TECHNICAL MEMORANDUM

DATE August 11, 2020 **Project No.** 1534482

TO Taylor Marquis
Nicolls Island Holdings Inc.

FROM Caitlin Cooke **EMAIL** ccooke@golder.com

DESKTOP HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
WRIGHT LANDS, OTTAWA, ONTARIO

This technical memorandum presents the results of a desktop hydrogeological study carried out for the proposed residential development site known as the Wright Lands (the Site), located west of River Road and about 400 metres north of Nicolls Island Road in Ottawa, Ontario. The hydrogeological assessment is required in support of an application to the City of Ottawa for approval of the proposed development.

The purpose of this hydrogeological study was to determine the general soil and groundwater conditions across the Site using existing on-site borehole information and data from nearby sites, and to assess possible construction-related impacts to private water supply wells. The on-site information was enhanced with published mapping and publicly available information. The water well records in the Ministry of the Environment, Conservation and Parks (MECP) Water Well Information System (WWIS) for nearby water wells were used to provide further information regarding hydrogeological conditions in the area and identify the geological deposits from which nearby water well users are taking their water.

1.0 DESCRIPTION OF PROJECT AND SITE

The following information is known about the site and the proposed residential development:

- The Site occupies an area of approximately 200 metres by 200 metres in plan dimension (Site Plan, Figure 1); it consists primarily of undeveloped land with agricultural activities and no associated buildings or structures, and a residential building located on the northeast portion of the Site. The municipal address is 788 River Road. The Site is bounded by a residential building and forested ravine lands to the north; River Road to the east followed by agricultural lands plus some residential houses; vacant land to the south; and the Royal Canadian Mounted Police (RCMP) Campground followed by the Rideau River to the west. The Site has been undeveloped since 1936 (earliest available aerial image) and has remained unchanged until present day except for the house on the northeast portion which was built prior to 1975. This house will be demolished as part of the site development.
- The site is generally flat, with a gentle slope from east to west. A less than 5 metre high slope separates the site from the adjacent lower-lying RCMP Campground. A watercourse flows along the north boundary of the site, within a shallow valley.

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- The site is currently mostly undeveloped with treelines along the north, east and west borders. A line of trees also extends through the middle of the site along a linear drainage feature running north-south.
- It is understood that the site is proposed to be developed into a fully serviced residential subdivision consisting of a number of residential dwellings and a pump station structure to be located at the northeast corner of the site. A preliminary site grading plan by Novatech, dated February 2020, was provided to Golder for the purposes of this study.

2.0 GEOLOGY AND HYDROGEOLOGY

The following sections describe the published local geology and hydrogeology in the vicinity of the site.

2.1 Surficial Geology

Based on published mapping (Figure 2), the surficial geology at the site is interpreted to predominantly consist of a thick deposit of silty clay. Published mapping indicates the bedrock surface to range from about 10 to 15 metres below the ground surface in the vicinity of the site (Figure 3).

2.2 Bedrock Geology

The Ontario Geological Survey bedrock geology mapping indicates that the site is underlain by dolostone of the Oxford Formation (Figure 4).

2.3 Hydrogeology

2.3.1 Overburden Aquifers

The silty clay deposits in the area are generally not capable of supplying sufficient quantities of groundwater to be considered an aquifer. As a result, the principal aquifer within the vicinity of the site is considered to be the underlying bedrock formation.

2.3.2 Bedrock Aquifers

The Oxford formation is frequently found to be a highly transmissive aquifer, and well yields in this formation have been reported between 45 and 115 L/min[1]. Generally, the Oxford Formation provides an adequate resource for domestic water supplies. Groundwater flow in the Oxford formation is controlled predominately by fractures, as the primary porosity has been reduced by cementation.

2.3.3 Local Water Supply Wells

There are ten water wells identified in the MECP WWIS, with a location accuracy of 300 metres or less, located within 100 metres of the site. The locations of the water supply wells in the WWIS are shown on Figure 1.

[1] Golder Associates Ltd., Renfrew County – Mississippi – Rideau Groundwater Study. Prepared for Mississippi Valley Conservation Authority Study Group. September 2003.

3.0 SITE SPECIFIC GEOLOGY AND HYDROGEOLOGY

3.1 General

Golder Associates Ltd. completed a geotechnical investigation at this site in July 2016 and in June 2019, which included eleven boreholes advanced across the site.

Based on a review of this previous investigation and published geological mapping, the subsurface conditions at the site are interpreted to consist of a thin layer of surficial sandy silt underlain by a deposit of stiff (becoming firm with depth) silty clay underlain by glacial till. Available borehole logs are included in Attachment A, and borehole locations are indicated on Figure 1.

3.2 Site Specific Geology

Topsoil

Topsoil exists at ground surface at boreholes 16-4, 16-6, 19-01, 19-02, 19-03, 19-04 and 19-05 and has a thickness ranging from about 120 to 300 millimetres.

