



**Foundations,
Excavation &
Shoring
Specialists**

February 15, 2024
Reference: 23-9650

Via email: ARobertson@islengineering.com

ISL Engineering and Land Services Ltd.
#503 - 4190 Lougheed Highway
Burnaby, BC V5C 6A8

Attn: Andrew Robertson, BCSLA, CSLA, LEED AP

Re: Geotechnical Exploration Report
Minoru Park Ditch Improvements
Minoru Park, Richmond, BC

Braun Geotechnical
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Foundations

**Excavation &
Shoring**

Slope Stability

Natural Hazards

**Pavement Design
and Management**

**Reinforced Soil
Walls and Slopes**

1.0 INTRODUCTION

As requested, Braun Geotechnical Ltd. (BGL) has completed a geotechnical exploration and assessment for the above referenced project. The geotechnical work has been performed in general accordance with Braun’s Proposal (Ref. P22-7798) dated May 3, 2022. The scope of work included an intrusive test hole exploration program and provision of geotechnical recommendations in support of design and construction for the proposed Minoru Park Ditch Improvements project.

The scope of services was limited to the evaluation of geotechnical characteristics at the site and no consideration has been given to any environmental aspects.

2.0 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

Minoru Park is an approximately 160-acre park located at 7191 Granville Avenue, Richmond, BC. The existing park contains man-made lakes, sports fields, asphalt paved parking, and asphalt pathways. Details of the proposed Minoru Park Ditch Improvements project were provided on drawings “Minoru Park Ditch Improvements” prepared by ISL Engineering and Land Services Ltd. dated July 27, 2023. The project is located adjacent to the recently completed Minoru Lakes Renewal Project.

3.0 DESK STUDY REVIEW

The Desk Study was non-intrusive in nature and involved review of available geological and geotechnical information.

Review of available published and in-house geological information indicated that the study site area is generally underlain by Fraser River Sediments comprising overbank silty to silt clay loam normally less than 2 m thick overlying 15 m or more of interbedded fine to medium sand and minor silt beds (Figure 1).

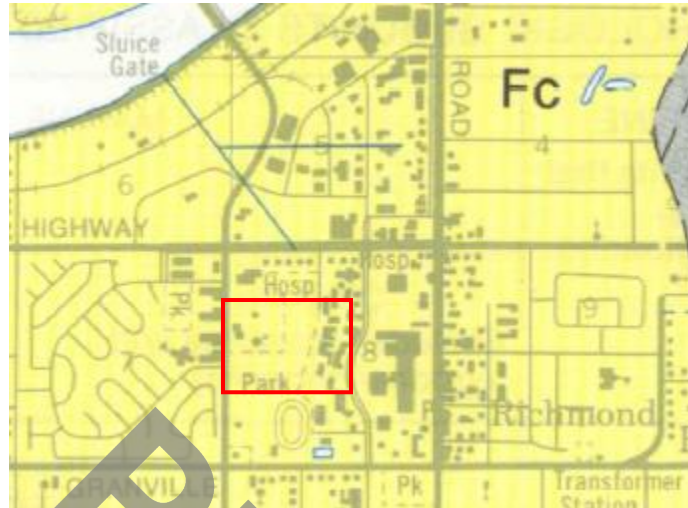


Figure 1 - Surficial Geology (Geological Survey of Canada)

4.0 EXPLORATION & TESTING

Three test holes (TH23-01 to -03) were drilled along the south edge of the ditch on September 12, 2023 using a truck mounted drill rig under subcontract to BGL. The test holes were advanced to depths of 9.1 m to 10.7 m within accessible areas. The approximate test hole locations are shown on the enclosed Location Plan (Dwg. no. 23-9650-01). Subsurface conditions were logged in the field by BGL. Soil samples were retrieved from the auger flights and returned to our laboratory for visual classification and moisture content testing.

5.0 SOIL AND GROUNDWATER CONDITIONS

The findings of the test hole exploration are provided on the attached test hole logs and should be referred to for detailed subsurface conditions at test locations. A generalized subsoil profile based on the test holes is provided below:

FILL/ORGANICS

Fill, including brown, damp, loose SAND with some silt to silty SAND to firm sandy SILT with trace to some organics and occasional root/rootlets was encountered below the existing grass within each test hole to depths of 0.2 to 1.4 m.

