



THURBER ENGINEERING LTD.

MEMORANDUM

To: Ryan Gustafson, P.Eng
BC Ministry of Transportation and Infrastructure

Date: Jan. 3, 2023

From: Mark Byram, P.Eng, NACE #265762

File: 33450

Review: Stephen M. Bean, M.Eng., P.Eng.

PENDER ISLAND – CANAL ROAD SLIDE SOIL CORROSIVITY ASSESSMENT FOR SHOTCRETE AND ANCHOR WALL

This memorandum presents the findings of a soil corrosivity assessment and provides expected steel corrosion rates for use in the design of a proposed shotcrete and anchor retaining wall at the Canal Road site on Pender Island, BC.

It is a condition of this memo that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

1. BACKGROUND

The BC Ministry of Transportation and Infrastructure (MoTI) intends to stabilize the approximately 300 m segment of Canal Road after identifying a possible worsening of a known active landslide on South Pender Island. A retaining wall is required on the upslope side of the roadway from approximately Sta 100+275 to Sta. 100+345. Parsons has provided design drawings for a proposed shotcrete and anchor wall up to about 11 m in height. It is understood that the design has been based on double corrosion protected rock anchors.

This memorandum provides a summary of the corrosivity testing and provides an expected corrosion rate for the anchors in case an alternative corrosion protection approach is considered.

Steel structures in soil are susceptible to corrosion attacks that result in the metal dissolving electrochemically in the soil with an associated cross section reduction and subsequently a reduction in structural capacity.

The corrosivity of the surrounding soils can be analyzed to develop expected corrosion rates for steel. Soil corrosivity is generally assessed by reviewing the type of soil and its chemical and physical properties such as sulfate content, chloride content, pH, and soil resistivity. Thurber has assessed the corrosivity of soil samples from the site and provides the following comment on the expected corrosion rate of the steel anchors.

It is noted that the BC supplement to S6-14 section 2.9 requires that "Unless otherwise consented to by the Ministry, soil and rock anchors permanently incorporated into the structure shall be a PTI – Class 1, Double Corrosion Protection (DCP) system. Additionally, the more recent Supplement to S6-19 clarifies that the consent is primarily intended for rock anchors; "Rock bolts



other than DCP may be used for the purposes of rock slope design per SS and DBSS 206 and T-04/17 Geotechnical Design Criteria when not integral to the stability of a structure” (Modification to Clause 2.3.6.10).

2. SOIL ASSESSMENT APPROACH

2.1 Soil Sampling

Soil sampling was completed on May 3rd, 2022 by Thurber during the geotechnical investigation. Four samples from TH22-4 were selected and combined for corrosivity testing. The samples were selected to represent both the colluvium soil unit and the till-like soil unit identified on site. Two samples of each unit were selected. The colluvium generally consisted of sandy, gravelly silt which was loose to compact in density (SM/ML). The till-like unit consisted of sandy gravelly silt with sandy clay pockets and was dense to very dense (GM/GC). Detailed soil descriptions are shown on the appended test hole record for TH22-4. The samples are expected to be representative of the anticipated soil conditions at the wall.

The quantity of the individual samples was not sufficient to perform a full suite of corrosivity tests on the samples. Therefore, soil samples with similar composition were combined as shown in Table 1 to assess the soils.

Table 1 Soil Sample Details

| Combined Sample ID | Label ID | Reference Number | Soil Unit | Depth (ft) | Combined Samples |
|--------------------|------------|------------------|-------------------|------------|--------------------------------|
| 1 | 22G1700-01 | TH22-4 20'-22' | GM/GC (Till-like) | 20 to 22 | TH22-4 – Sa 9 20'-22' – 537g |
| | | | | | TH22-4 – Sa 10 20'-21' – 1327g |
| 2 | 22G1700-02 | TH22-4 10'-17' | SM/ML (Colluvium) | 10 to 17 | TH22-4 – Sa 6 10'-15' – 414g |
| | | | | | TH22-4 – Sa 7 15'-17' – 554g |

2.2 Soil Corrosivity Test Results

The samples were sent to Caro Analytical Services for resistivity (ASTM G57), pH, sulfate content (AASHTO T290-95), and chloride content (AASHTO T291-94). The following table summarizes the results of the soil corrosivity testing. Test reports for the laboratory testing have been appended.



