NICOLSTON DAM REHABILITATION

CIVIL WORKS
TECHNICAL SPECIFICATIONS

Project No. A000492F

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Fisheries and Oceans Canada
Pêches et Océans Canada

SEA LAMPREY CONTROL CENTER

NICOLSTON DAM REHABILITATION

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SEA LAMPREY CONTROL CENTER

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00	2017-06-05	Issued For Bid and Authorization
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1. GENERAL INSTRUCTIONS

1.1 DESCRIPTION

1.1.1 This technical specification covers the requirements for the supply of all labour, materials, tools, equipment and execution of the civil works as described by the drawings and specifications. These civil works are part of the Nicolston Dam Rehabilitation project.

1.1.2 The coordinates of Nicolston Dam are the following:

Latitude: 44°09'59.65"

Longitude: -79°48'42.45"

1.2 INCLUDED WORK

1.2.1 Structures and civil works covered by these specifications are the following:

- Main Spillway;
- Auxiliary Spillway;
- Abutment Walls;
- Access Roads;
- Cofferdam and Dewatering;
- Fabricated Steel for all of the previous items;
- Overshot gates

1.2.2 The work includes but is not limited to the following:

a) Supply and installation of all temporary cofferdam structures and environmental protection components such as turbidity curtains, sediment fences and erosion protection structures to be fixed at the perimeter of the construction zones in order to allow excavation, demolition, concrete work and dewatering;
b) Demolition and reconstruction of the Main and Auxiliary spillways;
c) Earth excavation (spillways, abutment walls, river bed);
d) Supply and construction of all concrete structures;
e) Supply and installation of all embedded parts in concrete;
f) Supply and installation of steel structures, grating decks, handrails and fences to insure safety of the site;
g) Supply and installation of overshot gates for Main spillway;

h) Supply and installation of all materials for the construction of access roads, landscaping and cleaning of the site;
i) Repair of any roads or other structures that may have been damaged by the Contractor during the works.
j) Installation of auxiliary mechanical equipment (gates, hoists, etc.)

1.3 SCOPE OF WORK

1.3.1 The Contractor shall provide all qualified labor, materials, equipment and accessories required to complete the works described below. The following list is not exhaustive and any element appearing in the drawings and not expressly mentioned in this list is also an integral part of the contract. If, after beginning the work, the Contractor discovers discrepancies between the drawings and actual site conditions or any error or omission on the drawings, he shall immediately inform the Departmental Representative in writing. Following such a discovery, any unauthorized work performed shall be at the expense of the Contractor.

1.3.2 Access Roads

The works associated to the installation of roads providing access to the various construction areas include, but are not limited to, the following:

a) Design, supply and installation of foundation/platform for all access roads respecting the property limits shown on the drawings, in such a manner so as not to cause damage to the site.
b) Removal of protective measures and access roads once the works are complete.
c) Rehabilitation of the site, including re-seeding of any damaged areas.

1.3.3 Water Level Control

The works associated with the control of water levels during construction include, but are not limited to, the following:

a) Design, supply, transportation and installation of all temporary cofferdams required to execute excavation, demolition, concreting and backfilling works in the dry.
b) Dewatering of work areas behind temporary cofferdams as well as control and evacuation of seepage and rain water by methods approved by the Departmental Representative.
c) Supply and installation of a settling basin and a basin to collect waste water from concrete demolition.
d) Maintenance and repair of cofferdams to ensure their stability.

e) Removal of cofferdams and deviation works as well as settling basin and waste water collection basin. Transportation and disposal of these materials from the construction site according to environmental regulations.

1.3.4 Main Spillway

The rehabilitation works for the Main Spillway include, but are not limited to, the following:

a) Supply of manpower and equipment for riverbed excavation on the upstream and downstream sides of the spillway, as shown on the drawings, as well as removal and disposal of the excavated material from the site.
b) Supply of manpower, materials and equipment for concrete demolition on the surface of the spillway, as shown on the drawings. Removal and disposal of all materials resulting from demolition works, as well as local concrete repairs as indicated by the Engineer.
c) Supply of manpower, equipment and materials for concreting works, as shown on the drawings.
d) Supply of manpower, equipment and materials for voids grouting of the spillway, as shown on the drawings.
e) Supply of manpower, equipment and materials for backfilling, as shown on the drawings.
f) Supply of manpower and equipment for the installation of auxiliary mechanical equipment and all associated accessories.

1.3.5 Auxiliary Spillway

The rehabilitation works for the Auxiliary Spillway include, but are not limited to, the following:

a) Supply of manpower and equipment for riverbed excavation on the upstream and downstream sides of the spillway, as shown on the drawings, as well as removal and disposal of the excavated material from the site.
b) Supply of manpower and equipment for concrete demolition on the surface of the spillway, as shown on the drawings. Removal and disposal of all materials resulting from demolition works.
c) Supply of manpower, equipment and materials for concreting works, as shown on the drawings. Supply of manpower, equipment and material for voids grouting of the spillway, as shown on the drawings.
d) Supply of manpower, equipment and materials for sheet pile installation.
e) Supply of manpower, equipment and materials for backfilling, as shown on the drawings.

1.3.6 Abutment Walls

The rehabilitation works for the Abutment Walls include, but are not limited to, the following:

a) Supply of manpower and equipment for any excavation work required for the construction or rehabilitation of the abutment walls, as well as removal and disposal of the excavated material from the site.
b) Supply of manpower and equipment for concrete demolition, as shown on the drawings. Removal and disposal of all materials resulting from demolition works.
c) Supply of manpower, equipment and materials for concrete repair works, as shown on the drawings and as indicated on site by the Engineer.
d) Supply of manpower, equipment and materials for any backfilling work required.

1.4 STANDARDS

1.4.1 Reference is made to national and international standards. These standards, when quoted, form an integral part of and are to be read in conjunction with the specification as if reproduced herein.

1.4.2 Abbreviations used are:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CGSB	Canadian General Standards Board
CAN/CSA	Canadian Standard Association
NBC	National Building Code of Canada
RSIC	Reinforcing Steel Institute of Canada
SSPC	Steel Structures Painting Council
WSIB	Work Place Safety and Insurance Board

1.4.3 The latest edition of Standards mentioned prevails, unless otherwise specified. If the Contractor proposes to use different standards than those specified, a written request for the substitution must be sent to the Departmental Representative prior to construction. The Departmental Representative has the right to refuse the Contractor's proposed alternative standard if not acceptable and keep the specified standard.

1.5 ENVIRONMENT

1.5.1 The Contractor shall execute all works in accordance with the environmental laws and any applicable local regulation for the type of work undertaken.

1.5.2 All material shall be free of deleterious substances as defined in the Fisheries Act.

1.5.3 All material shall be delivered, stored and placed in such a manner as to prevent introduction of deleterious substances into the river.

1.5.4 The Contractor shall take special care to prevent damage to the grounds and property of the landowner(s), and minimize the footprint associated with the work.

1.5.5 The Contractor shall stabilize or restore the stream banks if damaged by the transport of equipment.

1.5.6 The Contractor shall clean up the site after the works to the satisfaction of the Departmental Representative.

1.5.7 The Contractor shall use equipment in good repair and free from leaks. He shall remove any equipment developing a leak from the site immediately. The Contractor shall report any leaks to the Ministry of the Environment and Climate Change, and clean up immediately.

1.5.8 The Contractor shall keep removal of vegetation to a minimum. He shall obtain approval from the Departmental Representative prior to removing any trees.

1.5.9 The Contractor shall stabilize all disturbed soils with seed mat approved by the Departmental Representative.

1.5.10 The Contractor shall stabilize stock piles of debris, spoil, fill material or other waste at least 30 meters from the river and protect with silt fencing if there is a risk of erosion.

1.5.11 The Contractor shall place sediment fencing along the top of river banks and along the edges of the work area when the distance from the work area to the river is less than 30 m.

1.5.12 No in-stream activity shall occur until silt curtains have been placed around the work area. The amount of in-stream works should be minimized.

1.5.13 In-stream activity must be avoided in high flow conditions.

1.5.14 The Contractor shall monitor sedimentation outside of sedimentation fencing and silt curtains on a daily basis. Maintenance of silt curtains and sediment fencing shall be executed regularly by the Contractor to prevent failure of the installed protection.

1.5.15 In addition to working in an isolated area with downstream turbidity curtains, the Contractor is to develop contingency measures for the containment of turbid water and/or sediments prior to commencement of the works.

1.5.16 The Contractor shall clean batch mixers and concrete transport and pouring equipment in a dedicated area at least 60 m away from the water course in an appropriate containment area that can later be emptied and disposed of at an authorized disposal site.

1.5.17 Fuelling and maintenance activities shall occur within designated areas, at a minimum of 100 m from the shoreline, where sediment erosion control measures and all precautions have been made to prevent oil, grease, antifreeze or other materials from inadvertently entering the ground or the surface water flow. If contaminant spilling occurs, the Contractor shall confine and recuperate it. The Contractor shall keep absorbent material on site at all times.

1.5.18 All in water work will occur during the established timing window (July 15 – September 30, inclusive).

1.5.19 The Contractor shall submit the dewatering and the erosion/sediment control plan to the Departmental Representative for approval prior to construction.

1.6 HEALTH AND SAFETY

1.6.1 Prior to beginning the work, the Contractor shall prepare a site-specific safety program designed to eliminate risks to the health, safety and physical well-being of workers.

1.6.2 Work shall be conducted in accordance with the Safety Code for the construction industry and shall take into account all applicable regulations in the field of occupational health and safety.

1.6.3 The Contractor shall give special attention to the health and safety plan for work near and under water. Qualifications of workers, water rescue equipment and emergency actions must be identified in the plan. All workers shall receive special training regarding the use of safety and rescue equipment, including life jackets and rescue boats.

1.7 CONSTRUCTION SEQUENCES, WATER LEVELS AND RIVER FLOWS

1.7.1 Maximum water levels during and after construction are indicated on the construction drawings.

1.7.2 The Contractor shall conduct work in the river during the time frame schedule specified on the drawings, and following all constraints described under sub-section 1.6 of this specification.

1.7.3 The Contractor shall monitor water levels at all times and shall immediately evacuate the site if it becomes apparent that that water levels will exceed the elevations indicated on the drawings.

1.7.4 Any required cold weather work must adhere to all applicable standard industry practices and approvals, as well as any winter-specific requirements (e.g. BMP 038 from Genivar and NRSI, 2012; CCA, 1956). The season in which construction is conducted does not relieve the Contractor of the responsibility to carry out the works with safety, proper notification to the public and the implementation of proper emergency response plans.

1.8 SITE LAYOUT AND DRAWING INTERPRETATION

1.8.1 Layout coordinates; dimensions, reference points and axis for work are presented to the Contractor in the drawings. The Contractor shall not measure on the drawings but refer to the dimensions, elevations and annotations shown.

1.8.2 All dimensions, ground profiles of the existing terrain as well as profiles of existing structures must be verified on site by the Contractor prior to starting work.

1.8.3 The Contractor shall submit to the Departmental Representative, prior to beginning work, a layout drawing showing the actual dimensions of the existing structures, including spillway profiles, and all measurement discrepancies between the drawings and actual site conditions.

1.8.4 The Contractor shall survey the elevation of the concrete crest of the existing spillways prior to demolition work based on the project benchmark. The concrete crests are to be re-built as indicated on the drawings.

2. CONSTRUCTION MANAGEMENT

2.1 GENERAL

2.1.1 The Contractor shall be responsible for opening of the construction site, mobilisation, coordination, demobilisation and closure of the construction site.

These responsibilities include, but are not limited to:

- All rights of passage outside of the land access provided by the Departmental Representative as well as any required permits. Removal, displacement, support or protection of any underground or aerial service such as power lines, aqueducts, sewer lines, etc. as well as any other obstacle having the potential to impede the progress of the work;
- Maintenance of existing access roads during the works and their rehabilitation;
- Materials quality control by a certified laboratory;
- Construction site installations, including any necessary land rental, electrical, lighting, heating, potable water supply and adequate hygiene and security services;
- All insurance costs;
- Site restoration after completion of construction works.

2.1.2 The Contractor shall be responsible for coordination of the work schedule, submission of documents, use of the construction site, supply of temporary utilities and erection of construction site installations, as well as the execution of the works including those performed by sub-contractors.

2.1.3 The Contractor shall ensure that a foreman is present on site at all times. This foreman shall have the proper qualifications and have a very good understanding of all the work sequences to be accomplished.

2.1.4 The Contractor shall ensure that a copy of the most recent version of each of the following documents is available on site at all times:

1. The Drawings;
2. The Technical Specifications;
3. All Addenda;
4. All Design Change Notices;
5. Any other modifications to the contract;
6. Reports of investigations and tests performed on site;

7. The construction schedule, approved by the Departmental Representative;

8. Any other document deemed important by the Departmental Representative.

2.1.5 Once the construction works are complete, the Contractor shall remove from the site, in addition to his own material, any garbage, waste or debris. He shall clean all areas which he may have obstructed and repair or replace any fences or other components which may have been damages during the works. The Contractor shall dispose of all removed material by transporting it away from the site to locations approved by the Departmental Representative.

2.1.6 The Contractor shall be responsible for coordination of all the works, including coordination between all of his employees, sub-contractors, the Departmental Representative as well as any public utilities. He shall advise his own sub-contractors as well as any person involved in the project of any delay or problem having the potential to impede the progression of the work.

2.1.7 No reclamation for supplementary work shall be awarded due to insufficient or improper definition of sub-contractors' tasks. The Contractor shall be fully responsible for the coordination required to deliver the totality of the works as described in the drawings and in these specifications.

3. COFFERDAM CONSTRUCTION

3.1 GENERAL

3.1.1 Work described in this section includes the supply and installation of the cofferdam structures used to undertake the works described in sub-section 1.2 of these specifications and shown on the Drawings.

3.1.2 The Contractor shall supply and install the cofferdam structure in such a manner so that the work area is maintained dry for the period of construction. Infiltration through the cofferdam and the riverbed must be adequately controlled, treated and discharged into the river by the Contractor.

3.1.3 The Contractor shall submit to the Departmental Representative, for information purposes, shop drawings and installation procedures for the cofferdam structures according to the Drawings and these specifications. The shop drawings and procedures provided by the Contractor must be stamped and signed by a Professional Engineer registered in the province of Ontario.

3.2 MATERIALS AND EQUIPMENT

3.2.1 All material and equipment used on site must be in good working condition and handled in a safe manner that does not cause injury or damage.

3.2.2 The Contractor shall use materials as described in the drawing specifications for the construction of cofferdams.

3.3 EXECUTION

3.3.1 The Contractor shall complete all work and provide all materials, equipment and services for the installation, operation, maintenance and removal of the cofferdam structures.

3.3.2 The Contractor shall provide and adapt the water control system within the cofferdam interior area as necessary to maintain the work area secure and dry in the event of unanticipated conditions or events.

4. DEWATERING

4.1 GENERAL

4.1.1 The works described in this section include the dewatering of work areas and temporary surfaces during construction, as well as the pumping and evacuation of runoff water and seepage water.

4.1.2 The works include, but are not limited to, the following:

a) Design, supply, transportation, installation, operation, maintenance and dismantling of the dewatering system;
b) Design, excavation in overburden and bedrock, transportation of materials as required, of any trenches or sumps required to divert water or lower the water table by gravity in the work areas, including their maintenance and backfilling;
c) Sedimentation ponds or filter bags for elimination of suspended sediment in the water according to permits issued by regulatory authorities.

4.2 DEFINITIONS

4.2.1 Dewatering includes all necessary measures to prevent or control water flow into the excavation, or water accumulation in excavations, to ensure that the bottoms and sides of excavations remain stable during construction.

4.2.2 A normal dewatering system consists of ditches, trenches, drains, cofferdams, sumps, conduits, pumping systems as well as the equipment, materials, and labor required to carry out the work.

4.2.3 Dewatering consists of the lowering of the water table, and the collection and evacuation of runoff and groundwater.

4.3 DEWATERING PLANNING

4.3.1 The Contractor shall present to the Departmental Representative detailed drawings showing the methods and sequences for dewatering. The Contractor shall provide a dewatering system with adequate capacity to keep the work areas free from water at all times.

4.4 DEWATERING WORKS

4.4.1 The dewatering system shall maintain work areas dry during excavation, demolition and concreting works, foundation preparations, backfilling works, and it shall insure excavated slope stability and prevent material erosion as long as required.

4.4.2 The Contractor shall evacuate water away from the excavation areas and the access roads in such a way that it does not go back into the excavations, whether directly or by infiltration.

4.4.3 Under winter conditions, the Contractor shall adequately protect dewatering installations from the cold and insure that they are in working conditions for the duration of the works.

4.4.4 All temporary dewatering components must be removed upon completion of the works and the site must be restored to its initial condition. The contractor shall remove the dewatering system in such a manner as to allow surface water elevations to slowly return to natural elevations without causing erosion or damage to the structures or foundations.

5. CLEARING, GRUBBING AND CLEANING

5.1 GENERAL

5.1.1 Works described in this chapter include the supply of manpower, equipment and materials required for the execution of clearing, grubbing and cleaning as shown on the drawings, in accordance with these specifications and according to the requirements of the Departmental Representative.

5.1.2 Works include, but are not limited, to the following:

a) Clearing, grubbing and cleaning where required for cofferdams, access roads, excavations, backfilling, spillway and abutment wall repair and construction;
b) Clearing, grubbing and cleaning of all areas specified by the Departmental Representative;
c) Removal of dead wood along the shores inside the clearing and grubbing limits as shown on the drawings.

5.2 DEFINITIONS

5.2.1 Clearing and grubbing includes, but is not limited to, cutting, logging if required, removal and disposal of all trees, bushes, shrubs, branches, dead wood and other vegetal debris located inside the clearing limits. The Contractor shall cut trees, stumps and all vegetation to a maximum height of 150 mm above natural ground.

5.2.2 Stump removal, when completed after clearing by the Contractor or by others, includes removal of all stumps and roots with a diameter greater than 50 mm and all entangled roots of lower diameter located within the specified limits.

5.2.3 Cleaning includes the removal of any unsuitable material not meeting the requirements of these specifications.

5.2.4 Bushes include all vegetation composed of branches with a diameter of 50 mm or less located near the ground surface. Trees include all vegetation not considered as bushes.

5.2.5 Laydown areas include storage, service, waste areas and all other areas used by the Contractor and not specified in these specifications.

5.3 PLANNING

5.3.1 The Contractor shall complete clearing in stages to limit damages to the environment. He is allowed to start clearing works only after the clearing, grubbing and cleaning limits have been established and with the authorization of the Departmental Representative. The Contractor shall limit clearing to the minimum area required within the limits of the contract.

5.4 GENERAL REQUIREMENTS

5.4.1 The Contractor shall execute clearing in such a manner as to avoid damaging the surrounding forest and allow accumulation and salvage of topsoil for subsequent rehabilitation works. Use of a bulldozer is prohibited.

5.4.2 The Contractor's operations shall follow the rules related to forest exploitation as stipulated by the following documents:

a) Forest Laws;
b) The Contractor shall abide by all written directions issued by regulating authorities.

5.4.3 The Contractor shall be held responsible for all cleared areas located outside of the approved cleaning limits and shall replant at his own expense.