SILT/Silty SAND/Sandy SILT

Brown, occasionally rust mottled, damp, stiff SILT with some sand and some organic fibres was encountered within TH23-02 to the depth of 1.0 m.

Grey-brown to grey, occasionally rust-mottled, moist, firm SILT with trace to some sand to sandy SILT, with trace to some clay and some organics was encountered below within each test hole to depths of 2.3 to 4.3 m.

Grey, wet, loose to compact silty SAND to firm sandy SILT was encountered below within TH23-01 & -02 to depths of 3.0 m.

SAND

Grey, wet, loose to compact, SAND with trace to some silt was encountered within test holes to the depth of exploration at 9.1 to 10.7 m.

GROUNDWATER

Groundwater was observed within all test holes at the depths of 2.4 to 3.0 m at the time of exploration. Groundwater levels and near-surface run-off flows are expected to fluctuate seasonally, and with drainage conditions.

The subsurface conditions described above were encountered at the test hole locations only. Subsurface conditions at other locations could vary.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

The subsurface exploration generally encountered near surface fill/organics over firm to stiff silt overlying compact sand. It is anticipated the proposed boardwalk structures can supported on the shallow foundations founded on firm to stiff silt and/or compact sand. A minimum 300 mm thick zone of high friction structural fill encapsulated in non-woven geotextile (Terrafix 360R or approved equivalent) should be provided below footings for improving bearing resistance.

The following sections provide geotechnical recommendations for the project.

6.2 Site Preparation

Site preparation below any pavement areas and/or hardscaped surfaces should include removal of vegetation, surficial organics, water softened soils, and other deleterious materials to reveal the natural silt subgrade that is substantially free of organics.

Where granular fill is exposed at subgrade, the fill should typically be compacted to a minimum of 95% Modified Proctor Density (MPD). Existing fills that cannot achieve satisfactory compaction may require removal and replacement.

Drainage measures should be implemented to reduce potential for water ponding on exposed subgrades. Temporary and final grades should be established so as to avoid uncontrolled offsite discharge of surface and/or near-surface run-off flows.

The natural soils are susceptible to softening and disturbance from construction equipment traffic. It is preferable that construction be carried out such that heavy equipment would not travel on the base of the completed excavations. Final trimming to design subgrade should be carried out using excavator equipment equipped with a clean-out bucket.

Stripped subgrade should be field reviewed by Braun Geotechnical.

As above subgrade preparation for shallow foundations should include excavation and replacement with a zone of granular structural fill that is encapsulated in a geotextile.

6.3 Temporary Dewatering

It is anticipated that excavations that are less than approximately 2.4 m in depth could be kept free of standing water using conventional sump and pump methods. Temporary dewatering for deeper excavation below the semi-static water level encountered at an approximate depth of 2.4 to 3.0 m would be more difficult to achieve and would likely require the use of well points and/or heavy pumping from within the excavation. Final dewatering requirements should be determined by a qualified geotechnical engineer retained by the contractor.

6.4 Structural Fill

General structural fill for establishing subgrade within elevated pathway areas should typically consist of clean, free draining well graded sand and gravel sand with less than 5% fines (percent

passing the #200 sieve). Structural fill should be placed and compacted in maximum 300 mm loose lifts with each lift compacted to at least 95% Modified Proctor Density (MPD). Structural fills should extend beyond the edges of the proposed structures a distance equal to the depth of confined structural fill. Note that unconfined structural fill (i.e. sloping surface grades) should extend beyond the edges of the proposed structures by a distance at least twice the depth of unconfined structural fill.

Density testing during site fill placement should be carried out on a regular basis to confirm adequacy of compaction, and the results forwarded to the Geotechnical Consultant for review.

6.5 Slopes

For the proposed detention pond the recommended maximum permanent cut slope angle is 1H:1V (Horizontal: Vertical). It is understood that the detention pond slope consists of compacted 19 mm minus crushed granular base below stacked boulders separated by non-woven geotextile (Terrafix 360R or approved equivalent and clay geotextile liner would be provided between natural subgrade and compacted structural fill.

