORARY LAY DOWN AREAS
▦	SEDIMENTATION CONTROL AREA

CONSULTANT

STAMP

DATE	REVISION	NO.
16/03/03	ISSUED FOR EPR	A

PROJECT

CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

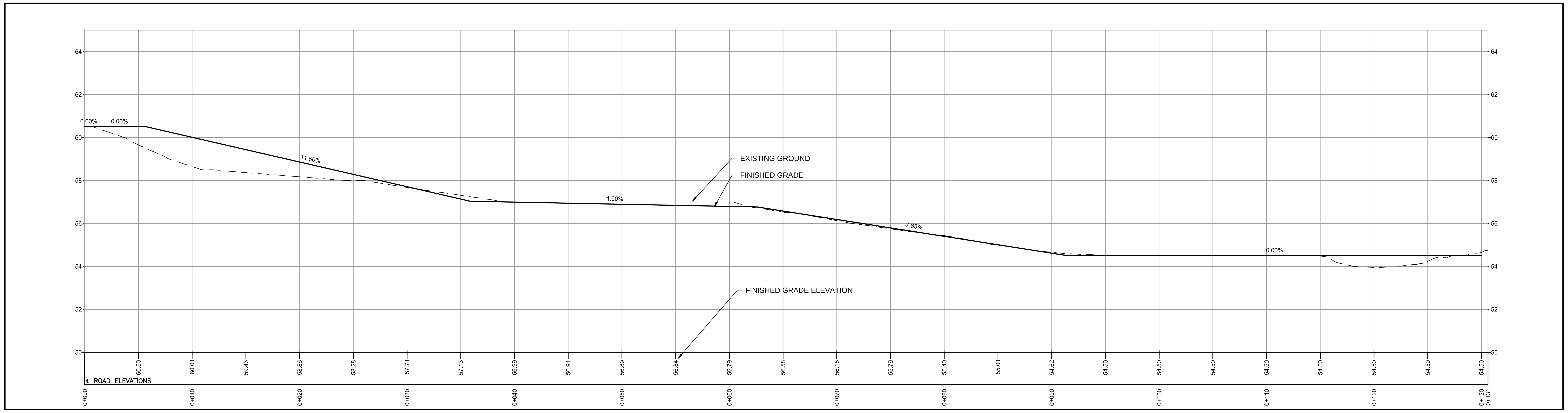
SHEET TITLE

SITE ACCESS 2
PLAN

AUTHORITY

ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: - OF -
CHECKED BY: JB
DRAWING NUMBER: -
APPROVED BY: GS
PROJECT NUMBER: 143063.02



PROFILE
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PRELIMINARY
NOT FOR CONSTRUCTION

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NOTES

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PROJECT

CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE

SITE ACCESS 2
PROFILE

AUTHORITY

ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

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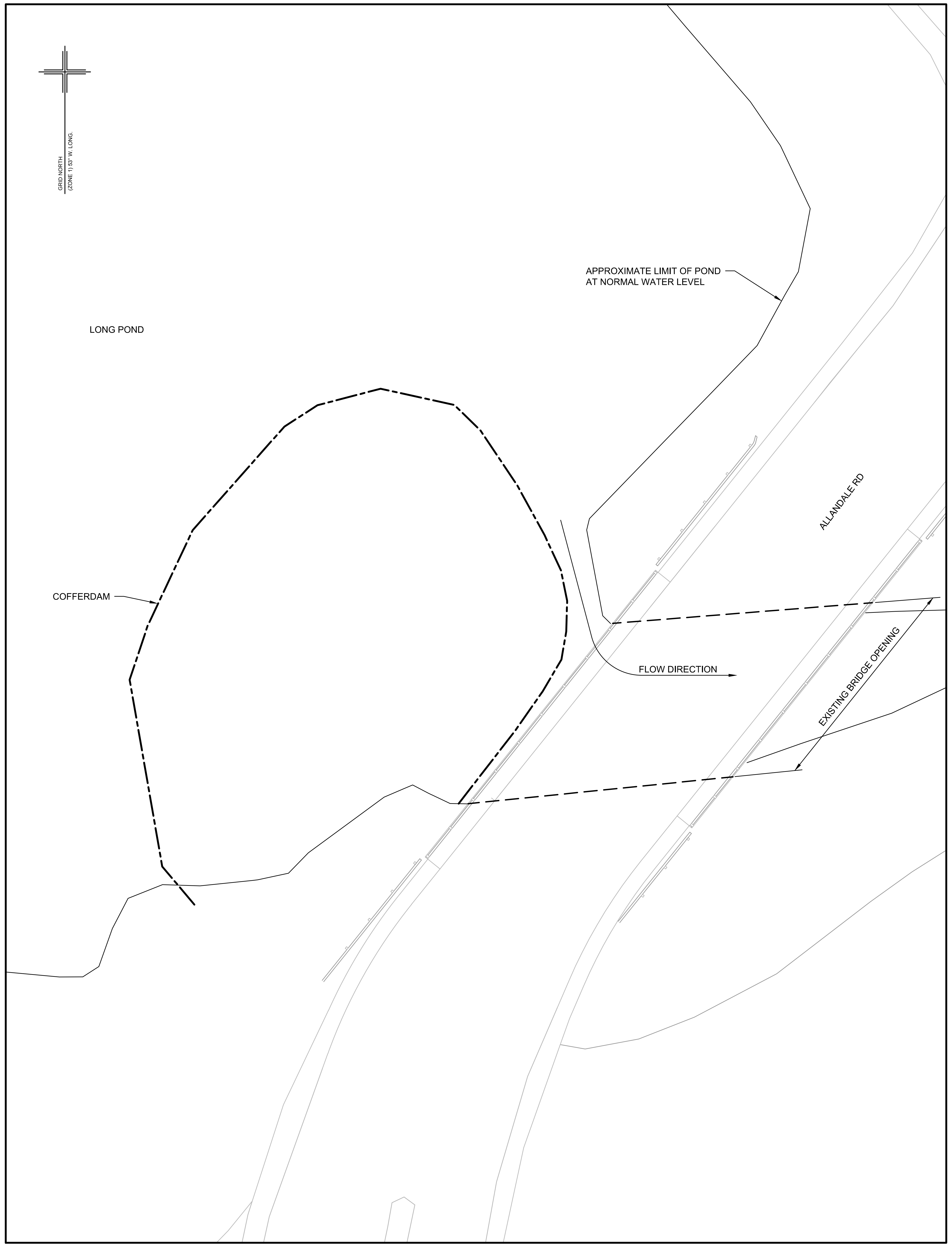

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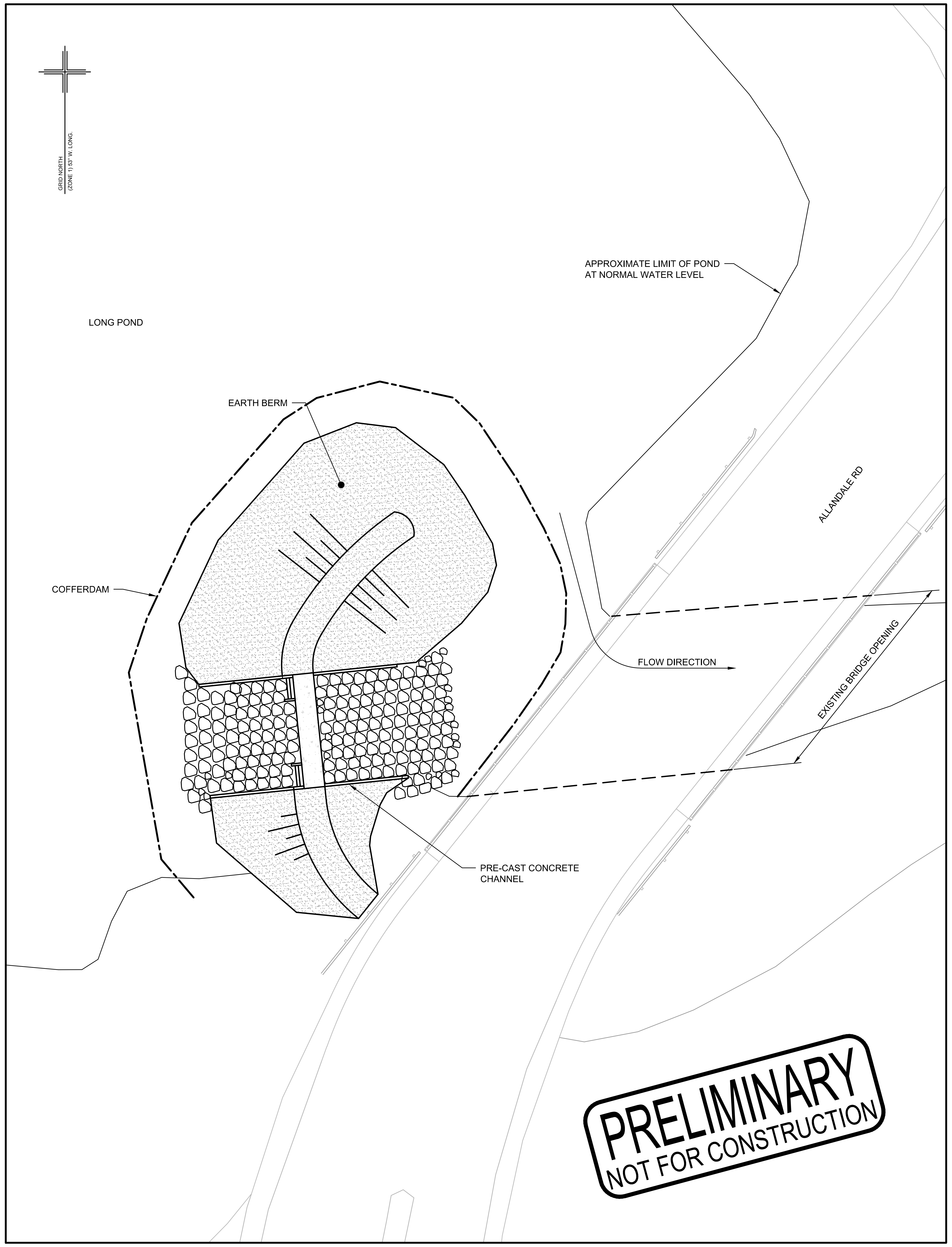

PRELIMINARY
NOT FOR CONSTRUCTION

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DO NOT SCALE FROM PRINT

N O T E S

1. CONTRACTOR TO VERIFY ALL DIMENSIONS PRIOR TO PROCEEDING WITH THE WORK. ALL WORK SHALL CONFORM TO THE CITY OF ST. JOHN'S SPECIFICATIONS BOOK.