5.4.4 The Contractor shall dispose of all wood and debris from clearing and grubbing that is not sold or used for construction. He shall recycle or dispose of materials according to the Departmental Representative's instructions. Burial of trees, bushes, branches or other vegetal debris is prohibited within the limits of the area to be cleared.

5.5 PARTICULAR REQUIREMENTS

5.5.1 The Contractor shall execute clearing within the limits indicated by the Departmental Representative.

5.5.2 The Contractor shall complete grubbing and cleaning if the underlying materials are to be used as construction material.

5.5.3 The Contractor shall take special care to conserve any trees that do not impede the completion of the works. He shall avoid having trees fall outside of the clearing area.

5.5.4 Where temporary storage of felled trees is necessary, the Contractor shall do so within the limits of the area to be cleared so as to avoid causing damage to areas outside of the clearing zone.

5.6 WASTE DISPOSAL

5.6.1 The Contractor shall dispose of waste in accordance with the Departmental Representative's instructions.

5.6.2 The Contractor shall place debris from clearing, grubbing and cleaning at least 30 m away from waterways and lakes, depending on current government rules.

6. CONCRETE DEMOLITION

6.1 GENERAL

6.1.1 Work described in this section includes the equipment, materials, manpower, temporary bracing, protection devices and all other items that may be required in order to execute the demolition of structures and the disposal of debris.

6.1.2 The demolition of structures includes, but is not limited to, the demolition of the required components of existing Main and Auxiliary spillways as well as the existing abutment walls.

6.1.3 Demolition works shall also include local repairs that shall be coordinated on site with the Engineer. Specific repair types and procedures are provided on drawing S01.

6.1.4 Concrete demolition works include structural concrete and any other material of similar nature and disposal of any embedded parts, wire mesh, rods, reinforcing bars or any other material found inside of the demolition zone.

6.1.5 The works also include the removal of demolished material from the site and disposal following environmental regulations.

6.1.6 The Contractor shall execute the work according to CAN/CSA S350 - *Code of Practice for Safety and* Demolition *of Structures*.

6.1.7 The Contractor shall submit demolition procedures to the Departmental Representative prior to undertaking the work. These procedures shall include the description of the demolition equipment to be used and the disposal and protection methods to be employed.

6.1.8 Existing fences or other embedded steel parts to be preserved shall be removed, stored in a safe location and re-installed by the Contractor at the end of the works as directed by the Departmental Representative.

6.1.9 The Contractor shall dispose of debris in accordance with the environmental protection specifications described in Section 1 of these specifications.

6.2 EXECUTION

6.2.1 The Contractor shall protect all existing structures to be preserved as well as all equipment that must be conserved. In case of damage, repair or replacement shall be conducted immediately at the expense of the Contactor, to the satisfaction of the Departmental Representative.

6.2.2 The Contractor shall conduct concrete demolition according to the demolition lines shown on the drawings. The demolition lines show the limit inside of which no material must remain. This line corresponds to the limit of payment for demolition works.

6.2.3 The Contractor shall prepare final profiles of the Main and Auxiliary spillways after demolition to match with the profiles shown on the drawings. The final profiles shall be subject to the Departmental Representative's approval.

6.2.4 Where partial local demolition is required, the Contractor shall perform concrete scouring down to sound concrete. Surfaces to be repaired and applicable repair types shall be determined on site by the Engineer. No local concrete repairs shall be performed without prior approval from the Departmental Representative.

6.2.5 The Contractor shall ensure that exposed concrete surfaces after demolition works are free of any loose material or exposed partially detached aggregates.

6.2.6 The Contractor shall prepare surfaces that are to receive a new layer of concrete to a roughness of 5 mm. He shall ensure that aggregates are exposed and clean.

6.2.7 The Contractor shall remove any unsound layer of concrete as requested by the Departmental Representative.

6.2.8 The Contractor shall temporarily deposit debris at a distance at least 30 m from the shoreline, or immediately dispose of it outside of the construction site, at an approved disposal site.

6.2.9 The Contractor shall brace the existing structures if it appears that demolition works could compromise their integrity or stability. In case of doubt, the Contractor shall stop the work and contact the Departmental Representative.

6.2.10 The Contractor shall maintain a minimum distance of 2 m between vibration sources (demolition equipment, drill, etc.) and fresh concrete or grout. If the 2 m limit cannot be respected, the Contractor shall wait a minimum of 24 hours and ensure that the fresh concrete or grout has reached a minimum compressive strength of 20 MPa prior to undertaking the demolition works.

6.2.11 At the end of each day of work, the Contractor shall ensure that the structures are safe, solid and stable.

6.2.12 The Contractor shall use appropriate methods (installation of tarps, spraying of materials, etc.) to avoid the propagation of dust, water or other particles into the environment. The Departmental Representative reserves the right to demand that the Contractor adopt corrective measures in the event that his methods are not sufficiently effective.

7. EXCAVATIONS

7.1 GENERAL

7.1.1 Work described in this chapter includes the supply of equipment, material, manpower, protection devices and all other items that may be required for excavations and the disposal of excavated material.

7.1.2 Rock and earth excavation include, but are not limited to, embankments, the spillways and the abutment walls, as shown on the drawings.

7.1.3 The excavation bottom elevations shown on the drawings are approximate values. The Contractor shall perform excavation as required to reach the dense till layer of the riverbed, as described in the Geotechnical Investigations Report. Any additional excavation required to reach the till layer in comparison to the elevations shown on the drawings shall be payed at the unit price provided in the Bid Form.

7.1.4 The Contractor shall survey and submit the final elevations of the excavated profiles to the Departmental Representative.

7.1.5 Excavation work shall follow the latest changes in the Fisheries Act for measures to avoid causing harm to fish and fish habitat (http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html).

7.1.6 Prior to proceeding with excavation works, the Contractor shall review the Geotechnical Investigations Report presented in Appendix A of these specifications.

7.2 DEFINITIONS

7.2.1 Overburden excavation includes all material, organics, and debris located at the surface including rock blocks of less than two cubic meters, excluding snow and ice, to achieve the required elevations.

7.2.2 Cleaning for concreting: Foundation preparation that involves the cleaning of the excavation bottom using mechanical shovels down to the dense riverbed foundation followed by a manual cleaning using appropriate methods to remove loose debris and prepare the surface to receive concrete.

7.3 PLANNING OF EXCAVATIONS

7.3.1 General

7.3.1.1 Before beginning excavation work, the Contractor shall present to the Departmental Representative detailed drawings showing, among other things, the methods and sequences of excavation including access ramps if required.

7.3.1.2 The Contractor's planning of excavations shall take into account the requirements concerning sequencing, methods and special measures to take in the immediate vicinity of existing structures and freshly poured concrete.

7.3.1.3 Where required, the Contractor shall carry out test pits in order to determine the elevation at which the base of abutment walls are located.

7.3.1.4 In the event that the base of an abutment wall is located above the required elevation of the adjacent excavation, temporary support of the abutment wall shall be designed and installed by the Contractor. The Contractor shall provide shop drawings illustrating the intended temporary support system, signed and stamped by a professional Engineer licenced in the province of Ontario.

7.3.1.5 Excavations shall be kept sufficiently free from water until the work has been completed.

7.3.1.6 The Contractor shall ensure that all excavation slopes follow applicable standards. If these standards are not respected, the Contractor shall be held responsible for any resulting accidents.

7.3.1.7 The Contractor shall regularly inspect excavation slopes within the work zone and apply any required corrective measures to ensure that slopes are stable and do not present any danger.

7.3.2 Excavation material disposal

7.3.2.1 Areas designated for stockpiling excavated materials and scrap disposal shall be subject to the Departmental Representative's approval.

7.3.2.2 The Contractor shall store or remove from site, as directed by the Departmental Representative, all excavated material that does not meet backfill specification requirements.

7.3.3 Foundation Treatment

7.3.3.1 The Contractor shall clean excavation bottoms and obtain approval of this work from the Departmental Representative.

7.3.3.2 The Contractor shall clean excavation areas to receive concrete as shown on the drawings as per section 7.2.2 of the present document. The foundations for concreting must be accepted by the Departmental Representative prior to installing reinforcement.

7.4 UNDERWATER OR NEAR WATER EXCAVATION

7.4.1 If required, any underwater or near water excavation procedure will follow the DFO guidelines and, especially, the work will be undertaken at the time of least biological activity or biological sensitivity. The in-water work window is July 15 to September 30.

8. BACKFILL

8.1 GENERAL

8.1.1 Works described in this section include the placing of permanent backfill according to the drawings and these specifications.

8.1.2 Works shall include, but not be limited to:

a) Borrow area exploitation for backfill materials and any required treatments;
b) Loading, transportation and unloading of backfill materials;
c) Placing and compacting of backfill materials as required.

8.2 NORMS, STANDARDS AND RULES

8.2.1 This specification refers to the following standards, specifications or publications:

- ASTM D2922. Standard Test Method for Density of Soil and Soils Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D2321. Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- ASTM D698. Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort
- Ontario Provincial Standard Specification, Material - OPSS 1001 Aggregates – General
- Ministry of Transportation, Ontario
- MTO Laboratory Testing Manual
- LS-602 Sieve Analysis of Aggregates
- LS-607 Percent Crushed Particles in Processed Coarse Aggregate
- LS-609 Petrographic Analysis of Coarse Aggregate
- LS-614 Freezing and Thawing of Coarse Aggregate
- LS-616 Petrographic Analysis of Fine Aggregate
- LS-617 Percent Particles with Two or More Crushed Faces and Uncrushed Particles in Processed Coarse Aggregate
- LS-618 The Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- LS-619 Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- LS-621 Determination of Amount of Asphalt Coated Particles in Coarse Aggregate

- LS-624 The Use of Control Charts for Construction Aggregates
- LS-625 Sampling of Granular Materials
- LS-702 Determination of Particle Size Analysis of Soils
- LS-703/704 Liquid Limit, Plastic Limit and Plasticity Index of Soils
- LS-709 Determination of Permeability of Granular Soils

8.3 BACKFILL EQUIPMENT

8.3.1 The construction equipment shall follow the requirements of these specifications and be approved by the Departmental Representative. Equipment shall be maintained in good condition by the Contractor for the entire work period, and be available in sufficient number and have adequate dimensions so as to complete the work within schedule.

8.3.2 The Contractor shall have on site measurement tools such as load cells, tachymeters and other measuring instruments in order to demonstrate the conformity of backfill materials in accordance with these specifications at all times. The Contractor shall have in his possession certificates of calibration in accordance with the manufacturer for every measuring instrument.

8.3.3 The Contractor shall use compactors of small dimensions and of the vibrating type. They shall be able to provide compaction that is equivalent to a roller-compactor.

8.4 BACKFILL MATERIALS

8.4.1 Backfill materials shall be composed of hard and durable particles and shall not contain organic matter, branches, roots, humus, snow, ice, frozen materials or other materials that do not meet the requirements of these specifications.

8.4.2 All backfill materials shall be well graded and present a continuous grain size curve, without excess or absence of any fraction, and within the grain size limits specified in these specifications or as shown on the drawings.

8.4.3 The Contractor may be required to use equipment for crushing, sorting, sieving and mixing of materials in order to obtain the required grain size characteristics. He shall transmit to the Departmental Representative the method he intends to use.

8.4.4 The Contractor shall use the type of backfill materials in accordance with the drawings.

8.5 PLACEMENT OF BACKFILL

8.5.1 The Contractor shall not place backfill materials on the foundation before first obtaining acceptance from the Departmental Representative.

8.5.2 No backfill shall be placed when the work cannot be executed according to these specifications due to rain, snow or freezing weather. The Contractor shall remove and replace with suitable material any materials that have become unsuitable due to frost action or rain, or any other cause, before any further backfilling.

8.5.3 No material shall be placed on ice or snow covered surfaces.

8.5.4 The Contractor shall place material in layers not exceeding a thickness of 150 mm before compacting.

8.6 COMPACTION OF BACKFILL

8.6.1 The Contractor shall compact each layer of backfill as required by the manufacturer or stated in these specifications before placing the following layer. Surfaces constructed with backfill materials shall be compacted and subject to compaction testing. The Contractor shall provide all necessary access and facilities for testing. The compacted surface shall be reinstated at sampled locations. The goal of testing is to determine gradation, moisture content and density of materials in place.

8.6.2 The Contractor shall compact each layer of general backfill to reach 95% of the Standard Proctor.

8.7 GEOTEXTILE

8.7.1 The Contractor shall supply needle-punched non-woven polypropylene geotextile in the areas indicated on the drawings. The geotextile shall be resistant to the biological and chemical environment on site. It shall be free of folds, tears and wrinkles.

8.7.2 The Contractor shall join the geotextile so that the material laps a minimum of 500 mm and is pinned together. He shall fix geotextiles in such a manner as to prevent movement during installation.

8.7.3 The Contractor shall wrap geotextile down into the ground a minimum of 300 mm at termination points.

8.7.4 Unless otherwise indicated, the geotextile shall comply with the minimum requirements as specified in following table:

PROPERTY	TEST METHOD	UNIT	REQUIREMENT
Thickness	ASTM D5199	mm	3.5
Weight	ASTM D5261	g/m^2	407
Tensile Strength	CAN 148.1 No.7.3	N	1470
Elongation at Break	CAN 148.1 No.7.3	%	50 – 150
Trapezoid Tear	CAN 4.2 No.12.2	N	600
Mullen Burst	CAN 4.2 No.11.1	kPa	3500
CBR Puncture	ASTM D6241	N	4000 (average value)
Puncture	ASTM D4833	N	850
UV Resistance	ASTM D4355	% / 500h	50
Permeability	CAN 148.1 No.4	cm/s	0.190
Permittivity	CAN 148.1 No.4	s^{-1}	0.41
FOS	CAN 148.1 No.10	µm	40 - 110

8.7.5 Prior to beginning the Work, the Contractor shall submit to the Departmental Representative for approval data sheets for the geotextile he intends to use demonstrating that the minimum requirements listed above are met or exceeded.

9. EROSION PROTECTION CONCRETE MATS

9.1 GENERAL

9.1.1 Works described in this section include the supply of materials, transportation, fabrication and manpower required for the placement of erosion protection concrete mats as shown on the drawings and according to these specifications.

9.1.2 The Contractor shall place concrete mats on both the left and right banks of the river on the upstream side of the Main and Auxiliary spillways in order to protect the river banks from erosion.

9.1.3 The Contractor shall design the mats to withstand a design flow velocity of 2.0 m/s.

9.2 MATERIALS

9.2.1 The mats shall be an articulated concrete block revetment system made up of sections placed side by side and clamped together to provide one homogeneous erosion protection system.

9.2.2 The mats shall consist of concrete blocks interlocked by integrally woven stainless steel cables, which are poured within each block. Geotextile fabric shall be attached to the base of each concrete mat.

9.2.3 Concrete

9.2.3.1 Concrete shall meet the requirements of CSA A23.1/A23.2 for materials, testing, and methods of construction. The concrete mix shall be designed to meet CSA A23.1 Exposure Class C-2 requirements. The minimum required concrete strength shall be 25 MPa at 28 days with a minimum of 5-8 % air entrainment throughout.

9.2.4 Cables

9.2.4.1 Cables shall be made of type 302/304 stainless steel aircraft cable, 1x19 construction. Cables shall be integral (poured into) to the concrete block and shall traverse through each block in both longitudinal and lateral directions, providing a flexible interlocked system.

9.2.5 Geotextile

9.2.5.1 Geotextile material shall be attached to the underside of the mats.

9.2.5.2 The Contractor shall supply geotextile material for the concrete mats complying to section 8.6 of these specifications. An overlap shall be incorporated on three sides in order to provide area for the adjoining mats to be placed upon and prevent undermining of the erosion control system.

9.2.6 Clamps

9.2.6.1 The Contractor shall use sufficient malleable or stainless steel cable clamps to connect adjoining concrete mats. Cable clamps shall be comprised of a U-bolt, a cover saddle and two nuts.

9.2.6.2 When placing clamps under existing water, the Contractor shall install a clamp designed for this condition.

9.2.7 Anchoring

9.2.7.1 The Contractor shall design and provide an anchorage system for the concrete mats according to the specified water flow velocities and the slopes encountered on the site.

9.3 EXECUTION

9.3.1 The Contractor shall supply installation equipment having a lifting capacity capable of completely lifting the concrete mats and lifting bar during unloading, stockpiling and installing.

9.3.2 The Contractor shall grade areas upon which mats are to be installed to a smooth plane finish. He shall remove and discard any roots, debris or stones.

9.3.3 The Contractor shall install the specified geotextile according to the manufacturer's recommendations and these specifications.

9.3.4 The Contractor shall lay the mats on the geotextile in such a manner as to produce a smooth plane surface. He shall close any gaps between mats exceeding 25 mm using cement based grout.

9.3.5 Once installation of the mat system is complete, the Contractor shall backfill and seed the matted area as directed by the Departmental Representative.

10. SHEET PILES

10.1 GENERAL

10.1.1 Work described in this chapter includes the supply of equipment, material, manpower, protection devices and all other items that may be required for the installation of sheet piles.

10.1.2 Works shall include, but not be limited to:

- Installation of sheet piles for temporary cofferdams.
- Installation of sheet pile cut-off wall at Auxiliary spillway.

10.1.3 Supply and installation of sheet piles shall conform to the following standards:

- CAN/CSA G40.20/G40.21 - General requirements for rolled or welded structural quality steel / Structural quality steel.
- CAN/CSA W47.1 - Fusion Welding of Steel Company Certification.
- CAN/CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

10.2 TRANSPORTATION, STORAGE AND HANDLING

10.2.1 The Contractor shall transport, store and handle the materials according to the manufacturer's recommendations.

10.2.2 The Contractor shall lift sheet piles using slings in such a manner as to uniformly distribute their weight and not subject them to excessive flexural stress.

10.2.3 The Contractor shall store sheet piles on flat terrain or provide supports so that they are stored level.

10.2.4 The Contractor shall provide spacers and place them at every 5 m maximum in order to avoid inducing excessive flexural stress in the sheet piles.

10.2.5 The Contractor shall ensure that cantilever lengths, at the extremities of sheet piles, do not exceed 0.5 m.

10.2.6 The Contractor shall place spacers between each row of sheet piles directly above the spacers in the inferior level.

10.2.7 If sheet piles are piled on a structure, the Contractor shall ensure that it is not over loaded.

10.3 REMOVAL

10.3.1 The sheet piles for the cofferdams shall be removed and transported away from site by the Contractor when directed by the Departmental Representative at the end of construction. The removal of sheet piles shall consist of pulling, sorting and cleaning the interlocks.

10.4 GEOTECHNICAL CONDITIONS

10.4.1 The Contractor shall take into consideration the geotechnical parameters provided in the Geotechnical Investigations Report provided in Appendix A of these specifications.

10.5 PRODUCTS

10.5.1 Structural steel for braces, bearing plates, angle irons and other various parts: conforming to CAN/CSA-G40.21, grade 350W and 300 W (for bearing plates).

10.5.2 Nuts and bolts: hex-nuts, bolts and washers conforming to ASTM A 325.

10.5.3 Backfill material: according to section 8 of these specifications.

10.6 EXECUTION

10.6.1 Examination

10.6.1.1 Verification of site conditions: prior to installing sheet piles, the Contractor shall ensure that the condition of surfaces/supports already in place is acceptable and will allow the work to be completed according to the manufacturer's written instructions.