Any deterioration of slopes should be immediately reported to the Braun Geotechnical. Based on our review, recommendations for stabilization will be provided which may include flattening of the slopes in addition to other possible mitigative measures.

6.6 Boardwalk/Pedestrian Bridge

It is understood that a short span and lightly loaded pedestrian bridge and/or boardwalk structures could likely be founded using grade supported footings (or pre-cast block foundations), with the structures detailed to accommodate some total/differential settlement.

Alternatively, helical piles supporting bridge/boardwalks could be designed as end bearing piles with the helix assembly embedded into the underlying compact sand below about 6 m. It is noted that equipment mobilized to site for helical piles often has a relatively small footprint capable of advancing piles in close proximity to existing structures with low potential for construction vibrations of concern.

Based on our discussion with ISL Engineering and Land Services Ltd., it is understood that the grade supported concrete footings or pre-cast block foundations is preferred foundation option for the lightly loaded pedestrian bridge and/or boardwalk structures. Shallow foundations were used previously for support of boardwalk elements for the recently completed Minoru Pond rehabilitation project.

6.7 Foundation Design

Foundations for the proposed structures may be supported on a minimum 300 mm thick zone of high friction structure fill over natural firm silt/compact sand. The following soil resistance (bearing) values may be adopted for preliminary foundation design:

Foundation Subgrade	Limit States Design		Working Stress Design
	Factored Ultimate Bearing Resistance	Serviceability Limit State	Allowable Bearing Pressure DL + LL
Firm to Stiff SILT/Compact SAND and/or compacted STRUCTURAL FILL	110 kPa (2300 psf)	75 kPa (1550 psf)	75 kPa (1550 psf)

Note: Larger bearing values may be feasible for specific foundation configurations and can be reviewed upon request.

The above design bearing pressures for soil subgrade assume the following:

- Strip and pad footings have minimum widths of 450 mm (18”) and 600 mm (24”), respectively.
- Footings are founded at least 450 mm (18”) below final finished adjacent grade.
- Site preparation is completed as indicated above and load-bearing surfaces are reviewed and approved by the Geotechnical Engineer.
- Foundation bearing surfaces are no higher than 2H:1V (Horizontal to Vertical) from the base or toe of adjacent walls, retaining structures, etc.
- Footings are placed below a 1H:1V line projected up from lower footings or buried structures such as utility lines, sumps, etc.
- Silty subgrade areas are protected immediately after exposure.

Foundation bearing surfaces should be reviewed by a Geotechnical Engineer. Any soft, wet, or deleterious material encountered at bearing surface level should be sub-excavated and replaced with structural fill compacted in maximum 300 mm thick lifts to at least 95% MPD.

The natural sand encountered within the test holes is considered susceptible to liquefaction during the design earthquake event. The silt is also considered to be potentially susceptible to cyclic softening due to design seismic event. Typically, liquefaction and soil cyclic softening could result in partial to total loss of foundation support under conventional footings, and horizontal and vertical movements.

Lateral movements in the order of 0.5 m and surface settlements of approximately 0.1 m are estimated. Note that the above values for lateral movements and surface settlements are estimates and could vary based on actual subsurface conditions and seismic shaking intensity. Proposed structures should be designed to accommodate estimated movements without collapse.

6.8 Asphalt Pavement Design Sections

The minimum recommended pavement structure completed on structural fills for the proposed asphalt pathways is provided as follows:

Minimum Thickness	Material
75 mm	Asphaltic Concrete Surface (MMCD Hot Mix Asphalt UC#2)
230 mm	19mm minus Granular Base (MMCD Sec. 31 05 17 2.10)

Asphalt surfacing should be placed in two lifts of 50 mm and 25 mm for the base and surface layers and may comprise MMCD compliant Lower Course #2 and Upper Course #2, respectively. The gradation of the above materials should comply with the appropriate Master Municipal Specifications. Construction materials should be placed and compacted in compliance with the current MMCD specifications.

7.0 GEOTECHNICAL RECOMMENDATIONS-DITCH SLOPE STABILIZATION

Based on the preliminary drawings provided, it is understood that the proposed ditch improvement includes ditch widening which includes south embankment slope reconstruction with options of placement of fractured rock on the slope and/or vegetated slope along the length of the ditch. Placement of embankment retention boulder is included on the north embankment toe of slope along the entirety of the ditch.