CONSULTANT

STAMP

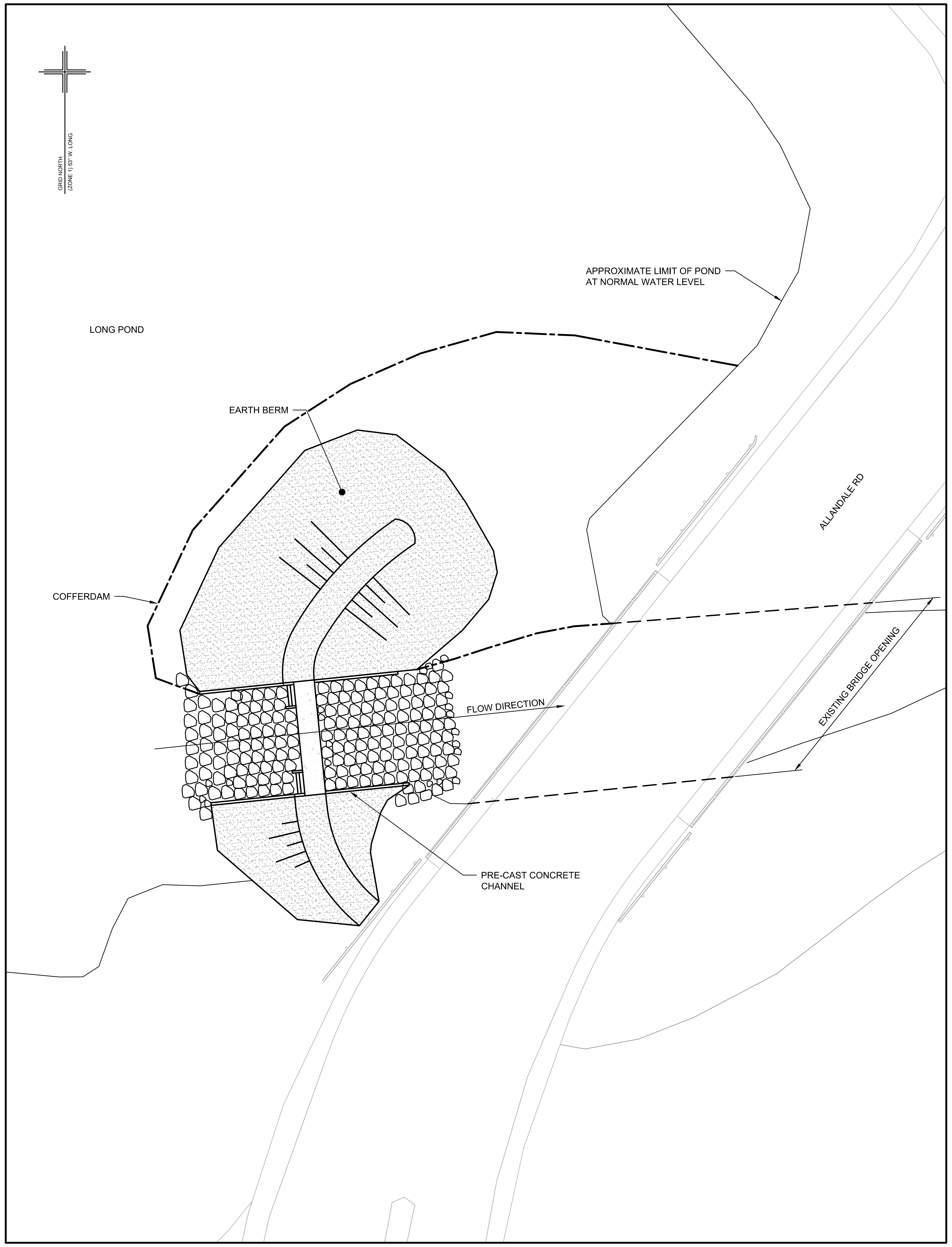
16/03/03	ISSUED FOR EPR	A
DATE	REVISION	NO.

PROJECT
CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE
COFFERDAM PLAN
STAGE 1

AUTHORITY
ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: 1 OF -
CHECKED BY: JB
DRAWING NUMBER: -
APPROVED BY: GS
PROJECT NUMBER: 143063.02



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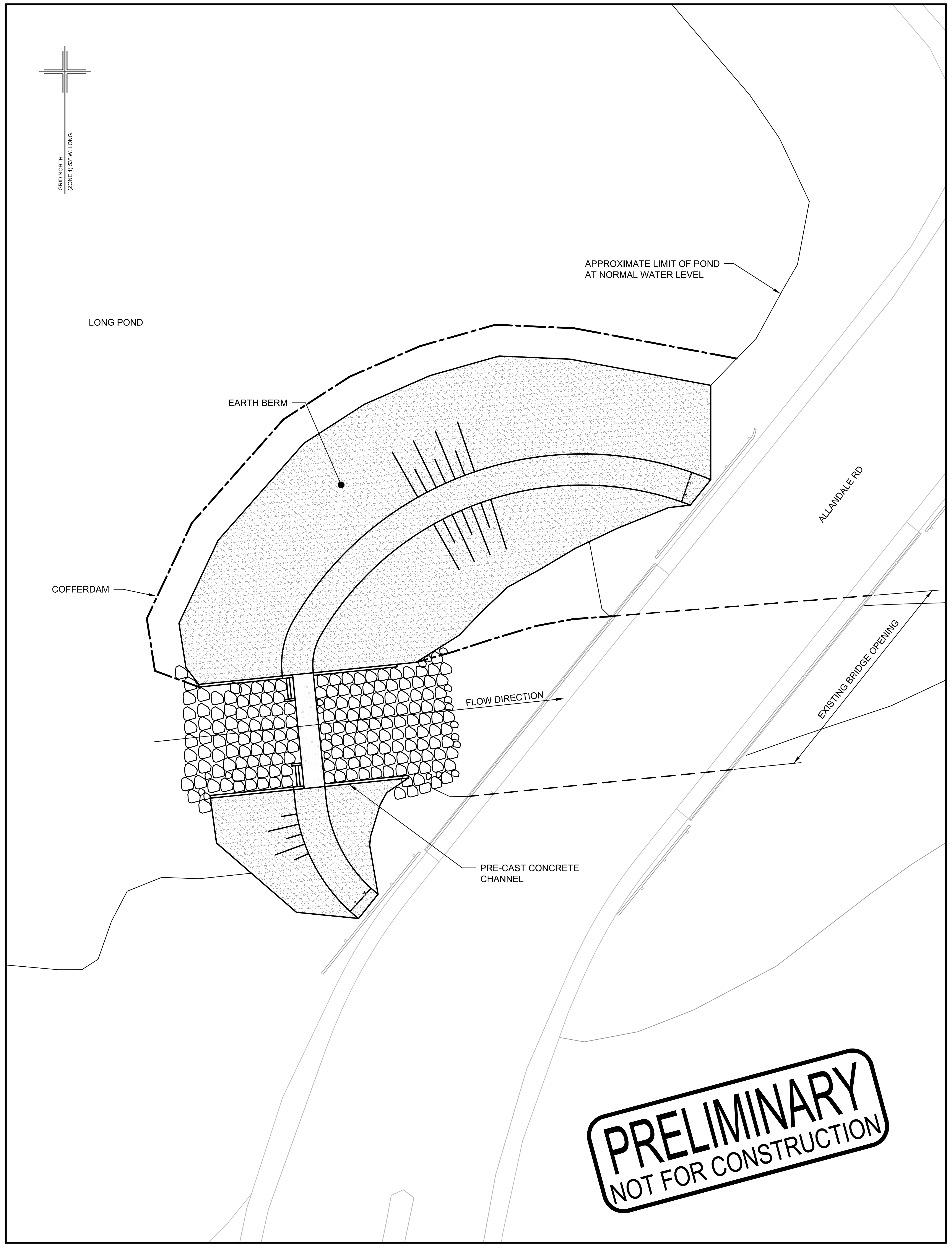

PRELIMINARY
NOT FOR CONSTRUCTION

PLAN - FINISH
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DO NOT SCALE FROM PRINT

NOTES

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CONSULTANT

STAMP

DATE	REVISION	NO.
16/03/03	ISSUED FOR EPR	A

PROJECT
CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE
COFFERDAM PLAN
STAGE 2

AUTHORITY
ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: 1 OF -
CHECKED BY: JB
DRAWING NUMBER: -
APPROVED BY: GS
PROJECT NUMBER: 143063.02

TYPICAL COFFERDAM SETUP

TYPICAL COFFERDAM SETUP

STEEL COFFERDAM

PRELIMINARY
NOT FOR CONSTRUCTION

DO NOT SCALE FROM PRINT

NOTES

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CONSULTANT

STAMP

16/03/03	ISSUED FOR EPR	A
DATE	REVISION	NO.

PROJECT

CITY OF ST. JOHN'S
LONG POND
FLOOD CONTROL STRUCTURE

SHEET TITLE

COFFERDAM PLAN
PHOTOS

AUTHORITY

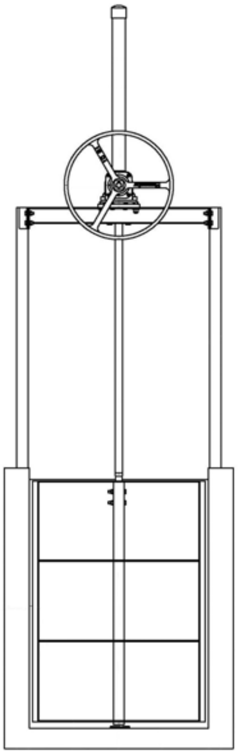
ST. JOHN'S
DEPARTMENT OF CORPORATE SERVICES

SCALE: AS NOTED
DATE: FEB., 2016
DRAWN BY: JRB
SHEET: 1 OF -
CHECKED BY: JB
DRAWING NUMBER: -
APPROVED BY: GS
PROJECT NUMBER: 143063.02

OUR PRODUCTS

- S Series Slide Gates
- W Series Weir Gates
- C Series Open Channel Gates
- AWWA C561: 2012 update

C SERIES OPEN CHANNEL GATES



These channel Gates will provide the best performance in wastewater applications, irrigation or any other duty to control flow in an open channel. Strictly compliant to the new AWWA C561-14 standard, the strength of the design combined with the innovative sealing system on the sides and bottom will provide unsurpassed leakage performance.

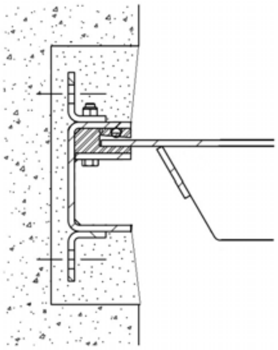
CUSTOM FABRICATION: Our channel gates are designed and fabricated to satisfy the specific dimensions and characteristics required by each application.

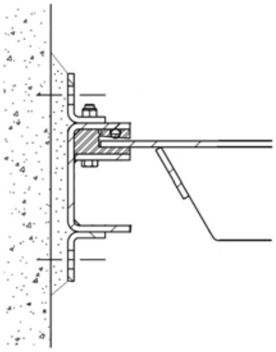
QUALITY MATERIALS: All gates are made with high quality materials, such as 304/304L or 316/316L grade stainless steel and virgin UHMWPE, ensuring the best corrosion resistance for a long life in the toughest environments with virtually no maintenance required.

DESIGN PRESSURE: All our weir gates are designed for water pressure equal to slide height with respect to all safety factors stated in AWWA C561-14

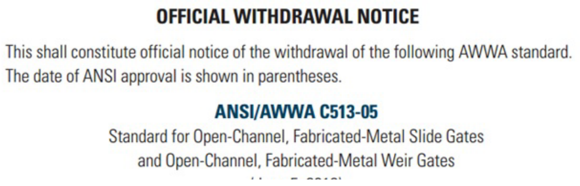
LONG LASTING PERFORMANCE: Guaranteed maximum leakage rate: 0.04 gpm/ft of sealing perimeter (only 40% of the maximum allowed by AWWA C561-14. The gates will also remain easily operable even after very long periods of inactivity.

EASE OF INSTALLATION: For new structures, gates with ES frames are generally installed in pre-cast wall recesses (Box-outs). For existing structures, FS type frames are used to mount on the channel surface. Self-adjusting seals do not require any field adjustment.





THE HIGHEST STANDARD: Since June 2012, weir gates and channel gates are covered by the new C561-14 standard. The C513-05 AWWA standard has therefore been pulled out by ANSI.



OFFICIAL WITHDRAWAL NOTICE

This shall constitute official notice of the withdrawal of the following AWWA standard.
The date of ANSI approval is shown in parentheses.

ANSI/AWWA C513-05

Standard for Open-Channel, Fabricated-Metal Slide Gates
and Open-Channel, Fabricated-Metal Weir Gates

(June 5, 2012)

EXTENDED WARRANTY: Series C Channel Gates come with ISE Metal's exclusive 5 year warranty against defects of design or manufacturing, ensuring peace of mind to the owners of our quality products.

* Gates designed specifically for requirements. Contact us for pricing & drawings : info@ISEaquanox.com

APPENDIX F

DFO’s Recommended Mitigation Measures

Fisheries and Oceans Canada
Pêches et Océans Canada

Fisheries Protection Program – Regulatory Review
P.O. Box 5667
St. John's, NL A1C 5X1

Your file *Votre référence*

March 23, 2015

Our file *Notre référence*
14-HNFL-00375

Dept. of Planning, Development & Engineering
P.O. Box 908
City of St. John's
St. John's, NL A1C 5M2

Attention: Mr. Scott Winsor, P. Eng.