10.6.1.2 The Contractor shall visually inspect surfaces/supports in the presence of the Departmental Representative. He shall inform the Departmental Representative of any observed unacceptable condition.

10.6.1.3 The Contractor shall begin installation only once unacceptable conditions have been corrected.

10.6.1.4 The Contractor shall monitor vibrations generated during sheet pile installation at residences located within a 50 m radius of the site.

10.6.1.5 Vibration monitoring shall be carried out by a specialized firm approved by the Departmental Representative.

10.6.1.6 The Contractor shall present the results of inspections and vibration monitoring to the Departmental Representative periodically as the work progresses.

10.6.2 Test Installation

10.6.2.1 The Contractor shall perform a test installation prior to beginning the work in the presence of the Departmental Representative. The objective of this test is to validate the installation procedure.

10.6.2.2 The Contractor is responsible for demonstrating through the test installation that the proposed installation procedure meets the requirements of these specifications.

10.6.2.3 In the event that the proposed installation procedure does not meet requirements, the Contractor shall adopt a new installation procedure that does meet the requirements, at no additional cost to DFO.

10.6.3 Installation

10.6.3.1 The Contractor shall perform welding in accordance with CAN/CSA W59 and CAN/CSA W59S1, except where otherwise indicated.

10.6.3.2 The Contractor shall submit to the Departmental Representative for approval all details regarding the method and sequence of sheet pile installation prior to beginning the work. The details must indicate the supports, sequence and program of installation as well as the number of sheet piles installed in each section.

10.6.3.3 The Contractor shall use supports and bracings to ensure that sheet piles remain in place during driving and installation.

10.6.3.4 The tolerances for sheet pile installation are as follows: no more than 50 mm offset from the location shown on the drawings and maximum deviation with respect to the vertical is 1:100.

10.6.4 Obstacle

10.6.4.1 When an obstacle is encountered during installation, the Contractor shall leave the obstructed sheet pile in place and proceed with the installation of the remaining sheet piles. He shall then come back and attempt to complete installation of the obstructed sheet pile.

10.7 OXYGEN CUTTING

10.7.1 When cutting sheet piles using a blow torch, the Contractor shall adopt the following procedure:

- When ambient temperature is above 0 °C, preheating is not required;
- When ambient temperature is less than 0 °C, the Contractor shall preheat until the steel has reached 35°C up to 25 mm on each side from the cutting line.
- The Contractor shall use guiding tools to ensure that cut lines are straight and true.
- The Contractor shall make smooth cuts, free of notches over the entire thickness. If grinding is used to correct notches or cracks, the finished radius must be at least 5 mm.

10.8 JOINTS

10.8.1 The Contractor shall use single lengths of sheet pile unless joints are necessary and accepted on site by the Departmental Representative.

11. CAST-IN-PLACE CONCRETE AND FORMS

11.1 GENERAL

11.1.1 Works described in this section include the supply of manpower, transportation, equipment, materials and installation required for the execution of all cast-in-place concrete elements as shown in the drawings.

11.1.2 Works also include the design, supply, construction, maintenance, dismantling and removal from site of all scaffolding, other temporary structures and formwork necessary for the execution of cast-in-place concrete.

11.1.3 Cast-in-place concrete and forms include, but are not limited to, the following components:

a) Main Spillway;
b) Auxiliary Spillway;
c) Abutment Walls;

11.2 STANDARDS

11.2.1 All cast-in-place concrete and formwork as well as scaffolding and other temporary structures shall be executed according to Ontario health and safety standards and shall conform to the following standards:

a) CAN/CSA-A5 – Portland Cement;
b) CAN/CSA-A23.1 – Concrete Materials and Methods of Concrete Construction;
c) CAN/CSA-A23.2 – Test Methods and Standard Practices for Concrete;
d) CAN/CSA-A23.3 – Design of Concrete Structures;
e) CAN3-A266.1-M – Air-Entraining Admixtures for Concrete;
f) CAN3-A266.2-M – Chemical Admixtures for Concrete;
g) CAN/CSA-S269.3 – Concrete Formwork.

11.3 CONCRETE FORMWORK

11.3.1 Shop drawings

11.3.1.1 The Contractor shall submit shop drawings and procedures for formwork to the Departmental Representative prior to construction and must comply with CAN/CSA-269.3 for formwork drawings.

11.3.1.2 Drawings must indicate method and sequence of construction, shoring, materials, arrangement of joints, waterstop placement, type and protection methods, concrete cover, exposed finishes, ties, liners, locations of embedded parts, placement rate, construction loads and location of thermocouples when required.

11.3.1.3 Temporary structures must be designed in such a manner as to avoid applying loads to the structure being constructed that exceed its design capacity.

11.3.1.4 The Contractor shall obtain approval from the Departmental Representative before modifying the layout of construction joints as shown on the drawings. He shall provide shop drawings illustrating the new dimensions of the concrete pours, waterstops placement, type and protection methods where required as well as any other relevant details or information requested by the Departmental Representative.

11.3.1.5 Each shop drawing submission shall bear a stamp and signature of a qualified Professional Engineer registered in the province of Ontario. Design data such as permissible rate of concrete placement related to the type of concrete must be indicated.

11.3.2 Products

11.3.2.1 The Contractor shall use wood and wood product formwork materials in accordance with CAN/CSA-O121 and CAN/CSA-O86.

11.3.2.2 Any removable or snap-off metal ties, of fixed or adjustable length, shall be free of devices leaving holes larger than 25 mm dia. and deeper than 50 mm in the concrete surface.

11.3.2.3 All falsework materials shall be in accordance with CAN/CSA-S269.1.

11.3.3 Execution

11.3.3.1 The Contractor is responsible for the execution and the construction methods. Intervention by the Departmental Representative does not relieve the Contractor of his responsibility for the execution of the work. The absence of intervention by the Departmental Representative does not constitute approval. Any discrepancy in the structural, architectural, electrical or mechanical plans must be brought to the attention of the Departmental Representative.

11.3.3.2 The Contractor shall verify lines, levels and centers before proceeding with formwork/falsework and ensure that dimensions correspond to those shown on the drawings.

11.3.3.3 The Contractor shall fabricate and erect falsework in accordance with CAN/CSA-S269.1 and COFI Exterior Plywood for Concrete Formwork.

11.3.3.4 If steel forms or other materials are used, the Contractor shall submit materials data, technical specifications and installation procedures for Owner's approval.

11.3.3.5 The Contractor shall not place shores on frozen ground. He shall provide site drainage to prevent washout of soil support.

11.3.3.6 The Contractor shall fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within the tolerances specified under CAN/CSA-A23.1.

11.3.3.7 The Contractor shall align form joints and ensure they are watertight. He shall keep form joints to a minimum.

11.3.3.8 The Contractor shall ensure that formwork is solid, adequately shored and supported in order to resist the loading to which it will be subjected while maintaining its shape and alignment until concrete has cured.

11.3.3.9 The Contractor shall use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners, joints, unless otherwise specified.

11.3.3.10 The Contractor shall clean formwork in accordance with CAN/CSA-A23.1 before placing concrete.

11.3.3.11 The Contractor shall leave formwork in place for a minimum period of 48 hours for all vertical walls or inclined surfaces. For concrete slabs or beams, a minimum of 21 days of shoring is required. The Contractor shall not remove formwork until concrete has reached at least 80% of its design strength or before the minimum period noted previously, whichever comes later. He shall immediately install adequate reshoring if necessary after the removal of formwork.

11.3.3.12 The Contractor shall communicate the results of concrete break tests to the Departmental Representative prior to removing formwork.

11.4 CAST-IN-PLACE CONCRETE

11.4.1 General

11.4.1.1 A minimum of four weeks prior to starting concrete work, the Contractor shall submit to the Departmental Representative manufacturer test data and certification by a qualified independent inspection and testing laboratory that the following materials will meet specified requirements:

a) Portland cement;
b) Blended hydraulic cement;
c) Supplementary cementing materials;
d) Expansive agent for concrete;
e) Other admixtures;
f) Aggregates;
g) Water;
h) Steel fibres;
i) Grout;
j) Repair mortar for local repairs;
k) Waterstops.

11.4.1.2 The Contractor shall provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes and will comply with CAN/CSA-A23.1.

11.4.1.3 The Contractor shall provide certification that the plant, equipment, and materials to be used for concrete production comply with the requirements of CAN/CSA-A23.1.

11.4.2 Materials

11.4.2.1 Portland cement, blended hydraulic cement and supplementary cementing materials: in accordance with CAN/CSA-A3001.

11.4.2.2 Water and aggregates: in accordance with CAN/CSA-A23.1. Coarse aggregates to be normal density. The Contractor shall provide quarry pit test results showing that the aggregates are non-alkali reactive.

11.4.2.3 Ribbed waterstops: extruded PVC as per CGSB 41-GP-35M, Type 2 with central bulb and legs, no less than 200 mm long. The Contractor shall submit technical

data sheets for ribbed waterstops to the Departmental Representative for approval.

11.4.2.4 All welded joints in PVC waterstop to be realized in shop, except longitudinal joints. The Contractor shall minimize longitudinal joints.

11.4.2.5 Waterproofing bands shall be of the type BFL Mastix, installed according to the manufacturer's recommendations.

11.4.2.6 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement and with a compressive strength of 40 MPa at 28 days. Conforming to ASTM C1107 type C.

11.4.2.7 The Contractor shall proportion "normal density" concrete in accordance with CAN/CSA-A23.1, Alternative 1.

11.4.2.8 For cast-in-place "normal density" concrete, the Contractor shall proportion the concrete mix as follows:

For cast-in-place concrete elements with thickness superior to 1500 mm, the concrete mix shall be as follows:

a) Type GU Portland cement replaced by up to 40% in mass with fly ash, natural pozzolans or blast furnace slag according to standard CAN/CSA-A3001 or Hydraulic cement type Enercem or approved equivalent, in accordance with standard CAN/CSA-A3000;
b) Minimum compressive strength at 56 days: 35 MPa;
c) Exposure class: C1;
d) Nominal size of coarse aggregate: 20 mm;
e) Slump at time and point of discharge: 50 to 100 mm;
f) Air content: 5 to 8%.

For cast-in-place concrete with thickness less than 1500 mm, the concrete mix shall be as follows:

a) Type GU Portland cement;
b) Minimum compressive strength at 28 days: 30 MPa;
c) Exposure class: F1;
d) Nominal size of coarse aggregate: 20 mm;
e) Slump at time and point of discharge: 50 to 100 mm;
f) Air content: 5 to 8%.

11.4.3 Execution

11.4.3.1 The Contractor shall execute cast-in-place concrete work in accordance with CAN/CSA-A23.1.

11.4.3.2 Concrete shall be fabricated at a batch plant, transported to site and poured in accordance with CAN/CSA A23.2/A23.2.

11.4.3.3 The Contractor shall obtain the Departmental Representative's approval before placing concrete. He shall provide at least 24 hours' notice prior to placing of concrete.

11.4.3.4 The Contractor shall ensure that hardened concrete surfaces receiving fresh concrete are clean, relatively level and sufficiently roughened. Any foreign substance having the potential to hinder adherence of the new concrete layer shall be removed.

11.4.3.5 The Contractor shall provide a delivery slip for each load of concrete and provide a copy to the Departmental Representative. The type and quality of any admixtures present in the batch of concrete must be clearly identified, in addition to all other information required according to CAN/CSA A23.2/A23.2.

11.4.3.6 The addition of water to the concrete mix after batching at the concrete plant is prohibited.

11.4.3.7 Pumping of concrete is permitted only after approval of equipment and mix by the Departmental Representative. The maximum permitted drop-off height of concrete from the pump nozzle is 1.3 meters.

11.4.3.8 The Contractor shall ensure that reinforcement, waterstops, embedded parts and all other inserts are well attached and stable and that they are not disturbed during concrete placement.

11.4.3.9 The Contractor shall prepare surfaces which are to receive concrete according to Chapter 7 of CAN/CSA-A23.1.

11.4.3.10 Prior to placing of concrete, the Contractor shall obtain the Departmental Representative's approval of proposed methods for protection of concrete during placing and curing.

11.4.3.11 The Contractor shall maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

11.4.3.12 The Contractor shall not place loads upon new concrete until authorized to do so by the Departmental Representative.

11.4.3.13 The Contractor shall vibrate fresh concrete gradually in layers not exceeding a thickness of 500 mm.

11.4.3.14 The Contractor shall finish concrete in accordance with CAN/CSA-A23.1:

a) Surface tolerances shall be measured by the Contractor according to the straightedge method;
b) The Contractor shall use procedures acceptable to the Departmental Representative or those noted in CAN/CSA-A23.1 to remove excess bleed water. He shall ensure that the surface is not damaged.
c) Once bleed water is removed, the Contractor shall perform final finishing of the surface by hand, with a wood trowel, in order to obtain a surface free of irregularities and, for surfaces exposed to water flow, free of rough spots.
d) Finishing of concrete decks over structures: when concrete has hardened sufficiently to prevent dislodgement of coarse aggregate particles, the Contractor shall give the surface a uniform broom finish free of porous spots, irregularities, depressions, small pockets or rough spots.

11.4.3.15 Waterstops

a) The Contractor shall install waterstops in such a manner as to provide a continuous water seal throughout the joint. He shall not distort or pierce waterstops in such a way as to hamper their performance. He shall not displace reinforcement when installing waterstops. The Contractor shall use equipment and procedures to manufacturer's requirements to field splice waterstops. He shall tie waterstops rigidly in place.
b) The Contractor shall use only straight heat sealed butt joints in the field. He shall use factory welded corners and intersections unless otherwise approved by the Departmental Representative.

11.4.3.16 Concrete tolerances shall be in accordance with CAN/CSA-A23.1, Class A in Table 22, specifying finish classes and tolerances.

11.4.3.17 For concrete elements of thickness greater than 1500 mm, the Contractor shall install thermocouples in order to monitor the temperature of concrete at the core,

75 mm from the outside face and outside of the form. The temperature at the core of the element shall not exceed 65°C and the thermal gradient within the element shall not exceed 20°C per meter of thickness. The number and location of thermocouples shall appear on the formwork shop drawings submitted by the Contractor to the Departmental Representative.

11.4.3.18 Cold weather protection

a) When outside temperature is below 5°C, the Contractor shall apply cold weather protection requirements as per CAN/CSA-A23.1.
b) Cast-in-place concrete must be realized within a heated enclosure.
c) The Contractor shall pre-heat surfaces which are to receive concrete to a minimum of 5°C and maintain this temperature for at least 12 successive hours prior to pouring.
d) Temperature drops within the enclosure must be progressive and shall not exceed the differential temperatures listed in CAN/CSA-A23.1 Table 21.

11.4.3.19 Hot weather protection: when outside temperature is at or above 27°C, the Contractor shall apply hot weather protection procedures as per CAN/CSA-A23.1.

11.4.3.20 Concreting under water: section 7.2.6 of CAN/CSA-A23.1 applies. In particular:

a) Placing concrete underwater shall be accomplished by the proper use of a tremie pipe, or a concrete pump with its discharge line used as a tremie pipe.
b) The Contractor shall take special precautions to prevent the loss of the cementing material paste by the action of the water. The use of anti-washout admixtures shall be acceptable for this purpose provided that they do not adversely affect the overall quality, durability, workability, placeability, and pumpability of the concrete, mortar, or grout mixture.
c) Concrete shall not be placed in water having a temperature below 5°C except when the strength gain of the concrete is sufficient when determined by special test specimens cured under identical conditions as the structure.
d) The Contractor shall take appropriate means to ensure that, at all times, fresh concrete does not come into contact with water flowing at a velocity greater than 3 m/min.

11.4.3.21 Curing: section 7.4 of CAN/CSA-A23.1 applies. In particular:

a) All equipment and materials necessary for curing shall be subject to the Departmental Representative's approval in advance and shall be available at the site, in good working condition and in sufficient quantity, prior to the beginning of concrete placing.
b) Curing of unformed flatwork: immediately following final finishing (floating and trowelling) of exposed flatwork surfaces, the Contractor shall continue the application of a fine water mist until the surface is sufficiently firm, so that it can be covered without danger of marring it, with two layers of absorptive synthetic fibre mats. The membranes shall completely cover the concrete and be adequately held in place. The Contractor shall maintain the fabric or mats continuously wet by continuous sprinkling of water until the concrete has hardened sufficiently to permit installation of a water wetting system without damaging the concrete surface. The Contractor shall maintain water curing 24 hours per day at a temperature above 10°C for an uninterrupted period of seven days.
c) Cure of formed elements: as soon as the forms are filled, the Contractor shall cover them completely with two layers of pre-wetted absorptive synthetic fibre mats. He shall hold the wetted mats in place and maintain them continuously wet by continuously sprinkling water onto the membranes until the concrete has hardened sufficiently to permit installation of a continuous wetting system without danger of damaging the surface by scouring. The Contractor shall remove side forms as soon as possible after concreting, as specified in Section 7.2 of these specifications or when required by the Departmental Representative. He shall take necessary precaution to avoid damaging the concrete during form removal. If form removal requires the interruption of curing, the Contractor shall take necessary measures in order to avoid surface drying and to shorten the duration of the interruption as much as possible. He shall maintain the mats in place and wet by continuously sprinkling water 24 hours a day at a temperature above 10°C for an uninterrupted period of seven days.

11.4.3.22 Repairs

a) The Contractor is responsible for repairs to cast-in-place concrete that does not meet the requirements of these specifications.
b) After the removal of formwork, concrete surfaces shall be examined by the Departmental Representative to identify any voids, bee's nests or other defects.

c) All repairs shall be subject to approval by the Departmental Representative. The Contractor shall submit to the Departmental Representative the repair procedure as well as the products he intends to use and shall not begin any repairs without written approval from the Departmental Representative.

11.4.4 Field quality control

11.4.4.1 Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by the Departmental Representative in accordance with CAN/CSA-A23.1 and General Requirements.

11.4.4.2 The Testing Laboratory will take additional test cylinders during cold weather concreting. The Contractor shall ensure that cylinders are cured on the job site under the same conditions as concrete which they represent, as per the requirements of CAN/CSA-A23.1.

11.4.4.3 Non-destructive Methods for Testing Concrete shall be in accordance with CAN/CSA-A23.2.

11.4.4.4 Inspection or testing by the Departmental Representative will not augment or replace the Contractor’s quality control nor relieve him of his contractual responsibility to provide concrete which meets these specifications.

11.5 TOPPINGS

11.5.1 Slab Preparation

11.5.1.1 All existing slab surfaces which shall receive a topping shall be free of bleeding, dust, debris, grease or other substances. The Contractor shall perform this cleaning by scouring the slab to a minimum depth of 2 mm.

11.5.1.2 Before casting the topping, the Contractor shall apply an epoxy resin bonding agent. He shall apply this product according to the manufacturer's recommendations and install the topping before the bonding agent dries.

11.5.2 Topping Curing

11.5.2.1 Topping curing shall be of the wet type. If these procedures are not possible, a curing agent may be used as a last resort with approval from the Departmental Representative.

11.5.2.2 The Contractor shall ensure the compatibility of the curing agent with the slab finish. He shall apply the product in strict compliance with the manufacturer's recommendations.

12. CONCRETE REINFORCEMENT

12.1 GENERAL

12.1.1 Works described in this section include the supply of manpower, equipment and materials as well as fabrication, transportation and installation of all concrete reinforcement as shown on the drawings.

