REPORT

Supplemental Hydrogeological Investigation

Newtonville Estates, Part of Lot 7, Concession 1, Newtonville, Ontario

Submitted to:

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by The Veltri Group (Veltri, or Proponent) to carry out a supplemental hydrogeological investigation for proposed additional residential lots at the existing Newtonville Estates residential development (also known as the Payne Farm Development). The 30.3 hectare (ha) Newtonville Estates development (Site) is located at Part of Lot 7, Concession 1, Town of Newcastle (Clarke), Village of Newtonville, Ontario, as shown on the Site Map, Figure 1, attached. Authorization to proceed was provided by Mario Veltri on August 10, 2018.

The factual data, interpretations and recommendations contained in this report 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 report should be read in conjunction with the attached "Important Information and Limitations of This Report", 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 report.

1.1 Background

Golder has previously carried out geotechnical and hydrogeological investigations at the Site related to the approved 39-lot Newtonville Estates residential development. Two of our previous reports are referenced below:

- Golder Associates Ltd., July 4, 1989. *Preliminary Geotechnical and Hydrogeological Evaluation, Proposed Residential Subdivision, Part of Lot 7, Concession 1, Town of Newcastle, (Clarke), Village of Newtonville, Ontario*. Golder Reference Number 891-8029-1. (“Golder 1989”); and,
- Golder Associates Ltd., November 12, 1991. *Hydrogeological Investigation, Proposed Veltri (Payne) Residential Subdivision, Newtonville, Ontario, MOE File 18T 89048*. Golder Reference Number 891-8029-2. (“Golder 1991”).

The reader is referred to these reports for details of the subsurface investigations that have been carried out at the Site. The residential lots at the Site are serviced with municipally-supplied water and have individual private sewage (i.e., septic) systems. A previous nitrate loading assessment is presented in Golder 1991, which recommended a maximum of 40 developable lots. Through the peer and regulatory review process, the final number of lots approved for the Site was amended to 39. The subdivision subsequently proceeded to be developed in two phases, and the layout of the 39 lots and associated stormwater management pond are shown on Figure 1.

Veltri has indicated plans to convert the existing stormwater management pond (SWMP), as yet unassumed by the municipality, from a wet pond facility to an infiltration facility. In this regard, the following redesign report was provided to Golder for reference:

- GHD, June 2018. *Newtonville Estates Phase II, Stormwater Management Facility Redesign*. Reference No. 11277.

The reader is referred to this report for additional details. It is understood that the above report has been submitted to the Municipality of Clarington in support of the redesign. The redesign is based on stated observations that the current pond does not maintain a permanent pool elevation due to the infiltration of stormwater through the bottom of the facility. It is proposed to raise the invert of the facility from its current elevation of approximately 145.4 m above sea level (masl) to 146.25 masl through the importation and placement of clean sand fill.

A copy of Municipality of Clarington Zoning By-Law 84-63, Schedule 16 (Newtonville), is provided in Appendix B. The zoning designation for the Site and adjacent lands is also shown on Figure B-1, Appendix B. The two phases of the subdivision are designated Residential “RH-17”. Lands zoned Environmental Protection “EP-9” are present on the south end of the Site and include the stormwater management pond block. Lands zoned Environmental Protection “EP-7” are centrally located on the east half of the Site and were designated as such to provide additional nitrate dilution area for the 39 existing lots.

Golder was retained to carry out a nitrate loading assessment for the purpose of determining if Site conditions would support the development of additional lots in the EP-7 block (i.e., the Lots) from a groundwater quality impact perspective. In this regard, Veltri has provided a concept drawing for a cul-de-sac with adjoining residential lots on the EP-7 block (see Figure 1). It is noted that the concept plan shows the proposed lots extending into the EP-9 lands to the south of the EP-7 block; this assessment assumes that the development area will be limited to the EP-7 block. This assessment considers the modified concept plan, assesses the feasibility of utilizing surface or subsurface Low Impact Development (LID) measures, considers infiltration contributions from the proposed infiltration facility, and includes a water balance to estimate post-development infiltration rates for the entire 30.3 ha Site and the 4.69 ha EP-7 block.

1.2 Scope of Work

The scope of work for the supplemental hydrogeological investigation included the following main tasks:

- A desktop review of MECP water well records to assess the potential for potable groundwater use hydraulically downgradient of the Site, and a windshield reconnaissance to assess the potential for potable groundwater use on hydraulically downgradient properties;
- A site visit to visually assess hydrogeological conditions at the Site including the Environmental Protection lands hydraulically downgradient of the SWMP;
- Drilling of boreholes at three locations, including the installation of i) one monitoring well in the EP-7 lands; ii) one monitoring well within the SWMP block, and iii) one bi-level monitoring well within the SWMP block;
- Monitoring of groundwater levels at the new monitoring well locations, plus one existing monitoring well installed by others and designated as “BH4” (see Figure 1) on three events, and estimate the water elevation in the SWMP;
- Collecting of one groundwater sample from each of two monitoring wells, and of two surface water samples from the SWMP, for the analysis of nitrate concentrations;
- Single well response testing (i.e., rising head tests) at two monitoring well locations;
- Use of the Guelph Permeameter apparatus to estimate the infiltration rate of the native soils above the water table at four locations;
- Assess the feasibility of implementing lot-level LID features and to re-classify the SWMP as an infiltration pond; and
- Preparation of this supplemental hydrogeological investigation report.

It is understood that this report will be submitted as part of a Draft Plan of Subdivision application process.

2.0 SITE AND PROJECT DESCRIPTION

2.1 Site and Project Description

The 30.3 ha Site is currently comprised of the following land uses:

Designation	Area (ha)	Description
RH-17	12.69 ha	Existing 39-lot subdivision, including portions of Jones Avenue and Charles Tilley Crescent
SWM Pond block	0.98 ha	Existing SWM Pond block
EP-7	4.69 ha	Currently vacant, undeveloped land with some stockpiled fill and tree cover near border with EP-9 lands. This block is proposed to be redeveloped with residential lots fronting on a cul-de-sac. The new lots are shown to be of similar size or larger than the 39 existing lots.
EP-9	11.98 ha	Mainly forested land zoned for environmental protection

The Site is bordered by similar residential lots to the north, the George Burley Street road allowance followed by undeveloped lands to the east, Highway 401 to the south, and by a residential subdivision under construction/contiguous forested lands to the west. The Lots are bounded by adjacent portions of the Newtonville Estates subdivision to the north and west, the EP-9 lands to the south, and by an unopened portion of the George Burley Street road allowance to the east.

The following development concept plan was provided to Golder and considered in this investigation:

- Clark Consulting Services, January 2018. *Figure 2 - Development Concept [Combined] – Newtonville Hamlet Expansion*. Paynes Crescent and George Burley Street, Newtonville, Ontario. It is noted that the proposed residential development to the east of George Burley Street is excluded from this assessment.

A copy of the concept plan is provided in Appendix B.

Similar to the rest of the Site, the Lots are to be serviced with municipal water supply and individual private sewage systems. No storm sewer is planned to be installed as part of the development.

2.2 Topography and Drainage

Published topographic mapping of the Site and vicinity is shown on Figure 1. The Site grade slopes gently to the southeast, from an elevation of approximately 154 m above sea level (masl) in the northwest corner to approximately 141 masl in the southeast corner. The Lots are located centrally on the east side of the Site at intermediate elevations.

Based on Golder's review of existing mapping and a Site visit on November 29, 2018, there are no watercourses mapped on the Lots, and none were observed. Visual indications of groundwater seepage resulting in tributary streams flowing in a southeasterly direction was observed in the southeast corner of the Site.

The Site is located within the West Lake Ontario watershed. Tributary flow from the Site and adjacent lands generally flow to the south and west and eventually to Lake Ontario (Trent Conservation Coalition Source Protection Region, 2014).

According to on-line information available from the Ministry of Natural Resources and Forestry (MNRF) (https://www.ontario.ca/page/make-natural-heritage-area-map) the south half of the Site is mapped as located within the Natural Heritage System, although the lands zoned EP-9 are smaller in area and do not extend as far north as indicated on the MNRF mapping. Two areas mapped as unevaluated wetland, totalling 6.41 ha, are located on the Site (i.e., not on the Lots) and typically below an elevation of approximately 146 masl to 148 masl. An assessment of the conditions in the wetland areas on the Site was outside of this scope of services.

2.3 Geology

According to geologic mapping (Ontario Geological Survey (OGS), 2010: *Surficial Geology of Southern Ontario,* MRD128-Revised, Scale 1:50,000) the surficial geology at the Site and vicinity consists of glaciolacustrine coarse textured deposits of sand and gravel with minor silt and clay which are shown to discontinuously overlie a drumlinized till plain, being located in the low areas between outcropping drumlins. Surficial soils on the Lots and most of the Site are mapped as the glaciolacustrine unit. Outcropping glacial till is mapped in the southwest corner of the Site, although the till is not mapped as a drumlin in this instance.

2.4 Water Well Records/Groundwater Use

Based on a search of the Ministry of the Environment, Conservation and Parks (MECP) water well record database, 47 water wells are recorded within approximately 500 m of the Site, dated between March 1957 and July 2015. It is noted that historically there was not a requirement to register dug wells with the MECP, and they can be under-represented in the water well record database. The recorded wells are comprised of 27 large diameter dug/bored wells, 15 small diameter drilled wells, and 5 records of abandonment which are not included in the following statistics. Five of the wells are recorded with public or municipal use, and the remainder are recorded with domestic use. The reported locations of the wells are shown on Figure C-1, Appendix C, and a tabulated summary of the water well record data is also provided in Appendix C.

Based on the well record information, water wells constructed within 500 m of the Site utilize three main zones of confined sand or sand and gravel aquifers that range in depth from approximately 4.9 m to 13.1 m (27 wells), 16.5 m to 29.0 m (8 wells), and the confined limestone bedrock aquifer or an overlying aquifer at depths of approximately 60.0 m to 77.1 m (7 wells).

One dug well (constructed in January 1966), one bored well (constructed in May 1963), one drilled well (constructed in November 1959), and one record of abandonment (August 2014) plot within the Site limits. The 39 lots of the Newtonville Estates are supplied with municipal water, and therefore the water wells, if they exist, are not in use as a potable source.

The two drilled wells (11.9 m and 76.2 m deep) recorded with municipal use are mapped on Paynes Crescent to the north of the Site. No obvious municipal well houses were observed on Paynes Crescent, and these are not inferred to be municipal water supply wells for Newtonville. This corroborates our understanding that the source of municipal water in Newtonville is Lake Ontario.

Shallow dug and bored wells are generally the most susceptible to changes in water quality and quantity resulting from climatic fluctuations and surficial contaminant sources. Based on the water well record database there no water well records within 500 m of the Site in a hydraulically downgradient direction (i.e., to the southeast).

On October 23, 2018 Golder also carried out a drive-by survey of potential groundwater users from publicly accessible areas within approximately 500 m of south half of the Site (i.e., in a hydraulically downgradient direction). Other information on file from another private well survey in the area was also considered. Eight private water wells were observed during the water well survey, as shown on Figure C-1, Appendix C. It is noted that the locations of the observed wells on Figure C-1 denote properties where wells were observed, but do not show the location of the well on those properties. One was a small diameter drilled well, and seven were large diameter concrete well casings assumed to be dug or bored wells. Six wells were located on residential lands along Highway 2 or Paynes Crescent to the north (hydraulically upgradient) and between 25 m to 325 m from the Site. The remaining two wells were located on residential lands along Newtonville Road, west of the Site (hydraulically cross-gradient), 300 m from the Site. It is noted that dug or bored and drilled wells were also observed along Concession Road 2 (south of Highway 401), hydraulically downgradient of the Site, outside of the 500 m radius.

In summary, no active use of water wells was identified on the Site, and none is expected within 500 m in a hydraulically downgradient direction (i.e., to the southeast). The lands to the southeast of the Site are comprised of undeveloped, forested, roadway (Highway 401), and agricultural land uses. Private well use, comprised of a mix of shallow dug/bored and deeper drilled wells was observed or may be expected on Paynes Crescent and George Burley Street to the north of the Site, and within the Newtonville community to the west and northwest.

3.0 SITE CHARACTERIZATION

3.1 Borehole Drilling and Monitoring Well Installation

The field investigation locations from Golder's previous work at the Site (see Section 1.1) are shown on Figure 1. Copies of the Record of Borehole Sheets, test pit logs, and grain size distribution test results are provided in Appendix D for convenience.

The drilling program for the current supplemental hydrogeological investigation was carried out in June 2018, at which time boreholes BH18-1-W, BH18-2-W and BH18-3-W were advanced at the locations shown on Figure 1. A total of four nominal 50 mm diameter monitoring wells were installed in the boreholes to permit further monitoring of groundwater conditions at the Site, including a bi-level installation at BH18-3-W.

The boreholes were drilled using a track-mounted drill rig supplied and operated by a specialist drilling contractor and subcontracted to Golder. Standard Penetration Testing (SPT N-values) and sampling were carried out at regular depth intervals in the boreholes using conventional nominal 35 mm internal diameter split spoon sampling equipment. Where applicable, the shallow groundwater conditions were noted in the open boreholes during drilling.

The drilling of the boreholes was observed by Golder technical staff who logged the boreholes and collected the recovered soil samples. All of the soil samples obtained during this investigation were brought to our Whitby laboratory for further examination and selective soil classification testing.

Record of Borehole sheets are provided in Appendix D. Grain size distribution curves for selected soil samples are also provided in Appendix D. It is noted that the boundaries between the strata have been inferred from drilling observations and non-continuous samples. They generally represent a transition from one soil type to another and should not be inferred to represent an exact plane of geological change. Further, conditions will vary between and beyond the boreholes.

The four new monitoring wells, an existing monitoring well known as BH4, and the stage elevation of the SWM Pond forebay and main cell were surveyed by J.D. Barnes Limited on November 7, 2018. It is understood that the elevation data provided to Golder were surveyed relative to a geodetic datum.

3.2 Soil Conditions

Based on the results of the previous investigations (see Section 1.1), the subsurface conditions encountered are typically comprised of sand to silty sand of varying thickness overlying glacial till ranging in grain size distribution from silty sand till to sandy silt till. The sand/silty sand unit was locally absent at some historical test pit locations (e.g., TP91-19, TP 91-21 and TP91-22) where the glacial till is inferred to outcrop at surface. Test pits were terminated in the glacial till typically on the north and northwest portions of the Site, with some exceptions. The surficial sand to silty sand unit extended beyond the depth of investigation at other locations, typically in the east and south portions of the Site.

The soils encountered as part of the current investigation corroborate mapped geological conditions (see Section 2.3). Subsurface conditions encountered at borehole BH18-1-W, located on the Lots, are comprised of topsoil underlain by sand to a depth of 2.9 m below ground surface (mbgs), underlain by silt and sand to a depth of 4.0 mbgs, underlain by sand to the terminal borehole depth of 6.6 mbgs. Subsurface conditions encountered at: borehole BH18-2-W, located on the SWM Pond block, are comprised of topsoil underlain by silty sand to sandy silt to the terminal borehole depth of 6.6 mbgs; and at borehole BH18-3-W are comprised of topsoil underlain by non-cohesive (i.e., gravelly sand to sand) and cohesive (i.e., gravelly silty clay and sand) fill materials to a depth of 2.1 mbgs, underlain by sand to silty sand to a depth of 4.1 mbgs, underlain by gravelly silty clay and sand till to a depth of 5.6 mbgs, underlain by sand to the terminal borehole depth of 8.1 mbgs.

3.3 Water Level Monitoring

Groundwater depths and elevations were measured in the four new monitoring wells (BH18-1-W to BH18-3-W(d)) and existing monitoring well BH4 on up to four dates: October 3, October 12, October 17 and October 23, 2018. Groundwater measurements are summarized in Table E-1, Appendix E. The depths to groundwater ranged from 2.24 m below ground surface (mbgs) to 4.22 mbgs (BH18-2-W on October 3, 2018 and BH4 on October 23, 2018, respectively), and from elevations of 145.07 masl to 147.55 masl (BH18-3-W(d) on October 23, 2018 and BH4 on October 17, 2018, respectively). The vertical hydraulic gradient at the bi-level installation at BH18-3 was downward on both dates measured in October 2018. Groundwater elevations at the monitoring well locations and the inferred piezometric contours on October 23, 2018 are shown on Figure 1. As shown, the inferred groundwater flow direction at the Site is toward the southeast.

The stage elevations of the SWM Pond was surveyed by J.D. Barnes on November 7, 2018. The water in the forebay was surveyed at an elevation of 145.68 masl, and the water in the main cell was surveyed at an elevation of 145.55 masl.

The recorded water levels reflect the groundwater conditions on the dates they were measured, and seasonal and annual fluctuations should be expected.

3.4 Hydraulic Testing

To estimate the bulk hydraulic conductivity (K) of the soil materials adjacent to the screened intervals at selected monitoring wells, a single well response test (i.e., a rising head test) was carried out at each of BH18-1-W (located on the Lots), and BH18-3-W(s) and BH18-3-W(d) (located in the SWM Pond block).

The tests were carried out by rapidly purging a known volume of water with a dedicated Waterra tube and footvalve and monitoring the subsequent water level recovery. The Bouwer and Rice (1976) method was applied to rising head test data, using the unconfined solution. The data were analyzed using the AQTESOLV for Windows version 4.50 Professional software. A summary of the results is presented below in Table 1.
A summary of the single-well response test data and the AQTESOLV printouts are attached in Appendix E.

Table 1: Summary of Hydraulic Conductivity Estimates

Location	Description of Soil at Screened Interval	Depth of Sand Pack Interval	Estimated Hydraulic Conductivity
		(mbgs)	K (cm/s)
BH18-1-W	(SP) SAND	4.1 to 6.1	4 x 10^{-3}
BH18-3-W(s)	(SP) SAND, layered with (SM) SILTY SAND	2.6 to 4.6	3 x 10^{-3}
BH18-3-W(d)	(SP) SAND	5.7 to 7.6	1 x 10^{-3}

Notes: mbgs = m below ground surface. cm/s = centimetres per second.

As summarized in Table 1 above, the hydraulic conductivity of the predominant sand unit ranged from approximately 1 x 10^{-3} cm/s to 4 x 10^{-3} cm/s. These results are within the range expected for this soil type.

3.5 Guelph Permeameter Testing

Four infiltration rate tests were conducted on October 17, 2018 proximal to BH18-1-W (i.e., test GP1) and BH4 (i.e., test GP4) on the Lots, and BH18-2-W (i.e., test GP2) and BH18-3-W (i.e., test GP3) in the SWM Pond block. Soil infiltration rate testing was carried out using the Guelph Permeameter (Model 2800K1) apparatus. The Guelph Permeameter was operated in general accordance with the instructions outlined in the 2800K1 Guelph Permeameter manual (Soilmoisture Equipment Corp., 2012) using a single head method. At each of the testing locations, the Guelph Permeameter was installed in a hand-augured hole in unsaturated ground conditions.

Once the outflow of water at the depth of installation reached a steady-state flow rate, the field-saturated hydraulic conductivity, K_{fs}, of the soil was estimated using following equation (Elrick et. al., 1989):

$$K_{fs} = \frac{C_1 Q_1}{2\,\pi\,H_1^2 + \pi\,a^2\,C_1 + 2\,\pi\frac{H_1}{\alpha^*}}$$

Where: C_1 = shape factor
Q_1 = flow rate (cm^3/s)
H_1 = water column height (cm)
a = well radius (cm)
α^* = alpha factor

The field data and analysis of the infiltration rate testing are presented in Figures E-1 to E-4, Appendix E. Based on the resulting K_{fs} (cm/s), the corresponding infiltration rates (mm/hr) were estimated using the approximate relationship presented in the *Low Impact Development Stormwater Management Planning and Design Guide* (TRCA and CVCA, 2010). A summary of the infiltration rate testing results is presented below in Table 2.

Table 2: Summary of Infiltration Rate Testing

Approximate Location	Soil Description	Approximate Test Depth	Estimated Field-Saturated Hydraulic Conductivity	Estimated Infiltration Rate[1]	Correction Factor [1]	Corrected[2] Estimated Infiltration Rate
		(mbgs)	K_{fs} (cm/s)	(mm/hr)		(mm/hr)
Test GP1	(SP) SAND	0.60	$3x10^{-3}$	111	2.5	44
Test GP2	(SM-ML) SILTY SAND to sandy SILT	0.70	$2x10^{-3}$	98	2.5	39
Test GP3	(SP) gravelly SAND to SAND (FILL)	0.55	$1x10^{-3}$	75	3.5	21
Test GP4	(SM) SILTY SAND	0.55	$3x10^{-4}$	65	2.5	26

Notes:
mbgs = m below ground surface
cm/s = centimetres per second
mm/hr = millimetres per hour
[1] – based on Table C1 from TRCA and CVCA (2010).
[2] – correction factor in accordance with Table C2 from TRCA and CVCA (2010).

The estimated field saturated hydraulic conductivity values are consistent with each other, and within the range expected for sandy soils.

The infiltration rate estimates from this investigation are based on the test methods discussed above and are for the corresponding native soil types encountered in undisturbed conditions. They represent the soil conditions at the tested locations and depths only; conditions may vary between and beyond the tested locations. Care should be taken during construction to preserve the existing soil structure and avoid compaction and re-working which could reduce its infiltrative properties.

For design purposes, a correction factor was applied to estimate the design infiltration rate in accordance with guidance provided in the *Low Impact Development Stormwater Management Planning and Design Guide* (TRCA and CVCA, 2010), to account for potential reductions in soil permeability due to compaction and smearing during the construction of a given infiltration feature and the gradual accumulation of fine sediments over the lifespan of the infiltration feature. Based on the guidance, a correction factor of 2.5 and 3.5 was applied to the estimated infiltration rates. As shown in Table 2, the surficial soils were estimated to have an average design infiltration rate in the order of 21 mm/hr to 44 mm/hr.

3.6 Groundwater Sampling

To assess existing nitrate concentrations hydraulically downgradient of the existing residential development, one groundwater sample was collected from each of BH18-1-W and BH18-2-W on October 12 and October 17, 2018, respectively. The nitrate concentrations in groundwater were used to assess the potential influence of existing sewage systems in the area on groundwater quality at the Site.

The groundwater samples were collected using a Waterra® footvalve and tubing. The groundwater samples were collected using generally accepted environmental engineering protocols, and were stored on ice in coolers until delivered, under chain-of-custody documentation, to the laboratory. The samples were analysed by Maxxam Analytics of Mississauga, Ontario. The laboratory certificate of analysis is included in Appendix F. The concentrations of nitrate ranged from 5.02 mg/L (BH18-1-W) to 6.07 mg/L (BH18-2-W), as summarized below in Table 3. The concentrations of nitrate were below the Ontario Drinking Water Quality Standard (ODWQS) of 10 mg/L.

Table 3: Nitrate Concentrations in Water

Location	Date	OWDQS	Nitrate (as N) (mg/L)
BH18-1-W	12-Oct-2018	10.0	5.02
BH18-2-W	17-Oct-2018	10.0	6.07
SWM Pond	17-Oct-2018	-	<0.10
SWM Pond	23-Oct-2018	-	0.38

Notes: ODWQS = Ontario Regulation 169/03, Ontario Drinking Water Quality Standards. Schedule 2, Chemical Standards.
- = not applicable
< = concentration less than accompanying method detection limit
mg/L = milligrams per litre

In addition, two grab samples of the water in the existing SWM Pond were collected on October 17 and October 23, 2018 using generally accepted environmental engineering protocols, to assess the concentrations in stormwater run-off from the existing lots. Precipitation data on or near the sampling events available on-line from https://www.theweather network.com/ca/monthly indicates 1.9 mm of precipitation on October 15, and 1.1 mm on October 17; and, 4.9 mm of precipitation on October 23, 2018. The concentrations of nitrate in water in the existing SWM Pond ranged from less than the method detection limit on October 17, 2018, to 0.38 mg/L on October 23, 2018, as summarized in Table 3, above.

3.7 Summary

The subsubsurface investigation activities carried out to date at the Site indicate that soil conditions are typically comprised of surficial sand to silt and sand, underlain by glacial till. The glacial till outcropped, or was encountered below thin sand to silty sand generally in the north and northwest portions of the Site. At other locations on the Site, only the surficial sand/silty unit was encountered within the depth of investigation.

On the Lots, the soil conditions were typically comprised of sand to silt and sand within the depths of investigation, except at TP91-2 and TP91-8 where 0.75 m of sand or silty sand was underlain by glacial till to the terminal test pit depths (2.7 m and 2.4 m, respectively). Within the SWM Pond block, silty sand to sandy silt was encountered at BH18-2-W, whereas at BH18-3-W 1.5 m of glacial till was overlain by 2 m of sand layered with silty sand and underlain by 2.4 m sand to the terminal borehole depth.

The hydraulic conductivity of the sand to silty sand was estimated to range from 1x10^{-3} cm/s to 4x10^{-3} cm/s (n=3), which is within the range expected for this soil type. The design infiltration rate of the sand to sandy silt was estimated to range in the order of 21 mm/hr to 44 mm/hr, with an average of 33 mm/hr (n=4).

Four monitoring wells are present on the Site: two on the Lots and two within the SWM Pond block. The depths to groundwater at the two monitoring wells on the Lots ranged from 3.29 mbgs to 4.22 mbgs, or from elevations of 147.47 masl to 146.62 masl, on the dates measured in October 2018. The depths to groundwater at the two shallow monitoring wells within the SWM Pond block ranged from 2.24 mbgs to 2.54 mbgs, or from elevations of 145.12 masl to 145.41 masl, on the dates measured in October 2018. The stage elevation of the SWM Pond main cell was 145.55 masl on November 7, 2018, compared to the design invert elevation of 145.4 masl. From the data it is inferred that groundwater elevations in the SWM Pond block were lower than the stage elevation of water in the main cell, being 0 m to 0.28 m below the design pond invert of 145.4 masl on the dates measured in October/November 2018. The vertical hydraulic gradient at the bi-level installation at BH18-3 was downward on both dates measured in October 2018. It is noted that seasonal and annual groundwater level fluctuations should be anticipated. The inferred groundwater flow direction at the Site is toward the southeast.

On the Site, the lands zoned RH-17 (see Figure B-1, Appendix B) comprise the approved 39 lot development of the Newtonville Estates. Lands zoned EP-7 are currently undeveloped and zoned to provide nitrate dilution capacity for the existing 39 lots, and are proposed to be developed with a cul-de-sac and additional lots. The lands zoned EP-9 include the SWM Pond block and forrested lands at the south end of the Site. No watercourses are mapped as being present on the Site, but visual indications of groundwater seepage resulting in tributary streams flowing in a southeasterly direction were observed by Golder in the southeast portion of the Site in November 2018. Two areas of unevaluated wetland totalling 6.41 ha are present within the EP-9 lands, including the general area of observed groundwater seepage/incipient streams.

The Site is expected to function primarily as a groundwater recharge area, although some groundwater seepage/discharge was observed in the southeast corner of the Site during the November 29, 2018 site visit. Groundwater recharge on the Site is expected to mainly contribute to baseflow in local streams, including those on-Site in the EP-9 lands, with contributions from the Site being proportional to the whole catchment area. A smaller portion of groundwater recharged on the Site is expected to recharge deeper aquifers and contribute to baseflow in streams lower down in the watershed. The condition of the wetlands was not investigated, and it is not known if they are primarily groundwater- or surface water-dependent. Either way, it is considered to be prudent to maintain pre-development infiltration rates on the Lots to the extent practical.

Groundwater elevations in the SWM Pond are slightly below the design invert elevation of the main cell, and evidence of recharging (infiltrating) conditions were present at the time of investigation (October/November 2018). Further, no visual indications of water flow away from the designed pond outfall in the southeast corner of the SWM Pond block were obvious during the November 29, 2018 site visit. Accordingly, it is inferred that stormwater directed to the SWM Pond, which is retained in the SWM Pond and does not result in discharge via the outfall structure, is lost to a combination of evaporatranspiration and infiltration, and that discharge from the outfall is likely to be relatively rare. This inference is made on the basis of limited field observations, and it is noted that Golder has made no direct or long-term observations of the operation of the outfall during precipitation events.

The concentrations of nitrate in groundwater downgradient of the existing lots ranged from 5.02 mg/L to 6.07 mg/L (n=2), and indicate that the existing sewage systems are not resulting in nitrate concentrations in groundwater in excess of the ODWQS of 10.0 mg/L downgradient of the lot lines. It is understood that development within the subdivision began in 2008 and continues at this time, with residential septic systems therefore being operational for up to 10 years.

This assessment considers the infiltration of storm water in the SWM Pond block in the nitrate dilution assessment. The concentration of nitrate in water sampled from the SWM Pond in October 2018 ranged from below detection to 0.38 mg/L. Accodingly, a median nitrate concentration of 0.25 mg/L has been used to estimate the average annual nitrate loading from water infiltrated via the SWM Pond.

No active private water well use is present on the Site, and none has been identified in a hydraulically downgradient direction (i.e., to the southeast) within 500 m. Based on MECP water well records and a drive-by reconnaissance, private well use is present witihin 500 m of the Site, mainly to the north and west in Newtonville, and comprised of a mix of shallow dug/bored and deeper drilled water wells, with shallow dug and bored wells being the most susceptible to surficial sources of contamination.

4.0 WATER BALANCE AND PRIVATE SEWAGE SYSTEM ASSESSMENT

4.1 Subsurface Investigation and Groundwater Sampling

A shallow borehole drilling program was carried out as described in Section 3.1, at which time one borehole (BH18-1-W) was advanced on the Lots at the location shown on Figure 1 and completed as a monitoring well.

Shallow groundwater conditions were noted in the open borehole during drilling, and groundwater was identified at a depth of 2.3 mbgs. As detailed in Section 3.3, static groundwater elevations were measured in October 2018 in BH18-1-W and existing monitoring well BH4, and the water table ranged from 3.3 mbgs to 4.2 mbgs.

The previous investigations completed by Golder on the Site included six test pits (TP3, TP91-1, TP91-2, TP91-6, TP91-7, and TP91-8) on the Site and an additional four test pits (TP91-9, TP91-14, TP91-15 and TP91-24) on the north and west sides of the Site. Shallow groundwater conditions were noted in the open test pit for TP91-1 during excavation, and groundwater was identified at depth of 1.5 mbgs. Static groundwater elevations were measured in a piezometer installed in TP91-1 in August and October 1991, and the water table ranged from 1.4 m to 1.5 mbgs. All other test pits were dry upon completion of excavation at depths ranging from 2.35 m to 2.90 mbgs.

The inferred groundwater elevations on the Lots on October 23, 2018 are shown on Figure 1. Seasonal and annual groundwater fluctuations should be anticipated.

As detailed in Section 3.6, a groundwater sample was collected from monitoring well BH18-1-W on October 12, 2018 to assess background nitrate concentrations on the proposed Lots. The concentration of nitrate in BH18-1-W was 5.02 mg/L. Additional comment on background nitrate concentrations is provided in Section 4.3.

4.2 Sewage System Sizing

To provide preliminary sewage system sizing for conventional Class 4 treatment systems, the maximum daily sewage flow was assumed to be 3,000 L/d, as per the Region’s Lot Sizing Policy (Durham Region, 2010). Based on this flow rate, the minimum septic tank size for a conventional Class 4 sewage system would be 6,000 L.