Dear Mr. Winsor:

Subject: Long Pond Weir - Implementation of mitigation measures to avoid and mitigate serious harm to fish

The Fisheries Protection Program (the Program) of Fisheries and Oceans Canada received your proposal on September 5, 2014.

Your proposal has been reviewed to determine whether it is likely to result in serious harm to fish which is prohibited under subsection 35(1) of the *Fisheries Act*. The proposal has also been reviewed to determine whether it will adversely impact listed aquatic species at risk or contravene sections 32, 33 and 58 of the *Species at Risk Act*.

Our review consisted of:

- Application for project review and associated documentation;
- Additional information provided on February 19, 2015;
- Additional information provided on March 6, 2015;
- Telephone conversation – O'Rourke/Sheppard (CBCL);
- Additional information provided on March 20, 2015; and
- Additional information provided on March 23, 2015.

We understand that you propose to construct a water control weir at the outflow of Long Pond in the City of St. John's.

To avoid the potential of serious harm to fish and their habitat, we are recommending that the following mitigation measures be included in your plans:

- Carry out all in-stream works between June 1 and September 30 and during periods of low flow;

- Avoid or reduce the release of suspended sediment by:
    - isolating work areas by cofferdams;
    - pumping sediment-laden water from the work area to a basin to allow settling before discharge back into Rennies River;
    - ensuring sediment and erosion controls are in place and operating effectively; and
    - stabilizing and/or re-vegetating any disturbed areas.

- Relocate any fish from the dewatered work area to Long Pond or Rennies River;

- Maintain natural water flows immediately downstream of the construction site that at all times;

- Ensure fish passage for all species in the Rennies River system is maintained in the weir during all operating conditions by:
    - constructing the weir to meet flow specifications set out in the "Report on fish passage at the proposed Long Pond weir, Rennies River, St. John's, NL";
    - placing rip-rap in the weir opening and downstream so as not to impede fish passage; and
    - verifying that fish passage is maintained by measuring flow rates at the weir under varying conditions during the first year of operation and reporting these to the Program within three months of the end of the first year of operation.

Provided that these mitigation measures are incorporated into your plans, the Program is of the view that your proposal will not result in serious harm to fish. The Program is also of the view that your proposal will not contravene sections 32, 33 or 58 of the *Species at Risk Act*. No formal approval is required from the Program under the *Fisheries Act* or the *Species at Risk Act* in order to proceed with your proposal.

If your plans have changed or if the description of your proposal is incomplete, or changes in the future, you should consult our website (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html) or consult with a qualified environmental consultant to determine if further review is required by the Program.

If you have any questions, please contact Jason Kelly at our St. John's office at (709) 772-4126, by fax at (709) 772-5562, or by email at Jason.Kelly@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Sincerely,

Tilman Bieger
Manager, Regulatory Review – Fisheries Protection Program

Cc. Greg Sheppard, CBCL Limited
Jason Kelly, FPP-DFO

APPENDIX G

Report on Fish Passage

Thaumas
ENVIRONMENTAL
CONSULTANTS Ltd.

www.THAUMAS.ca
(902)466-2095
BobRutherford@Accesswave.ca

December 6, 2014

Re: Report on fish passage at the proposed Long Pond weir, Rennies River, St John's, NL.

Thaumas Environmental Consultants Ltd has been contracted by CBCL Ltd. to review fish passage conditions for a proposed flood control weir to be located in Long Pond, which is on the Rennies River, St John's, NL. CBCL recommended the flood control weir in a 2104 study that was completed for the City of St John's. The findings outlined in this report are in support of the weir design.

The opening in the proposed weir is four meters wide and will extend to the bottom of the pond with concrete sides and rock rip rap bottom. It is suggested that the upstream corners of the weir opening be rounded with a radius of 1/3 the length of the weir for smoother flow pattern in the opening, this will improve the flow pattern for migrating fish. The velocities through the opening, under different flow conditions and the percent duration of these flows, was provided by CBCL and are in Appendix 1.

The fish species present at the site include Brown trout (*Salmo trutta*), Brook trout (*Salvelinus fontinalis*), American eel (*Anguilla rostrata*), Atlantic salmon (*Salmo salar*) and forage fish primarily three spined Stickleback (*Gasterosteus aculeatus*) (Piercey 2104).

Swimming speeds of fish are dependent on species, age class, body length, condition and health of the fish, and water quality particularly temperature. Also fish migration behaviour needs to be considered as they will migrate against strong velocities during spawning runs than normal foraging, they navigate natural barriers better than man-made structures, and have depths and velocities they prefer to swim at and against.

The velocities used are the mean velocity in the weir and there will be lower velocities at the bottom over rip rap and along the sides. These velocities will be used by the smaller fish for better passage outcomes than calculated below which are based on the mean velocity.

This makes a complete picture of the outcome of migration through a weir difficult to fully predict under all seasons and conditions. To deal with the uncertainty we have taken a conservative approach to the swimming speeds and looked at a range of age classes and body lengths for the three main swimming behaviours, sustained, prolonged (1800 sec) and burst speed (10 sec). Fish also have a burst escape speed which is much higher and of shorter duration than the burst speed used here, however, this behaviour is seldom used during migration so has not been included.

Swimming speeds used are from Katopodis (1992) and Peake (2002). The fish for which there was data suitable for modeling include Brook trout, Atlantic salmon, and American eel. Swimming ability of the Brown trout are between those of Brook trout and Atlantic salmon based on Peake (2002) and Stickleback and other forage fish that may be present are based on a general formula for minnow species.

Brook trout passage

Brook trout are native trout to Newfoundland. In the Rennies system, most are located in the upper areas of the watershed, in Three Pond Barrens, although they have been seen and caught in Long Pond. Like Brown trout, they are anadromous, and seasonally migratory. The spawning season for Brook trout is a little earlier than Brown trout, typically in early to mid-September, depending on water temperature (Piercey, R. 2014).

The velocities proposed by Peake (2008) for Brook trout passage through culverts up to 100m long in Newfoundland proposed that water velocities up to 30.0 and 50.0 cm/s or less should allow passage of most juvenile and adult Brook trout, respectively. This means if the passage at the weir was this long passage in October / November passage would be 3% and 20% of the time respectively, the October / April the passage would be 20% to 80% of the time respectively, the May to September 4% to 20% of the time respectively. In these cases the distance that the fish would have to traverse to get through a culvert is much greater than that of the proposed weir so they would have to use sustained or prolonged swimming to complete the passage and endurance would be a major issue. This is the case for all the species of fish in the river.

Using the swimming ability of Brook trout from Katopodis (1992) we can generate the percent of the time various sized trout will be able to pass through the weir of 5m in length (Fig 1). This approach is more realistic as the fish can approach the weir in low velocities and only encounter the highest velocities for very short period and use their higher burst swimming speeds. Endurance is not an important and issue here as it is in culverts. This approach provides more detail including the use of burst velocities for short distances.

It can be seen that in October /November flows that all sizes can pass using burst speeds from 37% to 100% of the depending on fish length. The October / April low flows provide passage 69% to 100% of the time with burst speeds. May / September high flows allow passage 34% to 84% of the time again with the larger fish passing a greater percent of the time.

Fig 1 Brook trout tables

Brook trout October / November flows										
age	Length cm	Sustained m/sec	Current passage % time	4m weir Passage % time	Prolonged for 1800 sec m/sec	Current passage % time	4m weir Passage % time	Burst 10 for sec m/sec	Current passage % time	4m weir Passage % time
0+	3.0	0.022	70	3	0.178	100	18	0.394	100	37
1	12.0	0.081	95	9	0.359	100	35	0.798	100	67
2	16.5	0.121	100	13	0.422	100	40	0.938	100	75
3	20.0	0.148	100	16	0.465	100	43	1.034	100	80
4	24.0	0.185	100	19	0.510	100	47	1.100	100	83
5	27.0	0.200	100	20	0.541	100	49	1.205	100	87
6	28.0	0.208	100	21	0.552	100	50	1.227	100	88
7	29.6	0.223	100	23	0.567	100	51	1.263	100	100

Brook trout October / April low flows										
age	Length cm	Sustained m/sec	Current passage % time	4m weir Passage % time	Prolonged for 1800 sec m/sec	Current passage % time	4m weir Passage % time	Burst 10 for sec m/sec	Current passage % time	4m weir Passage % time
0+	3.0	0.022	80	0	0.178	100	56	0.394	100	69
1	12.0	0.081	90	0	0.359	100	68	0.798	100	88
2	16.5	0.121	95	52	0.422	100	71	0.938	100	93
3	20.0	0.148	100	54	0.465	100	73	1.034	100	95
4	24.0	0.185	100	56	0.510	100	76	1.100	100	97
5	27.0	0.200	100	57	0.541	100	77	1.205	100	99
6	28.0	0.208	100	58	0.552	100	78	1.227	100	100
7	29.6	0.223	100	59	0.567	100	79	1.263	100	100

Brook trout May / September high flows										
age	Length cm	Sustained m/sec	Current passage % time	4m weir Passage % time	Prolonged for 1800 sec m/sec	Current passage % time	4m weir Passage % time	Burst 10 for sec m/sec	Current passage % time	4m weir Passage % time
0+	3.0	0.022	70	0	0.178	92	0	0.394	98	34
1	12.0	0.081	85	0	0.359	100	31	0.798	100	61.5
2	16.5	0.121	90	0	0.422	100	36	0.938	100	69
3	20.0	0.148	32	0	0.465	100	39	1.034	100	74
4	24.0	0.185	93	0	0.510	100	43	1.100	100	77
5	27.0	0.200	94	0	0.541	100	45	1.205	100	82
6	28.0	0.208	95	0	0.552	100	46	1.227	100	83
7	29.6	0.223	98	0	0.567	100	47	1.263	100	84

Brown trout passage

Brown trout are a non-native species, introduced to Newfoundland in the late 1880's. The Rennies system has the densest concentration, in terms of weight per cubic meter of water, of this particular species of any trout stream in North America. They are anadromous so are seasonally migratory, as they move out of ponds/lakes in early October, into the spawning beds located in adjoining rivers, and streams. Just below the eastern outflow of Long Pond there is a prime spawning area, located at the beginning of Rennies River (Piercey, R. 2014).

The Brown trout swimming ability formula is not available but based in the information provided in Peake (2008) the results would fall between Brook trout and the Atlantic salmon in swimming ability. Peake (2008) suggested culvert velocities are 35 cm/sec to 70 cm/sec higher than for Brook trout but lower than Atlantic salmon.

Atlantic salmon passage

Atlantic Salmon have not been found in this river system for over sixty years, and documented evidence of salmon as far in the river system as Long Pond in recent years doesn't exist. The Fluvarium has been releasing salmon fry into the tributaries around Long Pond for close to twenty years as part of our Fish Friends program. Adult salmon have not been seen, but Fluvarium staff have witnessed young salmon parr and smolt. The Salmon Association of Eastern Newfoundland (SAEN) are currently involved in a salmon reintroduction program in Rennies River, and are concerned about any development on Long Pond (Piercey, R. 2014).

Salmon passage at the weir under all scenarios is 100% for grilse and adults using their burst speeds. Parr passage during October /November flows, all sizes can pass using burst speeds from 44% to 78% of the time depending on fish length. The October / April low flows provide passage 73% to 95% of the time with burst speeds. May / September high flows allow passage 39% to 78% of the time again with the larger fish passing a greater percent of the time.