12.1.2 Concrete reinforcement covered by this section includes reinforcing bars, wire mesh and rock dowels for all reinforced concrete elements.

12.1.3 Supply, fabrication and installation of reinforcement shall include all ties, spreader bars, spacers, supports and any other accessories required to ensure proper placement and stability of reinforcement during concreting.

12.1.4 The Contractor shall submit reinforcement shop drawings to the Departmental Representative for approval at least ten (10) days prior to fabrication. He shall indicate on shop drawings: bar bending details, lists, quantities of reinforcement, sizes, spacing, locations of reinforcement and mechanical splices if approved by the Departmental Representative. He shall include identifying code marks to permit correct placement without reference to structural drawings. The Contractor shall prepare reinforcement drawings in accordance with the Reinforcing Steel Manual of Standard Practice - by the Reinforcing Steel Institute of Canada.

12.1.5 The Contractor shall detail lap lengths and bar development lengths in accordance with CAN/CSA-A23.3. He shall provide type B tension lap splices unless otherwise indicated.

12.1.6 Any shop drawing deemed incomplete and for which additional details or sections are required to ensure that it is well understood by installers shall be revised and completed by the Contractor.

12.2 PRODUCTS

12.2.1 The Contractor shall store materials on site in such a manner as to prevent damage and protect from weather.

12.2.2 All reinforcing steel shall be new, unused and free of non-adhering rust or other material having the potential to prevent or diminish concrete adherence.

12.2.3 The Contractor shall substitute different size bars than those shown on the drawings only if permitted in writing by the Departmental Representative.

12.2.4 Reinforcing steel: billet steel, grade 400W, deformed bars in accordance with CAN/CSA-G30.18, unless indicated otherwise.

12.2.5 Cold-drawn annealed steel wire ties: in accordance with CAN/CSA-G30.3.

12.2.6 Deformed steel wire for concrete reinforcement: in accordance with CAN/CSA-G30.14.

12.2.7 Welded steel wire fabric: in accordance with CAN/CSA-G30.5.

12.2.8 Chairs, bolsters, bar supports, spacers: in accordance with CAN/CSA-A23.1.

12.2.9 The Contractor shall fabricate reinforcing steel in accordance with CAN/CSA-A23.1 and the Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada, unless indicated otherwise.

12.2.10 The Contractor shall obtain the Departmental Representative's approval for locations of reinforcement splices other than those shown on shop drawings.

12.2.11 Upon request, the Contractor shall provide the Departmental Representative with a certified copy of the mill test report of reinforcing steel, showing physical and chemical analysis.

12.3 EXECUTION

12.3.1 The Contractor shall not field bend or field weld reinforcement except where indicated or authorized by the Departmental Representative.

12.3.2 When field bending is authorized, the Contractor shall bend without heat, applying a slow and steady pressure.

12.3.3 The Contractor shall replace bars which develop cracks or splits.

12.3.4 The Contractor shall place reinforcing steel as indicated on reviewed shop drawings. Tolerances for rebar placement shall be as per the Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada. Tolerances for out of plumb and level shall follow CAN/CSA-A23.1, unless otherwise noted.

12.3.5 Field-cutting of reinforcing bars shall be performed only by sawing. Cutting of reinforcing bars using a blow torch is not permitted.

12.3.6 Reinforcing bars that have been unexpectedly bent or damaged must be corrected by the Contractor using a method approved by the Departmental Representative.

12.3.7 At construction joints, upon approval from the Departmental Representative, reinforcing bars that are deformed or not properly embedded in concrete shall be mechanically straightened by the Contractor, without the use of heat and applying a slow and steady pressure. The Departmental Representative may request that the concrete around these bars be injected after inspection.

12.3.8 Prior to placing concrete, the Contractor shall obtain the Departmental Representative's approval of reinforcing material and placement. He shall provide at least 24 hours' notice prior to pouring concrete.

12.3.9 The Contractor shall ensure cover to reinforcement is maintained during concrete placement. Typically, the concrete cover is 75 mm for concrete elements in contact with water, rock or backfill material and 60 mm for slabs, or as specified on the drawings.

12.4 INSPECTION AND QUALITY CONTROL

12.4.1 The Contractor shall be responsible for quality control of the reinforcing steel material delivered to site.

12.4.2 The Contractor shall provide at least 24 hours' notice to the Departmental Representative so that he may inspect and approve the dimensions and placement of reinforcement prior to the installation of formwork and the pouring of concrete.

13. STRUCTURAL STEEL AND METAL FABRICATION

13.1 GENERAL

13.1.1 Works described in this section include the supply of manpower, equipment and materials as well as fabrication, transportation and installation of all structural steel and metal fabrication as shown on the drawings.

13.1.2 Structural Steel and Metal Fabrication covered by this section include:

a) Main Spillway;
b) Abutment walls;

13.2 PRODUCTS

13.2.1 Materials:

a) Structural steel: in accordance with CAN/CSA-G40.21, Grade 350W;
b) Steel sections and plates: in accordance with CAN/CSA-G40.20/G40.21, Grade 350W;
c) Grating: in accordance with CAN/CSA-G40.20/G40.21, Grade 300W;
d) Anchor bolts: in accordance with CAN/CSA-G40.21, Grade 300W;
e) Bolts, nuts and washers: in accordance with ASTM A325M;
f) Welding materials: in accordance with CAN/CSA-W48 Series, CAN/CSA-W59 and certified by the Canadian Welding Bureau;
g) Shop paint primer: in accordance with CGSB-1.40;
h) Hot dip galvanizing: in accordance with ASTM A123;
i) Stainless steel: in accordance with ASTM 304L.

13.2.2 The Contractor shall fabricate structural steel and metal in accordance with CAN/CSA-S16 and in accordance with approved shop drawings.

13.2.3 Shop painting:

a) The Contractor shall clean, prepare surfaces and shop prime structural steel in accordance with CAN/CSA-S16 except where members are to be encased in concrete or galvanized.
b) The Contractor shall clean all members, remove loose mill scale, rust, oil, dirt and other foreign matter. He shall prepare surfaces according to SSPC (brush) blast method, SP6.
c) The Contractor shall apply two coats of primer in shop.

d) The Contractor shall apply paint under cover, on dry surfaces when surface and air temperatures are above 5°C.
e) The Contractor shall maintain dry conditions and a minimum temperature of 5°C until paint is thoroughly dry.
f) The Contractor shall strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

13.2.4 All exposed structural steel and embedded steel must be galvanized unless otherwise noted. The Contractor shall apply hot dipped galvanizing with zinc coating 610 g/m² in accordance with ASTM A123, unless otherwise specified on the drawings.

13.2.5 Any damaged galvanized surface shall be repaired by the Contractor to the satisfaction of the Departmental Representative.

13.2.6 Fabrication and welding after galvanization are not permitted, unless written approval is given by the Departmental Representative.

13.3 EXECUTION

13.3.1 Installation:
a) Structural steel work and metal fabrication: in accordance with CAN/CSA-S16;
b) Welding: in accordance with CAN/CSA-W59;
c) Welding companies shall be certified under Division 1 or 2.1 of CAN/CSA-W47.1 for fusion welding of steel structures and/or CAN/CSA-W55.3 for resistance welding of structural components.

13.3.2 The Contractor shall verify dimensions and condition of existing work and report any discrepancies or potential problem areas to the Departmental Representative for direction before beginning fabrication.

13.3.3 The Contractor shall erect structural steel in accordance with CAN/CSA-S16 and as indicated on the reviewed erection drawings.

13.3.4 The Contractor shall obtain approval from the structural engineer before field cutting or altering structural members. He shall seal members by continuous welds where indicated and grind smooth.

13.3.5 The Contractor shall erect structural steel within a tolerance of 6 mm, except where otherwise indicated.

13.3.6 Any assembly or fabrication error shall be corrected by the Contractor at his own expense, to the satisfaction of the Departmental Representative.

13.4 SHOP DRAWINGS

13.4.1 The Contractor shall submit to the Departmental Representative, prior to construction, shop drawings including fabrication and erection documents and materials list. On erection drawings, he shall indicate all details and information necessary for assembly and erection purposes such as description of methods, sequence of erection, type of equipment used in erection and temporary bracings.

13.4.2 Shop drawings shall include sizes and lengths of weld beads necessary for all steel elements as well as the dimensions of bolted assemblies. These drawings shall conform to CAN/CSA-S16.

13.4.3 The Contractor shall design details and connections in accordance with the requirements of CAN/CSA-S16 to resist forces, moments, shears and allow for movements indicated.

13.4.4 The Contractor shall take responsibility for the design of assemblies, components and connections, and ensure that fabricator designed drawings are stamped and signed by a qualified Professional Engineer licensed in the Province of Ontario.

13.4.5 The Contractor shall not begin the manufacturing and erection of structural steel elements until he has received shop drawings from the Departmental Representative, duly annotated and stamped.

14. OVERSHOT GATES

14.1 GENERAL

14.1.1 Works described in this section include the supply of manpower, equipment and materials as well as fabrication, transportation and installation of two (2) overshot gates, as shown on the drawings.

14.2 SCOPE OF SUPPLY

14.2.1 The Contractor shall design and supply a complete overshot gate system suitable for the environment as defined herein and shown on the drawings. For simplicity, these specifications use the term “gate” as a generic term to describe the gate, cables, pulleys, abutment plates, gearboxes or any other technology which the Contractor may propose.

14.2.2 The Contractor shall supply overshot gates for the Main spillway in two sections, as shown on the drawings. He shall supply the overshot gates in two equal spans.

14.2.3 Fully raised gate elevation: 204.57 m, normal operation.

14.2.4 Fully lowered gate elevation: 203.97 m, flood condition.

14.3 SPECIAL CONDITIONS AND PROJECT ENVIRONMENT

14.3.1 Operation and Installation Conditions

14.3.1.1 Nicolston Dam is comprised of a Main and an Auxiliary spillway. While, the Auxiliary spillway is not operated, monitoring and control for the Main spillway shall be provided locally by on-site personnel using a manually operated mechanical system.

14.3.1.2 Installation temperatures may be lower than operational norms, so packaging, shipment and potential storage of equipment shall account for such conditions, including possible on-site storage for periods of up to 4 months. Any storage restrictions for any equipment shall be noted in the bid.

14.3.2 Site, Ambient Temperature Range and Rainfall

14.3.2.1 The Contractor shall assume norms in accordance with Environment Canada Climate data for nearest recorded location, as required.

14.3.2.2 Water design temperature: 15°C (typical). Range: 0 to 20°C (year round). Ice is likely to form.

14.3.3 Upstream Water Levels

14.3.3.1 Normal Operation Water Level: 204.57 m.

14.3.3.2 Design Flood Water Level: 206.10 m.

14.3.4 Design Flows

14.3.4.1 When in fully lowered position, the crest gates shall have a hydraulic capacity similar to a standard broad crested weir.

14.4 ENGINEERING UNITS

14.4.1 All dimensions, masses, volumes, etc., shall be expressed in SI Metric units on all drawings, manuals and equipment provided in accordance with these specifications. Documents may include Imperial or US units in addition to metric units provided both unit systems are clearly defined.

14.5 APPLICABLE STANDARDS AND CODES

14.5.1 Unless otherwise specifically indicated in these specifications, all equipment design, fabrication, material selection, manufacturing, welding, testing, inspection, assembly, and other operations related to preparation of the work shall conform and comply to the specifications of the latest edition or issue of all relevant applicable standards and codes from the organizations specified below or elsewhere. Design, materials and workmanship incorporated into the services and not specifically covered by these specifications and applicable codes shall be of the highest quality and shall conform to good utility practice and without limitations, shall be in accordance with the latest versions of the international organization's standards and norms:

- AFBMA Anti-Friction Bearing Manufacturers Association
- AGMA American Gear Manufacturers Association
- AISC American Institute of Steel Construction
- AISI American Iron and Steel Institute
- ANSI American National Standard Institute
- ASME American Society of Mechanical Engineers
- ASNT American Society for Non-destructive Testing
- ASTM American Society of Testing and Materials
- AWS American Welding Society

- CSA Canadian Standards Association
- CWB Canadian Welding Bureau
- EEMAC Electrical Equipment Manufacturers Association of Canada
- IEC/CE International Electro technical Commission
- IEEE Institute of Electrical and Electronic Engineers
- IESO Independent Electricity System Operator
- ISO International Organization of Standardization
- JIC Joint Industrial Council
- NBCC National Building Code of Canada
- NEMA National Electrical Manufacturers Association
- NFPA National Fire Protection Association
- OSHA Occupational Safety & Health Administration
- Ontario Electrical Safety Code
- Piping Code (TSSA)
- Ontario Health and Safety Code

14.6 MAIN SPILLWAY OPERATION REQUIREMENTS

14.6.1 The operator shall have the option to operate each of the overshot gate sections independently from one another.

14.6.2 The Contractor shall provide and install a separate gearbox operator for each overshot gate. The operator for the right bank overshot gate shall be installed atop the right bank abutment wall of the Main spillway and the operator for the left bank overshot gate shall be installed atop the left bank abutment wall of the Main spillway.

14.6.3 The Contractor shall provide a locking system to prevent unauthorized gate operation or tampering.

14.6.4 The overshot gate gearbox operators shall be manually operated.

14.6.5 The overshot gates shall have the ability to drop partially, thus allowing the operator to control the flow over the crest on the entire course of the gate. The precision on the gate position shall be fully described in the bid documents.

14.7 EQUIPMENT SUPPLY

14.7.1 The Contractor shall supply a complete set of overshot gates for the Main spillway. This equipment shall include but not be limited to:

- The gates themselves, including all anchoring.
- All mechanical parts required to actuate the gates, including cables, piping, pulleys and gearboxes.

- All components required to ensure the gates are completely water tight all around, such as abutment plates, seal plates, gaskets, etc.

14.8 SITE INSTALLATION, TESTING AND COMMISSIONING

14.8.1 The Contractor shall be responsible for all installation, testing and commissioning activities, to the satisfaction of the Departmental Representative. He shall submit detailed erection procedures to the Departmental Representative containing full cross-referencing to the drawings and to the location of measurement points. These procedures shall constitute part of the maintenance manual. Erection tolerances shall follow Canadian and International practices and standards.

14.8.2 The procedures shall give tolerances for locations of embedded parts, which shall be verified and monitored by the Contractor prior to pouring concrete.

The procedures shall also define the measurements to be carried out and recorded during the installation. These include relative location, clearances, elevations, rotational checks etc.

14.9 DOCUMENTS

14.9.1 The Contractor shall supply adequate documents to the Departmental Representative for all equipment included in the scope of supply.

14.9.2 The Contractor shall submit to the Departmental Representative, prior to construction, shop drawings including fabrication and erection documents and materials list. On erection drawings, he shall indicate all details and information necessary for assembly and erection purposes.

14.10 OPERATION AND MAINTENANCE MANUAL

14.10.1 The Contractor shall supply operation and maintenance manuals for all his equipment. These manuals shall include parts and service information, a complete set of all arrangement and detail drawings necessary to define mechanical and electrical components requiring maintenance, product data sheets and technical information, equipment operating parameters and settings, installation procedures, maintenance procedures, and commissioning procedures for all equipment supplied under the agreement. The manuals shall be written in English and shall include, but shall not be limited to, the following information:

- A detailed list of parts and components;
- A detailed list of designs and specifications;

- A detailed list of operating instructions;
- A detailed list of installation and removal instructions;
- Detailed operating instructions for all equipment furnished;
- As-built drawings showing assembled parts, construction details and installation tolerances;
- Original copy of all the brochures, instructions, technical data sheets, and instruction manuals for all equipment supplied;
- Control diagrams for all equipment;
- A schematic and description of operating principles for all equipment;
- Preventative maintenance program;
- Spare parts lists;
- List of special tools required for installation and maintenance;
- Copy of all equipment tests;
- All other supplementary information that may be requested by the Departmental Representative.

14.10.2 All documents shall be the latest “As-built”.

14.10.3 The manual shall be in binders that are clearly identified on the cover and on the spine with the Project name, the title and volume and all other relevant information to the identification of its contents.

14.10.4 The Contractor shall submit two copies of the operation and maintenance manual to the Departmental Representative for review and acceptance prior to commissioning. All modifications that occur during installation shall be included in the manual.

14.10.5 Other documents:

- Schedules for all major equipment, including design, order of major materials, assembly and delivery;
- Drawing/Document and Report List for approval;
- Field Testing Reports list;
- Factory Test Reports. All equipment test reports for approval 1 week prior to shipment.

14.11 SPECIAL TOOLS

14.11.1 The Contractor shall provide a full set of tools including any special tools required for the installation, operations, and maintenance of all equipment.

14.12 SPARE PARTS

14.12.1 The Contractor shall prepare a list of spare parts required for 10 years' trouble free operation of the equipment. The Contractor shall manufacture and deliver the spare parts with the main equipment.

14.12.2 Bidders shall submit their list of recommended spares and price with the tender.

14.13 TRAINING

14.13.1 The Contractor shall provide a training program and manuals that will describe in a practical manner all instructions related to equipment operation and preventative maintenance. The training course outline and materials shall be submitted to the Departmental Representative for review and acceptance. All documents and training shall be given in English.

14.14 PAINTING AND SURFACE PREPARATION

14.14.1 The Contractor shall furnish all the paint, and materials necessary for painting of all components as required. Factory and on site painting shall be executed by the Contractor. All surfaces, with the exception of pre-finished items, galvanized metals, metals embedded in concrete, and non-ferrous metals shall be painted.

14.14.2 The Contractor shall paint the gates using 2 component epoxy marine grade paint, following manufacturer's recommendations.

14.14.3 The Contractor shall provide materials that conform to the aforementioned standards of paint systems and finishes. Multiple-coat paint systems shall be from the same manufacturer.

14.14.4 The Contractor shall submit the name of paint manufacturers and the type of paint that will be used. Products must be submitted to the Departmental Representative for approval prior to their application.

14.14.5 For all items, the Contractor shall deliver 5% of the quantity of each painting material, but at least one litre, in new sealed containers, for later repair works.

14.14.6 Machined or bare metal surfaces, which are to receive no coat of paint, shall be protected during transportation, storage and erection by a suitable anti-corrosion film.

14.15 CABLES

14.15.1 All cable provided for the overshot gate system shall be stainless steel aircraft cable, type 304.

14.15.2 The Contractor shall design and install the gate system in such a way that all cables, pulleys and any other critical components are protected from ice and debris at all times, including under high flow conditions.

15. VOIDS GROUTING

15.1 GENERAL

15.1.1 This section specifies requirements for voids grouting works. These works shall be performed as generally depicted on the drawings, as outlined in these specifications and as directed by the Departmental Representative.

15.1.2 Changes may be called for in both the exact layout and number of injection holes required as conditions encountered during work are evaluated.

15.1.3 The purpose of the work is to fill any voids that may exist between the concrete layers of the Main and Auxiliary spillways and the underlying existing granular material.

15.1.4 Work described in this section includes the supply of materials, manpower and equipment as well as transportation, mixing and execution for all voids grouting.

15.2 REFERENCES

15.2.1 Unless otherwise stated, the most recent version of the following standards shall be followed during the works:

- CAN/CSA A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
- CAN/CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- Can/CSA A283-00 Qualification Code for Concrete Testing Laboratories.
- OPSS 180 November 2011, Management of Excess Materials.
- OPSS 903 November 2009, Deep Foundations.
- OPSS 906 November 2012, Structural Steel for bridges.
- OPSS 1301 November 2007, Cementing Materials.
- OPSS 1302 September 1996, Water.
- OPSS 1350 November 2014, Concrete - Materials and Production.