The borehole and test pit records indicate that the surficial native soils are sand within 1.5 mbgs at BH18-1-W, TP3, TP91-1, TP91-6, TP91-7, TP91-15 and TP91-24, whereas the native soil at TP91-2, TP91-8, TP91-9 was sand to 0.67m to 0.75 mbgs, underlain with silty sand or sandy silt up to 2.74 mbgs. The native soil at TP91-14 consisted of silty sand to a depth of 0.83 mbgs underlain with sand to 2.84 mbgs. Using the Unified Soil

Classification System in the Ontario Building Code (OBC), the grain size distributions for the surficial sand soils are characterized as soil group SP and SW(sand), and SM-ML (silty sand to sandy silt).

Tables 2 and 3 in the Supplementary Guidelines to the OBC provide percolation (T) times ranging from 2 min/cm to 8 min/cm for SP soils, 2 min/cm to 12 min/cm for SW soils, 8 min/cm to 20 min/cm for SM soils and 20 min/cm to 50 min/cm for ML soils. The distribution piping will be installed within the sand layer. For the proposed lots with sand extending up to 1.5 mbgs, we have conservatively selected a percolation time of 12 min/cm. For the proposed lots with silty sand or sandy silt within 1.5 mbgs, we have selected a percolation time of 20 min/cm. This will need to be confirmed during the detailed design of the sewage systems during the building permit stage for each lot.

Since the water table and bedrock at the Site are approximately 1.5 mbgs or deeper, and the Site consists of a relatively sandy soil, we recommend that in-ground systems be installed for each proposed lot. This will need to be confirmed during the detailed design of the sewage systems during the building permit stage for each lot. Based on the water level readings of 1.4 mbgs in TP91-1, partially raised systems may be required.

Since these systems are proposed to be installed in-ground, the loading rate calculations from Table 8.7.4.1 of the OBC do not apply. If a partially raised system is required due to the presence of groundwater within 1.5 mbgs, then the area of the system would be determined based on the loading rate calculations from Table 8.7.4.1 of the OBC.

Based on the percolation time of 12 min/cm for an in-ground sewage system in native sand soils, the total length of distribution piping for the sewage systems would be 180 m. Assuming the piping is installed in 10 runs, each 18 m in length, the total footprint for the system would be 14.4 m x 18 m, or 260 m^2. Therefore, the total area for the primary and reserve sewage systems would be 520 m^2.

Irrespective of the above, the Region's Lot Sizing Policy indicates that for soil percolation rates (T) of 1<T<20 min/cm, a loading rate of 10 L/m^2/day, and a daily sewage flow rate of 3,000 L/day, the combined area of the primary and reserve areas for each private sewage system should be 600 m^2. Therefore, it is recommended that a 600 m^2 area be dedicated at the rear of the lot for each private sewage system in native sand soils.

Based on the percolation time of 20 min/cm for an in-ground sewage system in native silty sand or sandy silt soils, the total length of distribution piping for the sewage systems would be 300 m. Assuming the piping is installed in 10 runs, each 30 m in length, the total footprint for the system would be 14.4 m x 30 m, or 432 m^2. Therefore, the total area for the primary and reserve sewage systems would be 864 m^2. The Region's Lot Sizing Policy indicates that that for soil percolation rates (T) of 20<T<35, a loading rate of 10 L/m^2/day, and a daily sewage flow rate of 3,000 L/day, the combined area of the primary and reserve areas for each private sewage system should be 750 m^2. It is recommended that an 864 m^2 area be dedicated at the rear of the lot for each private sewage system in native silty sand or sandy silt soils, which exceeds the Region's Lot Sizing Policy requirements.

The minimum clearance distances for the distribution piping for the sewage systems are expected to be:

Table 4: Minimum Clearance Distances for Sewage Systems

Description	Distance (m)
Structure	5
Well with watertight casing to a depth of 6 m	15
Any other well	30
Lake	15
Pond	15
Reservoir	15
River	15
A spring not used as a source of potable water	15
Stream	15
Property Line	3

For partially raised systems, the minimum clearance distances shall be increased by twice the height that the leaching bed is raised above the original grade as per 8.7.4.2.(11) of the OBC.

Conservatively, it is recommended that as subdivision design progresses, that an area of 864 m^2 in the rear of the lots be allocated for the private sewage systems with the appropriate setbacks as stated above. Setback distances as identified above must be observed for on-site and off-site features. The lots are bounded to the north and west by existing lots within the approved Newtonville Estates subdivision, to the east by a road allowance followed by vacant lands proposed for similar residential development by the Proponents and others that would front on to George Burley Street, and to the south by the EP-9 lands. Newtonville is serviced by municipal water supply although private water well use remains in the area as detailed in Section 2.4. Based on the findings of this investigation, there are no known active shallow dug/bored or deeper drilled water wells within 30 m of the conceptual locations of the rear yards.

4.3 Hydrologic Water Balance

The following water balance method was used to assess the potential hydrogeological impacts of the proposed residential development of the EP-7 block (i.e., the Lots) with respect to post-development infiltration rates. The assessment considered the existing pre-development and proposed post-development land uses on the Lots, with the objective of estimating changes in average annual surplus, infiltration and runoff rates for these two scenarios. In addition, a post-development scenario incorporating the use of the proposed infiltration facility and Low Impact Development (LID) features on the Lots was considered to estimate the benefits of incorporating these features into the Lot design.

The water balance method was also used to estimate post-development infiltration rates on a Site-wide basis. The post-development infiltration rate was subsequently used in a nitrate loading assessment to confirm the total number of allowable lots on the Site (i.e., the approved 39 lots on the RH-17 zoned lots, plus the additional 12 Lots proposed for the EP-7 block).

4.3.1 Methods

The following method was applied to the Site-wide estimate of post-development infiltration rates and the water balance assessment for the proposed Lots, as applicable. The water balance assessment was carried out using historic meteorological records (1969 to 2017) obtained from Environment and Climate Change Canada (ECCC) for the Oshawa WPCP Station (ID 6155878), provided information on current and proposed land uses, and existing soil types as identified through the subsurface investigation activities at the Site as described above. The Oshawa WPCP meteorological station is the closest station to the Site with expected similar climatic conditions and where significant historical records exist from which to evaluate climatic normals of the input parameters used in a water budget assessment.

Water balance calculations are based on the following equation:

$$P = S + ET + R + I$$

Where: P = precipitation;
S = change in soil water storage;
ET = evapotranspiration;
R = surface runoff; and
I = infiltration (groundwater recharge).

Precipitation data collected at the Oshawa WPCP station indicate a mean annual precipitation (P) of 868 mm/year.

Short-term or seasonal changes in soil water storage (S) are anticipated to occur on an annual basis as demonstrated in Southern Ontario by the typically dry conditions in the summer months and the wet conditions in the spring. Long-term changes (e.g., year-to-year) in soil water storage are considered to be negligible.

Evapotranspiration (ET) refers to water lost to the atmosphere from surfaces. The term combines evaporation (i.e., water lost from soil or water surfaces) and transpiration (i.e., water lost from plants and trees) because of the difficulties in measuring these two processes separately. Potential ET refers to the loss of water from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of ET is typically less than the potential rate under dry conditions (e.g., during the summer months when there is a moisture deficit). The mean annual potential ET for the Site is approximately 738 mm/year based on data provided by ECCC.

Annual water surplus is the difference between P and the actual ET. The water surplus represents the total amount of water available for either surface runoff (R) or groundwater infiltration (I) on an annual basis. On a monthly basis, surplus water remains after actual evapotranspiration has been removed from the sum of rainfall and snow-melt, and maximum soil or snow pack storage is exceeded. Maximum soil storage is quantified using a water holding capacity (WHC) specific to the soil type and land use. The WHC data obtained from ECCC are presented in Table G-1, Appendix G.

Infiltration factors were estimated using the method presented in the Ontario Ministry of the Environment (“MOE”) *Stormwater Management Planning and Design (“SWM”) Manual* (MOE, 2003). There are three main factors that determine the percent infiltration of the total surplus: topography, soil type and ground cover. The sum of the fractions representing the three characteristics establishes the approximate annual percentage of surplus which can be infiltrated in an area with a sufficient downward groundwater gradient.

4.3.2 Water Balance Parameters

Based on the results of the borehole drilling program (see Section 3.2) and grain size distribution test results for selected surficial soil samples, surficial soil types throughout the Site were categorized into three general types (i.e., fine sand, fine sandy loam, and silt loam) based on the U.S. Bureau of Soils classification system and the relative percentages of sand, silt and clay. Water holding capacities were then assigned to these soil types using the values listed in "*Table 3.1: Hydrologic Cycle Component Values*" (Table 3.1) of the *SWM Manual* (MOE, 2003) and the existing or proposed vegetative covers, as summarized in Table G-2, Appendix G. Impervious surfaces were considered to produce 10% evapotranspiration and 90% runoff, and were therefore not assigned a water holding capacity.

The surplus data obtained from ECCC for the respective water holding capacities were split into infiltration and runoff components by applying an infiltration factor based on Table 3.1 (MOE, 2003). The infiltration factors were based on a sum of site-specific topography, surficial soil type and vegetative cover factors as presented in Table G-2 of Appendix G. Based on the survey data for the Site (J.D. Barnes Ltd, June 8, 2011, see Appendix B), a topography factor of 0.15 (i.e. between "hilly" and "rolling") was applied for the pre-development condition. It was assumed that post-development grading would not significantly change the overall slope of the Lots, so the same topography factor was applied for the post-development condition.

A soils factor of 0.4 (i.e. "open sandy loam") was applied to represent the fine sand and the fine sandy loam soils. A soils factor of 0.3 (i.e. between "open sandy loam" and "medium combinations of clay and loam") was applied to represent the silt loam soil. Treed areas were assigned a cover factor of 0.2, representing woodland. Meadow and lawn areas were assigned a cover factor of 0.1, representing cultivated land. For impervious surfaces (i.e., buildings and paved areas), no infiltration factor was applied.

The water balance analysis was developed under the following assumptions:

- WHCs were chosen based on Table 3.1 in the MOE *SWM Manual* (2003) and corresponding to soil type, land use and proposed post-development conditions.
  - Soil Group A – fine sand:
    - Forest (Mature Forests): 250 mm WHC and 0.75 infiltration factor (pre- and post-development condition);
    - Meadow (Pasture and Shrubs): 100 mm WHC and 0.65 infiltration factor (pre-development condition); and
    - Lawns (Urban Lawns): 50 mm WHC and 0.65 infiltration factor (post-development condition).
  - Soil Group B – fine sandy loam:
    - Forest (Mature Forests): 300 mm WHC and 0.75 infiltration factor (pre- and post-development condition);
    - Meadow (Pasture and Shrubs): 150 mm WHC and 0.65 infiltration factor (pre-development condition); and
    - Lawns (Urban Lawns): 75 mm WHC and 0.65 infiltration factor (post-development condition).
  - Soil Group C – silt loam:
    - Meadow (Pasture and Shrubs): 250 mm WHC and 0.55 infiltration factor (pre-development condition); and

    - Lawns (Urban Lawns): 125 mm WHC and 0.55 infiltration factor (post-development condition).
  - Impervious Areas (i.e. driveways and aprons): Surplus assumed as 90% of precipitation and null (i.e., 0%) infiltration factor (CO, 2013).
  - Roofs: Surplus assumed as 90% of precipitation and null (i.e., 0%) infiltration factor.
- Net surplus was estimated by multiplying the estimated monthly surplus (mm/month) for the assumed WHC by the associated drainage area. Monthly evapotranspiration and surplus values were obtained from the meteorological data from the Oshawa WPCP ECCC Meteorological Station based on the WHC assigned to each land use area.
- Runoff was calculated as the difference between surplus and infiltration.

Pre-Development Land Uses

Land use on the EP-7 block under existing (pre-development) conditions was identified from satellite imagery (Figure 1) and a site reconnaissance. The existing EP-7 was considered to be entirely undeveloped meadow areas (or “pasture and shrubs” in Table 3.1).

Post-Development Land Uses

In the absence of a grading plan, the post-development surficial soil types are assumed to remain consistent with the pre-development soil types (i.e., fine sand, fine sandy loam and silt loam). Post-development land uses for Newtonville Estates, including the 39 approved lots, roads and SWM pond, were identified based on individual plans for developed lots and other plans provided by Veltri.

Assuming the Newtonville Estates and the EP-7 development will be similar, the sizes of the future houses, garages, driveways on the Site and Lots were assumed to be the same as average sizes obtained from plans of the actual Newtonville Estates development. Accordingly, based on the actual Newtonville Estates development, the average residential building footprint for future houses was assumed to be 260 m^2, the average driveway area was 129 m^2 and the average apron area was 77 m^2. The 4.69 ha EP-7 lands include 0.47 ha of paved area (i.e. road, driveways, and aprons). The permeable portion of the EP-7 lands (i.e., not covered by the house, garage, driveway, or road) was assumed to be comprised of urban lawns. Table 5 summarizes the post-development land uses for the proposed EP-7 development, including 12 houses.

Table 5: EP-7 Post Development Land Uses

Land Use	Area (ha)	% Permeable
Residential/Urban Lawns	3.91	100%
Pavement (Road, Driveways and Aprons)	0.47	0%
Building Footprints (Houses & Garages)	0.31	0%
TOTAL	**4.69**	-

4.3.3 Pre-Development Condition Results

Based on the parameters described in Section 4.3.2, the average annual pre-development water balance was estimated for the 4.69 ha EP-7 block. The results are summarized in Table 6 and detailed in Table G-3 in Appendix G.

Table 6: Average Annual Pre-Development Water Budget for the EP-7 block (m^3/year)

Component	Site (m^3/year)
Precipitation (P)	40,710
Evapotranspiration (ET)	27,110
Surplus (S)	13,470
Infiltration (I)	8,810
Runoff (R)	4,660

4.3.4 Post-Development Condition (Excluding Sewage Systems)

Based on the parameters described in Section 4.3.2, the average annual post-development water balance, excluding the influence of the individual sewage systems, was estimated for the 4.69 ha EP-7 block, assuming 12 lots. The results are summarized in Table 7 below, and detailed in Table G-3, Appendix G.

Table 7: Average Annual Post-Development Water Budget for the EP-7 block (m^3/year)

Component	Site (m^3/year)
Precipitation (P)	40,710
Evapotranspiration (ET)	20,900
Surplus (S)	19,740
Infiltration (I)	8,880
Runoff (R)	10,860

From the water balance summaries for the EP-7 block (Tables 6 and 7), the 12-lot development is estimated to result in average annual infiltration that remains relatively unchanged (i.e., an average annual increase in infiltration of approximately 1%) and an increase in average annual runoff of approximately 133% (from 4,660 m^3/year to 10,860 m^3/year) resulting from the changes in land use.

4.3.5 Mitigated Post-Development Condition (with LID)

The use of LID mitigation measures to enhance the infiltration of stormwater runoff from development sites supports the natural hydrologic cycle by helping to maintain groundwater recharge, providing additional water quality treatment and reducing the volume of runoff from a site. It is considered to be prudent to incorporate low impact development (LID) mitigation measures into the design to the extent practical.

As described in Section 3.3, groundwater levels on the Lots on measured dates in October 2018 ranged from 3.3 mbgs to 4.4 mbgs. Groundwater levels are expected to vary seasonally. A typical design for subsurface LIDs has both an invert below the frost line (understood to be 1.3 m) and 1 m separation from the seasonally high water table to promote the effectiveness of the feature. If seasonally high groundwater levels are 1 m higher than measured in October 2018, it is likely that sub-surface LID mitigation measures can be utilized on at least some of the lots depending on grading designs. Individual soakaway pits may be considered for the front yards to capture rainfall runoff from the front half of roofs.

In the absence of grading plans and other design details on which to base an invert elevation for subsurface LIDs, and for the purposes of this assessment, a surface-based LID measure was considered for the EP-7 block. The water balance accounted for the use of the disconnection of downspouts to discharge to pervious areas in the front and rear yards of each house as a LID technique. It is recommended that the flow from the downspout disconnections be directed away from the distribution piping for the private sewage systems. A runoff reduction of 50% was adopted for runoff from roofs directed to lawns with hydrologic soil groups “A” and B” and a runoff reduction of 25% was adopted for runoff from roofs directed to lawns with hydrologic soil group “C” in accordance with guidance provided in the *Low Impact Development Stormwater Management Planning and Design Guide* (TRCA & CVC, 2010).

Based on the parameters described in Section 4.3.2, the average annual post-development water balance, including the downspout disconnection LID measure, was estimated for the 4.69 ha EP-7 Block. The results are summarized in Table 8 below, and detailed in Table G-3, Appendix G.

Table 8: Average Annual Mitigated Post-Development Water Budget for the EP-7 block (m^3/year)

Component	Site (m^3/year)
Precipitation (P)	40,710
Evapotranspiration (ET)	20,900
Surplus (S)	19,740
Infiltration (I)	10,100
Runoff (R)	9,640

Accounting for the implementation of the front and rear yard downspout disconnection LID measure, the average annual post-development infiltration within the Lot development area is estimated to increase by approximately 15% over pre-development conditions (8,810 m^3/year to 10,100 m^3/year). An estimated increase in average annual runoff of approximately 107% (from 4,660 m^3/year to 9,640 m^3/year) is expected with the use of the proposed mitigation, compared to 133% under post-development conditions with no mitigation.

4.3.6 Discussion

A pre- and post-development water balance was prepared on an average annual basis for the EP-7 block development. The proposed 12-lot development without mitigation is estimated to result in an average annual increase in infiltration of approximately 1% (from 8,810 m^3/year to 8,880 m^3/year) and an increase in runoff of approximately 133% (from 4,660 m^3/year to 10,860 m^3/year) resulting from the changes in land use.

Since the EP-7 block is considered a groundwater recharge area, it is considered prudent to mitigate against potential recharge reductions as a result of development. Although there may be a possibility for subsurface LID mitigation, the use of downspout disconnection was adopted for this assessment. The proposed development with downspout disconnection is anticipated to result in an average annual increase in infiltration of approximately 15% (from 8,810 m^3/year to 10,100 m^3/year) and an increase in runoff of approximately 107% (from 4,660 m^3/year to 9,640 m^3/year). Post-development infiltration rates would be further enhanced by the input of septic effluent to the subsurface, given the lake-based municipal water supply in Newtonville. As such, it is expected that groundwater recharge and baseflow contributions to local streams will be maintained or increase on an average annual basis following the development of the proposed 12 lots in the EP-7 block.

4.4 Nitrate Loading Assessment

Groundwater was considered to be the receptor of any potential impact from the proposed use of private sewage systems on the Lots. An assessment of the potential impacts to groundwater quality was considered using the Three-Step Process outlined in Procedure D-5-4 (Ministry of Environment and Energy, *Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment*, August 1996).

Step 1 - Exclusion for lots 1 ha and greater: Given that the Lots are less than 1 ha in area, the process proceeded to Step 2.

Step 2 - System isolation: As discussed in Section 3.2, shallow soils were comprised of sand, silt and silty sand underlain by glacial till. As discussed in Section 2.4, the MECP Water Well Records and a drive-by reconnaissance have identified private water well use in the area. Given that shallow dug and bored well use is present within 500 m of the proposed development, although not known to be located in a hydraulically downgradient direction within 500 m of the Site, the assessment conservatively proceeded to Step 3.

Step 3 - Nitrate loading assessment: A nitrate loading assessment for the entire Site, including the proposed 12 lot development in the EP-7 block is provided in the following sections. A water balance assessment was carried out on a Site-wide basis to assess potential hydrogeological impacts related to changes in post-development infiltration rates, and to provide a post-development infiltration rate number to be used in the nitrate loading assessment. The methods and parameters used in the water balance are described in Section 4.3.

4.4.1 Post-Development Condition (Excluding Sewage Systems and LID)

Based on the parameters described in Section 4.3.2, the average annual post-development water balance, excluding the influence of the individual sewage systems and LID measures, was estimated for the 30.3 ha Site including the 4.69 ha EP-7 development area as described in the preceding section. The results are summarized in Table 9 below, and detailed in Table G-4, Appendix G.

Table 9: Average Annual Post-Development Water Budget for Site (m^3/year)

Component	Site (m^3/year)
Precipitation (P)	263,350
Evapotranspiration (ET)	166,740
Surplus (S)	95,920
Infiltration (I)	46,540
Runoff (R)	49,380

In summary, the average annual unmitigated post-development infiltration across the entire Site is estimated to be 46,540 m^3/year (i.e. 128 m^3/day).

4.4.2 Mitigated Post-Development Condition (with LID)

It is understood that the roofs of all houses on the Site are, or will be, disconnected and directed to pervious areas. The water balance accounted for the use of the disconnection of downspouts to discharge to pervious areas in the front and rear yards of each house as a LID technique. As described in Section 4.3.5, a runoff reduction of 50% was adopted for runoff from roofs directed to lawns with hydrologic soil groups “A” and “B” and a runoff reduction of 25% was adopted for runoff from roofs directed to lawns with hydrologic soil group “C” in accordance with guidance provided in the *Low Impact Development Stormwater Management Planning and Design Guide* (TRCA & CVC, 2010). This LID measure has been assumed for all of the existing and proposed lots, including the 39 approved lots in the Newtonville Estate subdivision, as this was excluded from the estimate in Section 4.4.1.

In addition, Veltri has indicated plans to convert the existing SWMP from a wet pond facility to an infiltration facility (GHD, 2018). The proposed infiltration facility was designed to capture, pre-treat and infiltrate runoff from a catchment area of approximately 8.81 ha. The total storage area of the infiltration was estimated to be approximately 840 m^3, including surficial storage and storage within the infiltration gallery, assuming a void ratio of 0.35 to account for the sandy infill material proposed. The retention time of the entire infiltration facility, including surficial storage and the infiltration gallery, was assumed to be no more than 24 hours. Although it was estimated that events up to 9.5 mm would be captured based on the total available storage volume, the infiltration facility was assumed to infiltrate all daily rainfall depth that was equal to or less than 5 mm to account for potentially seasonally high groundwater levels within 1 mbgs of the invert of the facility. Infiltration from the proposed infiltration facility was estimated on an annual basis by analysing the daily precipitation at Oshawa WPCP (1969 to 2017), which indicated that the infiltration of rainfall events of 5 mm or lower would result in a runoff reduction factor of 0.41 (41%). Therefore, the rate of mitigated post-development runoff was reduced 41% and infiltration was accordingly increased. Based on the parameters described in Section 4.3.2, the average annual post-development water balance, including the front and rear yard downspout disconnection LID measure and the proposed infiltration facility, was estimated for the 30.3 ha Site, including the 4.69 ha EP-7 development area. The results are summarized in Table 10 below, and detailed in Table G-4, Appendix G.

Table 10: Average Annual Mitigated Post-Development Water Budget for Site (m^3/year)

Component	Site (m^3/year)
Precipitation (P)	263,350
Evapotranspiration (ET)	166,740
Surplus (S)	95,920
Infiltration (I)	57,820
Runoff (R)	38,100

Accounting for the implementation of the front and rear yard downspout disconnection LID measure and the proposed infiltration facility, the average annual mitigated post-development infiltration for the total 30.3 ha Site is estimated to be 57,820 m^3/year (i.e. 158 m^3/day, including 18 m^3/day from the infiltration facility).

4.4.3 Nitrate Loading Assessment

Groundwater was considered to be the receptor of any potential impact from the proposed use of private sewage systems. An assessment of the potential impacts to groundwater quality was considered using the Three-Step Process outlined in Procedure D-5-4. Steps 1 and 2 were not considered to be applicable, and therefore the assessment proceeded to Step 3, Nitrate Loading Assessment.

All 51 lots, including the proposed 12 lots in the EP-7 block, will be provided with a municipal water supply that is understood to be Lake Ontario-based. Given that potable water will not be supplied by groundwater from the Site, it is assumed that municipal water provided to the lots and introduced to the subsurface as effluent from the private sewage systems will, in effect, provide additional water to be factored into the post-development infiltration rate. Stormwater runoff infiltrated to the subsurface via the proposed infiltration facility was also considered, assuming a concentration of nitrate in runoff that was based on samples of the water quality in the existing SWMP facility obtained in October 2018 (i.e., 0.25 mg/L, see Section 3.7).

The nitrate loading assessment is provided assuming the use of conventional Class 4 sewage systems with effluent nitrate concentrations of 40 mg/L. The nitrate loading assessment was based on the dilution of septic effluent by infiltrating precipitation on the Site plus infiltrating runoff via the infiltration facility and assuming even mixing over the Site, such that the resulting nitrate concentration in groundwater at the Site boundary is below the ODWQS of 10.0 mg/L.

The concentration of nitrate in groundwater at the Site boundary was estimated using the following formula:

$$[NO_{3\,PL}] = \frac{(Q_{g1} \ \times [NO_{3\,bck1}]) + (Q_{g2} \ \times [NO_{3\,bck2}]) + (Q_{eff} \ x \ [NO_{3\,eff}])}{(Q_{g1+g2} + \ Q_{eff})}$$

where:

$[NO_{3\,PL}]$ = Resulting Nitrate Concentration at the Property Line (in mg/L);

$[NO_{3\,bck1}]$ = Nitrate Concentration in Background (i.e., 0 mg/L in infiltrating precipitation);

$[NO_{3\,bck2}]$ = Nitrate Concentration in Infiltration Facility (i.e., 0.25 mg/L, see Section 3.7);

$[NO_{3\,eff}]$ = Nitrate Concentration of Sewage Effluent (40 mg/L);

Q_{g1} = Volume of Direct Infiltration (140 m^3/day, see Section 4.4.2); and

Q_{g2} = Volume of Infiltration from Infiltration Facility (18 m^3/day, see Section 4.4.2); and

Q_{eff} = Volume of Septic Effluent (1 m^3/day per lot, per Procedure D-5-4).

Based on the assessment method and assumptions provided above, and assuming the use of conventional Class 4 sewage systems, the total Site, including the proposed 12-lot development in the EP-7 block, would result in an estimated nitrate concentration of 9.8 mg/L at the Site boundary which is below the ODWQS of 10.0 mg/L.

In summary, the proposed use of private sewage systems on the 51 lots in the Site, is not anticipated to have an unacceptable impact on groundwater quality. Accounting for the septic effluent in the water budget (i.e., 140 m^3/day infiltration from permeable land uses + 18 m^3/day from the infiltration facility + 51 m^3/day septic effluent from 51 lots), the mitigated post-development infiltration rate with sewage systems at the Site is approximately 209 m^3/day or 76,435 m^3/year.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The 30.3 ha Newtonville Estates subdivision has been approved for the development of 39 lots with municipal water supply and individual private sewage systems. A 4.69 ha block at the Site has been zoned EP-7 to provide nitrate dilution capacity for the approved subdivision. Veltri is proposing to develop an additional 12 residential lots on a cul-de-sac (including pavement, driveways, and aprons) on the EP-7 block that would also utilize private sewage systems on each lot.

An investigation was carried out to assess the existing hydrogeological conditions to estimate the pre- and post-development water budget for the new Lots, to assess the feasibility of the use of subsurface infiltration structures enhance post-development infiltration rates, and to assess the potential hydrogeological impacts of the Lots with respect to post-development infiltration rates. In addition, the suitability of the Lots for the use of individual private sewage systems was assessed. Also, Veltri proposes to convert the existing stormwater management pond from a wet pond facility to an infiltration facility. This report provides an estimate of the average annual infiltration from the facility, and its corresponding benefit to post-development infiltration rates. A mitigated post-development infiltration rate was estimated for the purpose of carrying out a nitrate loading assessment to reassess the number of viable lots for the entire 30.3 ha Site. The investigation included the installation and testing of four monitoring wells: one within the EP-7 block and three installations at two locations within the SWMP block.

Based on the assessment described in this report, the following conclusions and recommendations are provided:

1) The native soil conditions encountered in the boreholes, and in previous investigations at the Site, were predominantly comprised of non-cohesive sand to silty sand of varying thickness overlying glacial till. The hydraulic conductivity of the surficial sand unit was estimated to range from 1×10^{-3} cm/s to 4×10^{-3} cm/s (n=3). The design infiltration rate of the surficial sand unit was an average of 33 mm/hr (n=4).

2) Groundwater elevations on the Lots ranged from 147.47 masl to 146.62 masl, and groundwater elevations within the SWMP block ranged from 145.12 masl to 145.41 masl on the dates measured in October 2018. The stage elevation of the SWMP main cell was 145.55 masl on November 7, 2018, compared to the design invert elevation of 145.4 masl. A downward hydraulic gradient (or recharging conditions) was identified within the SWMP block at the time of the investigation. No visual indications of water flow away from the designed pond outfall in the southeast corner of the SWMP block were obvious during a November 29, 2018 site visit, which corroborates observations by others that the pond does not maintain a permanent pool. It is

noted that seasonal and annual groundwater level fluctuations should be anticipated. The inferred groundwater flow direction at the Site is toward the southeast.

3) The Site has three zoning designations. Lands zoned RH-17 (i.e., the approved 39 lot development) and the undeveloped lands zoned EP-7 are present on the north portion of the Site. Primarily forested lands zoned EP-9 are present to the south. No watercourses are mapped on the Site, but visual indications of groundwater seepage resulting in tributary streams flowing in a southeasterly direction were observed in the southeast portion of the EP-9 lands in November 2018. Two areas of unevaluated wetland totalling 6.41 ha are present within the EP-9 lands.

4) The Site is expected to function primarily as a groundwater recharge area. Groundwater recharge on the Site is expected to mainly contribute to baseflow in local streams, including those on-Site in the southeast portion of the EP-9 lands, with contributions from the Site being proportional to the whole catchment area. A smaller portion of groundwater recharged on the Site is expected to recharge deeper aquifers and contribute to baseflow in streams lower down in the watershed.

5) No active private water well use is present on the Site or on the lands 500 m hydraulically downgradient. Although municipal water supply is available in Newtonville, a review of the MECP water well records and a drive-by reconnaissance indicate that private well use is present in the area comprised of a mix of shallow dug/bored and deeper drilled water wells. Accordingly, a nitrate loading assessment was conservatively used to assess the potential impacts of Site development with respect to groundwater quality.

6) For the purposes of preliminary private sewage system sizing, the surficial native soils encountered at tested locations consist of sand, silty sand and sandy silt within 1.5 mbgs, and are characterized as soil group SP and SW (sand), and SM-ML (silty sand to sandy silt). Since the water table and bedrock at the Site are approximately 1.5 mbgs or deeper, and the Site consists of a relatively sandy soil, we recommend that in-ground systems be installed for each proposed lot. This will need to be confirmed during the detailed design of the sewage systems during the building permit stage for each lot. Based on the historical water level readings of 1.4 mbgs in TP91-1, partially raised systems may be required. It is recommended that as subdivision designs progress that an area of 864 m^2 in the rear of the lots be allocated for the private sewage systems with the appropriate setbacks stated in Table 4 of this report.