Fig 2 Atlantic salmon tables

Atlantic salmon October / November flows

age	Length cm	Sustained m/sec	Current passage % time	4m weir opening Passage % time	Prolonged for 1800 sec m/sec	Current passage % time	4m weir opening Passage % time	Burst 10 for sec m/sec	Current passage opening % time	4m weir opening Passage % time
0+	4.2	0.022	70	3	0.2389	100	24	0.468	100	44
1	5.6	0.081	95	9	0.2609	100	26	0.542	100	49
2	9.3	0.121	100	13	0.319	100	31	0.701	100	60
3	11.6	0.148	100	16	0.3551	100	34	0.784	100	66
4	17.4	0.185	100	19	0.4462	100	42	0.964	100	76
5	18.8	0.200	100	20	0.4682	100	44	1.003	100	78
grilse	52	0.449	100	42	0.989	100	77	2.080	100	100
1 syr adult	95	0.712	100	61	1.665	100	100	3.800	100	100

Atlantic salmon October / April low flows

age	Length cm	Sustained m/sec	Current passage % time	4m weir opening Passage % time	Prolonged for 1800 sec m/sec	Current passage % time	4m weir opening Passage % time	Burst 10 for sec m/sec	Current passage % time	4m weir opening Passage % time
0+	4.2	0.022	80	0	0.2389	100	24	0.468	100	73
1	5.6	0.081	90	0	0.2609	100	26	0.542	100	77
2	9.3	0.121	95	52	0.319	100	31	0.701	100	85
3	11.6	0.148	100	54	0.3551	100	34	0.784	100	88
4	17.4	0.185	100	56	0.4462	100	42	0.964	100	94
5	18.8	0.200	100	57	0.4682	100	44	1.003	100	95
grilse	52	0.449	100	72	0.989	100	77	2.080	100	100
1 syr adult	95	0.712	100	100	1.665	100	100	3.800	100	100

Atlantic salmon May / September high flows

age	Length cm	Sustained m/sec	Current passage % time	4m weir opening Passage % time	Prolonged for 1800 sec m/sec	Current passage % time	4m weir opening Passage % time	Burst 10 for sec m/sec	Current passage % time	4m weir opening Passage % time
0+	4.2	0.022	60	3	0.2389	95	24	0.468	99	39
1	5.6	0.081	58	8	0.2609	97	26	0.542	100	45
2	9.3	0.121	90	12	0.319	100	28	0.701	100	56
3	11.6	0.148	94	14	0.3551	100	31	0.784	100	61
4	17.4	0.185	95	17	0.4462	100	40	0.964	100	71
5	18.8	0.200	96	18	0.4682	100	58	1.003	100	78
grilse	52	0.449	99	38	0.989	100	72	2.080	100	100
1 syr adult	95	0.712	100	56	1.665	100	95	3.800	100	100

American eel passage

The American eel is a native fish species to Newfoundland, it is catadromous, meaning it is born in salt water, and moves into the fresh water systems to spend the majority of their lives. They often overwinter in deeper ponds and lakes, but will move into rivers and streams seasonally (Piercey, R. 2014).

Swimming ability has not been found but Peake (2008) suggests not exceeding 20 cm/sec for culvert passage of elvers returning from the sea to freshwater.

Katopodis (1992) does not provide formula for American eel but does provide information on swimming abilities of fish with the same body form as the eels. From this swimming ability formula for the 5m of maximum velocities through the weir for a 10cm elver would be 35 cm/sec using burst speed. For a 30cm resident eel the velocity would be 75 cm /sec.

Passage at the weir in October /November flows, Eels can pass using burst speeds from 60% of the time. The October / April low flows provide passage 80% for larger Eels and for elvers 20% of the time with burst speeds. May / September high flows allow passage for larger Eels 50% and for elvers 2% of the time again with the larger fish passing a greater percent of the time.

Elver migration is in the spring and passage would have to be mainly under low flows. Eels also use the bottom cover and turbulence provided by the rip rap and slower velocities along the face of the sides of the weirs so this is a very conservative estimate of passage it will be substantially higher.

Three spined Stickleback passage

The predominant forage fish is the three-spine Stickleback. These fish can be anadromous, although the ones found in the Rennies system are totally freshwater, and live out their entire lifespan in the river, and the joining streams and ponds. They are an important food source to the larger trout and eels. There have been reports of the Banded killifish in the waters of Long Pond. They are found in Burtons Pond on the MUN campus, which has no connection to this system (Piercey, R. 2014).

The swimming ability of stickleback for passage from Peake (2008) is through flows of 25cm/sec or less velocity. Using formula for minnows from Katopodis (1992) for a 2.5cm stickleback the velocity would be 22cm/sec or less for passage.

From this the ability to swim the 5m of maximum velocities through the weir for a 2.5cm minnow forage fish would be 22 cm/sec using burst speed. Passage at the weir for minnow species during October /November flows is 2% of the time. The October / April low flows provide passage 10% of the time with burst speeds. May / September high flows allow passage 4% of the time. These are small fish and will use the lower velocities along the bottom where there is turbulence and cover for passage so these numbers are conservative.

Conclusion

The weir will provide fish passage for all the species present over periods suitable for migration and distribution through the watershed. The smaller fish will be limited in the percent of the time they will be able to pass based on the mean flow through the weir but will be able to use the slower flows and cover form the flows along the rip rap bottom to move through the area more of the time than shown in the is analysis. Exactly what that percent time they will be able to pass cannot be calculated without knowing the velocities that will be found in this bottom layer.

The velocities through the weir under all flows will be lower than the river above Long Pond (see (Appendix 1). The fish do move up through the river which is a clear indication of the positive effect the bottom morphology has on the velocities and fish migration.

RJ Rutherford

Bob Rutherford
President
Thaumas Environmental Consultants Ltd

References

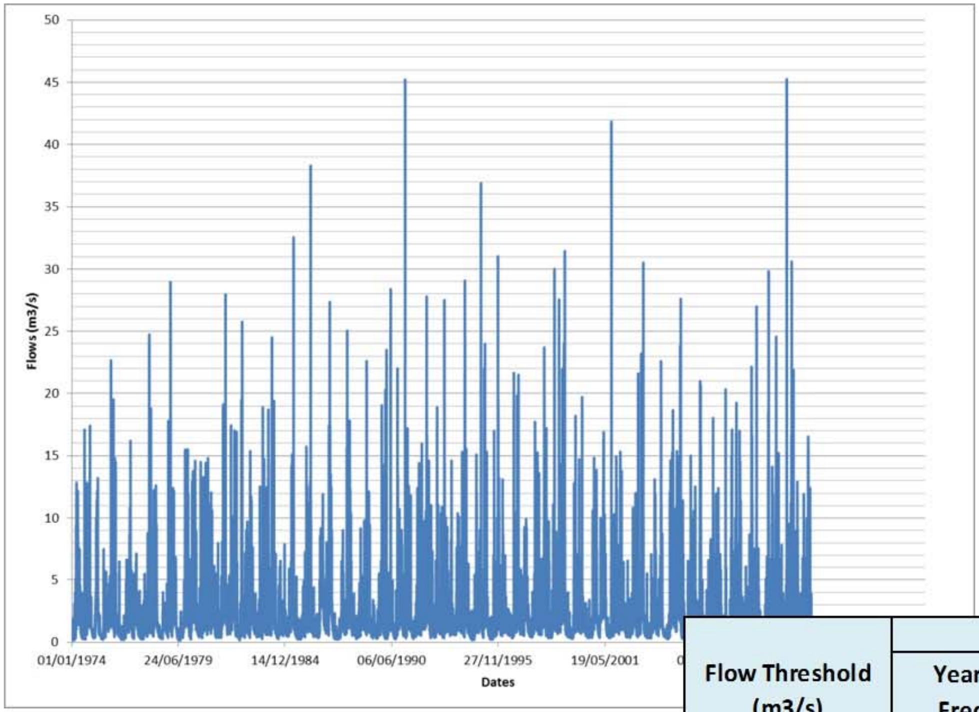
CBCL 2014, Rennies River Catchment Stormwater Management Plan, Final Report

Katopodis, C. 1992 Introduction to Fishway Design, Freshwater Institute
Central and Arctic Region, Department of Fisheries and Oceans.

Peake, S.J. 2008. Swimming performance and behaviour of fish species endemic to Newfoundland and Labrador: A literature review for the purpose of establishing design and water velocity criteria for fishways and culverts. Can. Manuscr. Rep. Fish. Aquat. Sci. 2843: v + 52p.

Piercey, R. 2014 Education Manager, Suncor Energy Fluvarium, personal communication

Appendix 1



Flow Threshold (m3/s)	Non Exceedance Frequency (% Time)			
	Year Round Frequency	High Flow Season (May-Sept)	Low Flow Season (Oct-Apr)	October & November
0.2	0.00	0.00	0.00	0.00
0.5	4.52	1.20	9.12	0.91
1	23.89	9.91	43.27	10.48
2	52.37	36.60	74.25	41.16
2.5	61.31	47.44	80.55	52.72
5	84.00	77.30	93.29	81.19
10	94.58	91.93	98.26	94.22
20	98.77	98.15	99.62	98.49
45	99.95	99.95	99.95	100.00
66	100.00	100.00	100.00	100.00