Fill

Fill was encountered below the topsoil in borehole 19-01 and generally consists of silty clay with some sand. The fill extends to a depth of 3.5 m below the existing ground surface.

Sandy Silt

A deposit of sandy silt was encountered below the topsoil in boreholes 19-02 and 16-6, as well as at ground surface in boreholes 16-1, 16-2, 16-3, and 16-5. The sandy silt to silty sand extended to depths of between 200 and 600 millimetres below the existing ground surface.

Silty Clay

The topsoil and sandy silt to silty sand, where encountered, is underlain by a thick deposit of sensitive silty clay to clay (generalized hereafter as silty clay). The upper portion of the silty clay has been weathered to a grey brown crust, and extends to depths of between 3.8 and 6.1 metres below the existing ground surface (elevations of 80.2 to 84.5 metres), with a thickness of between 2.0 and 5.9 metres.. A layer of sand and gravel was encountered in borehole 16-4 at a depth of about 5.6 metres below the existing ground surface, with a thickness of about 20 millimetres.

Beneath the weathered zone of silty clay, the clay is grey in colour. The unweathered clay was fully penetrated in borehole 19-01 to a depth of 9.75 metres below the ground surface, while borehole 16-01 proved the unweathered grey silty clay to a depth of 5.3 metres (elevations of 78.7 to 80.2 metres). While the remaining boreholes did not fully penetrate the silty clay layer, the deposit was inferred to extend to depths of between 5.8 and 8.3 metres at these locations.

Glacial Till and Interbedded Sand/Silt/Gravel

A deposit of glacial till was encountered beneath the silty clay at boreholes 16-1 and 19-01, at depths of 5.33 and 9.75 metres, respectively. The glacial till generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt. This layer was not fully penetrated in either borehole, however borehole 19-01 was terminated on inferred bedrock at a depth of about 13.5 metres (Elevation of 75.0 metres).

3.3 Hydrogeology

Standpipe piezometers were sealed into boreholes 16-1, 16-5 and 19-01 to allow subsequent measurement of the groundwater level across the site. The groundwater levels in these standpipe piezometers were measured on August 2, 2016 (boreholes 16-1 and 16-5) and June 26, 2019 (borehole 19-01) and are summarized in the table below:

Borehole Number	Geologic Unit of Screened Interval	Ground Surface Elevation (m asl)	Groundwater Depth (m)	Groundwater Elevation (m asl)
16-1	Glacial till/silty clay	85.54	5.74	79.80
16-5	Silty clay	86.71	2.94	83.77
19-01	Glacial till	88.46	5.05	83.41

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

4.0 POTENTIAL IMPACTS TO EXISTING GROUNDWATER USERS

The greatest potential impacts to private water wells could occur when temporary groundwater control occurs from trenches for site servicing, and from excavations for the pumping station and associated wet well. Based on the preliminary site grading plan provided by Novatech, the maximum depth of the proposed trenches is expected to be approximately 5 metres below ground surface, and excavations for the installation of site services will be made through the topsoil, sandy silt and into the silty clay. The highest measured water levels at the site were found to be approximately 3 metres below ground surface; therefore, dewatering during construction of site services could require up to 2 metres of groundwater level drawdown during dewatering. The radius of influence of groundwater level drawdown during construction dewatering can be estimated using the modified Sichart and Kryieleis equation (Cashman and Preene, 2013, equation 7.15. “Groundwater Lowering in Construction: A Practical Guide to Dewatering” By P.M. Cashman, Martin Preene):

$$R_o = 1750(H - h)\sqrt{K}$$

where R_o represents the radius of influence in metres, H-h represents the amount of groundwater level drawdown in metres and K represents the hydraulic conductivity of the aquifer in metres per second (m/s). Using an assumed hydraulic conductivity for the weathered silty clay (i.e., 1 x 10^{-6} m/s) and assuming a maximum drawdown of 2 metres, the radius of influence is estimated to be less than 5 metres from the service trench.

The pumping station located in the northeast corner of the site has a proposed wet well excavation diameter of 2.4 metres and an invert at elevation 79.8 metres (depth of about 8.6 metres below ground surface). The excavation is expected to be made through the weathered and unweathered silty clay. Construction of the wet well could require about 5.6 metres of groundwater level drawdown during dewatering. The radius of influence of groundwater level drawdown during construction dewatering can be estimated using the Sichart and Kryieleis equation for a non-linear excavation:

$$R_o = 3000(H - h)\sqrt{K}$$

Using an assumed hydraulic conductivity for the silty clay (i.e., 1 x 10^{-6} m/s) and assuming a maximum drawdown of 5.6 metres, the radius of influence is estimated to be 17 metres from the excavation for the wet well.

It is understood that there are no structures or land uses planned for the site that would permanently lower the groundwater levels in the area surrounding the site (i.e., deep drained foundations).