7) A water budget assessment was carried out to estimate pre-development, post-development, and mitigated post-development conditions for the proposed 12-lot development in the EP-7 block. A surface-based LID measure, comprised of downspout disconnection on the front and rear yards of the lots, was considered. It is recommended that the flow from the downspout disconnections be directed away from the distribution piping for the private sewage systems. The proposed development is expected to result in an average annual increase in infiltration of approximately 15% (from 8,810 m^3/year to 10,100 m^3/year) and an increase in runoff of approximately 107% (from 4,660 m^3/year to 9,640 m^3/year). Post-development infiltration rates would be further enhanced by the input of septic effluent to the subsurface, given the lake-based municipal water supply in Newtonville. As such, it is expected that groundwater recharge and baseflow contributions to local streams will be maintained or increase on an average annual basis as a result of the proposed 12-lot development in the EP-7 block.

8) Using a similar method, the mitigated post-development infiltration rate was estimated for the entire 30.3 ha Site. Downspout disconnection on the front and rear yards of the lots was considered in conjunction with contributions from the proposed infiltration facility. Given that municipal water from outside of the Site

boundaries will be supplied to all lots and introduced to the subsurface via the septic effluent, daily water use was factored into the assessment. Accordingly, the mitigated average annual post-development infiltration rate with the use of private sewage systems for the total Site is 76,435 m^3/year (or 209 m^3/day).

9) Based on a nitrate loading assessment, the use of 51 conventional Class 4 sewage systems on all lots (i.e., 39 existing lots plus 12 additional lots) would result in an estimated nitrate concentration of 9.8 mg/L at the property boundary, which is below the ODWQS of 10.0 mg/L. Therefore the proposed development is therefore not anticipated to have an unacceptable impact on groundwater quality.

Signature Page

We trust that this submission meets your current requirements. Please contact the undersigned with any questions.

Yours truly,

Golder Associates Ltd.

LICENSED PROFESSIONAL ENGINEER
D.V. KERR
100041183
May 6/2019
PROVINCE OF ONTARIO

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PROFESSIONAL GEOSCIENTIST
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LPH/ST/DK/CMK/lb

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REFERENCES

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Clark Consulting Services, January 2018. *Figure 2 - Development Concept [Combined] – Newtonville Hamlet Expansion. Paynes Crescent and George Burley Street, Newtonville, Ontario*.

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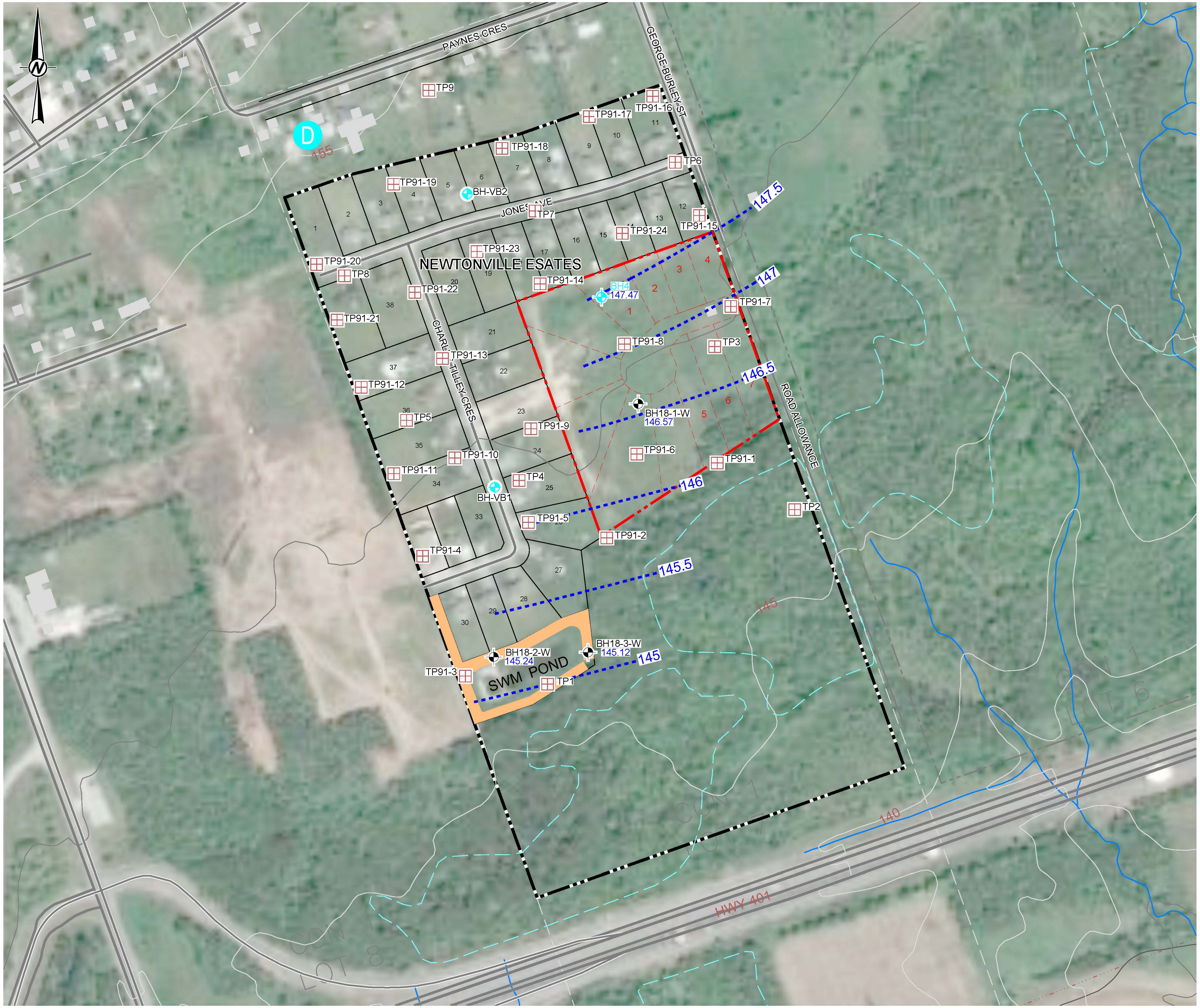
FIGURE 1

Site Map



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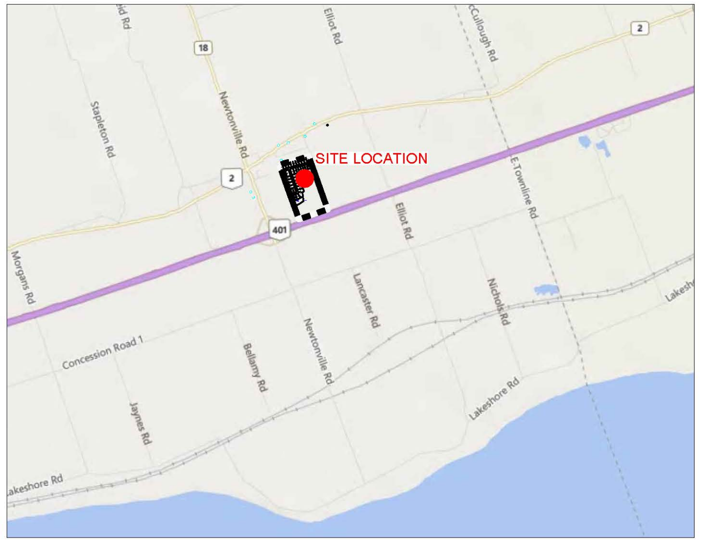

LEGEND

- Site Property Line
- Proposed Development Plan (Lots)
- Proposed Lots
- Unevaluated Wetland (MNRF)
- ⊞ ● Historical Test Pit / Borehole
- ⊕ Monitoring Well Location
- 147.54 Groundwater Elevation (October 23rd, 2018)
- Groundwater Contour (masl)

0 100 200
1:4,000 METRES

REFERENCES AND NOTES

1. Mapping based on ESRI Geography Network OBM Features and Bing Orthophotos
2. JD Barnes, Survey Plan, June 2011. Updated sketch of subject lands Feb 2017.
3. Mapped Features and Locations are Approximate and Not to Scale
4. Zoning Information from Municipality of Clarington Zoning By-Law 64-63, Schedule 16 (Newtonville)
5. Wetlands and Catchment area mapped from Ministry of Natural Resources and Forestry, accessed February 2019.

CLIENT
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PROJECT
SUPPLEMENTAL HYDROGEOLOGICAL INVESTIGATION
NEWTONVILLE ESTATES
PT LOT 7, CONCESSION 1, NEWTONVILLE, ON.

TITLE
SITE LOCATION MAP

CONSULTANT
GOLDER

YYYY-MM-DD	2019-02-12
DESIGNED	XXX
PREPARED	JPR
REVIEWED	LPH
APPROVED	CMK

PROJECT NO.	CONTROL	REV.	FIGURE
1530386	0001	----	1

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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 can not 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.

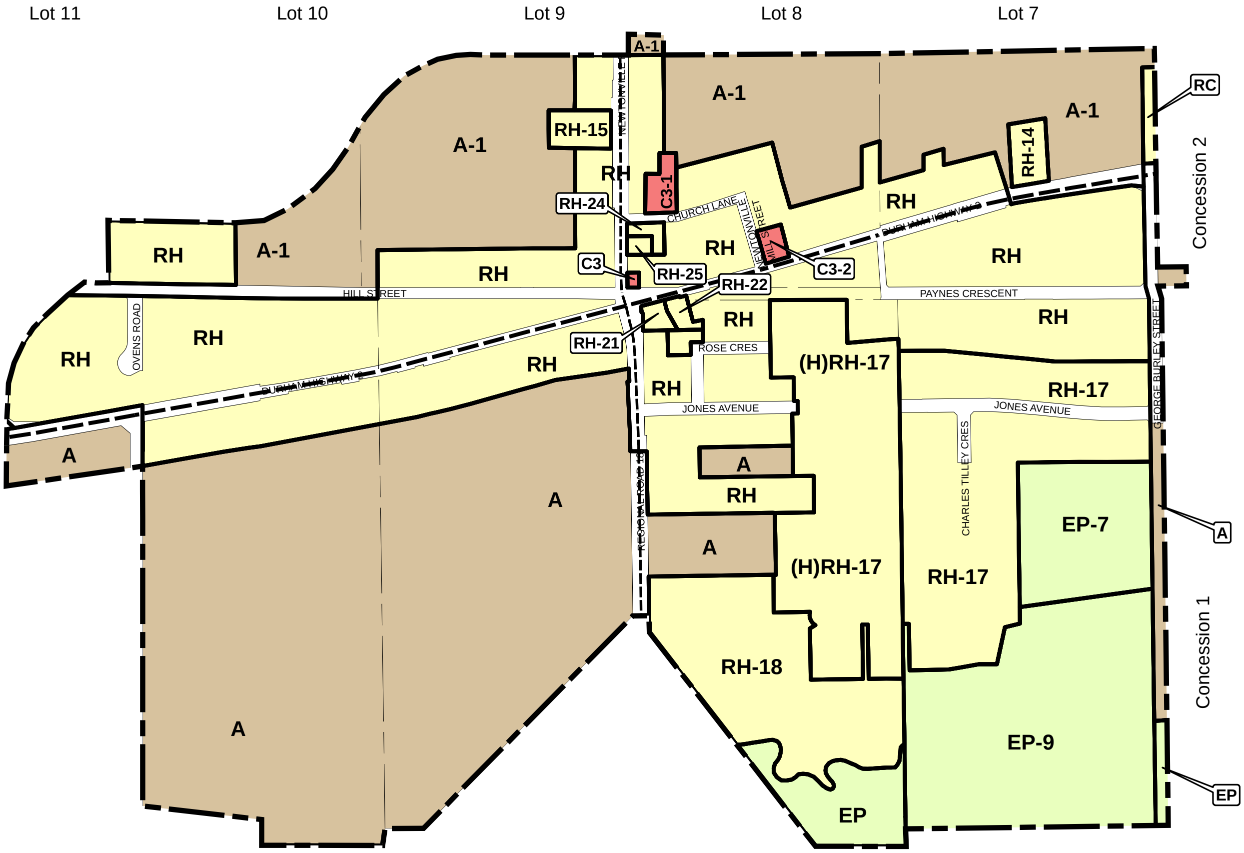
During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and 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.

APPENDIX B

Provided Design Concept Information



CORPORATION of the
MUNICIPALITY of CLARINGTON
(Former Town of Newcastle)
NEWTONVILLE
(FORMER TOWNSHIP OF CLARKE)

**THIS IS SCHEDULE '16'
TO BY-LAW 84-63
PASSED THIS 10th DAY
OF SEPTEMBER, 1984**

G B Rickard
G.B. RICKARD, MAYOR

Gertrude Gray
DEPUTY CLERK

🟨 Residential
🟥 Commercial
🟪 Institutional
🟦 Industrial
🟩 EP
🟫 Agricultural

N

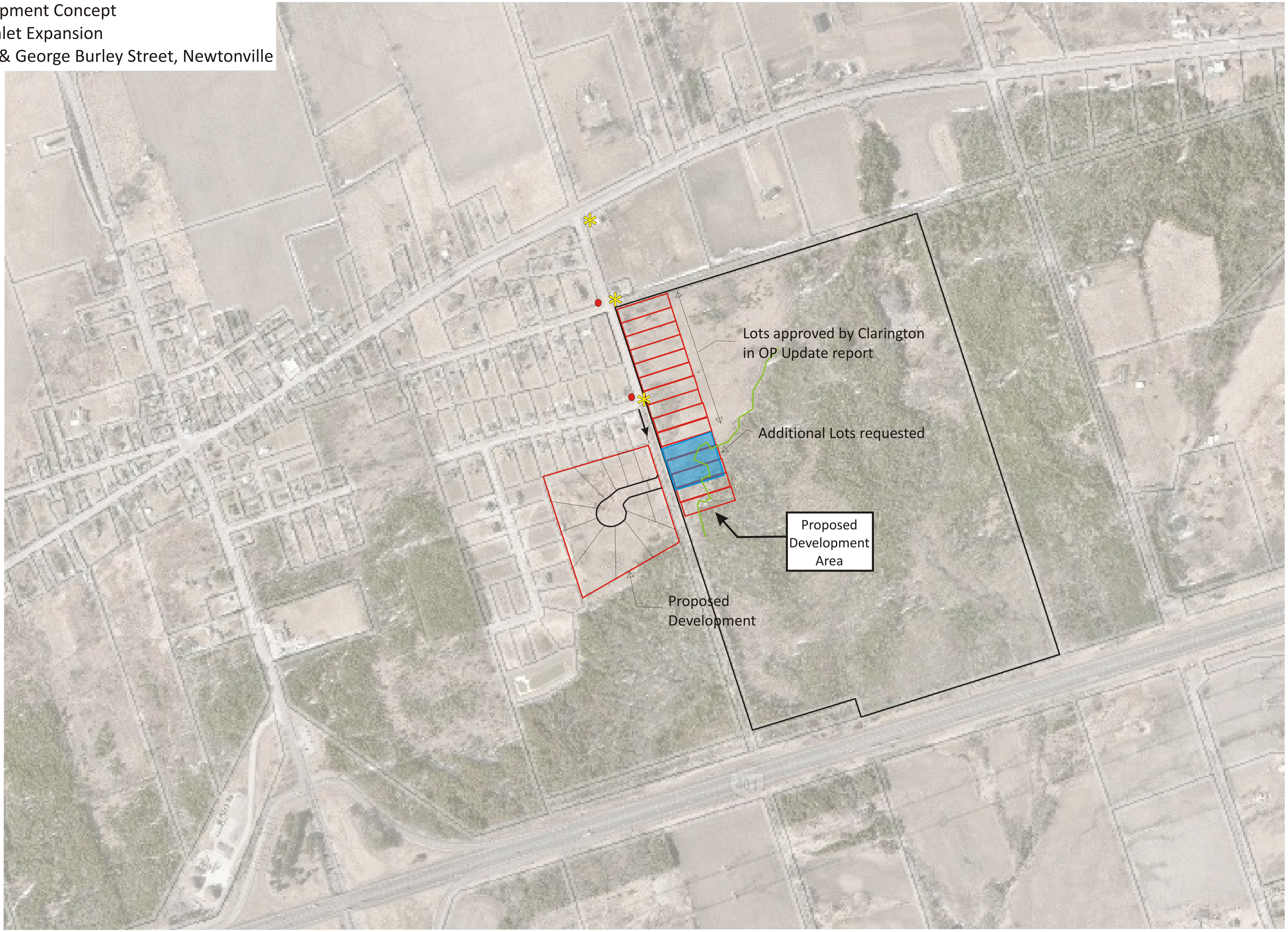
December, 2010

─── ZONE BOUNDARY
— — ARTERIAL ROAD TYPE 'A'
- - - ARTERIAL ROAD TYPE 'B'

Municipality of Clarington
Zoning By-Law 84-63
Schedule 16 (Newtonville)

2B
2B **16** 2B
2B

Figure 2 - Development Concept
Newtonville Hamlet Expansion
Paynes Crescent & George Burley Street, Newtonville



Legend

🟥 Proposed Development Area

☐ Subject Lands

✳ Streetlights

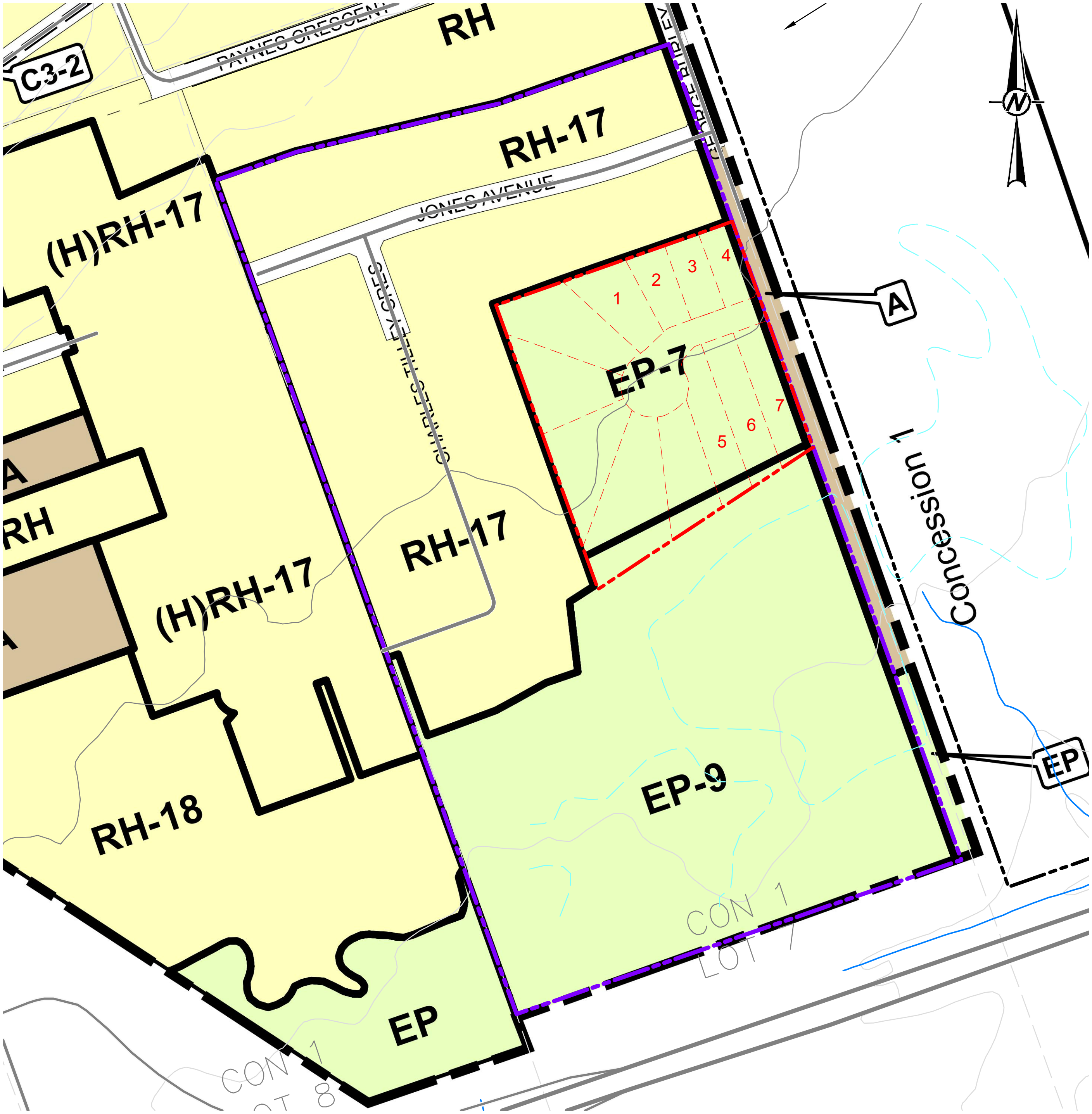
● Fire Hydrants

→ Storm Outlet

CLARK

Date: June 2015

Z:\3093-Veltri Newtonville\Figure 2 - Development Concept.cdr



LEGEND

Newtonville Estates Site Boundary

Proposed Development Plan (Lots)

Proposed Lots

0 100 200
1:5,000 METRES

REFERENCES AND NOTES
1. Mapping based on ESRI Geography Network OBM Features and Bing Orthophotos
2. JD Barnes, Survey Plan, June 2011. Updated sketch of subject lands Feb 2017.
3. Mapped Features and Locations are Approximate and Not to Scale
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CLIENT
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PROJECT
SUPPLEMENTAL HYDROGEOLOGICAL INVESTIGATION
NEWTONVILLE ESTATES
PT LOT 7, CONCESSION 1, NEWTONVILLE, ON.

TITLE
ZONING MAP

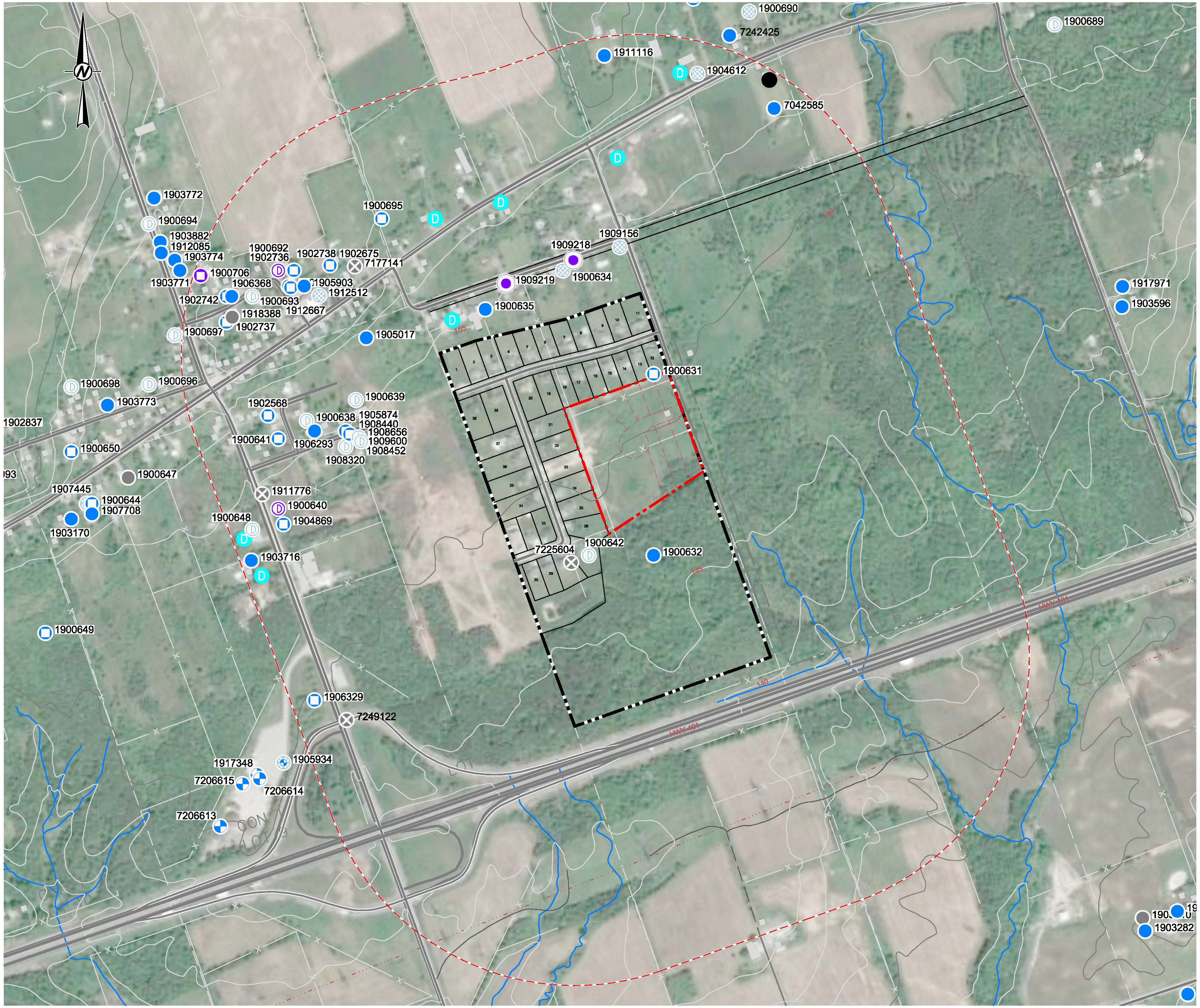
CONSULTANT
GOLDER

YYYY-MM-DD	2019-02-12
DESIGNED	XXX
PREPARED	JPR
REVIEWED	LPH
APPROVED	CMK

PROJECT NO.	CONTROL	REV.	FIGURE
1530386	0001	----	B-1

APPENDIX C

MECP Water Well Records



LEGEND

- ▬ · ▬ Site Property Line
- ▬ · ▬ Proposed Lot Development Area (Lots)
- - - - 500 m Offset
- ⓘ Shallow Dug or Bored Well <10 m
- ☐ Deep Bored Well >10 m
- ● Drilled Overburden Well
- ◍ Drilled Bedrock Well
- ● Municipal Supply
- Ⓓ ☐ Public Supply
- ⊗ Record of Abandonment
- ● Observed Drilled Well Casing
- Ⓓ Observed Dug / Bored Well Casing

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REFERENCES AND NOTES

1. Mapping based on ESRI Geography Network OBM Features and Bing Orthophotos
2. JD Barnes, Survey Plan, June 2011. Updated sketch of subject lands Feb 2017.
3. Mapped Features and Locations are Approximate and Not to Scale
4. Water Well Records, Ministry of Environment; Queen's Printer, 2018
5. Site Water Well Reconnaissance completed by Golder 23rd October 2018

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PROJECT
SUPPLEMENTAL HYDROGEOLOGICAL INVESTIGATION
NEWTONVILLE ESTATES
PT LOT 7, CONCESSION 1, NEWTONVILLE, ON.

