AllRock
Consulting Ltd

Geotechnical Investigation Report
Fire Pump Replacement, St. Anthony, NL

SNC-Lavalin Group Inc.

December 16, 2021

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Contents

1.0 Introduction

At the request of SNC-Lavalin Group Inc (SNC), AllRock Consulting Ltd. (AllRock) has completed a geotechnical investigation for the design and construction of a new underground storage reservoir in support of replacing the existing fire pump located at the St. Anthony Airport near the town of St. Anthony, NL. The scope of the program was to complete the following:

- Complete a Geotechnical field investigation program including two (2) boreholes.
- Complete laboratory testing on select soil samples.
- Soil Classification in accordance with the "Unified Soil Classification System".
- Geotechnical Soil parameters to aid in the design process.
- Groundwater characteristics of the site.
- Bedrock depth.
- Provide a geotechnical report summarizing the findings of the field investigation and recommendations for pavement and foundation design.

2.0 Site Description

The project site is located at the St. Anthony Airport, which is approximately 55 kilometers west of the town of St. Anthony along route 430. The investigation was completed on a previously developed parcel of land that is between the existing pumphouse and maintenance building. The site is partially covered in asphalt while the remainder of the site is a landscaped area. It is understood that a new underground storage reservoir will be installed, measuring approximately 8m x 15.5m and buried to a depth of approximately 3m below the existing grade. The reservoir is to be constructed as a reinforced concrete tank.

3.0 Methodology

Fieldwork for the investigation was supervised by a senior geotechnical technician from AllRock's Corner Brook officestaff on November 19th and 20th, 2021 and consisted of two (2) boreholes at the locations indicated on the location plan in Appendix C`. Borehole locations were selected by the Client.

The boreholes were advanced to the required depths by means of a track-mounted, geotechnical drill rig. Standard Penetration tests were completed at frequent intervals and the results are shown on the Borehole Log as N-values. The subsurface soils were visually inspected, logged and sampled at the borehole locations along with any other relevant field information. Upon completion, boreholes were backfilled with suitable material and compacted as necessary with the equipment available.

4.0 Laboratory Testing

Samples recovered from the boreholes were taken to the AllRock laboratory in Corner Brook, NL for final classification and testing. Laboratory testing on select soil samples include:

- ASTM D2216 – Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass;
- ASTM D6913 – Standard Test Method for Particle-Size Distribution of Soils Using Sieve Analysis;

Results of the laboratory testing are shown in Appendix B. Soil descriptions used throughout the borehole records are classified in accordance with the Unified Soil Classification System (ASTM D2487 – Standard

Practice for Classification of Soils for Engineering Purposes/ ASTM D2488 Standard Practice for Description and Identification of Soils).

5.0 Subsurface Conditions

Subsurface conditions were observed and recorded by AllRock's representative. A summary of the subsurface conditions encountered during drilling are provided below, with additional details provided in the attached Borehole Logs (Appendix A).

5.1 Soils

Soils encountered during excavation generally consisted of a silty sand or gravel native glacial till. Four (4) soil samples were obtained in the field; two (2) of which were analyzed for Particle-Size Distribution in accordance with ASTM D6913, and two (2) of which was analyzed for Moisture Content in accordance with ASTM D2216. Soils were classified in accordance with ASTM D2487 based on the percentage of gravel (passing 3-in., retained on No.4), percentage of sand (passing No.4, retained on No.200) and percentage of fines (passing No. 200) present in the soil. The presence and relative frequency of cobbles and boulders are presented in the borehole logs.

5.2 Glacial Till

Native till encountered during excavation generally consisted of a silty sand with gravel (SM). Undisturbed native till was encountered in all boreholes.

During the investigation, the density of the native till was described as dense to very dense based on SPT values. Based on laboratory testing of the sample obtained from the till layers encountered, the sample was comprised of 29.3% to 40.9% gravel, 32.2% to 41.4% sand, and 11.8% to 12.6% fines (silt and clay), with moisture contents ranging from 4.1% to 9.9%.

