

CI C0053295

L5004 Kearney Lake Structure Replacement

ATO

NON-CONFIDENTIAL

August 4, 2026



NSEB APPROVAL SHEET

Project Title: L5004 Kearney Lake Structure Replacement

CI Number: C0053295

Date: August 4, 2026

Expenditure Profile			Type of Filing	
Year	Budget Amount	Project Estimate	☐	Capital Project Authorization
2023	19	19	☐	Unforeseen and Unbudgeted (U&U)
2024	235,902	235,902	☐	Planned & Advanced (P&A)
2025	188,018	188,018	☐	Subsequent Approval Item
2026	2,054,599	6,169,104	☒	Authorization to Overspend (ATO)
2027		243,742	☐	Scope Change
			☐	Final Cost (FIN)
Total	\$2,478,537	\$6,836,784		

COMMENTS

Approved	2,478,537
Current Submission	\$6,836,784
ATO Request	\$ 4,358,247

Submitted on behalf of NOVA SCOTIA POWER INCORPORATED

David Pickles

Approved on behalf of NOVA SCOTIA ENERGY BOARD

Authorized Signatory
Dave Pickles
Chief Operating Officer

DATE
08042026

DATE

CI Number: C0053295**Title: L-5004 Kearney Lake Structure Replacement**

Start Date:	2023/06
In-Service Date:	2026/12
Final Cost Date:	2027/06
Function:	Transmission
Forecast Amount:	\$6,836,784

DESCRIPTION:

This project includes the removal of nine existing wooden pole structures and replacing them with six new steel pole structures to increase the reliability and the useful life of the transmission Line L-5004 in Kearney Lake.

L5004 is a 13.06-kilometer 69kV transmission line that was originally built in 1966. This project is required to increase the safety, reliability, and serviceability of the line, specifically the portion of the line spanning the lake and neighbouring arterial roadway Kearney Lake Rd. NS Power's current infrastructure within and surrounding the lake is reaching the end of its serviceability lifespan and requires replacement.

Summary of Related CIs +/- 2 years:

Pursuant to Section 11.2 of the CEJC, related CIs for Transmission include "Work completed on the same asset class (Padmount transformers, Breakers, etc.) or in the same location (feeder, Transmission Line)."

- No other projects in 2023, 2024, 2025, 2026, or 2027.

Depreciation Class:	Transmission Plant - Land Rights – Easements
	Transmission Plant - Station Equipment
	Transmission Plant - Overhead Conductors and Devices
	Transmission Plant - Towers and Fixtures

Estimated Life of the Asset: 100 Years

Retirement Information:

- Categorization of Retirement: Accounting Policy 6420 - Retirement and Disposal
- Percentage of Asset Pool: 0.02%

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

Based on assessment from the transmission inspection program, the deteriorated condition of these assets, along with the existing and rapidly growing customer base for the Kearney Lake area, all indications that the transmission structures within and around the lake are required to be removed and replaced to mitigate the risk of disruption to NS Power's transmission system. Not completing this project would compromise the reliability of the transmission feeder and continue to compromise the ability to quickly return the feeder to service if any repairs are required.

Why do this project now?

Upon completion of this project the reliability of the transmission line will be significantly increased due to the removal and replacement of end of life assets and mitigating unplanned and unforeseen customer impacts that will occur if the line is left in its current state. This feeder currently supplies power to almost 30,000 commercial and residential customers. In the event of a failure, these customers will be out of power until NS Power can conduct repairs to the feeder. Since some of these poles are located inside the lake, this increases the recovery time exponentially, as well as the repair costs. The new structure locations will be accessible by roadway, hence reducing recovery time and related repair costs drastically.

This project is deemed in-service when the first portion of the work is complete (forecast to be May 2026), therefore the Final Cost Date (June 2027) is listed as six months after the work is forecast to be completed (December 2026)

Why do this project this way?

Replacing the existing deteriorated assets is the only technically feasible option to accomplish the intended scope of this project. The new design will result in stronger metallic structures with greater clearances and enhanced durability to reduce the likelihood of failure of the feeder section across the lake. The proposed location of the new structure is strategic and will position the structures in proximity to the roadway for easy access for inspection and maintenance. The improved structures and wire rating will allow for seamless expansion, looking to the near future in the form of new customers to the area.

Contingency Statement - ATO

Contingency for this ATO has been determined using a combination of internal subject matter expert judgment based on experience gained in previous transmission capital projects of this nature, progress of the project, and the non-binding contingency guidelines. Consistent with the maturity matrix, this ATO is being filed as a Class 1 estimate with a contingency of 5% applied to contracts and field labour. Contingency is intended to mitigate potential market volatility affecting steel, concrete, and foundation pile procurement, as well as potential land access challenges associated with the use of heavy machinery required for constructing the new structures. In addition, this project involves working in proximity to the Kearney Lake body of water, which may result in additional risks and associated costs during construction of the foundations, steel pole installation and removal of the existing wooden pole structures which are located inside the lake. Such activities may include underwater operations and the use of specialized equipment to install the new structures, contributing to increased complexity and potential cost variability.

Reason for Variance – ATO

The increase of \$4,358,247 from the approved 2025 ACE Plan budget of \$2,478,537 is primarily due to significant increases in the construction related costs for the engineered concrete foundation design requirements for each of the six structures, as well as increases in the cost of the steel poles required for construction. The initial estimates for the foundation construction were underestimated, as the complexity of the required foundation design only became fully apparent upon completion of detailed engineering. The project includes large-scale concrete foundations with significant design, construction, and logistical complexities that require innovative solutions and heightened project oversight.

Detailed geotechnical investigations were completed in two phases, with the initial investigation undertaken in 2020 (please refer to Attachment 1) and a subsequent investigation completed in April 2025 (please refer to Attachment 2). The geotechnical investigations guided the ultimate foundation design requirements, which were reviewed and optimized by NS Power's engineering consultant (foundation designers). The design ensures all new foundations fit within NS Power's existing and available transmission Right-of-Way land easements. Based on the geotechnical requirements in the area, the foundation requirements increased greatly, resulting in an increase of approximately \$3.6 million in construction costs.

The foundation construction access along Kearney Lake, including specialized construction-related equipment required for excavation and water management, as well as road lane closures to provide access and adequate room to excavate and install micro piles and concrete foundations resulted in increased costs. The Kearney Lake area poses many complexities for construction, including environmental sensitivities. Taking all these items into account, NS Power has incorporated its design with the concrete foundation and steel poles to require minimal maintenance, as well as have a design life of approximately 100 years. This has resulted in an increase of approximately \$0.6 million in construction costs.

While NS Power did investigate an alternative transmission route to avoid a complex water crossing, this alternative was not viable, and the best option remained the installation of the steel poles with concrete foundation within NS Power's existing transmission line Right-of-Way easement. The alternate route would be a roadside option; however, due to lack of transmission width easements, similar construction costs and limiting factors for future growth in the area, this option was found not to be feasible. The selected option has considered future growth and development in the Bedford and Halifax areas.

This project is entering the construction phase. All designs for the steel structures, as well as the concrete foundations,

are complete. The remaining project scope includes removal of the old transmission assets, as well as the construction of the new foundations, assembly of the new steel pole structures, and installation of the new conductor.

Please refer to the Variance Sheet for more information.

C0053295 - L-5004 Kearney Lake Structure Replacement - ATO				
Account	Approved	Current Submission	Variance	Reason for Variance
Other Income - Salvage		(5,359)	(5,359)	
Regular Labour	51,654	99,721	48,068	
Overtime Labour		2,648	2,648	
Travel Expense		31,000	31,000	Site visit to the steel pole manufacturer's workshop location for Quality verification checks, as well as dimensional checks performed on a complete model assembly.
Materials	615,521	635,473	19,952	Slight increase in the cost of steel poles
Contracts	1,187,371	4,812,977	3,625,605	RFP results for contractor costs to construct the concrete foundations are much higher than estimated. Due to the requirements of the foundations and proximity of 2 structures, road lane closures are required, as well as construction equipment access has to be created into the lake for construction. Berms and other methods are required for water management to facilitate the foundation construction.
Freight Postage Delivery	89,129	126,140	37,010	Additional import duty imposed on steel products coming in from foreign countries by the Canadian Government. This was instituted after the Steel pole manufacturer was engaged in an agreement.
Consulting	12,640	196,284	183,644	Includes all design related costs, as well as geotechnical investigation, layout drawings for construction, foundation design, surveys and topography study.
Other Goods and Services	293,447	243,742	(49,705)	A 5% contingency has been applied to field labour and construction contract costs to address risks as identified in the description page.
Vehicle Allocated Costs	25,879	38,110	12,231	Increased labour costs lead to increased vehicle allocated costs.
Admin Overheads	29,315	54,951	25,636	Increased labour costs lead to increased admin overhead costs.
Contractor Admin Overhead	171,754	513,185	341,431	Increased contractor costs lead to increased contractor admin overhead costs.
AFUDC Interest	1,826	87,913	86,087	Increased due to the delays in the design phase and in-service date.
Total	2,478,537	6,836,784	4,358,247	