TITLE
RECORDED WATER WELLS

CONSULTANT
GOLDER

YYYY-MM-DD	2019-02-12
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REVIEWED	LPH
APPROVED	CMK

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LABEL	CON LOT	DATE mmm-yr	EASTING NORTHING	ELEV masl	WTR FND mbgl Qu	SCR TOP LEN mbgl m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
1900631	1 7	May-63	702089 4868172	150.6	7.3 Fr		2.4				2615 BR	WS DO	**MOE# 1900631** 0.0 TPSL 0.3 CLAY MSND 7.3 GRVL 9.8
1900632	1 7	Nov-59	702089 4867822	146.9	24.4 Fr		3.4	227	720	21.3	4811 CT	WS DO	**MOE# 1900632** 0.0 TPSL 0.9 WHTE MSND GRVL 24.7
1900634	1 7	Mar-57	701914 4868372	157.0	72.8 Fr		4.0	91	120	24.4	4713 CT	WS DO	**MOE# 1900634** 0.0 TPSL 0.6 BRWN CLAY STNS 9.1 FSND 36.6 MSND CLAY 48.8 BLUE CLAY MSND 61.0 BLUE CLAY STNS 72.2 BRWN LMSN 72.8
1900635	1 8	May-60	701764 4868297	154.8	28.3 Fr		12.2	9	180	26.5	2113 CT	WS DO	**MOE# 1900635** 0.0 TPSL 0.3 MSND STNS 21.3 BRWN MSND STNS 28.3
1900638	1 8	Jul-63	701419 4868082	155.8	4.6 Fr		2.4				2615 BR	WS DO	**MOE# 1900638** 0.0 TPSL 0.3 CLAY MSND 4.6 GRVL 6.7
1900639	1 8	Jun-64	701514 4868122	155.1	4.9 Fr		2.4				2615 BR	WS DO	**MOE# 1900639** 0.0 TPSL CLAY 1.2 BRWN CLAY 4.9 GRVL CLAY 7.3
1900640	1 8	Aug-65	701364 4867912	153.9	7.0 Fr		3.4	45			5437 BR	WS PU	**MOE# 1900640** 0.0 TPSL 0.3 BRWN CLAY 5.5 BLUE CLAY STNS 7.0 GRVL 7.9
1900641	1 8	Oct-66	701364 4868047	156.4	6.1 Fr		3.0	23			2609 BR	WS DO	**MOE# 1900641** 0.0 TPSL CLAY 0.3 BRWN CLAY 4.0 BLUE CLAY 6.1 BLUE CLAY MSND 9.4
1900642	1 8	Jan-66	701964 4867822	148.1	5.8 Fr 4.3 Fr		4.3	23			2609 BR	WS DO	**MOE# 1900642** 0.0 TPSL CLAY 0.3 BRWN CLAY 3.4 CLAY MSND 5.8 GRVL 6.1
1900648	1 9	Nov-64	701314 4867872	153.9	7.0 Fr 4.0 Fr		3.7	23			5437 BR	WS DO	**MOE# 1900648** 0.0 TPSL 0.3 BRWN CLAY 1.2 GRVL 4.3 FSND 7.0 CSND 7.6
1900692	2 8	Jun-61	701364 4868372	167.3	7.3 Fr		3.0	5			5437 BR	WS PU	**MOE# 1900692** 0.0 TPSL 0.3 BRWN CLAY STNS 7.3 BRWN CLAY MSND 8.5
1900693	2 8	Jun-63	701314 4868322	167.0	6.1 Fr		1.8				2615 BR	WS DO	**MOE# 1900693** 0.0 TPSL 0.3 CLAY MSND 4.3 GRVL 4.9 CLAY MSND 7.9
1900695	2 8	Apr-64	701564 4868472	164.6	9.1 Fr		7.0				2615 BR	WS DO	**MOE# 1900695** 0.0 BRWN TPSL CLAY 1.2 BRWN CLAY 5.2 BRWN CLAY MSND 12.2
1900697	2 9	Dec-60	701164 4868247	163.7	4.6 Fr		4.6	5	180		2615 BR	WS DO	**MOE# 1900697** 0.0 TPSL CLAY 0.9 CLAY MSND 4.3 STNS 4.6 BLUE CLAY STNS 6.1
1900706	2 8	Oct-61	701214 4868362	164.9	18.3 Fr 13.1 Fr		6.7	5	240	6.7	2202 BR	WS PU	**MOE# 1900706** 0.0 PRDG 10.1 MSND 13.1 CLAY BLDR 17.7 GRVL 18.3
1902568	1 8	Aug-68	701344 4868092	158.2	9.1 Fr 3.0 Fr		3.0				2609 BR	WS DO	**MOE# 1902568** 0.0 TPSL CLAY 0.3 BRWN CLAY 3.0 BRWN CLAY STNS 9.1 CSND 9.8

LABEL	CON	DATE	EASTING	ELEV	WTR FND	SCR TOP LEN	SWL	RATE	TIME	PL	DRILLER	TYPE	WELL NAME
	LOT	mmm-yr	NORTHING	masl	mbgl Qu	mbgl m	mbgl	L/min	min	mbgl	METHOD	STAT	DESCRIPTION OF MATERIALS
1902675	2	Nov-68	701464	166.7	11.0 Fr		11.0	14		12.2	2214	WS	**MOE# 1902675**
	8		4868382								BR	DO	0.0 TPSL 0.3 CLAY MSND 7.6 CLAY STNS 11.0 MSND GRVL 11.3 GREY CLAY 13.1
1902735	2	Sep-69	701384	167.9	7.6 Fr		7.6			12.8	2214	WS	**MOE# 1902735**
	8		4868342								BR	DO	0.0 BLCK TPSL 0.3 BRWN CLAY STNS 7.6 BLUE CLAY STNS 10.7 GREY CLAY 12.8
1902736	2	Sep-69	701364	167.3	6.1 Fr		6.1			12.2	2214	WS	**MOE# 1902736**
	8		4868372								BR	DO	0.0 BLCK TPSL 0.3 BRWN CLAY STNS 6.1 BLUE CLAY STNS 10.7 GREY CLAY 12.2
1902737	2	Sep-69	701264	165.8	4.6 Fr		4.6			10.7	2214	WS	**MOE# 1902737**
	8		4868272								BR	DO	0.0 BLCK TPSL 0.3 BRWN CLAY STNS 4.6 MSND 4.9 BLUE CLAY STNS 10.7
1902738	2	Sep-69	701394	167.6	7.6 Fr		7.6			12.8	2214	WS	**MOE# 1902738**
	8		4868372								BR	DO	0.0 BLCK TPSL 0.3 BRWN CLAY MSND STNS 7.6 BLUE CLAY STNS 10.7 GREY CLAY 12.8
1902742	2	Sep-69	701264	165.8	4.6 Fr		4.6			10.7	2214	WS	**MOE# 1902742**
	8		4868322								BR	DO	0.0 BLCK TPSL 0.3 BRWN CLAY MSND 4.6 BLUE CLAY STNS 10.7
1903716	1	Feb-73	701312	153.6	11.6 Fr		0.6	9	120	4.0	2118	WS	**MOE# 1903716**
	9		4867812								CT	DO	0.0 BRWN CLAY 3.0 GREY CLAY STNS GRVL 11.3 GREY CLAY GRVL 11.6
1903771	2	Jan-73	701174	164.6	26.5 Fr	32.9 -1.2	10.7	18	240	27.4	4761	WS	**MOE# 1903771**
	8		4868372								CT	DO	0.0 TPSL 1.8 CLAY 26.5 CLAY SAND GRVL 28.7 SAND GRVL 34.1
1903774	2	Oct-73	701164	164.6	18.3 Fr		2.4	18	150	15.2	4761	WS	**MOE# 1903774**
	8		4868392								CT	DO	0.0 TPSL 1.8 CLAY 17.7 SAND GRVL 18.9
1904612	2	Nov-77	702174	161.5	77.1 Fr		9.1	91	390		2104	WS	**MOE# 1904612**
	6		4868752								CT	DO	0.0 PRDR 9.8 BLUE CLAY FSND LYRD 76.8 WHTE LMSN PORS HARD 77.1
1904869	1	Mar-77	701374	154.2	10.7 Fr		4.6	36	60	15.8	3129	WS	**MOE# 1904869**
	8		4867882								BR	DO	0.0 TPSL 0.3 GREY CLAY 3.7 CSND 16.5
1905016	2	May-78	701534	158.5	15.5 Fr		6.1	45	180	10.7	2104	WS	**MOE# 1905016**
	8		4868242								CT	DO	0.0 BRWN TPSL SOFT 0.6 BRWN SAND CLAY 14.6 BRWN GRVL LOOS 15.5
1905017	2	May-78	701534	158.5	15.5 Fr	15.5 -3.0	6.1	45	240	13.7	2104	WS	**MOE# 1905017**
	8		4868242								CT	DO	0.0 PRDR 15.5 BRWN GRVL LOOS 18.6
1905874	1	Oct-80	701494	155.4	9.8 Fr		6.1	45	60	9.4	4867	WS	**MOE# 1905874**
	8		4868062								BR	DO	0.0 BLCK TPSL PCKD 0.3 BRWN CLAY STNS HARD 6.4 BLUE CLAY STNS HARD 9.8 GREY SAND GRVL SOFT 10.1
1905903	2	Nov-80	701414	167.6	22.6 Fr		14.9	55	480	16.5	2104	WS	**MOE# 1905903**
	8		4868342								CT	DO	0.0 BRWN TPSL SOFT 0.6 BRWN CLAY GRVL CMTD 21.3 BRWN GRVL LOOS 22.6
1905934	1	Jun-80	701374	149.4			NR				2517	TH	**MOE# 1905934**
	9		4867422								PC	NU	0.0 BRWN TPSL 0.6 CLAY GRVL BLDR 4.3 GREY CLAY GRVL BLDR 17.7 GREY FSND MUCK 24.4 GREY FSND CLAY MUCK 29.0 GREY CLAY HARD 61.0 GREY CLAY GRVL BLDR 68.3 GREY LMSN 74.7

LABEL	CON	DATE	EASTING	ELEV	WTR FND	CR TOP LEN	SWL	RATE	TIME	PL	DRILLER	TYPE	WELL NAME
	LOT	mmm-yr	NORTHING	masl	mbgl Qu	mbgl m	mbgl	L/min	min	mbgl	METHOD	STAT	DESCRIPTION OF MATERIALS
1906293	1	Nov-80	701434	155.4	6.1 Fr	9.8 -0.9	4.0	14	120		3136	WS	**MOE# 1906293**
	8		4868062								CT	DO	0.0 BRWN TPSL 0.3 BRWN CLAY STNS 6.1 GREY GRVL SAND 12.2
1906329	1	May-82	701434	149.4	5.5 Fr		3.0	27	60	9.1	3129	WS	**MOE# 1906329**
	9		4867542								BR	DO	0.0 TPSL 0.3 GREY CLAY 3.7 CLAY CSND 5.5 HPAN STNS 9.4
1906368	2	Mar-82	701274	167.6	25.3 Fr	26.8 -1.2	12.5	27	60	25.9	3136	WS	**MOE# 1906368**
	8		4868322								CT	DO	0.0 BRWN TPSL 0.9 BRWN CLAY SNDY 4.3 BRWN CLAY STNS 6.1 GREY CLAY STNS 25.3 BRWN FSND VERY 29.0
1908320	1	May-87	701494	154.5	4.6 Fr		2.1	36	60	3.7	3129	WS	**MOE# 1908320**
	8		4868032								BR	DO	0.0 TPSL 0.3 BRWN CLAY 1.8 GRVL WBRG 4.6
1908440	2	Jul-87	701502	154.8	19.5 Fr		20.4	36	60	21.3	3129	WS	**MOE# 1908440**
	9		4868056								BR	DO	0.0 TPSL 0.3 BRWN CLAY STNS 4.6 GREY CLAY STNS 13.7 SAND CSND 16.2 SAND FSND 21.9
1908452	1	Feb-87	701524	154.2	4.6 Fr		4.6	36	60	6.4	3129	WS	**MOE# 1908452**
	5		4868042								BR	DO	0.0 TPSL 0.3 SAND 0.9 BRWN CLAY 3.0 GRVL WBRG 4.6 CLAY HARD ROCK 5.2 QSND 8.2
1908656	1	Oct-87	701519	154.5	5.5 Fr		4.9	36	60	7.0	3129	WS	**MOE# 1908656**
	9		4868050								BR	DO	0.0 TPSL 0.3 BRWN CLAY 1.8 HPAN STNS 5.5 SAND GRVL WBRG 8.5
1909156	1	Oct-88	702024	154.2	73.8 -		12.8	55	420	45.7	4005	WS	**MOE# 1909156**
	7		4868417								CT	DO	0.0 BRWN SAND LOOS 2.4 BRWN SAND GRVL LOOS 4.9 BRWN CLAY SAND LOOS 6.7 BRWN SAND LOOS 13.7 GREY CLAY SAND PCKD 29.0 GREY CLAY SAND PCKD 42.7 GREY CLAY GRVL PCKD 57.9 GREY CLAY GRVL HARD 65.5 GREY CLAY SAND PCKD 72.5 GREY LMSN FSND HARD 74.7
1909218		Jul-88	701934	155.1	71.3 -		2.4	9	90	75.6	2662	WS	**MOE# 1909218**
	7		4868392								RA	MU	0.0 BRWN CLAY STNS 3.0 GREY CLAY STNS 9.1 BRWN CLAY SNDY 42.7 GREY CLAY STNS SILT 70.7 GREY LMSN 76.2
1909219		Jul-88	701804	154.8	10.7 -	11.0 -0.9	6.1	27	180	10.7	2662	WS	**MOE# 1909219**
	7		4868347								RA	MU	0.0 BRWN CLAY SNDY 2.4 GREY CLAY STNS 10.7 BRWN SAND 11.9
1909600	1	Dec-88	701519	154.5	4.3 Fr		4.3	36	60	6.1	3129	WS	**MOE# 1909600**
	8		4868050								BR	DO	0.0 TPSL 0.3 BRWN CLAY STNS 3.0 SAND 4.3 SAND GRVL WBRG 6.7
1911116	2	Jun-91	701994	177.1	64.6 Fr		22.9	91	150	30.5	3367	WS	**MOE# 1911116**
	6		4868787								CT	DO	0.0 BRWN TPSL SOFT 0.6 BRWN CLAY STNS PCKD 21.3 GREY SAND CLAY HARD 61.0 GREY CLAY SNDY LOOS 64.0 BRWN CGVL WBRG SAND 64.6
1911776	1	Aug-93	701333	154.5	3.7 -		NR				3129	AS	**MOE# 1911776**
	9		4867940								-	-	0.0
1912512	2	Jul-95	701443	165.5	59.7 -		4.6	91	270	9.1	2104	WS	**MOE# 1912512**
	8		4868323								CT	DO	0.0 BRWN TPSL 0.6 BRWN CLAY 5.5 GREY CLAY SOFT 32.6 GREY CLAY SLTY WBRG 33.8 GREY LYRD 59.7 GREY SHLE GRVL 60.0

LABEL	CON	DATE	EASTING	ELEV	WTR FND		SCR TOP	LEN	SWL	RATE	TIME	PL	DRILLER	TYPE	WELL NAME
	LOT	mmm-yr	NORTHING	masl	mbgl	Qu	mbgl	m	mbgl	L/min	min	mbgl	METHOD	STAT	DESCRIPTION OF MATERIALS
1912667	2	Jan-96	701388	166.1					7.6	136	60	13.1	6874	-	**MOE# 1912667**
	8		4868339										CT	DO	0.0 BRWN CLAY 13.1
1918388	2	Aug-06	701275	165.8					NR				3136	AB	**MOE# 1918388**
	8		4868282										-	-	0.0 CLAY 0.3 7.6 7.9
7042585	2	Apr-06	702322	155.8	71.6	Fr			12.8	23	60	48.2	1455	WS	**MOE# 7042585 TAG#A032956**
	6		4868685										CT	DO	0.0 BRWN TPSL 0.3 BRWN CLAY STNS SAND 43.6 GREY GRVL CLAY 46.6 GREY CLAY SNDY 60.0 GREY CLAY STNS 69.2 BRWN SAND GRVL 71.6
7177141	2	Jun-11	701512	165.8					NR				1455	AB	**MOE# 7177141**
	8		4868380										-	-	0.0
7225604		Aug-14	701930	147.5					NR				7148	AB	**MOE# 7225604**
			4867808										-	-	0.0
7242425	2	Feb-15	702236	NR	16.5	Fr	14.0	-2.7	9.8	45	60	13.7	3367	WS	**MOE# 7242425 TAG#A175886**
	6		4868826										CT	DO	0.0 BRWN TPSL SOFT 0.3 BRWN CLAY SAND SOFT 14.0 BRWN FSND LOOS 16.5
7249122	1	Jul-15	701496	NR	4.9	Un			NR				7560	AB	**MOE# 7249122**
	9		4867504										DG	DO	0.0

QUALITY:		TYPE:		USE:				METHOD :	
Fr	Fresh	WS	Water Supply	CO	Comercial	NU	Not Used	CT	Cable Tool
Mn	Mineral	AQ	Abandoned Quality	DO	Domestic	IR	Irrigation	JT	Jetting
Sa	Salty	AS	Abandoned Supply	MU	Municipal	AL	Alteration	RC	Rotary Conventional
Su	Sulphur	AB	Abandonment Record	PU	Public	MO	Monitoring	RA	Rotary Air
--	Unrecorded	TH	Test Hole or Observation	ST	Stock	-	Not Recorded	BR	Boring

Easting and Northings UTM NAD 83 Zone 17, Translated from Recorded UTM NAD, subject to Field Verified Location or Improved Location Accuracy.

Selected information tabulated to metric with changes and corrections subject to Driller's Records.

APPENDIX D

Record of Borehole Sheets, Grain Size Distribution Analysis

RECORD OF TEST PIT 1

LOCATION See Figure 2 DATE Feb. 27, 1989 DATUM Geodetic

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; SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- O	HYDRAULIC CONDUCTIVITY, k, CM/SEC; WATER CONTENT, PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE		147.67							
	Backhoe 2.0 x 0.7 m	TOPSOIL		0.00 147.38							
		Rusty brown to light brown SILTY FINE to MEDIUM SAND, some gravel, occ. cobbles, zones and small nodules of sandy silt		0.29	1	CS	-		O		
1					2	CS	-		O	MH	▽
2				145.42							
		END OF TEST PIT		2.25							Soils saturated at and below a depth of 1.35 m and some seepage observed at and below a depth of 2.05 m on completion of excavation, Feb. 27/89
3											
4											
5											

16 ⊕ 5 PERCENT AXIAL STRAIN AT FAILURE (0, 10)

DEPTH SCALE
1 : 25

Golder Associates

LOGGED AJH
CHECKED AJH

RECORD OF TEST PIT 2

LOCATION See Figure 2

DATE Feb. 27, 1989

DATUM Geodetic

PROJECT 891-8029

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 SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- O	HYDRAULIC CONDUCTIVITY, k, CM/SEC WATER CONTENT, PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE		146.23							
	Backhoe 2.0 x 0.7 m	TOPSOIL		0.00 145.94							
1		Rusty brown to brown SAND & GRAVEL, trace silt (some silt in upper 310 m)		0.29 144.73	1	CS	-		O		▽
		END OF TEST PIT Unable to excavate past a depth of 1.5 m due to excessive sloughing of the materials		1.60							Substantial groundwater seepage at and below a depth of 1.0 m and heavy sloughing of materials on completion of excavation, Feb. 27/89
2											
3											
4											
5											

0
15 - 8 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE
1 : 25

Golder Associates

LOGGED AJH
CHECKED AJH

PROJECT 891-8029

RECORD OF TEST PIT 3

LOCATION See Figure 2

DATE Feb. 27, 1989

DATUM Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (M)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- O	HYDRAULIC CONDUCTIVITY, k, CM/SEC WATER CONTENT, PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE		150.27							
	Backhoe 2.0 x 0.7 m	TOPSOIL		0.00 150.04							
		Rusty brown to light brown FINE to MEDIUM SAND, trace silt, occ. gravel		0.23							
1					1	CS	-		o	M	
2				147.92							Test pit dry on completion of excavation, Feb. 27/89
		END OF TEST PIT		2.35							
3											
4											
5											

0
15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE
1 : 25

Golder Associates

LOGGED AJH
CHECKED AJH

RECORD OF TEST PIT 4

LOCATION See Figure 2

DATE Feb. 27, 1989

DATUM Geodetic

PROJECT 891-8029

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 SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- O	HYDRAULIC CONDUCTIVITY, k, CM/SEC WATER CONTENT, PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE		150.60							
		TOPSOIL		0.00 150.40							
	Backhoe 2.0 x 0.7 m	Rusty brown FINE SAND, trace silt, occ. roots in upper zones, occ. cobbles near surface		0.20							
1					1	CS	-		O		
											Test pit dry on completion of excavation, Feb. 27/89
2				148.40 2.20							
		END OF TEST PIT									
3											
4											
5											

15 -$\oplus$- 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DEPTH SCALE
1 : 25

Golder Associates

LOGGED AJH
CHECKED AJH

PROJECT 891-8029

RECORD OF TEST PIT 5

LOCATION See Figure 2 DATE Feb. 27, 1989 DATUM Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (M)	SAMPLES NUMBER	TYPE	BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- ○	HYDRAULIC CONDUCTIVITY, k, CM/SEC WATER CONTENT, PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE	152.60							
	Backhoe 2.0 × 0.7 m	TOPSOIL	0.00							
		Rusty brown SILTY FINE SAND, numerous cobbles and boulders, numerous roots	152.37 0.23	1	CS	-		○		
1		Light brown SANDY SILT, some gravel, trace clay, large pockets of sandy silt and silty fine sand in upper zones (TILL)	151.80 0.80	2	CS	-		○	MH	Test pit dry on completion of excavation, Feb. 27/89
2		END OF TEST PIT	150.50 2.10							
3										
4										
5										

0
15-◆-5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE
1 : 25

Golder Associates

LOGGED AJH
CHECKED AJH

RECORD OF TEST PIT 6

LOCATION See Figure 2

DATE Feb. 27, 1989

DATUM Geodetic

PROJECT 891-8029

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- ○	HYDRAULIC CONDUCTIVITY, k, CM/SEC / WATER CONTENT, PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE		151.37							
	Backhoe 2.0 x 0.7 m	TOPSOIL		0.00 151.19							
		Rusty brown to brown MEDIUM SAND, trace silt, occ. roots in upper zones		0.18							
1					1	CS	-		o	M	
											Test pit dry on completion of excavation, Feb. 27/89
2				149.32							
		END OF TEST PIT		2.06							
3											
4											
5											

15-⊕-5 PERCENT AXIAL STRAIN AT FAILURE 0 10

DEPTH SCALE

1 : 25

Golder Associates

LOGGED AJH

CHECKED AJH

PROJECT 891-8029

RECORD OF TEST PIT 7

LOCATION See Figure 2

DATE Feb. 27, 1989

DATUM Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (M)	SAMPLES NUMBER	TYPE	BLOWS/0.3M	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE	152.76					
	Backhoe 2.0 x 0.7 m	TOPSOIL	0.00					
		Rusty brown SILTY FINE SAND, occ. roots in upper zones	152.46 0.30	1	CS	-		
1		Light brown SILTY SAND, some gravel, trace clay, occ. cobbles and boulders at depth (TILL)	151.51 1.25	2	CS	-	MH	Test pit dry on completion of excavation, Feb. 27/89
2		END OF TEST PIT	150.46 2.30					
3								
4								
5								

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- O

HYDRAULIC CONDUCTIVITY, k, CM/SEC

WATER CONTENT, PERCENT Wp W Wl 10 20 30 40

15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE 0 10

DEPTH SCALE
1 : 25

Golder Associates

LOGGED AJH
CHECKED AJH

PROJECT 891-8029

RECORD OF TEST PIT 8

LOCATION See Figure 2

DATE Feb. 27, 1989

DATUM Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (M)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- O	HYDRAULIC CONDUCTIVITY, k, CM/SEC WATER CONTENT, PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE		153.88							
	Backhoe 2.0 x 0.7 m	TOPSOIL		0.00							
				153.54							
		Rusty brown SILTY FINE SAND		0.32							
				153.38							
		Light brown SILTY SAND to SANDY SILT, some gravel, trace clay, occ. cobbles (TILL)		0.48							
1					1	CS	-		O		
											Test pit dry on completion of excavation, Feb. 27/89
				151.88							
2		END OF TEST PIT		2.00							
3											
4											
5											

16 ⊕ 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DEPTH SCALE

1 : 25

Golder Associates

LOGGED AJH

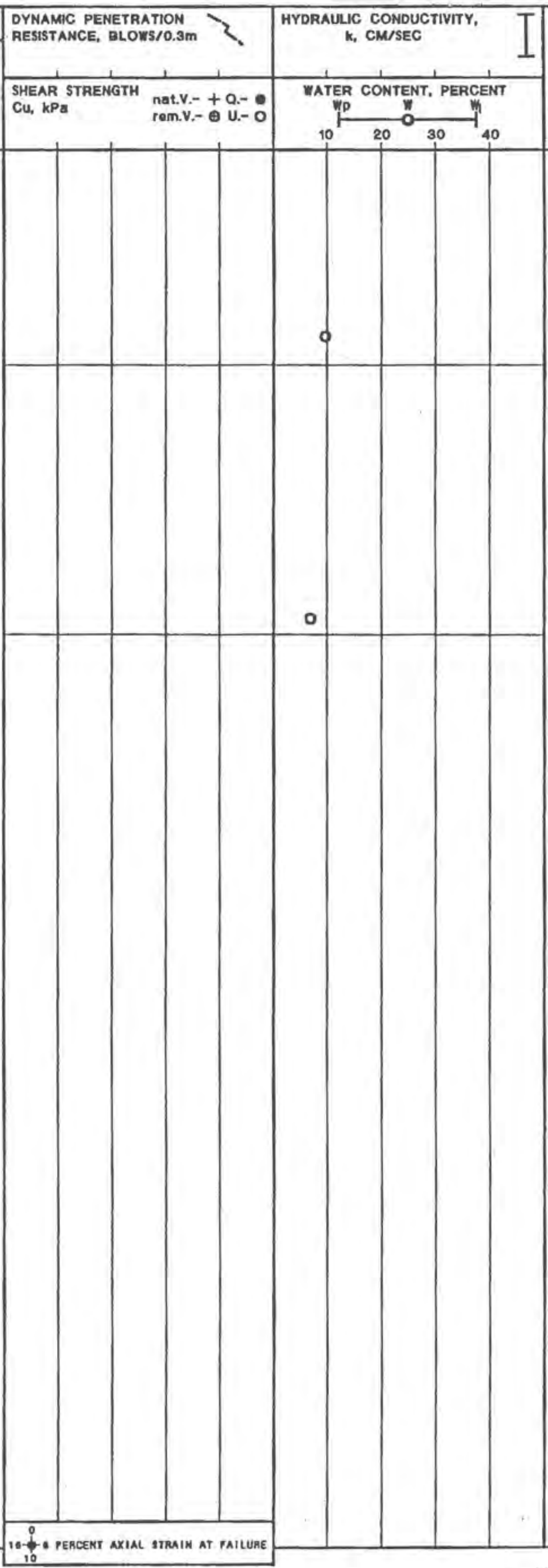
CHECKED AJA

PROJECT 891-8029

RECORD OF TEST PIT 9

LOCATION See Figure 2 | DATE Feb. 27, 1989 | DATUM Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (M)	SAMPLES NUMBER	TYPE	BLOWS/0.3M	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0		GROUND SURFACE	154.71					
	Backhoe 2.0 x 0.7 m	TOPSOIL	0.00					
		Rusty brown to light brown FINE to MEDIUM SAND, trace silt, numerous roots and cobbles near surface	154.47 0.24	1	CS	-		
1								
		Light brown SANDY SILT, some gravel, trace to some clay (TILL)	153.27 1.44	2	CS	-		Test pit dry on completion of excavation, Feb. 27/89
2		END OF TEST PIT	152.61 2.10					
3								
4								
5								



DEPTH SCALE
1 : 25

Golder Associates

LOGGED AJH
CHECKED AJH

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-1

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE	148.00					
0	BACKHOE 0.9m X 2.4m	TOPSOIL	0.00 147.70					
		Reddish brown SILTY SAND, trace clay, occasional roots	0.30 147.34	1	CS	-		
1		Brown medium SAND, trace to some silt, stratified	0.66 145.80	2	CS	-	M	Native Backfill
2								
		END OF TEST PIT	2.40					Heavy groundwater seepage encountered during excavation at 1.50m depth July 24, 1991
3								Groundwater El. 146.6 m on Aug. 13/91 Groundwater El. 146.5 m on Oct. 4/91
4								
5								

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ●

20 40 60 80

WATER CONTENT, PERCENT Wp ├──○W──┤ Wl

20 40 60 80

15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE (0, 10)

DATA INPUT. Disk Aug 1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029
LOCATION: See Figure 2

RECORD OF TEST PIT 91-2

DATE: July 24,1991

SHEET 1 OF 1
DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		149.00 0.00							
0	BACKHOE 1.0m X 3.0m	TOPSOIL		148.82 0.18							
		Reddish brown SILTY fine SAND, trace gravel, occasional roots		148.25 0.75	1	CS	-				
1 2		Light brown to grey SANDY SILT to SILTY SAND, some clay, some gravel, occasional cobbles (TILL)		146.26 2.74	2	CS	-			MH	
3 4 5		END OF TEST PIT									Test Pit dry upon completion of excavation July 24,1991

0
15 -◆- 5 PERCENT AXIAL STRAIN AT FAILURE
10

DATA INPUT: DISK AUG 1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED:

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-3

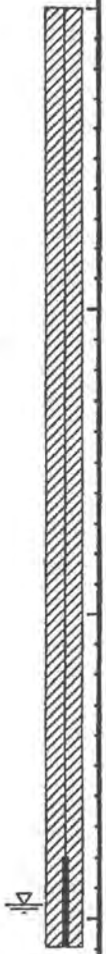
DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. (VANE TEST - +, PENETROMETER - ●) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE	146.00							
0		TOPSOIL	0.00 145.85							
1	BACKHOE 1.2m X 3.0m	Reddish brown to brown fine to medium SAND, trace to some silt, some gravel in upper zone, occasional roots in upper zone, occasional boulders in upper zone	0.15	1	CS	-				Backfill
3		END OF TEST PIT	142.90 3.10							∇

Depth scale marks: 0, 1, 2, 3, 4, 5



Groundwater seepage encountered during excavation at 2.95m depth July 24,1991

Groundwater El. 142.7 m on Aug. 13/91

Groundwater El. 142.8 m on Oct. 4/91

15 -◆- 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DATA INPUT: Disk Aug 1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029
LOCATION: See Figure 2

RECORD OF TEST PIT 91-4

DATE: July 24,1991

SHEET 1 OF 1
DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		148.00							
0	BACKHOE 0.9m X 2.5m	TOPSOIL		0.00							
		Reddish to light brown fine SAND, trace to some silt, trace gravel, occasional roots in upper zone, occasional cobbles in upper zone		147.80 0.20							
1					1	CS	-				
2					2	CS	-				
											▽
		END OF TEST PIT		145.26 2.74							Groundwater seepage encountered during excavation at 2.50m depth July 24,1991
3											
4											
5											

15-◆-5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DATA INPUT: Disk Aug.1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED: BAW

PROJECT: 891-8029
LOCATION: See Figure 2

RECORD OF TEST PIT 91-5

DATE: July 24,1991

SHEET 1 OF 1
DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE	149.00					
0	BACKHOE 1.0m X 2.80m	TOPSOIL	0.00 148.80					
		Reddish brown to brown fine to medium SAND, trace to some silt, stratified	0.20					
1				1	CS	-	M	
2				2	CS	-		
3			145.70					▽
		END OF TEST PIT	3.30					Groundwater seepage encountered during excavation at 2.86m depth July 24,1991
4								
5								

SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80

15-◆-5 0 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: Disk Aug.1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED: BAW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-6

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0	BACKHOE 1.0m X 3.00m	GROUND SURFACE		149.00 0.00							
		TOPSOIL		148.77 0.23							
1		Reddish brown to brown fine to medium SAND, trace to some silt, trace gravel, occasional cobbles in upper zones, occasional roots in upper zone			1	CS	-				
2					2	CS	-				
				148.20 2.80							
3		END OF TEST PIT									Test Pit dry upon completion of excavation July 24,1991
4											
5											

15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-7

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		150.00							
0	BACKHOE 1.0m X 3.0m			0.00							
		TOPSOIL		149.75 0.25							
1		Reddish brown to brown fine SAND, some silt, some gravel, occasional cobbles, frequent roots		148.50 1.50	1	CS	-				
2		Light brown SAND, trace to some gravel, trace silt		147.10 2.90	2	CS	-				
3		END OF TEST PIT									Test Pit dry upon completion of excavation July 24,1991
4											
5											

DATA INPUT: Disk Aug.1/91

15-◆-5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029
LOCATION: See Figure 2

RECORD OF TEST PIT 91-8

DATE: July 24,1991

SHEET 1 OF 1
DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
	BACKHOE 1.0m X 3.0m	GROUND SURFACE		150.00							
0		TOPSOIL		0.00							
		Reddish brown fine SAND, some silt, some gravel, occasional roots, occasional cobbles		149.80 0.20	1	CS	-				
1		Brown to grey SANDY SILT to SILTY SAND, some gravel, trace clay, occasional cobbles, fissured (TILL)		149.25 0.75	2	CS	-				Test Pit dry upon completion of excavation July 24,1991
2											
		END OF TEST PIT		147.56 2.44							
3											
4											
5											

0
15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE
10

DATA INPUT: Disk Aug.1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED: BAw

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-9

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80

WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
	BACKHOE 1.0m X 3.0m	GROUND SURFACE	151.00					
0		TOPSOIL	0.00					
		Reddish brown SILTY fine SAND, trace gravel, occasional cobbles, occasional roots	150.80 0.20	1	CS	-		
1		Brown SILTY SAND, trace clay, some gravel, occasional cobbles	150.33 0.67	2	CS	-		
2		Brown medium SAND, trace silt, trace gravel	148.85 2.15	3	CS	-		Test Pit dry upon completion of excavation July 24,1991
		END OF TEST PIT	148.25 2.75					
3								
4								
5								

0
15-◆-5 PERCENT AXIAL STRAIN AT FAILURE
10

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BJW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-10

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

SOIL PROFILE | SAMPLES | SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80 | HYDRAULIC CONDUCTIVITY, k, cm/s ⊕ WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80

DEPTH SCALE METRES	METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		151.00					
0	BACKHOE 0.9m X 3.0m	TOPSOIL		0.00					
		Reddish brown to light brown fine to medium SAND, trace silt, occasional roots and cobbles in upper zone		150.80 0.20					
1					1	CS	-	M	
2									
					2	CS	-		
3		END OF TEST PIT		147.95 3.05					Test Pit dry upon completion of excavation July 24,1991
4									
5									

15 -◆- 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BRW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-11

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
	BACKHOE 0.9m X 3.1m	GROUND SURFACE									
0		TOPSOIL		152.00 0.00							
1		Light brown SAND, some silt, some gravel, trace clay, occasional cobbles, occasional roots in upper zone		151.80 0.20	1	CS	-				
2		Light brown SANDY SILT, some gravel, trace clay, occasional cobbles, fissured, rusty oxidation stains		150.30 1.70	2	CS	-				
		END OF TEST PIT		149.41 2.59							Test Pit dry upon completion of excavation July 24,1991
3											
4											
5											