Flow input in XPSWMM to calculate velocities at weir

Figure 1 Frequency Analysis -Gauged Flows 1974-2011

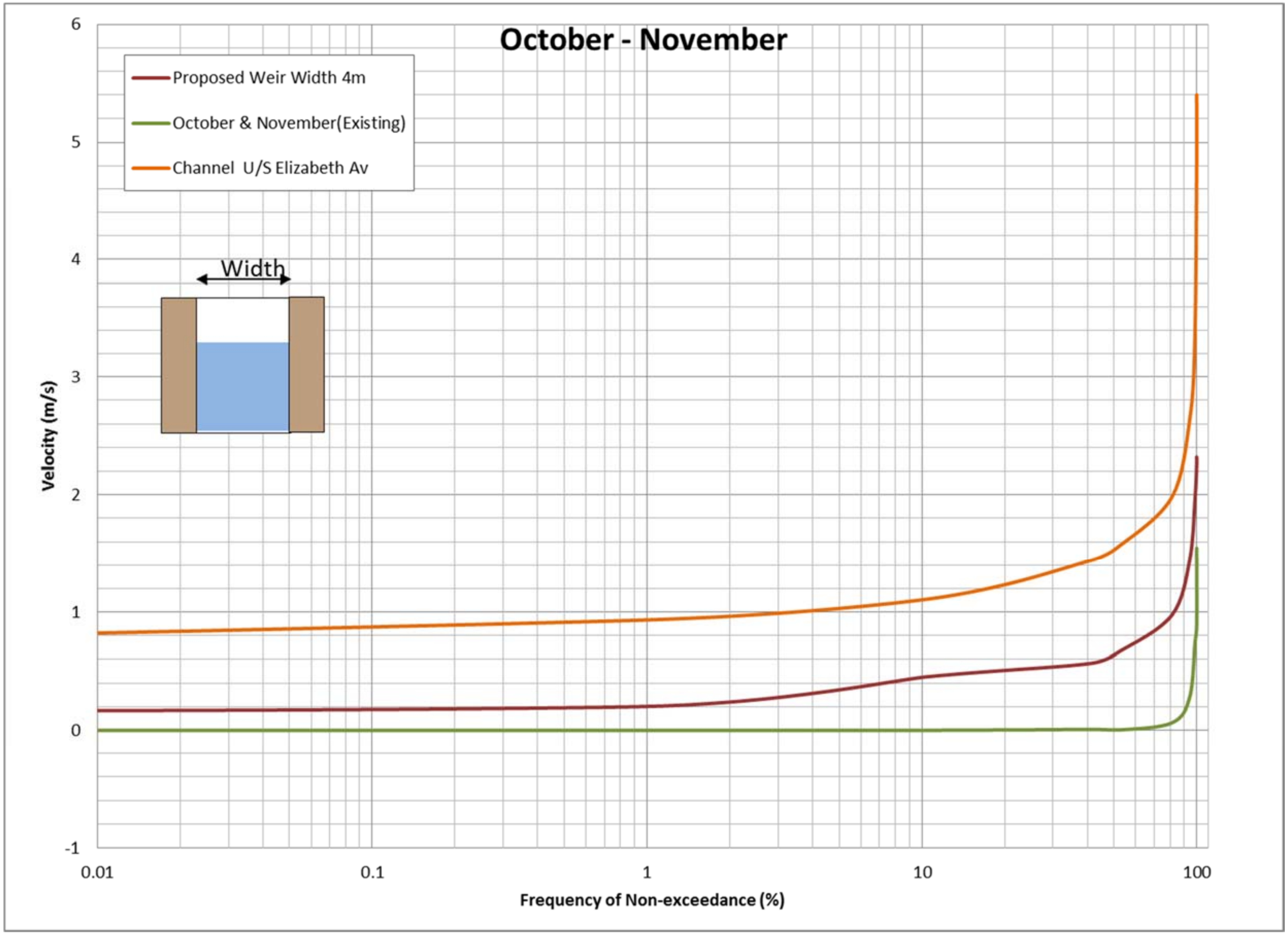


Figure 2 Calculated Velocities vs Non Exceedance Frequency- October and November

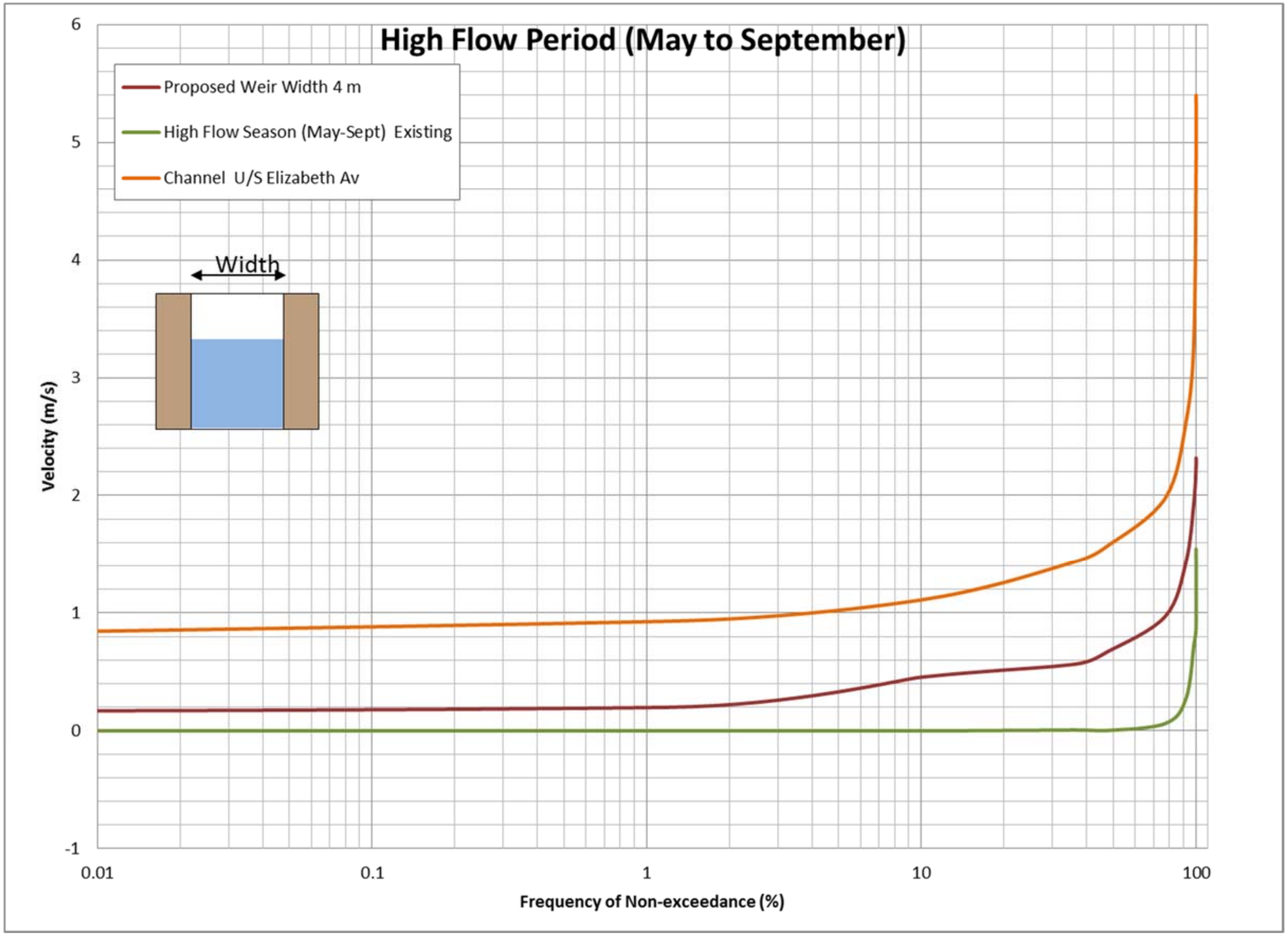


Figure 3 Calculated Velocities vs Non Exceedance Frequency- High Flow Season

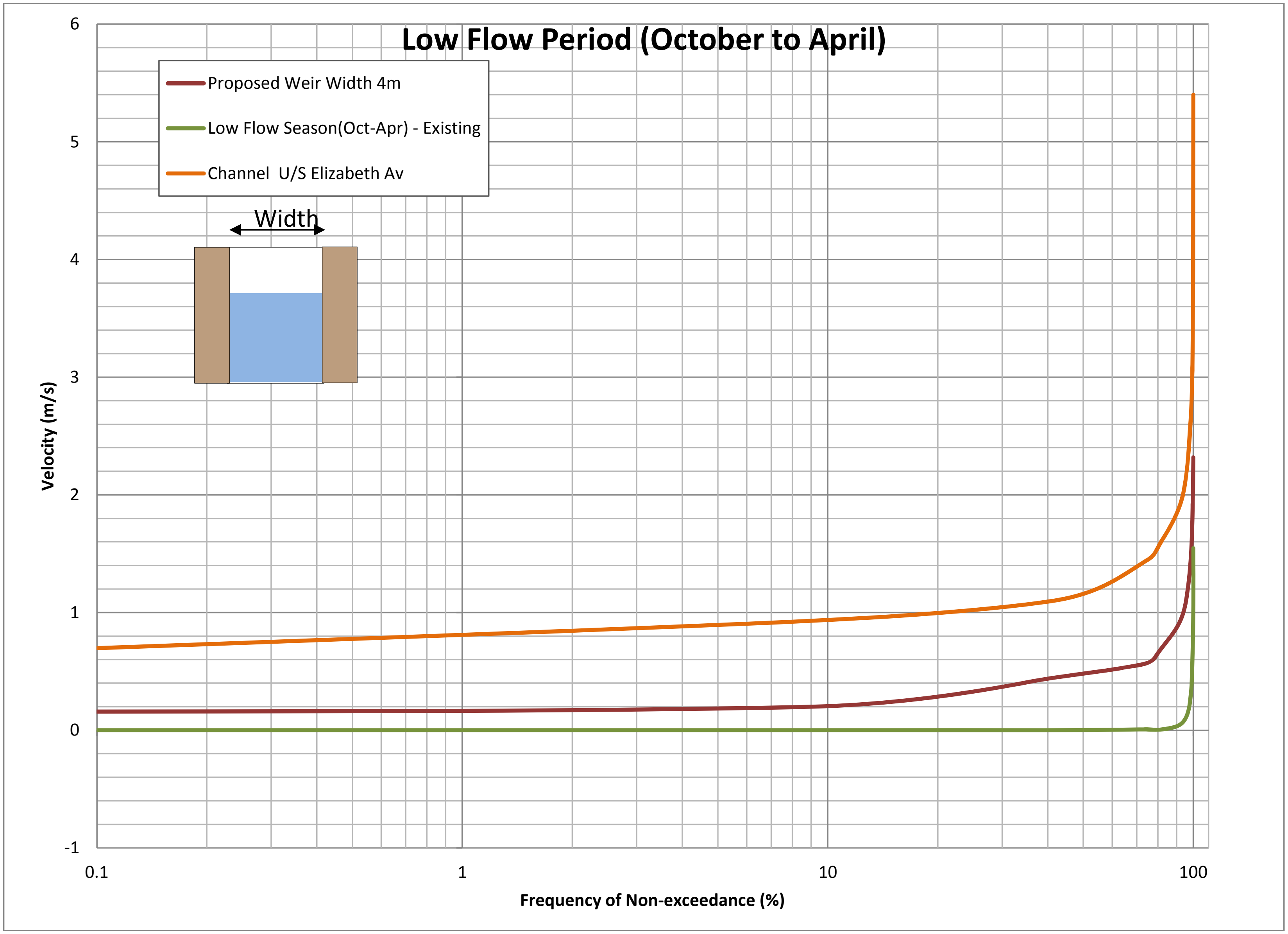


Figure 4 Calculated Velocities vs Non Exceedance Frequency- Low Flow Season

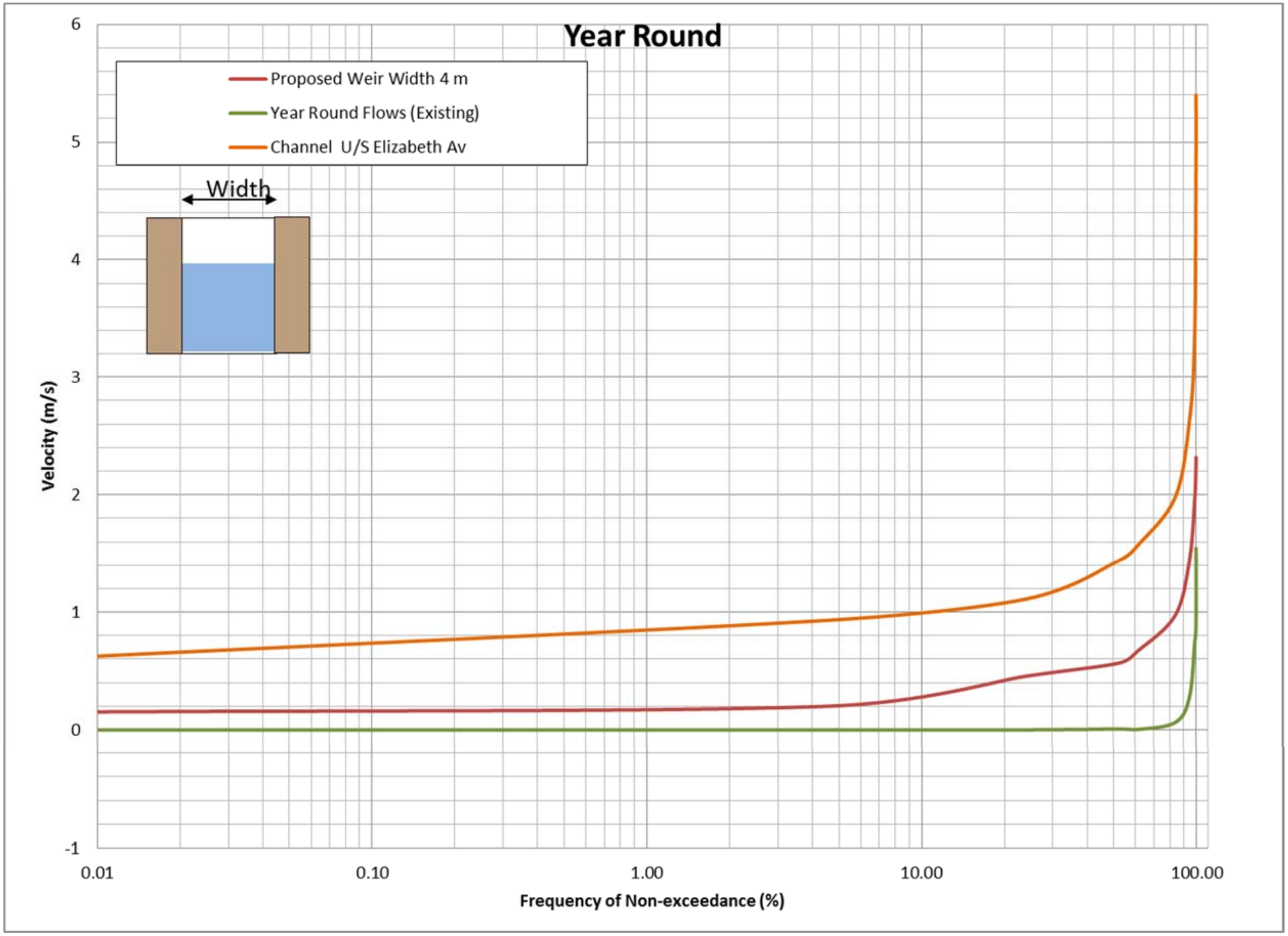


Figure 5 Calculated Velocities vs Non Exceedance Frequency- All Year Round

APPENDIX H

Geotechnical Report

November 2014

REPORT ON

Proposed Weir Structure
Long Pond
St. John's, NL

Submitted to:
Greg Sheppard
CBCL Limited
187 Kenmount Road
St. John's, NL
A1B 3P9

REPORT

Report Number: 1407587-0001-Rev1

Distribution:

1 e-copy - CBCL Limited
1 copy - Golder Associates Ltd.