Table 2 Soil Corrosivity Test Results from External Laboratory

| Combined Sample ID | Label ID | Reference Number | pH | Resistivity (Ohm-cm) | Sulfate (ppm) | Chloride (ppm) |
|--------------------|------------|------------------|------|----------------------|---------------|----------------|
| 1 | 22G1700-01 | TH22-04 20'-22' | 6.44 | 4001 | 333* | <20 |
| 2 | 22G1700-02 | TH22-04 10'-17' | 5.7 | 3516 | 178 | <20 |

*Sample above the 200 ppm threshold for non-corrosive soil

It should be noted that organic testing was not carried out on the samples. However, the soil log (TH22-4) does not indicate the presence of organics within the soil.

3. CORROSION ASSESSMENT

The corrosion rate assessment has been based on FHWA NHI-14-007 “Soil Nail Walls Reference Manual” by the US Department of Transportation Federal Highway Administration published in February of 2015 – FHWA-NHI-14-007 (Soil Nail Manual).

3.1 Soil Corrosivity Classification

Table 3 below is from Chapter 7 Clause 7.2 of the Soil Nail Manual. It provides a list of requirements and summarizes the criteria for classification of a soil as non-aggressive.

Table 3 Criteria for Assessing Ground Corrosion Potential (from Soil Nail Manual)

| Test | Units | Threshold for Non-Aggressive | Test Method |
|-------------|----------------------|------------------------------|-----------------------------|
| pH | – | 5.0 < pH < 10 | AASHTO T-289 |
| Resistivity | ohm-cm | Greater than 3,000 | AASHTO T-288 ⁽²⁾ |
| Sulfates | ppm ⁽¹⁾ | Less than 200 | ASTM D4327 |
| Chlorides | ppm | Less than 100 | ASTM D4327 |
| Organics | percentage by weight | Less than 1% | AASHTO T-267 |

Note: (1) ppm = parts per million.

(2) This method may have limitations for coarse soils that have very little, or no, material finer than the No. 10 sieve. See suggested alternatives in Elias et al. (2009).

Based on the criteria above and an assumption that the organics content is less than 1% the samples are classified as follows:



Table 4 Soil Corrosivity Analysis in Reference to Soil Nail Manual

| Combined Sample ID | Label ID | Reference Number | Aggressiveness Classification |
|--------------------|------------|------------------|-------------------------------|
| 1 | 22G1700-01 | TH22-4 20'-22' | Aggressive* |
| 2 | 22G1700-02 | TH22-4 10'-17' | Non-Aggressive |

*due to soluble sulfate content exceeding 200 ppm.

Sample 1 (till-like soil) has been labelled as aggressive due to the sulfate content of 333 ppm exceeding the 200 ppm limit defined in the soil nail manual. However, based on the criteria listed below in Table 5, the sulfate levels in the soil would be considered positive (but below considerable or severe) for the degree of corrosivity.

Table 5 Effect of Sulfates and pH on Corrosion of Buried Steel Pipelines

| Concentration of sulfate /ppm | Degree of corrosivity | pH | Degree of corrosivity |
|-------------------------------|-----------------------|---------|-----------------------|
| ≥10,000 | Severe | ≤5.5 | Severe |
| 1500–10,000 | Considerable | 5.5–6.5 | Moderate |
| 150–1500 | Positive | 6.5–7.5 | Neutral |
| 0–150 | Negligible | ≥7.5 | None (alkaline) |

Note: Table reprinted from: S. Arzola, M.E. Palomar-Pardave and J. Genesca “Effect of resistivity on the corrosion mechanism of mild steel in sodium sulfate solutions- Journal of Applied Electrochemistry 33 (2003)”.

The term “non-aggressive” should not be implied as to never cause corrosion. Rather, it implies that the level of corrosion can be tolerated with reasonable confidence within the design life of the structure, provided that the electro-chemical characteristics of the soils do not change over time.

3.2 Corrosion Mitigation

The Soil Nail Manual provides a framework for the corrosion mitigation of soil anchors depending on aggressiveness of the soil and a risk tolerance as agreed upon by the engineer of record and the owner.

Figure 1 depicts the procedure for selecting the appropriate soil nail corrosion protection level.