Capital Project Detailed Estimate

Location: Transmission CI#: C0053295 Title: L-5004 Kearney lake Structure Replacement Execution Year: 2025-2026						
Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#s)
Regular Labour						
T&D Labour - Engineering	PD	10	\$ 452	\$ 4,430		
T&D Labour - Project Management	PD	23	\$ 452	\$ 10,189		
T&D Labour - Design	PD	29	\$ 452	\$ 13,050		
T&D Labour - PLT Switching	PD	14	\$ 444	\$ 6,045		
T&D Labour - Site Supervision	PD	121	\$ 461	\$ 55,818		
T&D Labour - Planning	PD	23	\$ 452	\$ 10,189		
			Sub-Total	\$ 99,721		
Overtime Labour						
T&D Labour - Site Supervision	PD	3	\$ 922	\$ 2,648		
			Sub-Total	\$ 2,648		
Materials						
Project Material (conductor and all fitting hardware)	Lot	1	\$ 94,541	\$ 94,541		
NEW Steel Pole (L5004#43)	Lot	1	\$ 77,690	\$ 77,690		
NEW Steel Pole (L5004#44)	Lot	1	\$ 76,128	\$ 76,128		
NEW Steel Pole (L5004#45)	Lot	1	\$ 73,822	\$ 73,822		
NEW Steel Pole (L5004#46)	Lot	1	\$ 94,488	\$ 94,488		
NEW Steel Pole (L5004#47)	Lot	1	\$ 116,070	\$ 116,070		
NEW Steel Pole (L5004#50)	Lot	1	\$ 102,734	\$ 102,734		
			Sub-Total	\$ 635,473		
Contracts						
Tree Trimming / ROW Clearing	Lot	1	\$ 9,500	\$ 9,500		
Construct Road Access to L-5004#050	Lot	1	\$ 72,855	\$ 72,855		
NEW STR 43 FOUNDATION	Lot	1	\$ 1,100,700	\$ 1,100,700		
NEW STR 44 FOUNDATION	Lot	1	\$ 767,300	\$ 767,300		
NEW STR 45 FOUNDATION	Lot	1	\$ 766,100	\$ 766,100		
NEW STR 46 FOUNDATION	Lot	1	\$ 706,900	\$ 706,900		
NEW STR 47 FOUNDATION	Lot	1	\$ 374,400	\$ 374,400		
NEW STR 50 FOUNDATION	Lot	1	\$ 370,200	\$ 370,200		
TEAR DOWN (WOODEN) AND REBUILD (NEW STEEL POLE ERECTION AND FRAMING)	Lot	1	\$ 491,600	\$ 491,600		
Dive Support	Lot	1	\$ 35,000	\$ 35,000		
Environmental Asset Disposal	Lot	1	\$ 10,000	\$ 10,000		
Environmental and Permits	Lot	1	\$ 52,000	\$ 52,000		
QA/QC checks (steel poles)	Lot	1	\$ 8,338	\$ 8,338		
QA/QC checks (field assistance - concrete foundations)	Lot	1	\$ 23,084	\$ 23,084		
Environmental Remediation Support	Lot	1	\$ 25,000	\$ 25,000		
			Sub-Total	\$ 4,812,977		
Consulting						
Transmission Line Engineering Design	Lot	1	\$ 69,000	\$ 69,000		
Engineering Foundation Design (inclusive of archeological investigation and monitoring, geotechnical study & optimization reviews)	Lot	1	\$ 83,952	\$ 83,952		
Civil drawings for construction- site plans	Lot	1	\$ 22,068	\$ 22,068		
Construction Staking	Lot	1	\$ 8,624	\$ 8,624		
Survey and Topography Study	Lot	1	\$ 12,640	\$ 12,640		
			Sub-Total	\$ 196,284		
Travel						
Site Visit -Travel & Meal Expenses	Each	1	\$ 31,000	\$ 31,000		
			Sub-Total	\$ 31,000		
Freight						
Import Duty Tariffs for Steel Poles	Each	1	\$ 126,140	\$ 126,140		
			Sub-Total	\$ 126,140		
Salvage						
Salvage	Lot	1	\$ (5,359)	\$ (5,359)		
			Sub-Total	\$ (5,359)		
Other Goods & Services						
Contingency (captures only: field labour and construction contracts)	%	5%	\$ 4,874,840	\$ 243,742		
			Sub-Total	\$ 243,742		
Vehicle Overhead						
Vehicle AO	Each	1	\$ 38,110	\$ 38,110		
			Sub-Total	\$ 38,110		
AFUDC						
AFUDC	%		\$ 87,913	\$ 87,913		
			Sub-Total	\$ 87,913		
Administrative Overhead						
Labour AO	Each	1	\$ 54,951	\$ 54,951		
Contract AO	Each	1	\$ 513,185	\$ 513,185		
			Sub-Total	\$ 568,136		
SUB-TOTAL (no AO, AFUDC)				\$ 6,142,625		
TOTAL (AO, AFUDC included)				\$ 6,836,784		
Original Cost				\$ 104,198		

Note 1: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 2: Small differences in totals are attributable to rounding.



Instructions: Select option in Column B.
Columns C through G will auto-populate.

Document No: XXX-XX-XXXX-XXXX

Project Cost Estimate Input Checklist and Maturity Matrix						
Transmission Line Infrastructure	Required fields:	Estimate Classification				
Project Name: ATO L5004 Kearney Lake Structure Replacement	Started or Preliminary	Class 5	Class 4	Class 3	Class 2	Class 1
Maturity Level of Project Definition Deliverables	Defined or Complete					
General Project Data						
A. Scope						
Project Scope of Work Description	Defined (D)	P	P	D	D	D
Site Infrastructure (Access, Construction Power, Camp, etc.)	Defined (D)	NR	P	D	D	D
B. Capacity						
Voltage (kV) and Circuits	Defined (D)	P	P	D	D	D
C. Project Location						
Not Applicable						
D. Requirements						
Codes and/or Standards	Defined (D)	NR	P	D	D	D
Environmental Monitoring	Defined (D)	NR	NR	P	P	D
E. Technology Selection						
Not Applicable						
F. Strategy						
Right-of-Way (ROW)	Defined (D)	P	P	D	D	D
Contracting/Sourcing	Defined (D)	NR	P	D	D	D
Escalation	Not Applicable (NA)	NR				
G. Planning						
System/Grid Planning (including substation and interconnect locations)	Defined (D)	P	P	D	D	D
Logistics Plan	Defined (D)	P	P	P	D	D
Integrated Project Plan	Defined (D)	NR	P	D	D	D
Project Code of Accounts	Defined (D)	NR	P	D	D	D
Project Schedule	Preliminary (P)	NR	P			
Regulatory Approval & Permitting	Preliminary (P)	NR	P			
Risk Register	Defined (D)	NR	P	D	D	D
Stakeholder Consultation/Engagement/Management Plan	Defined (D)	NR	P	D	D	D
Work Breakdown Structure (WBS)	Not Applicable (NA)	NR				
Start-up & Commissioning Plan	Defined (D)	NR	P	P/D	D	D
H. Studies						
Routing Options	Defined (D)	P	P	D	D	D
Topography & Bathymetry	Defined (D)	P	P	P/D	D	D
Environmental Impact/Sustainability Assessment	Not Applicable (NA)	NR				
Environment/Existing Conditions	Defined (D)	NR	P	D	D	D
Meteorology and/or Oceanographic/Subsea	Not Applicable (NA)	NR				
Soils & Hydrology	Not Applicable (NA)	NR				
Technical Deliverables (Specifications and/or Drawings)						
Conductor, Insulator, Grounding, Joint Design (including protection for buried or subsea)	Complete (C)	S	P	C	C	C
Foundation/Structure (Tower) Design	Complete (C)	S	P	C	C	C
Route Mapping/Survey	Complete (C)	S/P	P/C	C	C	C
Design Specifications	Complete (C)	NR	S/P	C	C	C
Instrument List	Complete (C)	NR	S/P	C	C	C
Construction Permits	Complete (C)	NR	S/P	P/C	C	C
Geometric Layout, Alignment, Profile, Cross Section	Complete (C)	NR	S/P	P/C	C	C
Land/ROW Title Negotiation	Complete (C)	NR	S/P	P/C	C	C
Civil/ Site/Structural/Architectural Discipline Drawings	Complete (C)	NR	S/P	P	C	C
Crossings and Borings Designs and Drawings	Not Applicable (NA)	NR				
Demolition Plans and Drawings	Complete (C)	NR	S/P	P	C	C
Erosion Control Plan & Drawings	Not Applicable (NA)	NR				
Foundation/Structure (Tower) Discipline Drawings	Complete (C)	NR	S/P	P	C	C
Tower/Structure Location/Spotting	Complete (C)	NR	S/P	P	C	C
Instrument Datasheets	Not Applicable (NA)	NR	NR/S			
Electrical Discipline Drawings	Complete (C)	NR	NR	S/P	P/C	C
Instrumentation/Control System Discipline Drawings	Not Applicable (NA)	NR				
Total # Deliverables for this Project		10	30	30	30	30
% Defined/Complete towards Class Estimate		100%	100%	94%	94%	94%

Comments:

This project is being filed as a Class 1 estimate. The defined deliverables for this project indicate that 94% of Class 1 deliverables are completed. A contingency value of 5% was selected to account for specific risks such as contractor availability and constructability unknowns. The contingency will also provide a buffer for any unknown items that may/may not be discovered during the detailed engineering design process. No contingency has been allocated to material costs, however have been considered for field labour, as well as construction contracts.

Legend:

The maturity level is an approximation of the completion status of the deliverable. The completion is indicated by the following descriptors:

General Project Data:

- **Not Required (NR):** May not be required for all estimates of the specified class, but specific project estimates may require at least preliminary development.
- **Preliminary (P):** Project definition has begun and progressed to at least an intermediate level of completion. Review and approvals for its current status has occurred.
- **Defined (D):** Project definition is advanced, and reviews have been conducted. Development may be near completion with the exception of final approvals.

Technical Deliverables:

- **Not Required (NR):** Deliverable may not be required for all estimates of the specified class, but specific project estimates may require at least preliminary development.
- **Started (S):** Work on the deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion.
- **Preliminary (P):** Work on the deliverable is advanced. Interim, cross-functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.
- **Complete (C):** The deliverable has been reviewed and approved as appropriate.

Inclusions:

For the purposes of this document, the term *power transmission line infrastructure industries* is assumed to include greenfield or brownfield sites for overhead, buried and submarine transmission of electrical power in the infrastructure industries. High voltage is typically >100kV but may be less (e.g., 33 or 66kV) if long distance with light electrical loads. This excludes power supply and distribution scope within a process plant, mining facility, building complex or other facility site. It also excludes power generation facilities and substations. The defining deliverables of those excluded project scopes are covered in other RPs (e.g., 18R-97 for process plants [2]).

Power transmission is considered an element of the infrastructure industry. The Construction Industry Institute has provided a good definition of infrastructure in its Project Definition Rating Index for Infrastructure Projects as follows [3]:

“A capital project that provides transportation, transmission, distribution, collection or other capabilities supporting commerce or interaction of goods, services, or people. Infrastructure projects generally impact multiple jurisdictions, stakeholder groups and/or a wide area. They are characterized as projects with a primary purpose that is integral to the effective operation of a system. These collective capabilities provide a service that is made up of nodes and vectors into a grid or system.”

Using this definition, power transmission lines are a vector or linear scope element that connects substation or other facility nodes at its terminations. The substation nodes may be part of or associated with a generation, consuming or interconnection facility. As such, transmission projects are often executed as part of a program that also involves node project scope or facility operational changes (or at least considerations for integrated system commissioning and startup). As the definition states, a distinguishing feature of these projects is that they often traverse wide areas, cross country or subsea, which puts an emphasis on the definition of routing, land ownership and conditions, and establishing right-of-way (ROW). Associated scope definition challenges include defining stakeholder, permitting and regulatory requirements. Buried and submarine installations increase the focus on the protection philosophy and strategies affecting cable selection, armoring and joint considerations. While many distinguish power transmission (higher voltage, long distances) from power distribution (short distance, lower voltage connections to retail customers), the principles of estimating these elements are similar; i.e., the RP applies to both.