Golder Associates

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates Ltd (Golder) has been engaged by CBCL Ltd. (CBCL) to undertake a geotechnical investigation at the site of the proposed weir structure at Long Pond adjacent to the Allandale Road Bridge crossing near the Memorial University Campus, St John's, NL. The work was authorised by CBCL with a sub-consultant agreement dated July 24, 2014 and signed on August 6, 2014.

This report presents the results of a geotechnical investigation carried out by Golder at the site of the proposed weir structure. The work was carried out in general conformance with our proposal P1407587 dated July 9, 2014.

The purpose of the geotechnical investigation was to assess the subsurface conditions at the site by means of a limited number of boreholes.

Based on an interpretation of the factual information available for this site, a general description of the subsurface conditions across the site is presented. These interpreted subsurface conditions and available project details were used to prepare engineering guidelines on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The reader is referred to the "Important Information and Limitations of This Report" which follows the text and forms an integral part of this document.

2.0 SITE AND PROJECT DESCRIPTION

CBCL has been retained by the City of St. John's as the prime consultant to provide engineering support for a proposed weir structure located in Long Pond, just upstream from Rennies River in St. John's, Newfoundland (see Figure 1).

Based on drawings provided by CBCL dated August 11, 2014 (reference: 143063.00 SK-01 and SK-02), it is understood that the weir structure will be constructed on the western side of Allandale Road, between the north and south bridge abutments.

It is also understood that the proposed founding level of the weir structure is at an approximate elevation of 50.5 m (based on CBCL Drawing #SK-02, dated 11 August 2014, which was provided to Golder during the coarse of the investigation). Based on this drawing, the approximate maximum water level under future flood conditions following the construction of the weir structure is indicated to be at 55.8 m elevation.

The existing ground level on the western side of the north and south bridge embankments slopes down from Allandale Road into the pond. The slope surface currently comprises vegetation, small trees, cobbles and boulders. During the site investigation at the approximate location of the weir structure, vegetation and water grass were observed to be present within the pond between the bridge embankments.

3.0 FIELDWORK PROCEDURE

3.1 Permitting

Prior to carrying out the field investigation in Long Pond, Golder obtained a "*Permit to Alter a Body of Water*" from the Department of Environment and Conservation – Water Resources Management Division. The permit was issued on August 25, 2014 (permit No.: ALT7655-2014).

Golder has also undertaken a self-assessment for the proposed scope of work in order to meet the requirement introduced by the Department of Fisheries and Ocean (DFO). As a result of the self-assessment, it was determined that geotechnical drilling activities at Long Pond did not require a review from DFO.

Approvals from the City of St John's and the Pippy Park Commission were obtained by CBCL who provided confirmation to commence the field investigation in an email dated September 30, 2014.

The drilling of the boreholes at Long Pond followed the procedures, requirements and conditions as listed in the permits issued by the governing bodies.

3.2 Field Investigation

The field investigation was carried out on October 3 and 4, 2014. A total of three (3) boreholes (numbered BH1 to BH3) were drilled and the approximate locations of the boreholes are shown in Figure 1.

The drilling of the boreholes was undertaken on a barge with a CME 55 drill rig, supplied and operated by Logan Geotech Inc. The drilling equipment, barge and support boat were lifted into and out of Long Pond by utilising a 60t mobile crane, positioned on Allandale Road immediately to the north of the bridge crossing. Traffic management/control during the equipment mobilisation and demobilisation periods was provided by Safety First Ltd.

To minimise the disturbance to the pond, the boreholes were drilled utilising continuous split spoon sampling techniques which obtained soil samples from the major soil strata encountered in the boreholes. The equipment allowed performing standard penetration tests as per ASTM D 1586-11. This provided information on the compactness condition of soils through the measurement of N values. The soil samples collected were classified by visual and tactile examination. NW casing was also advanced following split spoon sampling to stabilise the borehole. NQ diamond coring technique was utilised in BH1 for rock coring. All soil and rock samples returned to the barge deck during the drilling process were collected, stored and disposed of offsite.

The field work was supervised by a member of our engineering staff who collected the soils and rock encountered and logged them. The field samples obtained during the field work were shipped to our St. John's office for further examination by the project engineer.

According to CBCL drawing SK-02, the top of the western sidewalk at Allandale Road is at elevation 56.3 m. This elevation was used by Golder as the reference level (i.e. job benchmark) during the site investigation to determine the approximate termination depth of the boreholes (to ± 15 cm) relevant to the founding level of the weir structure. The borehole locations were selected by Golder along the approximate alignment of the weir structure and were located in the field by Golder personnel using a handheld GPS with a ± 5 m accuracy.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions encountered in the boreholes are shown on the Record of Boreholes presented in Appendix A. A summary of the subsurface conditions encountered in the boreholes are presented in Table 1.

In general, below the water in the pond, the soils present on site consist of clayey silt overlying gravelly clay or sand and sandy gravel till which overlies inferred bedrock. The following sections present a more detailed overview of the subsurface conditions encountered in the boreholes.

4.2 Water

The water surface level of the pond at the time of the field investigation was measured to be approximately 3.3 m below the level of the sidewalk on the western side of the Allandale Road Bridge. The approximate elevation of the water surface was at elevation 53.0 m during the field investigation. Depths within each borehole are referenced to the water surface level.

The depth of water encountered at the three borehole locations was 1.80 m at Borehole BH1, 1.45 m at Borehole BH2 and 0.85 m at Borehole BH3.

4.3 Lacustrine deposits

Cohesive, wet clayey silt was encountered immediately below the water in the three boreholes. The lacustrine deposit extends to depths of 3.8 m in Borehole BH1, 2.8 m in Borehole BH2 and 4.0 m in Borehole BH3. Organic material such as rootlets and wood fragments was observed in this material. The clayey silt is soft to firm with measured N values of 2 to 12 within the lower half of this deposit. The upper half may be very soft as N values could not be performed. Note that in each of the three boreholes the drill rods sank under their own weight through the pond-bottom sediments. For example, in borehole BH1, the rods sank 2.0 m, 0.75 m in BH2, and 1.15 m in BH3.

4.4 Till

Wet gravelly clay, gravelly sand and sandy gravel till were encountered below the lacustrine deposit. The till also comprised cobbles and boulders. Boreholes BH2 and BH3 were terminated in this material at a depth of 5.8 m and 6.9 m respectively. In Borehole BH1, the till was observed to be overlying the inferred bedrock at a depth of 8.15 m. The till is generally compact to very dense with measured N values of 24 to 52. The top surface of the till is generally compact and slopes down to the north-east.

4.5 Probable Bedrock

Probable siltstone bedrock was encountered in Borehole BH1 underlying the till at a depth of 8.15 m and was cored to a depth of 8.60 m. The rock is very poor quality with a measured RQD of 0.

4.6 Summary

The depth ranges and elevation of the subsurface materials encountered in Boreholes BH1 to BH3 are summarised in Table 1.

Table 1: Depth ranges of subsurface materials

Description	Depth ranges of subsurface materials (m)		
	BH1 (water surface elevation 53.0 m)*	**BH2** (water surface elevation 53.0 m)*	**BH3** (water surface elevation 53.0 m)*
Water	0.0 – 1.8	0.0 – 1.45	0.0 – 0.85
Lacustrine deposit	1.8 – 3.8	1.45 – 2.8	0.85 – 4.0
Till	3.8 – 8.15	2.8 – 5.8	4.0 – 6.9
Probably Bedrock	8.15 – 8.6	-	-
End of Borehole	8.6	5.8^	6.9^

**- the pond's water surface elevation is referenced to the elevation of the top of sidewalk on the western side of Allandale Road bridge, defined as elevation 56.3 m from CBCL's drawing SK-02.*

^- Borehole BH2 terminated due to encountering cobbles or boulders within the till, pushing the drilling rod from its vertical alignment. Borehole BH3 terminated in till as the borehole wall collapsed during drilling.

5.0 DISCUSSION

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the proposed weir structure at Long Pond based on our interpretation of the borehole information and project requirements. The information in this portion of the report is provided for the guidance of the designers and is intended for this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the factual information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

5.2 Project Description

It is understood that the proposed weir is comprised of a semi-circular concrete structure with a fish passage opening towards the centre. The weir structure reaches an elevation of 54.8 m on the upstream side and 52.8 m on the downstream side, with riprap protection on both the upstream and downstream sides. The weir structural foundations will consist of spread footings founded on the till material.

According to CBCL, the maximum water level under future flood conditions following the construction of the weir structure is at an approximate elevation of 55.8 m.

The existing ground level on the western side of the north and south bridge embankments slopes down from Allandale Road into the pond. The slope surface currently comprises vegetation, small trees, cobbles and boulders.

In general, the subsurface conditions at the location of the proposed weir structure consist of very soft to firm clayey silt overlying either: a) very stiff gravelly clay or b) compact to dense gravelly sand glacial till or sandy gravel till. The glacial till rests on probable siltstone bedrock, which was penetrated 0.45 m by diamond drill rock coring. The glacial till directly underlying the clayey silt deposit was encountered at elevations 49.0 m and 50.2 m in boreholes BH3 and BH2, respectively.

5.3 Spread Footing

The very soft to firm lacustrine deposit (clayey silt) is not suitable for support of foundations. The weir structure foundations should be supported on native glacial till or on the very stiff gravelly clay. This will result in excavations that extend deeper than CBCL's proposed design level.

Foundations supported on the glacial till or on very stiff gravelly clay may be designed using a geotechnical resistance at Serviceability Limit States (SLS) of 150 kPa and a factored geotechnical resistance at Ultimate Limit States (ULS) of 200 kPa. The above resistances/reactions assume a minimum strip footing width of 400 mm.

The post-construction total and differential settlements of footings sized using the above SLS net bearing reaction should be less than about 25 and 15 millimetres, respectively, provided that the soil at or below founding level is not disturbed during construction.

The three boreholes performed indicate that the surface of the till slopes down in the north-east direction. The actual position of the till at the north-east abutment of the weir (i.e. north-east of BH3) is not known and may be deeper than 4.0 m.

The use of a structural backfill foundation may be used in the deeper portion of the excavation in order to limit the amount of concrete necessary for the proposed structure. In this case, the structural backfill should rest directly on intact glacial till or very stiff gravelly clay and be placed in individually compacted thin lifts.

The degree of compaction to be attained on each lift is a minimum of 95% of the Modified Proctor value of the material. The thickness of each lift will depend on the actual compaction equipment used on site and should be established based on the results of a trial pad or relevant experience. The structural backfill should be placed in horizontal lifts and should extend to the upstream and downstream edges of the excavation into the clayey silt. The material to be used for the structural backfill should consist of a well graded till with a minimum of 20% fines. The use of rockfill or other permeable material is not recommended since it may lead to excessive seepage beneath the proposed structure.

Prior to pouring the concrete for the footings, the foundation excavations should be inspected by a qualified geotechnical professional to confirm that the footings are located on undisturbed material, which has been cleaned of ponded water and loosened/softened material. If construction is carried out in the winter, special precautions will be required to avoid frost penetration and heave within foundation areas during construction, which may cause excessive settlements when thawed.

During the construction of the foundations, sufficient pumping capacity should be provided at the footing level to control water infiltration and keep founding surfaces free of water.

5.4 Site preparation and Foundation Excavation

It is understood that the water flow path from Long Pond into Rennies River is not likely to be diverted during the construction of the weir structure. The site preparation and excavation to the founding level for the footing would likely require constructing a cofferdam or similar system. Due to site constraints and environmental controls, it is understood that access of equipment into the working area may be limited and, at this stage, the type of cofferdam to construct the weir structure is not yet defined.