15 -◆- 5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-12

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		152.00							
0	BACKHOE 1.0m X 2.8m	TOPSOIL		0.00							
				151.80 0.20							
1		Light brown to grey SILTY SAND to SANDY SILT, trace clay, trace gravel, occasional cobbles, occasional roots in upper zone fissured, rusty oxidation stains			1	CS	-			MH	
2					2	CS	-				
				149.72 2.28							
		END OF TEST PIT									Test Pit dry upon completion of excavation July 24,1991
3											
4											
5											

DATA INPUT: Disk Aug.1/91

$\overset{0}{15\text{-}\blacklozenge\text{-}5}_{10}$ PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029
LOCATION: See Figure 2

RECORD OF TEST PIT 91-13

DATE: July 24,1991

SHEET 1 OF 1
DATUM: Geodetic

HYDRAULIC CONDUCTIVITY, k, cm/s
SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80
WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		152.00					
0		TOPSOIL		0.00					
	BACKHOE 0.9m X 2.7m	Light brown SANDY SILT, some gravel, trace clay, occasional cobbles, occasional roots in upper zone, fissured blocky structure		151.77 0.23					
1					1	CS	-		
2					2	CS	-		
		END OF TEST PIT		149.54 2.46					Test Pit dry upon completion of excavation July 24,1991
3									
4									
5									

0
15-◆-5 PERCENT AXIAL STRAIN AT FAILURE
10

DATA INPUT: Disk Aug.1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED: BAW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-14

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	HYDRAULIC CONDUCTIVITY, k, cm/s SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0	BACKHOE 0.9m X 2.4m	GROUND SURFACE		152.00 0.00							
		TOPSOIL		151.77 0.23							
		Reddish brown SILTY SAND, trace gravel, occasional roots		151.17 0.83	1	CS	-				
1		Brown SAND, trace to some gravel, trace silt			2	CS	-			M	
2					3	CS	-				
				149.38 2.64							
3		END OF TEST PIT									Test Pit dry upon completion of excavation July 24,1991
4											
5											

15 0 5 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-15

DATE: July 24,1991

SHEET 1 OF 1

DATUM: Geodetic

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80

WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE						
0	BACKHOE 1.0m X 2.8m	TOPSOIL	152.00 0.00					
		Reddish brown to brown medium SAND, trace silt, trace gravel, occasional roots	151.77 0.23					
1				1	CS	-	M	
2				2	CS	-		
3		END OF TEST PIT	148.11 2.89					Test Pit dry upon completion of excavation July 24,1991
4								
5								

15-◆-5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED:

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-16

DATE: July 25,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	GROUNDWATER CONDITIONS
		GROUND SURFACE	154.00				
0		TOPSOIL	0.00				
			153.80 0.20				
1				1	CS	-	Native Backfill
	BACKHOE 1.0m X 2.8m	Reddish to light brown fine to medium SAND, trace gravel, occasional roots in upper zone, stratified rusty oxidation stains					
2							
				2	CS	-	
3							▽
			150.70 3.30				
		END OF TEST PIT					Groundwater seepage encountered during excavation at 3.05m depth July 25,1991
4							Groundwater El. 151.0 m on Aug. 13/91 Groundwater El. <150.7 m on Oct. 4/91
5							

SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT Wp W Wl 20 40 60 80

ADDITIONAL LAB. TESTING

15 0 5 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: Disk Aug.1/91

DEPTH SCALE 1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BRW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-17

DATE: July 25,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE	154.00							
0	BACKHOE 0.9m X 2.8m	TOPSOIL	0.00							
		Reddish brown SILTY fine SAND, occasional roots	153.75 0.25	1	CS	-				
1		Light brown SILTY SAND, some gravel, trace clay, occasional cobbles (TILL)	153.47 0.53	2	CS	-				
2										
		END OF TEST PIT	151.60 2.40							Test Pit dry upon completion of excavation July 25,1991
3										
4										
5										

0
15 ◆ 5 PERCENT AXIAL STRAIN AT FAILURE
10

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029
LOCATION: See Figure 2

RECORD OF TEST PIT 91-18

DATE: July 25,1991

SHEET 1 OF 1
DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0	BACKHOE 1.0m X 2.8m	GROUND SURFACE	154.00 0.00					
		TOPSOIL	153.85 0.15					
		Reddish brown SILTY fine SAND, some gravel, occasional roots	153.25 0.75	1	CS	-		
1		Light brown to light grey SILTY SAND to SANDY SILT, some gravel, trace clay, occasional cobbles (TILL)		2	CS	-	MH	
2			151.33 2.67	3	CS	-		
		END OF TEST PIT						Test Pit dry upon completion of excavation July 25,1991
3								
4								
5								

SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ●
20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT
Wp ├──○W──┤ Wl
20 40 60 80

15-◆-5 PERCENT AXIAL STRAIN AT FAILURE
0
10

DATA INPUT: Disk Aug.1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED: BAW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-19

DATE: July 25,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		154.00							
0	BACKHOE 0.9m X 2.7m	TOPSOIL		0.00							
		Light brown SILTY SAND, some gravel, trace clay, occasional cobbles, occasional roots in upper zone (TILL)		153.75 0.25	1	CS	-				
		END OF TEST PIT		151.60 2.40							Test Pit dry upon completion of excavation July 25,1991

15 0 5 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: Disk Aug1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BMW

PROJECT: 891-8029

RECORD OF TEST PIT 91-20

SHEET 1 OF 1

LOCATION: See Figure 2

DATE: July 25,1991

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
	BACKHOE 1.0m X 3.0m	GROUND SURFACE		153.00 0.00					
0		TOPSOIL		152.80 0.20					
		Reddish brown SANDY SILT, some gravel, occasional roots		152.25 0.75	1	CS	-	MH	
1		Light brown SILTY SAND to SANDY SILT, some gravel, trace clay, occasional cobbles (TILL)		150.35 2.65	2	CS	-		Native Backfill
		END OF TEST PIT							Test Pit dry upon completion of excavation July 25,1991
3									Piezometer Destroyed
4									
5									

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, lb/sq.m. — VANE TEST - + — PENETROMETER - ● — 20 40 60 80

WATER CONTENT, PERCENT — Wp ├──○W──┤ Wl — 20 40 60 80

0 / 15 -◆- 5 / 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: Disk Aug 1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BRW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-21

DATE: July 25,1991

SHEET 1 OF 1

DATUM: Geodetic

SOIL PROFILE | SAMPLES

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80

WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	USCS	GROUNDWATER CONDITIONS
		GROUND SURFACE					
0	BACKHOE 1.0m X 2.7m	TOPSOIL	153.00 0.00				
		Reddish brown to light brown SANDY SILT, some clay, some gravel, occasional cobbles, fissured blocky structure (TILL)	152.80 0.20				
1				1	CS	-	
2							
		END OF TEST PIT	150.56 2.44				Test Pit dry upon completion of excavation July 25,1991
3							
4							
5							

15-0-5 PERCENT AXIAL STRAIN AT FAILURE 10

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029

LOCATION: See Figure 2

RECORD OF TEST PIT 91-22

DATE: July 25,1991

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE	153.00					
0		TOPSOIL	0.00					
			152.77 0.23					
1	BACKHOE 0.9m X 2.8m	Reddish brown to light brown SILTY SAND to SANDY SILT, trace clay, some gravel, occasional cobbles, fissured, blocky structure, occasional roots in upper zones (TILL)		1	CS	-	MH	
2				2	CS	-		
			150.36 2.84					
		END OF TEST PIT						Test Pit dry upon completion of excavation July 25,1991
3								
4								
5								

SHEAR STRENGTH Cu, lb/sq.m. — VANE TEST - + PENETROMETER - ● — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s ⊕

WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl — 20 40 60 80

0 15-◆-5 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: Disk Aug.1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED: BAW

PROJECT: 891-8029
LOCATION: See Figure 2

RECORD OF TEST PIT 91-23

DATE: July 25,1991

SHEET 1 OF 1
DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES USCS	SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
0	BACKHOE 1.0m X 2.7m	GROUND SURFACE		153.00 0.00							
		TOPSOIL		152.71 0.29							
1		Reddish to light brown SILTY fine SAND, some gravel, occasional roots		151.63 1.37	1	CS	-				
		Brown SAND, some gravel, trace silt		151.02 1.98	2	CS	-				
2		Light brown SANDY SILT, trace to some gravel, trace clay		150.07 2.93	3	CS	-				
3		END OF TEST PIT									Test Pit dry upon completion of excavation July 25,1991
4											
5											

15-◆-5 PERCENT AXIAL STRAIN AT FAILURE (0 above, 10 below)

DATA INPUT: Disk Aug.1/91

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: S.D.L
CHECKED: BAW

PROJECT: 891-8029

RECORD OF TEST PIT 91-24

SHEET 1 OF 1

LOCATION: See Figure 2

DATE: July 25,1991

DATUM: Geodetic

DEPTH SCALE METRES	METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	USCS	HYDRAULIC CONDUCTIVITY, k, cm/s SHEAR STRENGTH Cu, lb/sq.m. VANE TEST - + PENETROMETER - ● 20 40 60 80	WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
		GROUND SURFACE		153.00							
0		TOPSOIL		0.00 152.85 0.15							
1	BACKHOE 1.0m X 2.4m	Reddish to light brown fine to medium SAND, trace silt, occasional roots in upper zone			1	CS	-				
2					2	CS	-				
				150.11 2.89							
3		END OF TEST PIT									Test Pit dry upon completion of excavation July 25,1991
4											
5											

15 0 5 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: Disk Aug.1/91

DEPTH SCALE

1 to 25

Golder Associates

LOGGED: S.D.L

CHECKED: BAW

PROJECT: 891-8029

RECORD OF BOREHOLE VB1

SHEET 1 OF 2

LOCATION: SEE FIGURE 2

BORING DATE: Sept 5, 1991

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

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 SHEAR STRENGTH Cu, kPa nat.V - + Q - ● rem.V - ⊕ U - O	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—O W—⊣ Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		150.70							
0	POWER AUGER 114 mm Dia. Solid Stem Augers	TOPSOIL		0.00							
		Light brown FINE to MEDIUM SAND, trace gravel, trace silt		150.55 0.15							
1											Backfill
2											
3											
											Bentonite
4											Caved ▽
											Water level in monitoring well at El. 148.8 m Oct. 4/91
				145.78 4.92							
5											

15-◆-5 PERCENT AXIAL STRAIN AT FAILURE (0, 10)

DEPTH SCALE
1 to 25

Golder Associates

LOGGED: SDL
CHECKED: BAW

RECORD OF BOREHOLE VB2

PROJECT: 891-8029
LOCATION: SEE FIGURE 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

BORING DATE: Sept. 5, 1991

SHEET 1 OF 2
DATUM: GEODETIC
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat.V - + Q - ● rem.V - ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ├──○W──┤ Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	POWER AUGER 114 mm Dia. Solid Stem Augers	GROUND SURFACE		153.70							
		TOPSOIL		0.00							
		Light brown SAND, some silt, some gravel, trace clay, occ. cobbles (TILL)		153.45 0.25							Backfill
1											
2											
3											
4											Bentonite
				148.78 4.92							Water level in monitoring well at El. 148.9 m Oct. 4/91
5											

15-0-5 PERCENT AXIAL STRAIN AT FAILURE 10

DEPTH SCALE
1 to 25

Golder Associates

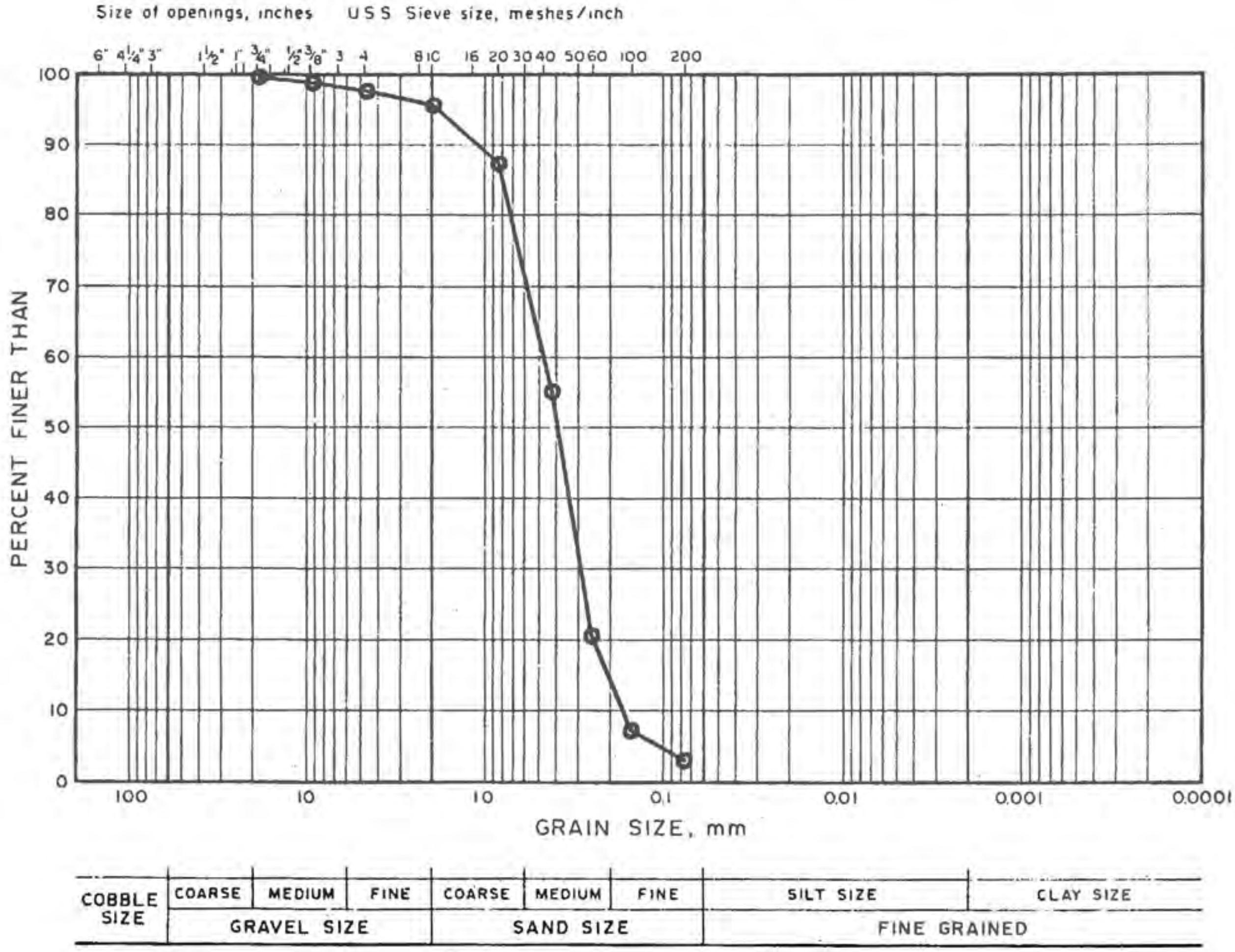
LOGGED: SDL
CHECKED: BAW

DATA INPUT: A:G029002.BH

GRAIN SIZE DISTRIBUTION

FIGURE 4

MEDIUM SAND, Trace to some gravel, trace silt



LEGEND

SYMBOL	TEST PIT	SAMPLE	DEPTH (m)
○	91-14	2	0.90-1.20

Project 891-8029

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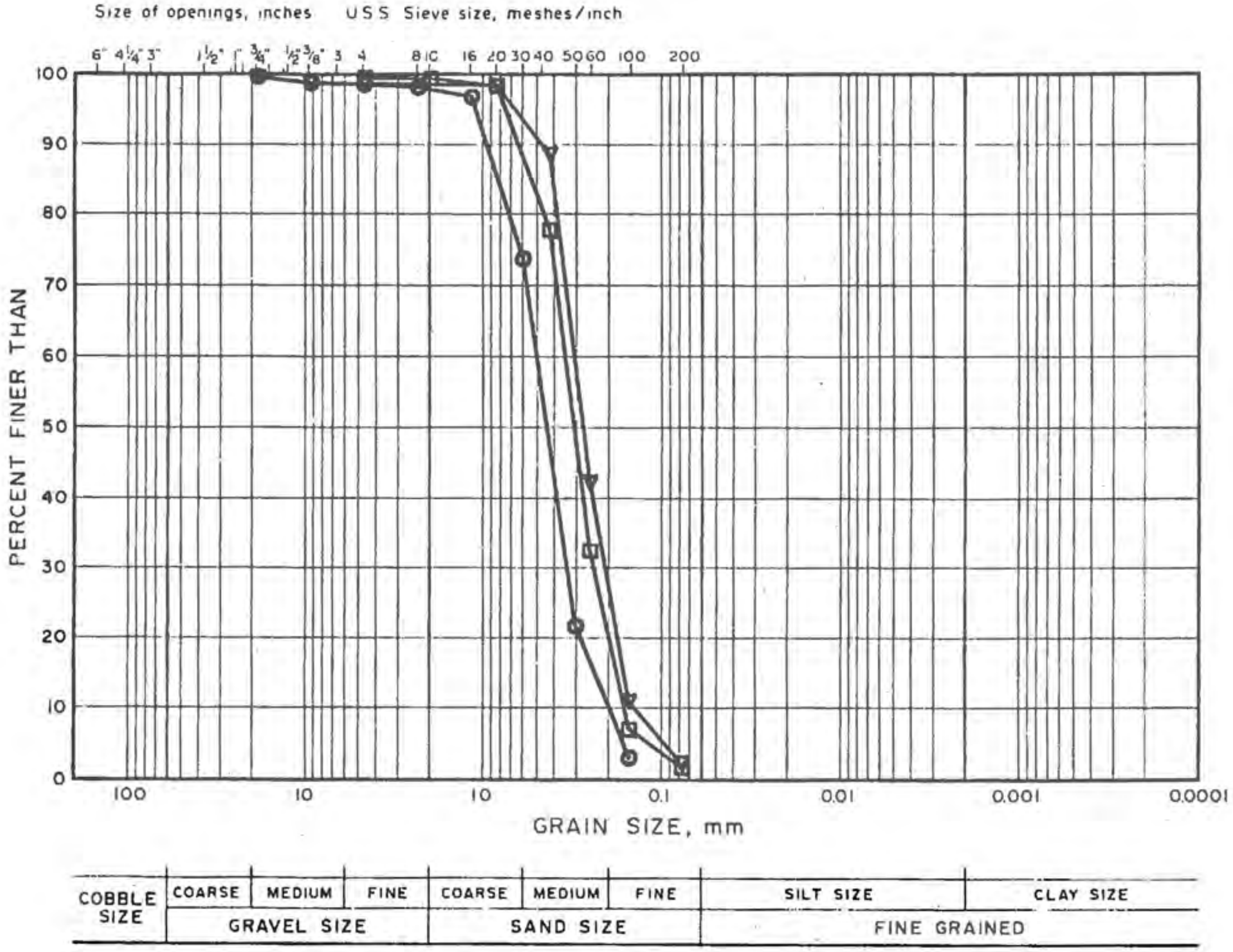
GRAIN SIZE DISTRIBUTION

FIGURE **5**

MEDIUM SAND



LEGEND

SYMBOL	TEST PIT	SAMPLE	DEPTH (m)
○	3	1	0.80-1.20
□	6	1	0.65-1.20
▽	91-1	2	0.90-1.70

Project **891-8029**

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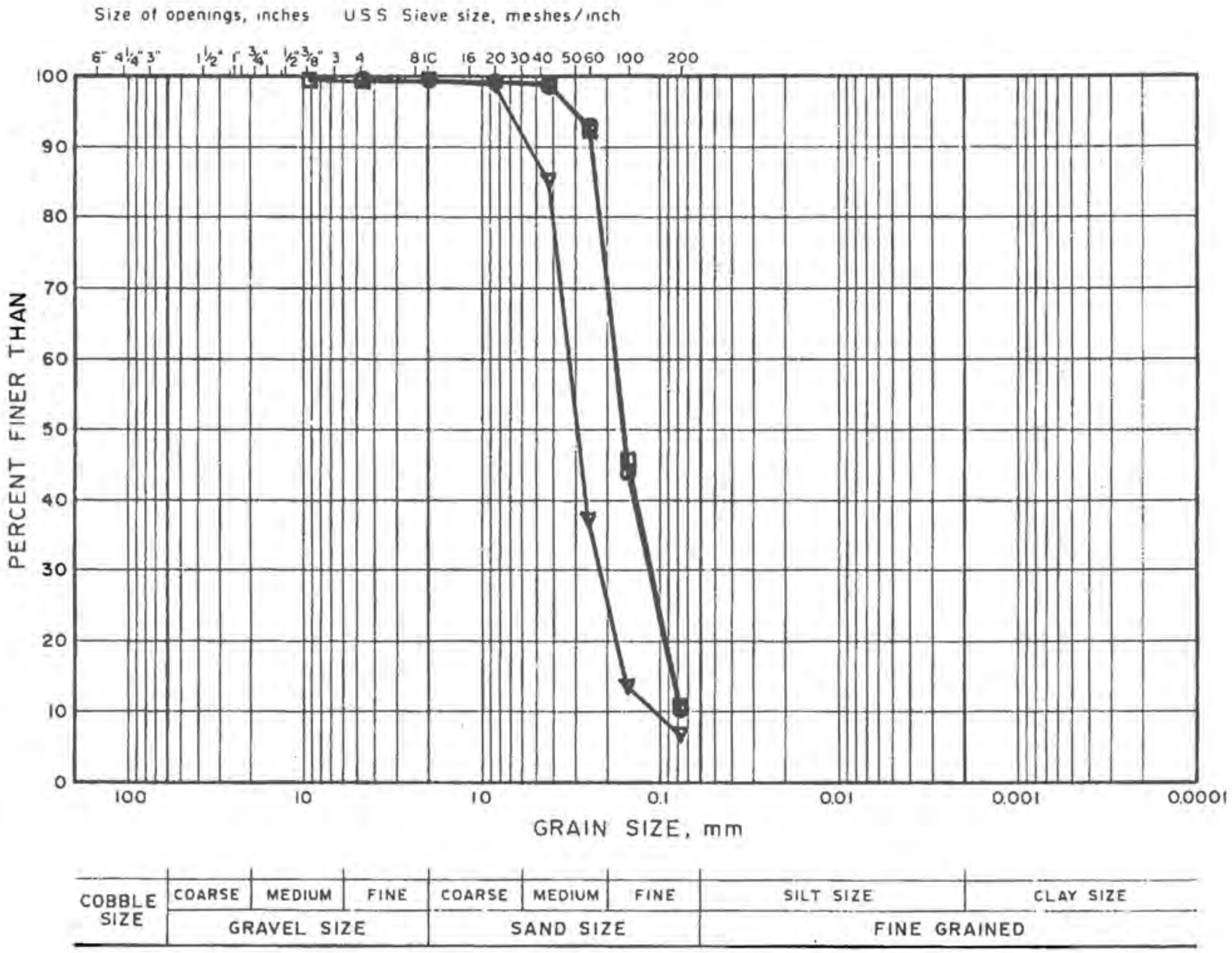
GRAIN SIZE DISTRIBUTION

FIGURE 6

FINE to MEDIUM SAND



LEGEND

SYMBOL	TEST PIT	SAMPLE	DEPTH (m)
○	91-5	2	0.90-1.20
□	91-10	1	0.90-1.20
▽	91-15	1	0.90-1.20

Project 891-8029

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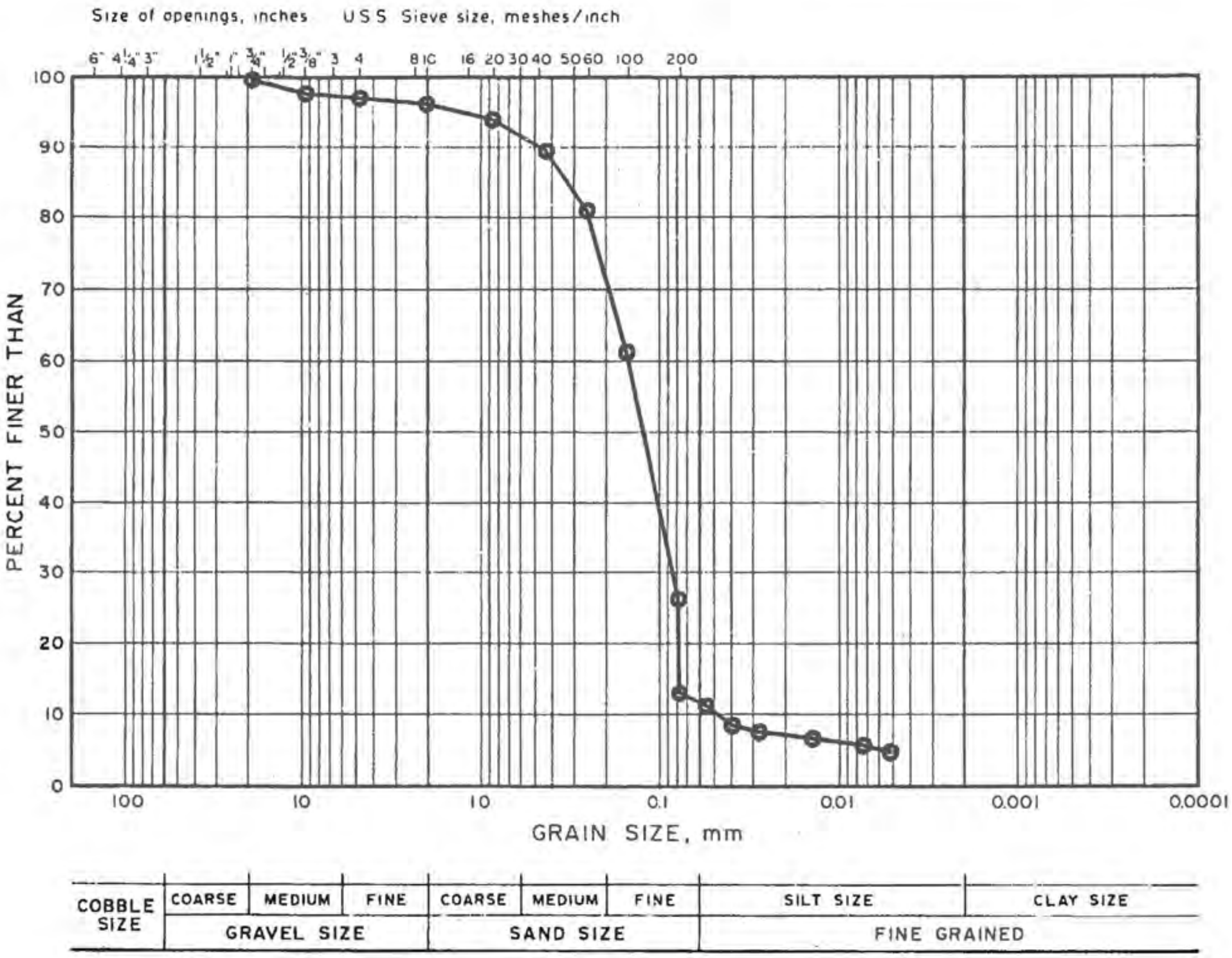
GRAIN SIZE DISTRIBUTION

FIGURE 7

SILTY FINE to MEDIUM SAND



LEGEND

SYMBOL	TEST PIT	SAMPLE	DEPTH (m)
○	1	2	0.40-0.45

Project 891-8029

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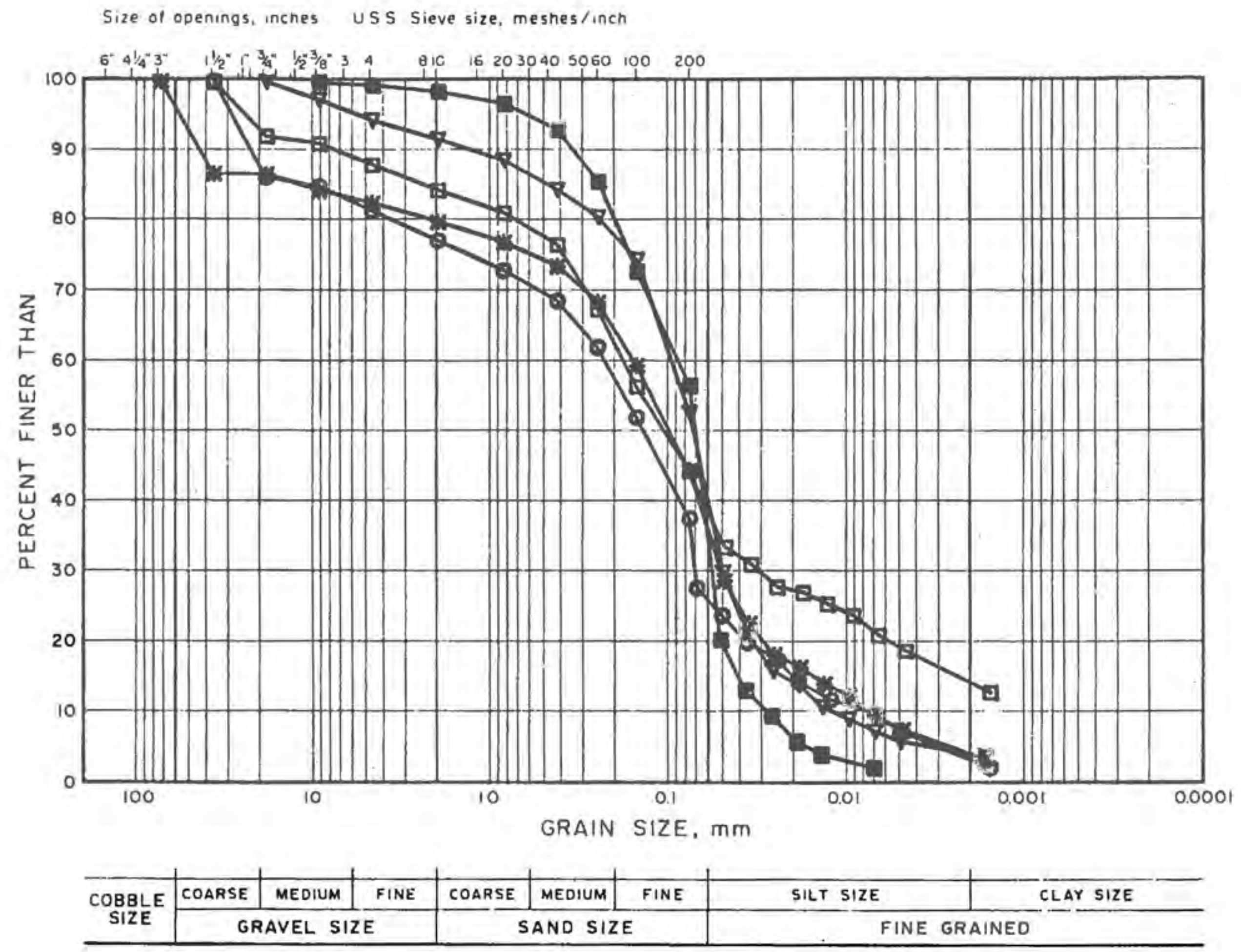
GRAIN SIZE DISTRIBUTION

FIGURE **8**

SILTY SAND TILL



LEGEND

SYMBOL	TEST PIT	SAMPLE	DEPTH (m)
○	7	2	0.60-1.00
□	91-2	2	0.90-1.20
▽	91-18	2	0.90-1.20
■	91-20	1	0.30-0.60
✱	91-22	1	0.90-1.20