4.1 Groundwater Quantity

Municipal water service terminates on River Road at the north end of the site. It is expected that the majority of wells recorded in the WWIS database in this area are in use. Depending on site conditions, temporary pumping from service trenches can impact local water supplies (potential for short term impact). Based on the geological conditions of the site, the maximum radius of influence associated with dewatering was estimated to be 17 metres; however, to provide a conservative assessment of potential impacts to groundwater users, groundwater use within 100 metres of the site has been reviewed.

There are ten wells in the WWIS database located within 100 metres of the site. Additional wells may be present near the site, and are missing from the WWIS database or have incorrectly recorded locations. Details regarding the water supply wells in the WWIS are presented in the following table. Refer to Figure 1 for the well locations.

Well ID	Depth of Well (m)	Depth to Static Water Level (m)	Depth to Water Found (m)	Available Drawdown (m)	Type of Well
1500334	30.5	7.0	30.5	23.5	Bedrock
1500341	19.8	4.3	19.8	15.5	Bedrock
1500346	22.9	12.2	22.9	10.7	Bedrock
1500336	11.3	-1.8	11.3	13.1	Overburden
1500337	15.8	0.6	15.5	15.2	Overburden
1513511	35.1	6.1	30.2	29.0	Bedrock
1514044	22.9	2.4	22.9	20.4	Bedrock
1516805	25.6	4.6	23.8	21.0	Bedrock
7122643	31.9	7.0	27.3	30.8	Bedrock
7129102	Record of Abandonment				

Two of the wells (1500336 and 1500337) were indicated to be constructed in 1964 to provide water for the RCMP Campground. These two well records indicate that the wells were completed in sand and gravel deposits underlying the silty clay. Well record 7122643 was constructed in 2009 at the RCMP Campground, and was completed in the bedrock underlying the clay. Well record 7129102 is a record of abandonment of a well (likely one of at the 1964 wells) at the RCMP Campground due to insufficient water supply.

The RCMP Campground wells are located about 6 to 7 metres lower in elevation than the site. Therefore, excavations on the Site will likely be completed above the elevation of the top of casing elevation of the RCMP Campground wells, and it is considered unlikely that construction dewatering from service trenches at the site could temporarily reduce the available drawdown in these wells.

The remaining six well records are for residential wells along River Road, and all six wells are completed into the bedrock. The available drawdown in these six wells (calculated as the difference between the static water level and the depth of the well) has a range of 10.7 to 29.0 metres, with an average of 20.0 metres. It is expected that all local wells are similarly constructed. Based on aerial photography, the nearest water supply well is estimated to be approximately 10 to 15 metres from the Site boundary, and therefore is not within the calculated radius of influence of construction dewatering. Therefore, the installation of site services is not expected to adversely affect the performance of any local water supply wells.

Prior to construction at the site, it is recommended that a well survey be completed of the residences with wells located within approximately 100 metres of the property boundary to verify well construction details. Information to be collected during the well survey could include the depth of the well, type of pump, and static water level.

4.2 Groundwater Quality

The temporary nature of the proposed construction dewatering will not result in significant short term or long-term changes in groundwater flow patterns; as a result, impacts to water quality at active water supply wells are not anticipated.

5.0 LIMITATIONS AND USE OF MEMORANDUM

This technical memorandum was prepared for the exclusive use of Nicolls Island Holdings Inc. and the City of Ottawa. The technical memorandum, which specifically includes all tables, figures and appendices, is based on data gathered by Golder Associates Ltd., and information provided to Golder Associates Ltd. by others. The information provided by others has not been independently verified or otherwise examined by Golder Associates Ltd. to determine the accuracy or completeness. Golder Associates Ltd. has relied in good faith on this information and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the information as a result of omissions, misinterpretation or fraudulent acts.

The services performed as described in this technical memorandum were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this technical memorandum, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made, or actions taken based on this technical memorandum.

6.0 CLOSURE

We trust this submission satisfies the requirements for a desktop hydrogeological assessment of the proposed residential development at the Wright Lands in Ottawa, Ontario. If you have any questions regarding this report, please contact the undersigned.

Golder Associates Ltd.

PROFESSIONAL GEOSCIENTIST
CAITLIN A. MARTIN COOKE
PRACTISING MEMBER
1481
Aug. 12/20
ONTARIO

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Senior Geo-Environmental Engineer

CAMC/PAS/sg
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Attachments: Figures 1 to 4
Attachment A – Record of Borehole Sheets

LEGEND

- APPROXIMATE BOREHOLE LOCATION
- PROPOSED BOREHOLE LOCATION
- MECP WWIS LOCATION
- SITE
- 100 METRE BUFFER AROUND SITE
- FENCE
- ROADWAY
- INTERMITTENT WATERCOURSE
- PERMANENT WATERCOURSE
- TOPOGRAPHIC CONTOUR, ELEVATION IN METRES ABOVE SEA LEVEL
- WETLAND
- WATERBODY
- PROPERTY PARCEL

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
2. SERVICE LAYER CREDITS:
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

0 40 80 160

1:4,000 METRES

CLIENT
NICOLLS ISLAND HOLDINGS INC.