If an earthfill cofferdam is used, consideration should be given to select a low permeability material such as a well graded till to limit the amount of seepage within the working area, Upstream protection against wave action and siltation will be required. Such protection could be provided by a geotextile and surficial rockfill.

At least two possibilities could be envisioned for the construction of an earthfill cofferdam:

- A future stability analysis will be required to determine if both the upper and lower parts of the lacustrine deposit are appropriate to support the weight of the cofferdam while maintaining an appropriate factor of safety along the excavation slope of the working area. This analysis will have to take into account the expected flood level conditions of Long Pond. If the results of such an analysis are positive, the cofferdam could then be built either directly onto the clayey silt deposit or following partial excavation of the softer upper portion of this deposit. This option may also consider pushing back the cofferdam further into Long Pond in order to limit the influence of the weight of the cofferdam onto the adjacent excavation slope required for the construction of the weir.
- If the results of the stability analysis prove to be negative, the cofferdam will then have to be founded directly onto the till following progressive removal of the clayey silt under most of the cofferdam width. This will result in the need for an additional temporary floating curtain in Long Pond in order to control siltation during the excavation process.

If sheet piling is used in order to form a cofferdam, the type of sheet pile should be selected as to provide tight joints and minimum leakage into the working area. The restraint offered by sheet piles will depend on the length of embedment into the soils and the proximity of the excavation zone. If sheet piles are to be placed at close proximity to the temporary excavation, it is recommended that the passive force to be developed within the soft clayey silt be neglected. The following parameters can be used for the design of sheet piles:

- Unit weight of the clayey silt: 16.5 kN/m^3;
- Unit weight of the till: 19 kN/m^3;
- Friction angle of the till: 35 degrees.

Sand bags could also be considered for the cofferdam. Sand bags are however likely to settle into the soft clayey silt under their own weight and to tilt downstream as a result of the applied water (lake) pressure. Sand bags will also allow larger water seepage into the open excavation compared to an earthfill cofferdam. The crest of sand bags will probably not be high enough to match the design flood elevation which will increase the risk of flooding of the working area for the contractor.

All excavations will need to conform to the Newfoundland and Labrador Occupational Health and Safety Regulations, 2009. Additional information on the properties of the upper portion of the clayey silt deposit will be required to determine safe excavation slopes within this material, especially around BH3 where the excavation will be in the order of 3.2 m deep.

Excavation for the installation of site footings will be through the lacustrine deposit and till. Conventional hydraulic excavating equipment would be suitable to excavate the lacustrine deposit and the till material within a confined water-controlled area.

5.5 Frost Protection

All foundation elements should be provided with a minimum of 1.2 m of earth cover for frost protection purposes.

6.0 ADDITIONAL CONSIDERATIONS

The provision of continuous water pumping from Long Pond into Rennies River will likely be required in order to limit the environmental impact of the cofferdam onto the fish habitat further downstream in Rennies River. The sizing of the pumping system should be performed in conjunction with the selection of the cofferdam crest elevation as to take into account possible flood events while the cofferdam is in place. This may require performing a hydrological analysis.

At the time of the writing of this report, only limited conceptual details for the proposed structure were available. Golder Associates should be retained to review the final drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

Report Signature Page

GOLDER ASSOCIATES LTD.

Michel

Michel Wawrzkow
Senior Geotechnical Engineer

Michel Lemieux
Associate

PEG
PERMIT HOLDER
This Permit Allows
practi Professional Engineering
Newfoundland Labrador.
PEGNL D0029
2014

MICHEL WAWRZKOW
Nov 26, 2014

MW/ML/kl

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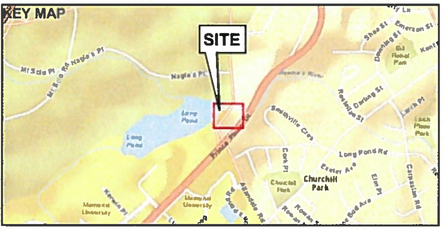
c:\users\klandry\appdata\local\microsoft\windows\temporary internet files\content.outlook\lrkzllqa\1407587-0001-r-rev 1- long pond weir (ml mw - nov 26 2014).docx

LEGEND

◈ APPROXIMATE BOREHOLE LOCATIONS

KEY MAP



0 5 10 20
1:500 METRES

NOTE(S)

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT NO. 1407587.

REFERENCE(S)

1. BING IMAGERY SUPPLIED BY ESRI AND MICROSOFT © 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS, IMAGE DATE: 2014-06.
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3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 22 VERTICAL DATUM: CGVD28

CLIENT
CBCL LIMITED

PROJECT
LONG POND WEIR

TITLE
APPROXIMATE BOREHOLE LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-10-16
DESIGNED	----
PREPARED	BR
REVIEWED	BW
APPROVED	CR

PROJECT NO.	PHASE	REV	FIGURE
1407587	4	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM

25mm

APPENDIX A

Record of Boreholes

PROJECT: 1407587

RECORD OF BOREHOLE: BH1

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: October 3-4, 2014

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

DRILL RIG: CME 55

DRILLING CONTRACTOR: Logan Geotech

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	REC. LENGTH (mm) / SA. LENGTH (mm)	BLOWS/0.15m	N VALUE	STANDARD PENETRATION RESISTANCE, N VALUE ■ (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10⁻⁶ 10⁻⁵ 10⁻⁴ 10⁻³); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	REMARKS, ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	PIEZOMETER OR STANDPIPE INSTALLATION
		WATER SURFACE		53.00								GR SA SI CL	
0	Continuous Split Spoon 90 mm Diam. Casing	WATER		0.00									
1													
2		(ML) CLAYEY SILT; dark grey brown, with organics; w>PL, cohesive, very soft		51.20 1.80									
3													
4		(CI) gravelly CLAY, fine to coarse gravel; pale grey; w<PL, very stiff		49.20 3.80	1	SS	305/610	0 7 23 19	30	30 ■			
		(GP) sandy GRAVEL, fine to coarse, subangular; pale grey to greenish grey, with low plasticity fines, cobbles and boulders (GLACIAL TILL); compact to dense		48.50 4.50	3	SS	356/610	13 13 12 32	25	25 ■			
5					4	SS	305/610	18 27 22 22	49	49 ■			
6					5	SS	203/534	33 16 21 50/0.08	37	37 ■			
	Rotary Drill NQ Core				6	SC	—						
7					7	SC	—						
8				44.85									
		Borehole continued on RECORD OF DRILLHOLE BH1 Note: 1. Drill string sank under it's own weight from 1.8 m to 3.8 m.		8.15									
9													
10													
11													
12													
13													
14													
15													

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: BW

CHECKED: ML

PROJECT: 1407587

RECORD OF DRILLHOLE: BH1

SHEET 2 OF 2

LOCATION: See Site Plan

INCLINATION: -90° AZIMUTH: ---

BORING DATE: October 3-4, 2014

DRILL RIG: CME 55

DRILLING CONTRACTOR: Logan Geotech

DATUM: Geodetic

JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate
BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL -
PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular
PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Point Load Index Legend:
- ● Diametral Test on Intact Sample
- ○ Diametral Test on Microdefect/Foliation
- ■ Axial Test on Intact Sample
- ☐ Axial Test on Microdefect/Foliation

UCS Legend:
- ▲ Intact Rock
- △ Partial Failure

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	UCS (MPa) 20 40 60 80 Point Load Index (MPa) 4 8 12 16	WEATHERING INDEX W1 W2 W3 W4 W5 W6	NOTES
		BEDROCK SURFACE		44.85														
	Rotary Drill NQ Core	Fresh, thinly bedded, red grey SILTSTONE, very poor quality		8.15 44.40	1	100												
		End of Drillhole		8.60														
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		
23																		

DEPTH SCALE
1 : 75

LOGGED: BW
CHECKED: ML

PROJECT: 1407587

RECORD OF BOREHOLE: BH2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 4, 2014

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

DRILL RIG: CME 55

DRILLING CONTRACTOR: Logan Geotech

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
		WATER SURFACE		53.00
0	Continuous Split Spoon 90 mm Diam. Casing	WATER	▤	0.00
		(ML) CLAYEY SILT; brown to dark grey, with organics; w>PL, cohesive, very soft to firm	▨	51.55 1.45
		(SP) gravelly SAND, medium to coarse, subangular; pale grey to greenish grey, with low plasticity fines, cobbles and boulders (GLACIAL TILL); compact to very dense	▨	50.20 2.80
		End of Borehole		47.20 5.80

SAMPLES NUMBER	TYPE	REC. LENGTH (mm) / SA. LENGTH (mm)	BLOWS/0.15m	N VALUE
1	SS	178/610	3 3 4 4	7
2	SS	229/610	5 12 29 35	41
3	SS	229/610	29 15 11 10	26
4	SS	432/610	2 15 11 10	26
5	SS	330/610	11 31 21 14	52

STANDARD PENETRATION RESISTANCE, N VALUE ■ 20 40 60 80

SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80

REMARKS, ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

PIEZOMETER OR STANDPIPE INSTALLATION

Note:

1. Borehole terminated at 5.8 m depth due to encountered cobbles or boulders within the fill, which caused the drill string to move out of vertical alignment.

2. Drill rods sank by own weight from 1.45 m to 2.2 m.

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: BW

CHECKED: ML

PROJECT: 1407587

RECORD OF BOREHOLE: BH3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 4, 2014

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

DRILL RIG: CME 55

DRILLING CONTRACTOR: Logan Geotech

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Continuous Split Spoon, 90 mm Diam. Casing

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	WATER SURFACE	53.00
0	WATER	0.00
0.85	(ML) CLAYEY SILT, some gravel and wooden fragments; dark brown, with organics; w>PL, cohesive, very soft to firm	52.15 0.85
4.00	(GP) sandy GRAVEL, fine to coarse, subangular, some fines; greenish grey, pale brown and red (GLACIAL TILL); compact to dense	49.00 4.00
6.90	End of Borehole	46.10 6.90

NUMBER	TYPE	REC. LENGTH (mm) / SA. LENGTH (mm)	BLOWS/0.15m	N VALUE
1	SS	152/610	1 1 1 2	2
2	SS	127/610	4 9 3 5	12
3	SS	127/585	1 2 1 50/0.13	3
4	SS	305/610	8 17 21 26	38
5	SS	305/610	21 20 29 7	49
6	SS	483/610	15 16 15 21	31
7	SS	381/610	17 12 12 13	24

STANDARD PENETRATION RESISTANCE, N VALUE ■ : 2, 12, 3, 38, 49, 31, 24

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢ ○W ⊣ Wl

REMARKS, ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

PIEZOMETER OR STANDPIPE INSTALLATION

Note:

1. Borehole terminated in fill as the borehole wall collapsed during drilling.

2. Drill rods sank by own weight from 0.85 m to 2.0 m.

DEPTH SCALE
1 : 75

LOGGED: BW

CHECKED: ML

APPENDIX B

Important information regarding this report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

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The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

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Golder Associates

APPENDIX I

Climate Change Projection Report

Projection of Precipitation Intensity-Duration-Frequency Data for the Mid-21st Century in St. John's, NL

Prepared by Dr. Joel Finnis
for CBCL Limited
as a contribution to a report to the City of St. John's
Final Report, Sept. 4, 2013

1.0 Introduction

As awareness of climate change continues to increase, a growing number of stakeholders have become interested in accessing climate projections at scales suitable for adaptation planning. Unfortunately, the desired information is rarely available in a usable form, and considerable work is often necessary before projections can be put in action. The core tool used in climate change research is the general circulation model (GCM). Given limited inputs such as variations in solar output or atmospheric composition, a GCM will provide a long-term simulation of the state of the atmosphere, ocean, land surface, and snow/ice across the entire planet. By using long simulations (typically longer than 100 years), and allowing different atmospheric compositions to be used, GCMs can be used as a virtual laboratory in order to test various climate-related hypotheses; the best known of these is the hypothesis that consumption of fossil fuels can influence global climate. This is a very different modeling approach than that used in short-term weather forecasts; here, the emphasis is not on predicting the evolution of specific storms, but instead on examining the long-term impact of multiple weather systems. At present, GCMs provide the best available means of assessing large-scale impacts of climate change, such as global mean temperatures or Arctic sea ice extent.

