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May 9, 2022

Twyn Rivers DUA and Trails

Addendum #4

Included in this addendum:

Clarification:

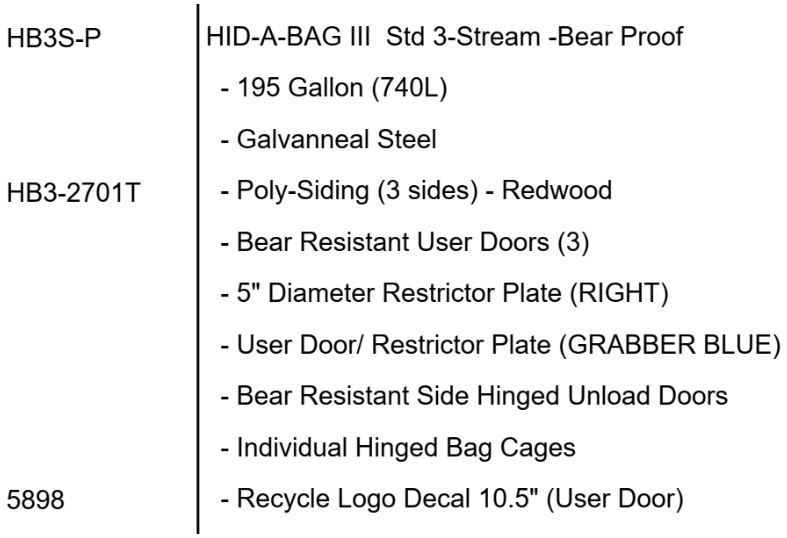
1. Delete “decking, framing and” from the title of detail 2/S-004 and revise title to: Typical Pile Layout for Boardwalk.

Questions and Answers:

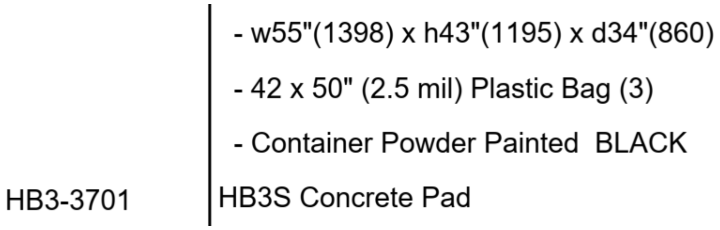
14. The specified vendor for the Haul All Waste receptacles has asked for clarification on the make/model as well as what options are needed (decals, type of siding & restrictor plate, etc), please provide. Apparently, the specified units are different from what was previously purchased by Parks Canada for this site?

Answer: The following information can be included to the garbage unit specification

2. GARBAGE UNITS
   1. Haul-all Series
      a. Haul All Equipment Systems, HB3S-P, powder coat Black, with decals and with HB3-3701 HB3S Concrete Pad Assembly, or approved equal.
      b. Contractor to supply and install units and concrete pads.



HB3S-P	HID-A-BAG III Std 3-Stream -Bear Proof
	- 195 Gallon (740L)
	- Galvanneal Steel
HB3-2701T	- Poly-Siding (3 sides) - Redwood
	- Bear Resistant User Doors (3)
	- 5" Diameter Restrictor Plate (RIGHT)
	- User Door/ Restrictor Plate (GRABBER BLUE)
	- Bear Resistant Side Hinged Unload Doors
	- Individual Hinged Bag Cages
5898	- Recycle Logo Decal 10.5" (User Door)



	- w55"(1398) x h43"(1195) x d34"(860)
	- 42 x 50" (2.5 mil) Plastic Bag (3)
	- Container Powder Painted BLACK
HB3-3701	HB3S Concrete Pad

15. Regarding the bridges; The clear width on the drawings state 2.4m, however the loading states maintenance truck 80kN (80kN loading comes with 3m clear width as per bridge code). Should we bid 3m clear for the 80kN loading or ignore the loading and bid the 2.4m clear?

Answer: Under review.

16. Regarding the white cedar lumber; The specifications state lumber is to meet FSC criteria, and with the current supply chain issues it will be challenging to find lumber which meets this criteria. Is non-FSC lumber acceptable?

Answer: Given the current situation, yes, non-FSC lumber is acceptable.

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GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE April 29, 2022

Project No. 21476761 (1000)

TO Mr. Connor Blaikie, BLA, OALA, CSLA.
WSP Canada Inc.

FROM Anastasia Poliacik
Sarah Poot

EMAIL apoliacik@golder.com
spootr@golder.com

GEOTECHNICAL INVESTIGATION
PROPOSED PEDESTRIAN BRIDGE AND PARKING LOT AT ROUGE NATIONAL URBAN PARK
55 TWYN RIVERS DRIVE, TORONTO, ONTARIO

Dear Mr. Blaikie,

Golder Associates Ltd. (Golder) was requested by WSP Canada Inc. (WSP) to carry out a geotechnical investigation for a proposed pedestrian bridge and parking lot to be located at 55 Twyn Rivers Drive in the City of Toronto, Ontario (the site). The general location of the site is shown on the Key Plan, Figure 1 (attached).

The purpose of this technical memorandum is to summarize the subsurface conditions (soil and groundwater) encountered within the boreholes drilled at site and to provide geotechnical recommendations for the pedestrian bridge foundations and asphalt pavement construction.

The factual data, interpretations and recommendations contained in this technical memorandum pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location, or elevation, or if the project is not initiated within eighteen months of the date of the report, Golder should be given an opportunity to confirm that the recommendations are still valid. In addition, this memorandum should be read in conjunction with the attached "*Important Information and Limitations of This Report*" which are included in Appendix A. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this memorandum.

It should be noted that this memorandum addresses only the geotechnical (physical) aspects of the subsurface conditions at the site. The geo-environmental (chemical) aspects, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources, are beyond the terms of reference for this assignment and are not addressed herein.

1.0 SITE AND PROJECT DESCRIPTION

The site is located within the Rouge National Urban Park at the north and west sides of Twyn Rivers Drive in Toronto, Ontario. In general, the site slopes downward from the north and south sides of the proposed bridge abutment locations towards the creek.

It is understood that a parking lot and two pedestrian bridges are proposed at the locations shown on Figure 2 at 55 Twyn Rivers Drive. Also, the east pedestrian bridge (south of the proposed parking lot) and the west pedestrian bridge (west of the proposed parking lot) will be built over the Little Rouge Creek.

Presently, the eastern portion of the proposed parking lot envelope is being utilized as an unpaved parking. In addition, dense vegetation was observed around the proposed pedestrian bridge locations including unpaved paths. It is our understanding that a structure was previously located at the southeast quadrant of the existing unpaved parking which was demolished and backfilled. The demolished structure footprint and backfilled area are beyond the footprint of the proposed parking lot.

2.0 INVESTIGATION PROCEDURES

The geotechnical field investigation for this assignment was carried out between September 20 and October 6, 2021, during which time eleven boreholes, designated as Boreholes 21-1B and 21-11B, were advanced to depths ranging from about 1.4 m to 9.3 m below ground surface (mbgs). The approximate borehole locations are shown on the Borehole Location Plan, Figure 2.

Boreholes 21-1B to 21-8B were advanced using a PowerProbe 9570 track-mounted drill rig supplied and operated by Golder. However, Boreholes 21-9B, 21-10B and 21-11B were advanced using a tripod mounted equipment with a rope and cathead hammer, supplied and operated by Walker Drilling of Utopia, Ontario and contracted by Golder.

Standard penetration testing (SPT) and the soil samples recovered from the boreholes were obtained at regular intervals of depth using 50 mm outer diameter split spoon samplers driven by a conventional automatic and manual hammer in accordance with ASTM International standard D1586: "*Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*". The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 38 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented. The results of the in-situ field testing (i.e., SPT 'N' values) as presented on the Record of Borehole sheets and in Section 3.2 are the values measured directly in the field and are unfactored.

SPT was not carried out in Boreholes 21-5B to 21-7B as these boreholes were only utilized for environmental purposes. Auger refusal was reached in Boreholes 21-4B to 21-11B on inferred shale bedrock.

Groundwater conditions were noted in the open boreholes during and upon completion of drilling. A total of seven monitoring wells were installed in Borehole 21-4B to 21-6B adjacent to the parking lot and Boreholes 21-8B to 21-11B at the proposed pedestrian bridge to allow for subsequent monitoring of the groundwater levels. Upon completion of drilling, sampling and installations, the boreholes were backfilled in accordance with the requirements of the Revised Regulations of Ontario (R.R.O.) 1990, Regulation 903 (as amended) of the Ontario Water Resources Act.

The fieldwork was directed by a member of our technical staff who also observed the drilling, sampling and in-situ testing operations, logged the boreholes, and examined and took custody of the recovered soil samples. The samples were identified in the field, placed in appropriate containers, labelled, and transported to our office for further examination and geotechnical laboratory testing. Index and classification tests, consisting of water content determinations as well as gradation analyses were carried out on the recovered soil samples. The results of the geotechnical laboratory tests are presented on Figures 3 to 5 and on the Record of Borehole sheets.

The borehole locations were determined by Golder staff based on existing site features/structures and should be considered approximate. The ground surface elevations at each borehole location were extrapolated from a survey drawing provided by WSP and should be considered approximate.

3.0 SITE GEOLOGY AND STRATIGRAPHY

3.1 Regional Geology

The surficial geology aspects of the general site area are referenced from: Chapman, L.J., and Putnam, D.F., 2007, “The Physiography of Southern Ontario”; 4th Edition, Ontario Geological Survey. Based on the physiographic mapping tor the vicinity of the site, the site lies within the physiographic region of Southern Ontario known as the South Slope.

The South Slope region slopes gradually downward towards Lake Ontario. The overburden immediately below ground surface within the South Slope generally consists of clayey silt till and silty clay till and at depth consists of alternating deposits of dense lacustrine sands and silts and overconsolidated lacustrine clays and clay tills overlying the bedrock. The stratigraphy encountered in the boreholes drilled as a part of this investigation indicates shallow surface soils overlying shale bedrock.

3.2 Subsurface Conditions

The subsurface soil and shallow groundwater conditions encountered in the boreholes, as well as the results of the field and laboratory testing are shown on the Record of Borehole sheets and on Figures 3 to 5. Also included, are sheets presenting the Method of Soil Classification, and Abbreviations and Symbols to assist in the interpretation of the borehole logs.

The Record of Borehole sheets indicate the subsurface conditions at the borehole locations only. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress, as well as results of the Standard Penetration Tests, and generally represent transitions from one soil type to another rather than exact planes of geological change. Further, the subsurface conditions will vary between and beyond the borehole locations and across the site and caution should be used when interpolating and extrapolating subsurface conditions between and beyond the borehole locations. The following provides an overview of the subsurface soil and groundwater conditions encountered in the boreholes advanced during this investigation, followed by more detailed descriptions of the major soil strata, and groundwater conditions.

In general, the subsurface conditions within the site consisted of topsoil and non-cohesive fill underlain by organic silt, non-cohesive deposits, residual soil, and inferred shale bedrock. The following is a detailed description of the major soil strata encountered during the geotechnical investigation.

3.2.1 Topsoil

Topsoil, with approximate thicknesses ranging between 50 mm and 460 mm, was encountered at the ground surface in Boreholes 21-1B, 21-7B to 21-11B. Topsoil was not encountered in the remaining boreholes mostly located within the existing unpaved parking lot.

Materials designated as topsoil in this report were classified based solely on visual and textural evidence. Testing of organic content, pH, alkalinity, acidity or for other soil nutrients was not carried out. Accordingly, materials classified as topsoil herein cannot necessarily be relied upon for the support and growth of landscaping vegetation without supplemental soil fertility analyses.

3.2.2 Fill

Non-cohesive fill consisting of gravelly sand to gravelly silty sand to silty sand was encountered at ground surface in Boreholes 21-1B to 21-6B. The fill materials encountered in Boreholes 21-1B, 21-2B and 21-4B were observed to be the granular base material used for the existing parking surface. The remainder of the existing fill encountered in Borehole 21-5B contained waste, bricks, and geofabric between depths of about 1.1 m and 1.4 mbgs.

The SPT 'N'-values measured within the non-cohesive fill ranged from about 19 blows to 89 blows per 0.3 m of penetration, indicating a compact to very dense state of compactness.

A grain size distribution curve for a sample of the gravelly silty sand fill is shown on Figure 3. The natural water contents measured on three samples of the non-cohesive fill were between about 2 percent and 6 percent.

3.2.3 Organic Silt

An organic silt deposit, containing a trace of gravel was encountered in Boreholes 21-1B, and 21-2B underlying the non-cohesive fill.

Two SPT 'N'-values of 3 blows and 6 blows per 0.3 m of penetration were measured within the organic silt deposit, indicating a soft to firm state of compactness. The natural water content measured on a single sample of sample of the organic silt was about 39 percent.

3.2.4 Silty Sand

Non-cohesive deposits ranging in composition from gravelly silty sand to silty sand, trace gravel to some gravel was encountered in Boreholes 21-1B, and 21-7B to 21-11B. Organic inclusions such as rootlets were observed within the upper layer of the silty sand deposit in Borehole 21-9B.

The presence of cobbles and/or boulders in the silty sand deposit can be inferred from auger grinding and the split-spoon sampler not advancing the full sample depth at some sample locations.

The SPT 'N'-values measured within the silty sand deposit ranged widely from 3 blows per 0.3 m of penetration to 50 blows per 0.13 m of penetration, indicating a very loose to very dense state of compactness, but predominantly being compact to very dense. The natural water contents measured on samples of the silty sand deposit ranged from about 4 percent to 15 percent.

3.2.5 Sand and Gravel, Sandy Silty Gravel, Sandy Gravel, and Gravel

Non-cohesive deposits ranging in composition from sand and gravel to gravel were encountered in Boreholes 21-2B, 21-3B, 21-6B, 21-7B, 21-9B and 21-11B, underlying topsoil or non-cohesive fill.

The presence of cobbles and/or boulders in these non-cohesive deposits can be inferred from auger grinding and the split-spoon sampler not advancing the full sample depth at some sample locations.

The measured SPT 'N'-values in these non-cohesive deposits ranged from 24 blows per 0.3 m of penetration to 50 blows per 0.1 m of penetration indicating a compact to very dense state of compactness. The natural water contents measured on samples of these non-cohesive deposits ranged from about 3 percent to 11 percent.

Grain size distribution curves for two samples of the non-cohesive deposits are shown on Figure 4 and Figure 5.

3.2.6 Residual Soil

Residual soil (soil material created from the in-situ degradation of parent bedrock) consisting of silty clay, trace gravel and containing shale fragments was encountered in Boreholes 21-2B to 21-5B, and 21-9B to 21-11B. Hard auger grinding was observed during drilling which is indicative of nearness to the bedrock.

The SPT 'N'-values measured within the residual soil ranged from 50 blows per 0.05 m of penetration to 50 blows per 0.1 m indicating a hard consistency. The natural water contents measured on three samples of the residual soil ranged from about 3 percent to 8 percent.

3.2.7 Shale Bedrock

Shale bedrock was inferred or encountered in Boreholes 21-1B to 21-4B, 21-6B, 21-8B to 21-11B at depths ranging from about 1.6 m to 4.7 mbgs. The bedrock encountered is inferred to be completely to highly weathered shale, based on the recovered split spoon samples.

It should be noted that no bedrock coring was carried out as part of the geotechnical investigation to confirm the bedrock depth or bedrock quality. However, based on the occurrence of auger refusal at relatively consistent depths in the boreholes and the recovery of shale fragments in the split spoon samplers, a bedrock surface elevation ranging between Elevation 100 m and 102 m is inferred.

3.3 Groundwater Conditions

Groundwater levels were measured in open boreholes upon completion of drilling and ranged between depths of about 1.4 m and 3.0 mbgs. Boreholes 21-1B, 21-3B, 21-4B, 21-5B, and 21-10B were found to be dry upon completion of drilling.

The groundwater levels measured in seven monitoring wells on October 5 and 14, 2021, ranged from about 0.8 m and 3.0 mbgs, respectively. The recorded depths to the groundwater level, and the corresponding groundwater elevations, are provided in Table 1 below.

Table 1: Groundwater Level in Monitoring Wells

Monitoring Well/Piezometer	October 5, 2021		October 14, 2021	
	Depth (mbgs)	Elevation (m)	Depth (mbgs)	Elevation (m)
21-4B	2.2	84.1	-	-
21-5B	2.1	84.2	-	-
21-6B	3.0	82.8	-	-
21-8B	1.3	73.2	-	-
21-9B	-	-	0.8	83.7
21-10B	-	-	0.9	85.2
21-11B	-	-	2.8	86.7

It should be noted that the observations presented above reflect the groundwater conditions measured in the boreholes and monitoring wells at the borehole locations during the time of the field investigation. Groundwater levels at the site are anticipated to vary between and beyond the borehole locations and to fluctuate with seasonal variations in precipitation and snowmelt.

4.0 DISCUSSION AND RECOMMENDATIONS

This section provides comments on the geotechnical design aspects of the proposed works, based on our interpretation of the borehole data and our understanding of the project requirements. The information in this section of the technical memorandum is provided for the guidance of the design engineers and professionals. Where comments are made on construction, they are provided only to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation carried out on the site, satisfy themselves as to the adequacy of the information for construction and make their own independent interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing, and the like.

4.1 Parking Lot

4.1.1 Site Preparation

All surficial vegetation, and topsoil should be stripped/removed within the footprint of the proposed parking lot. Organic silt was encountered in some boreholes advanced within the footprint of the proposed parking lot and should be subexcavated and replaced with engineered fill as described in Section 4.2.

4.1.2 Excavations and Groundwater Control

Based on the preliminary grading plan, the final grades will be up to about 0.5 m above the existing site grade. Excavation of any unsuitable fill and organic materials will require removal of materials of up to about 2.2 m below the current grades. Excavating equipment should be chosen that can handle removal of any cobbles/boulders.

All excavations extending to depths greater than 1.2 m below the adjacent ground surface should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Based on the OHSA, the existing fills and native soils within the proposed parking lot may generally be classified as Type 3 soils and all unsupported excavations through these soils should be sloped no steeper than 1 horizontal to 1 vertical (1H:1V) above the groundwater level. This classification must be confirmed by Golder during construction as required under OHSA. In addition, depending upon the construction procedures adopted by the contractor, the success of the contractor’s groundwater control and surface water diversion methods, and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required.

Groundwater was measured within the monitoring well nearest the parking lot area (in Borehole 21-4B) at a depth of approximately 2.2 mbgs and groundwater was measured in Borehole 21-2B at a depth of approximately 3.0 mbgs upon completion of drilling, which is below the proposed excavation depth. As such, active dewatering is likely not required and any localized groundwater seepage within the native soils can likely be controlled by pumping from properly filtered sumps within the excavation.

Although not anticipated to be required during excavations works for the parking lot, the rate and volume required for dewatering will be dependent on the depth of the required excavations, the groundwater levels at the time of construction and the construction methods and staging chosen by the Contractor. An Environmental Activity Sector Registry (EASR) registration with the Ontario Ministry of the Environment, Conservation and Parks should be undertaken in the event that the pumping volumes exceed 50,000 L/day. Under the EASR, a Permit to Take Water (PTTW) is not required for water takings for construction site dewatering for volumes less than 400,000 L/day. Considering the relatively shallow excavation depths anticipated, it is our opinion that that neither an EASR nor a PTTW would likely be required for the parking lot excavations.

4.1.3 Backfill and Grading Using Engineered Fill

It is recommended that the general grading and excavation backfill within the proposed new parking lot be carried out using engineered fill. Based on the preliminary grading plan, the final grade within the parking lot is anticipated to extend up to 0.5 m above the existing grade.

The excavated granular materials which are free of any deleterious materials and have water contents generally within +/-2 percent of the material's optiumum water content, may be reused as engineered fill. Imported materials for use as engineered fill should be approved by Golder prior to transporting them to the site.

Based on the soil classification and frost group described in Table 13.1 of the Canadian Foundation Engineering Manual (CFEM), the non-cohesive fill encountered at the site is considered to range from low to moderate sensitivity to frost. This should be considered for any design elements exposed to freezing temperatures (concrete flatworks, exterior concrete slabs, and the like).

In any event, the approved materials for engineered fill should be placed in maximum 300 mm thick loose lifts and uniformly compacted to at least 98 percent of their standard Proctor maximum dry density (SPMDD). All oversize cobbles and boulders (i.e., greater than 150 mm in size) or any other deleterious materials should be removed from the engineered fill material.

Prior to placement of engineered fill, any existing fill, and abandoned buried utilities must first be removed from the site. The exposed native subgrade area(s) should be proofrolled and inspected by geotechnical personnel from Golder to confirm the base is free of ponded water, loosened/softened or any other deleterious materials. Remedial work (further sub-excavation) may be required based on the performance observed by Golder during proofrolling. Full-time monitoring and in situ density testing must be carried out by Golder during placement of engineered fill for the parking lot.

The final surface of the engineered fill should be protected as necessary from construction traffic and should be sloped to provide positive drainage for surface water prior to construction. During periods of freezing weather, additional soil cover should be placed above final subgrade to provide temporary frost protection.

4.1.4 Pavement Design

As traffic data was not available, we have assumed the parking lot will support passenger vehicles as well as buses, RV's, maintenance vehicles including snowplows, and larger utility trucks for washroom maintenance. As such, pavement designs for both light duty and heavy-duty areas have been provided (light duty areas for passenger vehicle parking stalls and heavy duty for driveways and heavy vehicle routes within the parking lots). Based on the subsoil conditions encountered at the site, the following pavement designs may be considered for the proposed parking lot:

Table 3: Flexible Pavement Design Recommendations for Parking Lot

Material	Thickness of Pavement Elements (mm)	
	Light Duty Areas (parking stalls)	Heavy Duty Areas (driveways and heavy vehicle routes)
HL 3 (Surface Course)[1]	40	40
HL 8 Binder (Binder Course)[1]	50	70
Granular A, Base[2]	170	150
Granular B, Type I Subbase[2]	300	300
Subgrade	Existing Subgrade (Proofrolled and graded for drainage)	Existing Subgrade (Proofrolled and graded for drainage)

Notes:
[1] Asphaltic Material shall be in accordance with OPSS 310, 1150 (November 2010), and 1003 (November 2017)
[2] Granular Materials shall be in accordance with OPSS.MUNI 1010 (November 2013)

The organic silt within the proposed parking lot footprint (encountered in Borehole 21-1B and 21-2B) must be completely sub-excavated up to a depth of 2.2 m into the underlying competent sandy silty gravel / residual soil and replaced with approved engineered fill.

Prior to placing the granular subbase, the exposed subgrade should be proof-rolled and inspected by the geotechnical engineer. Any soft/loose or poorly performing areas should be sub-excavated and reinstated with approved granular material placed in loose lifts not exceeding 300 mm in thickness and uniformly compacted to at least 98 percent of the material's SPMDD.

The granular subbase materials should be placed in loose lifts not exceeding 300 mm in thickness and uniformly compacted to at least 100 percent of SPMDD. The granular base materials should be uniformly compacted to at least 100 percent of their SPMDD. The asphalt materials should be compacted to a minimum of 92 percent of their Marshall Maximum Relative Density in accordance with OPSS 310, as measured in the field using a nuclear density gauge. The asphalt cement for the HL 3 and HL 8 hot mix asphalt mixes should be PG 58-28 performance graded asphalt cement in accordance with OPSS.MUNI 1101.

Drainage of the pavement layers is critical to the long-term performance of the pavement. As such, continuous subdrains could be placed around the perimeter of the parking lot and subdrains placed around internal catch basin locations (if catch basins are installed as a part of the project). The invert of the subdrains should be at least 300 mm below the bottom of the subbase layer and should be sloped to drain towards the catch basins, or other frost-free outlets. The subdrains should consist of perforated pipe wrapped in a suitable geotextile and surrounded on all sides with a minimum thickness of 150 mm of clean free draining sand such as concrete sand. The subdrains should be constructed in accordance with the City of Markham's Drawing Number MR34.

In areas where the existing grade is lower than the design top of subgrade elevation, it is recommended that sufficient additional granular material be provided and built up to the top of subgrade.

It is recommended that tack coat be applied to all milled asphalt surfaces and butt joints and between all new lifts of asphalt. Tack coat is to be provided in accordance with OPSS 308.

Where new pavement abuts existing pavement, proper longitudinal lap joints, at least 500 mm wide and 50 mm deep, should be constructed to key the new asphalt into the existing surface. The existing asphalt edges should be saw cut to provide a clean, straight edge prior to keying in the new asphalt. Any undermining or broken edges resulting from the construction activities should be removed by the saw cut.

4.2 Pedestrian Bridge

4.2.1 Foundations and Subgrade Preparation

The proposed pedestrain bridges will be supported on abutments located at both ends of the bridge. The native soils at both bridge locations generally consist of compact to very dense silty sand, gravelly silty sand, gravelly sand, and hard residual soil (silty clay) underlain by shale bedrock.

The footings should be protected with at least 1.4 m soil cover or equivalent thermal insulation. The compact to very dense native soils at depths of about 1.4 mbgs are considered suitable for support the anticipated conventional footing foundation loads. The following table summarizes the recommended founding depths and the antipacted subgrade conditions at each propsoed abutment location.

Bridge	Abutment (Relevant Borehole)	Mimumum Founding Depth (m)	Antipacted Subgrade
West Bridge	North Abutment (21-10B)	1.4	Very dense gravelly silty sand / hard residual soil
	South Abutment (21-11B)	1.4	Dense to very dense sand and gravel to silty sand
East Bridge	North Abutment (21-8B)	1.4	Compact to very dense gravelly silty sand
	South Abutment (21-9B)	1.4	Very dense sandy gravel / shale bedrock

Shallow foundations founded on the properly prepared subgrade noted above may be designed using soil bearing resistances of 250 kPa at Serviceability Limit States (SLS) for 25 mm of total settlement and 375 kPa at Ultimate Limit States (ULS).Depending on localized variability in the elevation of the shale bedrock, shale bedrock may be encountered at the footing level, especially in the vicinity of Borehole 21-9B and possibly in the vicinity of Borehole 21-10B. If the final grade differs from the existing ground surface, Golder should be contacted to review and possibly revise the above founding stratum and geotechnical resistances.

The foundation excavations will extend through compact to very dense native soils with cobbles and boulders inferred from auger refusal, multiple instances of auger grinding and split-spoon sampler not advancing its full depth. As such, equipment used for foundation excavations should be capable of breaking through and removing any cobbles/boulders that may be encountered. The equipment should also be capable of removing the upper portion of the shale bedrock, if encountered at the founding level.

Foundation excavations must be inspected by Golder to confirm that the founding soils (or shale, if encountered at the founding level) are native, undisturbed, and capable of supporting the design foundation loads. Foundations on soils must be poured as soon as practical following inspection and approval by Golder. If required, foundations on shale must be poured immediately following inspection to prevent the exposed shale from deteriorating. Once constructed, the foundations should be backfilled as soon as it is practical.

4.2.2 Excavations and Groundwater Control

All excavations extending to depths greater than 1.2 m below the adjacent ground surface should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Based on the OHSA, the existing fills and native soils at the abutment locations may generally be classified as Type 3 soils and all unsupported excavations through these soils should be sloped no steeper than 1 horizontal to 1 vertical (1H:1V) above the groundwater level. This classification must be confirmed by Golder during construction as required under OHSA. In addition, depending upon the construction procedures adopted by the contractor, the success of the contractor's groundwater control and surface water diversion methods, and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required.

The depth to groundwater was measured at 0.8 mbgs and 0.9 mbgs in the monitoirng wells installed at the abutment locations. Therefore, the foundation excavations to 1.4 mbgs are antipacted to extend up to 0.6 m below the groundwater level and some form of active groundwater control will be required considering the native silty sand, gravelly sand and silty gravel are permeable. The rate and volume required for dewatering will be dependent on the depth of the required excavations, the groundwater levels at the time of construction and the construction methods and staging chosen by the Contractor. An Environmental Activity Sector Registry (EASR) registration with the Ontario Ministry of the Environment, Conservation and Parks should be undertaken in the event that the pumping volumes exceed 50,000 L/day. Under the EASR, a Permit to Take Water (PTTW) is not required for water takings for construction site dewatering for volumes less than 400,000 L/day.

4.2.3 Seismic Design

The 2012 Ontario Building Code (2012 OBC) came into effect on January 1, 2014 and contains updated seismic analysis and design methodology. Seismic hazard is defined for an earthquake with a 2 percent probability of exceedance in 50 years (i.e., a return period of 2,400 years) which encompasses a larger earthquake hazard than in prior editions of the OBC. Design earthquakes are commonly defined by an earthquake magnitude, distance, and peak ground acceleration (PGA). The 2012 OBC uses the uniform hazard spectra (UHS) to define the response of the structure to the design earthquake and also considers the effects of the localized Site conditions on the structural response. The 2012 OBC also uses a refined site classification system defined by the average soil/bedrock properties in the top 30 metres of the subsurface profile beneath the structure(s). There are six site classes designated as A to F related to decreasing ground stiffness from A for hard rock to E for soft soil and site Class F for problematic soils (e.g., sites underlain by thick peat deposits and/or liquefiable/collapsible soils). The site class is then used to obtain acceleration- and velocity-based site coefficients, Fa and Fv, respectively, used to modify the reference UHS to account for the effects of site-specific soil conditions in design.

Based on the results of the investigation, the building foundations may be designed using a Site Class C designation.

4.2.4 Lateral Earth Pressures

Based on the results of this geotechnical investigation, the active lateral earth pressure has been provided for the relevant underlying native soils. It should be noted that passive resistance around any abutment within the upper 1.4 m below ground surface should be neglected to account for frost action.

For preliminary design purposes, the appropriate values of parameters for use in preliminary design of the abutments are provided below:

Table 2: Lateral Earth Pressures for Various Soil Types

	Total Unit Weight, ɣ (kN/m^3)	Effective Angle of Internal Friction, ϕ' (degrees)	Coefficient of Lateral Earth Pressure at Rest, K_o	Coefficient of Active Pressure, K_a
New engineered fill	19	30	0.50	0.33
Compact to very dense silty sand, and gravelly sand	20	33	0.46	0.30
Residual soil	21	35	0.43	0.27

4.2.5 Backfill

Imported granular materials which meet the requirements for OPSS.PROV 1010 (Aggregates) SSM or OPSS Granular B, Type II are considered suitable for abutment wall backfill. The backfill material should be placed in maximum 300 mm loose lifts and uniformly compacted to 98 percent SPMDD.

Compaction of backfill material should be restricted to the use of hand operated or light vibratory compaction equipment behind all abutment walls in accordance with OPSS.PROV 501. Full-time monitoring and in situ density testing must be carried out by Golder during placement of abutment wall backfill.

The final surface of the compacted backfill fill should be protected as necessary from construction traffic and should be sloped to provide positive drainage for surface water. During periods of freezing weather, additional soil cover should be placed above final subgrade to provide for temporary frost protection. Frozen soil and ice must not be included in the backfill.

5.0 CLOSURE

We trust that this memorandum meets your immediate requirements. If conditions that differ from those assumed in this memorandum are encountered during construction, Golder should be given the opportunity to review the analyses presented herein. If you have any questions regarding the content of this technical memorandum, please do not hesitate to contact this office.

Yours truly,

Golder Associates Ltd.

Anastasia Poliacik, P.Eng.
Senior Geotechnical Engineer

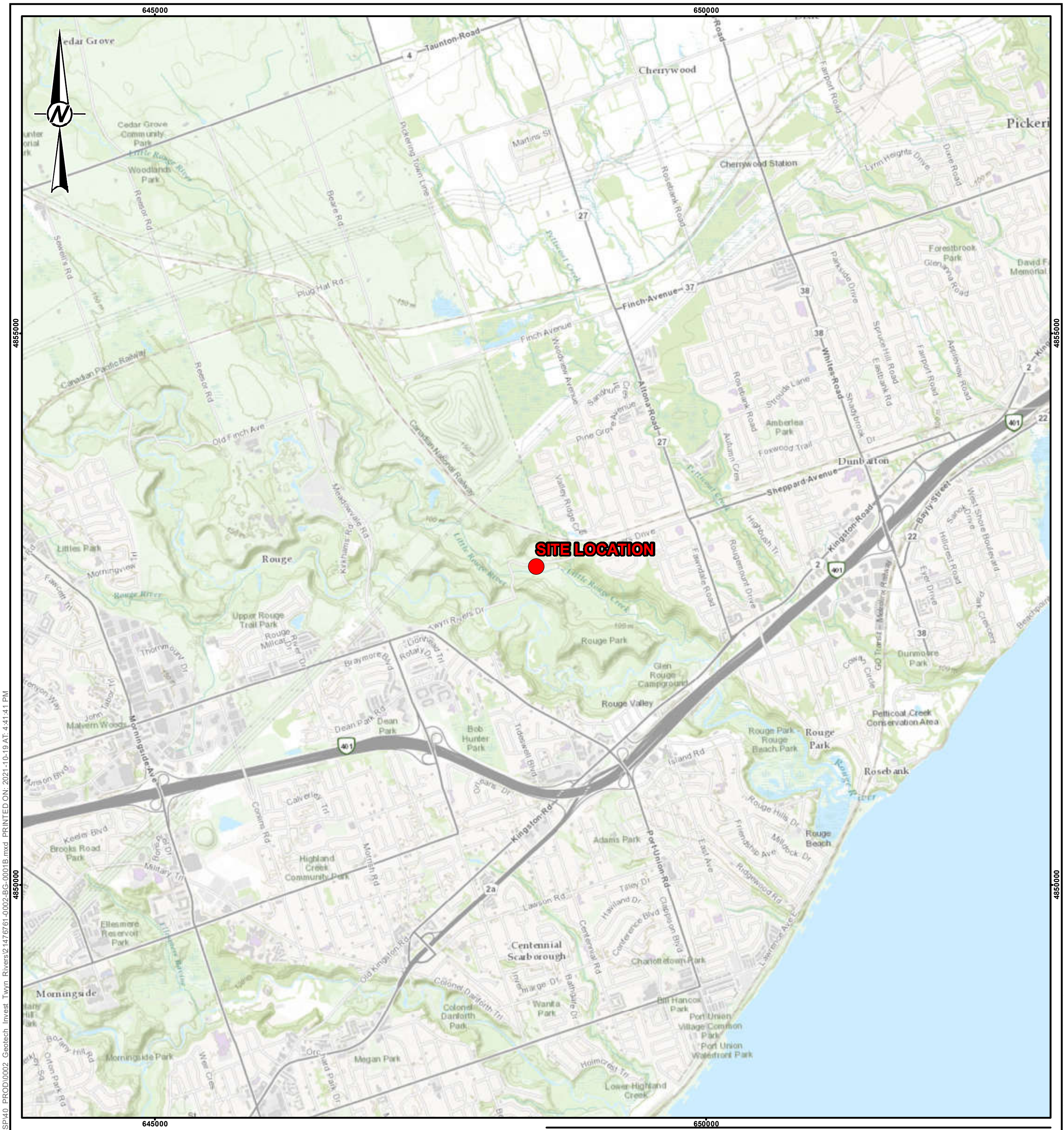
Sarah E. M. Poot, P.Eng.
Senior Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
S. E. M. POOT
90471921
2022'04'29
PROVINCE OF ONTARIO

KK/AMP/SEMP/mes

Attachments: Figure 1 – Key Plan
Figure 2 – Borehole Location Plan
Figures 3 to 5 – Laboratory Test Results
Method of Soil Classification
Abbreviations and Terms Used on Records of Boreholes
List of Symbols
Record of Boreholes (21-1B to 21-11B)
Appendix A: Important Information and Limitations of This Report

https://golderassociates.sharepoint.com/sites/149061/project files/6 deliverables/reports/twyn rivers/final/21476761 mem 2022'04'xx geotech invest - parking lot pedestrian bridge (twyn rivers) rev0.docx



0 1,000 2,000

1:50,000 METRES

REFERENCE(S)

1. BASE MAP SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 1983 COORDINATE SYSTEM: UTM ZONE 17N.

CLIENT
WSP CANADA INC.

PROJECT
GEOTECHNICAL INVESTIGATION
PROPOSED PEDESTRIAN BRIDGES AND PARKING LOT AT ROUGE NATIONAL URBAN PARK, TWYN RIVERS DRIVE, TORONTO, ONTARIO

TITLE
KEY PLAN - LOCATION 2

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	TO
PREPARED	JT
REVIEWED	TO
APPROVED	SEMP

PROJECT NO.	CONTROL	REV.	FIGURE
21476761	0001	A	1B

PATH: S:\Clients\Rouge_National_Parks\Markham_Rouge_Park_Lots\99_PROJ\21476761_WSP\40_PROD\0002_Geotech_Invest_Twyn_Rivers\21476761-0002-BG-0001B.mxd PRINTED ON: 2021-10-19 AT: 4:41:41 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

25mm

0

NOTE(S)

REFERENCE(S)
1. BASE DATA - MNRF, 2020.
2. BASE PLAN PROVIDED BY
3. BASE IMAGERY SOURCE: E
CNES/AIRBUS DS, USDA, USG
4. PROJECTION: TRANSVERS

CLIENT
WSP CANADA INC.