15.3 DEFINITIONS

15.3.1 Voids grouting: introducing cement grout that solidifies within joints and voids.

15.3.2 Grouting stage: the section of hole in which grouting is performed.

15.3.3 Grouting pressure: the measured pressure at the hole collar level during the pumping of the liquid in the hole.

15.3.4 Successful grouting stage: all the operations required to achieve, within a hole, the specified pressure until refusal is reached.

15.3.5 Redrilling: any drilling of a hole or drilling of part of a drill hole carried in a portion of hole already drilled during a preceding step.

15.3.6 Grout Mixes: mixes shall be proportioned with a water/cement ratio of 1.0. Adjustments may be required, as requested by the Departmental Representative, based on site conditions encountered in order to adequately fill voids at the interface between the existing granular material and concrete layers.

15.4 SUBMITTALS

15.4.1 Prior to the start of work, the Contractor shall submit the following information to the Departmental Representative. No work shall commence prior to the Departmental Representative's approval of the various submittals:

15.4.1.1 Grouting Plan

a. Description of all grouting equipment proposed for use, including, but not limited to, mixers, grout pumps, delivery lines and appurtenances. Information shall include the make, model, year manufactured, and general condition of each item.

b. A description of all equipment and instruments to be used for surveys and monitoring of the concrete surface and adjacent structures during the work.

c. Names and qualifications statements for all personnel who will be employed in the drilling, grouting, and monitoring operations. All listed personnel must have a minimum of three years' continuous experience in similar grouting work.

d. A description of the drilling methods and equipment to be used.

e. A description of the casing and the casing withdrawal system to be used.

f. Grout material sources, and the proposed mix design.

g. Methods and equipment for calibration of the proportioning of the grout constituents.

h. Methods and equipment for calibration of the grout quantity pumped and pumping rate.

i. Statement of the proposed sequence of operations.

j. Description of grouting operations.

k. Copies of proposed drilling and grouting record forms.

15.4.1.2 Monitoring procedures

a. General plan and description of proposed monitoring operations.

b. Description and specifications of monitoring equipment and instruments.

c. Proposed methods to obtain and record monitoring data.

d. Copies of proposed monitoring data forms.

15.5 QUALITY ASSURANCE AND CONTROL PLANNING

15.5.1 Drilling and grouting work shall be carried out by the Contractor under the technical control and supervision of the Departmental Representative. Technical control includes, without being limited to, the detailed design methods to use, materials, grout mixes, pressures, pressure tests, and any required modifications to be made during drilling and grouting work.

15.5.2 The Contractor may have to perform drilling in the work area with or without sampling at the request of the Departmental Representative before, during, and after the grouting work for verification purposes.

15.5.3 The Contractor shall carry out drilling and grouting following the sequences defined in these specifications or as shown on the drawings. Holes shall be grouted as soon as possible after drilling.

15.5.4 No drilling shall be performed within a 30 m radius of any fresh concrete that has not reached a maturity of 7 days and/or a minimum compressive resistance of 10 MPa.

15.5.5 During the work, the Contractor shall take all means required to keep concrete surfaces free of grout accumulation and other debris.

15.6 DELIVERY, STORAGE AND HANDLING

15.6.1 The Contractor shall store a sufficient quantity of cement and any other required material at or near the work site to ensure that grouting operations are not delayed by a shortage of materials.

15.6.2 In the event that the cement is found to contain lumps or foreign matter of a nature and in amounts which, in the opinion of the Departmental Representative, may be detrimental to grouting operations, the Contractor shall be required to screen the material through a standard 100 mesh screen. No payment shall be made for such screening.

15.6.3 The program shown and described on the drawings is based on currently available information. Conditions encountered during construction may require additions or deletions. The grouting program shall not be modified or curtailed as a construction expediency. It is a required part of design and shall not become secondary to any time or scheduling restrictions. Grout mixes, pressures, grouting rate and the sequence in which the holes are drilled and grouted will be determined in the field and shall be as directed by the Departmental Representative.

15.7 EQUIPMENT

15.7.1 The Contractor shall supply equipment of sufficient type and capacity to execute the grouting works according to the requirements of these specifications. The material shall be supplied in sufficient number, have the proper dimensions and be in good working condition. The equipment and the layout thereof shall meet all applicable requirements of local, provincial, and federal regulations and codes, both safety and otherwise.

15.7.2 Drilling Equipment

15.7.3 The Contractor shall use standard drilling equipment of the rotary type to perform drilling. He shall use water or air for removing cuttings from the hole during drilling operations. Supplies shall include all bits, drill rods, tools, casings, piping, pumps water, and power to accomplish the required drilling. All drilling rigs and pumps shall be equipped with pressure gauges.

15.7.4 Grouting Equipment

15.7.4.1 The grout plant shall be capable of supplying, mixing, stirring and pumping the grout and additives, to the satisfaction of the Departmental Representative.

15.7.4.2 The Contractor shall provide grouting equipment in sufficient numbers as necessary to perform the work specified herein.

15.8 MATERIAL

15.8.1 Grouting material shall be cement based shrink-free grout conforming to ASTM C1107 type C.

15.8.2 The Contractor shall employ a grout mix with a water/cement ratio of 1.0. He shall make adjustments, as requested by the Departmental Representative, based on site conditions encountered in order to adequately fill voids at the interface between the existing granular material and concrete layers.

15.8.3 The water used in the grout shall be furnished by the Contractor. It shall be fresh, clean and free of injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.

15.8.4 Portland cement used in grout shall conform to the requirements of ASTM C150, Type I or II. The Contractor shall submit to the Departmental Representative the source of cement, brand name and type.

15.8.5 Fly Ash shall conform to ASTM C618 grade C or grade F. Alternate sources of fly ash may be submitted and will be considered.

15.8.6 Admixtures may be added to the grout immediately before or during its mixing and will consist of accelerators, retarders, water reducers, plasticizers and thixotropic cement grout modifier.

15.8.7 If required, sand for mortar shall be clean and consist of hard, tough, durable, un-coated particles meeting the requirements and graduation of masonry sand ASTM C33.

15.8.8 Pipe and fittings required for batching grout, drainage and exploratory holes shall be furnished, cut, threaded, and fabricated by the Contractor.

15.8.9 The Contractor shall supply steel sleeves with a 80 mm interior diameter to be embedded in the new layers of concrete prior to pouring over the Main and Auxiliary spillways. The length, layout and spacing of the sleeves is shown on the drawings.

15.9 EXECUTION

15.9.1 The Contractor shall install 80 mm diameter steel sleeves prior to pouring the new concrete layers for the purpose of voids grouting. The length of the sleeves shall be equal to the full depth of new the concrete layer. Sleeves shall be installed as shown on the drawings.

15.9.2 The Contractor shall protect sleeves with caps during concreting in order to keep them free of obstruction.

15.9.3 Hole Washing

15.9.3.1 Prior to carrying out a grouting stage, the Contractor shall thoroughly clean the inside of the sleeve with water using a hose that reaches the bottom of the hole in order to remove all mud, dirt and debris. The hole is considered clean when the water return is clean.

15.9.3.2 Water used for washing and pressure testing must have a temperature between 7°C and 20°C.

15.9.4 Grouting Hole Drilling

15.9.4.1 The Contractor shall drill grouting holes with standard rotary or percussion drilling equipment. The type of drill bit used shall be left to the discretion of the Contractor.

15.9.4.2 The minimum diameter of drill holes shall be 50 mm at the point of maximum penetration. Drill holes shall fully penetrate the new and existing concrete layers through the steel sleeves into the underlying granular material.

15.9.4.3 The Contractor shall drill all holes for voids grouting at the locations, in the direction, angle, and to the depths indicated on the drawings or as directed by the Departmental Representative. Drilling operations shall be performed under the constant supervision of the Departmental Representative.

15.9.4.4 Hole drilling shall be performed firstly for primary holes only. Drilling for secondary holes shall be undertaken only after grouting of primary holes is fully complete.

15.9.4.5 The Contractor shall protect all drill holes from becoming clogged or obstructed by means of a cap or other suitable method approved by the Departmental

Representative.

15.9.5 Voids grouting

15.9.5.1 The Contractor shall conduct voids grouting works in a sequential manner, beginning from one corner of the spillway and progressing gradually towards the opposite corner while successively injecting adjacent holes. He shall progress from the lowest point to the highest point and from the downstream towards the upstream. The Contractor shall fully complete the grouting of primary holes before beginning drilling and grouting of secondary holes.

15.9.5.2 The Contractor shall perform voids grouting works in a continuous manner, under the required pressure until refusal and as directed in these specifications.

15.9.5.3 Injection pressure shall not exceed 100 kPa. Under no circumstances shall the pressure or rate of pumping be increased suddenly.

15.9.5.4 Should grout leaks develop, the Contractor shall caulk such leaks when and as directed, the cost thereof being included in the unit cost provided in the Bid Form under Voids Grouting.

15.9.5.5 If, due to size and continuity of a void, it is found impossible to reach the required pressure after pumping a reasonable volume of grout at the specified water/cement ratio, the Contractor shall reduce the speed of pumping or temporarily stop pumping and intermittent grouting shall be performed, allowing sufficient time between grout injections for the grout to stiffen.

15.9.5.6 Following such a reduction in pumping speed, if the desired result is not obtained, the Contractor shall discontinue grouting and the hole shall be discontinued as directed by the Departmental Representative. In such an event, the Contractor shall clean the hole, allow the grout to set, and then perform additional drilling and grouting in the hole or in an adjacent area, as directed by the Departmental Representative, until the desired resistance is built up.

15.9.5.7 If, during the grouting of a hole, the grout leaks through adjacent holes, the Contractor shall immediately block the adjacent leaking holes with a packer placed at the top of the interconnecting zone and installed with manometers for pressure monitoring. The Contractor shall be capable of connecting up to 5 connecting holes at a time in order to grout them all simultaneously at a specified pressure to reach refusal, as specified in this section.

15.9.5.8 The Contractor shall discard any grout that has not been placed, for any reason, within two hours after mixing. Only if such grout is mixed at the direction of the Departmental Representative or with their knowledge and consent, such discarded grout shall be paid for at the unit cost established in the Bid Form.

15.9.6 Backfilling of Holes

15.9.6.1 The Contractor shall backfill holes with grout proportioned as directed by the Departmental Representative and generally having a water/cement ratio less than 1.0. The backfilling shall be accomplished by injection of grout through a tremie pipe or hose inserted to the full depth of the hole. When grout vents at the surface, the tremie shall be gradually withdrawn, maintaining grout in the pipe or hose until completely removed. Holes containing freshly injected grout shall not be backfilled until the injected grout has set.

15.9.7 Equipment Arrangement and Operation

15.9.7.1 The Contractor shall arrange the grouting equipment in such a manner as to provide a continuous circulation of grout throughout the system and to permit accurate pressure control by operation of a valve on the grout return line, regardless of how small the grout absorption may be.

15.9.7.2 The Contractor shall prevent the fowling of the equipment and lines by ensuring constant circulation of grout and by periodically flushing out the system with water. Flushing shall be performed with the grout intake valve closed, the water supply valve open, and the pump running at full speed.

15.9.8 Coring

15.9.8.1 After all voids grouting works are complete, the Contractor shall take two core samples of the Main spillway and one core sample of the Auxiliary spillway, in locations specified by the Departmental Representative, in order to validate that voids grouting has been successful. In the event that core samples indicate that voids continue to exist, the Contractor shall undertake additional voids grouting works as directed by the Departmental Representative. Such additional work shall be paid at the unit costs specified in the Bid Form.

15.10 RECORDS

15.10.1 The Departmental Representative shall keep records of all grouting operations, such as a log of the grouting holes, results of washing operations, time of each change of grouting operation, pressure, rate of pumping, amount of cement for each change in water/cement ratio, and other data deemed relevant. The Contractor shall provide all necessary assistance and cooperation in this regard.

Appendix A

Geotechnical Investigations Report

CIMA+

Geotechnical Investigation
Nicolston Dam
5140 Fifth Line
Alliston, Ontario

Type of Document:
Final Report

Project Number:
BAR-00044331-A0

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February 15, 2017

Legal Notification

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Appendices

1 Introduction

1.1 General

Exp Services Inc. (**exp**) was retained by CIMA+ to complete a Geotechnical Subsurface Investigation and Factual Report at Nicolston Dam in Alliston, Ontario.

The site is located within the Nicolston Dam Campground & RV Park, at the municipal address of 5140 Fifth Line in Alliston, Ontario. The location of the site is roughly shown on the Site Location Plan included as Figure 1.

It is **exp**'s understanding that there is relatively limited existing information about the as-built and current condition of the two dams located near the south end of this property. The two dams are located adjacent to each other in the Nottawasaga River, and are separated by a small island in the centre of the river. The dams at this property are understood to have been earth fill dams that were subsequently converted into concrete dams after Hurricane Hazel in the 1950's caused extensive damage to the structures at that time.

The factual information obtained as part of **exp**'s geotechnical investigation will be used to support a dam safety review of the existing dam, to determine if reconstruction is required, and the ability of the dam in its existing condition to prevent the migration of sea lamprey's upstream.

1.2 Objective and Scope of Work

The purpose of the geotechnical investigation was to establish the existing condition of the two concrete dams, and the native subsoil and groundwater conditions both underneath the dam structures, and adjacent to the dam structures.

The locations of the boreholes are shown on the Borehole Location Plan included as Figure 2. All boreholes located on the dam structure were advanced to a sufficient depth to encounter the underlying native soil. The borehole locations were as follows:

- Two (2) boreholes adjacent to the existing dam structure within the embankments. One (1) borehole was advanced on the north side of the river to 13.8 metres below existing grade, and one (1) borehole was advanced on the south side of the river to 9.6 metres below existing grade.
- Three (3) boreholes on the concrete dams within the Nottawasaga River. Two (2) of the boreholes were located on the north dam, and were advanced to 3.9 metres below the top of dam surface. The remaining one (1) borehole was located on the south dam, and was advanced to 2.8 metres below the top of dam surface.

In addition to the boreholes advanced, a general overview of the observable features in the river where the boreholes were drilled, as well as within close proximity to the dams was conducted. Select photographs from this inspection are included as Appendix D, as well as historical photographs of the property included as Appendix E.

Based on the information gained during the on-site geotechnical investigation, a factual report detailing a summary of the field and laboratory testing results, and the existing concrete, soil and groundwater conditions, and lithology as encountered in the boreholes was prepared.

2 Site Description

2.1 General Site Description

The site is located within the Nicolston Dam Campground & RV Park, at the municipal address of 5140 Ninth Line in Alliston, Ontario. The location of the site is roughly shown on the Site Location Plan included as Figure 1.

The two dams under investigation are located at the south end of the property (just north of Highway 89). The dams are located adjacent to each other in the Nottawasaga River, and are separated by a small island in the centre of the river. The topography directly adjacent to the river is relatively flat within 100 metres of the site (the floodplain of the Nottawasaga River). Beyond the floodplain, the topography generally increases by 8 to 10 metres.

The following publically available geological maps and were reviewed by **exp**:

- "*Bedrock Geology of Ontario, Southern Sheet*", Map 2544, by Ministry of Northern Development and Mines, dated 1991.
- "*Quaternary Geology of Ontario, Southern Sheet*", Map 2556, by Ministry of Northern Development and Mines, dated 1991.
- "*Quaternary Geology, Alliston Area*", Preliminary Map P.835, by Ontario Division of Mines, dated 1973.
- "*Bedrock Topography, Alliston Area, Southern Ontario*", Map P.3213, by Mines and Minerals Division, Ontario Geological Survey, dated 1993.
- "*Physiography of the South Central Portion of Southern Ontario*", Map 2226, by Ontario Department of Mines and Northern Affairs, Ontario Research Foundation, dated 1972.

The site is located within the Simcoe Lowlands physiographic region. The Simcoe Lowlands are characterized by coarse textured glacio-lacustrine (foreshore and basinal) deposits, consisting of typically sands, gravels and minor silts and clays. Adjacent to the east and west of the site is the Peterborough Drumlin Field physiographic region. The Peterborough Drumlin Field is characterized by

drumlinized glacial tills. As the site is located at the Nottawasaga River, modern alluvium deposits are also located within the site.

Bedrock of the Lindsay Formation (Simcoe Group) underlies the site at approximately 130 metres below existing grade. The Lindsay Formation is typically a nodular to black laminated limestone.

2.2 Existing and Historical Dam Conditions

A photographic site inspection was conducted during the course of the field work. General site photographs are included in Appendix D. Historical photographs of the site are included in Appendix E, which were provided by the owner of the property, Mark Nicol.

Both the northern and southern dams are fully encased in concrete, with water flowing continuously over the northern dam, and intermittently over the southern dam. Large boulders are located directly downstream of the southern dam. Directly to the north of the northern dam, a headwall that is approximately 1 to 2 metres higher than the dam structure is present, with an overflow sluiceway (fish pass) present within the embankment that allows some diversion of river flow.

The site had been developed as early as the late 1800's (Photograph 1). Photographs of the northern dam as early as 1927 are available that show that the dam has not been moved from it's original position, and has the same concrete surface condition as the present day dam (Photographs 2 and 3). During Hurricane Hazel in 1954, extensive damage occurred to the northern dam, particularly the downstream and southern portions of the dam (Photograph 4). The dam was repaired, between 1954 and 1958 to its current state (Photographs 5 and 6).

In the early 1990's, the southern dam was showing signs of deterioration and water was flowing underneath the north portion of this dam (Photograph 7). It is understood that remedial action was taken by pouring concrete over the damaged areas to block any further water flow and help stabilize the southern dam structure.

3 Procedures and Methodology

Prior to the commencement of drilling activities, the locations of underground utilities including telephone, natural gas, electrical lines, etc. were marked out by public locating companies.

The fieldwork for the drilling program was carried out between December 6 and 19, 2016, inclusive. A total of five boreholes (Boreholes 1 to 5, inclusive) were advanced at the Site by Walker Drilling Ltd., under the full-time supervision of **exp** field staff.

The location and elevation of the explorations were determined by **exp**. The horizontal locations were laid out in the field by **exp** at the time of the drilling operations in conjunction with the client's on-site representatives. All elevation measurements were measured through the use of differential GPS

measurements and referenced to the NAD 83 datum. The approximate borehole locations are shown in Figure 2.

Boreholes 1 and 2 were advanced on the embankments of the river adjacent to the dams using a track mounted drill rig equipped with continuous flight, hollow stem augering equipment and standard soil sampling equipment. Boreholes 3, 4 and 5 were advanced on the dams using a combination of a concrete coring machine (75mm sized core barrel) and a tripod sampler.

The field work was conducted under the supervision of a qualified member of our geotechnical engineering staff. The field staff examined and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials, made groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. Representative samples of the overburden were recovered at frequent depth intervals for identification purposes using a conventional split spoon sampler. Standard penetration tests were carried out simultaneously with the sampling operations to assess the strength characteristics of the substrate. Upon completion of drilling, groundwater levels were observed and recorded.

All recovered soil samples were logged in the field, carefully packaged and transported to the laboratory for more detailed examination and classification. In the laboratory, the samples were classified as to their olfactory, visual and textural characteristics.