The ditch slope stabilization approach utilized is considered appropriate with respect to the geotechnical considerations.

8.0 GEOTECHNICAL FIELD REVIEW

During construction, geotechnical field reviews are required by the Geotechnical Engineer to confirm that the recommendations of the report are understood and followed. Geotechnical field reviews and materials testing services should be arranged by the Contractor to address the following, as required:

- Soil and groundwater conditions;
- Temporary excavation cut slopes;
- Suitability of exposed subgrade;
- Review and density testing of structural fills;
- Placement and compaction of pavement section materials;
- Asphalt hot mix field sampling and Mix Design testing;
- Retrieval of asphalt cores for thickness and density.

9.0 CLOSURE

This report is prepared for the exclusive use of ISL Engineering and Land Services Ltd. and their designated representatives and may not be used by other parties without the written permission of Braun Geotechnical Ltd. The City of Richmond may rely on the findings of this geotechnical report.

If during construction soil conditions are noted to be different from those described in this report, Braun Geotechnical must be notified immediately in order that the geotechnical recommendations can be confirmed or modified, if required. Further, this report assumes that field reviews will be completed by Braun Geotechnical during construction.

The site contractor should make their own assessment of subsurface conditions and select the construction means and methods most appropriate to the site conditions.

This report should not be included in the specifications without suitable qualifications approved by the geotechnical engineer.

The use of this report is subject to the Report Interpretation and Limitations, which is included with the report. The reader's attention is drawn specifically to those conditions, as it is considered essential that they be followed for proper use and interpretation of this report.

We hope the above meets with your requirements. Should any questions arise, please do not hesitate to contact the undersigned.

Yours truly,

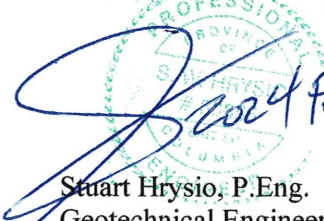
Braun Geotechnical Ltd.

Avinder Singh Cheema
- Feb 26, 2024

Avninder Singh Cheema, EIT
Geotechnical Engineer

Braun Geotechnical Ltd.

Stuart Hrysiu
2024 Feb 26



Stuart Hrysiu, P.Eng.
Geotechnical Engineer

Encl: Report Interpretation and Limitations
Location Plan
Test Hole Logs

X:\2023 Projects\23-9650 Minoru Ditch Improvement Project - 7191 Granville Avenue, Richmond, BC\Report\23-9650 Geotechnical Report 2024-02-15.docx

REPORT INTERPRETATION AND LIMITATIONS

1. STANDARD OF CARE

Braun Geotechnical Ltd. (Braun) has prepared this report in a manner consistent with generally accepted engineering consulting practices in this area, subject to the time and physical constraints applicable. No other warranty, expressed or implied, is made.

2. COMPLETENESS OF THIS REPORT

This Report represents a summary of paper, electronic and other documents, records, data and files and is not intended to stand alone without reference to the instructions given to Braun by the Client, communications between Braun and the Client, and/or to any other reports, writings, proposals or documents prepared by Braun for the Client relating to the specific site described herein.

This report is intended to be used and quoted in its entirety. Any references to this report must include the whole of the report and any appendices or supporting material. Braun cannot be responsible for use by any party of portions of this report without reference to the entire report.

3. BASIS OF THIS REPORT

This report has been prepared for the specific site, development, design objective, and purpose described to Braun by the Client or the Client's Representatives or Consultants. The applicability and reliability of any of the factual data, findings, recommendations or opinions expressed in this document pertain to a specific project as described in this report and are not applicable to any other project or site, and are valid only to the extent that there has been no material alteration to or variation from any of the descriptions provided to Braun. Braun cannot be responsible for use of this report, or portions thereof, unless we were specifically requested by the Client to review and revise the Report in light of any alterations or variations to the project description provided by the Client.

If the project does not commence within 18 months of the report date, the report may become invalid and further review may be required.

The recommendations of this report should only be used for design. The extent of exploration including number of test pits or test holes necessary to thoroughly investigate the site for conditions that may affect construction costs will generally be greater than that required for design purposes. Contractors should rely upon their own explorations and interpretation of the factual data provided for costing purposes, equipment requirements, construction techniques, or to establish project schedule.

The information provided in this report is based on limited exploration, for a specific project scope. Braun cannot accept responsibility for independent conclusions, interpretations, interpolations or decisions by the Client or others based on information contained in this Report. This restriction of liability includes decisions made to purchase or sell land.

4. USE OF THIS REPORT

The contents of this report, including plans, data, drawings and all other documents including electronic and hard copies remain the copyright property of Braun. However, we will consider any reasonable request by the Client to approve the use of this report by other parties as "Approved Users." With regard to the duplication and distribution of this Report or its contents, we authorize only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of this Report by those parties. The Client and "Approved Users" may not give, lend, sell or otherwise make this Report or any portion thereof available to any other party without express written permission from Braun. Any use which a third party makes of this Report – in its entirety or portions thereof – is the sole responsibility of such third parties. BRAUN GEOTECHNICAL LTD. ACCEPTS NO RESPONSIBILITY FOR DAMAGES SUFFERED BY ANY PARTY RESULTING FROM THE UNAUTHORIZED USE OF THIS REPORT.

Electronic media is susceptible to unauthorized modification or unintended alteration, and the Client should not rely on electronic versions of reports or other documents. All documents should be obtained directly from Braun.

5. INTERPRETATION OF THIS REPORT

Classification and identification of soils and rock and other geological units, including groundwater conditions have been based on exploration(s) performed in accordance with the standards set out in Paragraph 1. These tasks are judgemental in nature; despite comprehensive sampling and testing programs properly performed by experienced personnel with the appropriate equipment, some conditions may elude detection. As such, all explorations involve an inherent risk that some conditions will not be detected.

Further, all documents or records summarizing such exploration will be based on assumptions of what exists between the actual points sampled at the time of the site exploration. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of and accept this risk.

The Client and "Approved Users" accept that subsurface conditions may change with time and this report only represents the soil conditions encountered at the time of exploration and/or review. Soil and ground water conditions may change due to construction activity on the site or on adjacent sites, and also from other causes, including climactic conditions.

The exploration and review provided in this report were for geotechnical purposes only. Environmental aspects of soil and groundwater have not been included in the exploration or review, or addressed in any other way.

The exploration and Report is based on information provided by the Client or the Client's Consultants, and conditions observed at the time of our site reconnaissance or exploration. Braun has relied in good faith upon all information provided. Accordingly, Braun cannot accept responsibility for inaccuracies, misstatements, omissions, or deficiencies in this Report resulting from misstatements, omissions, misrepresentations or fraudulent acts of persons or sources providing this information.

6. DESIGN AND CONSTRUCTION REVIEW

This report assumes that Braun will be retained to work and coordinate design and construction with other Design Professionals and the Contractor. Further, it is assumed that Braun will be retained to provide field reviews during construction to confirm adherence to building code guidelines and generally accepted engineering practices, and the recommendations provided in this report. Field services recommended for the project represent the minimum necessary to confirm that the work is being carried out in general conformance with Braun's recommendations and generally accepted engineering standards. It is the Client's or the Client's Contractor's responsibility to provide timely notice to Braun to carry out site reviews. The Client acknowledges that unsatisfactory or unsafe conditions may be missed by intermittent site reviews by Braun. Accordingly, it is the Client's or Client's Contractor's responsibility to inform Braun of any such conditions.

Work that is covered prior to review by Braun may have to be re-exposed at considerable cost to the Client. Review of all Geotechnical aspects of the project are required for submittal of unconditional Letters of Assurance to regulatory authorities. The site reviews are not carried out for the benefit of the Contractor(s) and therefore do not in any way effect the Contractor(s) obligations to perform under the terms of his/her Contract.

7. SAMPLE DISPOSAL

Braun will dispose of all samples 1 month after issuance of this report, or after a longer period of time at the Client's expense if requested by the Client. All contaminated samples remain the property of the Client and it will be the Client's responsibility to dispose of them properly.

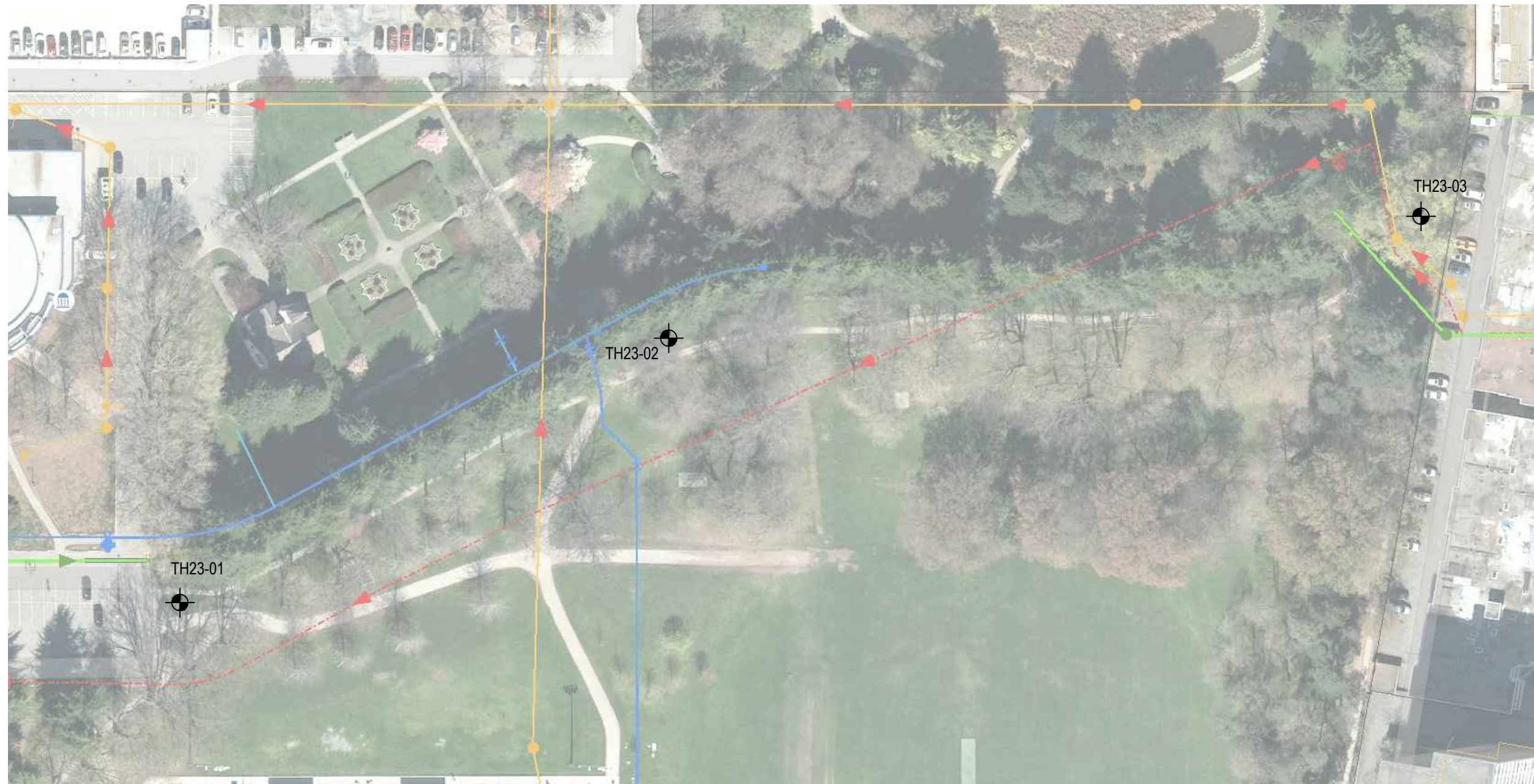
8. SUBCONSULTANTS AND CONTRACTORS

Engineering studies frequently require hiring the services of individuals and companies with special expertise and/or services which Braun does not provide. These services are arranged as a convenience to our Clients, for the Client's benefit. Accordingly, the Client agrees to hold the Company harmless and to indemnify and defend Braun from and against all claims arising through such Subconsultants or Contractors as though the Client had retained those services directly. This includes responsibility for payment of services rendered and the pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. These conditions apply to specialized subconsultants and the use of drilling, excavation and laboratory testing services, and any other Subconsultant or Contractor.