PROJECT
GEOTECHNICAL INVEST
PROPOSED PEDESTRIA
URBAN PARK, TWYN RI

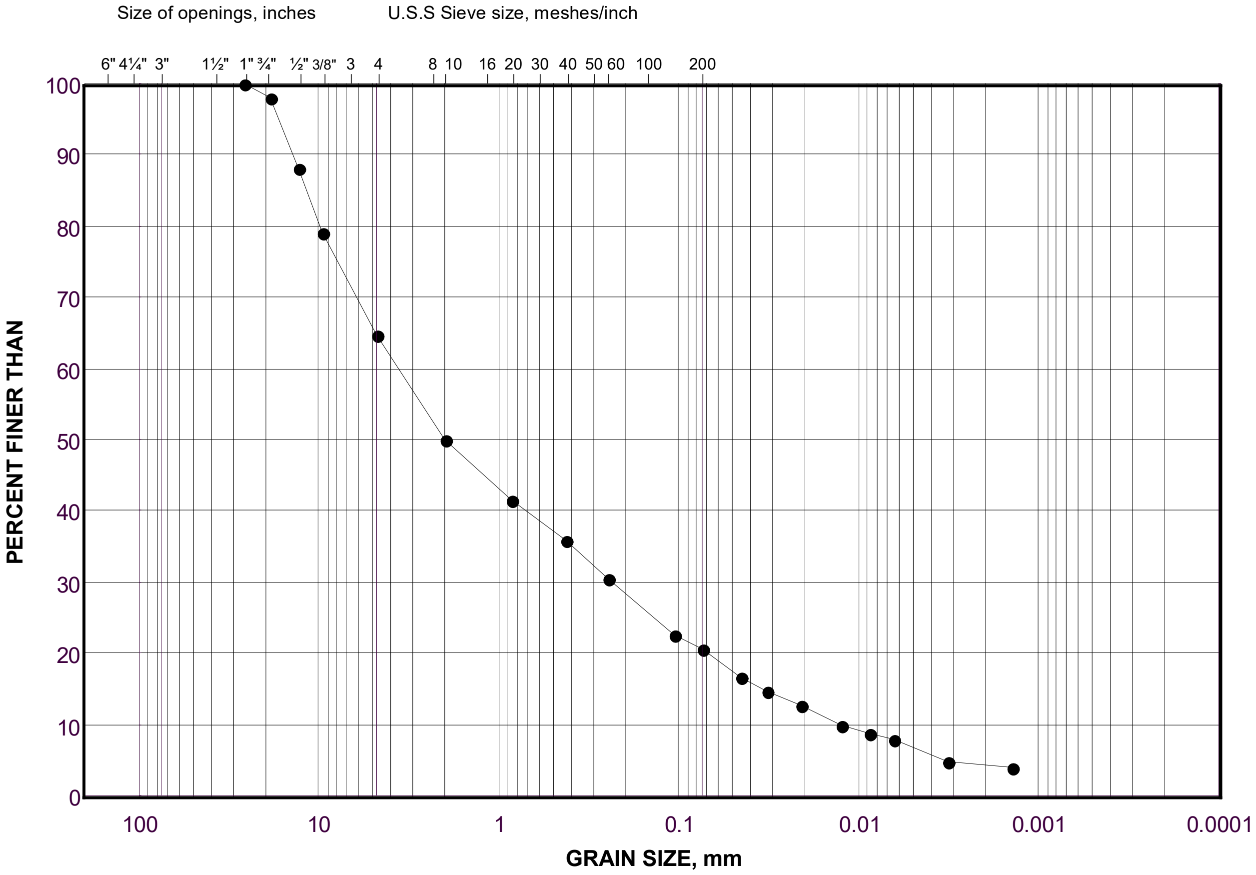
TITLE
BOREHOLE LOCAT

CONSULTANT

GRAIN SIZE DISTRIBUTION

FILL - (SM) gravelly SILTY SAND

FIGURE 3



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	21-2B	1	0.0 - 0.6

Project Number: 21476761

Checked By: TO/AP

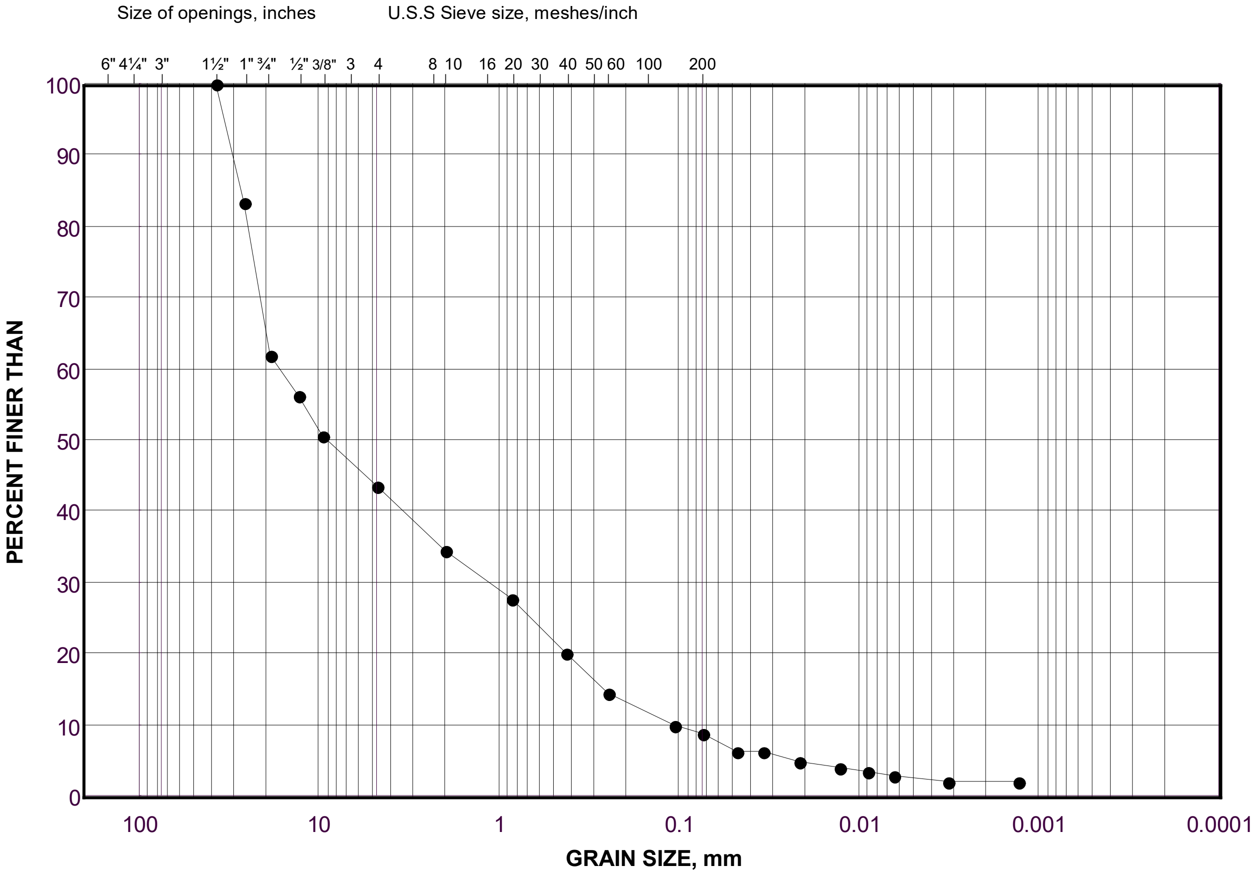
Golder Associates

Date: 29-Oct-21

GRAIN SIZE DISTRIBUTION

(GP-GM) sandy GRAVEL

FIGURE 4



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	21-3B	2	0.8 - 1.2

Project Number: 21476761

Checked By: TO/AP

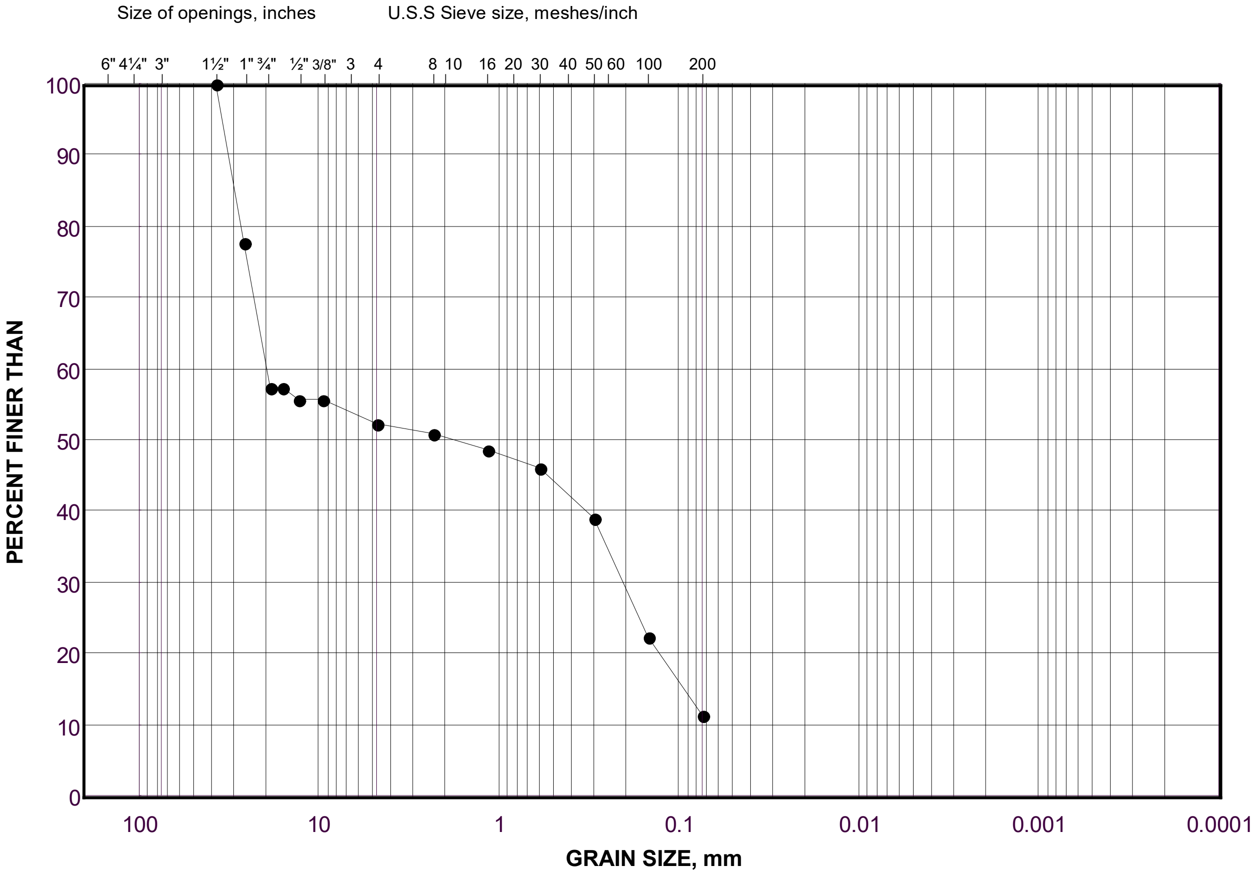
Golder Associates

Date: 29-Oct-21

GRAIN SIZE DISTRIBUTION

(SP-SM) SAND and GRAVEL

FIGURE 5



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	21-11B	3	1.2 - 1.8

Project Number: 21476761

Checked By: TO/AP

Golder Associates

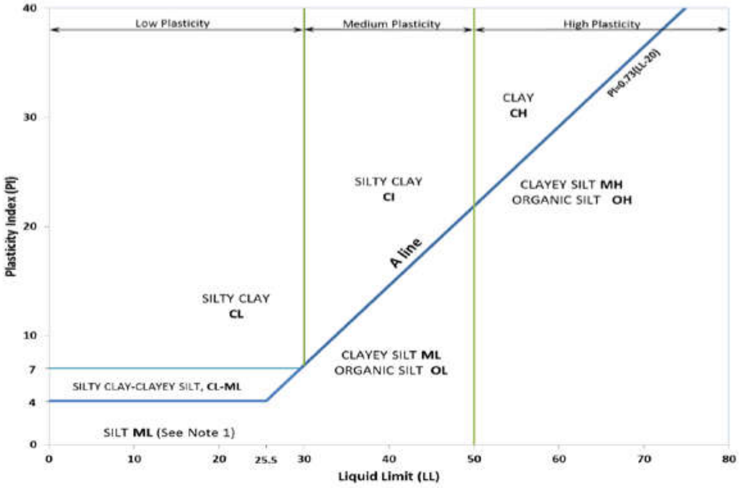
Date: 29-Oct-21

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10}xD_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes:
1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

PROJECT: 21476761 (Twyn Rivers)

LOCATION: N 4852889.00; E 648418.00

RECORD OF BOREHOLE: 21-1B

BORING DATE: September 20, 2021

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

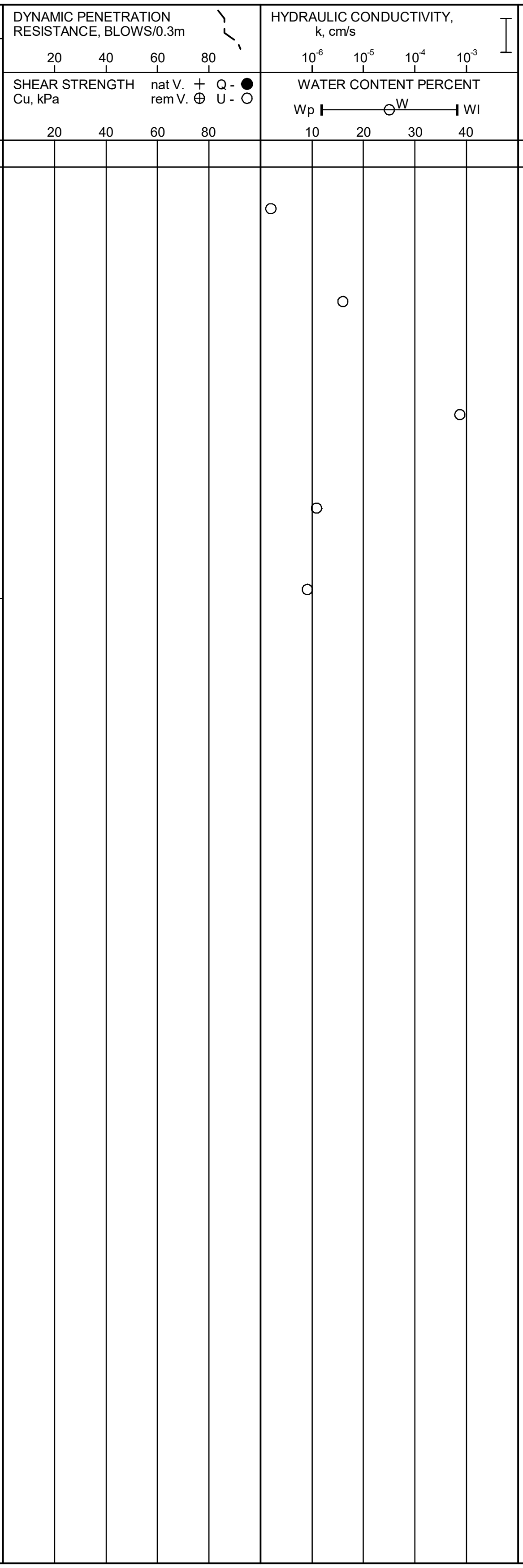
HAMMER TYPE: AUTOMATIC

BORING METHOD: Geoprobe 9570 Track Mounted
150 mm O.D. Hollow Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	86.56			
TOPSOIL	0.00			
FILL - (SP) gravelly SAND, trace fines; brown (Granular Base); non-cohesive, moist, compact	86.31 0.25	1	SS	19
(SM) SILTY SAND; brown; non-cohesive, moist, very loose	85.87 0.69	2	SS	3
(OL) ORGANIC SILT, trace sand; black; cohesive, w<PL, soft	85.19 1.37	3	SS	3
(CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL, hard	84.35 2.21	4	SS	67/ 0.28
- Inferred shale bedrock at a depth of 3.2 m		5	SS	50/ 0.13
END OF BOREHOLE	83.38 3.18			

Notes:

1. Borehole was open and dry upon completion of drilling.



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: TO/AP

GTA-BHS 001 S:\CLIENTS\ROUGE_NATIONAL_PARKS\MARKHAM_ROUGE_PARK_LOTS\02_DATA\GINT\TWYN_RIVERS.GPJ GAL-MIS.GDT 12/3/21

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852883.00; E 648417.00

RECORD OF BOREHOLE: 21-2B

BORING DATE: September 20, 2021

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.46							
0	Geoprobe 9570 Track Mounted 150 mm O.D. Hollow Stem Augers	FILL - (SM) gravelly SILTY SAND; brown (Granular Base); non-cohesive, moist, dense to very dense	▨	0.00	1	SS	89		○	MH	
1		- Auger grinding at a depth of 0.9 m	▨		2	SS	31				
		(OL) ORGANIC SILT; black; cohesive, w<PL, firm	▨	85.17 1.29	3	SS	6				
2		(SM) sandy SILTY GRAVEL; brown; non-cohesive, wet, very dense - Shale fragments at a depth of 2.6 m	▨	84.25 2.21	4	SS	50/ 0.13				
		(CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL, hard	▨	83.86 2.60							
3		- Inferred shale bedrock at a depth of 3.1 m		83.34 3.12	5	SS	50/ 0.13				
		END OF BOREHOLE									
4											
5											
6											
7											
8											
9											
10											

Notes:

1. Groundwater was measured at a depth of 3.0 m upon completion of drilling.

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: PM
CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852920.00; E 648516.00

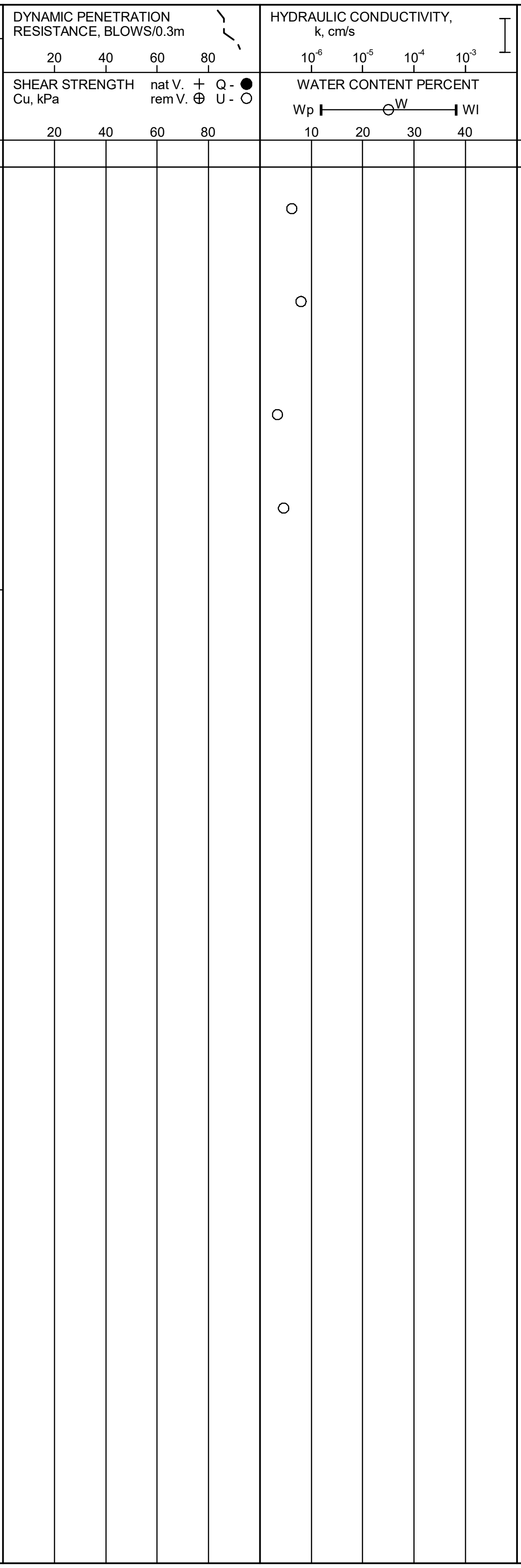
RECORD OF BOREHOLE: 21-3B

BORING DATE: September 23, 2021

SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.15					
	Geoprobe 9570 Track Mounted 150 mm O.D. Hollow Stem Augers	FILL - (SM) SILTY SAND,^{0}some gravel to gravelly; brown (Granular Base); non-cohesive, moist, compact	▩	0.00	1	SS	27		
1		(GP-GM) sandy GRAVEL, some fines; brown; non-cohesive, moist, compact to very dense - Auger grinding between the depths of 0.8 m and 1.2 m - Auger grinding between the depths of 1.5 m and 2.0 m	░	86.54 0.61	2	SS	24	MH	
2					3	SS	83/ 0.25		
		(CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL, hard - Inferred shale bedrock at a depth of 3.1 m	▨	84.94 2.21	4	SS	50/ 0.1		
3					5	SS	50/ 0.08		
		END OF BOREHOLE Notes: 1. Borehole open and dry upon completion of drilling.		84.03 3.12					
4									
5									
6									
7									
8									
9									
10									



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: PM
CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852900.00; E 648522.00

RECORD OF BOREHOLE: 21-4B

BORING DATE: September 21, 2021

SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm
HAMMER TYPE: AUTOMATIC

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40
ADDITIONAL LAB. TESTING
PIEZOMETER OR STANDPIPE INSTALLATION

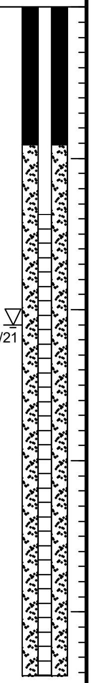
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		86.30			
0	Geoprobe 9570 Track Mounted Direct Push	FILL - (SM) gravelly SILTY SAND; brown (Granular Base); non-cohesive, moist	▩	0.00	1	DO	
1.52	150 mm O.D. Hollow Stem Augers	(CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL, hard - Auger grinding at a depth of 1.5 m	▨	84.78 1.52	2	DO	
					3	SS	50/ 0.13
		- Auger grinding at a depth of 2.9 m			4	SS	50/ 0.13
		- Inferred shale bedrock at a depth of 4.4 m					
4.42		END OF BOREHOLE (REFUSAL)		81.88 4.42			

Notes:

1. Borehole was open and dry upon completion of drilling.

2. Borehole could not advance beyond 4.4 m after auger grinding for about 10 minutes.

3. Groundwater level was measured in monitoring well at 2.2 m below ground surface, Oct., 5/21.



Bentonite Seal

Oct. 5/21

Silica Sand Filter

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: PM
CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852880.00; E 648513.00

RECORD OF BOREHOLE: 21-5B

BORING DATE: September 23, 2021

SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected 100 200 300 400 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ☐ ND = Not Detected 100 200 300 400	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.25							
0	Geoprobe 9570 Track Mounted 150 mm Solid Stem Augers	FILL - (SM) gravelly SILTY SAND; brown (Granular Base); non-cohesive, moist	▩	0.00							Bentonite Seal
1					1	DO		⊕☐ ND			
		- Geofabric and bricks encountered between the depths of 1.1 m and 1.4 m									Silica Sand Filter
2					2	DO		⊕☐ ND			
		(CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL	▥	84.12 2.13							Oct. 5/21
3		END OF BOREHOLE (REFUSAL)		83.20 3.05							

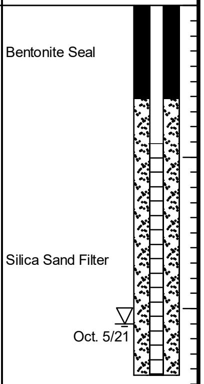
Notes:

1. Water encountered during drilling at a depth of 2.3 m.

2. Groundwater was measured at a depth of 1.7 m upon completion of drilling.

3. Borehole caved at a depth of 2.0 m upon completion of drilling.

4. Groundwater level was measured in monitoring well at 2.1 m below ground surface, Oct. 5/21.



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: PM
CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852888.00; E 648539.00

RECORD OF BOREHOLE: 21-6B

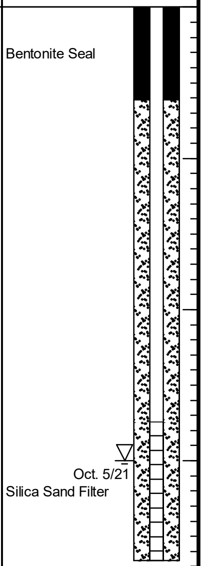
BORING DATE: September 23, 2021

SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		85.76							
0	Geoprobe 9570 Track Mounted 150 mm Solid Stem Augers	FILL - (SM) gravelly SILTY SAND; brown; non-cohesive, moist		0.00							Bentonite Seal
1					1	DO		⊞			
		(SP-SM) SAND and GRAVEL; brown; non-cohesive, moist		84.24 1.52							
2					2	DO		⊞			
3					3	DO					▽ Oct. 5/21 Silica Sand Filter
		CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL - Inferred cobble/boulder at a depth of 3.4 m - Inferred bedrock at a depth of 4.7 m		82.41 3.35	4	DO					
		END OF BOREHOLE (REFUSAL) Notes: 1. Water was encountered during drilling at a depth of 3.0 m. 2. Groundwater level was measured in monitoring well at 3.0 m below ground surface, Oct. 5/21.		81.04 4.72							

Scale values: headspace 100, 200, 300, 400; hydraulic conductivity 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}; water content 10, 20, 30, 40. Depth scale 0–10 m.



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: PM
CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)

LOCATION: N 4852852.00; E 648486.00

RECORD OF BOREHOLE: 21-7B

BORING DATE: September 27, 2021

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp ⊢ W ⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.16							
0	Geoprobe 9570 Track Mounted 150 mm Solid Stem Augers	TOPSOIL		0.00 0.05							
		(SM) gravelly SILTY SAND; brown; non-cohesive, moist			1	DO		⊕ ND			
1				84.64 1.52							
2		(GP) GRAVEL, trace sand; grey; non-cohesive, wet			2	DO		⊕ ND			
3		- Shale fragments at a depth of 3.2 m			3	DO		⊕ ND			
				82.50 3.66							
4		END OF BOREHOLE Notes: 1. Water encountered during drilling at a depth of 2.4 m.									
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: PM

CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852852.00; E 648490.00

RECORD OF BOREHOLE: 21-8B

BORING DATE: September 23, 2021

SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □
		GROUND SURFACE		86.20				
0	Geoprobe 9570 Track Mounted 150 mm Solid Stem Augers	TOPSOIL		0.00				
		(SM) gravelly SILTY SAND; brown; non-cohesive, moist to wet, compact to very dense		86.02 0.18	1	SS	11	ND
		- Auger grinding at a depth of 0.8 m						
1					2	SS	51	ND
		- Auger grinding at a depth of 1.5 m						
2					3	SS	58	ND
		- Auger grinding at a depth of 2.3 m			4	SS	25	ND
3		(GP) GRAVEL, trace sand; grey, shale fragments; non-cohesive, wet, very dense		83.30 2.90	5	SS	50/ 0.1	ND
		- Auger grinding at a depth of 3.0 m						
		- Inferred bedrock at a depth of 3.6 m		82.62 3.58				
		END OF BOREHOLE (REFUSAL)						

HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕
ND = Not Detected
100 200 300 400

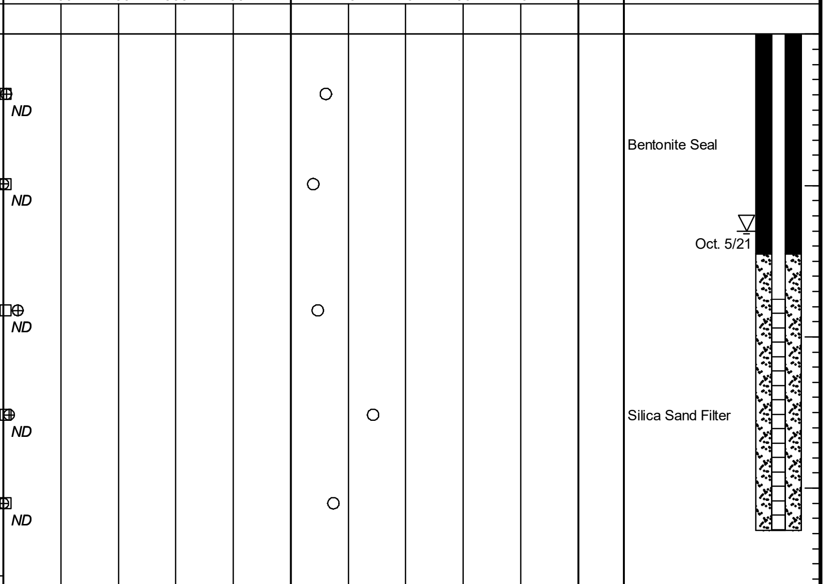
HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □
ND = Not Detected
100 200 300 400

HYDRAULIC CONDUCTIVITY, k, cm/s
10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT
Wp ⊢—○W—⊣ Wl
10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Notes:

1. Water encountered during drilling at a depth of 2.3 m.

2. Borehole could not advance beyond 4.4 m after auger grinding for about 20 minutes.

3. Groundwater level was measured in monitoring well at 1.3 m below ground surface, Oct. 5/21.

Depth scale: 4 5 6 7 8 9 10

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: PM
CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852816.00; E 648484.00

RECORD OF BOREHOLE: 21-9B

BORING DATE: October 5, 2021

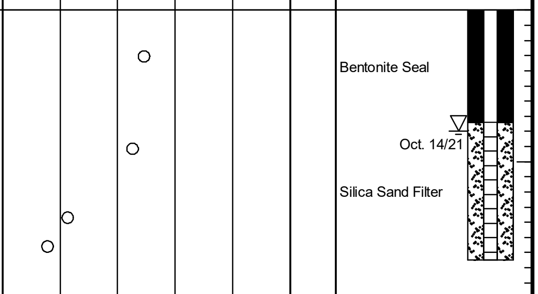
SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: CATHEAD

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		84.50			
0	Tripod	TOPSOIL		0.00			
		(SM) SILTY SAND, trace to some gravel; brown to grey, containing rootlets; non-cohesive, moist to wet, very loose to compact		0.15	1	SS	3
1				83.28	2	SS	10
		(GP-GM) sandy GRAVEL, some fines; brown; non-cohesive, wet, very dense		1.22 82.98	3A	SS	87/ 0.23
		Inferred highly weathered, grey SHALE		1.52	3B		
		END OF BOREHOLE (REFUSAL)		1.65	4	SS	50/ 0.05

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40
ADDITIONAL LAB. TESTING
PIEZOMETER OR STANDPIPE INSTALLATION



Notes:

1. Water encountered during drilling at a depth of 0.8 m.

2. Groundwater measured in open borehole at a depth of 0.8 m upon completion of drilling.

3. Groundwater level was measured in monitoring well at 0.8 m below ground surface, Oct. 14/21.

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: AS
CHECKED: TO/AP

PROJECT: 21476761 (Twyn Rivers)

LOCATION: N 4852831.00; E 648231.00

RECORD OF BOREHOLE: 21-10B

BORING DATE: October 1, 2021

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: CATHEAD

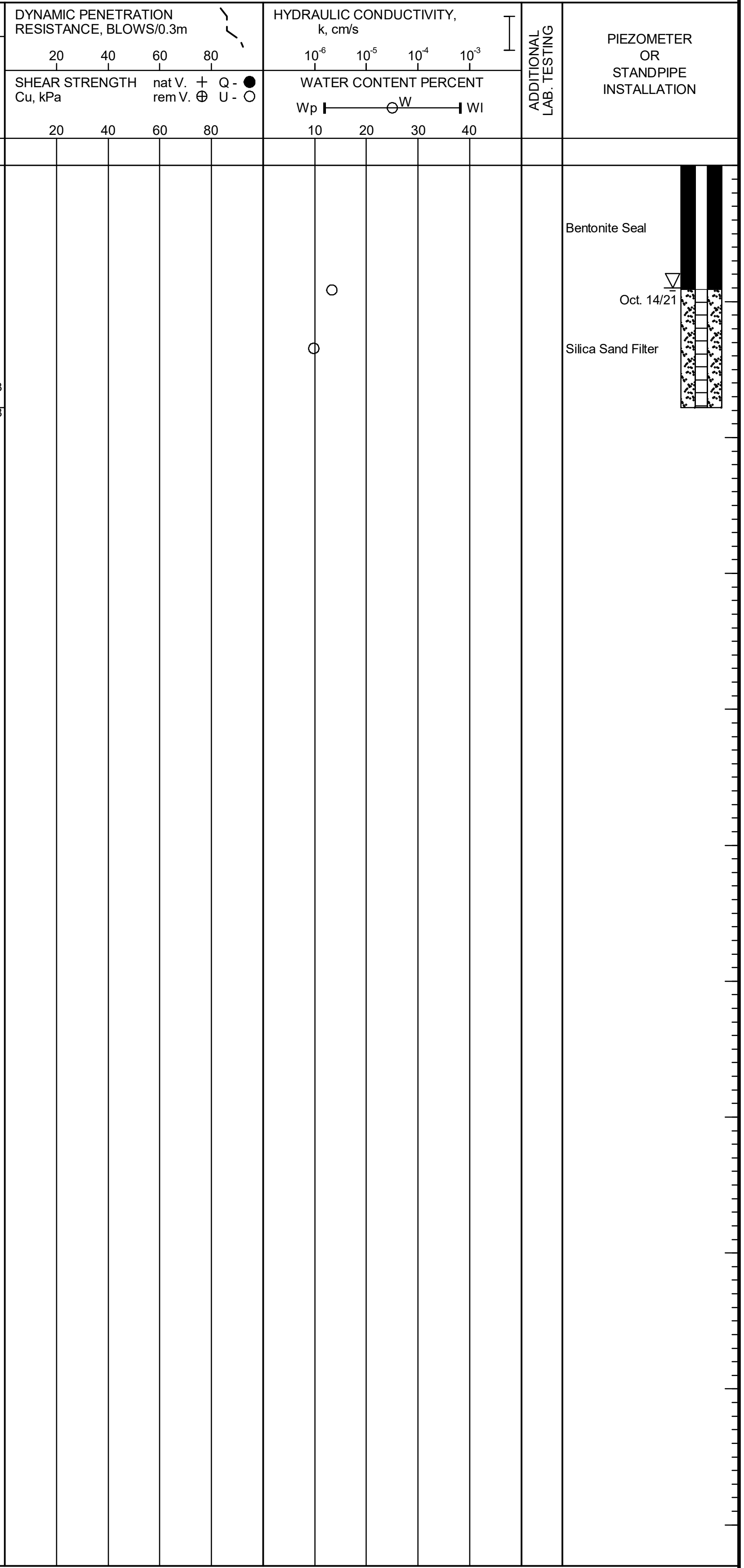
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE	86.05			
0	Tripod	TOPSOIL	0.00			
		(SM) gravelly SILTY SAND; brown, containing shale fragments; non-cohesive, moist, loose to very dense - Shale fragments from a depth of 1.2 m	0.15	1	SS	4
1				2	SS	15
				3	SS	50/ 0.1
		(CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL, hard	84.58 1.47	4	SS	50/ 0.08
			84.27 1.78	5	SS	50/ 0.08
2		- Inferred shale bedrock at a depth of 1.8 m				
		END OF BOREHOLE (REFUSAL)				

Notes:

1. Borehole was open and dry upon completion of drilling.

2. Borehole was advanced with a 50 mm O.D. split spoon sampler.

3. Groundwater level was measured in monitoring well at 0.9 m below ground surface, Oct. 14/21.



DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: AS

CHECKED: TO/AP

GTA-BHS 001 S:\CLIENTS\ROUGE_NATIONAL_PARKS\MARKHAM_ROUGE_PARK_LOTS\02_DATA\GINT\TWYN_RIVERS.GPJ GAL-MIS.GDT 12/3/21

PROJECT: 21476761 (Twyn Rivers)
LOCATION: N 4852794.00; E 648242.00

RECORD OF BOREHOLE: 21-11B

BORING DATE: September 30, 2021

SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: CATHEAD

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE	89.50			
0	Tripod	TOPSOIL	0.00	1	SS	15
		(SM) SILTY SAND, trace gravel; dark brown, contains organic inclusions; non-cohesive, moist, dense	89.04 0.46	2	SS	47
1		(SP-SM) SAND and GRAVEL, some fines; brown; non-cohesive, moist, dense	88.28 1.22	3	SS	37
2		(SM) SILTY SAND, trace gravel; brown to grey; non-cohesive,moist to wet, very dense - Becoming grey at a depth of 2.4 m - Clay pockets between the depths of 2.4 m and 3.1 m	87.71 1.79	4 5 6	SS SS SS	64 78 50/ 0.13
3		(CL) SILTY CLAY, trace sand; grey, shale fragments (RESIDUAL SOIL); cohesive, w<PL, hard - Inferred shale bedrock at a depth of 3.6 m	86.11 3.39	7	SS	50/ 0.01
4		END OF BOREHOLE (REFUSAL)	85.92 3.58			

Notes:

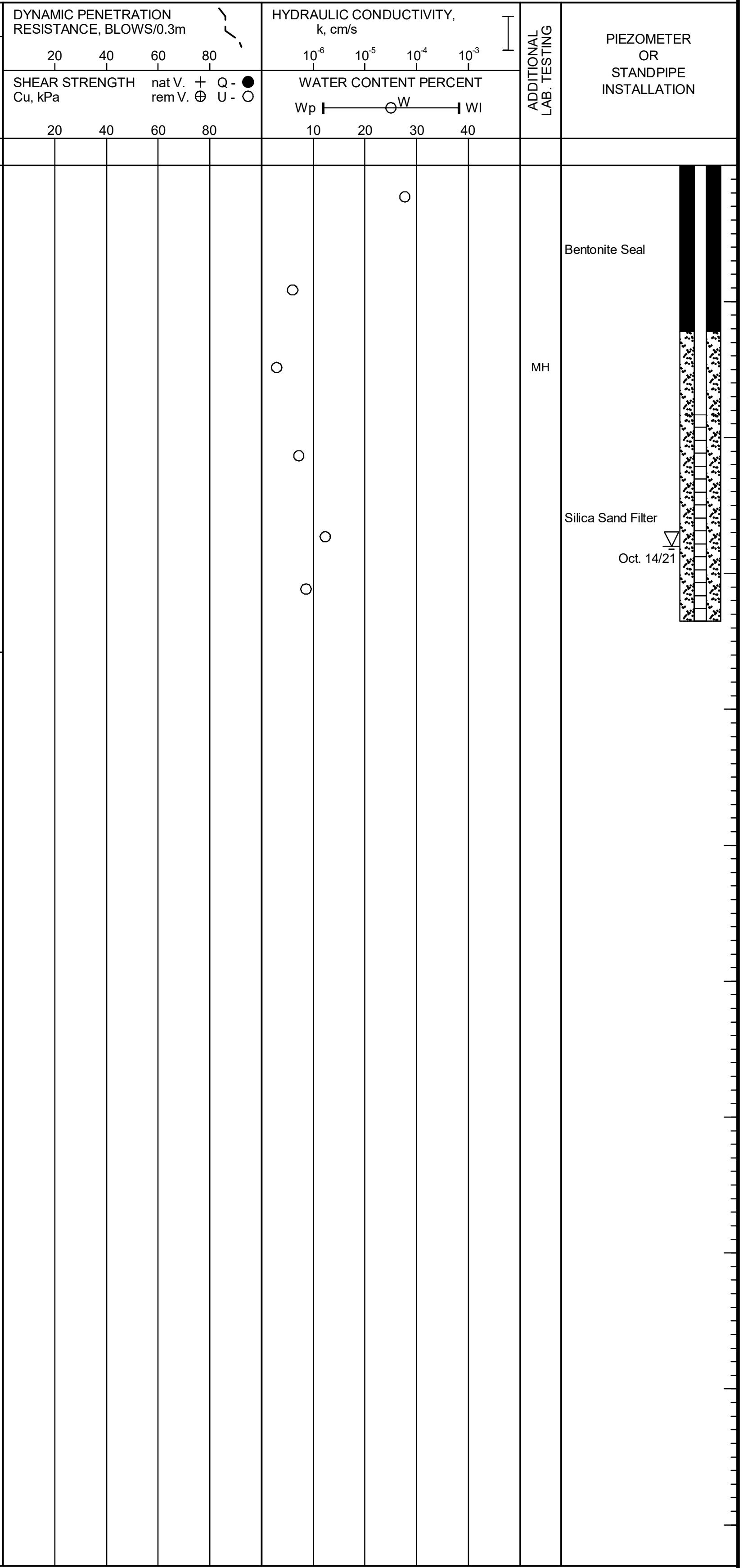
1. Water encountered during drilling at a depth of 3.1 m.

2. Borehole refusal at a depth of 3.6 m with no SPT split spoon penetration.

3. Groundwater measured at a depth of 1.4 m below ground surface.

4. Borehole was advanced using a 50 mm split spoon sampler.

5. Groundwater level was measured in monitoring well at 2.8 m below ground surface, Oct. 14/21.



DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SC
CHECKED: TO/AP

APPENDIX A

Important Information and Limitations of This Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground Water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client’s expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder’s report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder’s report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder’s report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder’s report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder’s responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.