4 Subsurface Conditions

4.1 General Overview

The detailed soil profiles encountered in the boreholes and the results of laboratory testing are indicated on the attached borehole logs in Appendix A. When reading this report and the attached borehole logs, the Notes on Sample Descriptions should be referenced for further descriptions behind the various notation on the borehole logs.

It should be noted that the conditions indicated on the borehole logs are inferred at specific locations only, and can vary between and beyond the borehole locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geological design and should not be interpreted as exact planes of geological change.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including: visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

4.2 Stratigraphy

4.2.1 North Dam Structure

Both boreholes advanced on the northern dam (Boreholes 3 and 4) encountered concrete with a thickness ranging from 420 to 940 mm at surface. Underlying the surficial concrete layer in Borehole 4, earth fill consisting of gravel and cobbles ranging in diameter from 1 to 10 cm was encountered at 0.9 and extended to 1.6 metres below the top of dam surface. Based on the historical photographs, Borehole 4 is believed to be advanced within a portion of the dam that was heavily damaged by Hurricane Hazel, while Borehole 3 is believed to be located in an area where less damage occurred. It is possible that these gravel and cobble sized particles encountered in Borehole 4 were placed to fill in the damaged area of the dam in the 1950's.

Underlying the surficial concrete layer in Borehole 3, and underlying the gravel and cobble layer in Borehole 4, an earth fill consisting of a gravelly sand (fine to coarse) with some to with silt, and trace to some wood fragments (inferred timber cribbing) was encountered at 0.6 to 1.6 metres and extended to 2.7 metres below the top of dam surface. The gravelly sand earth fill was generally brown and wet.

Underlying the gravelly sand earth fill, there was a coarser layer of earth fill consisting of gravel and medium to coarse sand with trace silt was encountered at 2.7 metres and extended to 2.8 to 3.2 metres below the top of dam surface (Elev. 200.3 metres). No wood fragments were encountered in this layer, and it is inferred to be the bedding layer that the timber cribbing structure may have been originally placed on. The gravel and sand earth fill was generally grey and wet.

Native sand with some silt and some gravel was encountered underlying the earth fill at 2.8 to 3.2 metres and extended to 3.3 to 3.7 metres below the top of dam surface. The native sand deposit is very dense with SPT "N" Values in excess of 50 blows per 150 mm of penetration. The native sand is generally grey and wet. This native sand deposit is inferred to be the original riverbed prior to the placement of the dam.

A silty sand glacial till with trace gravel and trace clay was encountered underlying the native sand deposit between 3.3 to 3.7 metres and extended beyond the vertical depth of investigation of 3.9 to 4.0 metres below the top of dam surface. The silty sand glacial till deposit is very dense with SPT "N" Values in excess of 50 blows per 150 mm of penetration. The silty sand glacial till is generally grey and moist.

4.2.2 South Dam Structure

Borehole 5 was advanced on the southern dam and encountered concrete with a thickness 760 mm at surface. Underlying the surficial concrete layer, earth fill consisting of silt and sand with trace clay and frequent gravel, cobble and wood fragments (inferred timber cribbing) was encountered at 0.8 metres and extended to 2.2 metres below the top of dam surface (Elev. 202.0 metres). The silt and sand earth

fill was generally brown and wet. Between 1.9 to 2.2 metres below the top of dam surface, drilling was difficult and significant wood fragments were obtained in the split spoon sampler. It is inferred that this particular borehole location went directly through timber cribbing at the base of the dam structure. The southern dam is believed to have not been as heavily damaged during Hurricane Hazel as portions of the northern dam, similar to the conditions in Borehole 3.

Underlying the silt and sand earth fill, there was a coarser layer of earth fill consisting of gravel and medium to coarse sand with trace silt was encountered at 2.2 and extended to 2.4 metres below the top of dam surface. No wood fragments were encountered in this layer, and it is inferred to be the bedding layer that the timber cribbing structure may have been originally placed on. The gravel and sand earth fill was generally grey and wet.

A silty sand glacial till with trace gravel and trace clay was encountered underlying the earth fill at 2.4 metres and extended beyond the vertical depth of investigation of 2.8 metres below the top of dam surface. The silty sand glacial till deposit is very dense with SPT “N” Values in excess of 50 blows per 300 mm of penetration. The silty sand glacial till was generally grey and moist.

4.2.3 Embankments

Borehole 1 encountered a gravelly sand with silt and trace grass/leaves at surface and extended to 3.2 metres below existing grade. The gravelly sand deposit is loose to compact with SPT “N” Values ranging between 8 to 28 blows per 300 mm of penetration. The silty gravelly sand is generally brown and moist to wet.

Borehole 2 encountered a sand with some gravel, some silt and trace organics/rootlets at surface and extended to 2.1 metres below existing grade. The sand deposit is very loose to compact with SPT “N” Values ranging between 2 to 14 blows per 300 mm of penetration. The sand is generally brown and moist. Underlying the sand in Borehole 2, a sand and silt with some gravel, trace organics/wood fragments was encountered at 2.1 metres and extended to 3.1 metres below existing grade. The organic sand and silt is very loose to compact with SPT “N” Values ranging between 3 to 26 blows per 300 mm of penetration. The organic sand and silt is generally brownish black and wet.

Silty sand glacial till with some gravel was encountered in both embankment boreholes below the loose to compact cohesionless soils. In Borehole 1, the silty sand glacial till was encountered at 3.1 metres and extended beyond the vertical depth of investigation of 13.8 metres below existing grade. In Borehole 2, the silty sand glacial till was encountered at 3.7 and extended to 6.9 metres below existing grade. The silty sand glacial till deposit is very dense with SPT “N” Values in excess of 50 blows per 150 mm of penetration. The silty sand glacial till is generally grey and moist.

A sand with some gravel and trace silt deposit was encountered in Borehole 2 underlying the silty sand glacial till at 6.9 metres and extended to beyond the vertical depth of investigation at 9.6 metres below existing grade. The sand deposit is compact to dense with SPT “N” Values ranging between 28 to 39

blow per 150 mm of penetration. SPT “N” Values in this stratum may not be representative due to possible blowback and loosening in the hollow stem augers. The silty sand glacial till was generally grey and moist.

4.3 Geotechnical Laboratory Testing

The results of the laboratory-testing program on selected native soil samples were conducted as per the following testing standards:

- natural moisture content (ASTM D2216), with results presented within the enclosed Borehole Logs in Appendix A;
- particle size distribution (ASTM D422 and D2217); and
- uniaxial compressive strength testing of concrete (CAN/CSA-A23.2-9C).

The results of the uniaxial compressive strength tests of the concrete capping the dams are presented on the Borehole Logs. A summary of the results are presented as follows:

Borehole Number	Run Number	Depth Below Dam Surface (m)	Compressive Strength (MPa)
4	1	0.00 to 0.48	25.7
5	2	0.18 to 0.76	22.4
Average			24.1

The results of the particle size distribution of the earth fill within the dam, and of the native sandy silt glacial till are presented in Appendix B. A summary of the results are presented as follows:

Borehole Number	Sample Number	Depth Below Ground Surface (m)	Sample Description	Grain Size Distribution %			
				Gravel	Sand	Silt	Clay
1	7	6.1 to 6.4	Sand and Silt Glacial Till	3	59	38	
3	3 & 4	1.8 to 3.1	Fill: Gravelly Sand	26	67	7	

4.4 Ground Water Conditions

Unstabilized groundwater conditions were observed in the open boreholes during the course of the fieldwork and at the end of drilling where possible. Due to some of the boreholes being cased and being filled with drill mud during the drilling process, accurate measurements of the cave-in and water level could not be made. The boreholes were backfilled immediately upon completion of drilling.

In general, the ground water elevation (both within the dams and in the embankments) is expected to be relatively close to the existing elevation of the water surface of the Nottawasaga River. The ground water and the river water are directly connected in the surficial cohesionless soils.

Ground water and river water levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions. Dewatering on site, or adjacent to the site, may also cause temporary fluctuations in the ground water table.

5 Limitations

Exp should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, **exp** Services Inc. will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent; should this occur, **exp** Services Inc. should be contacted to assess the situation and additional testing and reporting may be required.

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

Yours truly,

exp. Services Inc.

LICENSED PROFESSIONAL ENGINEER
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Feb. 15/2017
PROVINCE OF ONTARIO

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Figures

Reference:

Bing Maps, 2016

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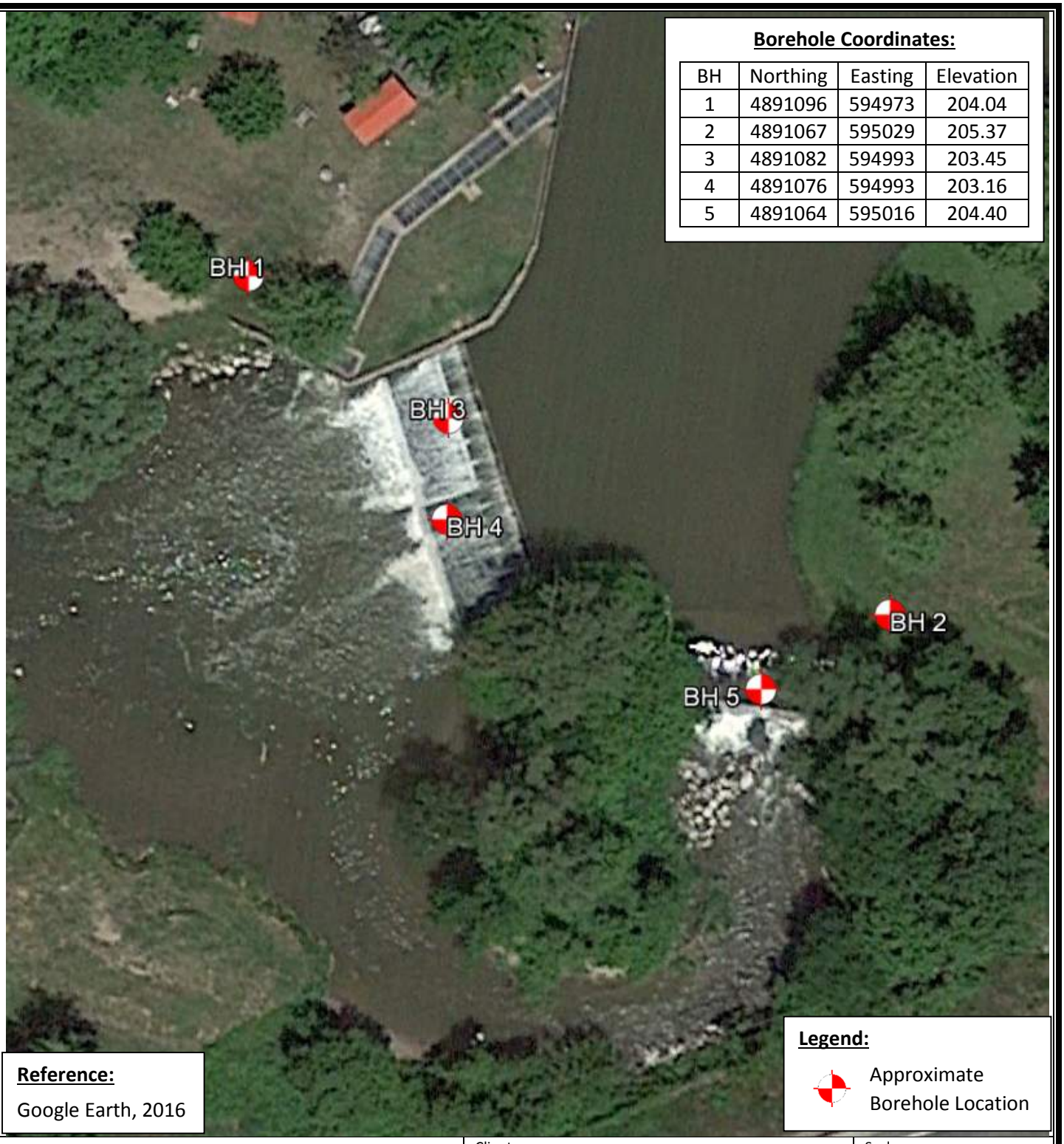
Client: CIMA+	Scale: N.T.S.
	Date: Feb.., 2016
Project: NICOLSTON DAM, ALLISTON	Drawn By: A.W.
	Project No: BAR-00044331-A0
Title: SITE LOCATION PLAN	DRAWING 1



Borehole Coordinates:

BH	Northing	Easting	Elevation
1	4891096	594973	204.04
2	4891067	595029	205.37
3	4891082	594993	203.45
4	4891076	594993	203.16
5	4891064	595016	204.40

Reference:
Google Earth, 2016

Legend:
Approximate Borehole Location

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Client: CIMA+

Project: NICOLSTON DAM, ALLISTON

Title: BOREHOLE LOCATION PLAN

Scale: N.T.S.

Date: Feb., 2017

Drawn By: A.W.

Project No: BAR-00044331-A0

DRAWING 2

Appendix A –
Borehole Logs and Terminology Sheet

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Unified Soil Classification System (USCS) as outlined by the Ministry of Transportation. Different classification systems may be used by others; one such system is the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), as outlined in the Canadian Foundation Engineering Manual. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

UNIFIED SOIL CLASSIFICATION

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Notes On Sample Descriptions

4. The following table gives a description of the soil based on particle sizes. With the exception of those samples where grain size analyses have been performed, all samples are classified visually. The accuracy of visual examination is not sufficient to differentiate between this classification system or exact grain size.

Soil Classification		Terminology	Proportion
Clay and Silt	<0.075 mm		
Sand	0.075 to 4.75 mm	“trace” (e.g. Trace sand)	0% to 10%
Gravel	4.75 to 75 mm	“some” (e.g. Some sand)	10% to 20%
Cobbles	75 to 200 mm	with (e.g. with sand)	20% to 35%
Boulders	>200 mm	and (e.g. and sand)	35% to 50%

For a given material listed as an adjective (e.g. silty sand) means the predominant grain size is sand sized with 30 to 40% silt sized particles.

The compactness of Cohesionless soils and the consistency of the cohesive soils are defined by the following:

Cohesionless Soil		Cohesive Soil		
Compactness	**Standard Penetration Resistance “N” value Blows/ 0.3 m**	**Consistency**	**Undrained Shear Strength (kPa)**	**‘N’ Values**
Very Loose	0 to 4	Very soft	<12	<2
Loose	4 to 10	Soft	12 to 25	2 to 4
Compact	10 to 30	Firm	25 to 50	4 to 8
Dense	30 to 50	Stiff	50 to 100	8 to 15
Very Dense	Over 50	Very Stiff	100 to 200	15 to 30
		Hard	>200	>30

5. **ROCK CORING**

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundless of the rock mass. It is obtained from the rock cores by summing the length of the core covered, counting only those pieces of sound core that are 100 mm or more length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very Poor Quality	<25
Poor Quality	25 to 50
Fair Quality	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

Recovery Designation: $$\% \text{ Recovery} = \frac{\text{Length of Core Per Run}}{\text{Total Length of Run}} \times 100$$

Log of Borehole BH1

Project No. BAR-00044331-A0 | Figure No. A-3

Project: Nicolston Dam | Sheet No. 1 of 2

City/ Municipality: 5140 5th Line, Alliston, ON

Location: North Embankment

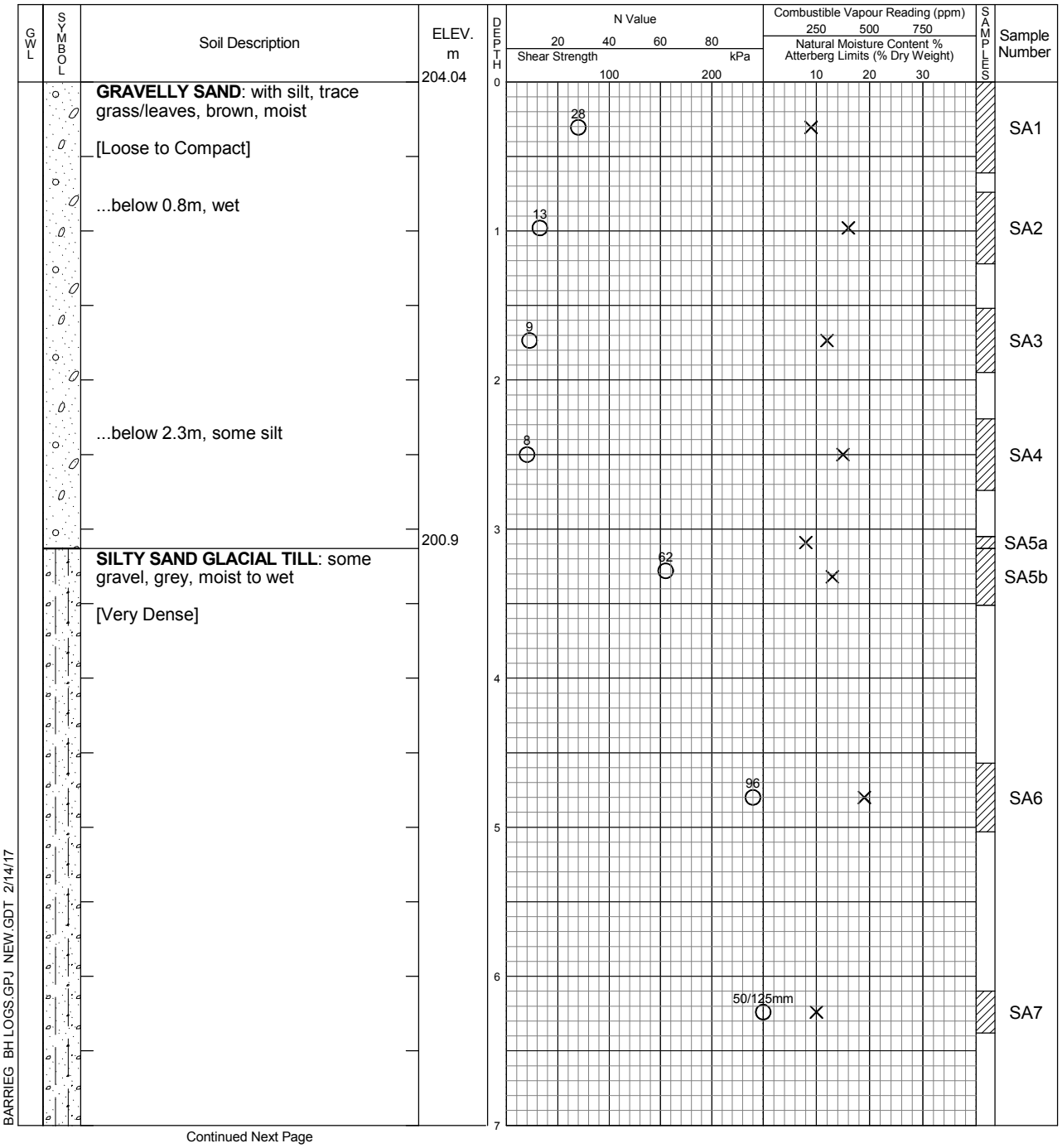
Date Drilled: Dec. 9, 2016

Drill Type: Track-Mount, Hollow Stem Augers

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



BARRIEG BH LOGS.GPJ NEW.GDT 2/14/17

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Borehole data requires interpretation assistance from **Exp** before use by others.