The direct application of GCMs in regional- or local-scale analyses is limited by the low spatial (100-1000km) and temporal (usually 24 hours) resolution of the GCM output. At these scales a location like Newfoundland appears as only a handful of data points, in which it is impossible to distinguish between the distinct climates of St. John's, St. Anthony, Corner Brook, or Gander. The limited resolution is necessary because of the physical complexity and global scope required in a reliable GCM; in order to complete the computations in a reasonable amount of time, resolution must remain low. However, there exist strong relationships between the large-scale phenomena GCMs simulate well and the small-scale phenomena of concern on regional scales. The process of extracting small-scale information from low-resolution data (whether GCM output or observations) is referred to as climate downscaling. Commonly used to assess climate on scales necessary for practical applications, downscaling can be performed with either statistical methods (statistical downscaling) or the use of regional climate models (RCMs) run with a) a limited domain and b) much higher resolution (~10-50 km). Referred to as dynamical downscaling, the RCM approach uses GCM output to provide boundary forcing for the RCM, making the RCM output a physically-constrained, high resolution extension of the original low-resolution GCM data.

2.0 Climate Projection Data

The IDF projections for the mid-21st century presented here were derived from RCM simulations prepared for the North American Regional Climate Change Assessment Project (NARCCAP; Mearns et al. 2012). NARCCAP used multiple RCM/GCM combinations to generate a multi-model ensemble of projections; each combination consists of a paired 20th century (1968-2000) simulation and 21st century (2038-2070) projection. Currently, seven paired ensemble members suitable for analysis in Newfoundland are available; all have been used in the current study. NARCCAP data is saved at 50km spatial resolution and 3 hour time intervals.

3.0 Methodology

3.1 Areal Reduction Factor Approach

Although raw RCM output offers an improvement over raw GCM output, additional analysis is still necessary before the projections can be put into practice. Precipitation statistics calculated from climate model output, whether RCMs or GCMs, do not typically match station observations well. One of the primary reasons for this is that the models calculate precipitation averaged for areas (grid cells; in this case, 50km x 50km), while stations measure precipitation falling over a single point (Emori et al. 2005). Extreme precipitation events typically affect an area much smaller than an RCM grid cell; in a model, the precipitation produced by these small, intense events will be distributed evenly across the grid cell, reducing their maximum intensity. Consequently, extreme events simulated by models are considerably lower than those observed at stations. A variety of methods have been proposed for translating between station data and model output; the current study uses the areal reduction factor (ARF) method proposed by Allen & DeGaetano (2005). In this approach, an ARF is calculated as:

$$ARF(T,d) = \frac{x_c^{(g)}(T,d)}{x_c^{(s)}(T,d)} \qquad (1)$$

where $x_c(T,d)$ is the precipitation amount for the return period T and duration d, in the 20th century (subscript c). Superscript s indicates values observed at a station, and g indicates values output for the model grid cell (here, the grid cell closest to the station). In the current implementation, ARFs were calculated for each requested return period (2, 5, 10, 20, 25, 50 and 100 year return periods) at event durations of 6, 12, and 24 hours. As multiples of the base 3 hourly data output by the NARCCAP RCMs, these are the event durations that can be estimated without additional extrapolation from the model output. Assuming ARFs remain constant under a changing climate, future (subscript f) station values can then be estimated as:

$$x_f^{(s)}(T,d) = \frac{x_f^{(g)}(T,d)}{ARF(T,d)} \qquad (2)$$

Following the methodology used to update the observational IDF curve, NARCCAP return period events were estimated for 6, 12, and 24-hour duration by fitting a three parameter lognormal distribution to an annual precipitation maxima timeseries at the model grid cell closest to the St. John's airport. Distributions were fit to both 20th century NARCCAP simulations and 21st century projections; the former were compared to a distribution fit to observed station values in order to calculate ARFs. These ARFs were then applied to the 21st century distributions to estimate future return period events.

3.2 Extrapolation of Short Duration Return Periods

Additional analysis was required to estimate values for durations shorter than three hours. Following the official IDF curves produced by Environment Canada, this was done by assuming a linear fit between the log of event intensity and log of event duration for a given return period (a log/log linear fit), and extrapolating to short durations. In order to improve the fit, additional data points were first derived by applying the ARF method described above to 3, 9, 15, 18, and 21 hour event durations. This provided a total of eight intensity vs. duration data points for each desired return period. The log/log linear relationship was then fit to these eight values, and intensities for the desired short duration events (5 minutes, 10 minutes, 15 minutes, 30 minutes, 1 hour, and 2 hours) were extrapolated. It is important to note that uncertainty in extrapolated intensities increases sharply as the duration decreases, and results for durations shorter than an hour must be interpreted with caution.

3.3. Monte Carlo Approach & Confidence Bounds

Extreme precipitation calculations are typically sensitive to outliers in a data set; that is, one or two events can dramatically shift return period estimates. Ideally, return period estimates would be based on extremely long precipitation time series; unfortunately, these are rarely available either in observations or RCM output. In the absence of these long time series, it is helpful to assess the robustness of the results by performing repeated calculations using a sub-sample of the full data set (referred to as a 'Monte Carlo' approach). By providing a range of results, this approach can be used to estimate confidence bounds on the results. A Monte Carlo approach has been used in the current study. Random samples of twenty-five yearly precipitation maxima (of the available thirty-three years) were taken from the RCM 20th and 21st century simulations. The procedures described above were then applied to obtain return period intensities for all requested durations (5 minutes, 10 minutes, 15 minutes, 30 minutes, 1 hour, 2 hours, 6 hours, 12 hours, and 24 hours). This sub-sampling approach was repeated 100,000 times for each of the seven NARCCAP model combinations, for a total of 700,000 estimates of each requested IDF data point. The mean, 5th percentile, and 95th percentile of the resulting 700,000 estimates is reported in the following table as the mean, minimum, and maximum projection respectively.

4.0 Results

Results of are provided in the following tables, respectively giving the mean (Table 1), 95th percentile (Table 2), and 5th percentile (Table 3) of the 700,000 Monte Carlo tests. Requested intensities are given in millimeters of precipitation for requested return periods and event durations.

Table 1: Mean of the Monte Carlo estimates of future (2038-2070) return period events for various durations.

Return Period	**5 mins**	**10 mins**	**15 mins**	**30 mins**	**1 hour**	**2 hour**	**6 hour**	**12 hour**	**24 hour**
2 year	9.7	12.5	14.4	18.5	23.8	30.5	48.5	59.9	71.4
5 year	11.9	15.5	18.1	23.5	30.7	40.0	64.5	82.1	98.3
10 year	13.4	17.5	20.5	26.9	35.3	46.3	75.1	96.9	116.3
20 year	14.9	19.5	22.9	30.1	39.7	52.3	85.2	111.1	133.5
25 year	15.3	20.2	23.7	31.2	41.1	54.2	88.4	115.6	139.0
50 year	16.8	22.1	26.0	34.3	45.4	60.1	98.3	129.5	155.9
100 year	18.2	24.1	28.3	37.5	49.7	65.9	108.1	143.4	172.7

Table 2: The 95th percentile of the Monte Carlo estimates of future (2038-2070) return period events for various durations.

	Duration								
Return Period	**5 mins**	**10 mins**	**15 mins**	**30 mins**	**1 hour**	**2 hour**	**6 hour**	**12 hour**	**24 hour**
2 year	12.0	14.7	16.7	20.8	26.4	34.1	54.4	70.3	82.3
5 year	15.0	19.2	22.1	28.5	36.7	47.4	74.2	97.5	114.5
10 year	17.8	22.7	26.3	33.8	43.6	56.5	87.5	115.7	136.3
20 year	20.6	26.3	30.4	39.1	50.4	65.2	100.4	133.2	157.1
25 year	21.5	27.4	31.7	40.7	52.5	67.9	104.5	138.8	163.8
50 year	24.3	31.0	35.8	45.9	59.2	76.5	117.0	156.0	185.2
100 year	27.1	34.5	39.9	51.1	65.7	85.0	129.5	173.1	207.0

Table 3: The 5th percentile of the Monte Carlo estimates of future (2038-2070) return period events for various durations.

	Duration								
Return Period	**5 mins**	**10 mins**	**15 mins**	**30 mins**	**1 hour**	**2 hour**	**6 hour**	**12 hour**	**24 hour**
2 year	7.3	9.7	11.5	15.3	20.3	27.0	44.2	53.2	59.4
5 year	9.1	12.2	14.5	19.4	26.0	34.6	57.3	70.9	81.8
10 year	9.5	13.0	15.7	21.4	29.1	39.1	65.5	81.2	95.2
20 year	10.0	13.8	16.7	23.0	31.7	43.3	73.3	90.5	107.3
25 year	10.1	14.1	17.1	23.6	32.7	44.7	75.7	93.5	111.1
50 year	10.6	14.8	18.1	25.2	35.2	48.7	83.2	102.5	122.7
100 year	11.1	15.7	19.2	26.9	37.9	52.9	90.7	111.2	134.1

References

Allen, R., and A. DeGaetano, 2005: Areal Reduction Factors for Two Eastern United States Regions with High Rain-Gauge Density. *Journal of Hydrologic Engineering*, **10,** 327-335, doi:10.1061/(ASCE)1084-0699(2005)10:4(327).

Emori, S., A. Hasegawa, T. Suzuki, and K. Dairaku, 2005: Validation, parameterization dependence, and future projection of daily precipitation simulated with a high-resolution atmospheric GCM. *Geophys Res Lett*, **32,** L06708, 10.1029/2004gl022306.

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APPENDIX J

Breach Parameters

Proposed Dam Breach Parameters for Long Pond Berm

Project No.	143-063
Phase No.	02
Task No.	****
Created by	Hua Zhang
Date Created	08-Sep-15
Date Revised	
Reviewed by	Anil Beersing
Date Reviewed	09-Sep-15

1. Information on Dam and Pond

Dam and Reservoir Data	Metric Unit	English Unit
As Built Top-of-Dam Elevation (HDD) (m, ft)	56.3	184.7
Operating Level (m, ft)	55.7	182.7
Bottom Invert (YBMIN) (m, ft)	52.6	172.6
Height of the Dam (HD) (m, ft)	3.7	12.1
Water Depth at Operating Level (H) (m, ft)	3.1	10.2
Dam Crest Length (m, ft)	50	164.0
Pond Suface Area at FSL (km^2, acre)	0.21	53.0
Pond Capacity at FSL (V_r) (dam^3, acre-ft)	480	390
Pond Suface Area at Top of Dam (km^2, acre)	0.23	56.8
Pond Capacity at Top of Dam (V_r) (dam^3, acre-ft)	613	497

2. Fread's Equation

Estimates of Dam Breach Parameters	Piping Failure	Overtopping Failure
	English Unit	English Unit
BR [= $9.5 * k_o * (V_r * H)^{0.25}$] (ft)	52.8	83.7
BR / HD	4.3	6.9
TFH [= $0.3 * V_r^{0.53} / H^{0.9}$] (hour)	0.9	0.9

0.5<BR/HD<8

The equation for calculating the BR and TFH from the paper "Some Existing Capabilities and Future Direction for Dam-Breach Modeling/Flood Routing" written by D.L. Fread

3. Proposed Dam Breach Parameters

Recommendation for Dam Breach Parameters	Golder's Recommendation			
	Piping Breach		Overtopping Breach	
	Metric Unit	English Unit	Metric Unit	English Unit
BR / HD	4.0	4.0	6.0	6.0
Average Width of Breach (BR) (m, ft)	14.8	48.6	22.2	72.8
Bottom Width of Breach (BBD) (m, ft)	11.1	36.4	18.5	60.7
Side Slope of Breach (ZBCH or S)	1.0	1.0	1.0	1.0
Time to Failure (TFH) (hour)	0.5	0.5	0.2	0.2
Elev. Breach Commences (HFDD) (m, ft)	55.7	182.7	56.6	185.7
Bottom Invert (YBMIN) (m, ft)	52.6	172.6	52.6	172.6