Project **891-8029**

Golder Associates

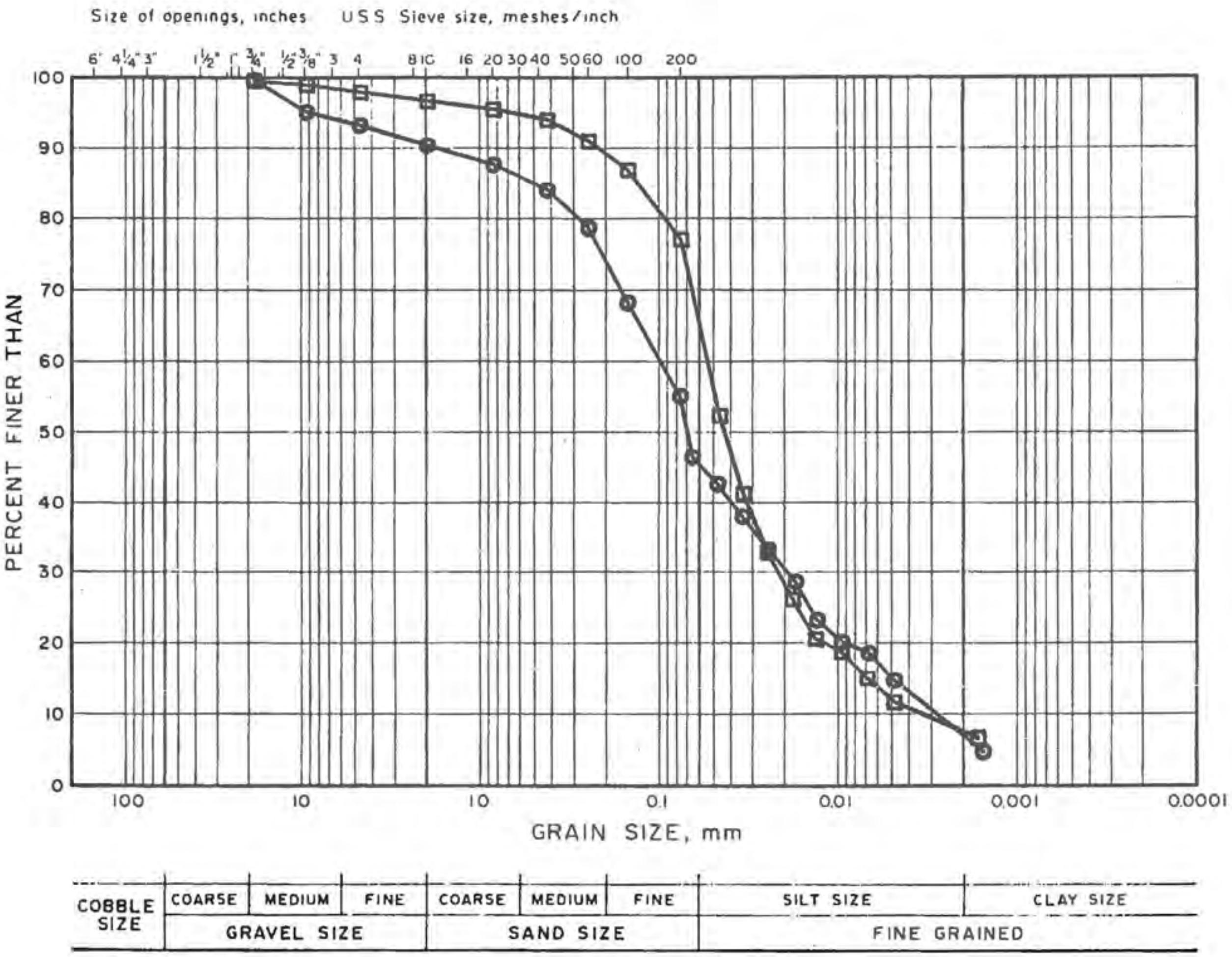
FORM PRODUCED FEB 1989

Form GA-050

GRAIN SIZE DISTRIBUTION

FIGURE 9

SANDY SILT TILL



LEGEND

SYMBOL	TEST PIT	SAMPLE	DEPTH (m)
○	5	2	0.90-1.25
☐	91-12	1	0.90-1.20

PROJECT: 1530385

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH18-1-W

SHEET 1 OF 1

DATUM: Geodetic

BORING DATE: June 21, 2018

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

HAMMER TYPE: AUTOMATIC

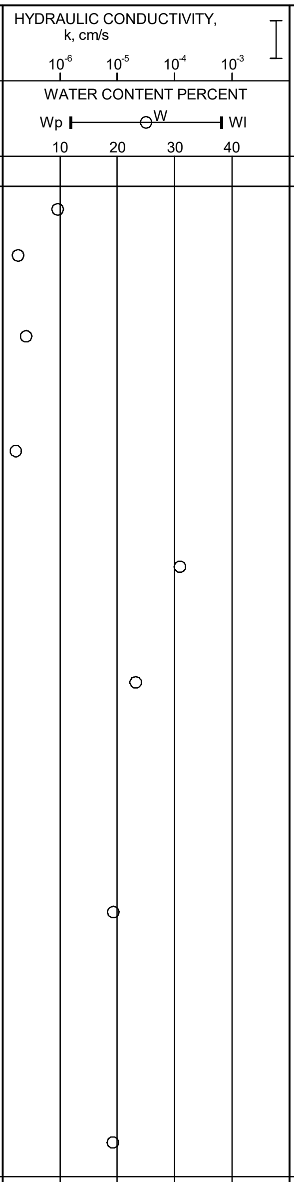
BORING METHOD: CME 75 Track Mounted Power Auger; 216 mm O.D. Hollow Stem Augers

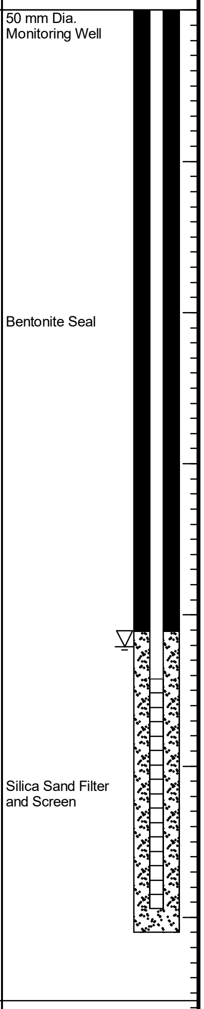
SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	149.91
TOPSOIL/FILL	0.00
(SP) SAND, trace to some fines; reddish-brown to brown, iron oxidation staining to ~1.2 m, rootlets; non-cohesive, moist to wet, very loose to compact	149.61 0.30
(ML) SILT and SAND; greyish-brown, layered; non-cohesive, wet, compact	147.01 2.90
(SP) SAND, trace to some fines; greyish-brown; non-cohesive, wet, dense to very dense	145.87 4.04
END OF BOREHOLE	143.36 6.55

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1A	SS	2	
1B			M
2	SS	2	
3	SS	16	
4	SS	2	
5	SS	15	
6	SS	38	
7	SS	59	

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○; 20 40 60 80





NOTES:

1. Groundwater encountered at a depth of 2.3 m below ground surface during drilling, June 21, 2018.

2. Groundwater level measured at a depth of 3.0 m below ground surface upon completion of driling, June 21, 2018.

3. Groundwater level measured in monitoring well at a depth of 4.21 m below ground surface, or at an elevation of 146.57 m above sea level, on October 23, 2018.

DEPTH SCALE

1 : 50

GOLDER

LOGGED: EAW/MB

CHECKED: CMK

PROJECT: 1530385

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH18-2-W

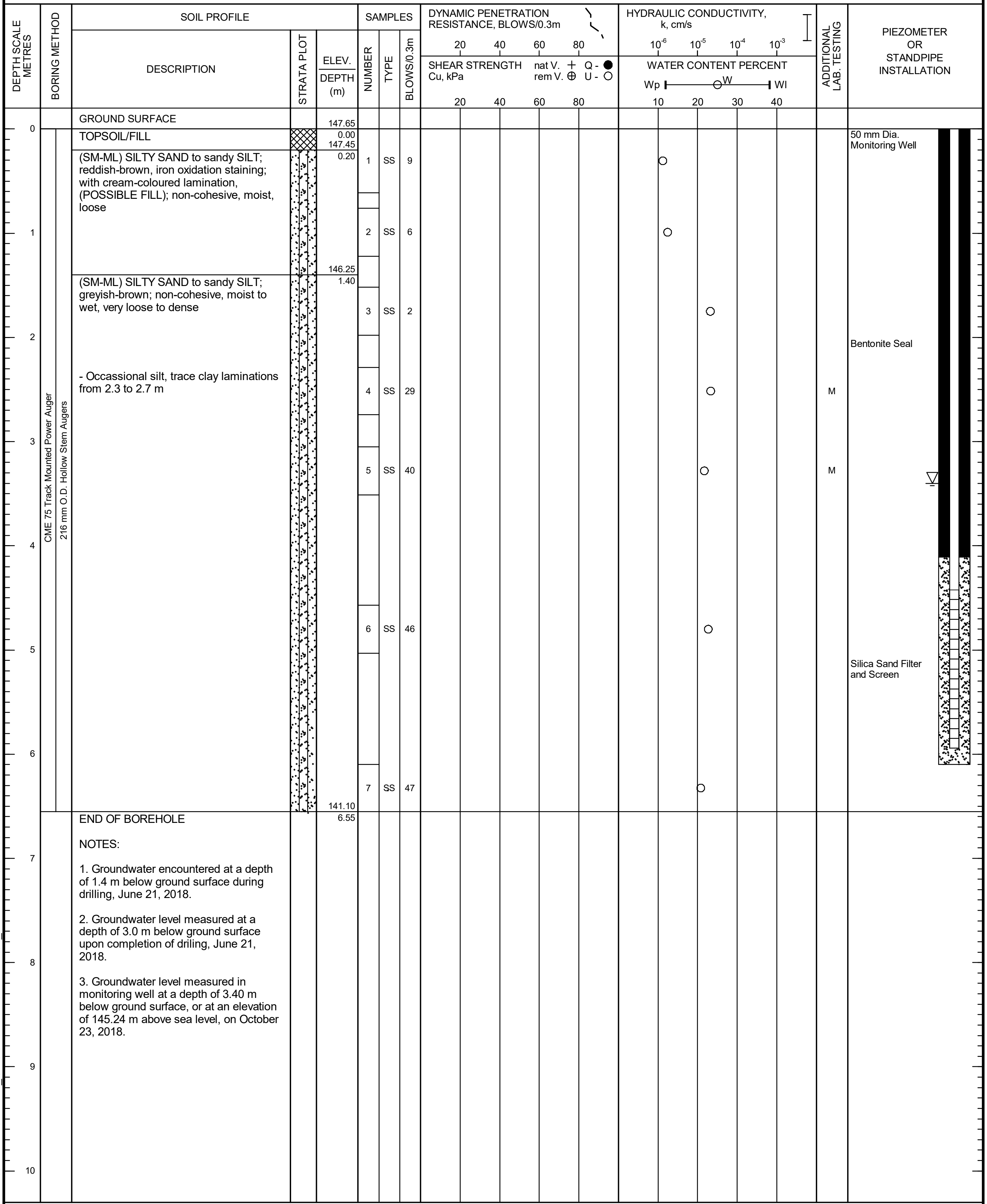
SHEET 1 OF 1

DATUM: Geodetic

BORING DATE: June 21, 2018

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

HAMMER TYPE: AUTOMATIC



DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	147.65
TOPSOIL/FILL	0.00
(SM-ML) SILTY SAND to sandy SILT; reddish-brown, iron oxidation staining; with cream-coloured lamination, (POSSIBLE FILL); non-cohesive, moist, loose	147.45 0.20
(SM-ML) SILTY SAND to sandy SILT; greyish-brown; non-cohesive, moist to wet, very loose to dense - Occassional silt, trace clay laminations from 2.3 to 2.7 m	146.25 1.40
END OF BOREHOLE	141.10 6.55

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	9	
2	SS	6	
3	SS	2	
4	SS	29	M
5	SS	40	M
6	SS	46	
7	SS	47	

NOTES:

1. Groundwater encountered at a depth of 1.4 m below ground surface during drilling, June 21, 2018.

2. Groundwater level measured at a depth of 3.0 m below ground surface upon completion of driling, June 21, 2018.

3. Groundwater level measured in monitoring well at a depth of 3.40 m below ground surface, or at an elevation of 145.24 m above sea level, on October 23, 2018.

DEPTH SCALE

1 : 50

GOLDER

LOGGED: EAW/MB

CHECKED: CMK

PROJECT: 1530385
LOCATION: See Figure 2

RECORD OF BOREHOLE: BH18-3-W

BORING DATE: June 21, 2018

SHEET 1 OF 2
DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

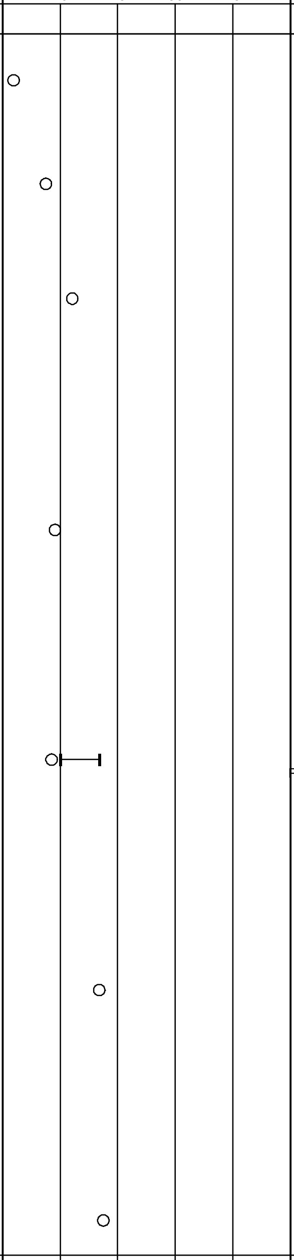
BORING METHOD: CME 75 Track Mounted Power Auger; 216 mm O.D. Hollow Stem Augers

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	147.56
FILL - (SP) gravelly SAND to SAND, trace gravel; reddish-brown, iron oxidation; non-cohesive, dry to moist, loose	0.00
FILL - (CL-ML) gravelly SILTY CLAY and sand; brown, possible re-worked TILL; cohesive, w<PL, firm	146.19 1.37
(SP) SAND, trace to some fines, layered with (SM) SILTY SAND, trace gravel; brown; non-cohesive, wet, compact to very dense	145.43 2.13
(CL-ML) gravelly SILTY CLAY and sand; grey, iron oxidation on fractures, (TILL); cohesive, w<PL, hard	143.45 4.11
(SP) SAND, trace to some fines; greyish-brown to grey; non-cohesive, wet, compact to very dense	141.92 5.64
END OF BOREHOLE	139.48 8.08

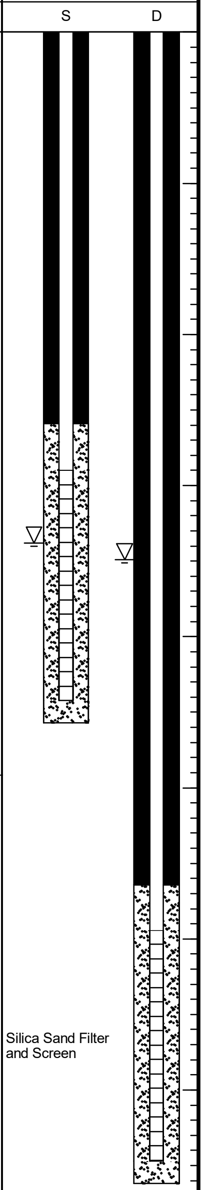
NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	6	
2	SS	9	
3	SS	5	
4	SS	51	
5	SS	17	
6	SS	64	MH PL LL
7	SS	49	
8	SS	26	

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



PIEZOMETER OR STANDPIPE INSTALLATION



NOTES:

1. Groundwater encountered at a depth of 2.7 m below ground surface during drilling, June 21, 2018.

2. Groundwater level measured at a depth of 3.0 m below ground surface upon completion of driling, June 21, 2018.

3. Groundwater level measured in monitoring well 18-3Ws (shallow) at a depth of 3.49 m below ground surface, or

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: EAW/MB
CHECKED: CMK

PROJECT: 1530385

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH18-3-W

BORING DATE: June 21, 2018

SHEET 2 OF 2

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	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 S D
		--- CONTINUED FROM PREVIOUS PAGE ---									
10		at an elevation of 145.12 m above sea level, and in monitoring well 18-3-Wd (deep) at a depth of 3.38 m below ground surface and at an elevation of 145.07 m above sea level, on October 23, 2018.									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

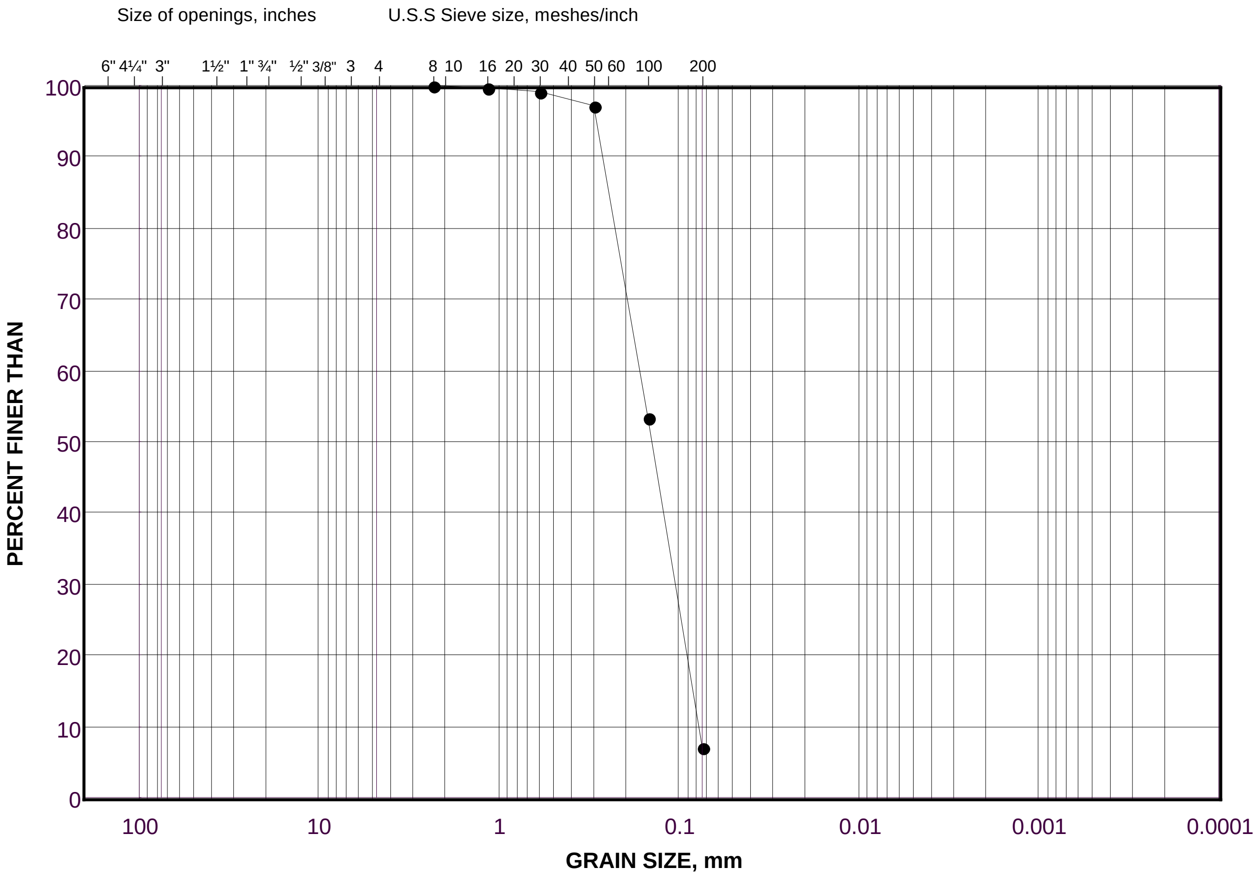
LOGGED: EAW/MB

CHECKED: CMK

GRAIN SIZE DISTRIBUTION

(SP) SAND

FIGURE D-1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	18-1-W	1B	0.30 - 0.61

Project Number: 1530386

Checked By: ______________________

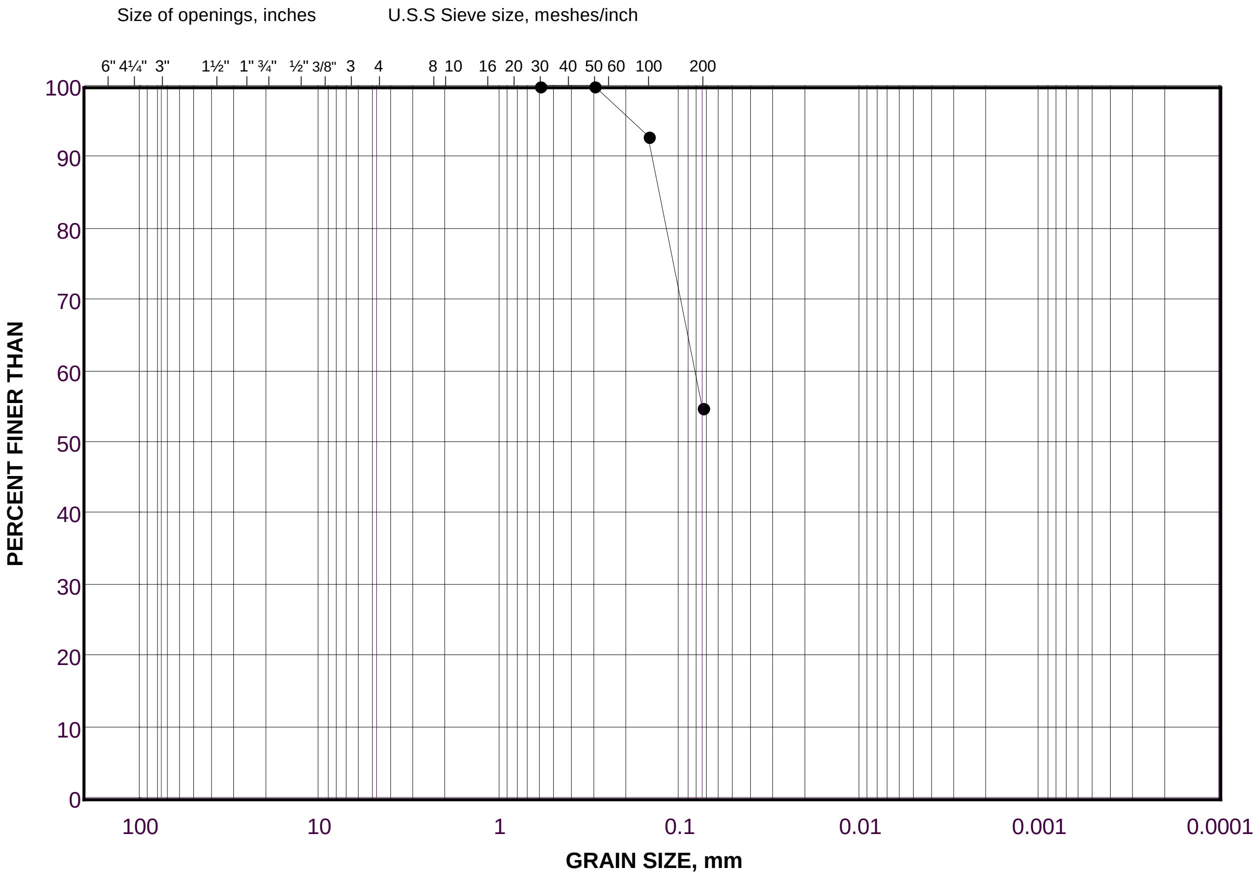
Golder Associates

Date: 14-Feb-19

GRAIN SIZE DISTRIBUTION

(SM-ML) SILTY SAND to sandy SILT

FIGURE D-2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	18-2-W	4	2.29 - 2.74

Project Number: 1530386

Checked By: ______________________

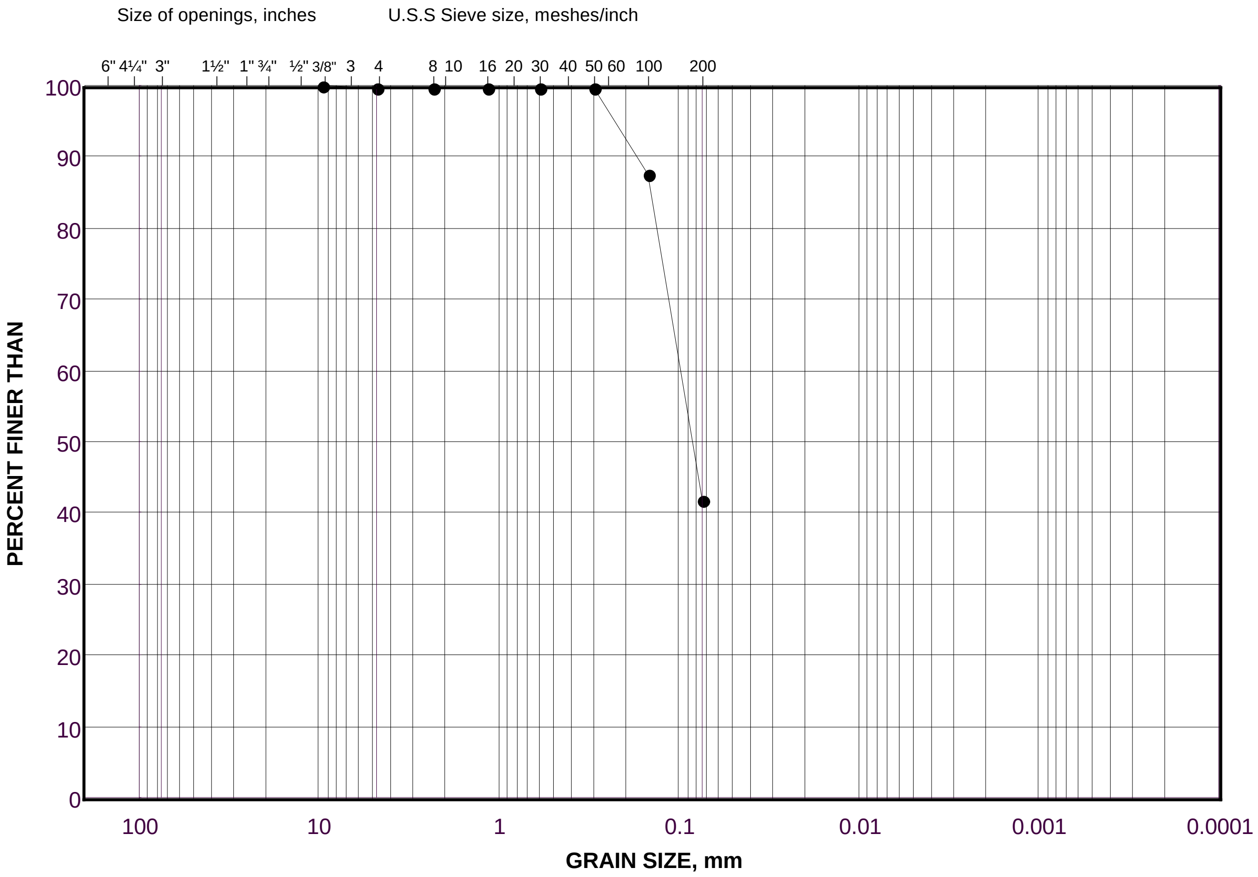
Golder Associates

Date: 14-Feb-19

GRAIN SIZE DISTRIBUTION

(SM-ML) SILTY SAND to sandy SILT

FIGURE D-3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	18-2-W	5	3.05 - 3.51

Project Number: 1530386

Checked By: ______________________

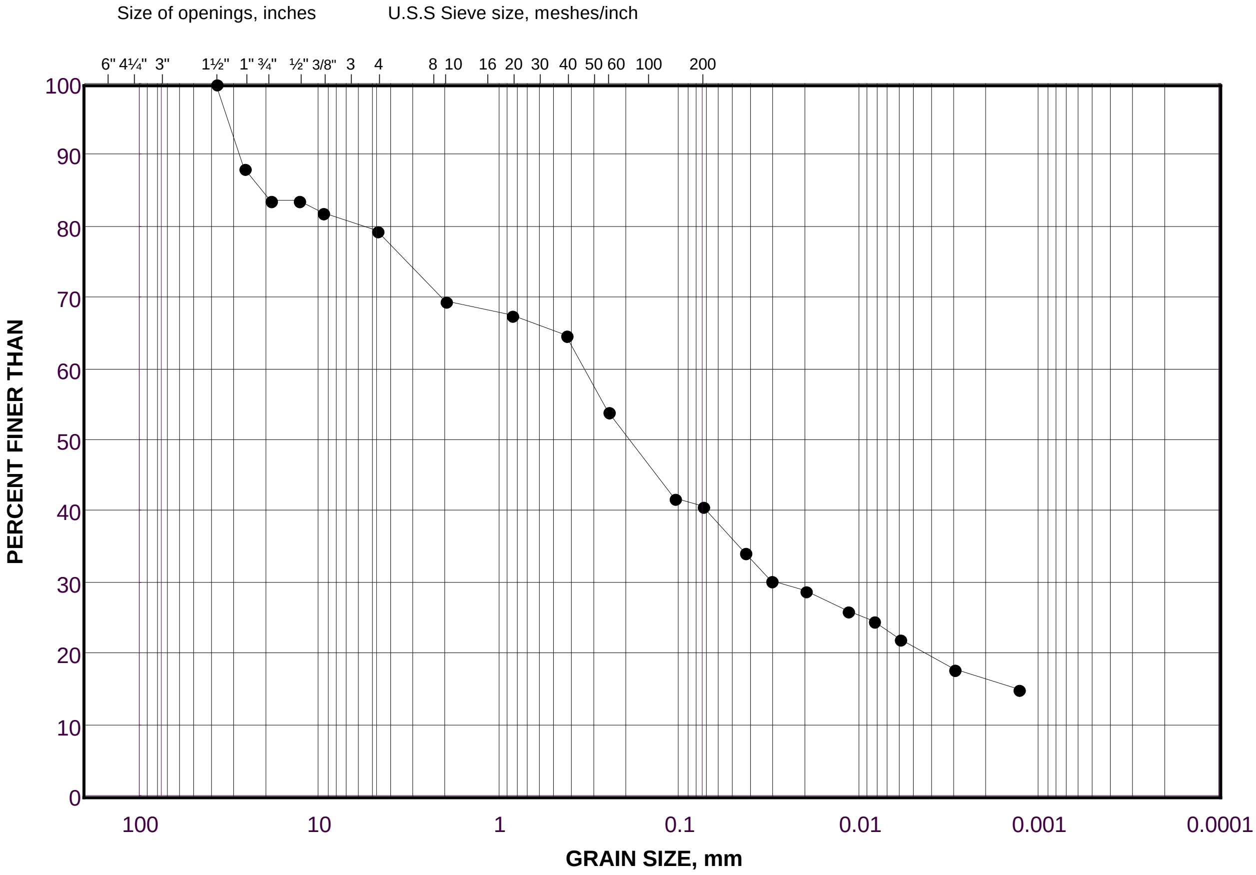
Golder Associates

Date: 14-Feb-19

GRAIN SIZE DISTRIBUTION

(CL-ML) gravelly SILTY CLAY (TILL)

FIGURE D-4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	18-3-W	6	4.57 - 5.03

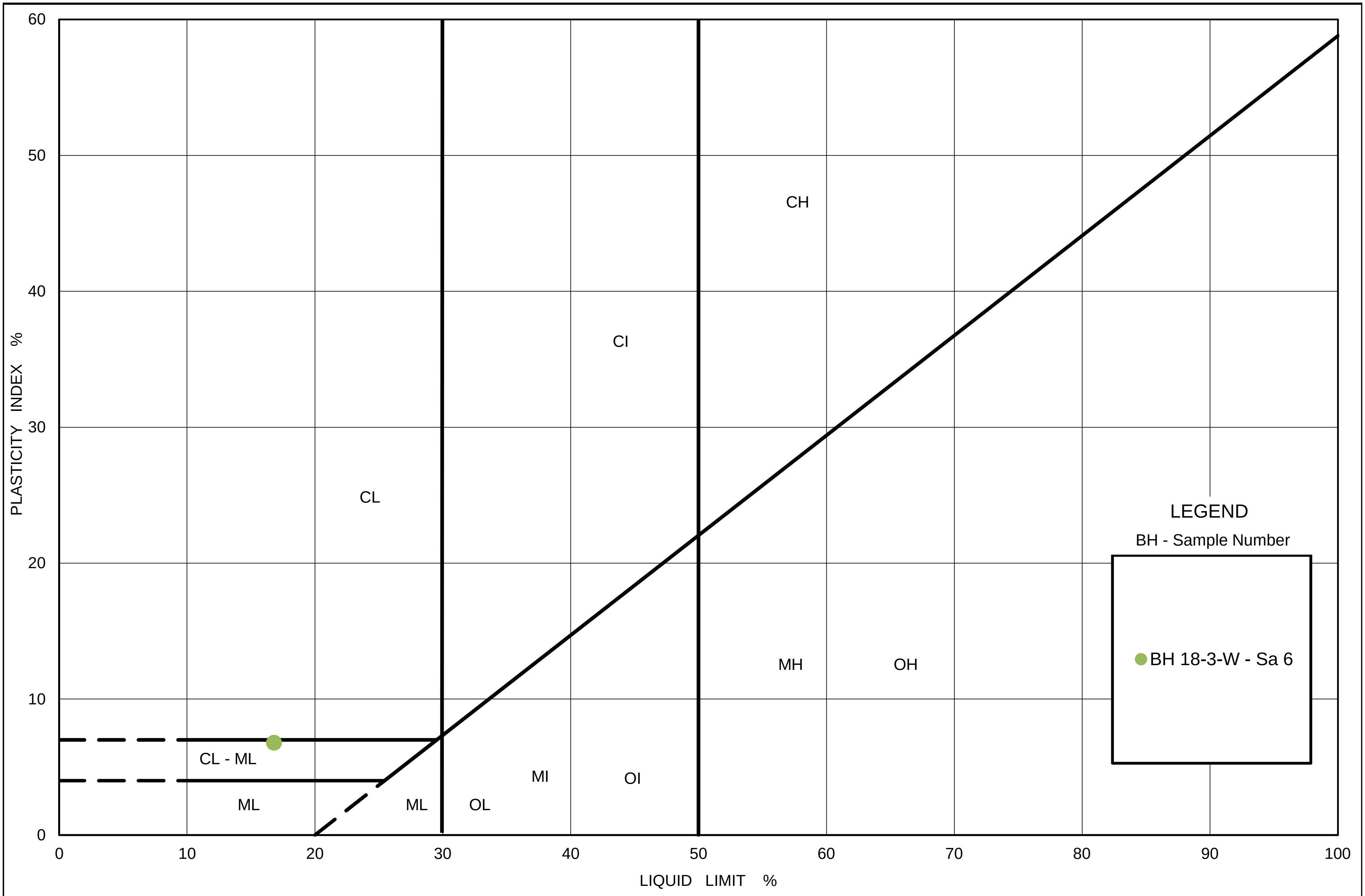
Project Number: 1530386

Checked By: ________________________

Golder Associates

Date: 14-Feb-19

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (MTO LS-703/704)



GOLDER	**PLASTICITY CHART** (CL-ML) gravelly SILTY CLAY (TILL)	Figure No.: D-5 Project No.: 1530386 Checked By:

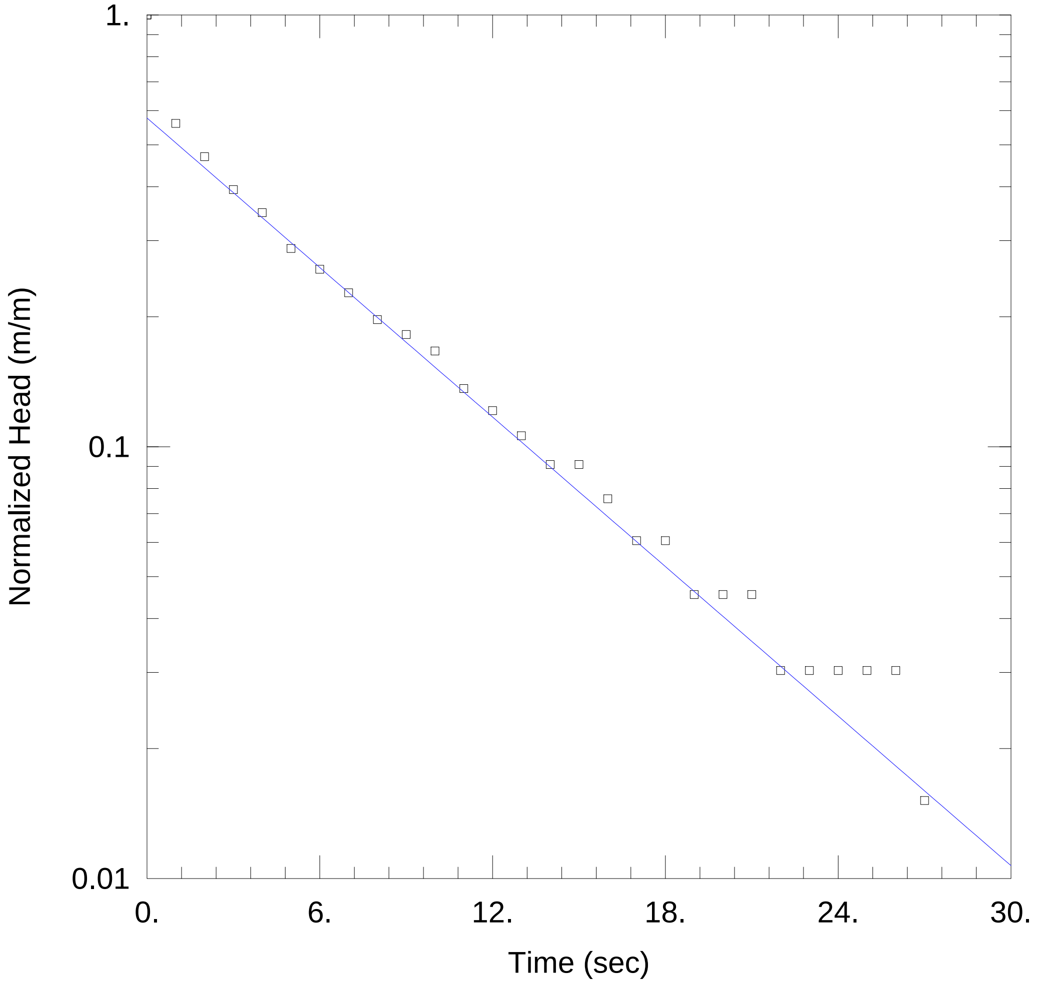
APPENDIX E

Hydraulic Testing

Table E-1: Groundwater Level Measurements
Proposed Residential Lots
Newtonville, Ontario

Monitoring Well ID	Ground Surface Elevation*	03-Oct-18		12-Oct-18		17-Oct-18		23-Oct-18		7-Nov-18
	masl	mbgs	masl	mbgs	masl	mbgs	masl	mbgs	masl	masl
BH18-1-W	149.91	3.31	146.60	3.29	146.62	3.30	146.62	3.34	146.57	-
BH18-2-W	147.65	2.24	145.41	-	-	2.37	145.28	2.40	145.24	-
BH18-3-W (S)	147.66	2.45	145.21	-	-	2.51	145.15	2.54	145.12	-
BH18-3-W (D)	147.56	2.40	145.16	-	-	-	-	2.49	145.07	-
BH4	151.70	4.20	147.50	4.16	147.53	4.15	147.55	4.22	147.47	-
SWM Pond Forebay*	-	-	-	-	-	-	-	-	-	145.68
SWM Pond Main Bay*	-	-	-	-	-	-	-	-	-	145.55

Notes: * = Data provided by J.D.Barnes Limited, relative to a geodetic benchmark on Nov. 7, 2018
mbgs = metres below ground surface
masl = metres above sea level



WELL TEST ANALYSIS

Data Set: C:\...\BH18-1W.aqt
Date: 01/31/19
Time: 20:12:32

PROJECT INFORMATION

Company: Golder Associates Ltd.
Client: Veltri and Son Ltd.
Project: 1530386
Location: Newtonville
Test Well: BH18-1W
Test Date: 23-Oct-18

AQUIFER DATA

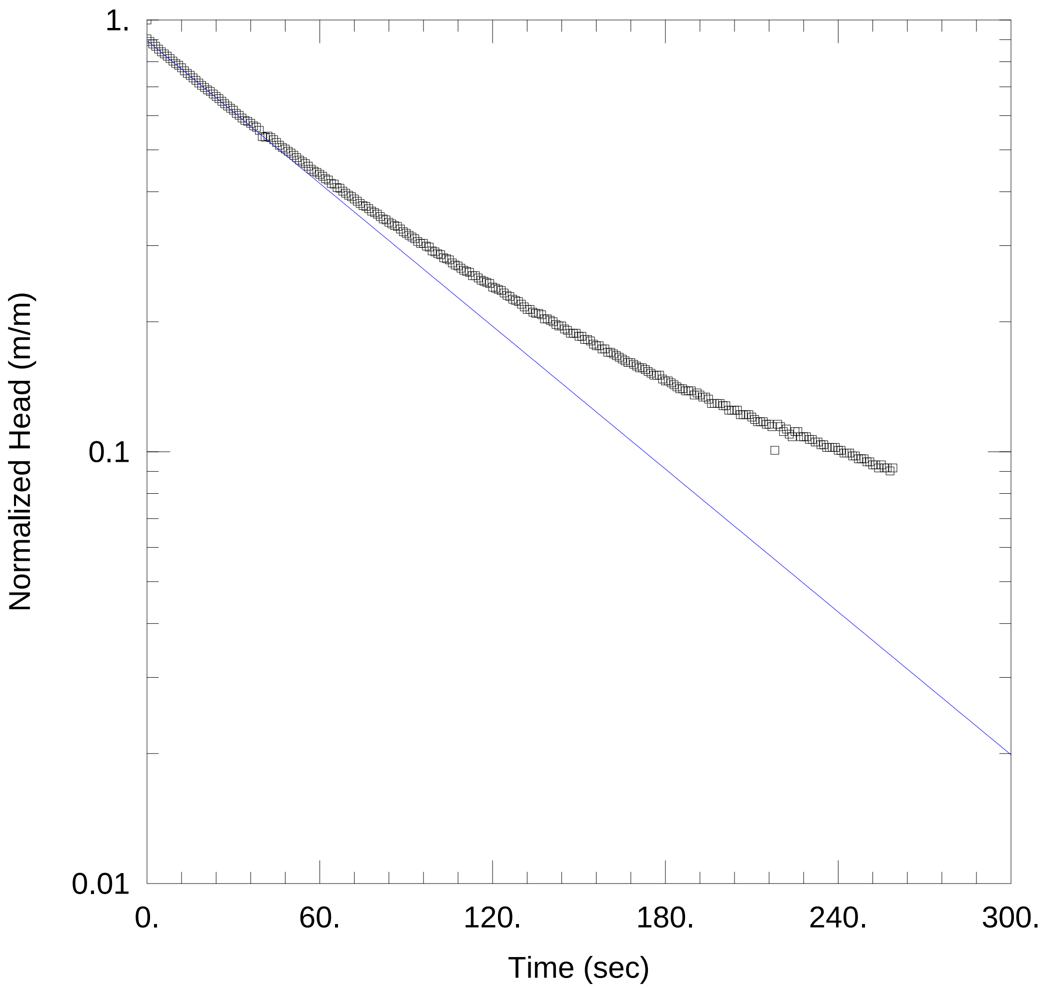
Saturated Thickness: 3.768 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (18-1W)

Initial Displacement: 0.66 m
Static Water Column Height: 2.768 m
Total Well Penetration Depth: 2.77 m
Screen Length: 2. m
Casing Radius: 0.025 m
Well Radius: 0.108 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 4.219E-5 m/sec
y0 = 0.381 m



WELL TEST ANALYSIS

Data Set: C:\...\BH18-3W(s).aqt
Date: 01/31/19 Time: 20:38:12

PROJECT INFORMATION

Company: Golder Associates Ltd.
Client: Veltri and Son Ltd
Project: 1530386
Location: Newtonville
Test Well: BH18-3W(s)
Test Date: 23-Oct-18

AQUIFER DATA

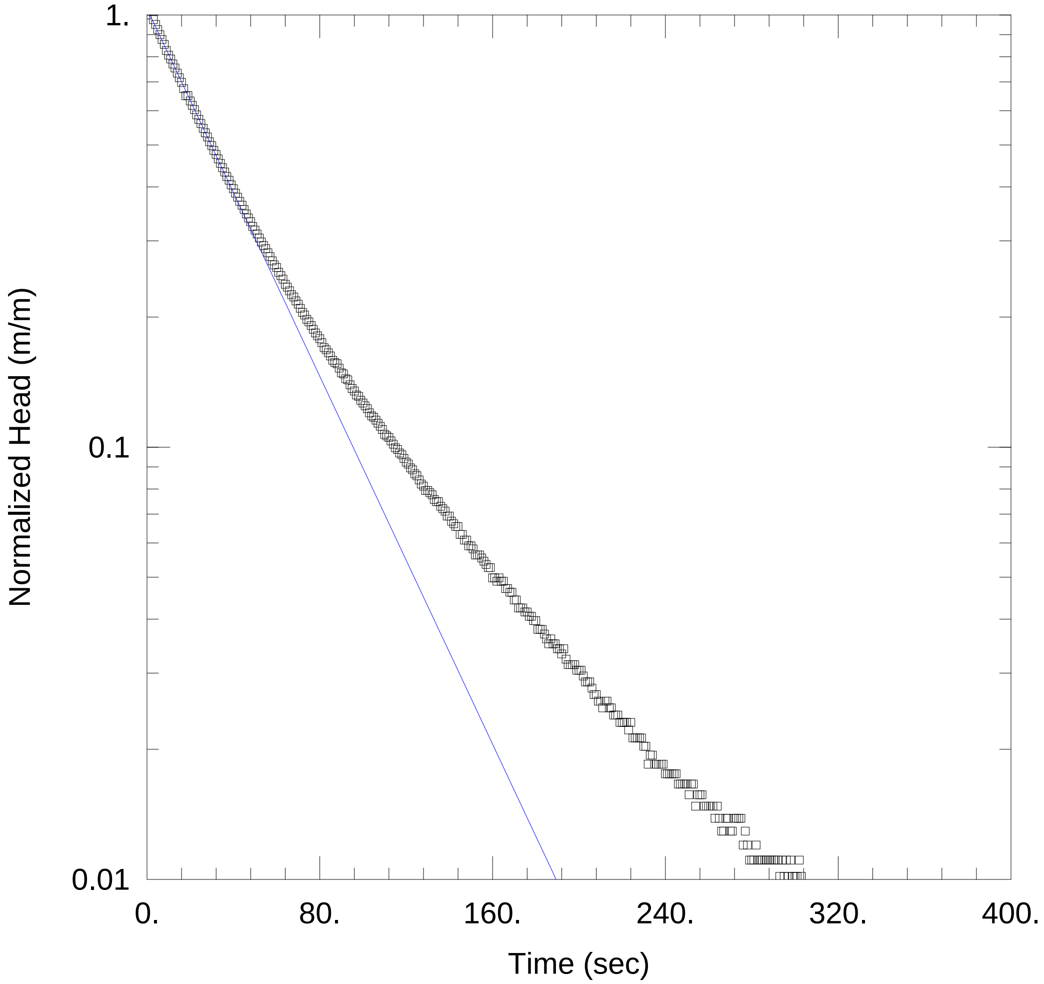
Saturated Thickness: 1.675 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH18-3W(s))

Initial Displacement: 0.665 m
Static Water Column Height: 1.675 m
Total Well Penetration Depth: 1.675 m
Screen Length: 1.51 m
Casing Radius: 0.063 m
Well Radius: 0.108 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.299E-5 m/sec
y0 = 0.5956 m



WELL TEST ANALYSIS

Data Set: C:\...\BH18-3W(d).aqt
Date: 01/31/19 Time: 20:46:52

PROJECT INFORMATION

Company: Golder Associates Ltd.
Client: Veltri and Son Ltd.
Project: 1530386
Location: Newtonville
Test Well: BH18-3W(d)
Test Date: 23-Oct-18

AQUIFER DATA

Saturated Thickness: 2.45 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (18-3W(d))

Initial Displacement: 1.083 m
Static Water Column Height: 5.111 m
Total Well Penetration Depth: 5.121 m
Screen Length: 1.98 m
Casing Radius: 0.025 m
Well Radius: 0.108 m

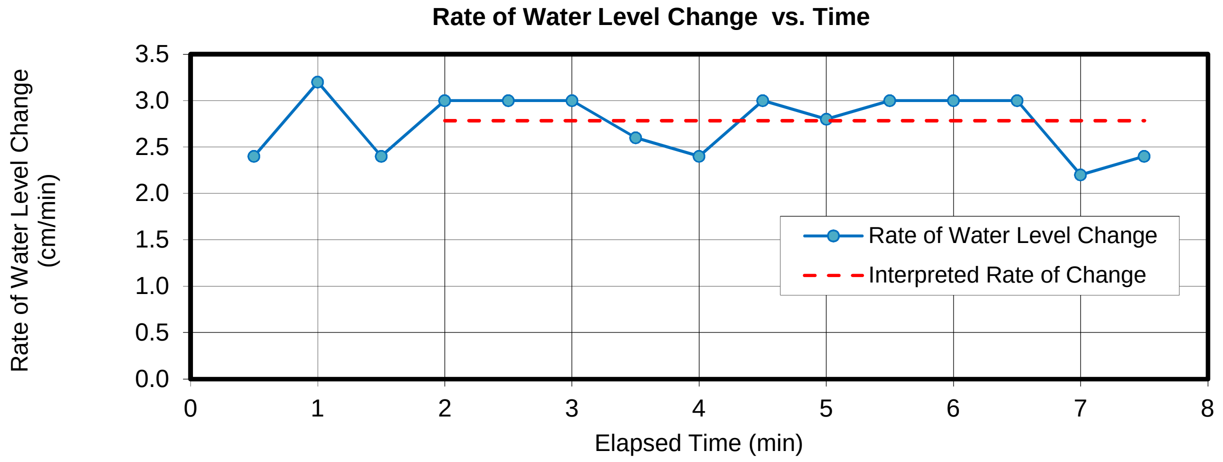
SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.037E-5 m/sec
y0 = 1.121 m

Constant Head Permeameter Test Report - Test GP1

Figure E-1

Approximate Location: **Near BH18-1W**
Test Depth: **0.6 m below ground surface**



Elapsed Time (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0	0.0	-	-
0.5	1.2	1.2	2.4
1.0	2.8	1.6	3.2
1.5	4.0	1.2	2.4
2.0	5.5	1.5	3.0
2.5	7.0	1.5	3.0
3.0	8.5	1.5	3.0
3.5	9.8	1.3	2.6
4.0	11.0	1.2	2.4
4.5	12.5	1.5	3.0
5.0	13.9	1.4	2.8
5.5	15.4	1.5	3.0
6.0	16.9	1.5	3.0
6.5	18.4	1.5	3.0
7.0	19.5	1.1	2.2
7.5	20.7	1.2	2.4

Soil Type 3 - (SP) SAND, trace to some fines

Interpreted Rate of:

Water Level Change (R_1) =	0.046	cm/s
Steady Intake Water Rate (Q_1) =	1.63	cm^3/s
hole radius (a) =	2.55	cm
Water column height in hole (H_1) =	6.5	cm
Shape factor for H_1/a = (C_1) =	1.077	-
Soil Type Coefficient α* =	0.12	cm^{-1}

Single Head Analysis

$$K_{fs} = \frac{C_1 Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \frac{H_1}{\alpha^*}}$$

Field Saturated Hydraulic Conductivity (K_{fs})

K_{fs} = **3E-03** cm/s

🟩 =input data

DATE: 24-Jan-19
PROJECT: 1530386

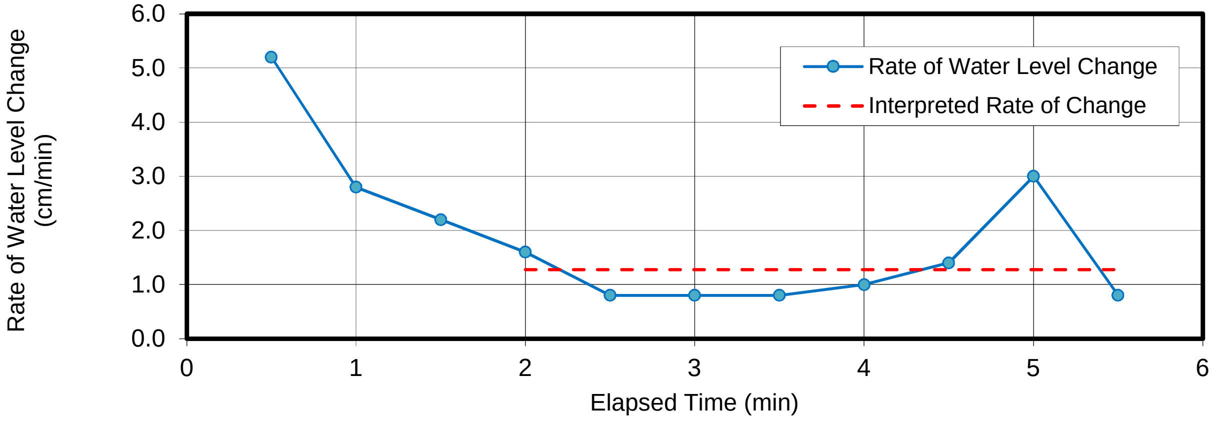
PREPARED BY: AB
REVIEW: CMK

Constant Head Permeameter Test Report - Test GP2

Figure E-2

Approximate Location: **Near BH18-2W**
Test Depth: **0.7 m below gorund surface**

Rate of Water Level Change vs. Time



Elapsed Time (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0	0.0	-	-
0.5	2.6	2.6	5.2
1.0	4.0	1.4	2.8
1.5	5.1	1.1	2.2
2.0	5.9	0.8	1.6
2.5	6.3	0.4	0.8
3.0	6.7	0.4	0.8
3.5	7.1	0.4	0.8
4.0	7.6	0.5	1.0
4.5	8.3	0.7	1.4
5.0	9.8	1.5	3.0
5.5	10.2	0.4	0.8

Soil Type 3 - (SM-ML) SILTY SAND to sandy SILT

Interpreted Rate of:

Water Level Change (R_1) =	0.021	cm/s
Steady Intake Water Rate (Q_1) =	0.75	cm^3/s
hole radius (a) =	2.5	cm
Water column height in hole (H_1) =	5	cm
Shape factor for H_1/a = (C_1) =	0.912	-
Soil Type Coefficient α^* =	0.12	cm^{-1}

Single Head Analysis

$$K_{fs} = \frac{C_1 Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \frac{H_1}{\alpha^*}}$$

Field Saturated Hydraulic Conductivity (K_{fs})

K_{fs} = **2E-03** cm/s

🟩 =input data

DATE: 24-Jan-19
PROJECT: 1530386

GOLDER

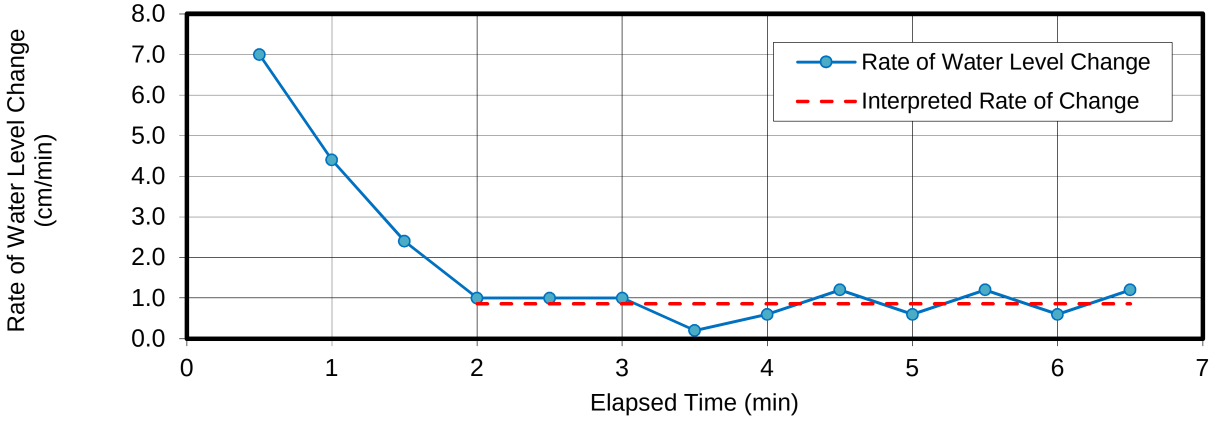
PREPARED BY: AB
REVIEW: CMK

Constant Head Permeameter Test Report - Test GP3

Approximate Location: **Near BH18-3W**
Test Depth: **0.55 m below gorund surface**

Figure E-3

Rate of Water Level Change vs. Time



Elapsed Time (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0	0.0	-	-
0.5	3.5	3.5	7.0
1.0	5.7	2.2	4.4
1.5	6.9	1.2	2.4
2.0	7.4	0.5	1.0
2.5	7.9	0.5	1.0
3.0	8.4	0.5	1.0
3.5	8.5	0.1	0.2
4.0	8.8	0.3	0.6
4.5	9.4	0.6	1.2
5.0	9.7	0.3	0.6
5.5	10.3	0.6	1.2
6.0	10.6	0.3	0.6
6.5	11.2	0.6	1.2

🟩 =input data

Soil Type 3 - (SP) gravelly SAND to SAND (FILL)

Interpreted Rate of:

Water Level Change (R_1) =	0.014	cm/s
Steady Intake Water Rate (Q_1) =	0.50	cm^3/s
hole radius (a) =	2.5	cm
Water column height in hole (H_1) =	5	cm
Shape factor for H_1/a = (C_1) =	0.912	-
Soil Type Coefficient α* =	0.12	cm^{-1}

Single Head Analysis

$$K_{fs} = \frac{C_1 Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \frac{H_1}{\alpha^*}}$$

Field Saturated Hydraulic Conductivity (K_{fs})

K_{fs} = **1E-03** cm/s

DATE: 24-Jan-19
PROJECT: 1530386

GOLDER

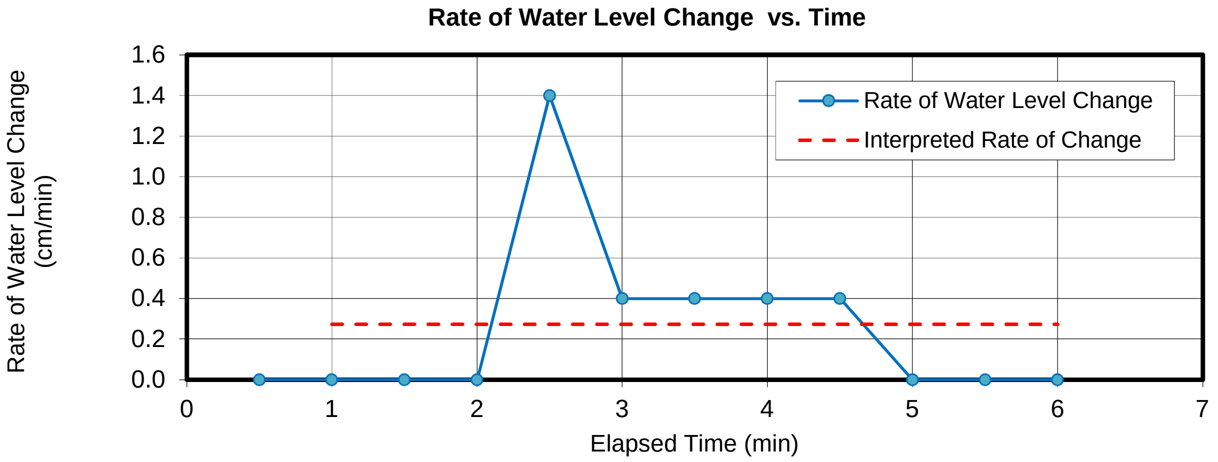
PREPARED BY: AB
REVIEW: CMK

Constant Head Permeameter Test Report - Test GP4

Figure E-4

Approximate Location: **GP4, west side of site**
Test Depth: **0.55 m below ground surface**

Rate of Water Level Change vs. Time



Elapsed Time (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0	0.0	-	-
0.5	0.0	0.0	0.0
1.0	0.0	0.0	0.0
1.5	0.0	0.0	0.0
2.0	0.0	0.0	0.0
2.5	0.7	0.7	1.4
3.0	0.9	0.2	0.4
3.5	1.1	0.2	0.4
4.0	1.3	0.2	0.4
4.5	1.5	0.2	0.4
5.0	1.5	0.0	0.0
5.5	1.5	0.0	0.0
6.0	1.5	0.0	0.0

Soil Type 3 - (SM) SILTY SAND

Interpreted Rate of:

Water Level Change (R_1) =	0.0045	cm/s
Steady Intake Water Rate (Q_1) =	0.16	cm^3/s
hole radius (a) =	2.55	cm
Water column height in hole (H_1) =	5	cm
Shape factor for H_1/a = (C_1) =	0.900	-
Soil Type Coefficient α* =	0.12	cm^{-1}

Single Head Analysis

$$K_{fs} = \frac{C_1 Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \frac{H_1}{\alpha^*}}$$

Field Saturated Hydraulic Conductivity (K_{fs})

K_{fs} = **3E-04** cm/s

🟩 =input data

DATE: 24-Jan-19
PROJECT: 1530386

GOLDER

PREPARED BY: AB
REVIEW: CMK

APPENDIX F

Laboratory Certificates of Analysis

Your Project #: 1530386
Site Location: VENTRI WEST
Your C.O.C. #: 592245-02-01

Attention: Laurel Hoffarth

Golder Associates Ltd
121 Commerce Park Drive
Unit L
Barrie, ON
CANADA L4N 8X1

Report Date: 2018/10/18
Report #: R5446906
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8R1516
Received: 2018/10/12, 15:20

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Nitrate (NO3) and Nitrite (NO2) in Water (1)	1	N/A	2018/10/17	CAM SOP-00440	SM 23 4500-NO3I/NO2B

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Your Project #: 1530386
Site Location: VENTRI WEST
Your C.O.C. #: 592245-02-01

Attention: Laurel Hoffarth

Golder Associates Ltd
121 Commerce Park Drive
Unit L
Barrie, ON
CANADA L4N 8X1

Report Date: 2018/10/18
Report #: R5446906
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8R1516
Received: 2018/10/12, 15:20

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF WATER

Maxxam ID		IAD813		
Sampling Date		2018/10/12 13:15		
COC Number		592245-02-01		
	UNITS	**BH18-1-W**	**RDL**	**QC Batch**
Inorganics				
Nitrate (N)	mg/L	5.02	0.10	5786066

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID:	IAD813	**Collected:**	2018/10/12
Sample ID:	BH18-1-W	**Shipped:**	
Matrix:	Water	**Received:**	2018/10/12

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5786066	N/A	2018/10/17	Chandra Nandlal

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.7°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5786066	C_N	Matrix Spike	Nitrate (N)	2018/10/17		94	%	80 - 120
5786066	C_N	Spiked Blank	Nitrate (N)	2018/10/17		95	%	80 - 120
5786066	C_N	Method Blank	Nitrate (N)	2018/10/17	<0.10		mg/L	
5786066	C_N	RPD	Nitrate (N)	2018/10/17	0.67		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Service Specialist

Maxxam
A Bureau Veritas Group Company

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-free:800-563-6266 Fax:(905) 817-5777 www.maxxam.ca

CHAIN OF CUSTODY RECORD

Page 1 of 1

REC'D IN PORT HOPE

INVOICE TO:

Company Name: #12323 Golder Associates Ltd
Attention: Accounts Payable
Address: 121 Commerce Park Drive Unit L
Barrie ON L4N 8X1
Tel: (705) 722-4492 Fax: (705) 722-3786
Email: AP_CustomerService@golder.com

REPORT TO:

Company Name: ~~Laurel~~ Golder
Attention: ~~Christi Groves~~ Laurel Hoffarth
Address:
Tel: (705) 722-4492 ~~x2220~~ Fax:
Email: ~~Christi_Groves@golder.com~~ LHoffarth@golder.com

PROJECT INFORMATION:

Quotation #: B66357
P.O. #:
Project: ~~1667268 (3000, 220)~~ 1530386
Project Name: Ventn West.
Site #:
Sampled By: J. Dale

Laboratory Use Only:

Maxxam Job #:
Bottle Order #: 592245
COC #: C#592245-02-01
Project Manager: Ema Gitej

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)

☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ **For RSC**
☐ Table ___

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ______
☐ PWQO
☐ Other ______

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ______

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ______ Time Required: ______ ☐
Rush Confirmation Number: ______ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	O.Reg 153 VOCs & F1-F4	O.Reg 153 PAHs	O.Reg 153 Metals & Inorganics Pkg	Nitrate							# of Bottles	Comments
1		BH18-1-W	2018/10/12	1:15	GW	N				X								
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

12-Oct-18 15:20
Ema Gitej
B8R1516
GK1 ENV-695

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
J. Dale	18/10/12	3:00	Ema Gitej	2018/10/12	15:20	
			Rah NADA MARKEVICH	2018/10/15	12:14	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
	2°/5°/7°C	Present	✓	
		Intact	✓	

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxam Yellow: Clie

Maxxam Analytics International Corporation o/a Maxxam Analytics

32263

on ice 0/7/7

Your Project #: 1530386
Site Location: NEWTONVILLE
Your C.O.C. #: 68425

Attention: Laurel Hoffarth

Golder Associates Ltd
121 Commerce Park Drive
Unit L
Barrie, ON
CANADA L4N 8X1

Report Date: 2018/10/23
Report #: R5453124
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8R6216
Received: 2018/10/17, 16:30

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Nitrate (NO3) and Nitrite (NO2) in Water (1)	2	N/A	2018/10/22	CAM SOP-00440	SM 23 4500-NO3I/NO2B

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Your Project #: 1530386
Site Location: NEWTONVILLE
Your C.O.C. #: 68425

Attention: Laurel Hoffarth

Golder Associates Ltd
121 Commerce Park Drive
Unit L
Barrie, ON
CANADA L4N 8X1

Report Date: 2018/10/23
Report #: R5453124
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8R6216
Received: 2018/10/17, 16:30

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF WATER

Maxxam ID		IBD571	IBD571	IBD572		
Sampling Date		2018/10/17 01:00	2018/10/17 01:00	2018/10/17 01:30		
COC Number		68425	68425	68425		
	UNITS	**SW-1**	**SW-1 Lab-Dup**	**BH18-2-W**	**RDL**	**QC Batch**
Inorganics						
Nitrate (N)	mg/L	<0.10	<0.10	6.07	0.10	5793509

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

TEST SUMMARY

Maxxam ID: IBD571
Sample ID: SW-1
Matrix: Water

Collected: 2018/10/17
Shipped:
Received: 2018/10/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5793509	N/A	2018/10/22	Chandra Nandlal

Maxxam ID: IBD571 Dup
Sample ID: SW-1
Matrix: Water

Collected: 2018/10/17
Shipped:
Received: 2018/10/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5793509	N/A	2018/10/22	Chandra Nandlal

Maxxam ID: IBD572
Sample ID: BH18-2-W
Matrix: Water

Collected: 2018/10/17
Shipped:
Received: 2018/10/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5793509	N/A	2018/10/22	Chandra Nandlal

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.3°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5793509	C_N	Matrix Spike [IBD571-01]	Nitrate (N)	2018/10/22		104	%	80 - 120
5793509	C_N	Spiked Blank	Nitrate (N)	2018/10/22		106	%	80 - 120
5793509	C_N	Method Blank	Nitrate (N)	2018/10/22	<0.10		mg/L	
5793509	C_N	RPD [IBD571-01]	Nitrate (N)	2018/10/22	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eva

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
Eva Pranjic

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam
A Bureau Veritas Group Company

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/2

CHAIN OF CUSTODY RECORD 68425

Page 1 of 1

Invoice Information

Company Name: Golder Associates
Contact Name: Accounts Payable.
Address: 121 Commerce Park Drive
Phone: 705 722 4492 Fax:
Email: AP_CustomerService@golder.com

Report Information (if differs from invoice)

Company Name: Golder Associates
Contact Name: Laurel Hoffarth
Address: 121 Commerce Park Dr
Phone: 705 722 4492 Fax:
Email: Laurel_Hoffarth@golder.com

Project Information (where applicable)

Quotation #:
P.O. #/AFE#:
Project #: 1530386
Site Location: Newtonville.
Site #:
Sampled By: J. Dale

Turnaround Time (TAT) Required

☒ Regular TAT (5-7 days) Most analyses

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)
☐ 1 Day ☐ 2 Days ☐ 3-4 Days

Date Required:
Rush Confirmation #:

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153

☐ Table 1 ☐ Res/Park ☐ Med/ Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/ Other
☐ Table ____
FOR RSC (PLEASE CIRCLE) Y / N

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ MISA ☐ Storm Sewer Bylaw
☐ PWQO Region
☐ Other (Specify)
☐ REG 558 (MIN. 3 DAY TAT REQUIRED)

Include Criteria on Certificate of Analysis: Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

LABORATORY USE ONLY

CUSTODY SEAL [✓ Y] / N		COOLER TEMPERATURES
Present	Intact	
X	Y	2/4/2

COOLING MEDIA PRESENT: [✓ Y] / N

Analysis Requested

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS (REFER TO BACK OF COC)	REG 153 ICPMS METALS (REFER TO BACK OF COC)	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B) (REFER TO BACK OF COC)	Nitrate								HOLD- DO NOT ANALYZE	COMMENTS
1	SW-1	2018/10/17	1:00	SW									X									
2	BH18-2-W	↓	1:30	GW									X									On Ice
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

17-Oct-18 16:30
Ema Gitej
B8R6216
URE ENV-734

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
J. Dale	2018/10/17	15:20	Jenna Woodward	2018/10/17	16:30	
			[illegible]	2018/10/18	11:35	

WB3284 1/1/1

COC-1004 (10/14) - ENV. ENG

White: Maxxam - Yellow: Client

Your Project #: 18101993
Site Location: VELTRI
Your C.O.C. #: 686550-03-01

Attention: Laurel Hoffarth

Golder Associates Ltd
121 Commerce Park Drive
Unit L
Barrie, ON
CANADA L4N 8X1

Report Date: 2018/10/29
Report #: R5460654
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8S2139
Received: 2018/10/24, 14:02

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Nitrate (NO3) and Nitrite (NO2) in Water (1)	1	N/A	2018/10/26	CAM SOP-00440	SM 23 4500-NO3I/NO2B

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Your Project #: 18101993
Site Location: VELTRI
Your C.O.C. #: 686550-03-01

Attention: Laurel Hoffarth

Golder Associates Ltd
121 Commerce Park Drive
Unit L
Barrie, ON
CANADA L4N 8X1

Report Date: 2018/10/29
Report #: R5460654
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8S2139
Received: 2018/10/24, 14:02

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF WATER

Maxxam ID		ICM583		
Sampling Date		2018/10/23 12:30		
COC Number		686550-03-01		
	UNITS	**SWMP**	**RDL**	**QC Batch**
Inorganics				
Nitrate (N)	mg/L	0.38	0.10	5803708

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID: ICM583
Sample ID: SWMP
Matrix: Water

Collected: 2018/10/23
Shipped:
Received: 2018/10/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5803708	N/A	2018/10/26	Chandra Nandlal

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	1.0°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5803708	C_N	Matrix Spike	Nitrate (N)	2018/10/26		95	%	80 - 120
5803708	C_N	Spiked Blank	Nitrate (N)	2018/10/26		99	%	80 - 120
5803708	C_N	Method Blank	Nitrate (N)	2018/10/26	<0.10		mg/L	
5803708	C_N	RPD	Nitrate (N)	2018/10/26	17		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Maxxam Job #: B8S2139
Report Date: 2018/10/29

Golder Associates Ltd
Client Project #: 18101993
Site Location: VELTRI
Sampler Initials: AC

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Brad Newman, Scientific Service Specialist

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Maxxam A Bureau Veritas Group Company

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-free:800-563-6266 Fax:(905) 817-5777 www.maxxam.ca

24-Oct-18 14:02
Ema Gitej
B8S2139
NSQ ENV-981

Page 1 of 1

INVOICE TO:

Company Name: #12323 Golder Associates Ltd
Attention: Accounts Payable
Address: 121 Commerce Park Drive Unit L
Barrie ON L4N 8X1
Tel: (705) 722-4492 Fax: (705) 722-3786
Email: AP_CustomerService@golder.com

REPORT TO:

Company Name:
Attention: Laurel Hoffarth
Address:
Tel: Fax:
Email: Laurel_Hoffarth@golder.com

PROJECT INFORMATION:

Quotation #: B80683
P.O. #:
Project: 18101993 / 1530386
Project Name: Vettri
Site #:
Sampled By: A. Chlebak

Only:

Bottle Order #: 686550
COC #: C#686550-03-01
Project Manager: Ema Gitej

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)

☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ **For RSC**
☐ Table ___

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558. ☐ Storm Sewer Bylaw
☐ MISA Municipality ________
☐ PWQO
☐ Other ________

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ______

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☑
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests..
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ________ Time Required: ______ ☐
Rush Confirmation Number: ________ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Nitrate										# of Bottles	Comments
1		SWMP	10/23/18	12:30pm	SW	N	✓										1	
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
A. Chlebak	18/10/23	3pm		2018/10/24	12:05	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	1/1/1	Present	✓	
		Intact	✓	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

APPENDIX G

Water Balance Results

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

OSHAWA WPCP WATER BUDGET MEANS FOR THE PERIOD 1969-2017 6150830

Water Holding Capacity	50	mm
Heat Index	38.28	
Lower Zone	30	mm
A	1.103	
Date Range	1969	2017

Date	Temperature	Precipitation	Rain	Melt	Potential Evaporation	Actual Evapotranspiration	Deficit	Surplus	Snow	Soil	Accumulated Precipiation
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	44	34	50	286
February	-4.2	52	25	33	1	1	0	57	28	50	339
March	0.2	59	45	37	9	9	0	73	5	50	399
April	6.5	75	73	7	47	47	0	37	0	46	474
May	12.4	77	77	0	92	89	-3	9	0	26	551
June	17.5	82	82	0	129	94	-36	5	0	9	633
July	20.4	75	75	0	159	84	-75	0	0	0	707
August	20	78	78	0	158	76	-81	0	0	1	785
September	16	82	82	0	106	74	-33	2	0	7	868
October	9.7	73	73	0	20	20	0	21	0	39	73
November	5.2	75	72	2	13	12	-2	54	0	49	149
December	-1.7	73	41	17	3	3	0	54	15	50	222
Average	7.9										
Total		868	748	117	738	510	-230	356			

Entered by: DPH
Checked by: DK

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

Water Holding Capacity	75	mm
Heat Index	38.28	
Lower Zone	45	mm
A	1.103	
Date Range	1969	2017

Date	**Temperature**	**Precipitation**	**Rain**	**Melt**	**Potential Evaporation**	**Actual Evapotranspiration**	**Deficit**	**Surplus**	**Snow**	**Soil**	**Accumulated Precipiation**
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	44	34	75	286
February	-4.2	52	25	33	1	1	0	57	28	75	339
March	0.2	59	45	37	9	9	0	72	5	75	399
April	6.5	75	73	7	47	47	0	37	0	71	474
May	12.4	77	77	0	92	92	-1	9	0	48	551
June	17.5	82	82	0	129	108	-21	5	0	17	633
July	20.4	75	75	0	159	91	-68	0	0	1	707
August	20	78	78	0	158	78	-80	0	0	2	785
September	16	82	82	0	106	74	-33	2	0	8	868
October	9.7	73	73	0	20	20	0	9	0	52	73
November	5.2	75	72	2	13	12	-1	45	0	70	149
December	-1.7	73	41	17	3	3	0	51	15	74	222
Average	7.9										
Total		868	748	117	738	536	-204	331			

Entered by: DPH
Checked by: DK

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

Water Holding Capacity	100	mm
Heat Index	38.28	
Lower Zone	60	mm
A	1.103	
Date Range	1969	2017

Date	**Temperature**	**Precipitation**	**Rain**	**Melt**	**Potential Evaporation**	**Actual Evapotranspiration**	**Deficit**	**Surplus**	**Snow**	**Soil**	**Accumulated Precipiation**
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	43	34	99	286
February	-4.2	52	25	33	1	1	0	57	28	99	339
March	0.2	59	45	37	9	9	0	72	5	100	399
April	6.5	75	73	7	47	47	0	37	0	96	474
May	12.4	77	77	0	92	92	0	9	0	73	551
June	17.5	82	82	0	129	119	-10	5	0	31	633
July	20.4	75	75	0	159	100	-59	0	0	6	707
August	20	78	78	0	158	81	-76	0	0	2	785
September	16	82	82	0	106	74	-32	1	0	8	868
October	9.7	73	73	0	20	20	0	3	0	59	73
November	5.2	75	72	2	13	12	-1	33	0	89	149
December	-1.7	73	41	17	3	3	0	46	15	98	222
Average	7.9										
Total		868	748	117	738	559	-178	306			

Entered by: DPH
Checked by: DK

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

Water Holding Capacity	125	mm
Heat Index	38.28	
Lower Zone	75	mm
A	1.103	
Date Range	1969	2017

Date	**Temperature**	**Precipitation**	**Rain**	**Melt**	**Potential Evaporation**	**Actual Evapotranspiration**	**Deficit**	**Surplus**	**Snow**	**Soil**	**Accumulated Precipiation**
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	41	34	123	286
February	-4.2	52	25	33	1	1	0	56	28	124	339
March	0.2	59	45	37	9	9	0	71	5	125	399
April	6.5	75	73	7	47	47	0	37	0	121	474
May	12.4	77	77	0	92	92	0	9	0	98	551
June	17.5	82	82	0	129	125	-5	5	0	50	633
July	20.4	75	75	0	159	112	-47	0	0	13	707
August	20	78	78	0	158	87	-70	0	0	4	785
September	16	82	82	0	106	75	-32	1	0	9	868
October	9.7	73	73	0	20	20	0	1	0	61	73
November	5.2	75	72	2	13	12	-1	20	0	104	149
December	-1.7	73	41	17	3	3	0	40	15	119	222
Average	7.9										
Total		868	748	117	738	584	-155	281			

Entered by: DPH
Checked by: DK

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

Water Holding Capacity	150	mm
Heat Index	38.28	
Lower Zone	90	mm
A	1.103	
Date Range	1969	2017

Date	**Temperature**	**Precipitation**	**Rain**	**Melt**	**Potential Evaporation**	**Actual Evapotranspiration**	**Deficit**	**Surplus**	**Snow**	**Soil**	**Accumulated Precipiation**
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	37	34	146	286
February	-4.2	52	25	33	1	1	0	55	28	148	339
March	0.2	59	45	37	9	9	0	71	5	150	399
April	6.5	75	73	7	47	47	0	37	0	146	474
May	12.4	77	77	0	92	92	0	9	0	123	551
June	17.5	82	82	0	129	127	-2	5	0	72	633
July	20.4	75	75	0	159	124	-35	0	0	24	707
August	20	78	78	0	158	94	-63	0	0	7	785
September	16	82	82	0	106	76	-30	1	0	11	868
October	9.7	73	73	0	20	20	0	1	0	64	73
November	5.2	75	72	2	13	12	-1	11	0	116	149
December	-1.7	73	41	17	3	3	0	32	15	139	222
Average	7.9										
Total		868	748	117	738	606	-131	259			

Entered by: DPH
Checked by: DK

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

Water Holding Capacity	200	mm
Heat Index	38.28	
Lower Zone	120	mm
A	1.103	
Date Range	1969	2017

Date	**Temperature**	**Precipitation**	**Rain**	**Melt**	**Potential Evaporation**	**Actual Evapotranspiration**	**Deficit**	**Surplus**	**Snow**	**Soil**	**Accumulated Precipiation**
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	28	34	187	286
February	-4.2	52	25	33	1	1	0	48	28	196	339
March	0.2	59	45	37	9	9	0	69	5	199	399
April	6.5	75	73	7	47	47	0	36	0	196	474
May	12.4	77	77	0	92	92	0	9	0	173	551
June	17.5	82	82	0	129	129	0	5	0	120	633
July	20.4	75	75	0	159	143	-16	0	0	52	707
August	20	78	78	0	158	109	-48	0	0	21	785
September	16	82	82	0	106	80	-27	1	0	21	868
October	9.7	73	73	0	20	20	0	1	0	74	73
November	5.2	75	72	2	13	12	-1	3	0	134	149
December	-1.7	73	41	17	3	3	0	18	15	172	222
Average	7.9										
Total		868	748	117	738	646	-92	218			

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

Water Holding Capacity	250	mm
Heat Index	38.28	
Lower Zone	150	mm
A	1.103	
Date Range	1969	2017

Date	**Temperature**	**Precipitation**	**Rain**	**Melt**	**Potential Evaporation**	**Actual Evapotranspiration**	**Deficit**	**Surplus**	**Snow**	**Soil**	**Accumulated Precipiation**
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	21	34	223	286
February	-4.2	52	25	33	1	1	0	38	28	242	339
March	0.2	59	45	37	9	9	0	66	5	249	399
April	6.5	75	73	7	47	47	0	36	0	246	474
May	12.4	77	77	0	92	92	0	9	0	222	551
June	17.5	82	82	0	129	129	0	4	0	170	633
July	20.4	75	75	0	159	152	-7	0	0	93	707
August	20	78	78	0	158	124	-34	0	0	47	785
September	16	82	82	0	106	84	-22	1	0	44	868
October	9.7	73	73	0	20	20	0	1	0	96	73
November	5.2	75	72	2	13	13	-1	2	0	157	149
December	-1.7	73	41	17	3	3	0	11	15	201	222
Average	7.9										
Total		868	748	117	738	675	-64	189			

Entered by: DPH
Checked by: DK

Table G-1: Environment Canada Precipitation, Surplus Data
Oshawa WPCP, Ontario

Water Holding Capacity	300	mm
Heat Index	38.28	
Lower Zone	180	mm
A	1.103	
Date Range	1969	2017

Date	**Temperature**	**Precipitation**	**Rain**	**Melt**	**Potential Evaporation**	**Actual Evapotranspiration**	**Deficit**	**Surplus**	**Snow**	**Soil**	**Accumulated Precipiation**
	(oC)	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
January	-5	67	25	21	1	1	0	18	34	260	286
February	-4.2	52	25	33	1	1	0	32	28	285	339
March	0.2	59	45	37	9	9	0	61	5	297	399
April	6.5	75	73	7	47	47	0	35	0	295	474
May	12.4	77	77	0	92	92	0	9	0	271	551
June	17.5	82	82	0	129	129	0	4	0	219	633
July	20.4	75	75	0	159	156	-3	0	0	139	707
August	20	78	78	0	158	134	-24	0	0	83	785
September	16	82	82	0	106	89	-18	1	0	75	868
October	9.7	73	73	0	20	20	0	1	0	127	73
November	5.2	75	72	2	13	13	0	1	0	188	149
December	-1.7	73	41	17	3	3	0	9	15	235	222
Average	7.9										
Total		868	748	117	738	694	-45	171			

Entered by: DPH
Checked by: DK

Table G-2

Summary of Annual Infiltration Rates

Land Use	Surficial Soil	Land Use type	Infiltration Factor				WHC (mm)	Precip (mm)	Evap (mm)	Surplus (mm)	Runoff (mm)	Infiltration (mm)
			Topo	Soils	Cover	Total						
Forest	Fine Sand	Mature Forest	0.15	0.40	0.20	0.75	250	868	675	189	47	142
Forest	Fine Sandy Loam	Mature Forest	0.15	0.40	0.20	0.75	300	868	694	171	43	128
Meadow	Fine Sand	Pasture and Shrubs	0.15	0.40	0.10	0.65	100	868	559	306	107	199
Meadow	Fine Sandy Loam	Pasture and Shrubs	0.15	0.40	0.10	0.65	150	868	606	259	91	168
Meadow	Silt Loam	Pasture and Shrubs	0.15	0.30	0.10	0.55	250	868	675	189	85	104
Lawns	Fine Sand	Urban Lawns	0.15	0.40	0.10	0.65	50	868	510	356	125	231
Lawns	Fine Sandy Loam	Urban Lawns	0.15	0.40	0.10	0.65	75	868	536	331	116	215
Lawns	Silt Loam	Urban Lawns	0.15	0.30	0.10	0.55	125	868	584	281	126	155
Impermeable Surfaces	Impervious	Impermeable Surfaces	0	0	0	0	0	868	87	781	781	0
SWM Pond	N/A	SWM Pond	0	0	0	0	0	868	738	130	130	0
Buildings - Downspout Disconnection	Fine Sand	Impermeable Surfaces	0	0	0	0.5	0	868	87	781	391	391
Buildings - Downspout Disconnection	Fine Sandy Loam	Impermeable Surfaces	0	0	0	0.5	0	868	87	781	391	391
Buildings - Downspout Disconnection	Silt Loam	Impermeable Surfaces	0	0	0	0.25	0	868	87	781	586	195
Infiltration Facility	N/A	Infiltration Facility	0	0	0	0.41	0	868	738	130	77	53
Buildings - To Infiltration Facility	Fine Sand	Impermeable Surfaces	0	0	0	0.71	0	868	87	781	230	551
Buildings - To Infiltration Facility	Fine Sandy Loam	Impermeable Surfaces	0	0	0	0.71	0	868	87	781	230	551
Buildings - To Infiltration Facility	Silt Loam	Impermeable Surfaces	0	0	0	0.56	0	868	87	781	346	436
Lawns - To Infiltration Facilty	Fine Sand	Urban Lawns	0.15	0.30	0.10	0.79	0	868	510	356	74	282
Lawns - To Infiltration Facilty	Fine Sandy Loam	Urban Lawns	0.15	0.40	0.10	0.79	0	868	536	331	68	263
Lawns - To Infiltration Facilty	Silt Loam	Urban Lawns	0.15	0.40	0.10	0.73	0	868	584	281	75	206
Impermeable Surfaces - To Infiltration Facility	Impervious	Impermeable Surfaces	0	0	0	0.41	0	868	87	781	461	320

Entered by: DPH
Checked by: DK

Table G-3

Summary of EP-7 Hydrologic Budget

Table 1: Pre-Development Water Balance Results

Catchment	Area	Precipitation		Potential Evapotranspiration		Actual Evapotranspiration		Surplus		Infiltration		Runoff	
	(ha)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)
Forest - Fine Sand	0.23	868	2,030	738	1,720	675	1,580	189	440	142	330	47	110
Forest - Fine Sandy Loam	0.08	868	680	738	580	693	540	187	150	140	110	51	40
Meadow - Fine Sand	3.28	868	28,460	738	24,200	559	18,330	306	10,030	199	6,520	107	3,510
Meadow - Fine Sandy Loam	1.10	868	9,540	738	8,110	606	6,660	259	2,850	168	1,850	91	1,000
Total	**4.69**		**40,710**		**34,610**		**27,110**		**13,470**		**8,810**		**4,660**

Table 2: Proposed Development Water Balance Results

Catchment	Area	Precipitation		Potential Evapotranspiration		Actual Evapotranspiration		Surplus		Infiltration		Runoff	
	(ha)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)
Lawn - Fine Sand	2.86	868	24,780	738	21,070	510	14,560	356	10,160	231	6,610	124	3,550
Lawn - Fine Sandy Loam	1.06	868	9,160	738	7,790	536	5,660	331	3,490	215	2,270	116	1,220
Impervious	0.78	868	6,770	738	5,750	87	680	781	6,090	0	0	781	6,090
Total	**4.69**		**40,710**		**34,610**		**20,900**		**19,740**		**8,880**		**10,860**

Difference relative to pre-development condition: *47%* *1%* *133%*

Table G-3
Summary of EP-7 Hydrologic Budget

Table 3: Proposed Development Water Balance Results with Mitigation

Catchment	Area	Precipitation		Potential Evapotranspiration		Actual Evapotranspiration		Surplus		Infiltration		Runoff	
	(ha)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)
Lawn - Fine Sand	2.86	868	24,780	738	21,070	510	14,560	356	10,160	231	6,610	124	3,550
Lawn - Fine Sandy Loam	1.06	868	9,160	738	7,790	536	5,660	331	3,490	215	2,270	116	1,220
Impervious - Downspout Disconnect - Fine Sand	0.08	868	730	738	620	87	70	781	660	391	330	391	330
Impervious - Downspout Disconnect - Fine Sandy Loam	0.23	868	1,980	738	1,680	87	200	781	1,780	391	890	390	890
Impervious	0.47	868	4,060	738	3,450	87	410	781	3,650	0	0	782	3,650
Total	**4.69**		**40,710**		**34,610**		**20,900**		**19,740**		**10,100**		**9,640**

Difference relative to pre-development condition: 47% 15% 107%

Table G-4
Summary of Site-Wide Hydrologic Budget

Table 1: Proposed Development Water Balance Results

Catchment	Area	Precipitation		Potential Evapotranspiration		Actual Evapotranspiration		Surplus		Infiltration		Runoff	
	(ha)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)
Forest - Fine Sand	6.66	868	57,820	738	49,160	675	44,960	189	12,590	142	9,440	47	3,150
Forest - Fine Sandy Loam	4.69	868	40,720	738	34,620	694	32,560	171	8,020	128	6,020	43	2,000
Lawn - Fine Sand	6.19	868	53,760	738	45,710	510	31,590	356	22,050	231	14,330	125	7,720
Lawn - Fine Sandy Loam	5.38	868	46,710	738	39,720	536	28,840	331	17,810	215	11,580	116	6,230
Lawn - Silt Loam	3.35	868	29,060	738	24,710	584	19,550	281	9,410	155	5,170	127	4,240
SWM Pond	0.88	868	7,620	738	6,470	738	6,480	130	1,140	0	0	130	1,140
Impervious	3.19	868	27,660	738	23,520	87	2,760	781	24,900	0	0	781	24,900
Total	**30.34**		**263,350**		**223,910**		**166,740**		**95,920**		**46,540**		**49,380**

Table 2: Proposed Development Water Balance Results with Mitigation

Catchment	Area	Precipitation		Potential Evapotranspiration		Actual Evapotranspiration		Surplus		Infiltration		Runoff	
	(ha)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)
Forest - Fine Sand	6.66	868	57,820	738	49,160	675	44,960	189	12,590	142	9,440	47	3,150
Forest - Fine Sandy Loam	4.69	868	40,720	738	34,620	694	32,560	171	8,020	128	6,020	43	2,000
Lawn - Fine Sand	4.07	868	35,310	738	30,020	510	20,750	356	14,480	231	9,410	125	5,070
Lawn - Fine Sandy Loam	4.54	868	39,440	738	33,540	536	24,360	331	15,040	215	9,780	116	5,260
Lawn - Silt Loam	1.42	868	12,320	738	10,470	584	8,290	281	3,990	155	2,190	127	1,800
Infiltration Facility	0.88	868	7,620	738	6,480	738	6,470	130	1,140	53	470	76	670
Impervious	1.01	868	8,780	738	7,470	87	880	781	7,910	0	0	782	7,910
Impervious - Downspout Disconnect - Fine Sand	0.22	868	1,920	738	1,630	87	190	781	1,730	391	860	393	870
Impervious - Downspout Disconnect - Fine Sandy Loam	0.50	868	4,380	738	3,720	87	440	781	3,940	391	1,970	390	1,970
Impervious - Downspout Disconnect - Silt Loam	0.08	868	680	738	580	87	70	781	610	195	150	584	460
Lawn - Infiltration Facility - Fine Sand	2.13	868	18,450	738	15,690	510	10,840	356	7,570	282	6,000	74	1,570
Lawn - Infiltration Facility - Fine Sandy Loam	0.84	868	7,270	738	6,180	536	4,490	331	2,770	263	2,200	68	570
Lawn - Infiltration Facility - Silt Loam	1.93	868	16,740	738	14,240	584	11,260	281	5,420	206	3,980	75	1,440
Impervious - Downspout Disconnect - Infiltration Facility - Fine Sand	0.22	868	1,940	738	1,650	87	190	781	1,750	551	1,230	232	520
Impervious - Downspout Disconnect - Infiltration Facility - Fine Sandy Loam	0.10	868	860	738	730	87	90	781	770	551	540	233	230
Impervious - Downspout Disconnect - Infiltration Facility - Silt Loam	0.20	868	1,740	738	1,480	87	170	781	1,570	436	870	349	700
Impervious - Infiltration Facility	0.85	868	7,360	738	6,250	87	730	781	6,620	320	2,710	461	3,910
Total	**30.34**		**263,350**		**223,910**		**166,740**		**95,920**		**57,820**		**38,100**

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