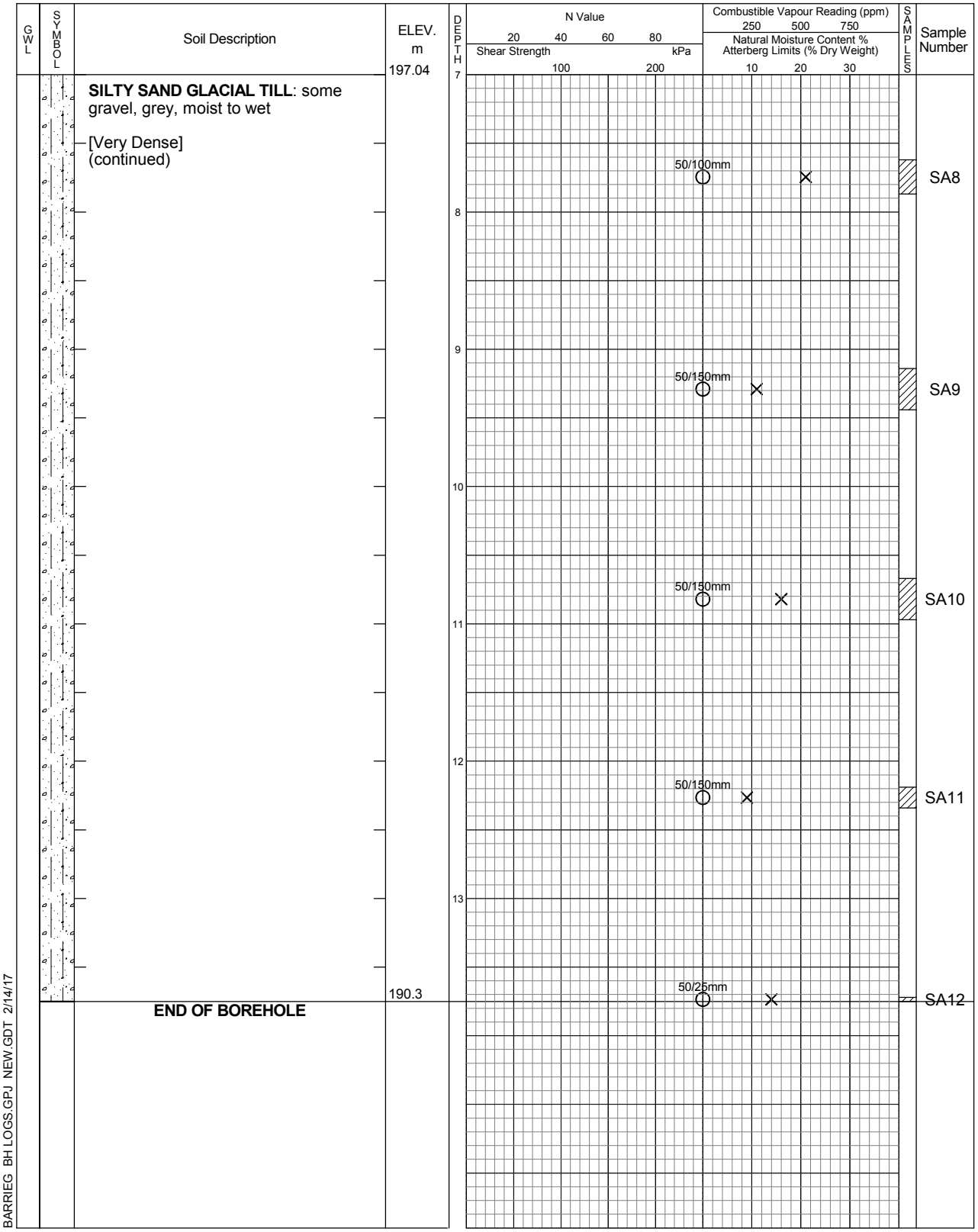
See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 9, 2016	N/A	Cased

Log of Borehole BH1

Project No. BAR-00044331-A0 Figure No. A-3

Project: Nicolston Dam Sheet No. 2 of 2



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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 9, 2016	N/A	Cased

Log of Borehole BH2

Project No. BAR-00044331-A0 | Figure No. A-4

Project: Nicolston Dam | Sheet No. 1 of 2

City/ Municipality: 5140 5th Line, Alliston, ON

Location: South Embankment

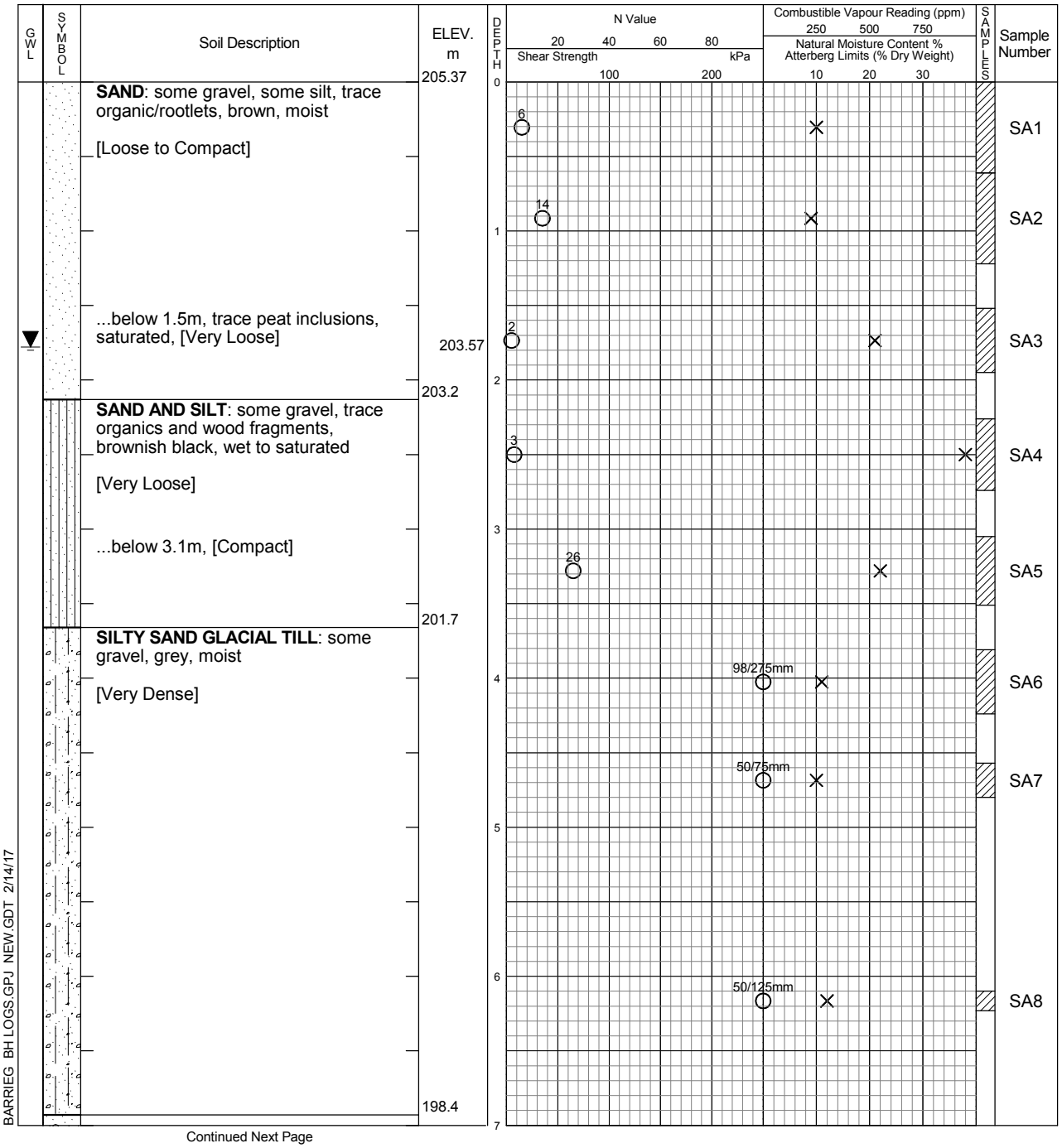
Date Drilled: Dec. 12, 2016

Drill Type: Track-Mount, Hollow Stem Augers

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 12, 2016	1.8m	2.0m

Log of Borehole BH2

Project No. BAR-00044331-A0 Figure No. A-4

Project: Nicolston Dam Sheet No. 2 of 2

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Sample Number
		SAND: some gravel, trace silt, grey, wet [Compact to Dense] *Note: N Values in this stratum may not be representative due to possible blowback and loosening in the hollow stem augers.*	198.37	7	28			SA9
				8				
				9	39			SA10
		END OF BOREHOLE	195.8					

N Value: 20 40 60 80

Shear Strength kPa: 100 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 10 20 30

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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 12, 2016	1.8m	2.0m

Log of Borehole BH3

Project No. BAR-00044331-A0 | Figure No. A-5

Project: Nicolston Dam | Sheet No. 1 of 2

City/ Municipality: 5140 5th Line, Alliston, ON

Location: North Side of Northern Dam

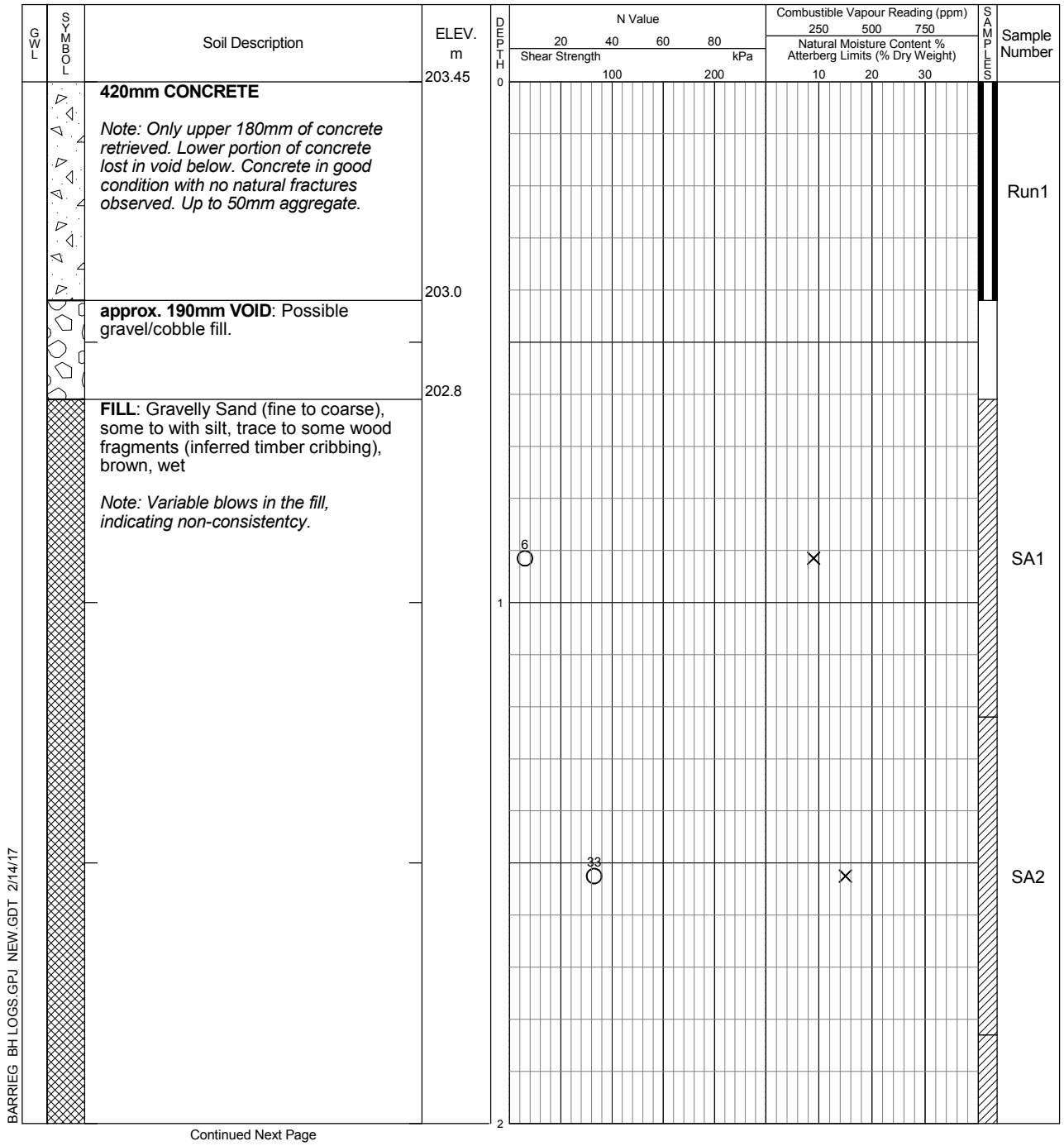
Date Drilled: Dec. 5-6, 2016

Drill Type: Tripod Sampler, Continuous

Datum: Geodetic

Auger Sample | SPT (N) Value | Dynamic Cone Test | Shelby Tube | Field Vane Test (S)

Combustible Vapour Reading | Natural Moisture | Plastic and Liquid Limit | Undrained Triaxial at % Strain at Failure | Penetrometer



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Borehole data requires interpretation assistance from **Exp** before use by others.

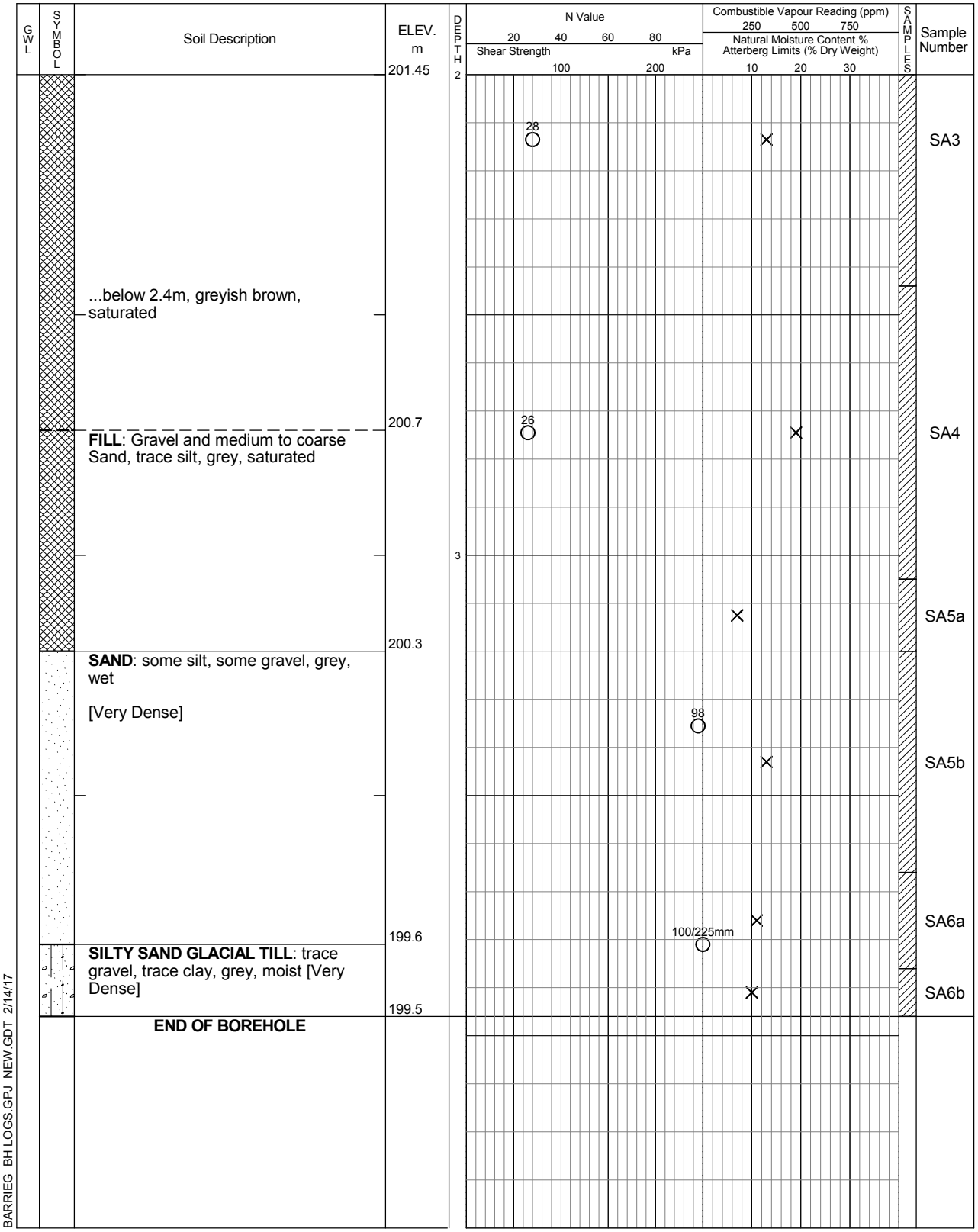
See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 6, 2016	N/A	Cased

Log of Borehole BH3

Project No. BAR-00044331-A0 Figure No. A-5

Project: Nicolston Dam Sheet No. 2 of 2



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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 6, 2016	N/A	Cased

Log of Borehole BH4

Project No. BAR-00044331-A0 | Figure No. A-6

Project: Nicolston Dam | Sheet No. 1 of 2

City/ Municipality: 5140 5th Line, Alliston, ON

Location: Centre of Northern Dam

Date Drilled: Dec. 7-16, 2016

Drill Type: Tripod Sampler, Continuous

Datum: Geodetic

Auger Sample ☒ | SPT (N) Value ○ ▨ | Dynamic Cone Test — | Shelby Tube ■ | Field Vane Test ✚ S

Combustible Vapour Reading □ | Natural Moisture × | Plastic and Liquid Limit —○— | Undrained Triaxial at % Strain at Failure ⊕ | Penetrometer ▲

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		940mm CONCRETE *Note: ~2 to 20cm diameter granite cobbles present within concrete matrix. Concrete in good condition with no natural fractures observed. Up to 50mm aggregate.* Concrete UCS (Run 1) = 25.7 MPa	203.16	0
		FILL: Gravel and Cobbles (various rock types), approx. 1 to 10cm in diameter. *Note: Generally high recovery. Larger cobbles were cored through, while gravel was either inferred washed away or retrieved in the core barrel.*	202.2	1
		...below 1.5m, wood fragments encountered	201.5	
▼		**FILL**: No sample retrieved. Cave-in materials retrieved in this zone were cobbles up to 5cm in size.	201.36	2

N Value: 20 40 60 80 | Shear Strength kPa: 100 200

Combustible Vapour Reading (ppm): 250 500 750 | Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES | Sample Number: Run1, Run2, Run3, Run4, Run5, Run6, Run7

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Borehole data requires interpretation assistance from **Exp** before use by others.