PROJECT
WRIGHT LANDS HYDROGEOLOGY STUDY

TITLE
SITE PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2020-08-11
DESIGNED	----
PREPARED	BR
REVIEWED	CAMC
APPROVED	PAS

PROJECT NO.	PHASE	REV.	FIGURE
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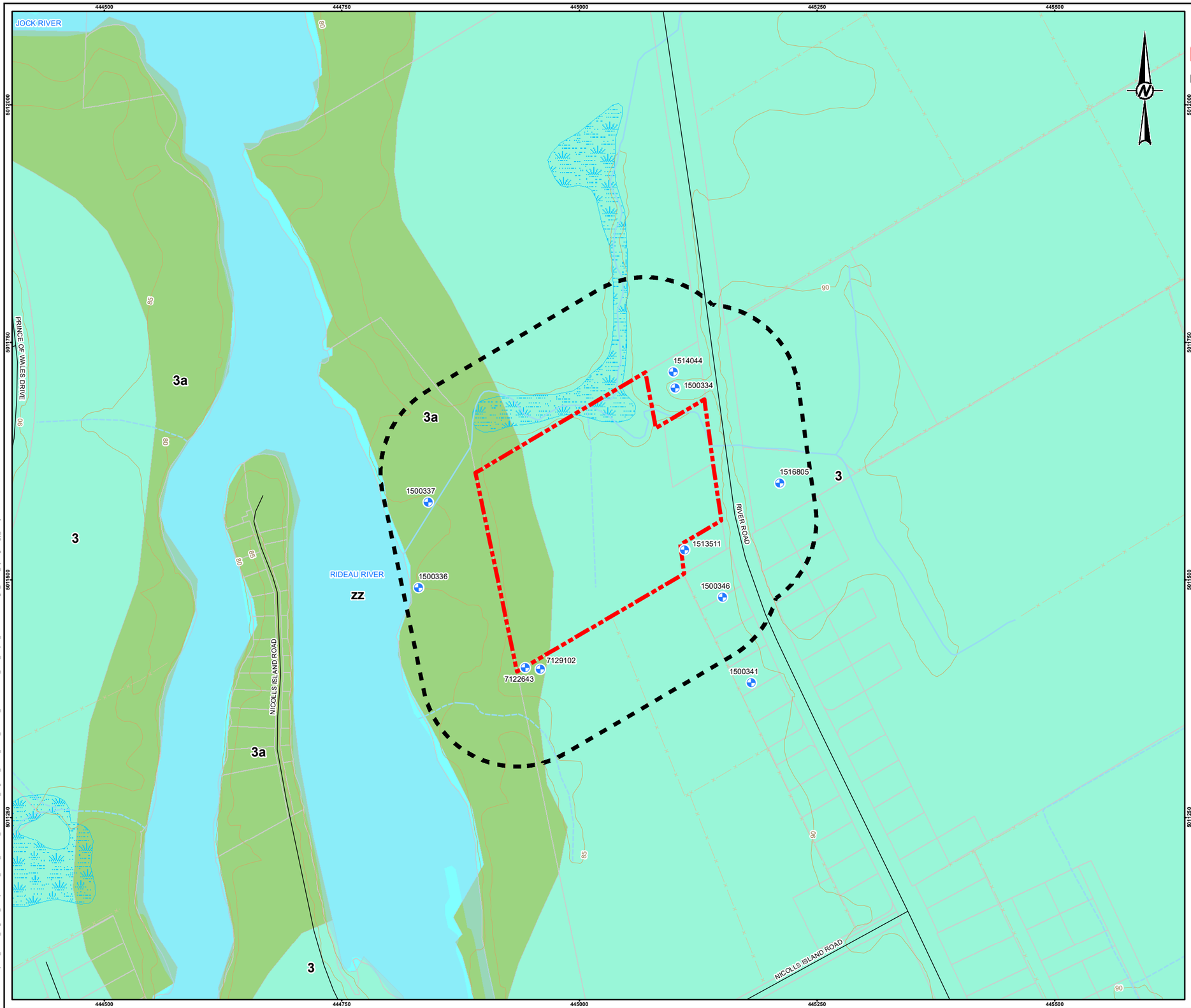

LEGEND

- MECP WWIS LOCATION
- SITE
- 100 METRE BUFFER AROUND SITE
- FENCE
- ROADWAY
- INTERMITTENT WATERCOURSE
- PERMANENT WATERCOURSE
- TOPOGRAPHIC CONTOUR, ELEVATION IN METRES ABOVE SEA LEVEL
- WETLAND
- WATERBODY
- PROPERTY PARCEL
- 3. OFFSHORE MARINE DEPOSITS: CLAY, SILTY CLAY & SILT
- 3a. OFFSHORE MARINE DEPOSITS: CLAY, SILT UNDERLYING EROSIONAL TERRACES
- zz. WATERBODY

REFERENCE(S)

1. BÉLANGER, J. R. 2008 URBAN GEOLOGY OF THE NATIONAL CAPITAL AREA, GEOLOGICAL SURVEY OF CANADA, OPEN FILE 5311, 1 DVD.
2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

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1:4,000 METRES

CLIENT
NICOLLS ISLAND HOLDINGS INC.