5.4 Organics

A layer of brown organic topsoil was encountered in borehole 2 from the surface to a depth of 0.61 m.

5.5 Bedrock

Bedrock was encountered in all boreholes. The bedrock was encountered at depths ranging from 1.52 to 2.13 m and was determined based on refusal during drilling. It should be noted that due to the spacing of boreholes it is possible that bedrock may exist at varying depths along the project area that was not encountered during this investigation. The bedrock consisted of a soft to medium-hard, grey, siltstone bedrock with quartz veins

5.6 Groundwater

At the time of the investigation, no groundwater was encountered in any of the boreholes. Groundwater levels may fluctuate with seasonal weather changes, precipitation events, and construction activity.

6.0 Discussion

6.1 Site Preparation

All fill, organics, debris, asphalt, and deleterious material should be removed down to dense, native material or competent, unfractured bedrock. Due to the silty nature of the underlying native materials, soil may become soft, spongy, and difficult to work with when saturated and disturbed. Care should be used when handling, stockpiling, and compacting native material to avoid saturating the material past its optimum moisture content. Exposed native material and layers of compacted subgrade material should be protected from precipitation, freezing temperatures, and groundwater seepage.

6.2 Structural Fill

Structural fill should consist of an approved, well-graded, non frost susceptible, granular material such as a processed rockfill or pit run sand and gravel. The maximum particle size should not exceed 200 mm and should have a maximum 8% passing the no. 200 sieve. Particle size should not exceed 100 mm within 300 mm of the pavement structure. Structural fill should be placed in even, horizontal lifts and compacted to 100% standard proctor maximum dry density (ASTM D698). The material should be compacted in appropriate lift thickness given the available compaction equipment and material type to ensure compaction is achieved throughout the lift. Generally, material should be placed in 300 mm lifts and sufficiently compacted with a 10-tonne vibratory roller. Due to the particle size distribution of coarse-grained soils, such as a processed rockfill, verification of the field density by visual inspection during proof rolling will be required. It is recommended that all placement and compaction of structural fill be visually approved by qualified geotechnical personnel.

Native soils have potential for reuse as structural fill material provided the material is 1-2% below its optimum moisture content and is free of organic and deleterious matter. Qualified geotechnical personnel should be consulted for inspection of the material to determine if it is suitable for reuse as structural fill during construction. It should also be noted that reused native soils are susceptible to freezing and thawing and that previously approved compacted material should be sufficiently protected during freezing temperatures and precipitation. Geotechnical personnel should assess the imported materials prior to being brought to use on site.

Where two types of materials with different grain sizes are planned, the use of a filter fabric should be considered to avoid particle migration of finer particles into coarse layers of material.

6.3 Slopes

All slopes and excavations should conform to NL's Occupational Health and Safety Act and all proposed slopes and excavations should be reviewed by qualified geotechnical personnel prior to excavation. Shallow excavations, less than 1.2 m depth, founded in competent soil above the water table may be excavated at 1.5-Horizontal to 1.0-Vertical. Flatter slopes, bracing, or a combination thereof will be required for excavations deeper than 1.2 m or sites where soil and water conditions warrant further slope protection. Temporary slopes consisting of approved structural fill should be placed at a slope no steeper than 1.0-Horiztonal to 1.0-Vertical and 1.5-Horizontal to 1.0-Verticle for an approved pit run sand or gravel. Careful monitoring of the excavation sides is recommended to ensure soil has not become disturbed because of construction activity or surface and/or groundwater infiltration.

Final permanent slopes constructed with approved structural fill should be placed and compacted no steeper than 2.0-Horizontal to 1.0-Vertical. Final permanent slopes excavated in native soils should be no steeper than 2.5-Horizontal to 1.0-Vertical. Erosion control, drainage ditches, and protection of all slopes is recommended.

6.4 Foundation Design

Typical shallow foundations will be suitable for the proposed development if soils are suitably prepared as outlined in previous sections. Shallow foundations founded on undisturbed native silty sand/gravel, or properly prepared structural fill may be designed for the Limit States Design Parameters outlined in table 1 below. The estimated Serviceability Limit States (SLS) bearing pressure value for properly prepared undisturbed native glacial till or structural rockfill is based on a total settlement of 25 mm for a foundation not smaller than 1m in width.

Design Parameters for Shallow Foundations	SLS Bearing Pressure	ULS Bearing Pressure
Unfractured Bedrock	400 kPa	600 kPa
Undisturbed Native Till	250 kPa	400 kPa
Structural Fill (In accordance with Section 6.2)	150 kPa	250 kPa

Table 1: Design Parameters for Shallow Foundations

Footings in unheated areas should have a minimum soil cover of 1.8 m or equivalent frost protection such as insulation. Foundations should not be constructed on frozen ground, and temporary frost protection during freezing conditions should be provided following construction of footings. Foundation walls should be backfilled with a free-draining, non-frost susceptible and non-deleterious material. A perforated pipe with clear stone directly toward a positive discharge is recommended.

Any foundations placed on coarse structural rockfill should also contain a layer such as NL DTI Class B granular that will minimize point loading between the foundations and large particles in the rockfill.

6.5 Pavement Structure

Site preparation and structural fill placement for roadway areas should be constructed in accordance with the recommendations in the previous sections. Table 2 below is based off standard traffic loading and does not include a calculation for non-standard roadway vehicles such as aircraft or heavy airport support vehicles.

Pavement structure material types, placement, and compaction should follow the NL Department of Transportation Specification Book. Adequate subgrade and site drainage are recommended in the design of the pavement structure to ensure long term performance.

Material	Thickness
Standard Loading	
Surface Course Asphalt	40 mm
Base Course Asphalt	50 mm
Class A Granular	150 mm
Class B Granular	250 mm

Table 2: Pavement Structure Recommendation

6.6 Seismic Site Classification

Based on the 2021 Building Code Compendium, the classification of soils for seismic design should be based on the average properties of the top 30 metres of the soil profile. The boreholes encountered dense to very dense native till at approximately 1-2m depth, the site may be classified as seismic Site Class B.

6.7 Assumed Soil Parameters

The following unfactored soil parameters are provided as a guide for preliminary planning and design purposes. A review of the design should be conducted by AllRock once the design is made available.

Parameter	Natural In-Situ Silty Sand w/ Gravel (SM)	Compacted Structural Fill (GW)
Unit Weight (kN/m^3)	21	22
Angle of Internal Friction (Deg)	34	36
At Rest Earth Coefficient	0.28	0.27
Active Earth Pressure Coefficient	0.44	0.41
Passive Earth Pressure Coefficient	3.54	3.86

Table 3: Assumed Soil Design Parameters

7.0 Quality Assurance/Quality Control

A quality assurance/ quality control program should be completed by AllRock geotechnical personnel during construction of the roadway, bridge abutments, roundabout etc. The program should consist of founding level inspections prior to placement of structural fill, proof rolling and testing of structural fill/granular material, and field and laboratory testing of soils, concrete and asphalt testing during placement.

8.0 Closure

This report has been prepared for guidance during the design process for a new fire pump located at the St. Anthony Airport in St. Anthony, NL. The data presented in this report is limited to the exact location where boreholes have been advanced, and at the time of year which they have been advanced; subsurface soil and groundwater conditions around the project site may differ from the data collected in the boreholes. Actual roadway structure and sub-surface conditions may differ from the information presented in this report. The comments and data provided are therefore based on the information collected at the specific borehole locations.

If you have any questions or require any additional information, please feel free to contact the undersigned below.

Thank you.

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pegnl
ENGINEERING PERMIT
N1078
ALLROCK CONSULTING LTD.
Signature or Member Number
(Member-in-Responsible Charge)

Appendix A: Borehole Records

AllRock Consulting Ltd.
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Corner Brook, NL, A2H 5P9
Telephone: 1 (709) 660-1696

BORING NUMBER BH01

CLIENT SNC Lavalin Inc.
PROJECT NAME St. Anthony Airport Fire Pump Replacement
PROJECT NUMBER 21221
PROJECT LOCATION St. Anthony, NL
DATE STARTED 11/19/21 **COMPLETED** 11/20/21
GROUND ELEVATION **HOLE SIZE** 100mm
DRILLING CONTRACTOR Logan Drilling and Geotechnical
GROUND WATER LEVELS:
DRILLING METHOD Track Mounted CME Drill Rig
AT TIME OF DRILLING ---
LOGGED BY W. Ball **CHECKED BY** S. Allen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	GRAPHIC LOG	MATERIAL DESCRIPTION
0.10					Asphalt;
	SS 1	54	14-23-24-45 (47)		Compact, green to grey, sand and gravel; trace silt. [FILL].
0.71	SS 2	100	45-50/0.05		Dense to very dense, brown, silty SAND with gravel (SM); Occasional boulders.
	SS 3	37	15-40-50/0.11		
2.13	RC 5	83 (52)			Soft to medium-hard, grey, siltstone with quartz veins; BEDROCK; Fractured to severely fractured, thinnly bedded.
	RC 6	95 (51)			
	RC 7	93 (0)			
6.05	RC 8	91 (57)			

Bottom of borehole at 6.05 meters.

AllRock Consulting Ltd

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BORING NUMBER BH02

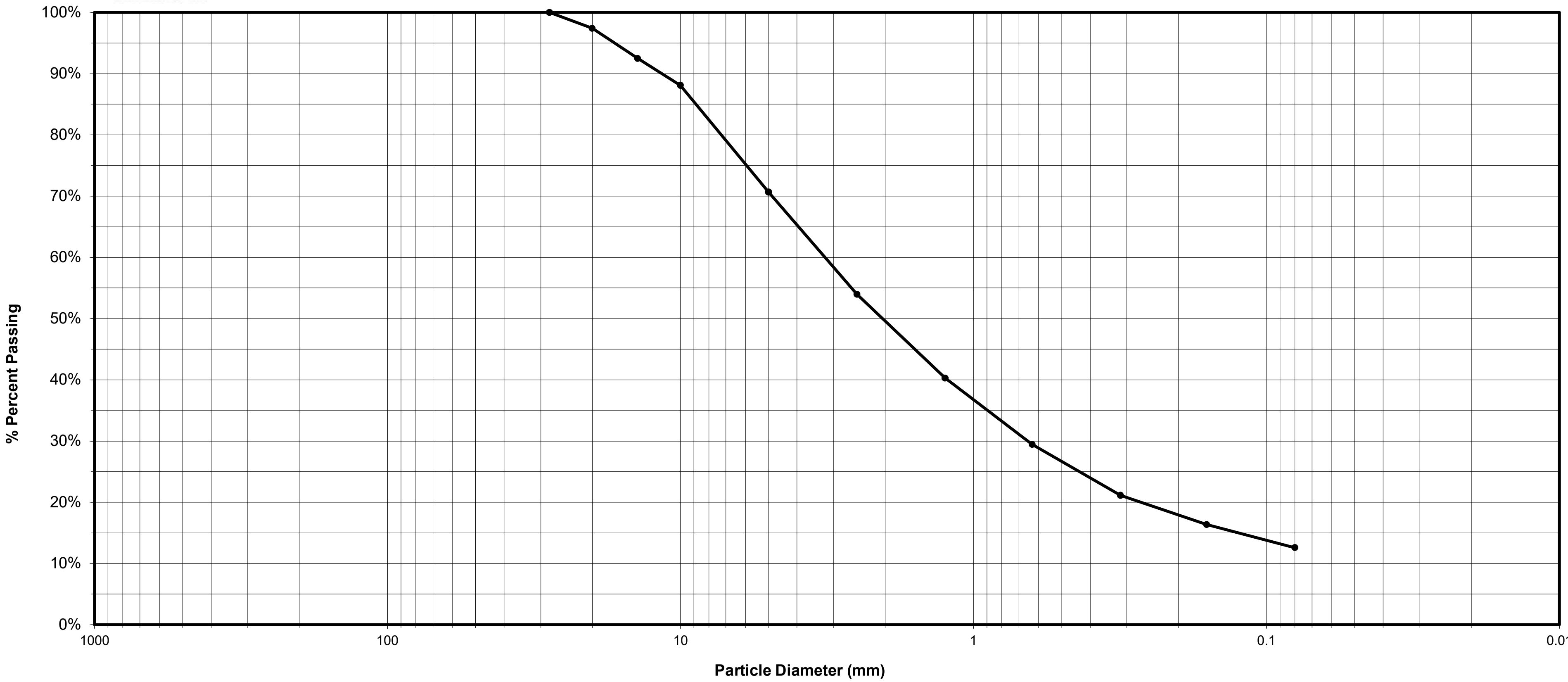
CLIENT SNC Lavalin Inc.
PROJECT NAME St. Anthony Airport Fire Pump Replacement
PROJECT NUMBER 21221
PROJECT LOCATION St. Anthony, NL
DATE STARTED 11/20/21 **COMPLETED** 11/20/21
GROUND ELEVATION **HOLE SIZE** 100mm
DRILLING CONTRACTOR Logan Drilling and Geotechnical
GROUND WATER LEVELS:
DRILLING METHOD Track Mounted CME Drill Rig
AT TIME OF DRILLING ---
LOGGED BY W. Ball **CHECKED BY** S. Allen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	GRAPHIC LOG	MATERIAL DESCRIPTION
0.00–0.61					Topsoil;
0.61–1.52	SS 1	70	3-14-31-27 (45)		Dense to very dense, brown to grey, SILTY SAND WITH GRAVEL (SM).
	SS 2	30	50/0.10		
1.52–5.92	RC 3	100 (0)			Soft to medium-hard, grey, siltstone with quartz veins; BEDROCK; Thinnly bedded.
	RC 4	80 (20)			
	RC 5	84 (0)			
	RC 6	97 (56)			
	RC 7	100 (79)			

Bottom of borehole at 6.02 meters.

Appendix B: Laboratory Testing Results

AllRock Consulting Ltd
19B Union Street, A2H 5P9
Corner Brook, NL



AllRock Sample Gradation Analysis	
Project:	St. Anthony Fire Pump Replacement
Project #:	21221
Client:	SNC Lavalin
Date	26-Nov-21
Sample:	Silty Sand with Gravel (SM)
Sample #:	1
Source:	SS #2 2'-4'

Sieve Size (mm)	Specification Lower % Passing	Specification Upper % Passing	Tested Sample % Passing
28			100.0%
20			97.4%
14			92.5%
10			88.1%
5			70.7%
2.5			54.0%
1.25			40.3%
0.63			29.5%
0.315			21.1%
0.16			16.4%
0.08			12.6%
Moisture Content:			4.1%
Technician Sampled:	W. Ball		
Technician Tested:	C. Dolland		
Reviewed By:	B. Evans		

Remarks

No grading specification available for test pits.

AllRock Consulting Ltd
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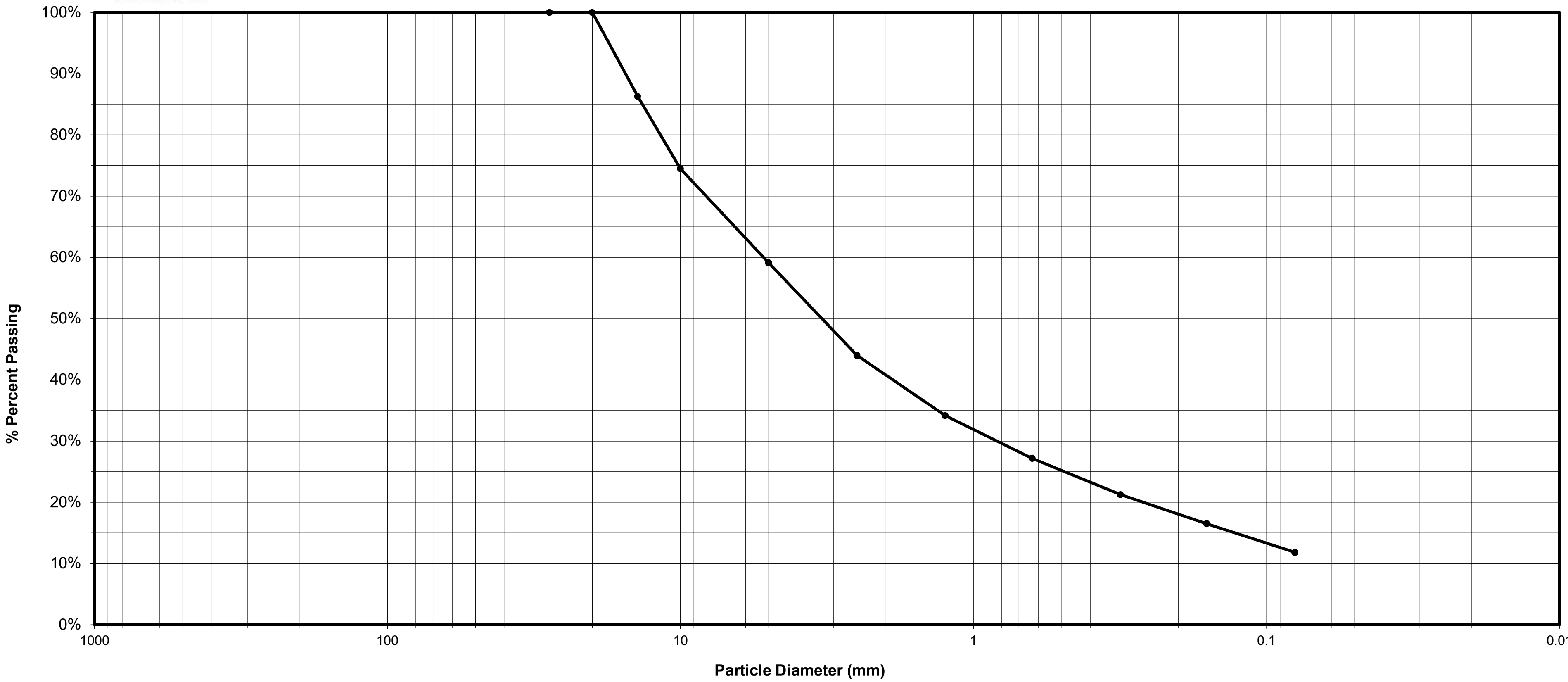


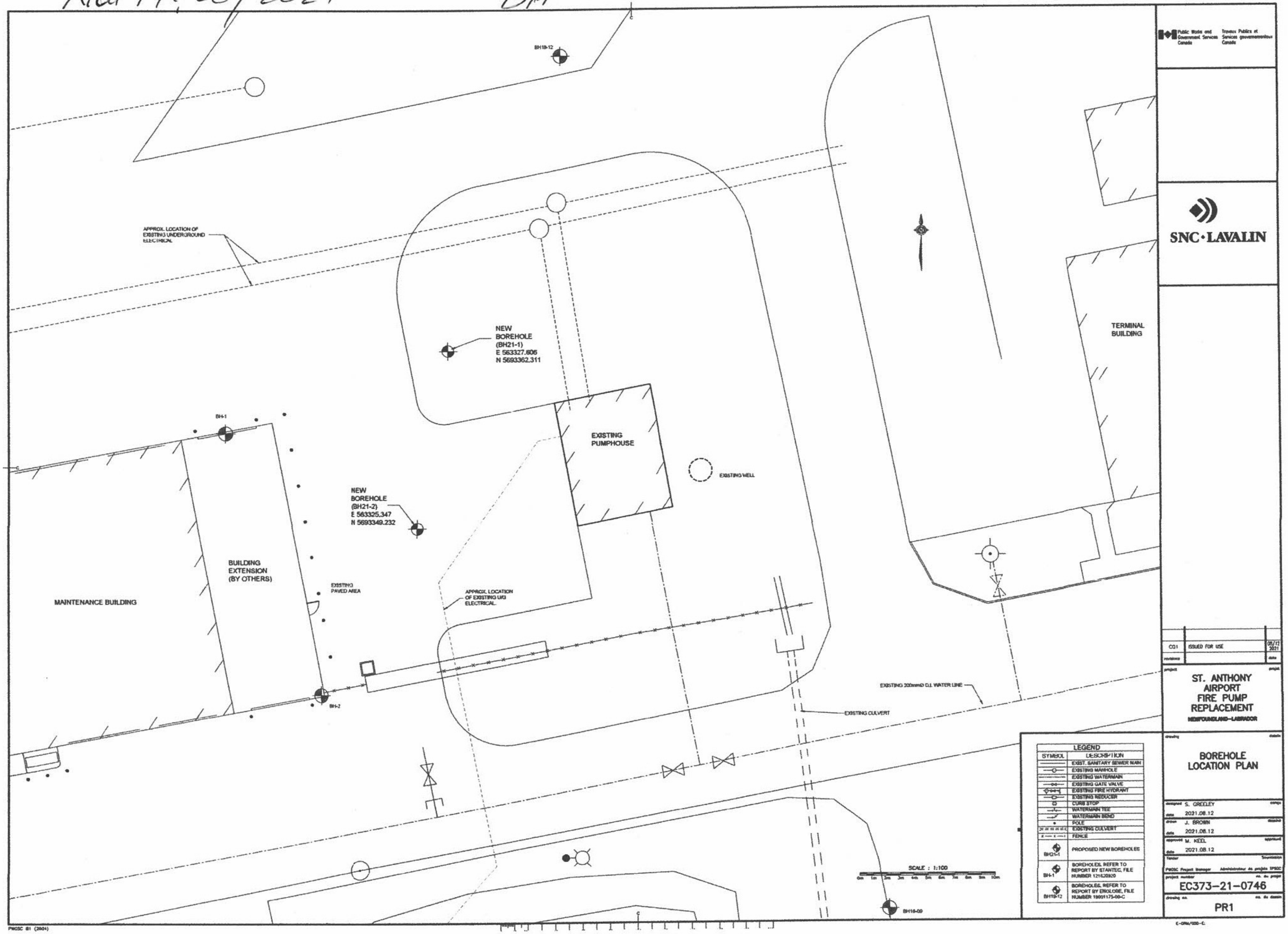
AllRock Sample Gradation Analysis	
Project:	St. Anthony Fire Pump Replacement
Project #:	21221
Client:	SNC Lavalin
Date	26-Nov-21
Sample:	Silty Sand with Gravel (SM)
Sample #:	2
Source:	SS #3 5'-6'4"

Sieve Size (mm)	Specification Lower % Passing	Specification Upper % Passing	Tested Sample % Passing
28			100.0%
20			100.0%
14			86.3%
10			74.5%
5			59.1%
2.5			44.0%
1.25			34.2%
0.63			27.2%
0.315			21.2%
0.16			16.5%
0.08			11.8%
Moisture Content:			9.9%
Technician Sampled:	W. Ball		
Technician Tested:	C. Dolland		
Reviewed By:	B. Evans		

Remarks
No grading specification available for test pits.

Appendix C: Borehole Approximate Locations

Nov 19 & 20/2021 BH # 21221



Appendix D: Rock Core Photographs

Figure 1: BH01 - RC 4-6

Figure 2: BH01 - RC 6-8

Figure 3: BH01 - RC 8

Figure 4: BH02 - RC 4-6

Figure 5: BH02 - RC 6-7