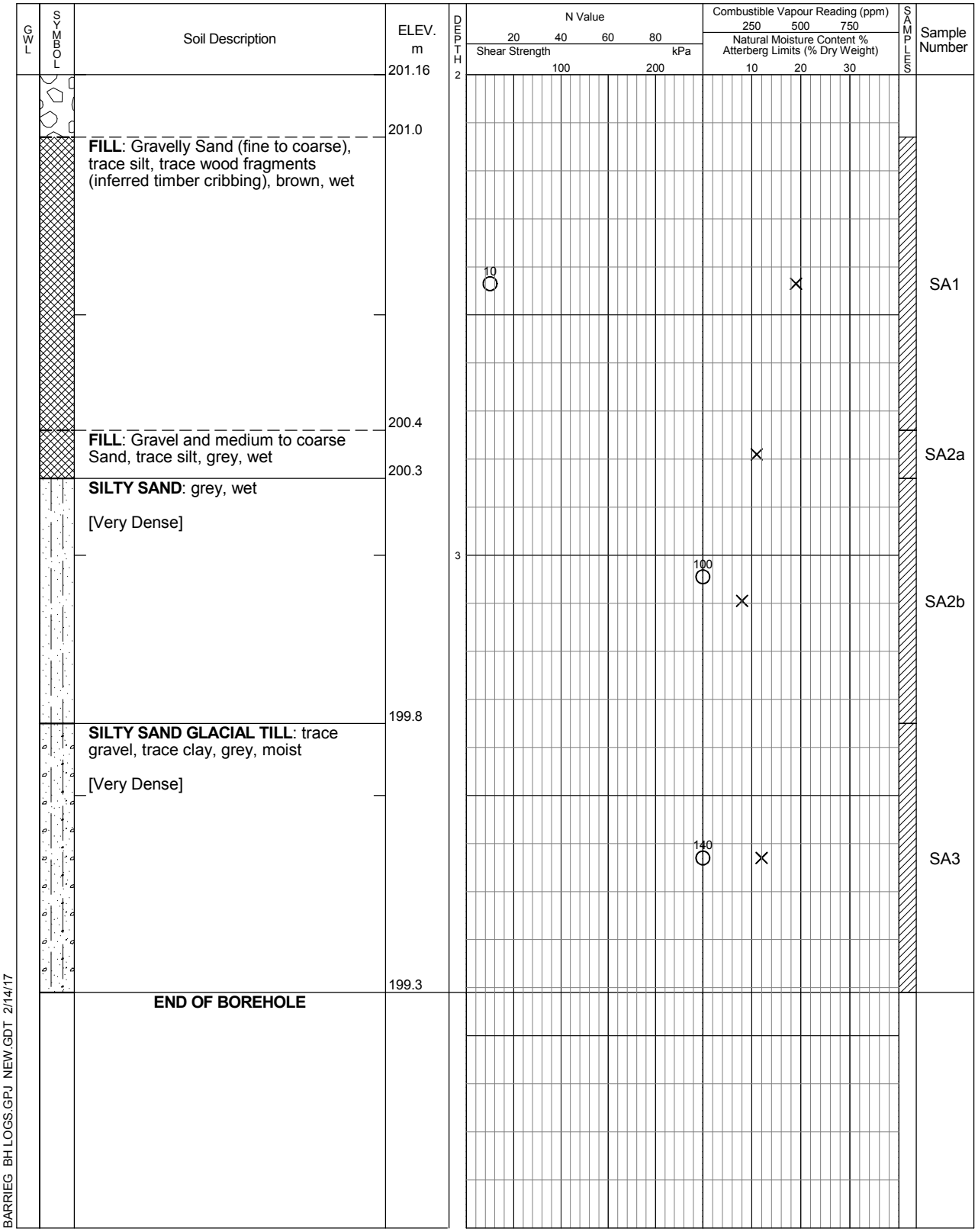
See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 16, 2016	1.8m	1.8m

Log of Borehole BH4

Project No. BAR-00044331-A0 Figure No. A-6

Project: Nicolston Dam Sheet No. 2 of 2



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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 16, 2016	1.8m	1.8m

Log of Borehole BH5

Project No. BAR-00044331-A0 | Figure No. A-7

Project: Nicolston Dam | Sheet No. 1 of 2

City/ Municipality: 5140 5th Line, Alliston, ON

Location: Centre of Southern Dam

Date Drilled: Dec. 17, 2016

Drill Type: Tripod Sampler, Continuous

Datum: Geodetic

Auger Sample | SPT (N) Value | Dynamic Cone Test | Shelby Tube | Field Vane Test (S)

Combustible Vapour Reading | Natural Moisture | Plastic and Liquid Limit | Undrained Triaxial at % Strain at Failure | Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		760mm CONCRETE *Note: Only upper 540mm of concrete retrieved. Lower portion of concrete lost in void below. Possible gravel/cobble fill in this zone. Concrete in good condition with no natural fractures observed. Up to 50mm aggregate.* Concrete UCS (Run 2) = 22.4 MPa	204.40	0
		FILL: Silt and Sand, trace clay, with frequent gravel, cobbles and wood fragments (inferred timber cribbing), brown, wet	203.6	1
		...below 1.8m, coarser with less silt present	202.5	
		FILL: No sample retrieved. Cave-in materials retrieved in this zone were		2

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N Value: 20 40 60 80 | Shear Strength: 100 200 kPa

Combustible Vapour Reading (ppm): 250 500 750 | Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES	Sample Number
	Run1
	Run2
SA1	SA1
SA2	SA2
SA3	SA3

6 | 178 | 170/100mm

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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 17, 2016	N/A	Cased

Log of Borehole BH5

Project No. BAR-00044331-A0 Figure No. A-7

Project: Nicolston Dam Sheet No. 2 of 2

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH 2	N Value 20 40 60 80 / Shear Strength kPa 100 200	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 10 20 30	SAMPLES	Sample Number
		cobbles up to 5cm in size, and lots of wood fragements which is inferred to be the base of the timber cribbing structure.	202.40					
		FILL: Gravel and medium to coarse Sand, trace silt, grey, wet	202.2					
		SILTY SAND GLACIAL TILL: trace gravel, trace clay, grey, moist [Very Dense]	202.0		98		SA4	
		END OF BOREHOLE	201.6					

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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Dec. 17, 2016	N/A	Cased

Appendix B –
Core Photographs

BOREHOLE 3
Run 1
Depth: 0.0 to 0.61m

BOREHOLE 4
Run 1
Depth: 0.0 to 0.48m

BOREHOLE 4
Run 2
Depth: 0.48 to 0.84m

BOREHOLE 4
Run 3
Depth: 0.84 to 1.22m

BOREHOLE 4
Run 4
Depth: 1.22 to 1.32m

BOREHOLE 4
Run 5
Depth: 1.32 to 1.37m

BOREHOLE 4
Run 6
Depth: 1.37 to 1.52m

BOREHOLE 4
Run 7
Depth: 1.52 to 1.63m

BOREHOLE 5
Run 1
Depth: 0.0 to 0.18m

BOREHOLE 5
Run 2
Depth: 0.18 to 0.76m

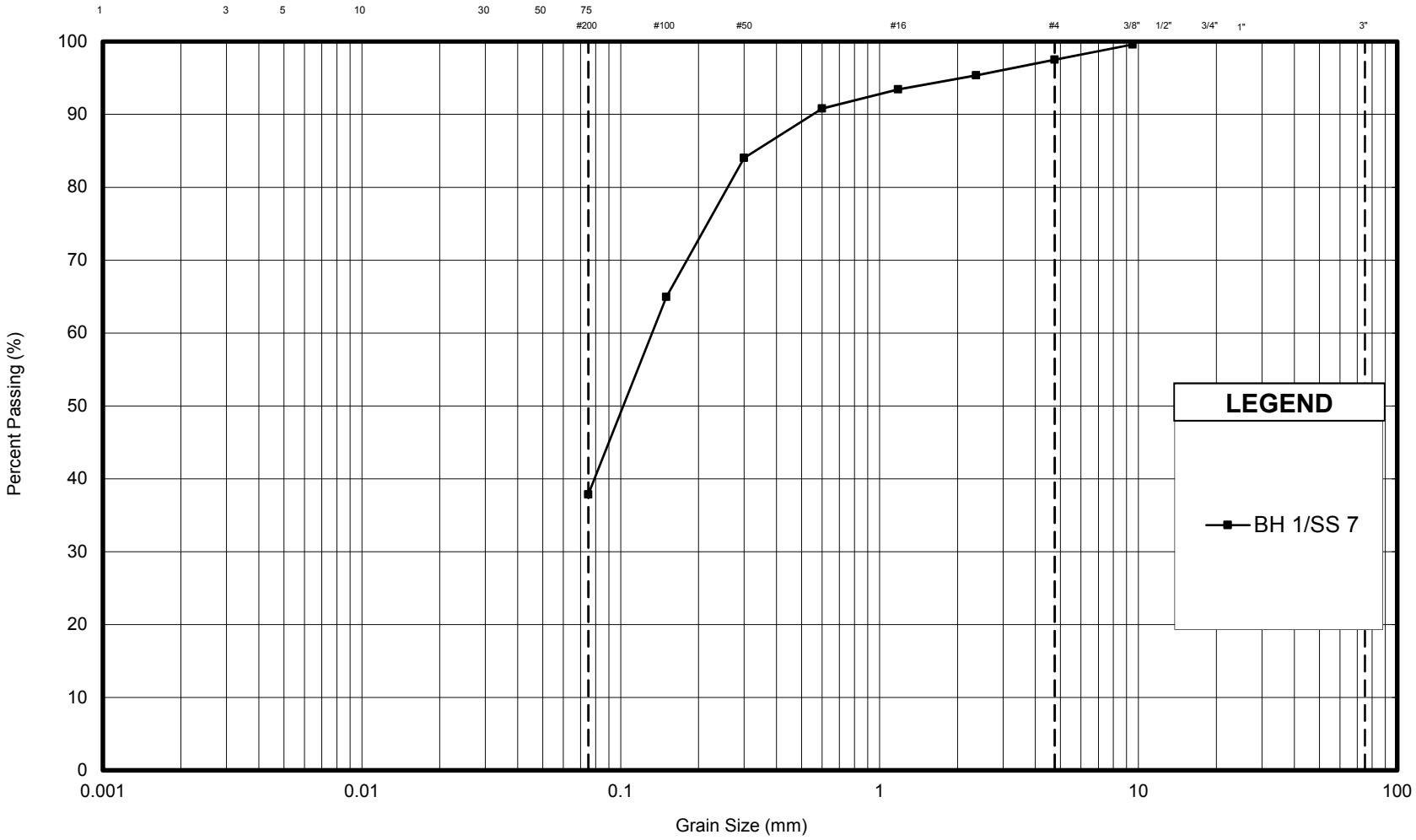
Appendix C –
Geotechnical Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



GRAIN SIZE DISTRIBUTION

Sand and Silt Glacial Till

FIGURE No.	C-1
REF. No.	BAR-00044331-A0
DATE	February 2017

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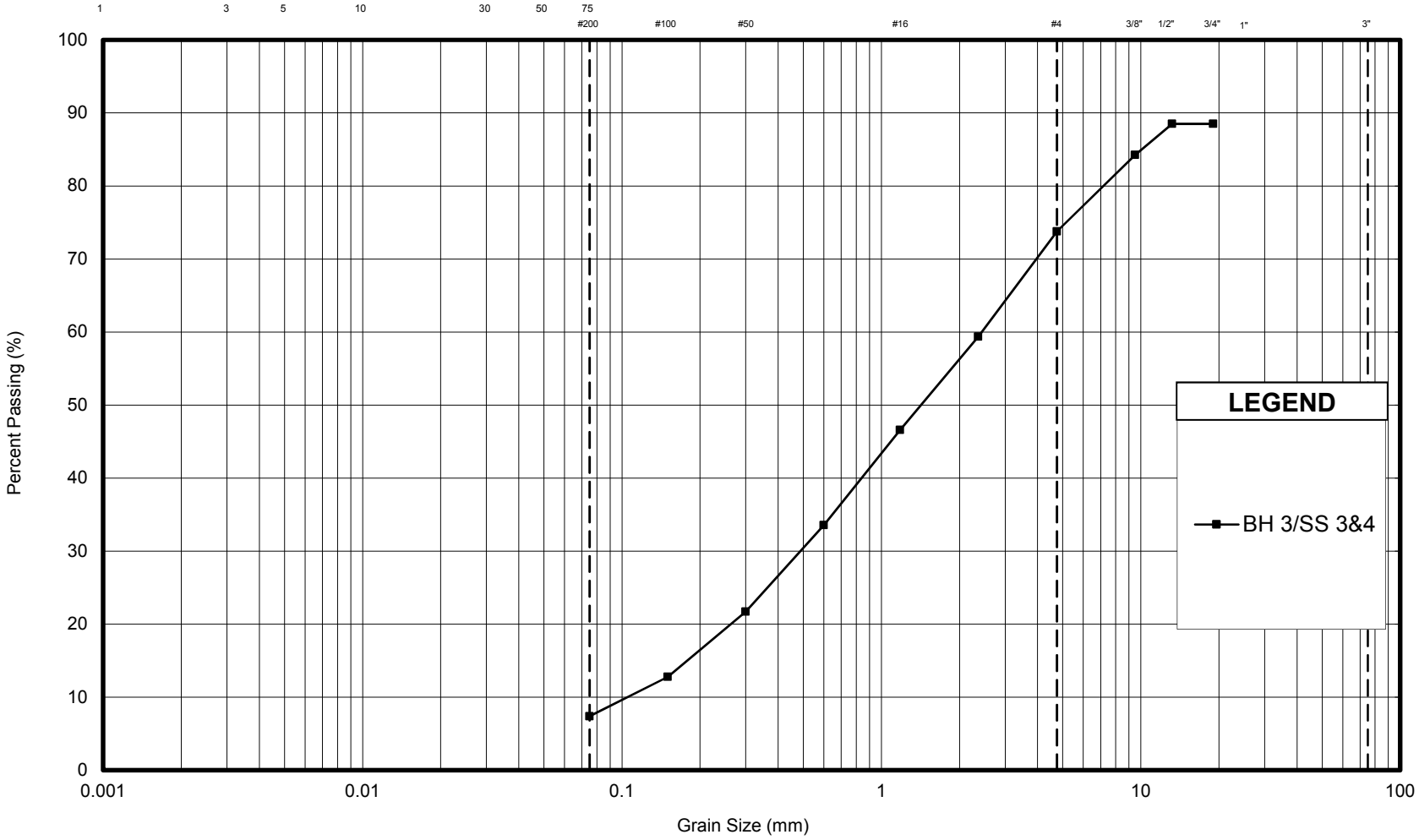
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



GRAIN SIZE DISTRIBUTION

FILL: Gravelly Sand

FIGURE No.	C-2
REF. No.	BAR-00044331-A0
DATE	February 2017

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Appendix D –
Site Photographs

PHOTO 1
Location: North Dam

PHOTO 2
Location: North Dam

PHOTO 3
Location: North Dam

PHOTO 4
Location: North Dam

PHOTO 5
Location: South Dam

Appendix E –
Historical Photographs

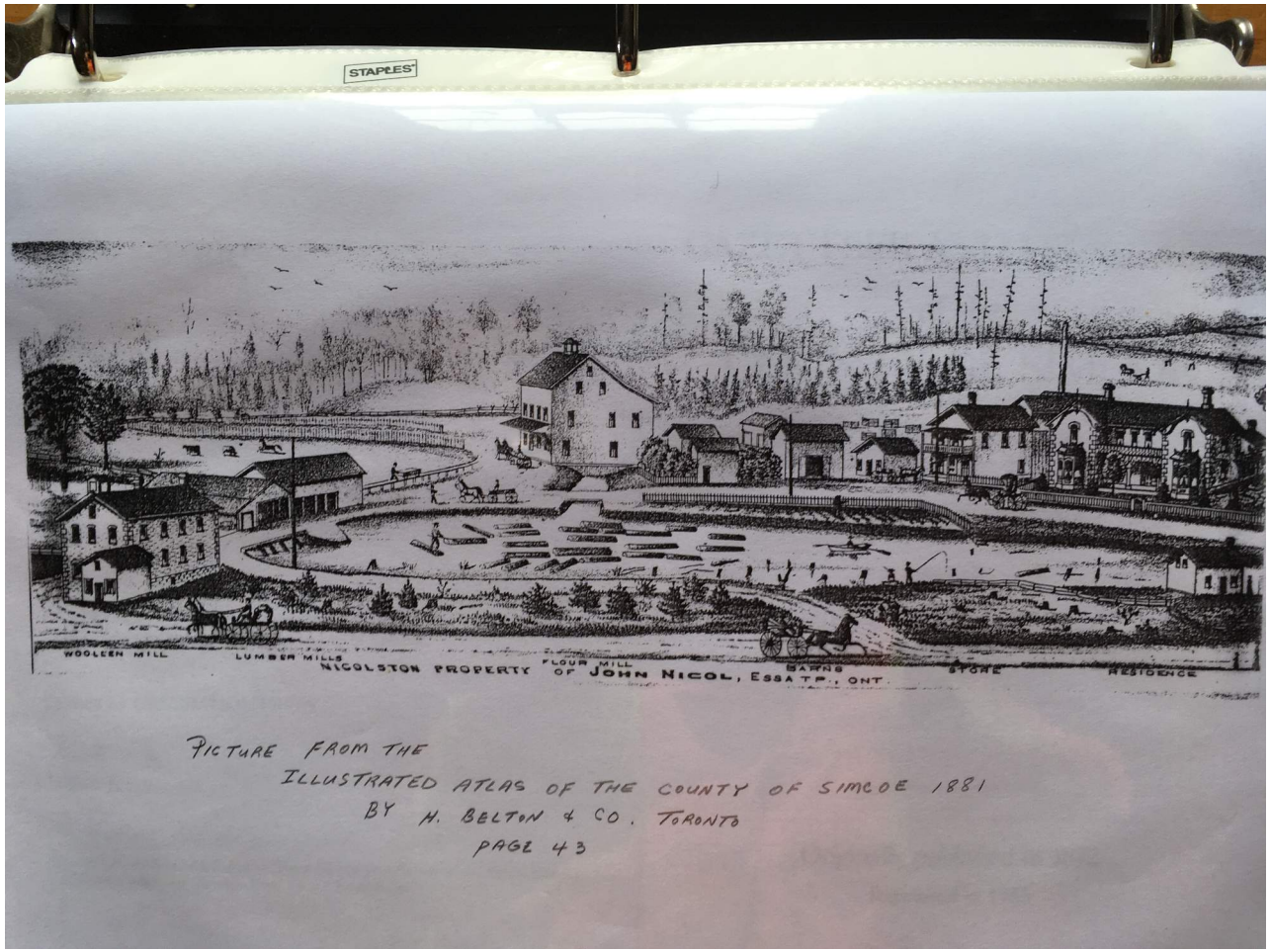

PHOTO 1
Date/Location: 1881, Entire Area Surrounding Dam
Description: An artist's representation of the area surrounding Nicolston Dam.

PHOTO 2
Date/Location: 1927, North Dam
Description: The original condition of the dam prior to reconstruction from the damage due to Hurricane Hazel.

PHOTO 3
Date/Location: 1927, North Dam
Description: The original condition of the dam prior to reconstruction from the damage due to Hurricane Hazel.

PHOTO 4
Date/Location: 1954, North Dam
Description: Extent of damage done to the dam due to Hurricane Hazel.

PHOTO 5
Date/Location: 1958, North Dam
Description: Reconstruction of the dam after the damage due to Hurricane Hazel.

PHOTO 6
Date/Location: 1990's, North Dam
Description: No major work has been done to the dam since the reconstruction in the 50's.

PHOTO 7
Date/Location: 1997, South Dam
Description: Condition of the south dam prior to concrete placement, in particular where water is flowing underneath the dam.