PROJECT
WRIGHT LANDS HYDROGEOLOGY STUDY

TITLE
SURFICIAL GEOLOGY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-08-11
DESIGNED	----
PREPARED	BR
REVIEWED	CAMC
APPROVED	PAS

PROJECT NO.	PHASE	REV.	FIGURE
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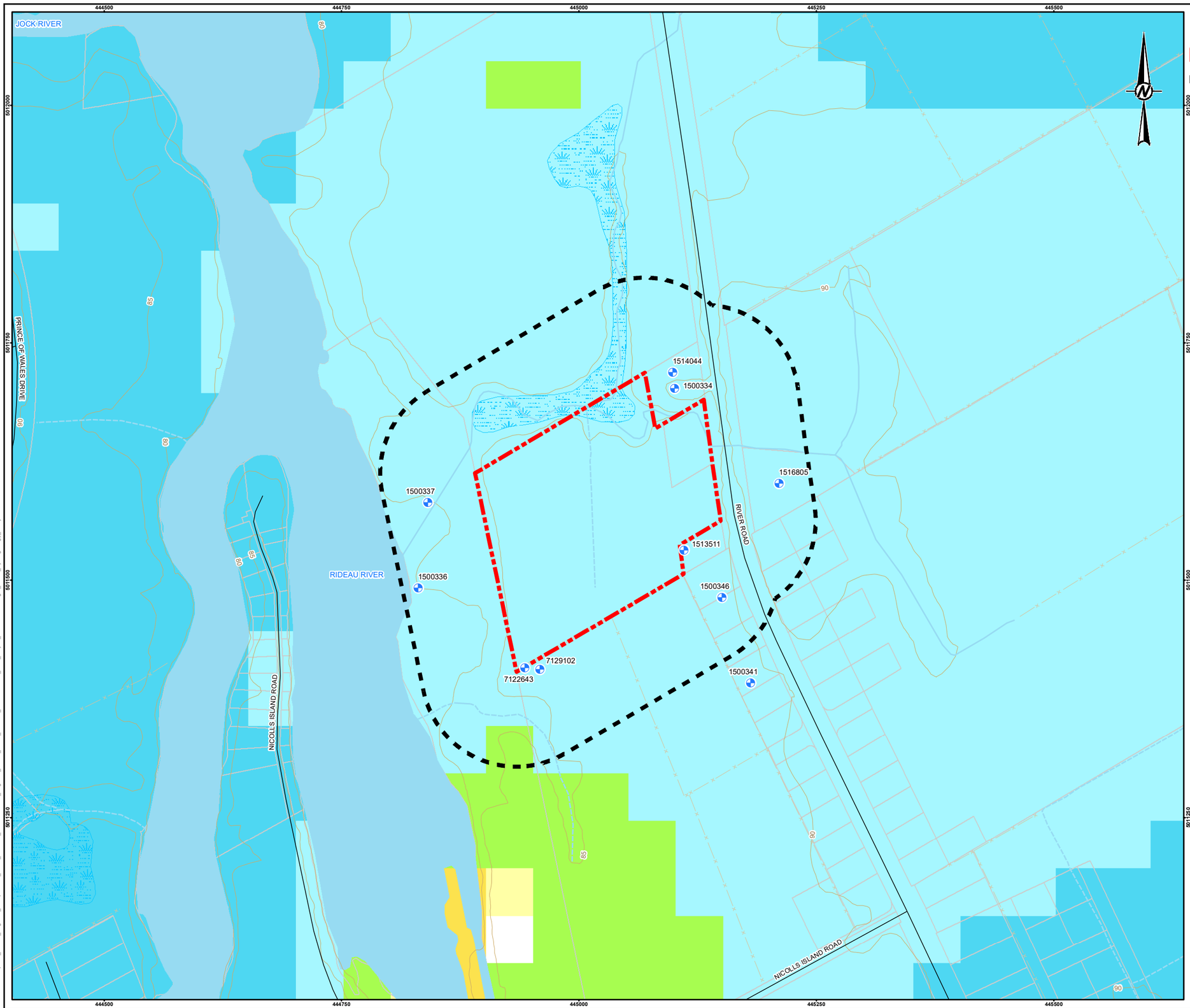

LEGEND

- MECP WWIS LOCATION
- SITE
- 100 METRE BUFFER AROUND SITE
- FENCE
- ROADWAY
- INTERMITTENT WATERCOURSE
- PERMANENT WATERCOURSE
- TOPOGRAPHIC CONTOUR, ELEVATION IN METRES ABOVE SEA LEVEL
- WETLAND
- WATERBODY
- PROPERTY PARCEL

GSC TREND IN DEPTH TO BEDROCK (METRES)

- 1 to 2
- 2 to 3
- 3 to 5
- 5 to 10
- 10 to 15
- 15 to 25

REFERENCE(S)

1. 2010 BÉLANGER, J. R., URBAN GEOLOGY OF THE NATIONAL CAPITAL AREA, GEOLOGICAL SURVEY OF CANADA, OPEN FILE D3256, 2001
2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

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1:4,000 METRES

CLIENT
NICOLLS ISLAND HOLDINGS INC.