9. SITE SAFETY

Braun assumes responsibility for site safety solely for the activities of our employees on the jobsite. The Client or any Contractors on the site will be responsible for their own personnel. The Client or his representatives, Contractors or others retain control of the site. It is the Client's or the Client's Contractors responsibility to inform Braun of conditions pertaining to the safety and security of the site – hazardous or otherwise – of which the Client or Contractor is aware.

Exploration or construction activities could uncover previously unknown hazardous conditions, materials, or substances that may result in the necessity to undertake emergency procedures to protect workers, the public or the environment. Additional work may be required that is outside of any previously established budget(s). The Client agrees to reimburse Braun for fees and expenses resulting from such discoveries. The Client acknowledges that some discoveries require that certain regulatory bodies be informed. The Client agrees that notification to such bodies by Braun will not be a cause for either action or dispute.



BASE IMAGE OBTAINED FROM RICHMOND WEBMAP

LEGEND	
TH23-01	2023 TEST HOLE APPROXIMATE LOCATION


	Rev.	Description	Date	Client	ISL Engineering & Land Services Ltd.				Title LOCATION PLAN		
				Project	Minoru Ditch Improvement Project Minoru Park, Richmond, BC						
				Project no.	Drawn	Design	Checked	Date	Scale	Drawing no.	
				23-9650	DD	AC	SH	August 9, 2023	1:1000	23-9650-01	

Test Hole Log: TH23-01

File: 23-9650
 Project: Minoru Ditch Improvement Project
 Client: ISL Engineering & Land Services Ltd.
 Location: Minoru Park, Richmond, BC



PTP# 1002594

Depth	Thickness (mm)	Sample	Soil Description	Sample #	Water cont.	Remarks
0	0		GRASS OVER			
ft	m	○	brown, damp, loose SAND, some silt, occasional root/rootlets (FILL)	S1	15%	 Water Level (at time of drilling)
		○	dark-brown, damp, loose SAND, some silt to silty SAND, trace organics (FILL)	S2	24%	
1		○		S3	59%	
		○	brown, moist, firm SILT, some sand, trace clay, occasional organic fibres	S4	57%	
5		○	grey, moist, firm SILT, some clay, trace to some sand	S5	46%	
		○		S6	35%	
2		○	grey, wet, loose, silty SAND to firm sandy SILT	S7	28%	
		○	grey, wet, compact SAND, trace to some silt	S8		
10		○		S9		
		○		S10		
15		○		S11		
		○		S12		
20		○		S13		
25		○				
30		○				
35		○				
			End of Test Hole @ 10.7m			


PREVIEW
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Test Hole Log: TH23-02

File: 23-9650
 Project: Minoru Ditch Improvement Project
 Client: ISL Engineering & Land Services Ltd.
 Location: Minoru Park, Richmond, BC



PTP# 1002594

Depth	Thickness (mm)	Sample	Soil Description	Sample #	Water cont.	Remarks	
0	0		GRASS OVER				
ft	m						
		○	brown, damp, firm, sandy SILT, some organics, occasional root/rootlets (FILL/ORGANICS)	S1	4%	 Water Level (at time of drilling)	
	1	○	brown, occasionally rust-mottled, damp, stiff SILT, some sand, some organic fibres	S2	41%		
5		○	grey, moist, firm SILT, some sand, trace clay, trace organic fibres	S3	46%		
	2	○		S4	39%		
		○	grey, wet, loose to compact, silty SAND - poor recovery below 2.4m	S5	29%		
10	3	○	grey, wet, loose to compact SAND, trace to some silt	S6			
	4	○		S7			- poor recovery from 4.0m to 4.6m
15			- trace silt below 4.6m				
	5	○		S8			
20	6						
	7	○		S9			
25		○		S10			
	8	○		S11			
30	9	○		S12			
	10	○					
35	11		End of Test Hole @ 10.7m				

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