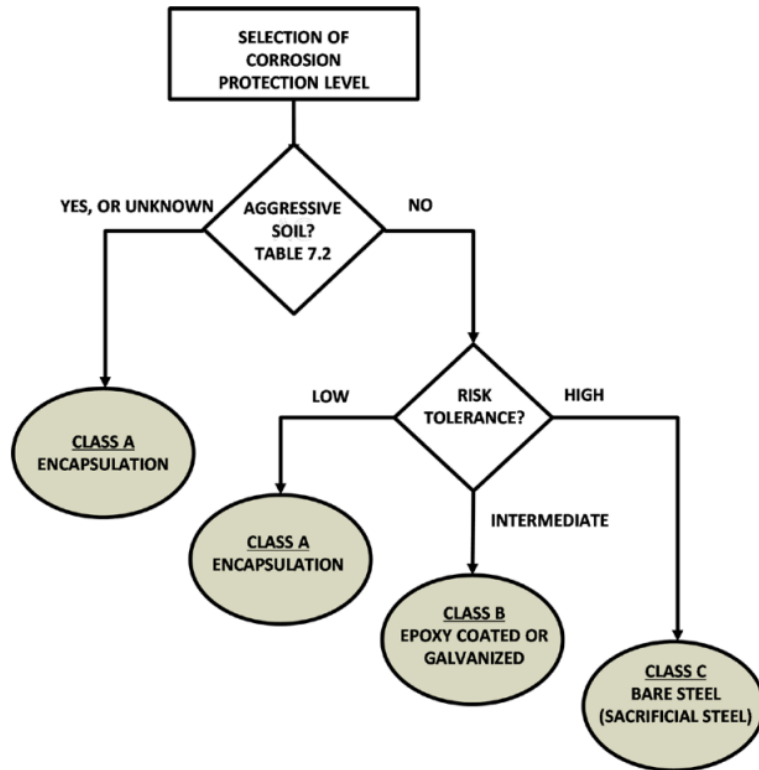


Figure 1 Levels of Corrosion Protection Flowchart

Table 5 has summarized the degree of corrosivity based on the test results and an assumption of <1% organics and the framework provided in the Soil Nail Manual. Table 6 below provides mitigation strategies for 3 different soil assessment and risk tolerance alternatives.

Table 6 Recommended Corrosion Mitigation for Soil Nails

| Combined Sample ID | Reference Number | Aggressive Soil? | Risk Tolerance | Mitigation Strategy |
|--------------------|------------------|------------------|----------------|--|
| 1 | TH22-04 20'-22' | Y | N/A | Class A - Encapsulation |
| 2 | TH22-04 10'-17' | N | Low | Class A - Encapsulation |
| 2 | TH22-04 10'-17' | N | High | Class C - Sacrificial Steel – 6.4 mm diameter reduction / 100 years* |

*The corrosion rate is based on 6.4 mm for 100 years of service life, based on U.S Department of Transportation Federal Highway Administration Publication No. FHWA-NHI-14-007.

Figure 2 and Figure 3 below show the referenced Class A and Class C corrosion mitigation options, respectively.