PROJECT
WRIGHT LANDS HYDROGEOLOGY STUDY

TITLE
DRIFT THICKNESS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-08-11
DESIGNED	----
PREPARED	BR
REVIEWED	CAMC
APPROVED	PAS

PROJECT NO.	PHASE	REV.	FIGURE
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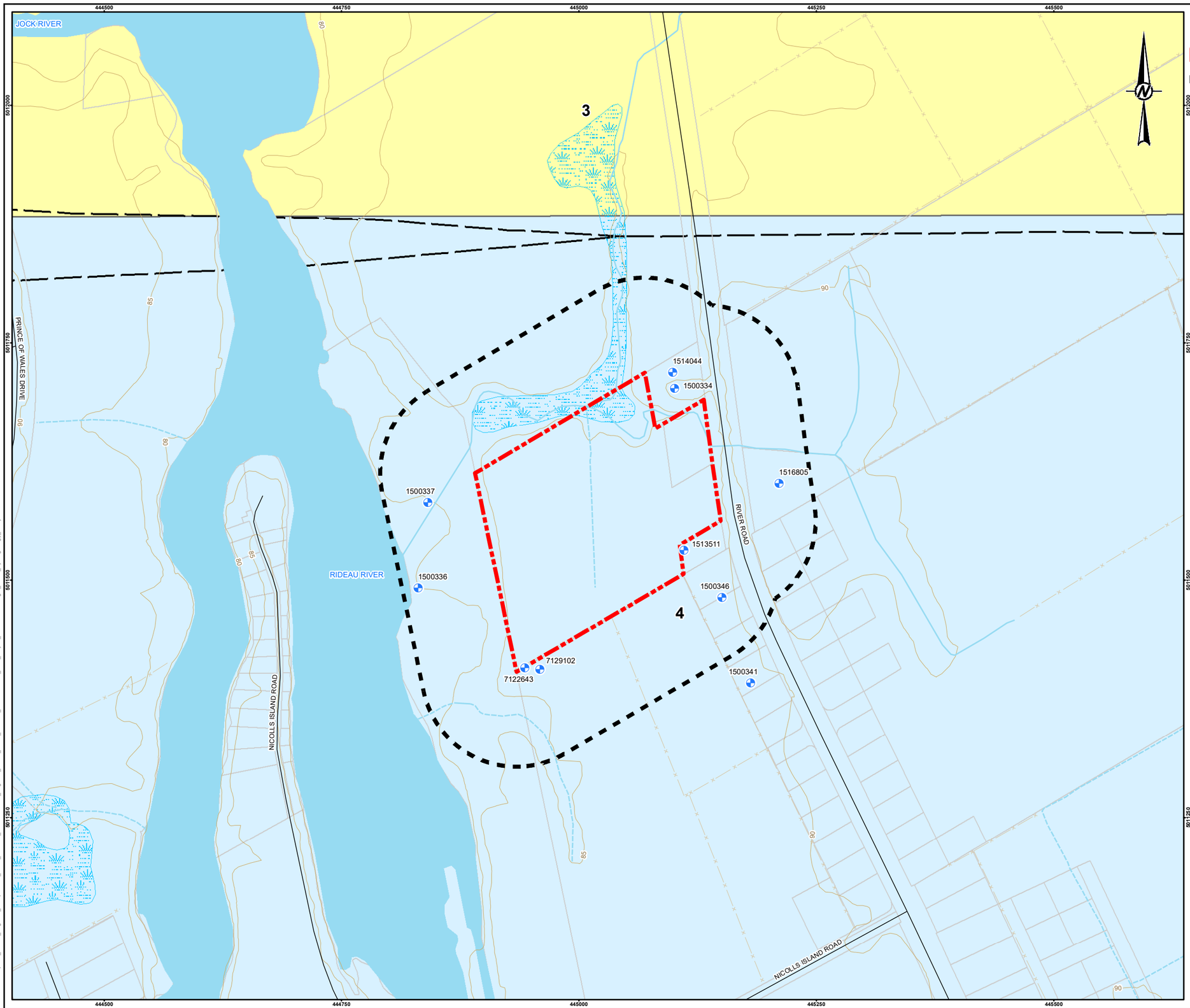

LEGEND

- MECP WWIS LOCATION
- SITE
- 100 METRE BUFFER AROUND SITE
- FENCE
- ROADWAY
- INTERMITTENT WATERCOURSE
- PERMANENT WATERCOURSE
- TOPOGRAPHIC CONTOUR, ELEVATION IN METRES ABOVE SEA LEVEL
- WETLAND
- WATERBODY
- PROPERTY PARCEL
- FAULT
- 4. OXFORD FORMATION: SUBLITHOGRAPHIC TO FINE CRYSTALLINE DOLOSTONE
- 3. MARCH FORMATION: INTERBEDDED QUARTZ SANDSTONE, SANDY DOLOSTONE, AND DOLOSTONE

REFERENCE(S)

1. BÉLANGER, J. R., URBAN GEOLOGY OF THE NATIONAL CAPITAL AREA, GEOLOGICAL SURVEY OF CANADA, OPEN FILE D3256, 2001.
2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

0 40 80 160
1:4,000 METRES

CLIENT
NICOLLS ISLAND HOLDINGS INC.