The main physical power transmission line scope elements are conductors and their support structures if installed overhead. Main installation elements include land clearing if over land (including forestry if applicable), foundation and structure erection and conductor stringing if overhead, or trenching, laying and horizontal boring if subsurface or subsea. Special scope elements are involved with crossings of water, road, rail and so on and at terminations. Because conductor (e.g., aluminum) and structure (e.g., steel) material costs are usually a significant cost element, these project estimates are particularly sensitive to escalation uncertainty. In general, the more developed the route, the more complex the installation will be. In urban areas, visual appeal and concern for safety and health can be major issues. Installation in remote location and/or difficult or environmentally sensitive terrain creates its own challenges. Subsea installation adds the need for bathymetry¹ and metocean² studies and specialized installation equipment and vessels. Before any installation work can begin in an area, stakeholder consultation must be advanced (sometimes requiring agreements with local populations with rights), and appropriate land and ROW must be acquired which creates unique scheduling as well as cost challenges.

For the purpose of estimate classification then, the main scope definition deliverables are associated with defining the power requirements (i.e., kV), the conductors and structure, and the routing. Conductors can vary widely in content (copper, aluminum, etc.) and insulation. Overhead structures may be wood, concrete, composite or steel in various configurations with various foundation designs including pilings, concrete and so on. The route's land or subsea characteristics and the nature of developments drive the need for special design features and execution strategies. Operability and maintainability considerations may also affect ROW and access design. Brownfield and revamp projects add their own concerns for interface with existing elements, crowded working conditions, etc. For each scope definition decision, stakeholder requirements need to be considered.

Power substation projects are usually associated with transmission projects. However, substations being equipment-centric and located on a facility site have physical and defining characteristics similar to process plant projects (e.g., reliance on one-line diagrams, plot plans, etc.).



**GEOTECHNICAL INVESTIGATION,
FOUR PROPOSED TRANSMISSION
TOWER REPLACEMENTS, KEARNEY
LAKE, HALIFAX, NOVA SCOTIA**

November 20, 2020

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**GEOTECHNICAL INVESTIGATION, FOUR PROPOSED TRANSMISSION TOWER REPLACEMENTS,
KEARNEY LAKE, HALIFAX, NOVA SCOTIA**

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GEOTECHNICAL INVESTIGATION, FOUR PROPOSED TRANSMISSION TOWER REPLACEMENTS, KEARNEY LAKE, HALIFAX, NOVA SCOTIA

1.0 INTRODUCTION

1.1 GENERAL

Stantec Consulting Ltd. (Stantec) has conducted a geotechnical investigation for four new proposed transmission tower structures along Kearney Lake in Halifax, Nova Scotia. The new structures are required to replace existing structures due to end of life. Structures STR#44 and STR#45 are located on the shoulder of Kearney Lake Road, structure STR#46 is located in a wooded area between Kearney Lake Road and Kearney Lake and Structure STR#47 is located on the beach access road off of Hamshaw Drive. The new tower structures will be Tangent H-frame steel structures.

A geotechnical investigation was carried out to assess the subsurface conditions and provide geotechnical recommendations to assist with the design of earthworks and foundations for the proposed towers.

1.2 SCOPE OF WORK

The scope of work for the geotechnical investigation consisted of:

- Drilling a single sampled geotechnical borehole using a conventional geotechnical drill-rig at each of the four proposed replacement tower locations,
- Completing laboratory classification testing of select soil samples and unconfined strength testing of select bedrock core, and
- Preparation of this geotechnical report including recommendations to assist with tower foundation planning and design.

2.0 SITE DESCRIPTION AND GEOLOGY

The sites of the proposed new towers are located alongside of Kearney Lake Road and off Hamshaw Drive. Structures STR#44 and STR#45 are located within the roadway fill adjacent to Kearney Lake Road, Structure STR#46 is located in a lightly forested area between Kearney Lake Road and Kearney Lake, and Structure STR#47 is located within the beach access road off of Hamshaw Drive.

Our experience in the area and geological mapping issued by the Nova Scotia Department of Natural Resources indicates that the principal native bedrock in this area consists of quartzite of the Goldenville formation. Mapping also indicates the principal native overburden overlying bedrock in the area consists of a thin layer of glacial till comprising a silty sandy matrix.



**GEOTECHNICAL INVESTIGATION, FOUR PROPOSED TRANSMISSION TOWER REPLACEMENTS,
KEARNEY LAKE, HALIFAX, NOVA SCOTIA**

3.0 INVESTIGATION PROCEDURE

The field work for the geotechnical investigation was carried out between August 10 and 13, 2020. The borehole locations were originally positioned at the proposed tower locations however, due to drill-rig access considerations, they were adjusted in the field. In particular, boreholes BH STR-44 and STR-45 were moved closer to the roadway shoulder.

The boreholes were advanced using a truck-mounted geotechnical drill-rig. Standard Penetration Testing (SPT) was completed in overburden while obtaining split-spoon samples at close intervals and bedrock was sampled by continuous diamond coring in HQ size. The Standard Penetration Test (SPT) "N-value" is the number of blows required to advance a standard 50-mm outer-diameter split-spoon sampler 300 mm into the soil using a standardized drop height and weight. N-values provide an indication of soil relative compactness/consistency and used to aid in the estimation of other soil parameters.

A Stantec geotechnical field representative was onsite to log the subsurface conditions encountered. All soil samples were stored in moisture tight containers and rock core was organized in wooden core boxes. Soil and rock samples were taken to our Dartmouth Laboratory for final classification and testing.

The various strata encountered in the boreholes are described in detail on the Borehole Records (Appendix A) and summarized below in the subsequent sections. Symbols and Terms Used on Borehole Records provide a brief explanation of the terminology and graphics used in this report and are also appended. Soil classification was based on procedures described in ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) and ASTM D 2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure).

For groundwater measurement a standpipe was installed in one of the boreholes (BH STR-47) prior to backfilling. Due to the proximity of the remaining boreholes to the lake, the water level is assumed to be at or near the lake level.

4.0 SUBSURFACE CONDITIONS

4.1 GENERAL

The subsurface conditions encountered are described on the appended Borehole Records and summarized herein.



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Table 1 Summary of Subsurface Conditions

Borehole No.	Ground Surface Elev. (m)*	Fill Thickness (m)	Silty Gravel with Sand		Glacial Till (m)		Bedrock (m)		Water Depth (m)
			Elev.	Thickness	Elev.	Thickness	Depth	Elev.	
BH-STR-44	43.9	3.2	40.7	3.3	-	-	6.5	37.4	-
BH-STR-45	43.5	1.8	-	-	41.7	1.9	3.7	39.8	-
BH-STR-46	44.4	1.5	42.9	2.3	40.6	2.3	6.1	38.3	-
BH-STR-47	44.5	2.1	-	-	42.4	>5.3	-	-	2.1

*Ground surface elevations are based on the proposed pole locations

(-)Not Applicable

4.2 FILL

All boreholes drilled encountered a mixture of silt, sand and gravel fill with occasional cobbles and boulders to depths between 1.8 to 3.2 meters.

The results of one grain size analyses of the fill yielded 58% gravel, 34% sand, and 8% silt and clay sized particles.

4.3 SILTY GRAVEL WITH SAND

Boreholes BH STR-44 and STR-45 encountered a 2.3 to 3.3 meter thick grey silty gravel with sand layer between the fill and glacial till. The gravel layer contained numerous cobbles and boulders making SPTs, and hence determination of the material density, difficult.

The results of a grain size analysis on the silty gravel with sand yielded 39% gravel, 38% sand and 22% silt and clay sized particles.

4.4 GLACIAL TILL

Grey silty gravel with sand/brown silty sand with gravel to brown sandy silty clay glacial till containing cobbles and boulders was encountered below the fill at all borehole locations. The thickness of the till ranged from 1.9 to greater than 5.3 meters and contained occasional to frequent cobbles and boulders. SPT N-values obtained in the till indicate the sand and gravel till soils to be generally dense to very dense and the clayey till soils to be firm to hard.

The results of two grain size analyses of the silty gravel with sand till yielded 22% to 53% to gravel, 33% to 34% sand, and 13% to 45% silt and clay sized particles.

The results on one grain size analysis of the sandy silty clay glacial till yielded 7% gravel, 36% sand and 57% silt and clay size particles.



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4.5 BEDROCK

Bedrock was cored at three of the four borehole locations. Bedrock comprised quartzite and was generally very severely fractured to moderately jointed with fresh to slight weathering. Bedrock was encountered at depths of 3.7 to 6.5 meters. An unconfined compressive strength test was performed on a rock core specimen from BH STR46, yielding an unconfined compressive strength of 195 MPa.

The Rock Quality Designation (RQD) of the bedrock is shown in detail on the attached borehole records. In general, the RQD was found to be as follows:

- BH STR-44: 26% to 90%
- BH STR-45: 0% to 38%
- BH STR-46: 52% to 75%
- BH STR-47: Bedrock was not cored

4.6 GROUNDWATER

A standpipe was installed in Borehole BH STR-47 upon completion of drilling. Groundwater level was measured on September 28, 2020. A water level of 2.1 meters below ground surface was recorded. Due to the proximity of the remaining boreholes to the Kearney Lake, it is anticipated that the water levels at these borehole locations will be at or near the lake level. For the purposes of design, the groundwater level should be taken as the ordinary high water mark for the Kearney Lake.

Water seepage levels will fluctuate seasonally, in response to specific precipitation events and with site and surrounding development.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 GENERAL

We understand that NSPI propose to replace the existing wooden tower structures alongside Kearney Lake Road and off Hamshaw Drive with Tangent H-frame steel structures. Tower structures STR#44 and STR#45 will be located near the existing tower structure locations adjacent to Kearney Lake Road while STR#46 and STR#47 structures will be at new locations on private property adjacent to Kearney Lake Road and the Kearney Lake beach access, respectively. It is understood that the planned STR#46 location was adjusted after the field work for the geotechnical investigation was completed and that the new location is closer to Kearney Lake.

Given the variation in subsurface conditions, proximity to the lake, and spatial restrictions for planned tower structures STR#44 and STR#45, use of shallow foundations for these two sites will be complex requiring use of coffer dams to permit excavation and structural fill placement below the lake level. Due to do these complexities, support of these two structures using rock-socket piles or smaller diameter micropiles socketed into rock is recommended.



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The proposed tower structure location for STR#46, while still on land, is close to Kearney Lake. The proximity to the lake may reduce the feasibility of shallow foundations as the bearing capacity would be reduced if footings are placed on or near the sloping ground near the bank of the lake. Therefore due to these uncertainties and further discussions with NSPI, support of this structure using rock-socketed pipe piles or micropiles socketed into rock is recommended.

For tower structure location STR#47, shallow foundation option would be feasible and practical.

5.2 SHALLOW FOUNDATIONS

5.2.1 Site Preparation

All existing fill and any other unsuitable materials encountered should be removed down to undisturbed till beneath the spread footings. Temporary excavation side slopes during removal of unsuitable materials and placement of structural fill should be no steeper than 1H:1V; flatter slopes may be required if groundwater seepage is encountered and should be evaluated on an individual basis during progress of the work.

Structural fill for bearing surface of spread footings should preferably consist of imported well-graded rock fill or sandy gravel. The material should have a maximum particle size of 200 mm and maximum fines content of 5 percent. Other approved inorganic imported soil and/or select portions of site excavated till found to be within optimum moisture content for compaction may be suitable for reuse as structural fill during periods of favorable weather and temperature. However, these types of soils will be more prone to disturbance and becoming wet and unsuitable as the site is worked. They will also require some processing and/or sorting to remove over-sized particles larger than 200 mm. Fine-grained soils should not be placed over coarse-grained soils without an adequate filter layer (i.e., geotextile or graded stone filter layer).

Structural fill should be compacted to 100 percent of its standard Proctor maximum dry density (SPMDD) determined in accordance with ASTM D-698. Lift thicknesses for structural fill must be compatible with the compaction equipment to ensure that the required density is achieved throughout the entire lift thickness. Typically, the compacted lift thickness should not exceed 300 mm assuming that each lift receives 5 passes from a 10-tonne vibratory roller to achieve compaction. The use of larger or smaller compaction equipment may require that the lift thickness or number of passes be adjusted at the discretion of qualified geotechnical personnel.

If existing fill or other unsuitable material extends below the proposed footing depth, then the horizontal extent of removal for existing fill and any other unsuitable materials encountered and structural fill placement should include the footprint of the foundation bearing surface plus a horizontal distance equivalent to the thickness of structural fill placed below the bearing surfaces.

To ensure that unsuitable materials are removed, that approved structural fill is used, and that proper placement techniques and procedures are being followed, it is recommended that excavation and placement of all structural fill be reviewed by experienced geotechnical personnel.



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Temporary de-watering of excavations may be required to control surface water runoff. Surface water should be directed away from excavations, and if present, groundwater seepage should be directed to sumps and disposed of by pumping. This is discussed in further detail in Section 5.2.2.

5.2.2 Water Control

Due to the proximity of Kearney Lake, it will likely be necessary to provide temporary dewatering measures during mass excavation and filling for shallow foundations. Control of surface water run-off and groundwater seepage will be required at the onset of construction, and throughout the duration of the work.

Diversion ditches, drainage swales and/or “French drains”, and possibly sand-bag dams, upgradient of work areas, should be provided to cut off and divert groundwater and surface water away from excavations at the beginning of the earthworks. Dewatering within the excavations can be accomplished by pumping from ditches and/or sump pits dug below the base of the excavations.

Discharge water quality should be reviewed and monitored prior to off-site disposal to ensure compliance with applicable regulations.

A site-specific water management plan prior to construction would be prudent to facilitate implementing adequate controls to minimize making normally suitable soils unsuitable.

If spread footings are to be considered for the tower locations adjacent to the Kearney Lake than coffer dams will likely be required to isolate the work area. Additional design information on coffer dams could be provided if required.

5.2.3 Spread Footing Design

The glacial till and bedrock encountered in the boreholes, or approved structural fill placed over glacial till or bedrock, are suitable bearing surfaces for spread footings. Due to the possibility of cobbles and boulders present within the native glacial till, over-excavation of the glacial till may be necessary. Where over-excavation is required, we recommend backfilling and compacting the excavation with granular fill meeting the requirements for structural fill outlined above.

It is understood that tower structure foundations are generally embedded to depths of approximately 2.5 to 3 meters as the backfill above the foundation is considered for resisting overturning moments. Backfill should be placed in suitable lifts and compacted to at least 98 percent of maximum standard Proctor dry density.

Geotechnical bearing resistance at serviceability Limit States (SLS) of 250 kPa and factored geotechnical bearing resistance at ultimate limit states (ULS) of 375 kPa are recommended for design of spread footings placed on native undisturbed till, approved structural fill over till, or bedrock.

These values are based on rectangular footings with widths ranging from 6 to 8 m, as consistent with previous designs for similar structures. Footings were assumed to have a minimum burial depth of 1.2 m



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below finished grade. In accordance with the National Building Code of Canada (NBCC, 2015) a resistance factor of 0.5 has been applied to the ULS value.

The SLS geotechnical bearing resistance is based on a maximum total settlement of 25 mm. Unfactored loads should be used for assessment of the SLS bearing resistances. The bearing resistances provided above assume vertical concentric loads and footings placed on horizontal ground away from any downward slopes. The bearing capacity will be reduced under eccentric or inclined loads or if footings are placed on or near sloping ground. Should this condition be present, particularly at STR#46 as previously noted, we would be pleased to provide updated bearing capacity values once more information on the foundation shape and proximity to the slope is determined.

For frost protection, footings should be provided with a minimum of 1.2 meters of soil cover or equivalent combination of soil and insulation. All bearing surfaces should be inspected by experienced geotechnical personnel prior to formwork installation or placement of concrete.

The following additional unfactored soil parameters may be used for design:

Table 2 Soil Parameters for Design of Foundations

Parameter	Design Value	
	Undisturbed Glacial Till	Re-compacted Glacial Till
Total Unit Weight (kN/m ³)	22	21
Submerged Unit Weight ^(b) (kN/m ³)	12	11
Internal Angle of Friction (degrees)	34	32
Concrete/Material Friction Factor (unformed)	0.38	0.35

(a) Backfill should be placed in suitable lifts and compacted to at least 98 percent of maximum standard Proctor dry density for these values to apply.

(b) For design purposes we recommend that the groundwater table be assumed to be at the ground surface, and therefore the submerged unit weights would be applicable.

5.3 DEEP FOUNDATIONS

5.3.1 Micropiles

Design of micropiles is based on the capacity of the socket, which is a function of the socket diameter, socket length and average factored bond resistance between the cementitious grout and in-situ material. The grout-to-ground nominal bond strengths are based on typical values reported by FHWA (2005) and PTI (2014). Provided values vary with actual ground conditions, drilling methodology, grouting and micropile installation procedures. A specialty contractor qualified to perform micropile design and construction should complete the final micropile design.

Drilled concrete micropiles may be designed to resist static axial tension and compressive loads based on the shaft resistance parameters at ULS without any contribution from the end bearing. For design of micropiles socketed into the quartzite bedrock, a factored compressive resistance at ULS of 700 kPa is recommended for the bond stress between the bedrock and grout. This incorporates a resistance factor



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of 0.4. A factored uplift resistance at ULS of 525 kPa is also recommended which incorporates a resistance factor of 0.3. Due to the possibility of cave-in of the upper layers, the micropiles should be constructed with a casing. It is recommended that casings be advanced a minimum of 1 meter into the bedrock surface prior to establishing the sockets.

The piles should be designed such that the bond lengths do not exceed 10 meters and the free stressing lengths are a minimum of 4.5 meters. As the loads will be cyclical in nature, design load must be less than 70% of the capacity to prevent progressive failures of the pile.

For uplift loading, it will also be necessary to check the total pullout resistance of the socket calculated as the weight of soil in a 60-degree apex cone from the bottom of the socket. A submerged unit weight of 12 kN/m³ and 15 kN/m³ may be used for the overburden soil and bedrock, respectively.

Additionally, the design of the piles should consider the uplift due to adfreeze along the portion of the shaft in the frost zone. An adfreeze bond strength of 150 kPa can be assumed for the portion of the pile shafts within the frost penetration depth. The frost depth should be assumed to be 1.2 m. As an alternative to mitigate the adverse effects of frost, the portion of the pile shaft in the frost zone can be isolated from the surrounding soil using a bond-breaker sleeve or “slip” material to reduce the adfreeze force on the pile.

For frost protection, the base of pile caps or grade beams should be founded a minimum of 1.2 m below finished grades.

It is recommended that a non-shrink grout mix be utilized to prevent shrinkage during curing which could affect the bond.

We recommend that verification and proof load testing in accordance with FHWA (2005) be conducted on a number of micropiles. To estimate the ultimate grout-to-ground bond strength, a verification testing program including pull-out (tension) test on sacrificial micropiles are recommended. For verification tests, we recommend that the sacrificial micropiles are loaded to 80% of the structural capacity of the micropile or until grout-to-ground bond failure, whichever occurs first. The location of the sacrificial micropiles should be as close as possible to the actual location of the production micropiles.

Proof load testing on micropiles is a quality assurance requirement to observe that they can safely carry the design load during their service life. During the proof tests that are carried out on production micropiles, they are typically loaded in tension to 160% of the design load that will be specified for the micropiles.

Given the nonlinear behavior of soil it is recommended that lateral pile resistances be assessed using the p-y curve approach with commercial computer software LPILE (or a similar software) once pile loads are available.

It is recommended that full-time inspection be provided during pile installation. Comparison of pile tip elevations with penetration design depths should be carried out on an ongoing basis to verify that the piles are installed to the specified requirements.



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5.3.2 Drilled CIP Concrete Piles

Similar to micropiles, design of conventional rock-socketed piles should be based on the capacity of the socket, which is a function of the rock socket diameter, socket length and average factored bond resistance between the concrete and bedrock. As presented in Section 5.3.1, a factored compressive resistance at ultimate limit states 700 kPa is recommended for the bond stress between the Quartzite bedrock and the concrete in compression and 525 kPa is recommended for the bond stress between the Quartzite bedrock and the concrete in tension. This incorporates a resistance factor of 0.4 and 0.3, respectively.

It is recommended that full-time inspection be provided during pile installation. Compressive strength testing of concrete used in the socket and pile shaft should also be completed. Installation of piles should be monitored by personnel having experience with socketed piles. Observing the advancement of the drill bit into rock can help assess the overall quality of the socket. Monitoring of the concrete placement is also important.

6.0 SEISMIC CLASSIFICATION

Based on the subsurface conditions encountered at the test pit locations, the site classification for seismic site response in accordance with Clause 4.1.8.4 of the National Building Code of Canada (NBCC, 2015) is Seismic Site Class C.

7.0 CLOSURE

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

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



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This report has been prepared by Matthew Weatherby P.Eng. and reviewed by Brian Grace, P.Eng. We trust that the information contained in this report is adequate for your present purposes. If you have any questions about the contents of the report, or if we can be of any other assistance, please do not hesitate to contact us at your convenience.

Yours very truly,

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APPENDIX A

Statement of General Conditions

Symbols and Terms Used on Borehole and Test Pit Records

Borehole Records

Grain Size Analyses Results

Figure No. 1, Borehole Location Plan

Preliminary Cost Estimate



STATEMENT OF GENERAL CONDITIONS

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

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

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

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

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

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Rootmat</i>	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

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

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

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

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

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

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25 - 0.5	12.5 - 25	2-4
<i>Firm</i>	0.5 - 1.0	25 - 50	4-8
<i>Stiff</i>	1.0 - 2.0	50 - 100	8-15
<i>Very Stiff</i>	2.0 - 4.0	100 - 200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

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

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	Crushed
Severely Fractured	Shattered or Very Blocky
Fractured	Blocky
Moderately Jointed	Sound
Intact	Very Sound

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

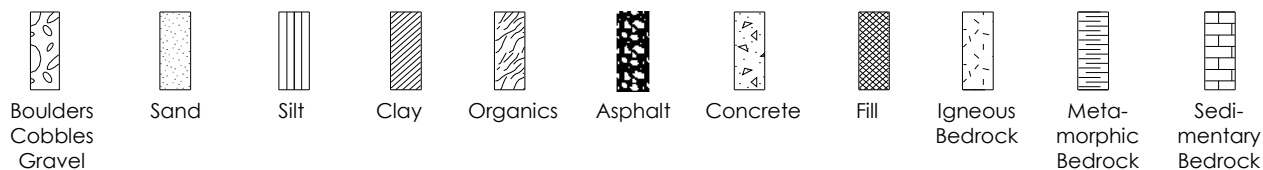
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

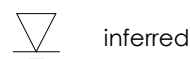
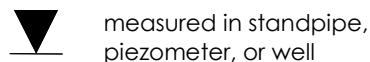
Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

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

**SAMPLE TYPE**

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

WATER LEVEL MEASUREMENT**RECOVERY**

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

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

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

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



BOREHOLE RECORD

BH STR-44

 CLIENT NOVA SCOTIA POWER INCORPORATED

 PROJECT No. 121623404

 LOCATION Kearney Lake Road

 BH SIZE HW

 DATES: BORING 2020/08/13

 WATER LEVEL not observed

 DATUM GEODETIC

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa		
					TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %		20	40	60
0	43.92	FILL: grey sandy gravel - occasional cobbles and boulders					mm					
	SS				1	250	18					
	SS				2	50	50/25mm					
2					SS	3	75	61/225mm				
3	40.72	Grey silty GRAVEL (GM) with sand - frequent cobbles and boulders			SS	4	50	54/150mm				
					SS	5	75	59				
					SS	6	400	48	S			
7	37.37	Severely fractured to moderately jointed grey QUARTZITE - fresh to slightly weathered			SS	7	0	50/60mm				
					HQ	8	100%	RQD 43%				
					HQ	9	100%	RQD 30%				
					HQ	10	100%	RQD 90%				
					HQ	11	100%	RQD 26%				
10	34.32	End of Borehole										



BOREHOLE RECORD

BH STR-45

CLIENT NOVA SCOTIA POWER INCORPORATEDPROJECT No. 121623404LOCATION Kearney Lake RoadBH SIZE HWDATES: BORING 2020/08/12WATER LEVEL not observedDATUM GEODETIC

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa									
					TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %		20 40 60 80 WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m 10 20 30 40 50 60 70 80 90 W _p W W _L									
0	43.52	FILL: grey gravel with silt and sand - occasional cobbles and boulders			SS	1	150	9	S										
1					SS	2	250	19											
2	41.69	Firm brown sandy silty clay (CL-ML) with gravel TILL - occasional cobbles and boulders			SS	3	100	9											
3	41.08	Compact to very dense grey silty gravel (GM) with sand TILL - occasional cobbles and boulders			SS	4	100	61/ 250mm											
4	39.77	Very severely to severely fractured grey QUARTZITE - slightly weathered			SS	5	325	90/ 250mm											
5					HQ	6	54%	RQD 29%											
6					HQ	7	100%	RQD 38%											
7					HQ	8	83%	RQD 0%											
8					HQ	9	90%	RQD 20%											
9	36.97	End of Borehole																	
10																			

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BOREHOLE RECORD

BH STR-46

 CLIENT NOVA SCOTIA POWER INCORPORATED

 PROJECT No. 121623404

 LOCATION Kearney Lake Road

 BH SIZE HW

 DATES: BORING 2020/08/11

 WATER LEVEL not observed

 DATUM GEODETIC

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa			
					TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %		20	40	60	80
0	44.41	FILL: brown to grey silty sand with gravel - occasional cobbles and boulders					mm						
					SS	1	200	16					
1					SS	2	250	57/					
								300mm					
	42.89	Grey silty GRAVEL (GM) with sand - frequent cobbles and boulders			SS	3	100	57/					
2					SS	4	75	225mm					
								50/					
								125mm					
3					SS	5	50	60/					
								125mm					
4	40.60	Very stiff to hard brown sandy silty clay (CL-ML): TILL - trace gravel - occasional cobbles and boulders			SS	6	500	18	S				
					SS	7	425	72/					
								225mm					
								50/					
5					SS	8	50	50/					
								125mm					
6	38.31	Fractured to moderately jointed grey QUARTZITE - slightly weathered											
					HQ	10	92%	RQD 75%					
7					HQ	11	88%	RQD 52%	Qu				
8													
9	35.57	End of Borehole											
10													

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BOREHOLE RECORD

BH STR-47

 CLIENT NOVA SCOTIA POWER INCORPORATED

 PROJECT No. 121623404

 LOCATION Kearney Lake Road

 BH SIZE HW

 DATES: BORING 2020/08/10

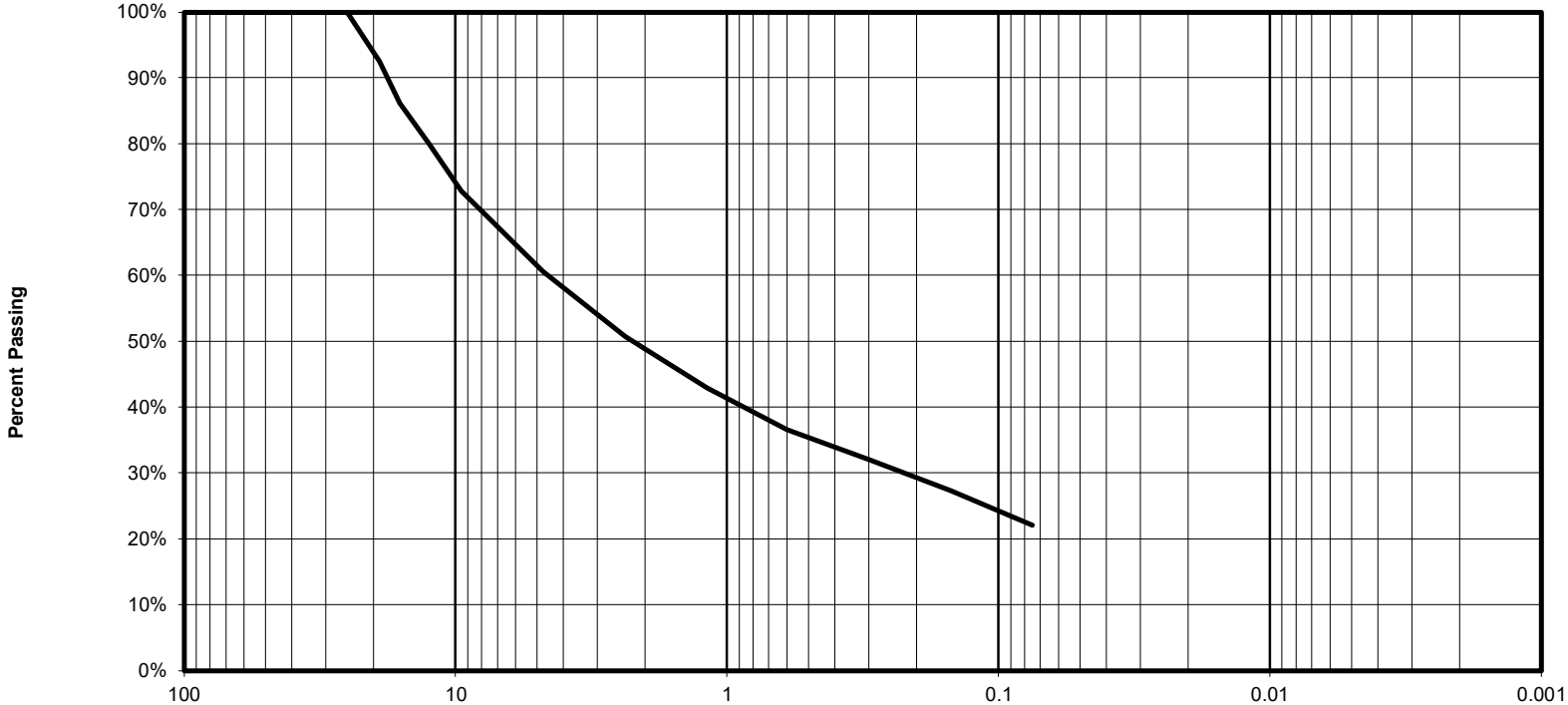
 WATER LEVEL 2020/08/10

 DATUM GEODETIC

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa		
					TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %		20	40	60
0	44.51	FILL: grey to brown silty sand with gravel - occasional cobbles and boulders					mm			WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m		
1					SS	1	400	24				
2					SS	2	300	17				
2	42.38	Very dense grey silty gravel (GM) with sand: TILL - frequent cobbles and boulders		▽	HQ	3	50%					
3					SS	4	250	110/				
4					HQ	5	80%	225mm				
5					HQ	6	58%					
6					SS	7	175	50/				
5	39.57	Very dense brown silty sand (SM) with gravel :TILL - frequent cobbles and boulders										
6	39.18				SS	9	150	50/				
6		End of Borehole - standpipe installed										
7					SS	10	75	150mm				
10												

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Approved: *MCW*



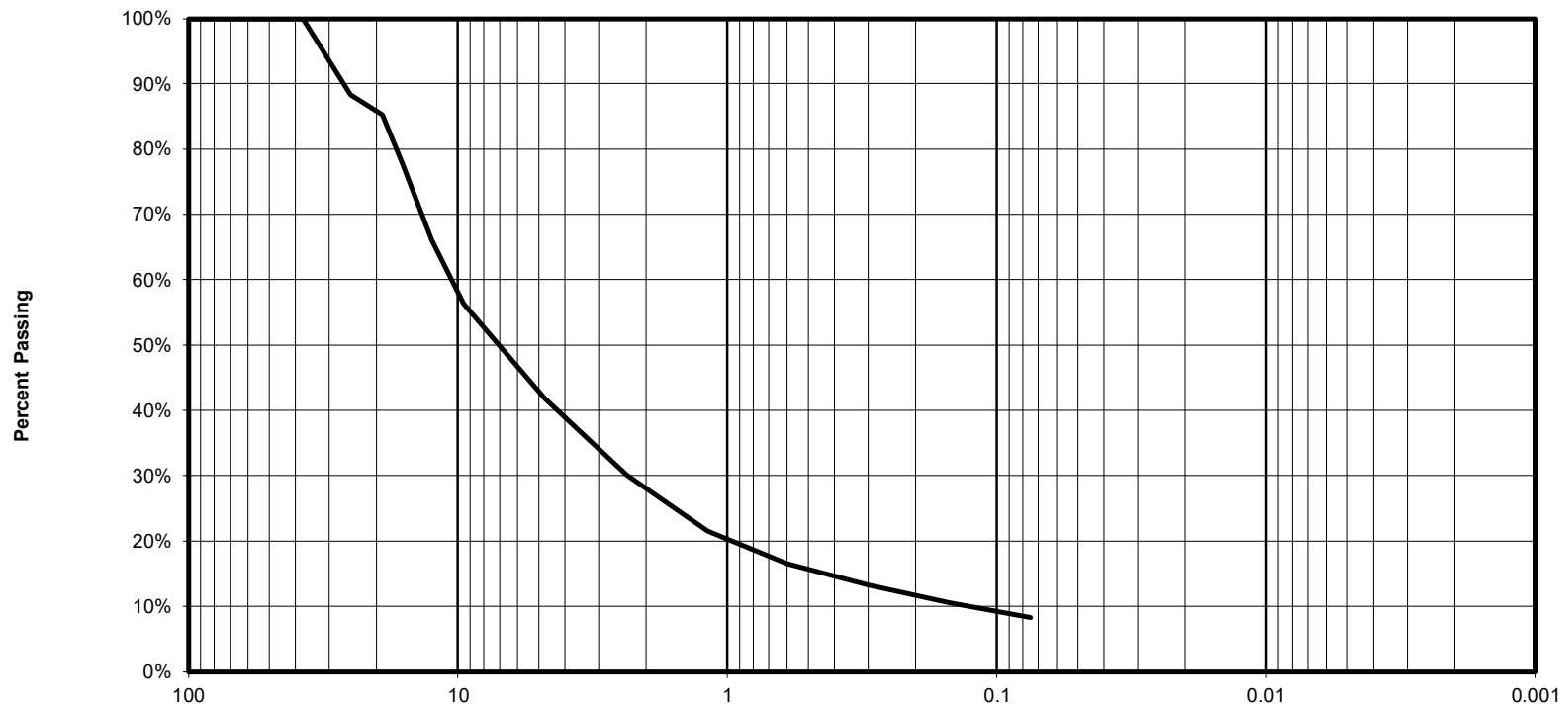
Grain Size in Millimetres

Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	LAB SAMPLE NUMBE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
—	BH-STR#44	Sa6	5.2 - 5.8	39%	38%	22%	Silty GRAVEL with Sand



Approved: *MCW*

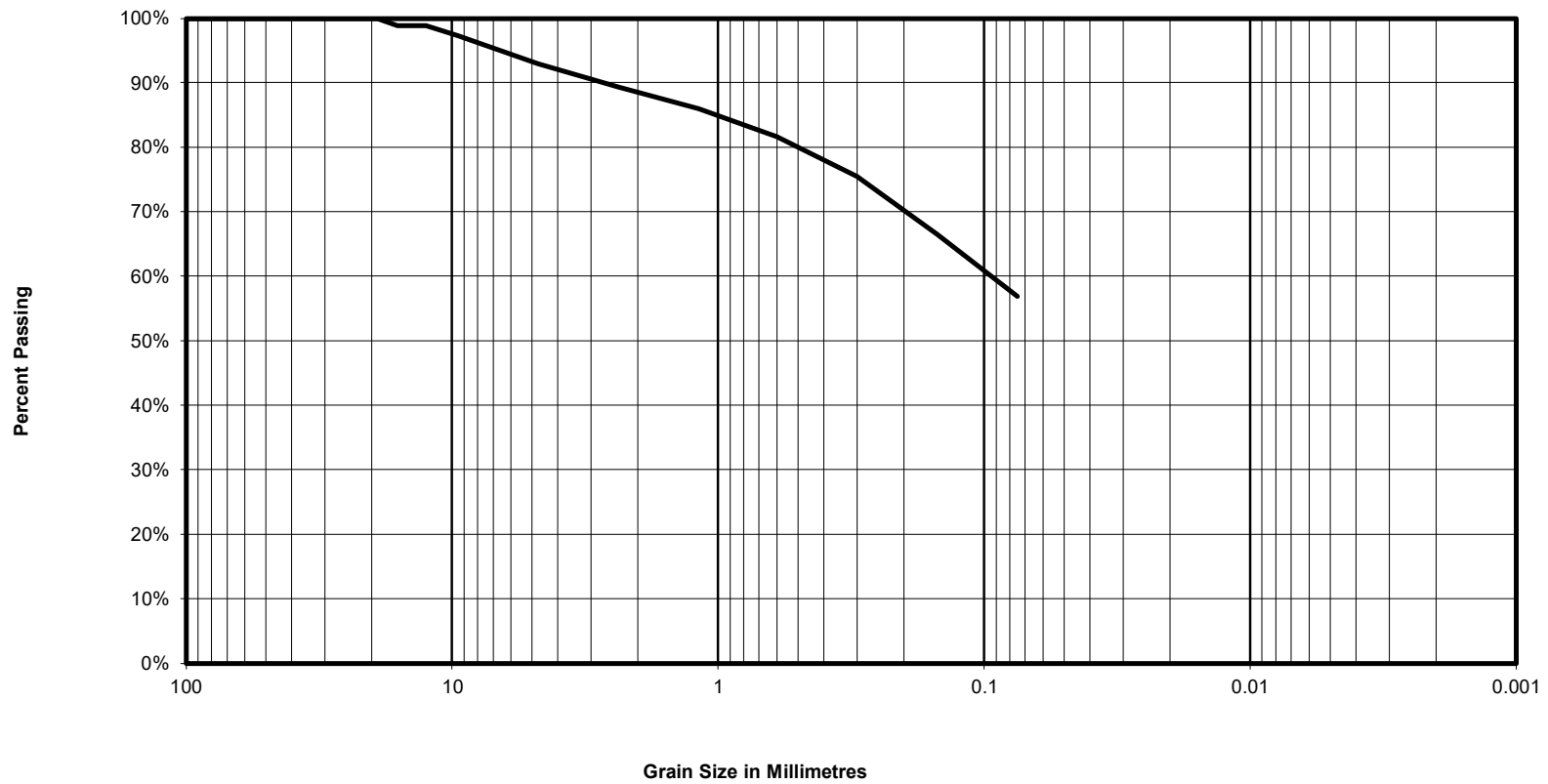
Grain Size in Millimetres

Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	LAB SAMPLE NUMBE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
—	BH-STR#45	Sa2	0.6 - 1.2	58%	34%	8%	GRAVEL with Silt and Sand

Job No.: 121623404

Approved: *MCW*

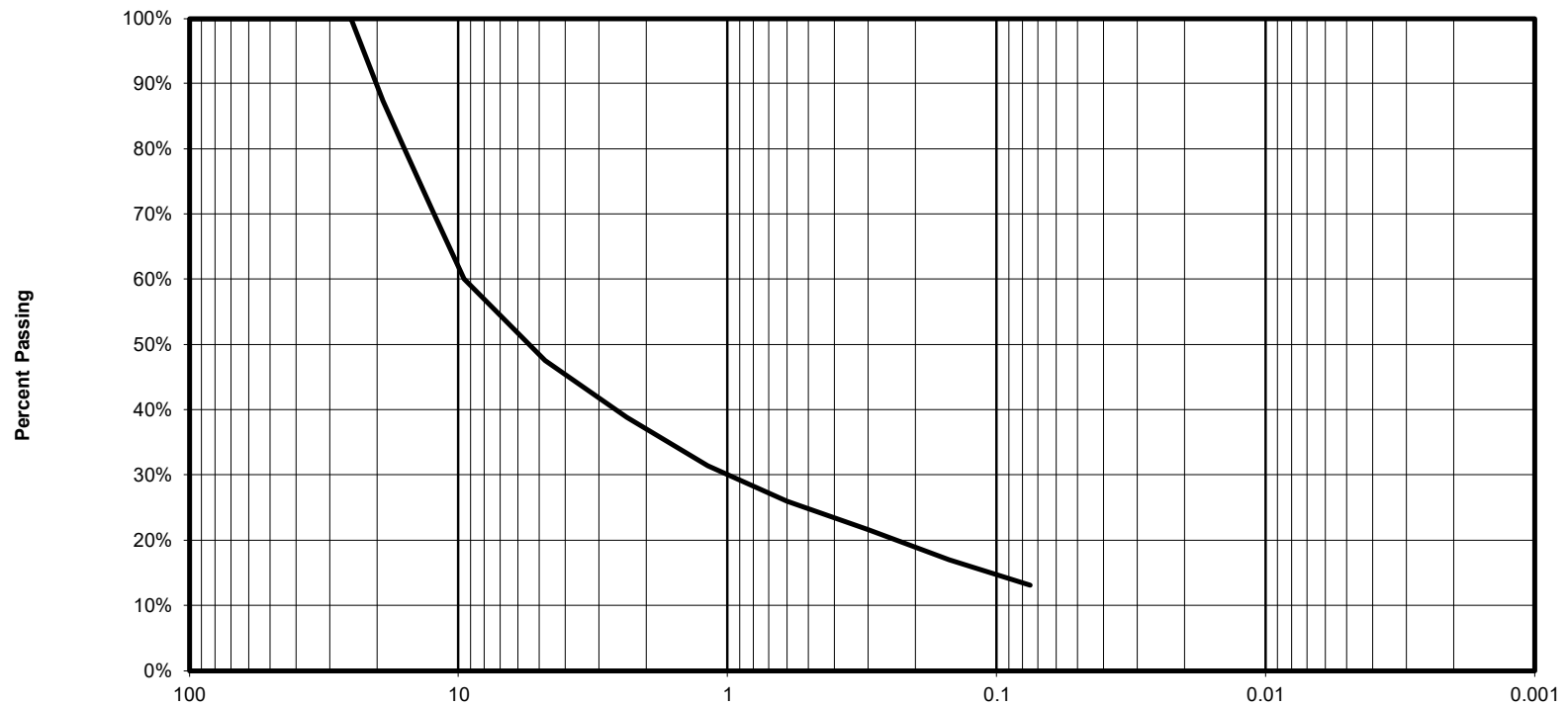
Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	LAB SAMPLE NUMBE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
—	BH-STR#46	Sa6	3.8 - 4.4	7%	36%	57%	Sandy Silty CLAY

Job No.: 121623404



Approved: *MCW*

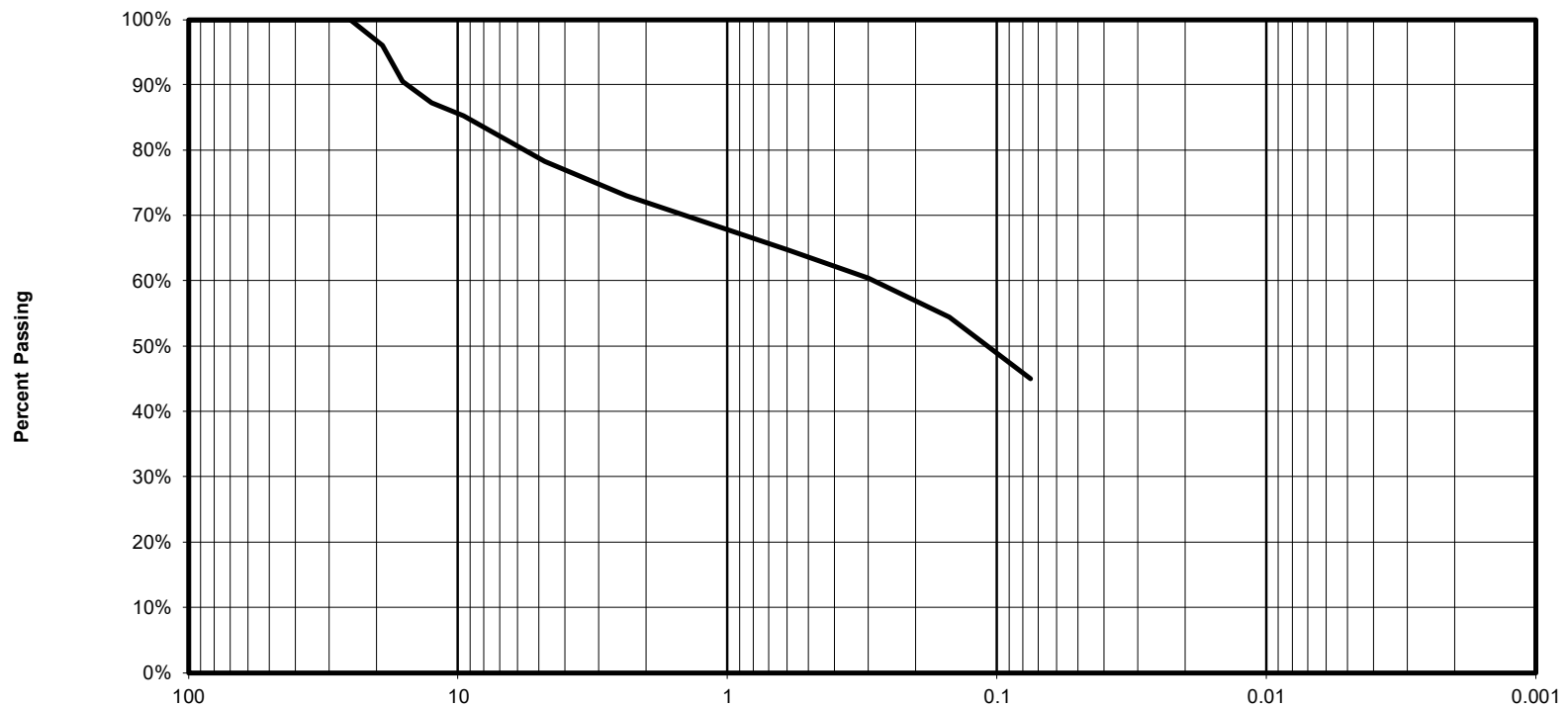
Grain Size in Millimetres

Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	LAB SAMPLE NUMBE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
—	BH-STR#47	Sa7	3.3 - 3.5	53%	34%	13%	Silty GRAVEL with Sand

Job No.: 121623404

Approved: *MCW*

Grain Size in Millimetres

Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	LAB SAMPLE NUMBE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
—	BH-STR#47	Sa9 + Sa10	4.9 - 5.2	22%	33%	45%	Silty SAND with Gravel

Job No.: 121623404

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2020/10/05 12:49 PM By: Pinnell, Brian



ORIGINAL SHEET - ISO A3



Kearney Lake Foundation Preliminary Cost Estimate

Item	Description - Assumptions	Unit Cost (\$)	# of Units	Cost (\$)
Mobilization	General Conditions, Permits	10,000	1	10,000
Safety	Security, Traffic Control - Lane shut downs as required	7,500	1	7,500
Site Preparation	Tree Clearing, grubbing, temp. removal of guardrails	3,500	1	3,500
Sub		21,000		21,000
Micro Pile Foundation Installation (#44, 45 & 46)	6-Pile circular cluster – 2 clusters/structure @ \$2,500/pile – Bedrock at 20' – anchored 15' into bedrock	30,000	3	90,000
Pile Load Testing	\$3,000/ Cluster - 2 clusters/structure	6,000	3	18,000
Pile Cap	5'x6'x6' Pile cap (7-yds ³), 2 pile caps/structure - @ \$1,000/yd ³	14,000	3	42,000
Sub		50,000		150,000
Conventional Foundation (#47)	20'x10'x5' spread footing foundations with Pedestals – 40-yd ³ @ \$1,000/yd ³	40,000	1	40,000
Excavation/Backfill (#47)	25'x15'x7' excavation, backfill, compaction of site material – 100-yd ³ @ \$65/yd ³	6,500	1	6,500
Sub		46,500		46,500
Engineering – Detailed Design	Detailed design and tender documents	15,000	1	15,000
Engineering - Construction Support	Shop drawing review, Geotechnical site support, rebar inspection, concrete sampling & testing	15,000	1	15,000
Sub		30,000		30,000
Total				\$247,500
+ 20% Contingency			x1.2	\$297,000
<u>Not included</u> - cost of supply and install of towers or embedment sections.				



Memo

To: Hadi Ali, M.Sc., P.Eng. Project Manager-Transmission Capital Nova Scotia Power Inc. P.O. Box 848 Halifax, NS B3J 2V7 Project/File: 133432381	From: Matthew Weatherby, P.Eng. Senior Geotechnical Engineer Stantec Consulting Ltd. 104-40 Highfield Park Drive Dartmouth, NS B3A 0A3 Date: April 16, 2025
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Reference: Kearney Lake Transmission Tower Supplemental Geotechnical Investigation

Introduction

Stantec Consulting Ltd. (Stantec) was retained by Nova Scotia Power Inc. (NSPI) to carry out a supplemental geotechnical investigation for two additional proposed transmission tower locations, Structure STR43 and Structure STR50, at either end of the existing Kearney Lake Road corridor as shown in Figure 1 below. These towers are part of the ongoing upgrade and replacement of existing infrastructure. The objective of the investigation was to characterize subsurface conditions and provide geotechnical foundation recommendations for each structure based on the local soil, bedrock, and access constraints.



Figure 1 Approximate Tower and Borehole Locations

This memorandum summarizes our findings and recommendations tailored to the anticipated site constraints and construction requirements.

April 16, 2025
Nova Scotia Power Inc.
Page 2 of 4

Reference: Kearney Lake Transmission Tower Supplemental Geotechnical Investigation

Field Investigation

Field work was completed in January 2025 and included the advancement of one borehole at each proposed tower location. Drilling was conducted using a track-mounted rotary drill rig equipped for both soil sampling and rock coring. Soil samples were obtained using the Standard Penetration Test (SPT) in accordance with ASTM D1586, and bedrock was cored using HQ-size bits. Each borehole was advanced to approximately 11 m below ground surface. Groundwater conditions were observed during and after drilling, and standpipe piezometers were installed at both sites to facilitate future monitoring.

Laboratory classification testing, including grain size analyses, was conducted on select samples to assist with soil characterization. Borehole records and grain size distribution results are provided in the attached appendices.

Subsurface Conditions and Recommendations

Structure STR43

At STR43, the borehole encountered approximately 1.1 m of compact to very dense, grey and brown gravel with silt and sand. This upper unit included trace organic material in the top 0.18 m and could possibly be fill derived from the local glacial till; it was underlain by dense to very dense silty sand with gravel glacial till with frequent cobbles and occasional boulders, extending to approximately 5.8 m below ground surface. Bedrock consisting of moderately weathered to fresh greywacke was cored from 5.8 m to the bottom of the borehole. While bedrock recovery was generally high, the RQD values indicated highly variable rock quality, ranging from 0% to 100%, with particularly fractured zones in the upper several meters.

Grain size analysis of the upper unit (0.6–1.1 m) classified the material as poorly graded gravel with silt and sand (GP-GM), with 63% gravel, 26% sand, and 11% fines. Groundwater was recorded at 4.8 m during a follow-up visit in February 2025.

A uniaxial compressive strength (UCS) test was performed on a representative bedrock specimen collected from HQ Sample 14 at approximately 10.5 m. The measured compressive strength was 72 MPa, indicating the rock is of high strength classification per typical engineering criteria.

The native till and bedrock at STR43 provide suitable bearing conditions for shallow foundations. However, based on discussions with the structural team and a review of site-specific constraints, including sloping terrain and limited overhead clearance, the use of shallow spread footings is considered impractical. These limitations are expected to present challenges for excavation, formwork, and frost protection, and may result in conflicts with adjacent property boundaries. A deep foundation solution is therefore recommended for this location to accommodate structural layout and access constraints.

A deep foundation solution is recommended, with rock-socketed micropiles preferred due to their compatibility with restricted access conditions and limited headroom from nearby overhead power lines. Micropiles can be installed with lightweight equipment, generate minimal vibration, and accommodate challenging ground profiles, making them well suited for this constrained site. Drilled cast-in-place (CIP) concrete piles could be considered as an alternative if overhead clearance and working space permit but may be more difficult to install given the reduced equipment mobility at the site. Driven piles were

April 16, 2025
Nova Scotia Power Inc.
Page 3 of 4

Reference: Kearney Lake Transmission Tower Supplemental Geotechnical Investigation

not considered viable due to vertical clearance limitations and associated safety concerns related to pile driving operations.

The following parameters are recommended for preliminary design:

- Minimum embedment of 1.0 m into competent bedrock plus the factored design length
- Factored bond resistance of 700 kPa in compression and 525 kPa in tension
- Resistance factor of 0.4 (compression) and 0.3 (tension)
- Installation of steel casing through overburden and fractured rock zones
- Design load not to exceed 70% of factored capacity under cyclic loading
- Frost depth of 1.2 m to be considered in pile shaft design; adfreeze force of 150 kPa may be used
- Verification and proof load testing per FHWA guidelines is recommended

Micropile or CIP pile design and construction should be undertaken by a qualified specialty contractor familiar with variable rock conditions and constrained access sites.

Structure STR50

The subsurface profile at STR50 consists of approximately 0.6 m of surficial gravel fill, underlain by very dense silty gravel till with frequent cobbles and boulders. Bedrock was encountered at approximately 3.3 m depth and consisted of greywacke of moderate to good quality. RQD values ranged from 0% to over 100%, with competent zones encountered throughout the core run.

A grain size analysis on the till sample collected from 1.8–2.0 m depth classified the material as silty gravel with sand (GM), comprising 47% gravel, 38% sand, and 15% fines. No groundwater was encountered during drilling, though a standpipe was installed for long-term monitoring.

A UCS test conducted on HQ Sample 11 at approximately 7.5 m yielded a compressive strength of 137 MPa, classifying the bedrock as very high strength, consistent with expectations for greywacke in this region.

Unlike STR43, the STR50 site is situated on relatively flat terrain with minimal site constraints or nearby obstructions. The shallow depth to competent bearing material, coupled with favorable access for equipment and construction staging, supports the use of conventional shallow spread footings. Excavation to native till or shallow bedrock is expected to be achievable using conventional equipment, although localized boulders may be encountered.

Based on the soil and bedrock conditions, and in keeping with previous recommendations for similar sites along the Kearney Lake corridor, we recommend the following geotechnical design parameters for a monolithic spread footing founded on native till at STR50:

- Serviceability Limit State (SLS) bearing resistance: 250 kPa
- Ultimate Limit State (ULS) factored bearing resistance: 375 kPa (using resistance factor of 0.5)
- Minimum footing embedment of 1.2 m for frost protection
- Bearing surface to be reviewed by qualified geotechnical personnel prior to concrete placement
- Backfill to meet structural fill specifications (well-graded granular material compacted to 100% SPMDD)

April 16, 2025
Nova Scotia Power Inc.
Page 4 of 4

Reference: Kearney Lake Transmission Tower Supplemental Geotechnical Investigation

Where footing excavation reaches competent bedrock, spread footings may alternatively be founded directly on bedrock. In that case, we recommend the following bearing resistance values:

- ULS factored bearing resistance: 2000 kPa
- SLS bearing resistance: Negligible total settlement anticipated (≤ 5 mm), no serviceability limitation expected

All rock-bearing surfaces should be cleaned of loose or weathered material prior to footing placement and reviewed by geotechnical personnel to confirm suitable contact conditions. The footing should be formed to ensure full bearing contact with the bedrock surface.

Closure

This technical memorandum presents the results of the supplemental geotechnical investigation for Structures STR43 and STR50 along the Kearney Lake transmission corridor. The recommendations provided herein are intended to guide the design and construction of foundations at these two locations based on site-specific conditions and constraints.

This document is intended to be read in conjunction with the original report titled "Geotechnical Investigation, Four Proposed Transmission Tower Replacements, Kearney Lake, Halifax, Nova Scotia" dated November 2020 (Stantec Project No. 121623404). Should construction conditions differ from those observed during drilling, or should foundation layouts be modified, Stantec should be contacted to review and, if necessary, update these recommendations.

Regards,

Stantec Consulting Ltd.

 Digitally signed by
Weatherby, Matthew
Date: 2025.04.16
10:57:00 -03'00'

Matthew Weatherby P. Eng.
Associate, Senior Geotechnical Engineer
Phone: (902) 468 0431
Mobile: (902) 402 8382
matthew.weatherby@stantec.com

Attachment: Borehole Records
Grain Size Analysis

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Rootmat</i>	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

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

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

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

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

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

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25 - 0.5	12.5 - 25	2-4
<i>Firm</i>	0.5 - 1.0	25 - 50	4-8
<i>Stiff</i>	1.0 - 2.0	50 - 100	8-15
<i>Very Stiff</i>	2.0 - 4.0	100 - 200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

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

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	Crushed
Severely Fractured	Shattered or Very Blocky
Fractured	Blocky
Moderately Jointed	Sound
Intact	Very Sound

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

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

**SAMPLE TYPE**

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

WATER LEVEL MEASUREMENT

measured in standpipe,
piezometer, or well



inferred

RECOVERY

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

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

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

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

BOREHOLE RECORD

NORTHING:
EASTING: **BH-STR43**

CLIENT NOVA SCOTIA POWER INCORPORATED

PROJECT No. 133432381

LOCATION KEARNEY LAKE, HALIFAX, NS

BH SIZE HQ

DATES: BORING 2025/01/21 WATER LEVEL 4.8 m (2025/02/12)

DATUM N/A

[illegible]

BOREHOLE RECORD

NORTHING:
EASTING: **BH-STR43**

CLIENT NOVA SCOTIA POWER INCORPORATED

PROJECT No. 133432381

LOCATION KEARNEY LAKE, HALIFAX, NS

BH SIZE HQ

DATES: BORING 2025/01/21 WATER LEVEL 4.8 m (2025/02/12)

DATUM N/A

[illegible]



Stantec

BOREHOLE RECORD

NORTHING:

EASTING:

BH-STR50

CLIENT NOVA SCOTIA POWER INCORPORATEDPROJECT No. 133432381LOCATION KEARNEY LAKE, HALIFAX, NSBH SIZE HQDATES: BORING 2025/01/27 - 2025/01/28 WATER LEVEL NOT OBSERVEDDATUM N/A

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa									
					TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %		200	400	600	800	WATER CONTENT & ATTERBERG LIMITS					
										W _P W W _L ★ DYNAMIC PENETRATION TEST, BLOWS/ft ● STANDARD PENETRATION TEST, BLOWS/ft 10 20 30 40 50 60 70 80 90									
0		FILL: Grey, poorly graded gravel with silt and sand			SS	1	125	71/200 mm											
1		Very dense, grey to brown, silty GRAVEL with sand: TILL -frequent cobbles and boulders			SS	2	50	75/125 mm											
2					SS	3	125	50/75 mm	S										
3					SS	4	75	50/75 mm											
4		Very poor to excellent quality, moderately weathered to fresh, grey GREYWACKE BEDROCK			HQ	5	100%	RQD 54%											
5					HQ	6	100%	0%											
6					HQ	7	92%	38%											

App'd Mar 25 2025 14:3:7



BOREHOLE RECORD

NORTHING:
EASTING: **BH-STR50**

CLIENT NOVA SCOTIA POWER INCORPORATED

PROJECT No. 133432381

LOCATION KEARNEY LAKE, HALIFAX, NS

BH SIZE HQ

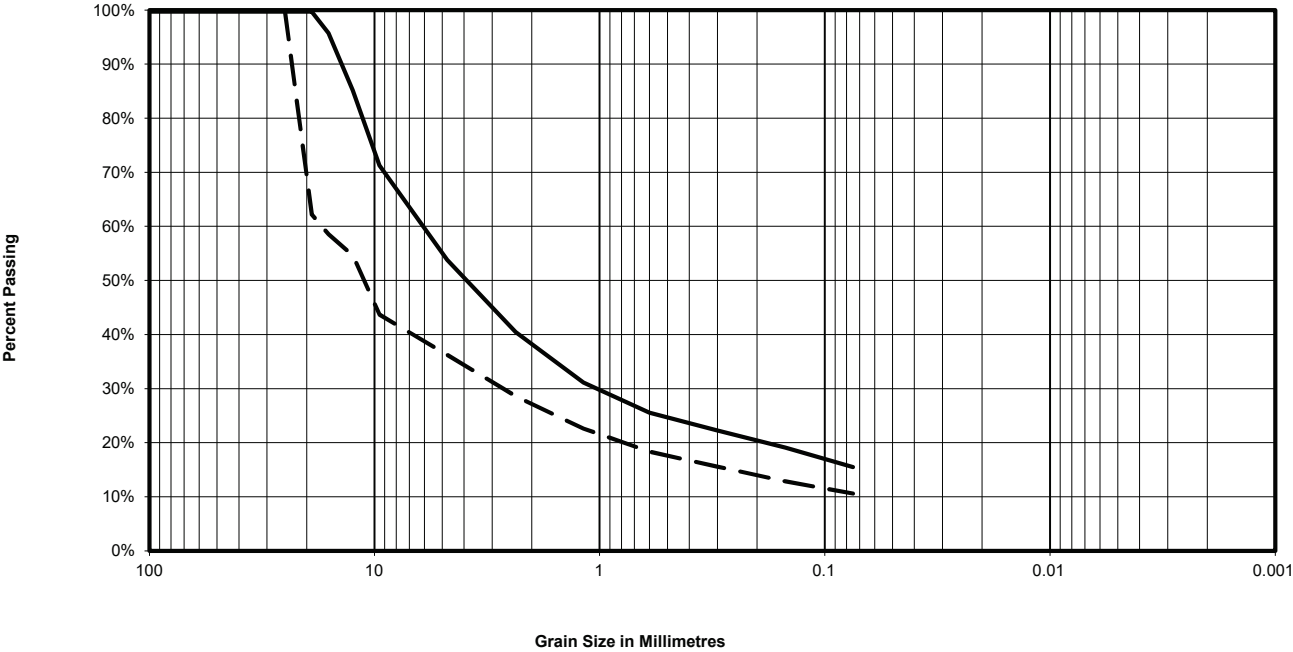
DATES: BORING 2025/01/27 - 2025/01/28 WATER LEVEL NOT OBSERVED

DATUM N/A

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				OTHER TESTS	UNDRAINED SHEAR STRENGTH - kPa									
					TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %		200	400	600	800	WATER CONTENT & ATTERBERG LIMITS					
										DYNAMIC PENETRATION TEST, BLOWS/ft ★ STANDARD PENETRATION TEST, BLOWS/ft ●									
										10 20 30 40 50 60 70 80 90									
6					HQ	8	90%	0%											
					HQ	9	67%	0%											
					HQ	10	100%	0%											
7					HQ	11	100%	63%	qu=137 MPa										
					HQ	12	100%	100%											
					HQ	13	0%	0%											
9					HQ	14	95%	63%											
					HQ	15	100%	48%											
10					HQ	16	93%	73%											
11		End of Borehole (11.13) -standpipe installed																	
12																			

App'd Mar 25 2025 14:3:8

Approved:



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	MOISTURE CONTENT	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
—	STR 50 - SA3	7%	1.8 - 2.0	47%	38%	15%	Silty Gravel with Sand (GM)
- - -	STR 43 - SA2B	2%	0.6 - 1.2	63%	26%	11%	Poorly Graded Gravel with Silt and Sand (GP-GM)