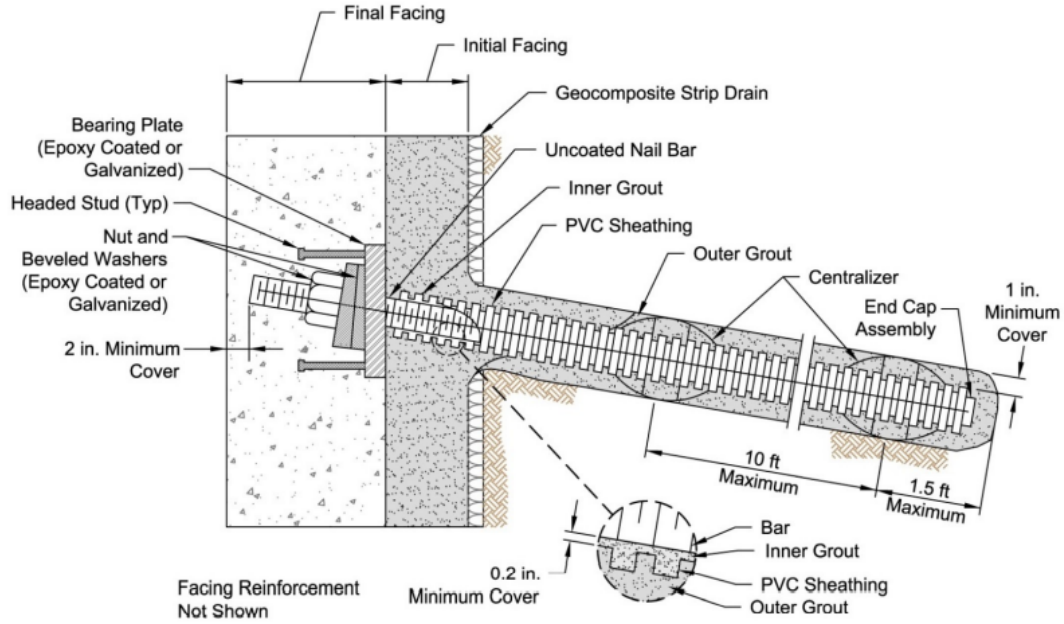


Figure 2 Class A Encapsulations – Excerpt from Soil Nail Manual

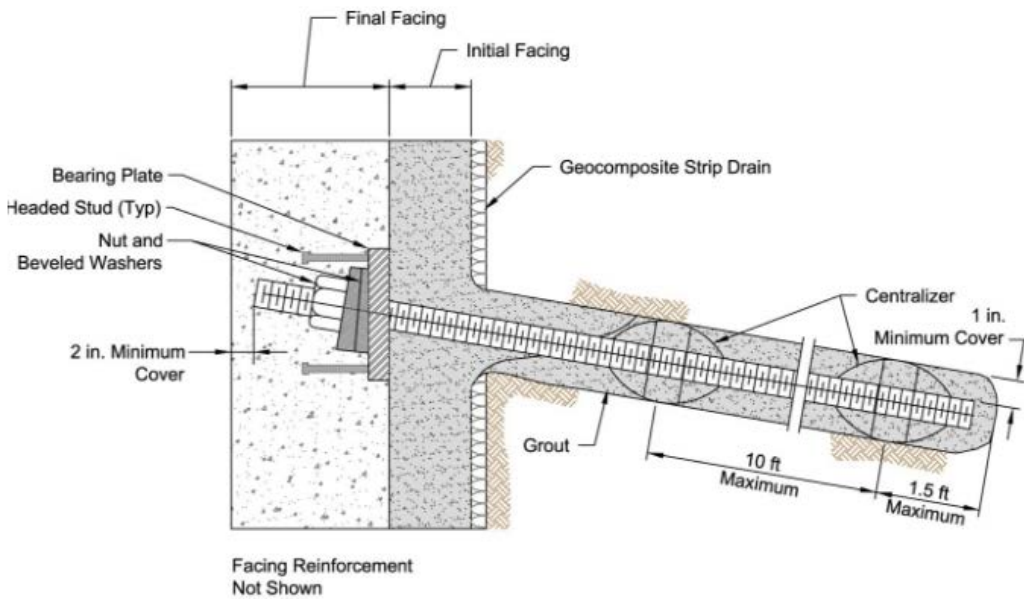


Figure 3 Class C Bare Steel Corrosion Mitigation – Excerpt from Soil Nail Manual



4. DISCUSSION

The colluvium soil sample (ID 2) has shown that the soils can be considered non-corrosive while the till-like sample (ID 1) showed slightly elevated sulfate levels. The marginal increase in sulfates is not expected to have a significant impact on the corrosion rate in the field.

When determining the corrosion mitigation strategy, the risk tolerance should be agreed upon by the owner and engineer of record. When assessing the risk tolerance, the following should be considered:

- utilization of anchors during non seismic conditions,
- consequence of failure,
- cost of repair,
- expected mode of failure, and
- impact of failure on the public and surrounding infrastructure.

5. RECOMMENDATIONS

The anchors should be class A encapsulation unless otherwise consented to by the Ministry.

If the option of a bare steel anchor is to be investigated further, then the owner and engineer of record would need to agree on the risk tolerance for this proposed installation.

Based on a low risk tolerance the corrosion mitigation strategy should be Class A encapsulation.

Based on a high-risk tolerance and an acceptance that the Till-like soils can be considered non-aggressive a Class C bare steel corrosion mitigation strategy could be considered which will require oversizing of the bars by a minimum of 6.4 mm in diameter. Confirmation of the soils having an organic content below 1% by weight would be required to support this option.

If an intermediate risk tolerance is selected, then the application of galvanizing in addition to the sacrificial metal is recommended.



6. CLOSURE

We trust this provides you sufficient information for your needs at this time. If you have any questions or would like to discuss these recommendations, please contact us.

Yours truly,
Thurber Engineering Ltd.
Stephen M. Bean, M.Eng., P.Eng.
Review Principal

Thurber Engineering Ltd.
Permit to Practice #1001319

Mark Byram, P.Eng NACE #265762
Construction Materials Engineer.

Attachments

- Statement of Limitations and Conditions
- CARO Test Report
- Test Hole Record TH22-04



STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client, the BC Ministry of Transportation and Infrastructure (MoTI) and Authorized Users as defined in the MoTI Special Conditions Form H0461d. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Any use which an unauthorized third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any unauthorized third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

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Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



CERTIFICATE OF ANALYSIS

REPORTED TO Thurber Engineering Ltd. (Victoria)
100 - 4396 West Saanich Road
Victoria, BC V8Z 3E9

ATTENTION Alex Minett

PO NUMBER
PROJECT 33450 Canal Road
PROJECT INFO

WORK ORDER 22G1700

RECEIVED / TEMP 2022-07-14 12:00 / 19.5°C
REPORTED 2022-07-21 17:39
COC NUMBER No#

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

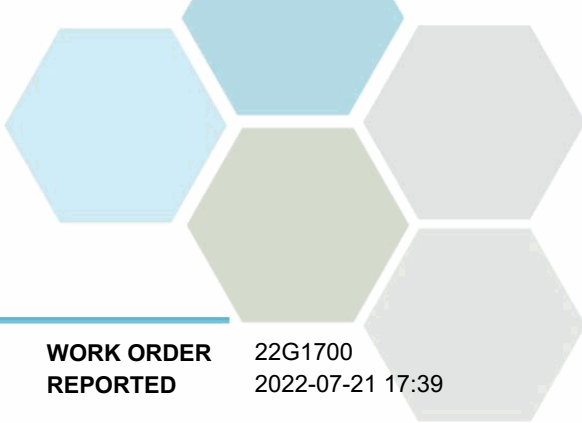
If you have any questions or concerns, please contact me at nyjpp@caro.ca

Authorized By:

Nicole Yipp
Client Service Team Lead

1-888-311-8846 | www.caro.ca

#110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7 | #108 4475 Wayburne Drive Burnaby, BC V5G 4X4



TEST RESULTS

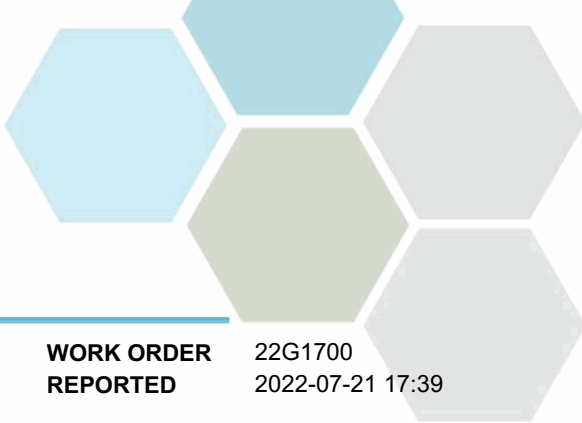
REPORTED TO PROJECT Thurber Engineering Ltd. (Victoria)
33450 Canal Road

WORK ORDER REPORTED 22G1700
2022-07-21 17:39

| Analyte | Result | RL | Units | Analyzed | Qualifier |
|--|--|------|-----------|------------|-----------|
| TH22-04 20'-22' (22G1700-01) Matrix: Soil Sampled: 2022-05-03 | | | | | |
| <i>General Parameters</i> | | | | | |
| Sulfate, Water-Soluble | 333 | 40 | mg/kg dry | 2022-07-19 | |
| Chloride, Water-Soluble | < 20 | 20 | mg/kg dry | 2022-07-18 | |
| pH (1:2 H2O Solution) | 6.44 | 0.10 | pH units | 2022-07-20 | |
| Resistivity | Please refer to appendix for full report | 10 | ohm-cm | 2022-07-21 | |

TH22-04 10'-17' (22G1700-02) | Matrix: Soil | Sampled: 2022-05-03

| | | | | | |
|---------------------------|--|------|-----------|------------|--|
| <i>General Parameters</i> | | | | | |
| Sulfate, Water-Soluble | 178 | 40 | mg/kg dry | 2022-07-19 | |
| Chloride, Water-Soluble | < 20 | 20 | mg/kg dry | 2022-07-18 | |
| pH (1:2 H2O Solution) | 5.70 | 0.10 | pH units | 2022-07-20 | |
| Resistivity | Please refer to appendix for full report | 10 | ohm-cm | 2022-07-21 | |



APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO PROJECT Thurber Engineering Ltd. (Victoria)
33450 Canal Road

WORK ORDER REPORTED 22G1700
2022-07-21 17:39

| Analysis Description | Method Ref. | Technique | Accredited | Location |
|---------------------------------|--------------------------------------|---|------------|----------|
| Chloride, Water-Soluble in Soil | AASHTO T291-94 | Hot Water Extraction / Potentiometric Titration | | Richmond |
| pH in Soil | Carter 16.2 / SM 4500-H+ B (2017) | 1:2 Soil/Water Slurry / Electrometry | ✓ | Richmond |
| Resistivity in Soil | ASTM G57-78 | Wenner Four-Electrode Method | | Sublet |
| Sulfate, Water-Soluble in Soil | AASHTO T290-95 | Hot Water Extraction / Gravimetry | | Richmond |

Glossary of Terms:

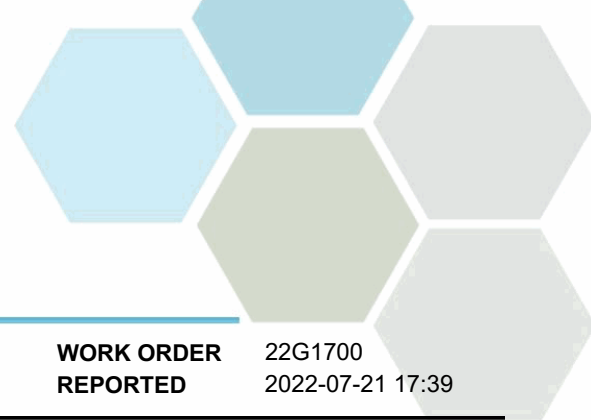
| | |
|-----------|---|
| RL | Reporting Limit (default) |
| < | Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors |
| mg/kg dry | Milligrams per kilogram (dry weight basis) |
| ohm-cm | Ohms-centimetre |
| pH units | pH < 7 = acidic, pH > 7 = basic |
| AASHTO | American Association of State Highway and Transportation Officials, Methods of Sampling and Testing |
| ASTM | ASTM International Test Methods |
| SM | Standard Methods for the Examination of Water and Wastewater, American Public Health Association |

General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued or once samples expire, whichever comes first. Longer hold is possible if agreed to in writing.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager: nyipp@caro.ca

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APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Thurber Engineering Ltd. (Victoria)
33450 Canal Road

WORK ORDER REPORTED 22G1700
2022-07-21 17:39

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

| Analyte | Result | RL Units | Spike Level | Source Result | % REC | REC Limit | % RPD | RPD Limit | Qualifier |
|---------|--------|----------|-------------|---------------|-------|-----------|-------|-----------|-----------|
|---------|--------|----------|-------------|---------------|-------|-----------|-------|-----------|-----------|

General Parameters, Batch B2G2038

| | | | | | | | | | |
|-----------------------------------|------|--|------|--|-----|--------|--|----|--|
| Blank (B2G2038-BLK1) | | Prepared: 2022-07-18, Analyzed: 2022-07-18 | | | | | | | |
| Chloride, Water-Soluble | < 20 | 20 mg/kg dry | | | | | | | |
| LCS (B2G2038-BS1) | | Prepared: 2022-07-18, Analyzed: 2022-07-18 | | | | | | | |
| Chloride, Water-Soluble | < 20 | 20 mg/kg dry | 20.0 | | 96 | 80-120 | | | |
| Duplicate (B2G2038-DUP1) | | Source: 22G1700-01 | | Prepared: 2022-07-18, Analyzed: 2022-07-18 | | | | | |
| Chloride, Water-Soluble | < 20 | 20 mg/kg dry | | < 20 | | | | 25 | |
| Matrix Spike (B2G2038-MS1) | | Source: 22G1700-02 | | Prepared: 2022-07-18, Analyzed: 2022-07-18 | | | | | |
| Chloride, Water-Soluble | 581 | 20 mg/kg dry | 499 | < 20 | 113 | 70-130 | | | |

General Parameters, Batch B2G2039

| | | | | | | | | | |
|-----------------------------------|-------|--|------|--|-----|--------|--|----|--|
| Blank (B2G2039-BLK1) | | Prepared: 2022-07-18, Analyzed: 2022-07-19 | | | | | | | |
| Sulfate, Water-Soluble | < 120 | 120 mg/kg dry | | | | | | | |
| Duplicate (B2G2039-DUP1) | | Source: 22G1700-01 | | Prepared: 2022-07-18, Analyzed: 2022-07-19 | | | | | |
| Sulfate, Water-Soluble | 344 | 40 mg/kg dry | | 333 | | | | 40 | |
| Matrix Spike (B2G2039-MS1) | | Source: 22G1700-02 | | Prepared: 2022-07-18, Analyzed: 2022-07-19 | | | | | |
| Sulfate, Water-Soluble | 1790 | 120 mg/kg dry | 1500 | 178 | 107 | 52-119 | | | |

General Parameters, Batch B2G2253



WSP CANADA INC.

100-20339 96 Avenue
Langley, BC V1M 0E4
T: 604.533.2992

Client: Caro Analytical Services Ltd.
Project: Caro Testing

File No.: 201-03094-00
Task: 64

Report of ASTM G57 Soil Resistivity

WO #: WO# 22G1700

Sampled By: Client

Tested By: ARP

Date Sampled: 2022-05-03

Date Tested: 2022-07-21

| Sample ID | As-Received Resistivity (ohm-cm) | As-Received Temperature (°C) | Saturated Resistivity (ohm-cm) | Saturated Temperature (°C) | As-Received Moisture Content (%) | Soil Description |
|-----------------|----------------------------------|------------------------------|--------------------------------|----------------------------|----------------------------------|------------------|
| 22G1700-01A & B | >1,000,000 | 24.4 | 4001 | 24.0 | 3.0 | Brown Silt |
| 22G1700-02A & B | >1,000,000 | 24.5 | 3516 | 24.0 | 8.2 | Brown Silt |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Remarks: _____

Reporting of these results constitutes a testing service only.
No engineering interpretation of the results is expressed or implied.
Engineering review and interpretation of these results can be provided upon written request.

WSP Canada Inc.

Per: _____

Anton Parsons, AScT.



Ministry of
Transportation
and Infrastructure

SUMMARY LOG

Drill Hole #: **TH22-4**

Project: **Canal Road - Pender Island Slide**

Location: Canal Road, South Pender Island, B.C.

Date(s) Drilled: May 3, 2022

Company: Drillwell Enterprises Ltd.

Prepared by: 33450
Thurber Engineering Ltd.

Datum: UTM NAD 83 ZONE 10U

Alignment:

Driller: Tyler Parkhouse

Northing/Easting: 5400717, 483496

Station/Offset:

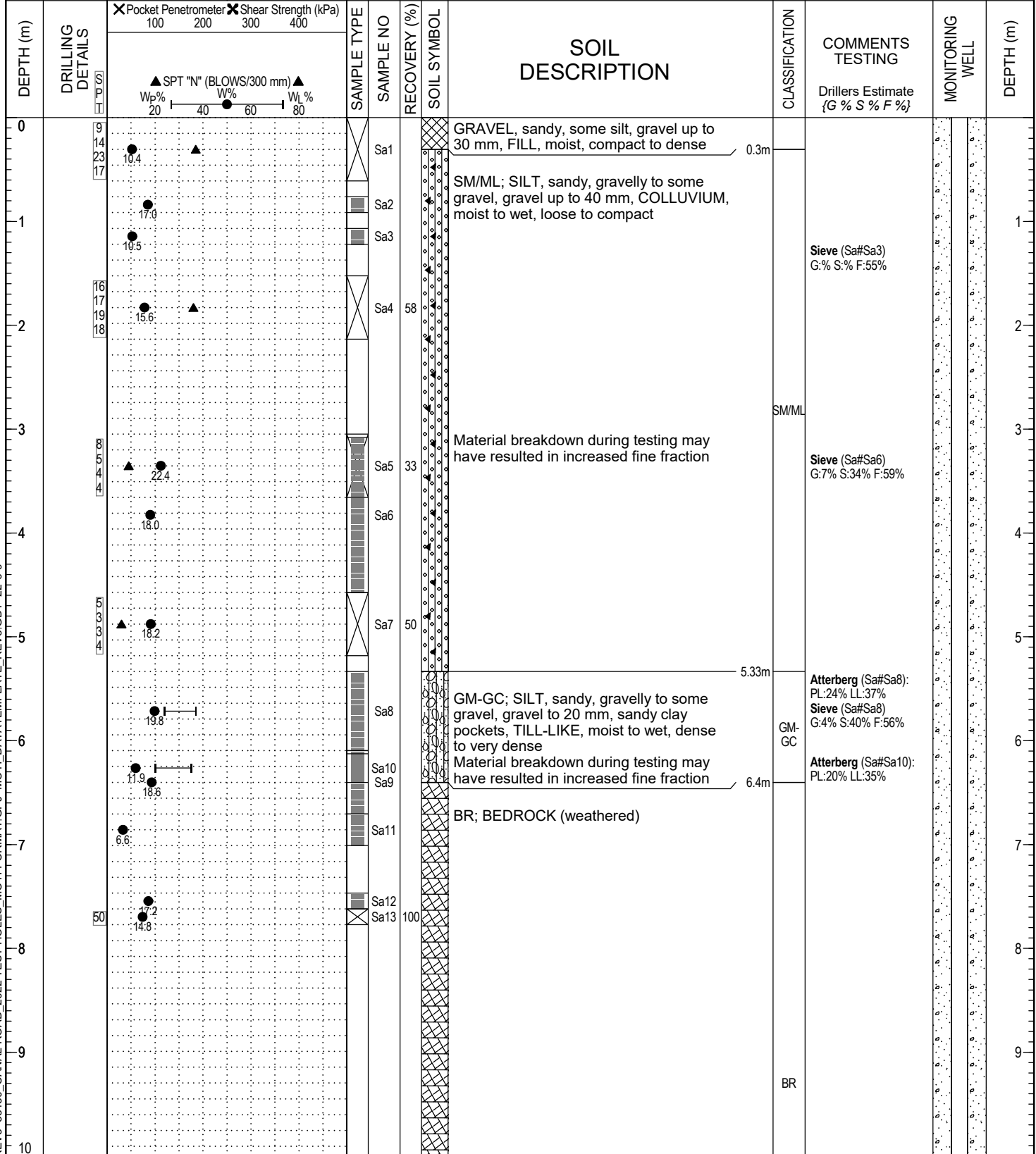
Drill Make/Model: Boart LS250 Sonic

Logged by: KPJ Reviewed by: WRW

Elevation:

Coordinates taken with GPS

Drilling Method: Sonic



MOTI-SOIL-REV3 33450 CANAL ROAD 2022 TEST HOLES MOTI DATATEMPLATE REV3.GDT 22-6-9

Legend
Sample Type: A-Auger, B-Becker, C-Core, G-Grab, V-Vane, L#-Lab Sample, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube

Legend
Installation: Sand, Grout, Cement, Bentonite, Drill Cuttings, Slotted, Slough, Piezometer

Final Depth of Hole: 16.0 m
Depth to Top of Rock: 6.4 m
Page 1 of 2



Ministry of
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SUMMARY LOG

Drill Hole #: **TH22-4**

Prepared by: 33450
Thurber Engineering Ltd.

Project: **Canal Road - Pender Island Slide**
Location: Canal Road, South Pender Island, B.C.

Date(s) Drilled: May 3, 2022
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Datum: UTM NAD 83 ZONE 10U Alignment:
Northing/Easting: 5400717, 483496 Station/Offset:
Elevation: Coordinates taken with GPS

Driller: Tyler Parkhouse
Drill Make/Model: Boart LS250 Sonic
Drilling Method: Sonic

| DEPTH (m) | DRILLING DETAILS | X Pocket Penetrometer | | X Shear Strength (kPa) | | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate {G % S % F %} | MONITORING WELL | DEPTH (m) |
|-----------|----------------------------------|-----------------------|-----|------------------------|-----|-------------|-----------|--------------|-------------|--|----------------|---|-----------------|-----------|
| | | 100 | 200 | 300 | 400 | | | | | | | | | |
| 10 | | | | | | | | | | BR; BEDROCK (weathered) (continued) | | | | |
| 11 | 50 blows / 101.6 mm penetration. | | | | | | Sa14 | 167 | | | | | | |
| 12 | | | | | | | Sa17 | | | | | | | |
| 13 | | | | | | | | | | BR; BEDROCK | | | | |
| 14 | | | | | | | Sa16 | | | | | | | |
| 15 | | | | | | | Sa15 | | | | | | | |
| 16 | | | | | | | Sa18 | | | | | | | |
| 17 | | | | | | | | | | End of Hole at 16.0 m depth. Upon completion of drilling: 50 mm PVC casing installed for SAA installation, backfilled with bentonite-grout. SAA installation on May 16, 2022; Serial Number 247601, active segments from 1.7 m to 16.0 m depth. | | | | |
| 18 | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | |

MOTI-SOIL-REV3 33450 CANAL ROAD 2022 TEST HOLES MOTI FORMAT.GPJ MOTI DATATEMPLATE REV3.GDT 22-6-9

| | | | | | | | | | |
|-------------------------------|---------------|---------------|---------------------|---------------------|---------------|----------------|---------|--------|------------|
| Legend Sample Type: | A-Auger | B-Becker | C-Core | G-Grab | V-Vane | Sand | Grout | Cement | Bentonite |
| | L#-Lab Sample | S-Split Spoon | O-Odex (air rotary) | W-Wash (mud return) | T-Shelby Tube | Drill Cuttings | Slotted | Slough | Piezometer |

Final Depth of Hole: 16.0 m
Depth to Top of Rock: 6.4 m
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