PROJECT
WRIGHT LANDS HYDROGEOLOGY STUDY

TITLE
BEDROCK GEOLOGY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-08-11
DESIGNED	----
PREPARED	BR
REVIEWED	CAMC
APPROVED	PAS

PROJECT NO.	PHASE	REV.	FIGURE
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ATTACHMENT A

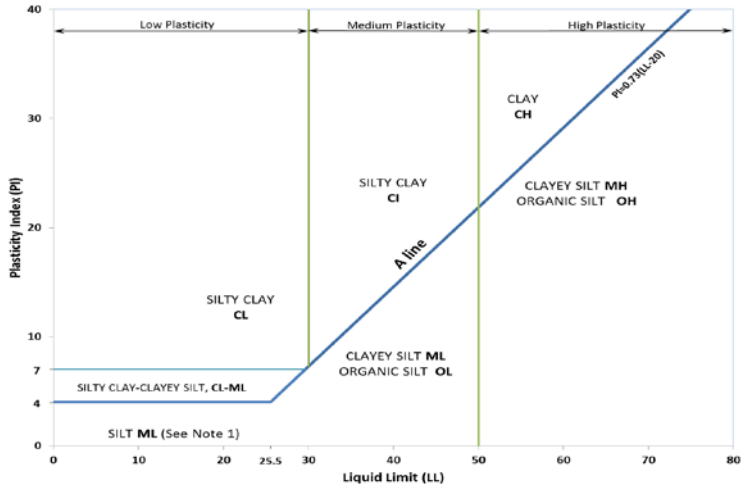
Record of Borehole Sheets

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	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	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: 1534482

RECORD OF BOREHOLE: 16-1

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 20, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		85.54							
0	Power Auger 200 mm Diam. (Hollow Stem)	(ML) sandy SILT; brown: non-cohesive, moist, loose		0.00	1	SS	8				Bentonite Seal
				84.93							
1		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); non-cohesive, w>PL; very stiff		0.61	2	SS	14				
2					3	SS	11				Native Backfill and Bentonite
					4	SS	8				
3					5	SS	6				
4					6	SS	7				Bentonite Seal
											Silical Sand
5					7	SS	5				
				80.21							Standpipe
		(ML) sandy SILT, some gravel; grey (GLACIAL TILL); non-cohesive, wet, loose to compact		5.33	8	SS	10				
6				79.44							
		End of Borehole		6.10							WL in Standpipe at Elev. 79.80 m on Aug. 2, 2016
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 6/18/19 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 16-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 21, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.15							
0	Power Auger 200 mm Diam. (Hollow Stem)	(ML) sandy SILT; brown; non-cohesive, moist, compact		0.00	1	SS	11				
				86.54							
		(CI/CH) SILTY CLAY to CLAY, trace sand; grey brown, contains silty sand seams; cohesive, w>PL, very stiff		0.61							
1					2	SS	8				
					3	SS	6				
2					4	SS	4				
3					5	SS	4				
4					6	SS	4				
				82.58							
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff		4.57	7	SS	WH	⊕ ⊕ + +			
5											
6					8	SS	1				
7								>96+			
					9	SS	4				
				79.23							
8		End of Borehole		7.92							
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 6/18/19 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 16-3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 20, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	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) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.87							
0	Power Auger 200 mm Diam. (Hollow Stem)	(ML) sandy SILT; brown; non-cohesive, moist, loose		0.00	1	SS	8				
				86.26							
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff		0.61							
1					2	SS	8				
					3	SS	8			CHEM	
2					4	SS	5				
3					5	SS	6				
4					6	SS	5				
					7	SS	3				
5					8	SS	4				
6				80.77							
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff		6.10	9	SS	1				
7					10	SS	3				
8					11	SS	5				
				78.59							
		End of Borehole		8.28							
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 6/18/19 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 16-4

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 20, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.57							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND, trace gravel; dark brown; non-cohesive, moist, loose		0.00 86.34							
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff		0.23	1	SS	7				
1					2	SS	9				
2					3	SS	5				
					4	SS	5				
3					5	SS	6				
4					6	SS	4				
					7	SS	4				
5					8	SS	10				
				80.93							
		(SP/GP) SAND and GRAVEL; grey brown; non-cohesive		5.66							
6		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff		80.47 6.10	9	SS	2				
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff						⊕ +	>96+		
7				79.25							
		End of Borehole		7.32							
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 6/18/19 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 16-5

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 20, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.71							
0	Power Auger 200 mm Diam. (Hollow Stem)	(SM) SILTY SAND, trace clay; grey brown; non-cohesive, moist, loose		0.00	1	SS	6				Bentonite Seal
				86.10							
1		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff		0.61	2	SS	6				
					3	SS	4				
2					4	SS	4				Native Backfill and Bentonite
3					5	SS	3				
				82.90							
4		(CI/CH) SILTY CLAY to CLAY, trace sand; grey; cohesive, w>PL, firm		3.81	6	SS	1				Bentonite Seal
											Silical Sand
5								⊕ + ⊕ +			
					7	SS	WH				Standpipe
6				80.61							
		End of Borehole		6.10							WL in Standpipe at Elev. 83.77 m on Aug. 2, 2016
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 6/18/19 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 16-6

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 21, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		88.42							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive, moist		0.00							
				88.12	1	SS	10				
		(ML) sandy SILT; brown; non-cohesive, moist, loose		0.30							
				87.81							
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff		0.61							
1					2	SS	8				
					3	SS	4				
2											
					4	SS	3				
					5	SS	2				
3											
				84.46					>96+		
4		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm to stiff		3.96							
					6	SS	1	⊕ +	○		
5								⊕ +			
				82.62							
		End of Borehole		5.80							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 6/18/19 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 19-01

SHEET 1 OF 2

LOCATION: N 5011640.9 ;E 445126.2

BORING DATE: June 6, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		88.46							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown, contains organics		0.00							Flush Mount Casing
		FILL - (CL) SILTY CLAY, some sand; grey brown, contains organics and bricks; cohesive, w>~PL, stiff		0.12							Silica Sand
1					1	SS	2				Bentonite Seal
					2	SS	4				
2											
					3	SS	2				
3											
					4	SS	3				
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, stiff to very stiff		84.95 3.51							
4					5	SS	3				
					6	SS	2				Native Backfill and Bentonite Mix
5											
		(CI/CH) SILTY CLAY; grey; cohesive, w>PL, stiff		82.97 5.49							
6					7	SS	WH				
7											
		(CI, CL-ML) SILTY CLAY to CLAYEY SILT; grey, layered; cohesive, w>PL, stiff to very stiff		80.84 7.62							
8					8	SS	3				
9					9	SS	1				Bentonite Seal
				78.71 9.75							
10					10	SS	11				
		CONTINUED NEXT PAGE									

DEPTH SCALE
1 : 50

GOLDER

LOGGED: PAH
CHECKED: AL

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 19-01

SHEET 2 OF 2

LOCATION: N 5011640.9 ;E 445126.2

BORING DATE: June 6, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger 200 mm Diam. (Hollow Stem)	(ML) sandy SILT, some gravel, low plasticity fines; grey, contains cobbles and occasional silty sand layers (GLACIAL TILL); non-cohesive, wet, compact			10	SS	11		○		Bentonite Seal
11					11	SS	24		○		Cave Silica Sand
12					12	SS	11		○		38 mm Diam. PVC #10 Slot Screen
13				74.95 13.51							
		End of Borehole Auger Refusal									WL in screen measured at 5.05 m (Elev. 83.40 m) on Jun. 6, 2019
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: PAH
CHECKED: AL

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 19-02

SHEET 1 OF 1

LOCATION: N 5011595.6 ;E 445032.9

BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.38							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND, fine; dark brown, contains organic matter		0.00 / 87.18							
		(SM) SILTY SAND, fine; brown; non-cohesive, moist, loose		0.20 / 86.92							
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff		0.46							
1					1	SS	5				
2					2	SS	8				
3					3	SS	6				
				83.42				>96+			
4		End of Borehole		3.96							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 19-03

SHEET 1 OF 1

LOCATION: N 5011568.5 ;E 444961.9

BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.10							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown, contains organic matter		0.00							
				86.90							
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff		0.20							
1					1	SS	6				
2					2	SS	4				
3					3	SS	5				
				83.14				>96+			
4		End of Borehole		3.96							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 19-04

SHEET 1 OF 1

LOCATION: N 5011487.0 ;E 444979.9

BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.77							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown, contains organic matter		0.00 86.54							
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff		0.23							
1					1	SS	4		W		
2					2	SS	6		W		
3					3	SS	5		W		
				82.96				>96+			
		End of Borehole		3.81							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS

PROJECT: 1534482

RECORD OF BOREHOLE: 19-05

SHEET 1 OF 1

LOCATION: N 5011523.6 ;E 445053.6

BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.58							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown, contains organic matter		0.00 / 87.33							
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff		0.25							
1					1	SS	6		W		
2					2	SS	4		W		
3					3	SS	5		W		
				83.62				>96+			
4		End of Borehole		3.96							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS