Hydrogeological Assessment and Water Balance
4134 16th Avenue, Markham

Sixteenth Land Holdings Inc.

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1.0 Introduction

Sixteenth Land Holdings Inc. has retained R.J. Burnside & Associates Limited (Burnside) to prepare this Hydrogeological Assessment and Water Balance report in support of an Official Plan Amendment (OPA) application to permit the development of a residential community on the Subject Property municipally known as 4134 16th Avenue, in the City of Markham, Region of York. The property is located in Part Lots 16, 17 and 18, Concession 5. The Subject Property is a total of 168.64 hectares (416.72 acres), and is located on the north side of 16th Avenue, on the west side of Kennedy Road, and has a small amount of frontage onto the east side of Warden Avenue as well (Figure 1). There is existing urban development surrounding the property on all sides.

Except for an area adjacent to Kennedy Road, the balance of the property is currently used by its former owner York Downs Golf & Country Club for a golf course. The golf course has been in operation since York Downs Golf & Country Club opened in the early 1970s. The current Official Plan designation of ‘Private Open Space’ for the areas outside of the valleylands reflects this historic golf course use.

Sixteenth Land Holdings Inc. intends to develop the property for a residential community and is submitting an OPA to re-designate the developable portion of the property from ‘Private Open Space’ to appropriate urban residential designations to permit the development of residential uses.

This report has been prepared in conjunction with the OPA application in support of the re-designation as proposed in the draft OPA and in the Planning Report (Gatzios Planning, September 2016). Please refer to the draft OPA and to the Planning Report for a description of the proposed Official Plan land use designations for the property.

The proposed residential development is detailed in the two Draft Plan of Subdivision applications that accompany the OPA application. There is one Draft Plan of Subdivision for the east portion of the property and one for the west portion of the property. The west Draft Plan of Subdivision also contains the valleylands associated with both the Berczy Creek and the Bruce Creek. References in this report to the two draft plans or to specific lots/blocks will include ‘East’ or ‘West’ to denote the appropriate area.

The purpose of the hydrogeological study is to characterize the geological and hydrogeological conditions on the property, identify potential development impacts on the local groundwater and surface water conditions, and to complete water balance calculations. The water balance calculations provide input to the stormwater management plans to be developed for the property by Stantec and provide recharge targets for the design of Low Impact Development (LID) measures to maintain, where possible, key hydrogeological functions.

1.1 Scope of Work

A comprehensive Terms of Reference (TOR) was developed in consultation with the City and TRCA for the MESP for the Subject Property (July 12, 2016). The scope of work for this study was specifically designed to fulfill the hydrogeological and water balance requirements as per the TOR and included completion of the following tasks:

1. Review of published geological and hydrogeological information: A review of existing mapping for the area was completed, including topography (Figure 2), surficial geology (Figure 3) and bedrock geology.

2. Review of the Ministry of the Environment and Climate Change (MOECC) well records: The MOECC maintains a database that provides geological records of water supply wells drilled in the province. A list of the available records for local wells is provided in Appendix A and the well locations are shown on Figure 5. It is noted that the well locations listed in the MOECC records are approximations only and may not be representative of the precise well locations in the field.

3. Review of the geotechnical report and liaison with the project geotechnical engineers (Golder Associates) for the installation of groundwater monitoring wells across the Subject Property: In 2014, Golder drilled 34 boreholes and installed 10 monitoring wells to investigate the soil and groundwater conditions for a preliminary geotechnical investigation. In 2016, Golder drilled an additional 20 boreholes and installed 18 monitoring wells to investigate the soil and groundwater conditions for a geotechnical investigation and the hydrogeological assessment. The locations of the monitoring wells and boreholes are shown on Figure 5 and copies of the borehole logs are provided in Appendix B.

4. Piezometer installations: Fifteen piezometers (three single piezometers and six nests of two piezometers installed at different depths) were installed along Bruce Creek, Berczy Creek, golf course ponds and within wetlands to investigate the shallow groundwater conditions. The locations of the piezometers are shown on Figure 4.

5. Review of grain-size analyses: Analyses were completed by the geotechnical consultants on representative soil samples obtained during the geotechnical investigation. These data were reviewed to characterize the surficial sediments and estimate the hydraulic conductivity of the soils encountered. Copies of the soil grain-size analyses are provided in Appendix C.

6. Hydraulic conductivity testing: Single well response tests were completed in seven groundwater monitoring wells (BH16-5, BH16-6, BH16-9, BH16-12s, BH16-13d, BH16-14 and BH16-15) to assess the in-situ hydraulic conductivity of the shallow soils. The hydraulic conductivity field testing results are provided in Appendix D.

7. Monitoring of groundwater levels: Monitoring is currently on-going to measure the depth to the water table and assess seasonal groundwater flow conditions. Groundwater level measurements have been obtained in the site monitoring wells and piezometers monthly since March 2016. Automatic water level recorders (dataloggers) were installed in six of the on-site monitoring wells (BH16-5, BH16-7, BH16-12d, BH16-13d, BH16-15d and BH16-16) and in eight of the piezometers (PZ4s/d, PZ5s/d, PZ8s/d and PZ9s/d) in order to record continuous water level fluctuations. The groundwater monitoring data and hydrographs are provided in Appendix E.

8. Monitoring of surface water: Surface water observations and spot-flow measurements have been obtained monthly since April 2016 at three locations along Bruce Creek and two locations along Berczy Creek (Figure 4). Flow was estimated using a stream area-velocity method. Automatic water level recorders (dataloggers) were installed at staff gauges SG4, SG5, SG8 and SG9 as well as at culverts SG C-1 and SG C-2. The surface water monitoring data are summarized in Appendix F.

9. Water quality testing: Groundwater samples were collected from two monitoring wells (BH16-5 and BH16-15s) and one surface water sample was collected from both the Bruce Creek and Berczy Creek monitoring stations (SS1 and SG7, respectively) to characterize the baseline water quality across the Subject Property. The water samples were submitted to a qualified laboratory for analysis of general quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals. The testing results are provided in Appendix G.

10. Water balance calculations: A spreadsheet model has been used to calculate the pre-development water balance (based on existing land use conditions) and post-development water balance (based on the proposed development concept) to assess the potential impacts of land development on the local groundwater recharge conditions. Separate calculations were completed for the East Draft Plan and West Draft Plan areas for the overall Subject Property as requested by the TRCA. A feature based water balance was also completed specifically for the catchment area of the Woodlot/Wetland feature located within the East Draft Plan area as requested by the TRCA. The detailed water balance calculations are provided in Appendix H.

2.0 Physical Setting

2.1 Physiography and Topography

The study area is located within a physiographic region known as the Peel Plain (Chapman and Putnam, 1984). The Peel Plain consists of a thin veneer of lacustrine silt and clay deposited over glacial till which has a flat to rolling topography with generally more incised slopes in the vicinity of the watercourses (Figure 2). The land surface regionally slopes to the south, with a maximum relief amplitude across the Subject Property of about 22 m. The highest elevations within the Subject Property are about 198 masl in the north sloping downwards to 174 masl in the southeast (Figure 2).

2.2 Drainage

The Subject Property is located in the Rouge River watershed within the jurisdiction of the Toronto and Region Conservation Authority (TRCA). The Subject Property is traversed by both Bruce Creek and Berczy Creek (Figure 2) which bisect the Subject Property and flow southeast. Bruce Creek enters the northern boundary of the property approximately 750 m east of Warden Avenue and 825 m south of Major Mackenzie Drive, meandering close to 2.2 km before exiting the property at 16th Avenue, approximately 400 m west of Kennedy Road. Berczy Creek enters the western property boundary at Warden Avenue and immediately exits the Subject Property flowing southeast through the existing residential area. Berczy Creek re-enters the Subject Property approximately 550 m east of Warden Avenue and 325 m north of 16th Avenue, flowing approximately 500 m before exiting the property at 16th Avenue, approximately 700 m east of Warden Avenue. The southwest corner of the Subject Property drains to the southwest, towards Berczy Creek, and the remainder of the property drains to Bruce Creek (Figure 2).

Flow monitoring has been conducted monthly in Bruce Creek at three monitoring locations: SS1 at the northern boundary of the Subject Property, SS2 located midway along the Creek in vicinity of the centre of the Subject Property, and SS3 at the southern boundary of the Subject Property as shown on Figure 4. Monitoring of flows on this watercourse indicate that Bruce Creek is perennial. Flow rates observed along the Creek ranged between a low of 82 L/s at SS2 on June 29, 2016 three days following a rainfall event and a high of 437 L/s at SS3 on April 22, 2016 one day following a rainfall event (Table F-1, Appendix F).

On three occasions, the flow in Bruce Creek was found to decrease from SS1 to SS2 then increase from SS2 to SS3. The loss in flow between SS1 and SS2 was found to range from 7 L/s to 36 L/s and may be attributed to flows from Bruce Creek diverted to a series of golf course ponds via culverts located along the Creek valley (Figure 2). Ponds C and D are connected to the flows of Bruce Creek via a culvert system; Bruce

Creek contributes flow to Pond C; Pond C flows to Pond D; and Pond D drains back to Bruce Creek. The gain in flow between SS2 and SS3 was found to range from 62 L/s on April 22, 2016 during spring runoff conditions and one day following a rainfall event to 10 L/s on June 29, 2016, three days following a rainfall event. As will be discussed in Section 2.3.3 of this report, the Bruce Creek valley appears to intersect a sand layer found beneath the Subject Property. Groundwater levels observed in the monitoring wells (discussed below in Sections 2.4.2 and 2.4.5), suggests that groundwater is discharging to Bruce Creek from the sand layer (refer to Section 2.3.3) and contributes baseflow to the watercourse.

It is noted that data collected on May 20, 2016 does not reflect the pattern observed during the other events reported above and measurement inaccuracy is suspected. Flow was observed to increase from SS1 to SS2 by approximately 10 L/s, and then decrease from SS2 to SS3 by approximately 32 L/s during the May 20, 2016 monitoring event.

Monthly flow monitoring was also conducted in Berczy Creek at SS5 located along Warden Avenue, south of Major Mackenzie and SS4 located in the southwest corner of the Subject Property as shown on Figure 3. Flow rates observed along Berczy Creek ranged between a low of 33 L/s on June 29, 2016, three days following a rainfall event and a high of 271 L/s on April 22, 2016, one day following a rainfall event (Table F-1, Appendix F). Flow in Berczy Creek was found to increase from SS5 (upstream) to SS4 (downstream) during three of the monitoring events. Monitoring at SS4 was not accessible during one of the events. The gain in flow was found to range from 10 L/s on June 29, 2016 to 70 L/s on July 29, 2016.

2.3 Geology

2.3.1 Surficial Geology

Surficial geology mapping published by the Ontario Geological Survey (1999) shows that the majority of the Subject Property are covered by glaciolacustrine silt and clay deposits (Figure 3). The north and northeastern portions of the East Draft Plan area have been mapped as glaciolacustrine sand and gravel deposits and a small area in the northwest corner of the West Draft Plan area is mapped as silty to sandy till. Sand, silt, clay and organics are mapped along the Bruce and Berczy Creek valleys (Figure 3).

The geotechnical drilling records generally confirm that the Subject Property are covered by glaciolacustrine silt and clay deposits, though they did not encounter glaciolacustrine sand and gravel at surface as widely shown on the published mapping. The borehole logs, provided in Appendix B, show that sand and gravel deposits were found at surface or underlying the fill material at boreholes BH14-18, BH14-20 and BH16-12 in isolated areas mapped as glaciolacustrine sand and gravel as well as at BH14-5, BH14-14 and

BH16-14 (refer to Figure 4 for locations). Silty to sandy till was not encountered at the surface during the drilling program in the northwest corner of the West Draft Plan area, but was found to be approximately 1 m to 2 m below ground surface underlying silty clay to clayey silt at boreholes BH14-29 and BH14-30.

2.3.2 Bedrock Geology

Bedrock in the study area consists of layered grey shale bedrock of the Blue Mountain Formation (OGS, 1991). Of the 44 MOECC well records within the Subject Property, six extend to the bedrock (Appendix A). The reported depth to bedrock ranges from approximately 35 m to 57 m and the reported bedrock elevations ranges between 128 masl and 150 masl. Published bedrock topography mapping suggests the bedrock generally slopes to the southwest in this area and the elevation ranges from approximately 134 masl in the southwest corner to 150 masl at the northeast corner of the property.

2.3.3 Hydrostratigraphy

The local MOECC well records (Appendix A) provide geology data that have been used along with all of the site-specific geological information obtained from the geotechnical boreholes and groundwater monitoring wells drilled on the property (Appendix B) to assess the local stratigraphy.

To illustrate the local geological conditions, six schematic cross-sections through the Subject Property have been prepared. The cross-section locations are shown on Figure 5 and the cross-sections are shown on Figures 6 through 11**.** On the cross-sections, an interpretation of the major hydrostratigraphic units has been made based on the overall sediment characteristics. The interpretation has also been informed by modelling work completed by the TRCA for the Rouge River Watershed (2008) that outlined the hydrostratigraphic framework in the Markham area. Cross-sections through the Rouge River Watershed prepared by the TRCA (2008) identified three major overburden aquifer systems described in order of increasing depth as the:

1. Oak Ridges Aquifer Complex (ORAC), formed within the ORM sediments and sometimes referred to as the Upper Aquifer.
2. Thorncliffe Aquifer (or Middle Aquifer), formed by the sandy sediments of the Thorncliffe Formation and generally separated from the overlying ORAC by the Newmarket till aquitard.
3. Scarborough Aquifer (Lower Aquifer), formed by sandy sediments of the Scarborough Formation overlying the bedrock, and separated from the Thorncliffe Aquifer by the Sunnybrook aquitard.

The cross-sections through the Subject Property (Figures 6 through 11) generally show a thick layer of finer-grained soils (glaciolacustrine silt and clay and glacial till deposits) overlying the bedrock, interspersed with lenses and layers of sand of variable thickness and extent. These silt, clay and till deposits typically restrict groundwater movement and are considered to form aquitard layers and the sandier deposits are considered as aquifers. The overburden sequence ranges in thickness from about 35 m to more than 60 m to bedrock (Figures 6 through 11).

The sand lenses and layers encountered between elevations of about 165 masl and 190 masl across the Subject Property are interpreted to be part of the Oak Ridges Aquifer Complex (ORAC) or equivalent deposits. The ORAC thins and pinches out on the south slope of the Oak Ridges Moraine, and in the Markham area, the aquifer may be thin and discontinuous or absent. These sand layers are interpreted to intersect the Bruce Creek valley and may locally provide contributions to baseflow (Figures 6, 8, and 10).

A deeper sand layer is found beneath the Subject Property between elevations of about 145 masl and 165 mas (Figures 6 through 11). This layer appears to be continuous from north to south beneath the west side of the Subject Property (Figure 9), but the well data suggest the aquifer may thin and pinch out to the east (Figures 6, 7 and 8). This deeper sand layer is interpreted to be the Thorncliffe Aquifer.

There is no evidence of the deeper Sunnybrook aquifer beneath the Subject Property.

2.3.4 Soil Hydraulic Conductivity and Infiltration Rates

There are various methods that can be used to assess soil hydraulic conductivity, i.e., the ability of the soil to transmit groundwater. Grain-size data and soil characteristics can be used to provide a general estimate of hydraulic conductivity. Single well bail-down tests and constant-head tests are used in groundwater monitoring wells to assess site-specific hydraulic conductivity. These methods have been used to estimate the hydraulic conductivity of the soils encountered in the Subject Property as discussed below.

2.3.4.1 Estimates from Soil Grain-Size

During the 2014 and 2016 drilling programs, 27 representative soil samples were collected and analysed for grain-size distribution by Golder (Appendix C). The grain-size analyses were conducted on various soil types found across the property. A summary of the hydraulic conductivity values estimated from the individual grain-size analyses using the Hazen approximation method is provided in Table C-1 (Appendix C) and ranges of hydraulic conductivities for each soil type are presented below in Table 1a. The Hazen method is designed to approximate the hydraulic conductivity of more permeable sediments; however, it is still considered useful in finer grained sediments to provide a general indication of the low range of the hydraulic conductivity values.

2.3.4.2 In-situ Well Tests

To assess the in-situ hydraulic conductivity of the screened intervals, single well response tests were completed at BH16-5, BH16-6, BH16-9, BH16-12s, BH16-13d, BH16-14s and BH16-15s (refer to Figure 4 for monitoring well locations and Appendix B for borehole logs). A constant-head test was completed in BH16-5 using a Waterra foot valves and tubing assembly to pump the well at different rates and measuring the (quasi) stead-state drawdown at each flow rate, using the field technique described by Rannie and Nadon (1988). Bail-down tests were completed at BH16-6, BH16-9, BH16-12s, BH16-13d, BH16-14s and BH16-15s as steady-state drawdown would not be achieved within a reasonable time frame under continuous, low-flow pumping. The test results are provided in Appendix D and the calculated hydraulic conductivity values are summarized below and in Table 1a.

- BH16-5 is screened in sand. The recovery in this well was rapid, and the results of the constant-head test at this location suggest a relatively high hydraulic conductivity of 8.3 x 10^{-4} cm/sec.

- BH16-6 is screened in silty sand to sandy silt. The results of the bail-down test at this location suggest a low-moderate hydraulic conductivity of 5.8 x 10^{-5} cm/sec.

- BH16-9 is screened in silty clay, sandy to trace sand. The results of the bail-down test at this location suggest a low-moderate hydraulic conductivity of 1.2 x 10^{-5} cm/sec.

- BH16-12s is screened in sand and silt to sandy silt till. The results of the bail-down test at this location suggest a low-moderate hydraulic conductivity of 1.6 x 10^{-5} cm/sec.

- BH16-13d is screened in sand and silt to sandy silt. The results of the bail-down test at this location suggest a low hydraulic conductivity of 8.8 x 10^{-6} cm/sec.

- BH16-14s is screened in silty sand. The results of the bail-down test at this location suggest a moderate hydraulic conductivity of 2.7 x 10^{-4} cm/sec.

- BH16-15s is screened in sand and silt. The results of the hydraulic conductivity testing at this location indicate a low-moderate hydraulic conductivity of 4.1 x 10^{-5} cm/sec.

Table 1a: Summary of Hydraulic Conductivity Test Results

Soil Type	Hydraulic Conductivity (cm/sec) Hazen Estimation	Hydraulic Conductivity (cm/sec) In-Situ Test
Silty Clay	$<1.0 \times 10^{-6}$	-
Sandy Clayey Silt to Clayey Sand Till	$<1.0 \times 10^{-6}$ to 2.3×10^{-6}	1.2×10^{-5}
Sandy Silt to Silty Sand Till	1.0×10^{-6} to 2.2×10^{-5}	1.6×10^{-5}
Silty Sand to Sand	2.6×10^{-4} to 8.3×10^{-3}	8.8×10^{-6} to 8.3×10^{-4}

2.3.4.3 Infiltration Tests

To assess surficial infiltration potential, a series of tests using a Turf-Tec double ring infiltrometer were completed at selected locations across the site (Figure 4). The test results are provided in Figures D8 to D14, in Appendix D. The tests were completed by removing the topsoil in the test area and installing the infiltrometer in the underlying soil. Both rings of the infiltrometer were then filled with water and the time for the water level in the inner ring to fall 10 mm was recorded. This was repeated until consistent readings were recorded for at least three consecutive intervals. The test results are discussed below and are summarized in Table 1b. Graphs of the test results are provided in Appendix D.

Seven infiltration tests were completed across the Subject Property on May 30 and June 3, 2016 (IT1, IT2, IT3, IT4, IT5, IT6 and IT7 on Figure 4). Tests IT1, IT2 and IT3 were completed across the southern extent of the West Draft Plan area. Test IT1 was conducted at a depth of 0.35 m in sandy silt till with some gravel. The results of the test show that the soil has an infiltration rate of approximately 200 mm/hour (Figure D-8, Appendix D). Test IT2 was completed at a depth of 0.4 m in silty sand till and gravel. The results of the test show that the soil has an infiltration rate of approximately 1,000 mm/hour (Figure D-9, Appendix D). Test IT3 was completed at a depth of 0.40 m in sandy silt till with some clay. The results of the test show that the soil has an infiltration rate of approximately 200 mm/hour (Figure D-10, Appendix D).

Test IT4 was conducted approximately in the centre of the West Draft Plan area (Figure 4) at a depth of 0.45 m in clayey silt with trace sand. The results of the test show that the soil has an infiltration rate of approximately 135 mm/hour (Figure D-11, Appendix D).

Tests IT5 and IT6 were completed in the northeast corner of the East Draft Plan area (Figure 4). Test IT5 was conducted at a depth of 0.35 m in clayey silt till and had an infiltration rate of approximately 50 mm/hour (Figure D-12, Appendix D). Test IT6 was completed at a depth of 0.4 m in sandy silt with trace clay. The results of the test show that the soil has an infiltration rate of approximately 360 mm/hour (Figure D-13, Appendix D).

Test IT7 was conducted at the northern extent of the West Draft Plan area (Figure 4) at a depth of 0.45 m in silty sand and gravel. The results of the test show that the soil has an infiltration rate of approximately 360 mm/hour (Figure D-14, Appendix D).

Table 1b: Summary of Infiltration Rates

Soil Type	Measured Field Infiltration (mm/hour)
Clayey Silt to Clayey Sand Till	50 to 135
Sandy Silt to Silty Sand	200 to 360

2.3.4.4 Discussion of Hydraulic Conductivity Results

The observed infiltration rates of 200 mm/hour to 360 mm/hour at test locations IT1, IT3 and IT7 (Table 1b) are higher than expected based on the nature of the material, i.e., silty sand to sandy silt deposits that would be expected to have a hydraulic conductivity of about 1 x 10^{-5} cm/sec (Table 1a). A hydraulic conductivity value of 10^{-5} cm/sec would be equivalent to about 30 mm/hour (Ontario Ministry of Municipal Affairs & Housing OMAH), 1997 – Site Evaluation and Soil Testing Protocol for Stormwater Infiltration). Tests IT4 and IT5 were completed in clayey silt soils and had infiltration rates of approximately 50 mm/hour and 135 mm/hour, respectively (Table 1b). Again, these infiltration rates are higher than expected for clayey silt soils, as the hydraulic conductivity of the clayey silt soils of 10^{-6} cm/sec or less would be equivalent to about 12 mm/hour or less).

Test IT6 was completed in sandy silt with trace clay with and had an infiltration rate of approximately 360 mm/hour. Test IT2 was completed in silty sand and gravel with an infiltration rate of 1,000 mm/hour. All of the field IT test rates show higher values than the other methods. This is likely because the upper sediments are fractured, weathered and disturbed leading to higher ‘secondary’ permeability, and the tests simulate saturated conditions. This is an important consideration for the success of lot level and shallow infiltration LID measures for stormwater management. Weathering and fracturing is expected to decrease with depth, so the overall infiltration potential across the Subject Property that will contribute groundwater recharge to depth will be more limited.

It is concluded that the hydraulic conductivity of the surficial soils is generally suitable for the use of LID measures to promote shallow infiltration. It is noted that all test locations were completed in areas where 0.5 m to 3.5 m of fill material will be added as part of the proposed grading plan. Site-specific testing of the soils proposed for fill material and at the depths of the proposed infiltration LID measures should be completed during detailed design to confirm actual infiltration rates.

2.4 Hydrogeology

2.4.1 Local Groundwater Use

The Subject Property is situated within a developed community. All lands surrounding the Subject Property are residential subdivisions that are municipally serviced with lake-based supplies. The proposed development will also be municipally serviced and there is no proposed on-site groundwater use for the development.

The York Downs Golf & Country Club has a Permit to Take Water (PTTW) No. 4201-8DEPTU that allows the golf club to draw water from five groundwater wells and Bruce Creek to supplement irrigation water stored in a large off-line storage reservoir. Groundwater supply wells at the Subject Property are separated into two clusters: the north cluster consisting of PW3 (TW1-69), PW4 (TW3-69) and PW6 (currently not used) and the south cluster consisting of PW1 (TW3-68) and PW2B (Figure 5) (Burnside, 2015).

TW1-69 and TW3-69 are completed to depths of 28.3 m and 26.2 m, respectively. TW3-68 is completed to a depth of 31.4 m. Groundwater taking at the site predominantly relies on pumping wells PW1 and PW4 to refill the irrigation storage pond. The total average daily irrigation volume for the golf course is 1,804,700 L (Burnside, 2015).

The golf course reports their annual groundwater use to the MOECC in accordance with their permits. It is anticipated that the golf course will continue this water use until such time as the Subject Property is developed. At that time, all pumping wells will be decommissioned in accordance with provincial regulations and, as noted above, there is no proposed future groundwater use for the development.

Well Head Protection Areas (WHPAs) are zones around municipal water supply wells where land uses must be carefully planned and restricted to protect the quality of the water supply. Based on our review of WHPA mapping available from the Region of York, the Subject Property is not located within a WHPA, and as such, the development is not considered to pose a significant threat to drinking water supplies.

2.4.2 Groundwater Levels

Groundwater levels have been monitored in monitoring wells and piezometers across the Subject Property since March 2016, and the data are summarized in Tables E-1 and E-2 in Appendix E. Hydrographs for each monitoring location are also provided as Figures E-1 through E-32 in Appendix E to illustrate the water level variations. In addition to the manual water level measurements recorded at each location, an automatic water level recorder (datalogger) was installed in six monitoring wells (BH16-5, BH16-7, BH16-12d, BH16-13d, BH16-15d and BH16-6) and in eight piezometers (PZ4s/d, PZ5s/d, PZ8s/d and PZ9s/d) to record continuous water levels.

The groundwater monitoring data show the following (refer to Figure 4 for the monitoring locations and the data tables and hydrographs in Appendix E):

- The shallow monitoring wells installed in the shallow till and shallow sand layers across the Subject Property (BH16-3, BH16-4, BH16-6, BH16-7, BH16-8, BH16-9, BH16-10, BH16-11, BH14-1, BH14-2, BH14-8, BH14-12, BH14-15, BH14-17, BH14-29 and BH14-33) were found to have groundwater levels fluctuating between approximately 0.2 m (BH16-10, Figure E-8 in Appendix-E) to 4.9 m (BH16-3, Figure E-1 in Appendix E) below ground surface. The seasonal variation in groundwater levels in these wells ranged from 0.3 m (BH14-1, Figure E-15 in Appendix E) to 2.1 m (BH14-17, Figure E-21 in Appendix E).

- Monitoring well BH16-5 is the only shallow well that had groundwater levels above ground surface. This well is located in a topographically low area in the north central portion of the property (Figure 4). Groundwater levels at this well ranged between approximately 0.3 m above ground surface (March and April) to 0.7 m below ground surface (refer to Figure E-3 in Appendix E).

- Nested monitoring wells (e.g., wells located adjacent to each other but completed at different depths) were installed in BH16-12s/d, BH16-13s/d, BH16-14s/d and BH16-15s/d. Monitoring wells BH14-3 (shallow) and BH16-16 (deep) is also interpreted as a nest, though they are located approximately 25 m apart.

  - Monitoring well nest BH16-12s/d is located within a small valley feature in the northeast corner of the site in vicinity of the existing stormwater management pond ‘Pond H’. The shallow well is installed in a sand layer and the deep well is installed in the underlying silty clay till (Figure 9). This well nest is located within a topographically low area adjacent to the stormwater management pond in the north east portion of the property (Figure 4). The groundwater levels in BH16-12s show a seasonal decline in the water levels with groundwater in the sand layer ranging from about 0.3 m to 2 m below grade (Figure D-10, Appendix E). The water levels recorded in BH16-12d have been above ground surface for the duration of the monitoring and have gently been declining over the summer months. The groundwater levels in BH16-12d are approximately 1 m to 2 m higher than the groundwater levels in the shallow well showing a strong upward gradient at this location ranging between approximately -0.06 m/m to -0.14 m/m (Figure E-10, Appendix E).

- Monitoring well nests BH16-13s/d, BH16-14s/d and BH14-3/BH16-16 are located in low-lying elevations in the southeast quadrant of the Subject Property and are within approximately 100 m of Bruce Creek (refer to Figure 4 for well locations). The shallow and deep wells are installed in the upper sand layers with the exception of BH16-14d; this well is installed in sandy clayey silt till (Figures 8, 10 and 11). The groundwater levels in BH16-13d are 1 m to 2 m or more higher than the groundwater levels in the shallow well, showing a strong upward gradient (Figure E-11, Appendix E). The water level in the deep well has generally been consistent during the monitoring period. The water level in the shallow well has been declining through the summer months and reflects recent drought conditions. Similarly the water levels in the BH16-14s/d nest have declined over the summer and the groundwater levels in BH16-14d have consistently been approximately 0.2 m higher than the groundwater levels in the shallow well (BH16-14s), showing an upward gradient (Figure E-12, Appendix E). The groundwater levels in BH16-16 were above ground surface in March and April showing spring discharge conditions and have gently been declining over the dry summer months to about 0.6 m below grade (Figure E-14, Appendix E). The groundwater levels in BH16-16 have also been higher than the groundwater levels in BH14-3 (shallow well) showing a strong upward gradient (Figures E-14 and E-17, Appendix E). Cross-sections C-C’ (Figure 8) and F-F’ (Figure 11) show that shallow sand deposits are present along the Bruce Creek Valley, and the upward gradients observed in BH16-13d, BH16-14d and BH16-16 suggest groundwater discharge conditions in these sands. Upward gradients in these wells nests ranged between -0.01 m/m at BH16-14s/d to -0.2 m/m at BH14-3/BH16-16. It is interpreted that discharge from these sand layers contributes baseflow to Bruce Creek. The Bruce Creek flow monitoring indicates the creek gains flow as it traverses across the Subject Property.

- Monitoring well nest BH16-15s/d is located at the south end of the Subject Property in vicinity of the site entrance (Figure 4). The shallow and deep wells are installed silty sand layers that are isolated from each other by a clayey silt till layer (Figure 8). The water levels in the shallow well are more than 3 m below grade and have declined throughout the summer month (Figure E-13, Appendix E). The groundwater levels in the shallow well are approximately 0.5 m to 1.1 m higher than the deep groundwater levels showing a downward gradient ranging between approximately 0.05 m/m to 0.1 m/m and suggesting recharge conditions in this location (Figure E-13, Appendix E).

- Piezometers were installed adjacent to a number of the golf course ponds that are located along the Bruce Creek (PZ1, PZ2 and PZ6; refer to Figure 4 for locations). Groundwater levels in PZ1 and PZ6 were consistently lower than the surface water levels measured in adjacent ponds at SG1 (Pond C) and SG6

(Pond A), respectively (Figures E-24 and E-29, Appendix E). These data suggest that the ponds will have a recharge function when they fill up with runoff and precipitation, particularly in the spring.

- Groundwater levels at PZ2 were below the surface water levels measured in the adjacent pond at SG2 (Pond D) during the spring and early summer (first four monitoring events), but during the summer months have been measured to be above the surface water level in the pond (Figure E-25, Appendix E). The steady rise in the water level in the piezometer suggests that this pipe is located in very low hydraulic conductivity soils that have restricted the inflow and stabilization to a static water elevation. This low hydraulic conductivity will also result in a lag of response between the pond levels and the local groundwater levels. Based on the closeness of the water elevations, it is interpreted that Pond D is excavated into the local water table and will function as described above for Ponds A and C, i.e., when the surface water levels are high in the ponds, they will have a recharge function. When surface water inputs are low, the local water table will sustain the pond features.

- Nested piezometers were installed along the Bruce Creek (PZ3s/d) and along Berczy Creek (PZ7s/d; refer to Figure 4 for locations). As shown on Figure E-26 in Appendix E, the groundwater levels in the shallow and deeper piezometer in the PZ3s/d nest are similar, showing a slight downward gradient from April through July (i.e., recharge conditions). The groundwater level in these piezometers was found to range between 0.16 mbgs to 0.68 mbgs. The groundwater levels in the shallow piezometer are very close to or slightly higher than the surface water levels measured at staff gauge SG3 suggesting groundwater discharge conditions to Bruce Creek. Groundwater levels in the deep piezometer were also higher than the surface water level measured at staff gauge SG3 on two occasions (Figure E-26, Appendix E).

- Groundwater levels in the shallow piezometer (PZ7s) reflect the surface water levels at SG7, illustrating the groundwater/surface water interaction in this location. The shallow groundwater levels at PZ7s were, however, consistently higher than the groundwater levels in the deeper PZ7d, showing a downward gradient (i.e. recharge conditions) in this location along Berczy Creek (Figure E-30, Appendix E). These data suggest that the watercourse may recharge the local groundwater in this area.

- Piezometer nest PZ4s/d is located within a reed/canary grass mineral marsh meadow (Natural Environment Report/Environmental Impact Study by Beacon, 2016) within the East Draft Plan area that receives runoff from the driving range area (Figure 4). The groundwater level in the shallow piezometer has been highly variable, ranging between approximately 0.2 mags in the spring to about

0.5 mbgs during the summer months (Figure E-27, Appendix E). The datalogger in the deeper piezometer has shown a slow recovery of water levels illustrating low hydraulic conductivity soils, but in recent months appears to have stabilized about 0.7 m below grade. The hydraulic gradient is downwards (Figure E-27, Appendix E). It is interpreted that when standing water occurs during spring runoff that the feature has a recharge function.

- Piezometer nests PZ5s/d and PZ8s/d were installed in a woodlot/wetland feature within the East Draft Plan area. This area is referred to as the ‘Feature 1 Woodlot/Wetland’ in the Natural Environment Report/Environmental Impact Study by Beacon, 2016 (Figure 4). PZ5s/d is located within the wetland portion of the feature and has been monitored since March 2016 (Figure E-28, Appendix E). PZ8s/d is located within the woodlot portion of the feature and has been monitored since June 2016 (Figure E-31, Appendix E). Groundwater levels measured in PZ5s/d and PZ8s/d have been below ground surface throughout the duration of the monitoring period; ranging from approximately 0.4 m to 1.4 mbgs at PZ5s/d and 0.7 to 1.6 mbgs at PZ8s/d. Similar to the discussion for PZ4s/d above, the datalogger in PZ5d has shown a slow recovery of water levels illustrating low hydraulic conductivity soils, but in recent months appears to have stabilized at about 0.8 m below grade and below the surface water elevations in the feature (Figure E-27, Appendix E). The preliminary data for PZ8s/d show below grade groundwater elevation and a strong downward gradient (Figure E-32, Appendix E). It is interpreted that the wetland and woodlot features are supported by precipitation and surface water runoff and have a groundwater recharge function.

- PZ9s/d was installed within a small wetland near the western limits of the West Draft Plan area on August 5, 2016 (refer to Figure 4 for piezometer nest location). The groundwater level monitored immediately after installation was 0.96 mbgs in the shallow piezometer and 1.51 mbgs in the deep piezometer, suggesting a downward gradient beneath this feature as well (Figure E-32, Appendix E).

2.4.3 Interpreted Groundwater Flow Conditions

Spring groundwater elevation data from April 2016 are shown on Figure 12, along with the interpreted groundwater elevation contours for the Subject Property. The contours shown on Figure 12 represent the interpreted shallow groundwater in the shallow surficial soils across the Subject Property.

The groundwater elevation data suggest that the water table in the upper till soils reflects the general surface topography and that the shallow groundwater flow patterns will mimic the surface water flow patterns (Figure 2), with flow moving from higher elevations towards lower elevations. A groundwater divide is interpreted to be roughly coincident with the surface water divide between the Bruce Creek and the Berczy Creek (compare Figure 2 and Figure 12). The shallow groundwater is interpreted to move across the Subject Property towards Bruce Creek, with the exception of the west half of the West Draft Plan area; shallow groundwater within the west half of the West Draft Plan Area is interpreted to flow towards Berczy Creek (Figure 12).

2.4.4 Groundwater Flow Systems

Areas where water from precipitation percolates or infiltrates into the ground and moves downward from the water table are known as recharge areas. These areas are generally in areas of relatively higher topographic elevation. Areas where groundwater moves upward are discharge areas and these generally occur in areas of relatively lower topographic elevation, such as along watercourses. Recharge and discharge may occur in local, intermediate and more regional flow systems. Infiltrating water at any given location may follow a shallow flow path and discharge a short distance away from the recharge area along the nearest slopes or in small watercourses, swales, agricultural ditches, wetlands, etc. This is referred to as a local groundwater flow system (i.e., flows that closely follow the existing topography with relatively short flow distances, e.g., up to a few hundred metres). Some water may follow much deeper and longer flow paths (hundreds to thousands of metres) to recharge underlying aquifers and discharge to features and watercourses possibly a very long way from the area of recharge. Such conditions may be referred to as intermediate and/or regional groundwater flow systems depending on the scale of analysis.

In the study area, the groundwater flow conditions are interpreted to involve: 1) a local shallow system involving groundwater flow in the upper surficial portions of the till and glaciolacustrine sediments, and 2) deeper more regional groundwater flow systems involving the ORAC and Thorncliffe aquifers. The shallow local flow system is superimposed over the regional flow systems and more closely follows the local topography and surface water drainage patterns (Figure 12). Water infiltrating on the Subject Property will move laterally through the shallow soils to recharge the underlying shallow sands and discharge locally in Bruce Creek.

The deeper regional systems are driven by recharge originating in the topographically higher Oak Ridges Moraine to the north of the study area. Flow moves through the aquifers to the south, and as the aquifer layers dip, thin and eventually pinch out, groundwater discharge conditions are evident. Artesian pressures are evident in MOECC well records for wells in the western portion of the Subject Property completed in the sand layer that has been interpreted as the Thorncliffe aquifer (refer to Section 2.3.3 and refer to Figures 8 and 9).

As discussed in Section 2.3.3, on the Subject Property, there are only isolated layers and lenses of sand that may be interpreted as possible ORAC deposits and the Thorncliffe aquifer may not be present in all locations. However, where present, the sandy layers of the ORAC may provide a means for shallow groundwater originating north of the Subject Property to locally contribute baseflow to Bruce Creek and the artesian heads in the Thorncliffe will act to support local high water table conditions. Local infiltration that seeps into the surficial soils is not able to move to depth to recharge the underlying Thorncliffe aquifer due to the upward hydraulic pressures.

2.4.5 Recharge and Discharge Conditions

Monitoring well nests installed on the Subject Property indicate both downward and upward hydraulic gradients (Section 2.4.2). Monitoring well nests BH16-13s/d, BH16-14s/d and BH14-3/BH16-16 show upward hydraulic gradients and are within approximately 100 m of Bruce Creek. Upward gradients ranged between -0.01 m/m at BH16-14s/d to -0.2 m/m at BH14-3/BH16-16. The interpreted cross-sections C-C’ (Figure 8) and F-F’ (Figure 11) through the Bruce Creek valley show shallow sand deposits are present along the Bruce Creek valley. The upward gradients observed in BH16-13d, BH16-14d and BH16-16 may reflect groundwater discharge from the sandy layers to Bruce Creek. The flow monitoring indicates that Bruce Creek gains flow as it traverses across the Subject Property, supporting the interpretation that the watercourse receives groundwater inputs (Section 2.2 and Table F-2 in Appendix F).

Monitoring well nest BH16-12s/d showed an upward gradient ranging between approximately -0.06 m/m to -0.14 m/m from a silty clay to a sand and silt unit, indicating a discharge area. The upward gradients observed at BH16-12s/d are interpreted to be influenced by the location of the well nest on the side of a hill sloping toward a topographic low where stormwater management pond ‘Pond H’ is located (Figure 4). The hydraulic head in the deep well is thought to be driven by a local flow system from the topographically higher recharge area in the northeast corner of the Subject Property.

Monitoring well BH16-5, located to the west of Pond H (Figure 4) is the only shallow well that had groundwater levels above ground surface and discharge conditions in March and April 2016. This well is screened in a confined sand deposit (refer to Figure E-3 in Appendix E). Similar to BH16-12s/d, this well is located in a topographically low area and the groundwater levels observed in the well are interpreted to be influenced by the local flow system from the topographically higher area to the northeast.

Monitoring well nest BH16-15s/d showed a downward gradient ranging between approximately 0.05 m/m to 0.1 m/m from a shallow sand and silt layer towards a deeper gravelly silty sand. These data suggest that this area of the property is a recharge area, i.e., an area where infiltrating precipitation may recharge into the topsoil and underlying sediments.

Groundwater levels in piezometer PZ4s were observed to be 0.15 m above ground surface on March 29, 2016 suggesting discharge conditions (Figure E-28, Appendix E). Runoff from the driving range area drains and discharges within the mineral marsh meadow via a buried pipe. The groundwater level that suggests discharge conditions may in fact just represent the discharge of runoff water from the driving range. Dataloggers have been installed in both piezometers at PZ4s/d, at staff gauge SG4 to measure surface water elevations and at SG C-2 to monitor surface water flows leaving the mineral marsh meadow to confirm the groundwater/surface water interactions in this feature.

Groundwater levels in PZ5s/d, PZ8s/d and PZ9s/d were all observed to have downward gradients indicating recharge conditions. Recharge at these locations is limited as a result of the underlying low hydraulic conductivity soils.

Significant Groundwater Recharge Areas (SGRAs) and Ecologically Significant Groundwater Recharge Area (ESGRA) have been mapped for this area (TRCA, 2016). Review of this mapping show that the Subject Property is not located within an SGRA or an ESGRA. The findings of this report support the TRCA mapping as our investigation identified low rates of infiltration across the tableland, limited by the fine grained surficial sediments and till, as well as discharge conditions along the Berczy Creek and Bruce Creek valleys.

2.5 Water Quality

2.5.1 Groundwater Quality

To characterize the background groundwater quality on the property, groundwater samples were collected in April 2016 from MW16-5 and MW16-15s. The groundwater samples were analysed for pH, conductivity, basic ions and selected metals.

The laboratory results are summarized in Table G-1 in Appendix G, and show the following:

- When compared to the Ontario Drinking Water Standards (ODWS), the groundwater is relatively hard (512 mg/L and 491 mg/L at MW16-5 and MW16-15s, respectively), exceeding the ODWS criteria of 100 mg/L. This is common for groundwater in southern Ontario.

- The sodium and chloride concentrations were higher at MW16-5 (68.8 mg/L and 150 mg/L, respectively) than MW16-15s (9.57 mg/L and 16 mg/L, respectively). The higher concentrations observed in MW16-5 may be more affected by inputs from surface activities (i.e., recharge of water impacted by road salt) than the shallow groundwater in MW16-15s. The chloride concentrations are below the ODWS of

250 mg/L in both wells. The sodium concentration in MW16-5 (68.8 mg/L) is above the ODWS of 20 mg/L.

- The concentration of total dissolved solids (TDS) in MW16-5 (760 mg/L) and MW16-15s (697 mg/L) exceed the ODWS criteria of 500 mg/L.
- The iron concentration in MW16-15s (1.22 mg/L) exceeds the ODWS of 0.3 mg/L.
- The manganese concentration in MW16-5 (486 µg/L) and MW16-15s (78.1 µg/L) both exceed the ODWS of 50 µg/L.
- Nitrate levels in both wells were very low, with reported concentrations of 0.22 mg/L and <0.06 mg/L for MW16-5 and MW16-15s, respectively, and well below the ODWS of 10 mg/L for nitrate.
- The colour of the water collected from MW16-5 has a value of 7 TCU exceeding the ODWS aesthetic value of 5 TCU.
- All other concentrations were reported below the ODWS for parameters tested.

2.5.2 Surface Water Quality

Surface water samples were collected at SS1 and SG7 in April 2016 to characterize the water quality in Bruce Creek and Berczy Creek, respectively. The surface water samples were analysed for pH, conductivity, basic ions and selected metals and the laboratory results are summarized in Table G-2 in Appendix G. In addition to the laboratory analyses, field monitoring of pH, temperature, dissolved oxygen, conductivity, salinity, total dissolved solids (TDS) and total suspended solids (TSS) was completed at the surface water stations when flow was present during the flow monitoring program. The results of the field quality monitoring are summarized in Table G-3 in Appendix G.

The surface water quality data (Tables G-2 and G-3, Appendix G) show the following:

- The reported chloride concentrations are 380 mg/L and 120 mg/L at SS1 and SG7, respectively. The sodium concentrations are reported at 241 mg/L and 69.6 mg/L for SS1 and SG7, respectively.
- The total phosphorus concentrations were reported below the Provincial Water Quality Objective (PWQO) for phosphorus of 30 pg/L.
- Nitrate levels in both samples were very low, with reported concentrations of 1.99 mg/L and 1.70 mg/L for SS1 and SG7, respectively.

- The field chemistry data show that the TSS concentrations in Bruce Creek ranged from 8 mg/L to 28 mg/L and 10 mg/L to 18 mg/L in Berczy Creek. The pH level measurements in Bruce Creek and Berczy Creek ranged from 8.6 to 9.1. Conductivity measurements in Bruce Creek ranged from 701 mS/cm to 927 mS/cm and 727 mS/cm to 1445 mS/cm in Berczy Creek.

The results of the surface water sampling show that the water quality in Bruce Creek and Berczy Creek meet the PWQO for the parameters tested, and show little impact from the surrounding land uses.

3.0 Water Balance

In order to assess potential land development impacts on the local groundwater conditions, a detailed water balance analysis has been completed for the East and West draft plans to determine the pre-development infiltration volumes (based on existing land use conditions) and the post-development infiltration volumes that would be expected based on the proposed land use plan. The water balance calculations are provided in Appendix H and discussed below.

3.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. As a concept, the water balance is relatively simple and may be estimated from the following equation:

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

where: P = precipitation
S = change in groundwater storage
ET = evapotranspiration/evaporation
R = surface water runoff
I = infiltration

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e. rainfall intensity, land slope, soil hydraulic conductivity and vegetation). Runoff, for example, occurs particularly during periods of snowmelt when the ground is frozen, or during intense rainfall events. Precise measurement of the water balance components is difficult and as such, approximations and simplifications are made to characterize the water balance of a study area. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important input considerations for the water balance calculations. The groundwater balance components for the Subject Property are discussed below:

Precipitation (P)

The long-term average annual precipitation for the area is 895 mm based on data from the Environment Canada Toronto Buttonville climate station (Station 615HMAK - 43° 51.440' N, 79° 22.120' W, elevation 198.1 masl) for the period between 1981 and 2010. Average monthly records of precipitation and temperature from this station have been used for the water balance component calculations in this study (Tables H-1 and H-2, Appendix H).

Storage (S)

Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero so this term is dropped from the equation.

Evapotranspiration (ET) / Evaporation (E)

Evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration (PET) refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of evapotranspiration (AET) is often less than the PET under dry conditions (i.e., during the summer when there is a soil moisture deficit). In this report, the monthly PET and AET have been calculated using a soil-moisture balance approach, using average temperature data and climate information adjusted to the local latitude (refer to Tables H-1 and H-2 in Appendix H).

Water Surplus (R + I)

The difference between the mean annual P and the mean annual ET is referred to as the water surplus. Part of the water surplus travels across the surface of the soil as surface or overland runoff and the remainder infiltrates the surficial soil.

The infiltration is comprised of two end member components: one component that moves vertically downward to the groundwater table (typically referred to as percolation, deep infiltration or net recharge) and a second component that moves laterally through the shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short time following cessation of precipitation. As opposed to the “direct” component of surface runoff that occurs overland during precipitation or snowmelt events, shallow interflow becomes an “indirect” component of runoff. The interflow component of surface water runoff is not accounted for in the water balance equation cited above since it is often difficult to distinguish between interflow and direct (overland) runoff, but both interflow and direct runoff contribute to the overall surface water runoff component from the property.

3.2 Approach and Methodology

The analytical approach to calculate a water balance for the Subject Property involved monthly soil-moisture balance calculations to determine the pre-development (based on existing land use conditions) and post-development (based on the proposed development concept plan) infiltration volumes. A soil-moisture balance approach assumes that soils do not release water as “potential infiltration” while a soil moisture deficit exists. During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

Considering the nature of the silt soils in the area, a soil moisture storage capacity of 125 mm was used for the predominantly short to moderate-rooted fairways throughout the golf course. A soil moisture storage capacity of 400 mm was used for longer-rooted vegetation, i.e., the wooded areas. Table H-1 (for 125 mm retention) and Table H-2 (for 400 mm retention) in Appendix H detail the monthly potential evapotranspiration calculations accounting for latitude and climate, and the actual evapotranspiration (AET) and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions.

The MOECC SWM Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used and a corresponding runoff component was calculated for the two soil moisture storage conditions (i.e., for 125 mm and 400 mm storage as presented on Tables H-1 and H-2 in Appendix H).

The calculated water balance components from these tables are used to assess the pre-development infiltration volumes on a draft plan basis (i.e., for the portions of the Subject Property within the East Draft Plan area and the West Draft Plan area) based on the existing land use characteristics (open space, buildings, wooded areas, etc.). The West Draft Plan area has been further divided into Berczy Creek and Bruce Creek catchment areas to assess conditions for each of these features. A post-development water balance scenario is then calculated for each draft plan area based on the proposed land development plan. The pre- and post-development calculations are provided in Tables H-4 (East Draft Plan), H-5a (West Draft Plan – Berczy Creek Catchment area) and H-5b (West Draft Plan – Bruce Creek Catchment area) in Appendix H.

3.3 Component Values

The detailed monthly calculations show that a water surplus is generally available from December to May. As shown on the calculation tables, infiltration occurs during periods when there is sufficient water available to overcome the soil moisture storage requirements. In winter climates, frozen conditions affect when the actual infiltration will occur, however, the monthly balance calculations show the potential volumes available for these water balance components.

The monthly calculations are summed to provide estimates of the annual water balance component values (Tables H-1 and H-2, Appendix H). A summary of these values is provided in Table 2.

Table 2: Water Balance Component Values

Water Balance Component	Golf Course/Open Space	Woodlot
Average Precipitation	853 mm/year	853 mm/year
Actual Evapotranspiration	599 mm/year	607 mm/year
Water Surplus	254 mm/year	246 mm/year
Infiltration	114 mm/year	135 mm/year
Runoff	140 mm/year	111 mm/year

3.4 Pre-Development Water Balance (Existing Conditions)

The pre-development water balance calculations for the portions of the Subject Property within the East Draft Plan and West Draft Plan areas are presented in Tables H-4 (East Draft Plan), H-5a (West Draft Plan – Berczy Creek Catchment area) and H-5b (West Draft Plan – Bruce Creek Catchment area) in Appendix H. As summarized on Tables H-4, H-5a and H-5b, the total areas of the Subject Property that are proposed for development within the East Draft Plan area, West Draft Plan Berczy Creek area and West Draft Plan Bruce Creek area are about 76.17 ha, 38.07 ha and 54.58 ha, respectively. Land use is predominantly the golf course or open space land and wooded lands. The total areas for these two land cover types have been estimated and assigned appropriate water balance component values for either short-rooted vegetation for the golf course and open space (125 mm soil moisture storage) or longer-rooted vegetation for the wooded areas (400 mm soil moisture storage). The total calculated pre-development infiltration, runoff and evapotranspiration volumes are summarized in Table 3.

Table 3: Summary of Pre-Development Infiltration, Runoff and Evapotranspiration

Draft Plan	**Estimated Pre-Development Infiltration Volume (m^3/year)***	**Estimated Pre-Development Runoff Volume (m^3/year)**	**Estimated Pre-Development Evapotranspiration (m^3/year)**
East Draft Plan	81,400	137,500	423,800
West Draft Plan – Berczy Creek	42,500	58,400	222,700
West Draft Plan – Bruce Creek	59,400	95,100	306,600
Total	**183,300**	**291,000**	**953,100**

*It is acknowledged that infiltration rates are directly dependent upon the hydraulic conductivity of soils that may naturally vary over several orders of magnitude. Recognizing the wide margins of error associated with this analysis, the infiltration volumes presented in this report are considered simply as reasonable estimates for water balance comparisons and not firm values of actual infiltration.

3.5 Potential Urban Development Impacts to Water Balance

Development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (i.e., roads, parking lots, driveways, and rooftops). Impervious surfaces prevent infiltration of water into the soils and the removal of the vegetation removes the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (about 71% of precipitation in the study area). So the net effect of the construction of impervious surfaces is that most of the precipitation that falls onto impervious surfaces becomes surplus water and direct runoff. The natural infiltration components (interflow and deep recharge) are reduced.

Water balance calculations of the potential water surplus for impervious areas are shown at the bottom of Table H-1 in Appendix H. There is an evaporation component from impervious surfaces and this is typically estimated to be between about 10% and 20% of the total precipitation. For the purposes of the calculations in this study, the evaporation has been estimated to be 15% of precipitation. The remaining 85% of the precipitation that falls on impervious surfaces is assumed to become runoff. Therefore, assuming an evaporation/loss from impervious surfaces of 15% of the precipitation, there is a potential water surplus from impervious areas of 725 mm/year.

It is noted that the proposed development will be serviced by municipal water supply and waste water services. Therefore there will be no impact on the water balance and local groundwater or surface water quantity and quality conditions related to any on-site groundwater supply pumping or disposal of septic effluent. There are some existing groundwater supply wells within the Subject Property used for golf course irrigation (refer to Section 2.4.1). Further discussion on interim monitoring and decommissioning of any active water supply wells in the study area is provided in Sections 5.5 and 5.6.

3.6 Post-Development Water Balance With No Mitigation

In order to assess the potential development impact on infiltration, the post-development infiltration volumes have been calculated for the East Draft Plan and West Draft Plan areas on Tables H-4 (East Draft Plan), H-5a (West Draft Plan – Berczy Creek Catchment area) and H-5b (West Draft Plan – Bruce Creek Catchment area) in Appendix H. These calculations assume no mitigation is in place and allow for the quantification of an infiltration target for the design of a low impact development (LID) strategy for stormwater management. The total areas for the proposed land uses in each subcatchment area have been estimated by Stantec based on the proposed development concept and the infiltration and runoff components for the post-development land uses have been calculated using the MOECC SWM Planning and Design Manual (2003) methodology based on topography, soil type and land cover as shown on Tables H-1 and H-2 in Appendix H. The infiltration and runoff factors for the post-development calculations reflect the proposed grading across the Subject Property as shown on Table H-3. The total calculated post-development infiltration, runoff, and evapotranspiration volumes (without mitigation) are summarized in Table 4.

Table 4: Summary of Post-Development Infiltration, Runoff and Evapotranspiration (no LID measures)

Draft Plan	**Estimated Post-Development Infiltration Volume ($m^{3/}$year)**	**Estimated Post-Development Runoff Volume (m^3/year)**	**Estimated Post-Development Evapotranspiration (m^3/year)**
East Draft Plan	38,700	370,200	182,300
West Draft Plan – Berczy Creek	23,900	163,200	113,000
West Draft Plan – Bruce Creek	49,000	166,100	229,600
Total	**111,600**	**699,500**	**524,900**

Comparing the values in Tables 3 and 4, the water balance calculations show that development has the potential to reduce the natural infiltration by 52% (42,800 m^3/a) in the East Draft Plan area, 44% (18,500 m^3/a) in the West Draft Plan – Berczy Creek Catchment area and 18% (10,400 m^3/a) in the West Draft Plan – Bruce Creek Catchment area, with an overall site reduction of 39%. LID measures for stormwater management are recommended to try to make up the difference between the pre- and post-development infiltration conditions, i.e., the overall infiltration deficit volume of 71,700 m^3/year. As noted above, with the wide margins of error associated with this type of analysis, the infiltration deficit volume is considered as a reasonable estimate that is suitable as a target or guide for LID strategy design.

Comparisons of the pre-development and post-development runoff volumes show that there is an increase in runoff within the catchment areas by 170% in the East Draft Plan area, 180% in the West Draft Plan – Berczy Creek Catchment area and 80% in the West Draft Plan – Bruce Creek Catchment area, with an overall site increase of 140%. Further discussion of the stormwater management strategies to address the surface water runoff are provided in the FSR (Stantec, 2016).

As discussed in Section 2.2, the East Draft Plan area and the eastern portion of the West Draft Plan area are within the Bruce Creek catchment. Comparing the pre-development infiltration and runoff to the post-development infiltration and runoff within the Bruce Creek Catchment area, the water balance calculations show that development has the potential to reduce the natural infiltration by 38% (53,100 m^3/a) and increase the runoff by approximately 130% (303,700 m^3/a).

Comparisons of the pre-development and post-development evapotranspiration rates show that there is a significant decrease in evapotranspiration within the East and West Draft Plan areas as is typical of urban development due to the increase of impervious areas. Measures to promote and enhance vegetation in the urbanized areas can be used to improve the post-development evapotranspiration. On the Subject Property, it is intended that rates of evapotranspiration will improve as a result of enhanced plantings in Area E and within the Bruce Creek valley; specifically, in vicinity of the existing ponds as the majority are proposed to be filled in. Further discussion of the enhanced planting areas is provided in the Natural Environment Report (Beacon, 2016).

3.7 Water Balance Mitigation Strategies

The basic premise for low impact development is to try to manage stormwater to minimize the runoff of rainfall and increase the potential for infiltration. As outlined in the MOECC SWMP Design Manual (2003) and Low Impact Development Stormwater Management Planning and Design Guide published by the CVC and TRCA (2010), there are a wide variety of mitigation techniques that can be used to try to reduce the increases in direct runoff that occur with land development and increase the potential for post-development infiltration.

Techniques to maximize the water availability in pervious areas such as designing grades to direct roof runoff towards lawns, side and rear yard swales, and other pervious areas throughout the development where possible can considerably increase the volume of infiltration in developed areas. These types of surface LID techniques promote natural infiltration simply by providing additional water volumes in the pervious areas (i.e., these areas would receive precipitation as well as extra water from roof runoff). Increasing the topsoil thickness by about two times the normal thickness is also considered as beneficial to enhance storage of water in the topsoil and increase the potential for infiltration. This may be particularly effective in the summer months, when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit.

Other mitigation techniques that can be considered to mitigate increases in runoff and reductions in infiltration include such measures as: permeable pavements, rain gardens, bioswales, subsurface infiltration trenches, galleries and pervious pipe systems. Subsurface methods should only be considered in areas where there is sufficient depth to water table to accommodate the systems within the unsaturated zone and sufficient soil hydraulic conductivity to function effectively. The MOECC manual recommends that subsurface galleries or trenches should be about 1 m above the high water table.

The water balance calculations suggest that, without mitigation, the developed area will receive about 61% of the current amount of average annual groundwater infiltration. To minimize the potential development impacts to infiltration, the FSR (Stantec, 2016) proposes the incorporation of amended soils, downspout disconnection, bioretention and infiltration facilities into the development plan.

East Draft Plan Area

Amended soils are proposed for select areas within the East Draft Plan area using infiltration rates shown in Table H-6 in Appendix H. The amended soils will aid in the infiltration of runoff from roof downspout disconnection to rear yard lawns. A volumetric runoff reduction of 25% was applied as the surficial soils across the site are generally characterized as hydrologic soil groups (HSG) C and D. The estimated volume of precipitation that will be infiltrated across the East Draft Plan area as a result of downspout disconnection from 34,400 m^2 of roof area is approximately 6,200 m^3/a (~14% of target) (refer to Table H-7).

Stantec also proposes to direct precipitation from 40,000 m^2 of roof area within the East Draft Plan to perforated roof leader collector pipes (RLC), bioretention or infiltration facilities designed to infiltrate a 25 mm storm event. The Buttonville Airport precipitation data was used to correlate storm events to annual precipitation volumes in Table H-7 in Appendix H. The 25 mm storm event accounts for approximately 93% of precipitation. The annual precipitation data from the Buttonville climate station of 853 mm has been used for these calculations. Assuming 15% of the precipitation is loss to evaporation, the rate of precipitation directed to the infiltration trenches is calculated to be 725 mm/year. Using a total impervious area of 40,000 m^2 from which roof runoff will be directed to RLC, a bioretention enclave or infiltration facilities, the total annual volume of runoff directed to these facilities was then calculated. The calculations in Table H-7 (Appendix H) show that, assuming 93% of the precipitation (i.e., the 25 mm storm) is infiltrated in the bioretention and infiltration facilities, approximately 63% of the target can be met (~27,000 m^3/a).

The calculations suggest that natural infiltration that occurs on pervious surfaces, along with the mitigative measures proposed to address the groundwater infiltration deficit, do not meet the pre-development infiltration volume for the East Draft Plan area leaving a deficit of approximately 9,200 m^3/a (~11% of pre-development infiltration volumes). It is noted that due to the high water table and the amount of cut proposed in the west-central portion of the East Draft Plan area, infiltration trenches are not proposed as they could intersect the water table. In addition, Stantec has advised that approximately 3,700 m^3/a of precipitation collected from roof tops will be directed to the West Draft Plan area to replicate similar conditions observed in the mineral marsh meadow in enhancement Area E.

West Draft Plan Area

Similar to the East Draft Plan area, amended soils are proposed for select areas within the West Draft Plan area using infiltration rates shown in Table H-6 in Appendix H. The amended soils aid in the infiltration of runoff from roof downspout disconnection from 32,500 m^2 of roof area to rear yard lawns; 20,500 m^2 of roof area in the West Draft Plan Berczy Creek Catchment area infiltrating approximately 3,800 m^3/a (~21% of target) and 12,000 m^2 of roof area in the West Draft Plan Bruce Creek Catchment area infiltrating approximately 2,200 m^3/a (~21% of target).

Stantec also proposes to direct precipitation from 73,900 m^2 of roof area (34,600 m^2 from West Draft Plan Berczy Creek Catchment area and 39,300 m^2 from West Draft Plan Bruce Creek Catchment area) to the RLC, bioretention enclaves or infiltration facilities designed to infiltrate a 25 mm storm event. Using the same methodology described above for the East Draft Plan area, the calculations in Tables H-8a and H-8b (Appendix H) show that, assuming 93% of the precipitation (i.e., the 25 mm storm) is infiltrated in the RLC, bioretention and infiltration facilities, the targets will be exceeded by approximately 26% in the West Draft Plan Berczy Catchment area (~23,300 m^3/a) and by 154% in the West Draft Plan Bruce Creek Catchment area (~26,500 m^3/a). Together, this results in an overall increase of 72% over target for the overall West Draft Plan area.

Natural infiltration that occurs on pervious surfaces along with the proposed mitigative measures for the West Draft Plan exceed the pre-development infiltration volume by approximately 8,800 m^3/a (~21% increase in infiltration) for the West Draft Plan Berczy Creek Catchment area and approximately 20,200 m^3/a (~34% increase in infiltration) for the West Draft Plan Bruce Creek Catchment area, with a total increase of approximately

29,000 m^3/a (~28% increase in infiltration) to the West Draft Plan area. The overall site-wide water balance for 4134 16th Avenue, incorporating low impact development techniques into the proposed development, will infiltrate 111% of the pre-development infiltration volume, amounting to an increase of ~19,800 m^3/a.

Comparing the pre-development infiltration of the Bruce Creek Catchment area to the post-development infiltration, the water balance calculations show that development with the proposed comprehensive LID strategy has the potential to increase infiltration by approximately 8% (11,000 m^3/a).

4.0 Woodlot/Wetland Feature Based Water Balance

The Feature 1 woodlot/wetland is located within the East Draft Plan area (Figure 2) and is approximately 43,200 m^2 in size (including buffer area); 32,100 m^2 of woodlot and 11,100 m^2 of wetland. There is an external catchment area of approximately 29,700 m^2 that also drains to the feature (refer to Stantec Figure 2.14 in Appendix H). Monitoring well BH16-4 and piezometer nest PZ5s/d are located within the wetland portion of the feature and have been monitored since March 2016. Piezometer nest PZ8s/d is located within the woodlot portion of the feature and has been monitored since June 2016. As discussed in Section 2.4.2 and 2.4.4, groundwater levels measured in BH16-4, PZ5s/d and PZ8s/d have been below ground surface throughout the duration of the monitoring period, indicating groundwater does not discharge to these features and that the woodlot/wetland feature is fed by precipitation and surface water runoff.

Dataloggers have been installed in both piezometers at PZ5s/d and PZ8s/d, at staff gauges SG4 and SG8 to measure surface water elevations and at SG C-1 to monitor surface water flows leaving the woodlot/wetland feature to confirm the groundwater/surface water interactions in this feature (refer to Figure 4).

A detailed water balance analysis has been completed for this feature to determine the pre-development runoff volumes (based on existing land use conditions) and the post-development runoff volumes that would be expected based on the proposed land use plan. The water balance calculations are provided in Appendix H and discussed below.

4.1 Pre-Development Water Balance (Existing Conditions)

The pre-development water balance calculations for the woodlot/wetland feature and external drainage area is presented in Table H-9 in Appendix H. Similar to the site-wide water balance methodology discussed in Section 3, a soil moisture storage capacity of 125 mm was used for the predominantly short to moderate-rooted wetland area and a soil moisture storage capacity of 400 mm was used for longer-rooted vegetation, i.e., the wooded areas (refer to Table H-1 (for 125 mm retention) and Table H-2 (for 400 mm retention) in Appendix H). In summary from these appendix tables, the total calculated pre-development runoff volumes are summarized in Table 5.

Table 5: Summary of Pre-Development Runoff to Woodlot/Wetland Feature

Land Use Area	**Estimated Pre-Development Runoff Volume (m^3/year)**	**Estimated Pre-Development Evapotranspiration (m^3/year)**
Wetland	1,550	6,650
Woodlot	3,550	19,500
External Drainage Area	4,150	17,800
Total	**9,250**	**43,950**

4.2 Post-Development Water Balance and Mitigation Strategies

The development of the East Draft Plan area proposes to build houses and roads within the external drainage area to the feature, essentially eliminating surface water contributions from the upland area and creating a runoff deficit of approximately 4,150 m^3/a (~45% of pre-development runoff). The wetland and woodlot areas will remain the same in post-development.

The FSR (Stantec, 2016) proposes the incorporation of amended soils and downspout disconnection into the development plan to maintain the surface water runoff contribution to the woodlot/wetland feature. Similar to the methods discussed above in Section 3.7, amended soils are proposed for the rear yards backing onto the woodlot/wetland feature using the runoff rates shown in Table H-6 in Appendix H. The amended soils will also aid in the infiltration of runoff from roof downspout disconnection to rear yard lawns. The volume of precipitation that will runoff and be directed as sheet flow to the woodlot/wetland feature as a result of runoff from rear yard lawns and downspout disconnection from approximately 6,900 m^2 of roof area is approximately 4,100 m^3/a (~99% of target). In summary from the appendix tables, the total calculated pre-development runoff volumes are summarized in Table 6.

Table 6: Summary of Post-Development Runoff and Evapotranspiration to Woodlot/Wetland Feature With Mitigation

Land Use Area		**Estimated Post-Development Runoff Volume (m^3/year)**	**Estimated Post-Development Evapotranspiration (m^3/year)**
Wetland		1,550	6,650
Woodlot		3,550	19,500
External Drainage Area	Natural Runoff from Rear Yard Lawns	300	1,600
	Roof Downspout Disconnection	4,100	0
Total		**9,200**	**27,800**

5.0 Construction Considerations

5.1 Water Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, bacteria and viruses. Generally, with the exception of the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater transport through the soils. As such, the potential for effects on groundwater quality from infiltration in the urban areas is therefore expected to be limited. Any potential changes to the shallow groundwater quality are not expected to influence conditions in the surface water features given the limited discharge volumes. The deeper aquifer zones in the study area are well protected by thick layers of low hydraulic conductivity sediments and upward gradients and no effect on the groundwater quality in these aquifers is expected from the proposed development.

5.2 Construction Below Water Table

The construction of buried services below the water table has the potential to capture and redirect groundwater flow through more permeable fill materials typically placed in the base of excavated trenches. Over the long-term, these impacts can lower the local groundwater table. To mitigate this effect, services to be installed below the water table should be constructed to prevent redirection of groundwater flow. This will involve the use of anti-seepage collars or clay plugs surrounding the pipes to provide barriers to flow and prevent groundwater flow along granular bedding material and erosion of the backfill materials.

5.3 Dewatering/Depressurization Requirements

The water table can be seasonally close to the existing ground surface in some areas, particularly along the watercourse valleys and in the west-central portion of the East Draft Plan area. Much of the upland area will be above the water table, however, subsurface excavations may encounter wet soil conditions, particularly in the spring and fall. The construction dewatering requirements may vary significantly depending on the local soils, the climate conditions, the construction season and the depth and size of the excavations. Over most of proposed development area, the surficial soils encountered during servicing will predominantly be relatively low hydraulic conductivity silt, clay and till sediments that would not be expected to produce much water. Minor seepage into excavations within the silty clayey soils can likely be handled, as required, by pumping from sumps within the trench excavations.

There are areas where coarser-grained sand or gravel layers and/or heavily weathered and fractured till deposits may be encountered that may produce more significant volumes of groundwater flow. The shallow sand layers encountered across the Subject Property appear to be relatively discontinuous (refer to Section 5.3.2) and may not sustain significant flow of groundwater; however, for excavations and servicing, such areas may require more active dewatering or groundwater control systems involving networks of well points or groundwater control wells.

Regional artesian conditions are evident in the western portion of the Subject Property, that are interpreted to be related to the presence of the Thorncliffe Aquifer (refer to Section 2.4.4). It is not anticipated that the regional aquifer will be directly encountered during servicing of the Subject Property; however, deeper excavations may require depressurization for construction.

Dewatering and/or depressurization requirements and anticipated water flow volumes will be confirmed by geotechnical and hydrogeological investigations completed in support of detailed servicing design. The studies will build on the current knowledge of the existing hydrogeological conditions (i.e., areas where saturated sand and gravel layers are present) and determine the most effective method to control groundwater during construction. A groundwater management plan and sediment control system will be established such that the dewatering discharge water is returned to the local environment in a clear (non-turbid) condition.

Recently the MOECC has introduced new regulations that allow for construction related dewatering to proceed under the Environmental Activity Sector Registry (EASR) process if dewatering volumes are below 400,000 L/d. Based on our knowledge of the regulations, the dewatering will either be allowed by a Category 3 Permit to Take Water (PTTW) or under the EASR process depending on the expected volume of water taking. Both the EASR process and the Category 3 PTTW application allow for the uncertainties of the construction process in relation to the duration of the dewatering period. The determination of which process should be followed (PTTW or EASR) is based on the expected volume of taking during dewatering; takings between 50,000 L/d and 400,000 L/d are required to register for the EASR while takings above 400,000 L/d are regulated by the PTTW process.

5.4 Well Decommissioning

Prior to or during construction, it is necessary to ensure that all inactive wells within the development footprint have been located and properly decommissioned by a licensed water well contractor according to Ontario Regulation 903. This regulation applies to the active and inactive irrigation supply wells for the golf course and the groundwater monitoring wells installed for this study unless they are maintained throughout the construction for monitoring purposes.

6.0 Monitoring

Groundwater and surface water monitoring at all monitoring wells, drive point piezometers, staff gauges and surface water stations will be completed on a monthly basis for a period of one year to establish seasonal fluctuations, confirm stable water elevations and assess the water table response to precipitation. Following one year of monthly monitoring, the monitoring frequency will change to quarterly for a period of one to two years, depending on the type and sensitivity of the features (wetlands, woodlots, etc.) in accordance with the ToR. Automatic water level recorders (dataloggers) were installed in six of the on-site monitoring wells (BH16-5, BH16-7, BH16-12d, BH16-13d, BH16-15d and BH16-16) and in eight of the piezometers (PZ4s/d, PZ5s/d, PZ8s/d and PZ9s/d) in order to record continuous water level fluctuations. Dataloggers were also installed at staff gauges SG4, SG5, SG8 and SG9 as well as at culverts SG C-1 and SG C-2.

Monitoring of the groundwater elevation and surface water flow conditions will continue during and post-construction activities following the LID implementation. New monitoring wells may be installed where necessary to replace existing monitoring wells that may be decommissioned to accommodate construction activities. The proposed monitoring locations and frequency will be determined based on the final LID strategy design.

7.0 Bibliography and References

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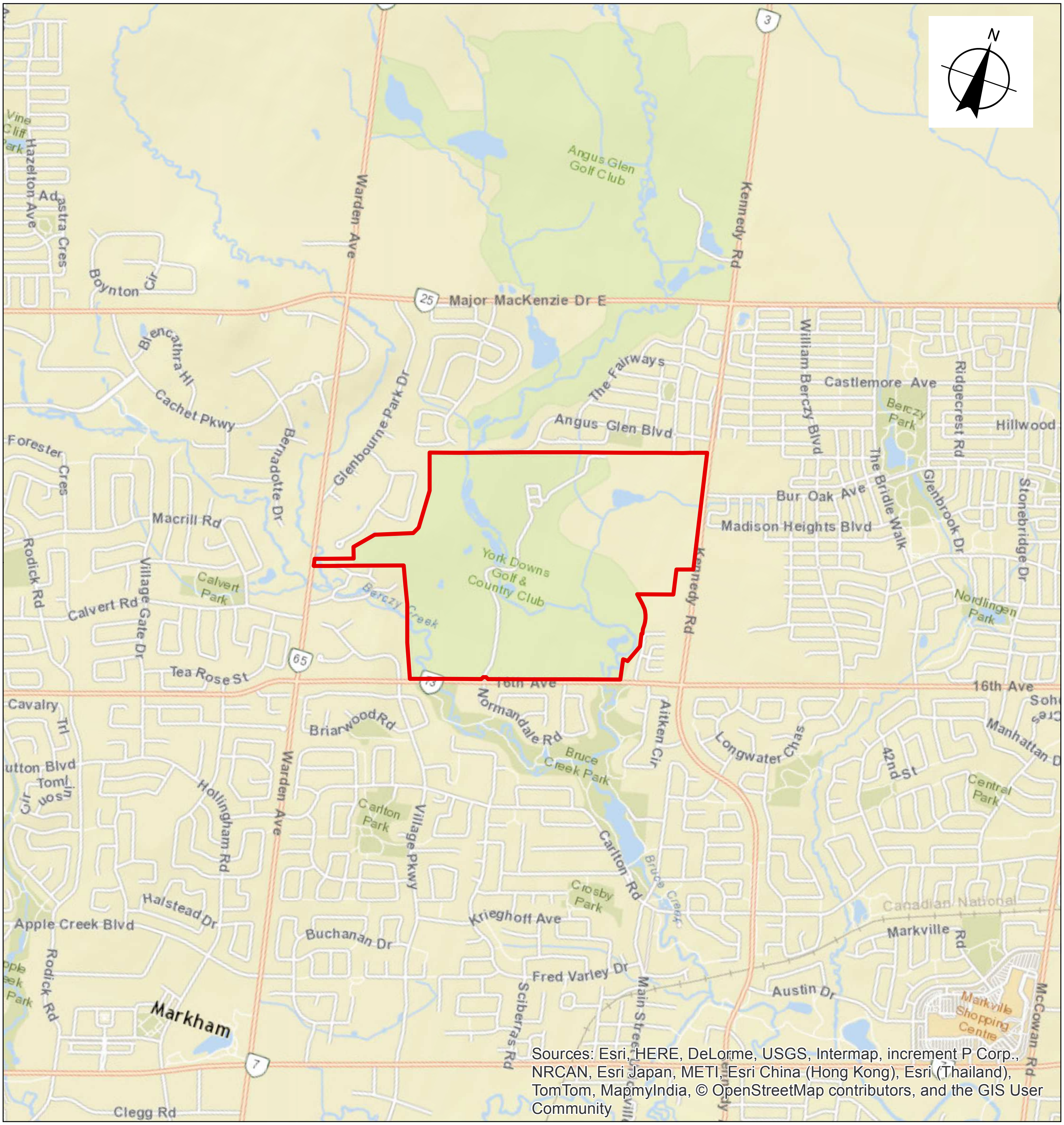
Figures



Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Stantec

BEACON ENVIRONMENTAL

BURNSIDE

0 500 1,000 1,500

Metres

LEGEND

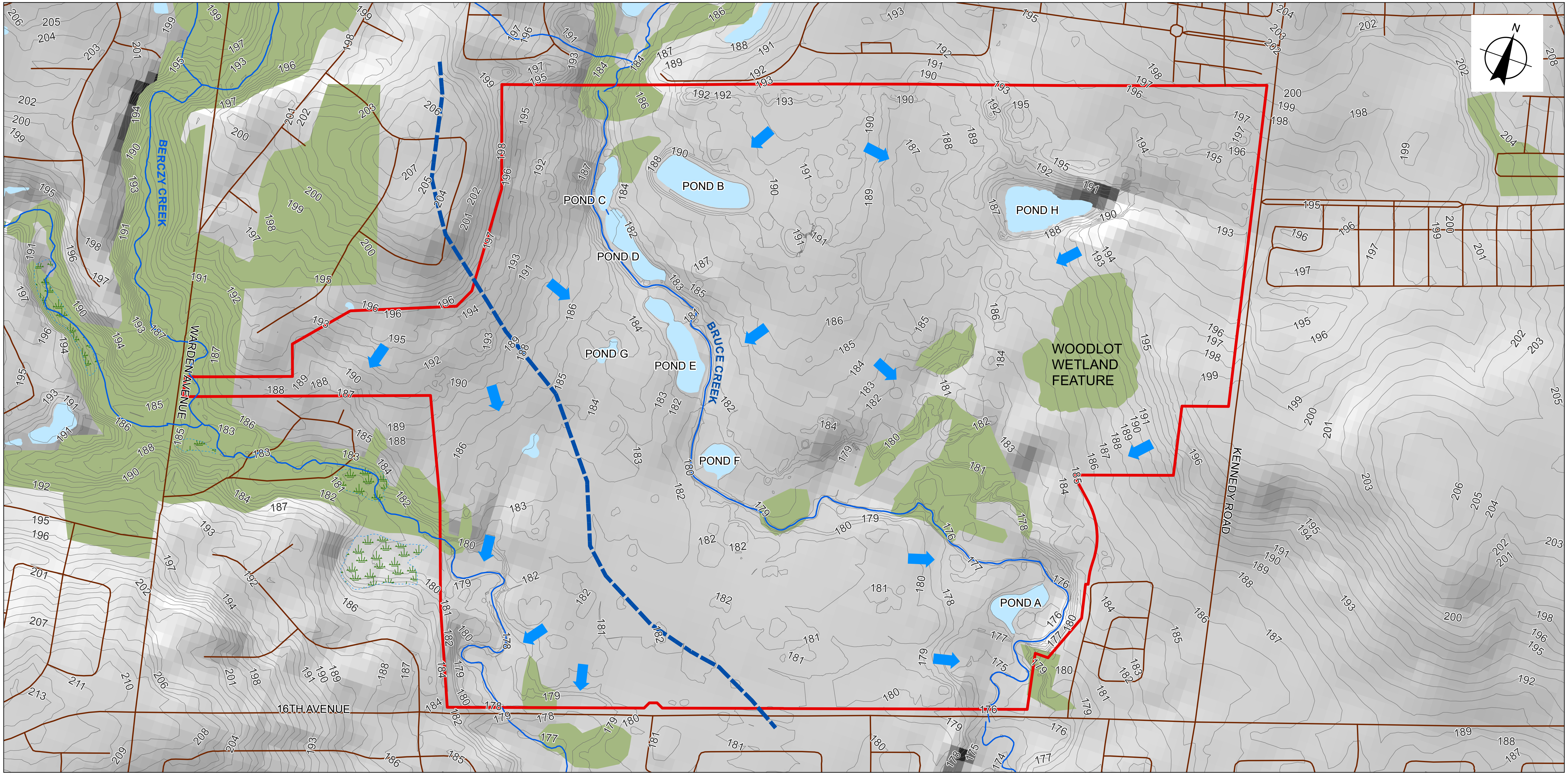
🟥 SUBJECT LANDS

HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE
4134 16TH AVENUE

FIGURE 1

SITE LOCATION

SEPTEMBER 2016



Stantec
BEACON ENVIRONMENTAL
BURNSIDE

0 100 200 300 400 500 600
Metres

LEGEND

🟥	SUBJECT LANDS
—	WATERCOURSE
—	ROADWAY
🟩	WOODED
—	CONTOUR (1m intervals - masl)
🟦	OPEN WATER
▨	WETLAND
- - -	DRAINAGE DIVIDE
➡	SURFACE WATER FLOW DIRECTION

HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 2

TOPOGRAPHY AND DRAINAGE

SEPTEMBER 2016

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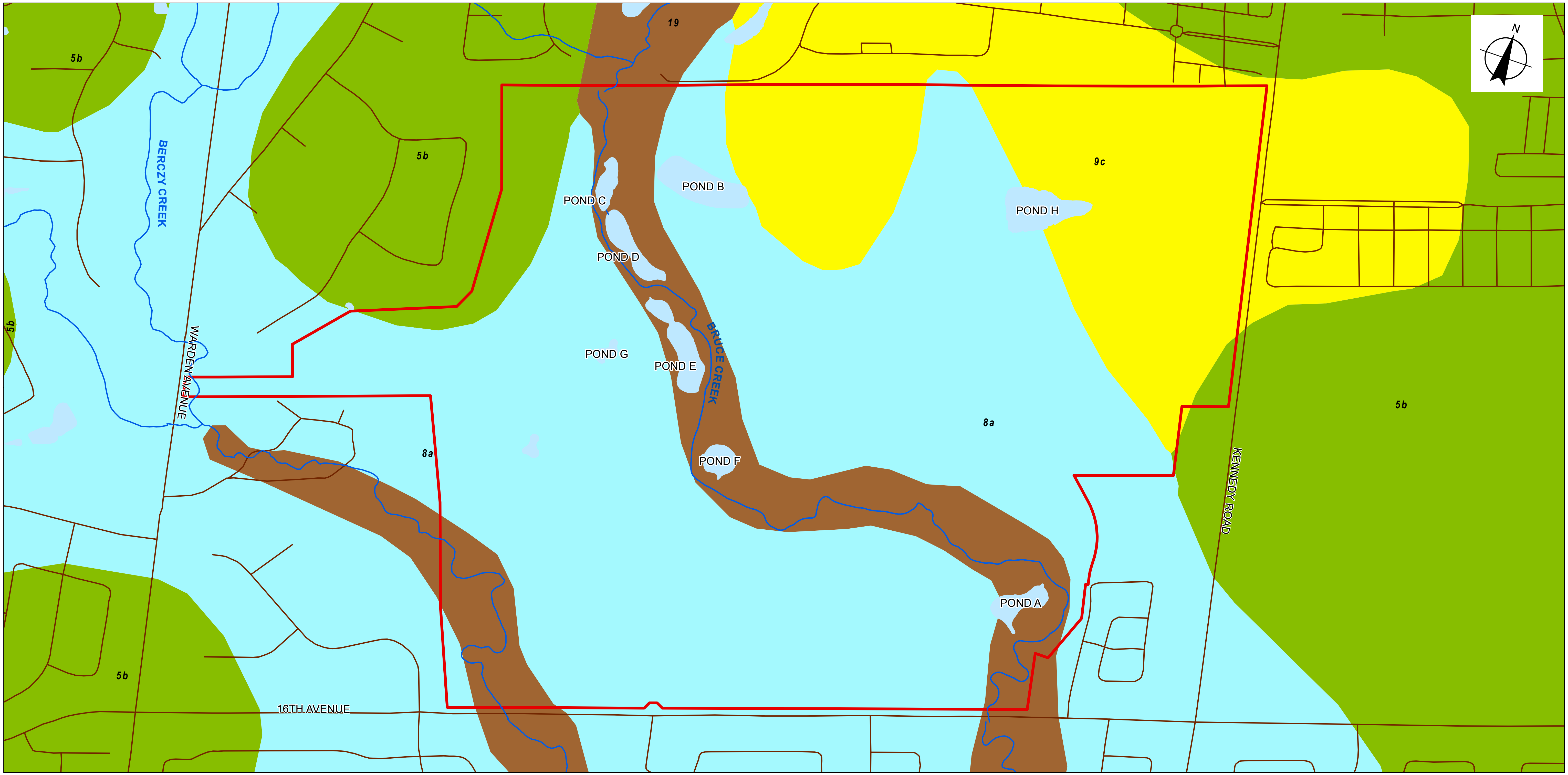

Stantec
BEACON ENVIRONMENTAL
BURNSIDE

0 100 200 300 400 500 600
Metres

LEGEND

🟥 SUBJECT LANDS
― WATERCOURSE
― ROADWAY
🟦 OPEN WATER
🟩 5b: Stone-poor, carbonate-derived silty to sandy till
🟦 8a: Fine-textured glaciolacustrine deposits: Massive-well laminated
🟨 9c: Coarse-textured glaciolacustrine deposits: Foreshore-basinal deposits
🟫 19: Modern alluvial deposits

HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 3

SURFICIAL GEOLOGY

SEPTEMBER 2016

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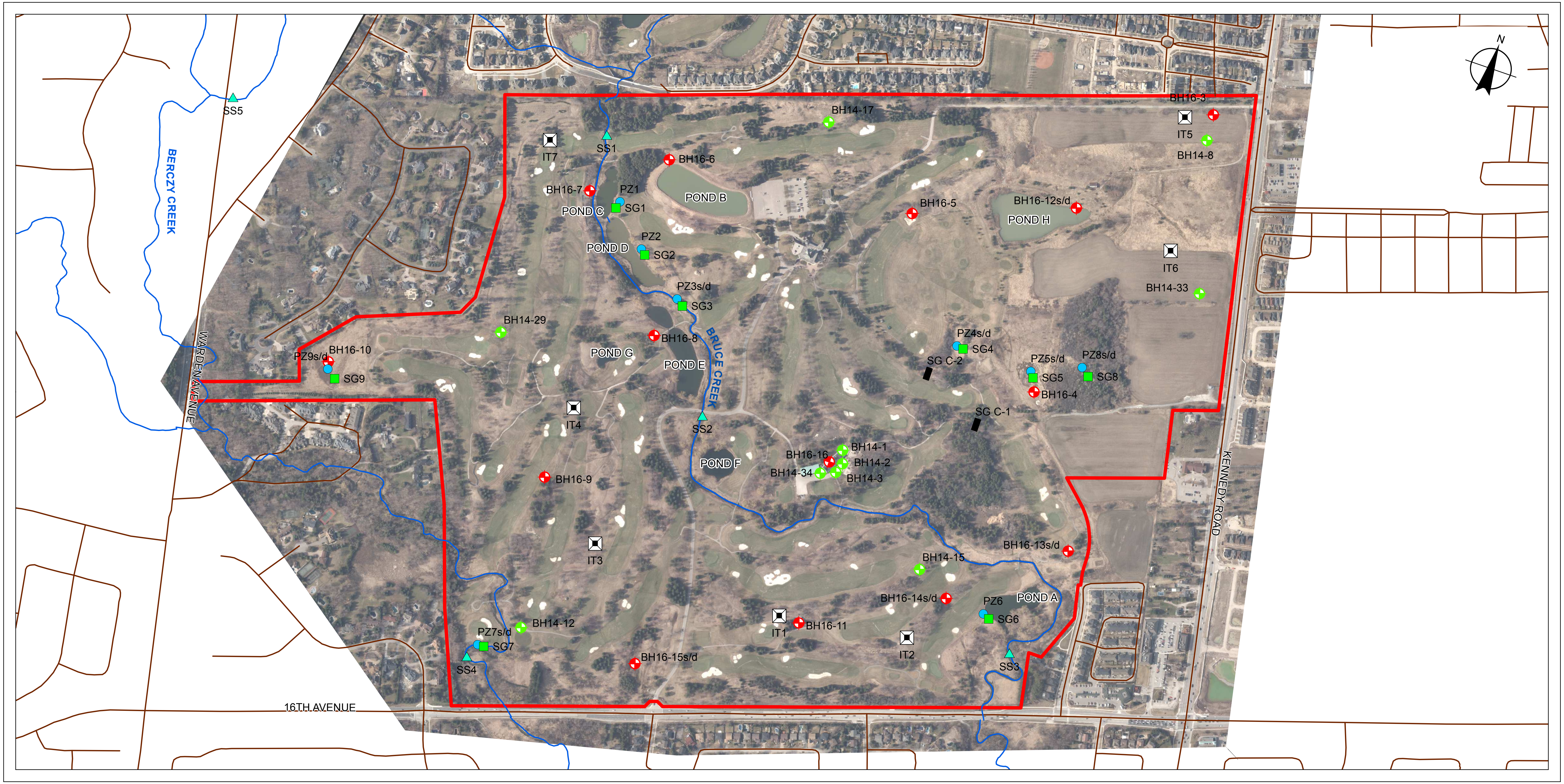

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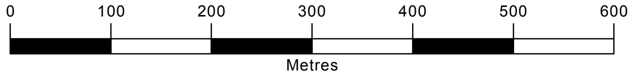

LEGEND

🟥 SUBJECT LANDS

● MONITORING WELL (GOLDER 2014)

● MONITORING WELL (GOLDER 2016)

— WATERCOURSE

● DRIVE POINT PIEZOMETER

🟩 STAFF GAUGE

▮ CULVERT

▲ SURFACE WATER MONITORING LOCATION

☒ INFILTRATION TEST LOCATION

HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 4

MONITORING LOCATIONS

SEPTEMBER 2016

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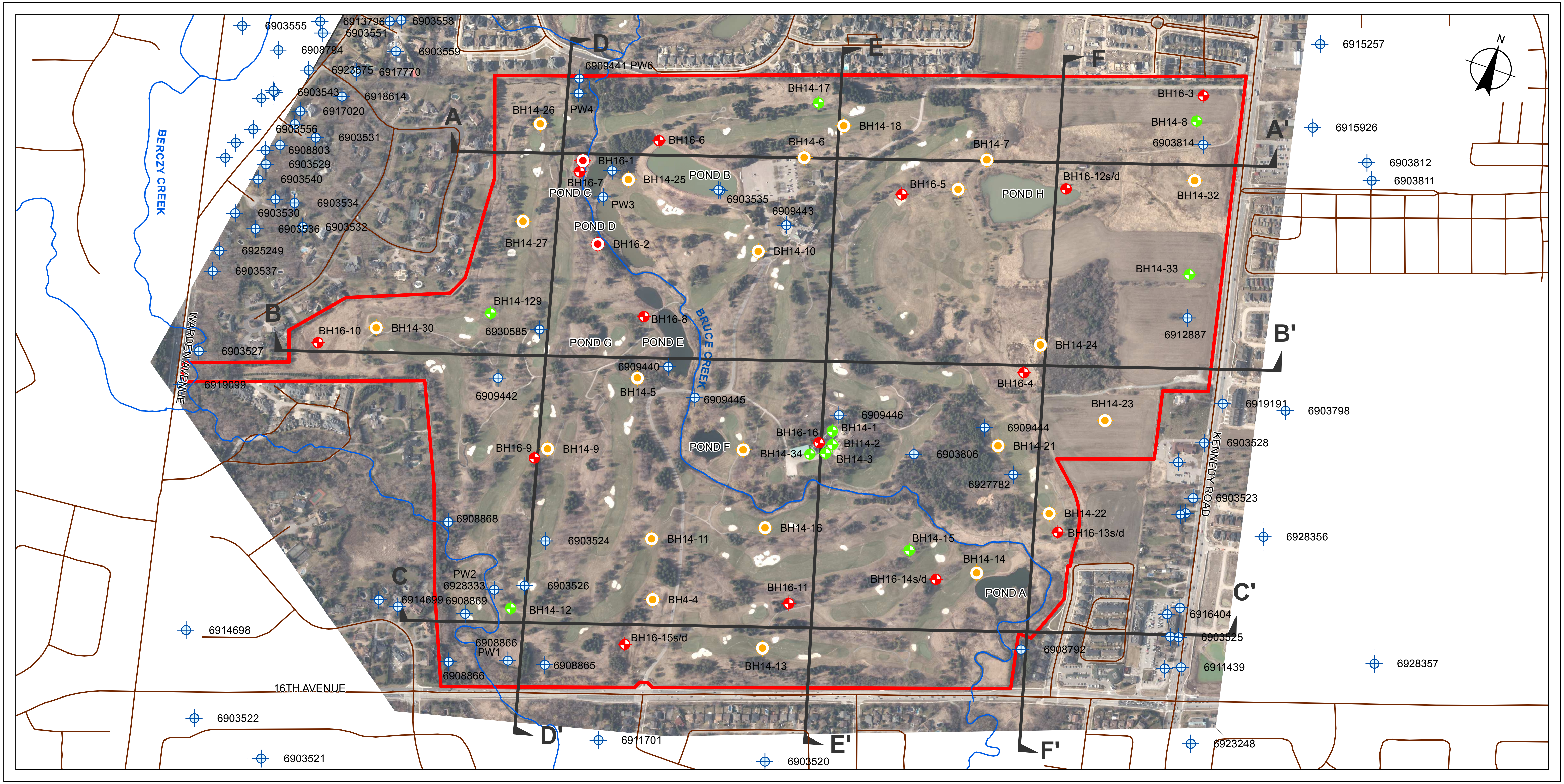

Stantec

BEACON ENVIRONMENTAL

BURNSIDE

0 100 200 300 400 500 600

Metres

LEGEND

🟥 SUBJECT LANDS

● MONITORING WELL (GOLDER 2014)

● MONITORING WELL (GOLDER 2016)

● BOREHOLE (GOLDER 2016)

● BOREHOLE (GOLDER, 2014)

— WATERCOURSE

⌖ MOECC WELL RECORD LOCATION

⌞⌟ CROSS SECTION LOCATION KEY

HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 5

CROSS SECTION LOCATION KEY

SEPTEMBER 2016

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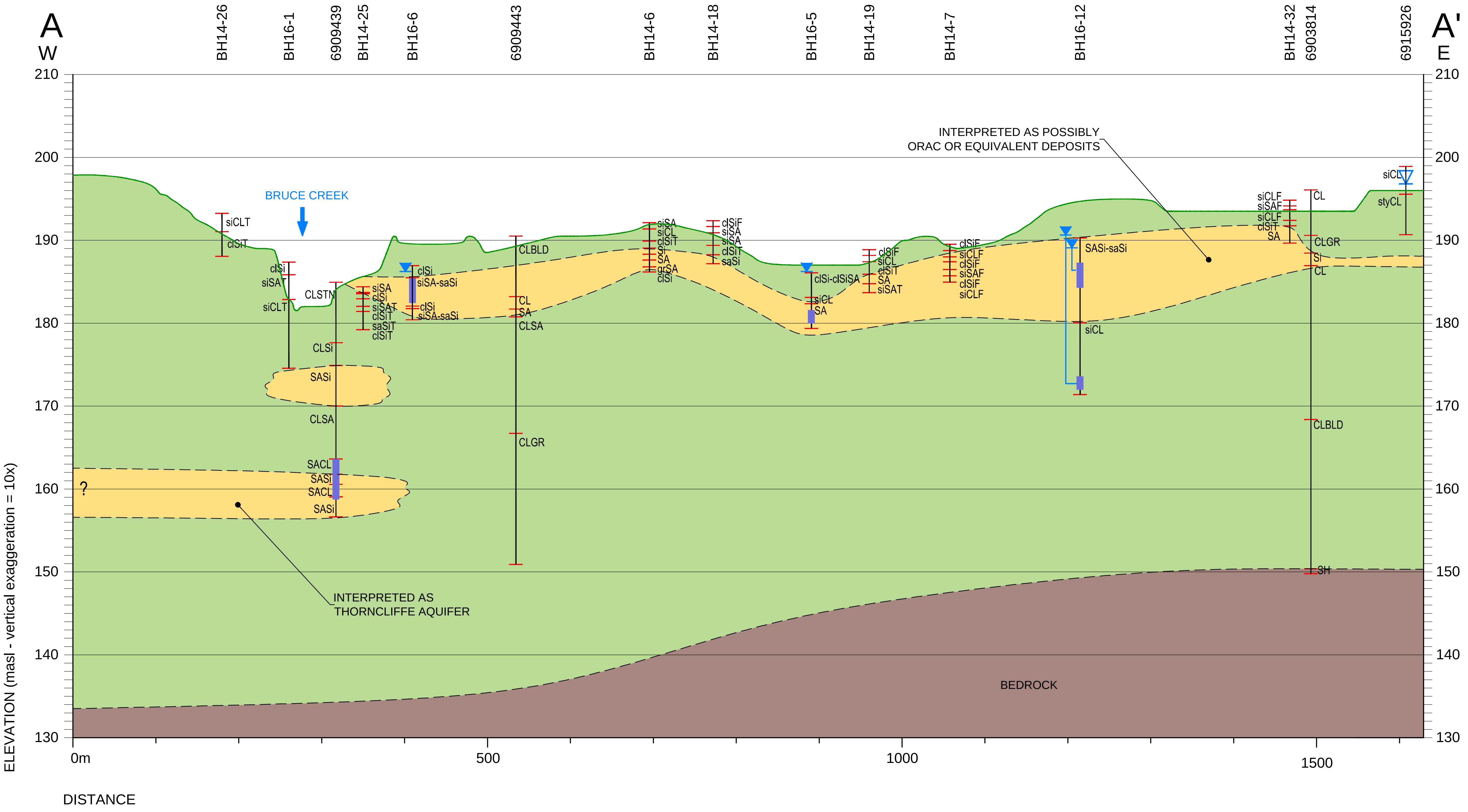

Stantec

BEACON
ENVIRONMENTAL

BURNSIDE

0 50 100 150 200 250
1:5000

Legend

MW9 WELL IDENTIFICATION

EXISTING GROUNDLINE

GEOLOGICAL STRATIGRAPHY CONTACT

▽ STATIC WATER LEVEL (MOECC WELL RECORD)

▼ MEASURED WATER LEVEL (APRIL 22, 2016)

▮ WELL SCREEN

🟩 CLAYEY SILT TILL

🟨 SANDY SILT

🟫 SHALE

- - - - - INTERPRETED GEOLOGICAL CONTACT

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil

CL	Clay
Si	Silt
SA	Sand
GR	Gravel
STN	Stones
BLD	Boulder
LMSN	Limestone

↓ WATERCOURSE CROSSING

HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 6

INTERPRETED GEOLOGICAL
CROSS SECTION A-A'

SEPTEMBER 2016

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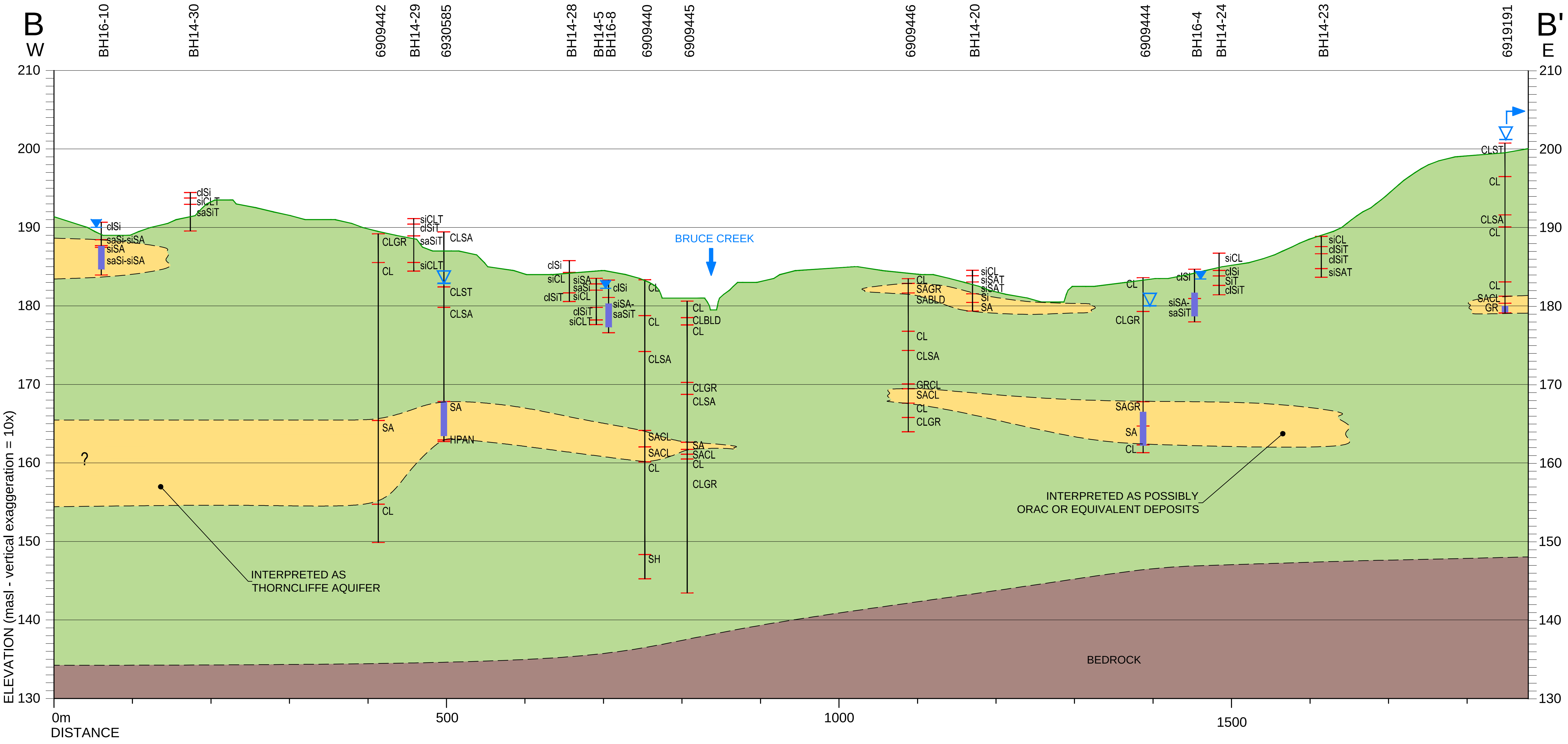


Stantec
BEACON
ENVIRONMENTAL
BURNSIDE

0 50 100 150 200 250
1:5000

Legend

MW9 WELL IDENTIFICATION
EXISTING GROUNDLINE
GEOLOGICAL STRATIGRAPHY CONTACT
▽ STATIC WATER LEVEL (MOECC WELL RECORD)
▼ MEASURED WATER LEVEL (APRIL 22, 2016)
WELL SCREEN

🟩 CLAYEY SILT TILL
🟨 SANDY SILT
🟫 SHALE
- - - - - INTERPRETED GEOLOGICAL CONTACT

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil

CL	Clay
Si	Silt
SA	Sand
GR	Gravel
STN	Stones
BLD	Boulder
LMSN	Limestone

WATERCOURSE CROSSING

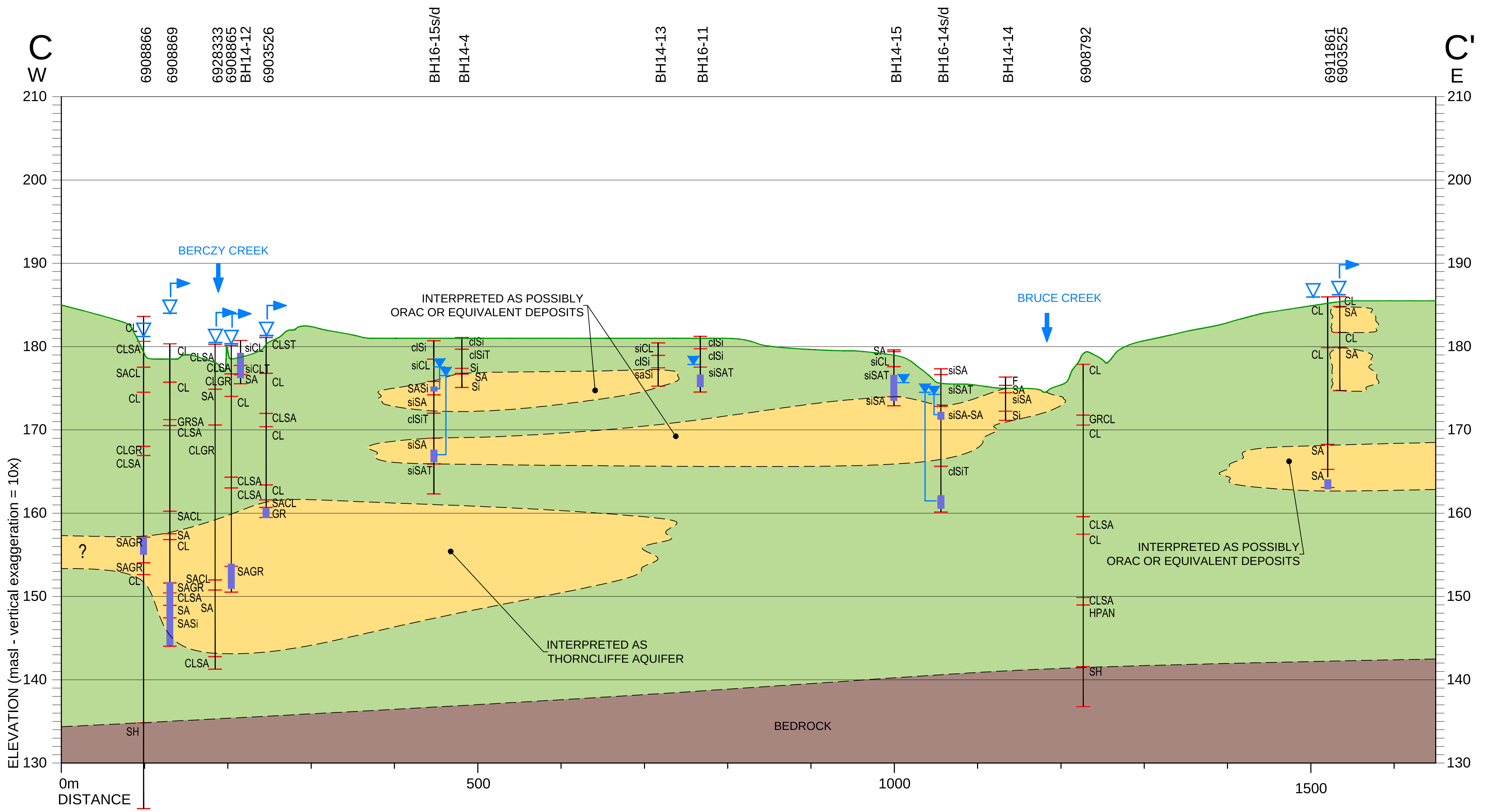
HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 7

INTERPRETED GEOLOGICAL
CROSS SECTION B-B'

SEPTEMBER 2016

File: 032847 (YORK DOWNS) HG STUDY CROSS SECTIONS.dwg



Legend

MW9 WELL IDENTIFICATION

EXISTING GROUNDLINE

GEOLOGICAL STRATIGRAPHY CONTACT

▽ STATIC WATER LEVEL (MOECC WELL RECORD)

▼ MEASURED WATER LEVEL (APRIL 22, 2016)

▮ WELL SCREEN

🟩 CLAYEY SILT TILL

🟨 SANDY SILT

🟫 SHALE

- - - - - INTERPRETED GEOLOGICAL CONTACT

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil

CL	Clay
Si	Silt
SA	Sand
GR	Gravel
STN	Stones
BLD	Boulder
LMSN	Limestone

⬇ WATERCOURSE CROSSING

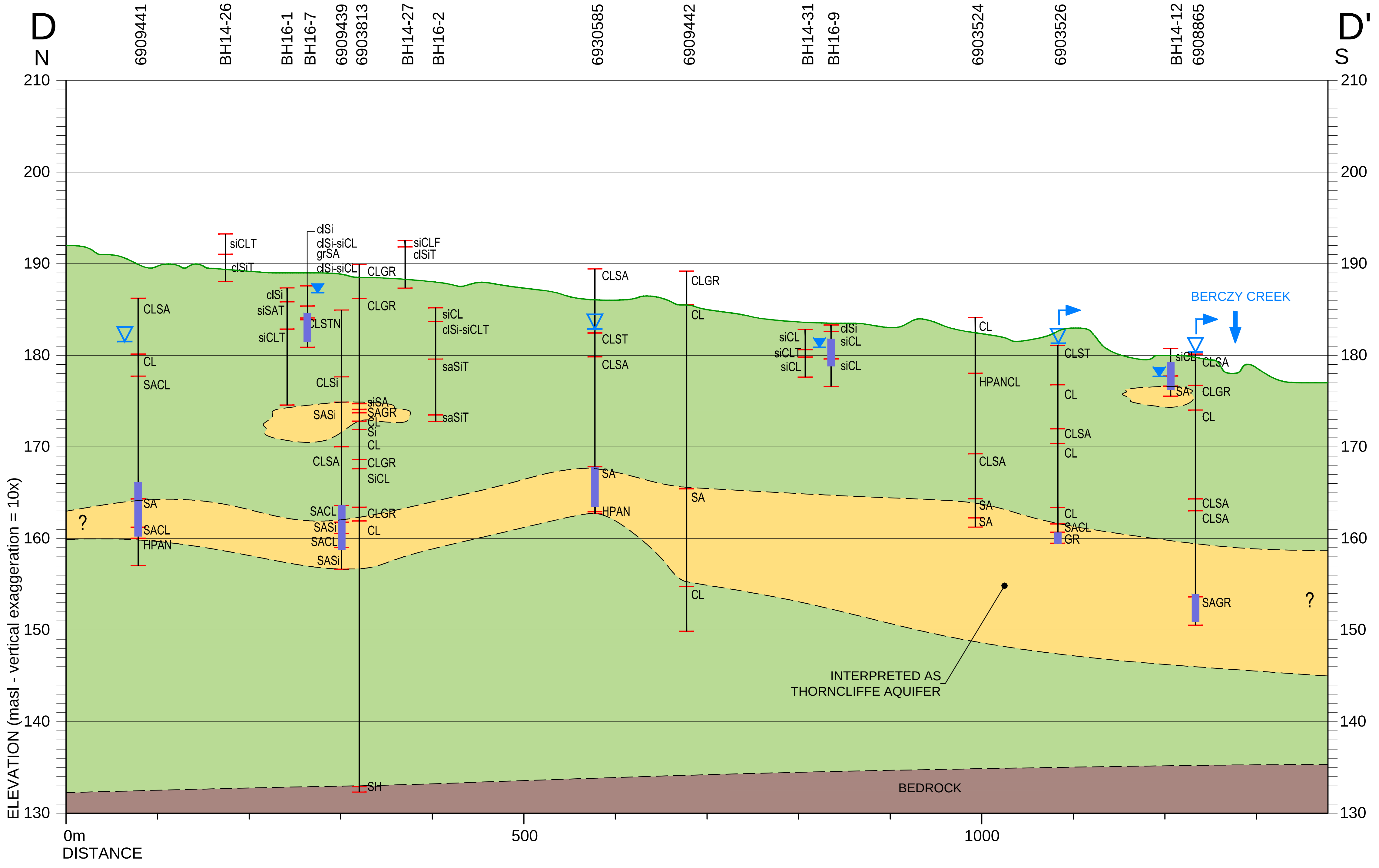
HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 8

INTERPRETED GEOLOGICAL CROSS SECTION C-C'

SEPTEMBER 2016

File: 032847 (YORK DOWNS) HG STUDY CROSS SECTIONS.dwg



0 50 100 150 200 250
1:5000

Legend

MW9 WELL IDENTIFICATION

EXISTING GROUNDLINE

GEOLOGICAL STRATIGRAPHY CONTACT

▽ STATIC WATER LEVEL (MOECC WELL RECORD)

▼ MEASURED WATER LEVEL (APRIL 22, 2016)

▮ WELL SCREEN

🟩 CLAYEY SILT TILL

🟨 SANDY SILT

🟫 SHALE

- - - - - INTERPRETED GEOLOGICAL CONTACT

↓ WATERCOURSE CROSSING

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil

CL	Clay
Si	Silt
SA	Sand
GR	Gravel
STN	Stones
BLD	Boulder
LMSN	Limestone

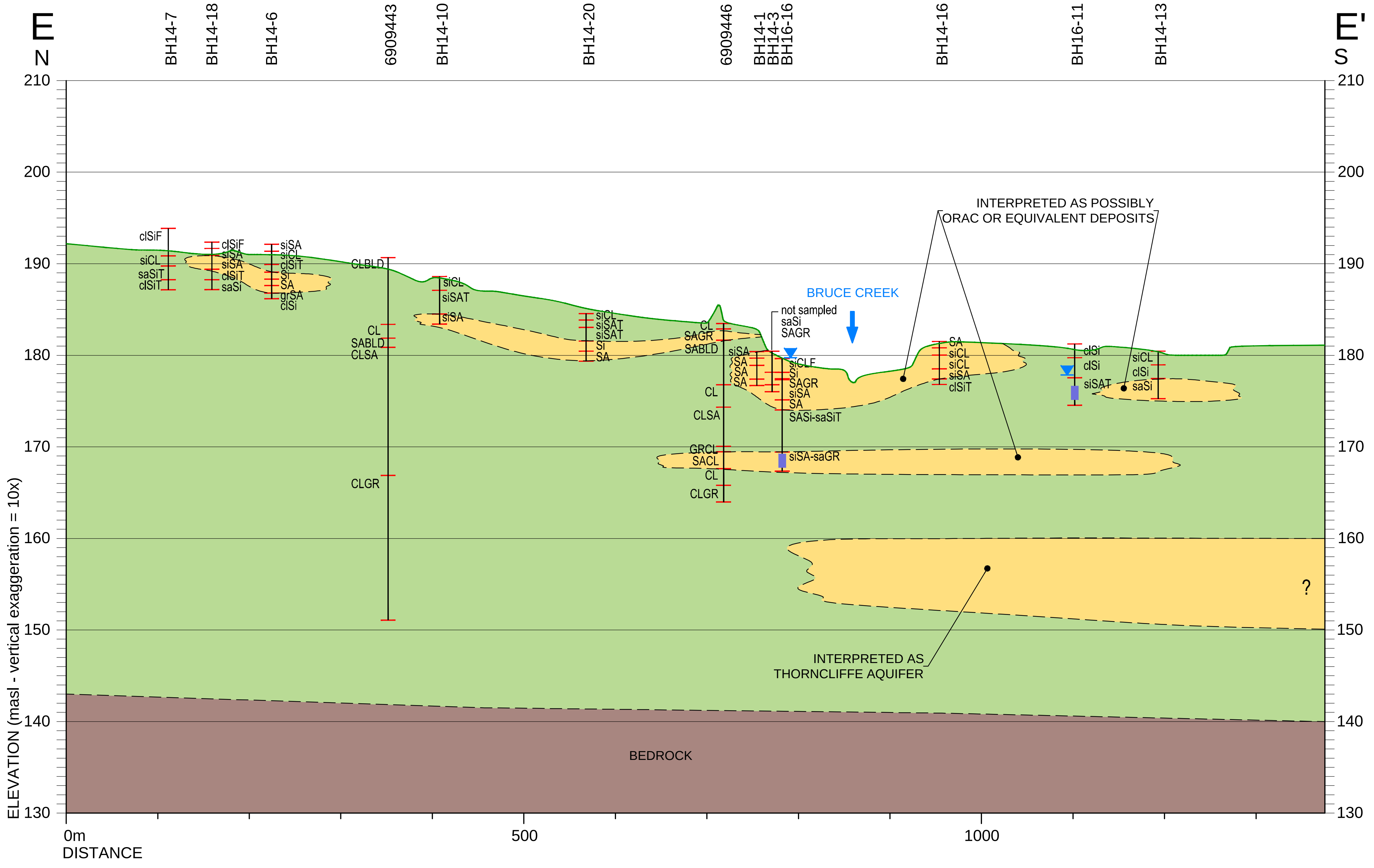
HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 9

INTERPRETED GEOLOGICAL
CROSS SECTION D-D'

SEPTEMBER 2016

File: 032847 (YORK DOWNS) HG STUDY CROSS SECTIONS.dwg



Stantec
BEACON ENVIRONMENTAL
BURNSIDE

1:5000
0 50 100 150 200 250

Legend

MW9 WELL IDENTIFICATION
EXISTING GROUNDLINE
GEOLOGICAL STRATIGRAPHY CONTACT
▽ STATIC WATER LEVEL (MOECC WELL RECORD)
▼ MEASURED WATER LEVEL (APRIL 22, 2016)
▮ WELL SCREEN

🟩 CLAYEY SILT TILL
🟨 SANDY SILT
🟫 SHALE
- - - - - INTERPRETED GEOLOGICAL CONTACT

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil

CL	Clay
Si	Silt
SA	Sand
GR	Gravel
STN	Stones
BLD	Boulder
LMSN	Limestone

↓ WATERCOURSE CROSSING

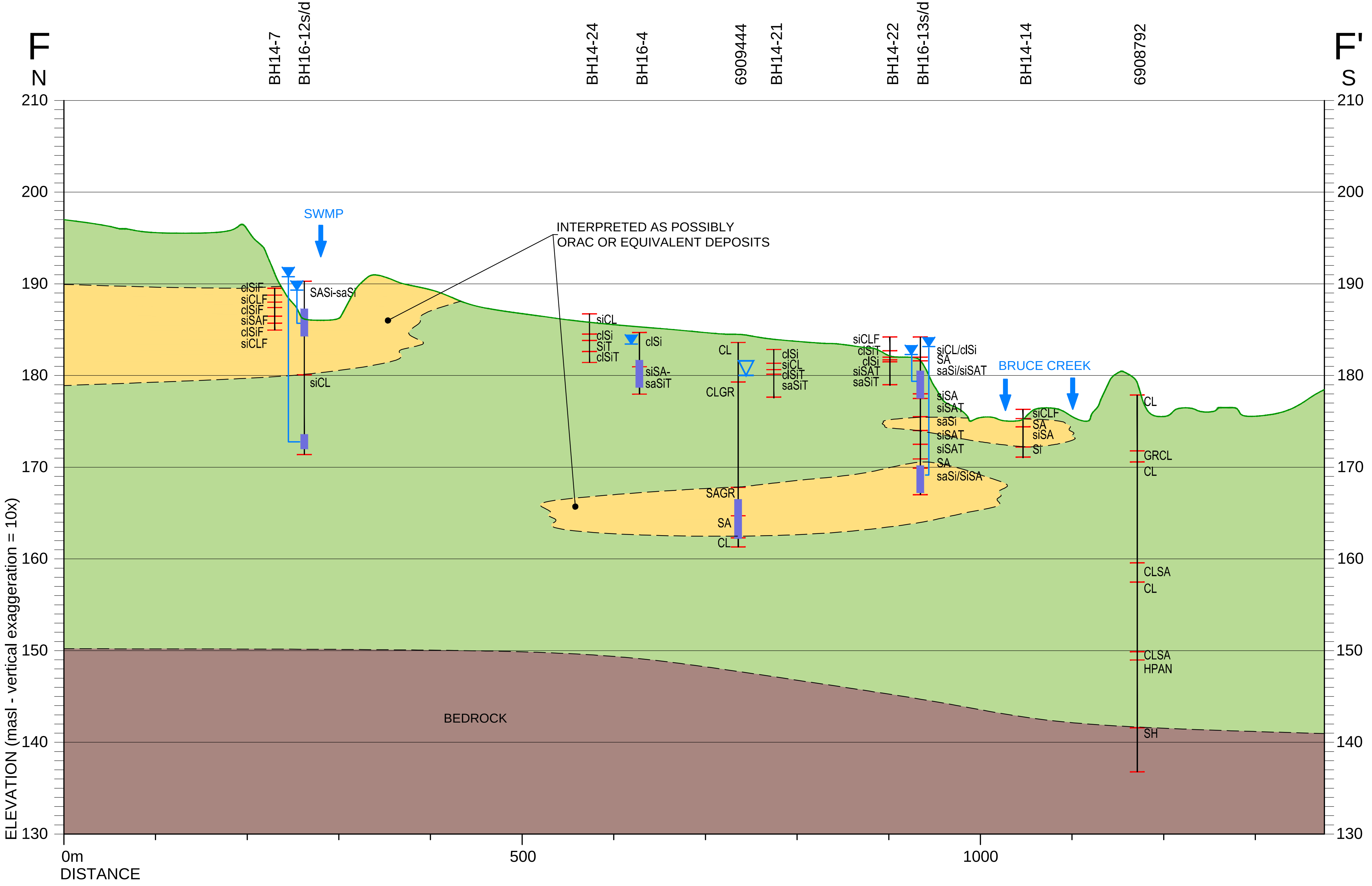
HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 10

INTERPRETED GEOLOGICAL
CROSS SECTION E-E'

SEPTEMBER 2016

File: 032847 (YORK DOWNS) HG STUDY CROSS SECTIONS.dwg



Stantec
BEACON ENVIRONMENTAL
BURNSIDE

1:5000
0 50 100 150 200 250

Legend

MW9 WELL IDENTIFICATION
EXISTING GROUNDLINE
GEOLOGICAL STRATIGRAPHY CONTACT
▽ STATIC WATER LEVEL (MOECC WELL RECORD)
▼ MEASURED WATER LEVEL (APRIL 22, 2016)
▮ WELL SCREEN

🟩 CLAYEY SILT TILL
🟨 SANDY SILT
🟫 SHALE
----- INTERPRETED GEOLOGICAL CONTACT

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil

CL	Clay
Si	Silt
SA	Sand
GR	Gravel
STN	Stones
BLD	Boulder
LMSN	Limestone

⬇ WATERCOURSE CROSSING

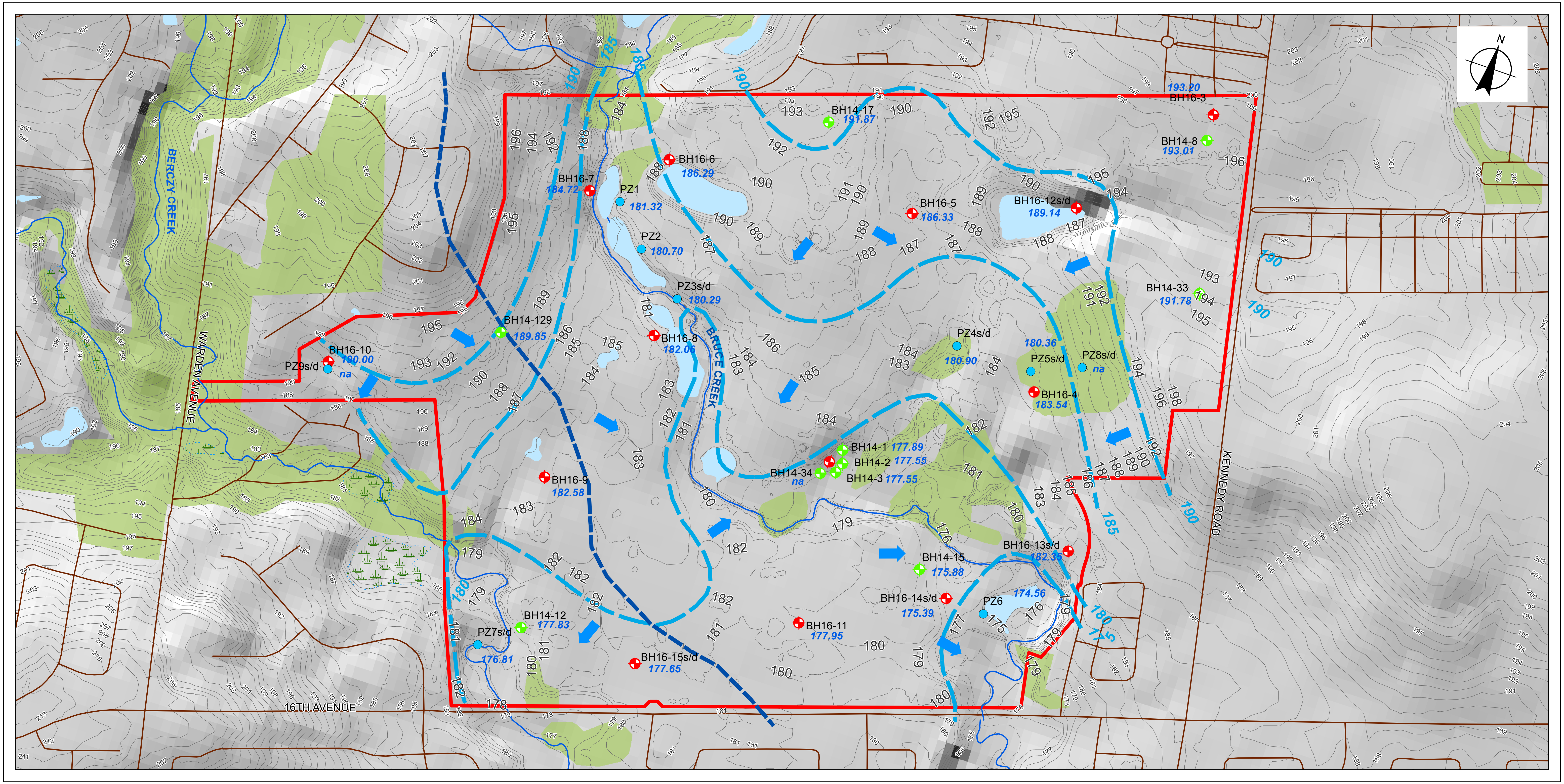
HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 11

INTERPRETED GEOLOGICAL
CROSS SECTION F-F'

SEPTEMBER 2016

File: 032847 (YORK DOWNS) HG STUDY CROSS SECTIONS.dwg



Stantec
BEACON ENVIRONMENTAL
BURNSIDE

0 100 200 300 400 500 600
Metres

LEGEND

🟥 SUBJECT LANDS
ROADWAY
contour_site_1m
DRAINAGE DIVIDE
WATERCOURSE
OPEN WATER
WOODED
WETLAND AREA
MONITORING WELL (GOLDER 2014)
MONITORING WELL (BURNSIDE 2016)
DRIVE POINT PIEZOMETER
INTERPRETED GROUNDWATER CONTOUR (masl)
INTERPRETED GROUNDWATER FLOW DIRECTION
177.95 MEASURED WATER LEVEL (APRIL 22, 2016)

HYDROGEOLOGICAL ASSESSMENT
AND WATER BALANCE
4134 16TH AVENUE

FIGURE 12

INTERPRETED SHALLOW GROUNDWATER FLOW

SEPTEMBER 2016

File Path: E:\Burnside work\038247 York Downs\038247 York Downs GW.mxd   Print Date: 2016/09/21 Time: 10:18 AM

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

MOECC Well Records

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(014)	17 634591 4858911^W	1955/08 2801	06					6903478 () BRWN CLAY 0003 BLUE CLAY 0007 BLDR CLAY MSND 0013 FSND 0024 BLUE CLAY 0030 BLUE CLAY MSND 0039 MSND SILT CLAY 0069 BLUE CLAY 0075 MSND SILT CLAY 0088 BLUE CLAY SILT 0123 BLUE CLAY MSND GRVL 0163 BLUE CLAY MSND BLDR 0164 BLUE CLAY MSND 0177 BLUE CLAY MSND GRVL 0181 BLDR CLAY MSND 0182 BLUE CLAY MSND 0185 BLUE CLAY GRVL 0208 BLUE SHLE 0212
MARKHAM TOWN (MARKHA CON 05(014)	17 635035 4859203^W	1972/07 4610	08 16 10	SA 0108	-008 / 080 200 / 24:0	MN	0110 07 0117 07	6910992 () BLCK LOAM 0002 BLCK MUCK SAND GRVL 0015 GREY GRVL BLDR 0020 GREY SAND GRVL CLAY 0028 GREY GRVL CLAY 0035 GREY CLAY SAND 0051 GREY CLAY SAND GRVL 0076 GREY CLAY 0096 GREY CLAY SILT 0104 GREY CLAY SILT FSND 0108 GREY SAND GRVL CLAY 0111 GREY SAND GRVL 0125 GREY SHLE 0141
MARKHAM TOWN (MARKHA CON 05(014)	17 635045 4858842^W	1965/11 2105	02	FR 0040	005 / 006 / 3:0	DO	0039 05	6903518 () PRDG 0020 FSND 0022 BLUE CLAY 0040 GRVL 0044
MARKHAM TOWN (MARKHA CON 05(014)	17 633735 4858434^W	1953/01 4623	05 05	FR 0225	060 / 090 006 / 3:0	DO		6903507 () LOAM 0005 HPAN 0055 GRVL 0060 HPAN 0095 WHIT MSND 0210 SHLE 0232
MARKHAM TOWN (MARKHA CON 05(014)	17 635210 4858844^W	1959/02 2105	02	FR 0038	013 / 006 / 3:30	DO	0037 05	6903509 () LOAM 0004 BRWN CLAY MSND 0013 BLUE CLAY STNS 0038 GRVL 0042
MARKHAM TOWN (MARKHA CON 05(014)	17 635536 4859189^W	1964/08 5420	34	FR 0034	016 / / :0	DO		6903516 () LOAM 0001 YLLW CLAY 0010 BLUE CLAY 0030 BLUE CLAY MSND 0040
MARKHAM TOWN (MARKHA CON 05(014)	17 635077 4858972^W	1958/07 3414	04	FR 0036	/ 026 010 / 2:0	DO	0032 04	6903508 () PRDG 0013 BLUE CLAY 0032 BRWN CSND 0036
MARKHAM TOWN (MARKHA CON 05(015)	17 633793 4859064^W	1984/11 2517	06	FR 0185	005 / 004 / :0	DO		6917518 () GREY CLAY GRVL BLDR 0128 GREY GRNT 0204
MARKHAM TOWN (MARKHA CON 05(015)	17 635419 4859701^W	1974/12 2610	06 06					6912497 () BRWN CLAY SAND 0018 GREY CLAY SAND 0065 GREY CLAY 0075 GREY CLAY SAND 0085 GREY CLAY 0160 GREY CLAY SAND 0170 GREY CLAY 0200 GREY CLAY SAND 0220 GREY SHLE 0330
MARKHAM TOWN (MARKHA CON 05(015)	17 633630 4858828^W	1958/05 4508	04 04	FR 0185	020 / 230 002 / 5:0	DO		6903519 () BRWN CLAY 0040 BRWN CLAY MSND 0047 BRWN MSND 0070 GREY FSND 0185 GREY SHLE 0241
MARKHAM TOWN (MARKHA CON 05(015)	17 633607 4859204^W	1966/03 4610	07	FR 0208 FR 0159	070 / 072 012 / 5:0	DO	0204 09	6903522 () LOAM 0001 BRWN CLAY 0010 HPAN BLDR 0063 BLUE CLAY GRVL 0110 BLUE CLAY 0159 MSND 0161 BLUE CLAY 0171 CLAY MSND 0185 BLUE CLAY 0208 FSND 0212 CSND GRVL 0213

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(015)	17 633755 4859063^{W}	1976/11 2651	06	FR	033 / 141 004 / 4:0	DO	0128 08	6913795 () FILL 0003 BRWN CLAY 0012 GREY CLAY GRVL 0083 GREY CLAY SAND 0111 FSND 0122 GREY CLAY SAND 0131 CSND 0141 GREY CLAY SAND 0141
MARKHAM TOWN (MARKHA CON 05(015)	17 634375 4859423^{W}	1973/07 1663	05	FR 0069 FR 0110	013 / 072 005 / 2:30	 DO	0075 04	6911701 () BRWN LOAM 0001 YLLW CLAY BLDR 0016 BLUE CLAY SAND 0047 BLUE CLAY 0069 GREY SAND GRVL 0098 BLUE CLAY GRVL 0110 GREY SAND GRVL 0127
MARKHAM TOWN (MARKHA CON 05(015)	17 633757 4859172^{W}	1962/07 1413	05	FR 0132	012 / 095 002 / 3:0	 DO	0128 04	6903521 () HPAN 0125 FSND 0132
MARKHAM TOWN (MARKHA CON 05(015)	17 634699 4859490^{W}	1961/08 4813	05	FR 0097	-001 / 006 / :0	DO	0095 05	6903520 () FILL 0003 BRWN CLAY 0018 BLUE CLAY 0036 CLAY QSND 0050 HPAN 0072 CLAY 0091 MSND 0101
MARKHAM TOWN (MARKHA CON 05(016)	17 635105 4859863^{W}	1968/08 4610	06					6908792 () BRWN CLAY 0020 GRVL CLAY BLDR 0024 BLUE CLAY 0060 BLUE CLAY MSND 0067 BLUE CLAY 0092 CLAY MSND 0095 HPAN 0119 BLUE SHLE 0135
MARKHAM TOWN (MARKHA CON 05(016)	17 635325 4860223^{W}	1970/06 5459	34	FR 0018	/ / :0	DO		6910172 () BLCK LOAM 0002 BRWN CLAY MSND 0009 BLUE CLAY 0018 GREY MSND 0020 BLUE CLAY STNS 0022
MARKHAM TOWN (MARKHA CON 05(016)	17 635391 4859987^{W}	1954/10 4619	04	FR 0037	/ / :0	 DO		6903525 () BRWN CLAY 0004 MSND 0014 BLUE MSND 0020 FSND 0037
MARKHAM TOWN (MARKHA CON 05(016)	17 635329 4860256^{W}	1955/02 1413	06	FR 0017	/ / :0	 DO		6903523 () PRDG 0009 BLUE CLAY 0017
MARKHAM TOWN (MARKHA CON 05(016)	17 633369 4859817^{W}	1987/09 1413	06	FR 0079	004 / 060 005 / 4:10	DO	0073 06	6919047 (13698) BRWN CLAY STNS HARD 0006 BRWN SAND STNS LOOS 0014 GREY CLAY SLTY 0069 BRWN SAND GRVL CLN 0079 GREY CLAY DNSE 0088
MARKHAM TOWN (MARKHA CON 05(016)	17 637355 4860778^{W}	1989/06 5459	06	FR 0062	/ 050 030 / 1:0	DO	0064 03	6920491 (58314) BRWN CLAY 0007 BLUE CLAY SOFT 0016 BLUE CLAY GRVL 0019 BLUE CLAY SAND 0040 GREY SAND FSND 0054 GREY CLAY STNS 0062 GREY GRVL 0067
MARKHAM TOWN (MARKHA CON 05(016)	17 635385 4859920^{W}	1990/11 1413	06	FR 0118	/ 100 030 / 1:0	DO	0115 03	6921321 (91655) BRWN CLAY DNSE 0017 GREY CLAY DNSE 0037 GREY CLAY SILT LYRD 0078 BLCK SAND GRVL CGVL 0118 BLCK SHLE HARD 0119
MARKHAM TOWN (MARKHA CON 05(016)	17 633915 4859543^{W}	1978/08 4816	06	FR 0190	011 / 185 002 / 3:0		0195 03	6914701 () CLAY GRVL BLDR 0019 SAND 0031 CLAY GRVL SAND 0053 SAND SHLE 0061 CLAY 0076 SAND CLAY 0153 CLAY SILT 0183 SAND GRVL CLAY 0197 SAND 0204 GRVL SHLE 0209 BRWN SHLE 0210

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(016)	17 634148 4859760[W]	1953/06 4619	04	FR 0065	/ / :0	DO		6903524 () BRWN CLAY 0020 HPAN CLAY STNS 0049 BLUE CLAY MSND 0065 FSND 0072 FSND CSND 0075
MARKHAM TOWN (MARKHA CON 05(016)	17 634138 4859663[W]	1962/10 5420	34	FR 0030	012 / / :0	ST DO		6903526 () LOAM 0001 YLLW CLAY MSND 0010 BLUE CLAY 0030 GRVL 0032
MARKHAM TOWN (MARKHA CON 05(016)	17 634084 4859636[W]	2004/08 1663	07	FR 0095	-003 / 070 / 1:0	IR		6928333 (Z19436) A013022 BLCK LOAM 0001 BRWN CLAY SAND 0018 BRWN MSND 0032 BLUE CLAY GRVL LYRD 0093 GREY SAND CLAY DRTY 0097 GREY MSND FSND 0123 BLUE CLAY FSND LYRD 0128
MARKHAM TOWN (MARKHA CON 05(016)	17 635316 4860217[W]	1974/08 5459	06	FR 0069	012 / 055 020 / 1:0	DO	0071 04	6912452 () LOAM 0002 BRWN CLAY 0018 BLUE CLAY 0060 BLUE CLAY SAND 0069 BLUE CSND 0075
MARKHAM TOWN (MARKHA CON 05(016)	17 631639 4858619[W]	1999/08 1663				NU		6925042 (206290) BRWN CLAY SNDY 0000 YLLW UNKN 0007 BRWN CLAY SNDY GRVL 0021 YLLW UNKN 0063
MARKHAM TOWN (MARKHA CON 05(016)	17 635375 4860043[W]	1981/08 5459	06	FR 0038	001 / 035 010 / :0	DO	0044 03	6916014 () PRDG 0015 BLUE CLAY STNS 0031 BLUE CLAY SOFT 0038 BLUE SAND 0047
MARKHAM TOWN (MARKHA CON 05(016)	17 633875 4859543[W]	1978/07 4816	06	FR 0189 FR 0035	019 / 004 / 2:0			6914699 () CLAY SAND STNS 0025 SAND GRVL BLDR 0050 GRVL SAND CLAY 0065 SAND CLAY SILT 0189 MSND 0206 CLAY SAND STNS 0211 BRWN SHLE 0215
MARKHAM TOWN (MARKHA CON 05(016)	17 634045 4859573[W]	1968/12 4610	06	FR 0108	-012 / 077 030 / :0	 NU	0094 25	6908869 () LOAM 0001 BRWN CLAY 0015 BLUE CLAY 0030 GRVL MSND 0032 CLAY MSND 0066 MSND CLAY 0075 MSND 0077 BLUE CLAY 0094 MSND GRVL 0098 CLAY MSND 0103 MSND 0108 MSND SILT 0119
MARKHAM TOWN (MARKHA CON 05(016)	17 635355 4860023[W]	1982/08 5459	06	FR 0050	003 / 045 010 / :0	DO	0051 03	6916404 () BRWN CLAY 0019 BLUE CLAY STNS 0038 BLUE CLAY SAND SOFT 0046 BLUE SAND CLAY SOFT 0050 BLUE SAND 0054
MARKHAM TOWN (MARKHA CON 05(016)	17 633915 4859543[W]	1978/12 4816	06	UK 0033	002 / 018 004 / 2:0	MN	0038 05	6914947 () SAND CLAY LYRD 0009 CLAY HARD 0015 SAND SILT CMTD 0033 FSND MSND SILT 0043 CLAY GRVL STNS 0062
MARKHAM TOWN (MARKHA CON 05(016)	17 634155 4859513[W]	1968/09 4610	07	FR 0087	-003 / 016 / 2:0	NU	0086 10	6908865 () LOAM 0008 CLAY MSND GRVL 0011 CLAY GRVL 0020 BLUE CLAY 0052 CLAY MSND GRVL 0056 CLAY MSND 0087 MSND GRVL 0097
MARKHAM TOWN (MARKHA CON 05(016)	17 633535 4859363[W]	1978/07 4816	06	FR 0194	069 / 010 / 2:0	DO	0197 03	6914698 () SAND CLAY STNS 0062 CLAY HARD 0090 CLAY SOFT 0142 CLAY SAND LYRD 0245
MARKHAM TOWN (MARKHA CON 05(016)	17 633875 4859543[W]	1978/08 4816	06	FR 0189	023 / / :0			6914700 () PRDG 0197

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(016)	17 635375 4859983^{W}	1973/09 5459	06	FR 0070	/ 060 008 / 2:30	DO	0072 03	6911861 () LOAM 0002 BLUE CLAY 0020 BLUE CLAY SILT 0058 FSND 0068 CSND 0075
MARKHAM TOWN (MARKHA CON 05(016)	17 635415 4859933^{W}	1973/05 5459	30		010 / / :0	DO		6911439 () BRWN CLAY 0008 BLUE CLAY 0015 BLUE CLAY 0020
MARKHAM TOWN (MARKHA CON 05(016)	17 633369 4859817^{W}	1987/10 1413	06	FR 0136	012 / 030 024 / 2:30	DO ST	0129 06	6919099 () BRWN CLAY SAND PCKD 0016 BLUE CLAY DNSE 0079 GREY SAND SILT CLAY 0122 GREY SAND CLN 0136
MARKHAM TOWN (MARKHA CON 05(016)	17 635324 4860451^{W}	1987/08 5459	06	FR 0067	-004 / 030 020 / 1:0	DO	0068 03	6919191 () BRWN CLAY STNS 0014 BLUE CLAY 0030 BLUE CLAY SAND 0035 BLUE CLAY 0058 BLUE CLAY SOFT 0064 BLUE SAND CLAY 0067 BLUE GRVL 0071
MARKHAM TOWN (MARKHA CON 05(016)	17 634045 4859473^{W}	1968/10 4610	07	FR 0087	008 / 075 075 / 9:0	IR	0087 07	6908866 () BRWN CLAY 0010 CLAY MSND STNS 0020 MSND CLAY 0030 BLUE CLAY 0051 CLAY GRVL 0055 CLAY MSND GRVL 0087 MSND GRVL 0097 MSND GRVL CLAY 0102 CLAY MSND GRVL 0160 BLUE SHLE 0194
MARKHAM TOWN (MARKHA CON 05(016)	17 633955 4859733^{W}	1968/11 4610		UK 0044		NU		6908868 () LOAM 0001 BRWN CLAY 0020 BLUE CLAY 0044 MSND 0048 MSND 0084 BLUE CLAY MSND 0094
MARKHAM TOWN (MARKHA CON 05(017)	17 635278 4860313^{W}	1986/06 5459	06	FR 0118	020 / 118 015 / 2:0	DO	0118 06	6918617 (01193) BRWN CLAY SAND 0009 GREY CLAY STNS 0023 GREY CLAY SILT 0044 GREY CLAY STNS 0053 GREY SAND STNS SILT 0058 GREY CLAY SAND STNS 0097 GREY SILT SAND 0107 GREY CLAY STNS 0111 GREY SAND STNS 0125
MARKHAM TOWN (MARKHA CON 05(017)	17 634780 4860158^{W}	1965/08 2801	06					6903806 () LOAM 0004 CLAY GRVL BLDR 0009 MSND 0017 BLUE CLAY 0033 MSND SILT 0040 CLAY BLDR 0043 SILT FSND 0053 MSND GRVL 0064 CLAY GRVL 0069 CLAY GRVL BLDR 0070 CLAY GRVL SHLE 0128
MARKHAM TOWN (MARKHA CON 05(017)	17 634615 4860183^{W}	1969/06 4610	07	FR 0046		NU		6909446 () CLAY 0002 MSND GRVL BLDR 0006 MSND BLDR 0022 BLUE CLAY 0030 CLAY MSND 0044 GRVL CLAY 0046 FSND CLAY 0052 FSND 0058 CLAY 0064 BLUE CLAY GRVL 0083
MARKHAM TOWN (MARKHA CON 05(017)	17 634335 4860123^{W}	1969/06 4610	07	FR 0059		NU		6909445 () BRWN CLAY 0007 CLAY BLDR 0010 CLAY 0034 CLAY GRVL 0039 CLAY MSND 0059 MSND 0062 MSND CLAY 0064 CLAY 0066 CLAY GRVL 0122
MARKHAM TOWN (MARKHA CON 05(017)	17 633380 4859891^{W}	1961/07 2204	02	FR 0064	-014 / 020 / :0	DO		6903527 () BLCK LOAM 0002 GRVL 0004 BLUE CLAY 0064 CSND 0065

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(017)	17 633955 4860033^{W}	1969/04 4610						6909442 () CLAY GRVL BLDR 0012 BLUE CLAY 0078 FSND CLAY 0113 BLUE CLAY 0129
MARKHAM TOWN (MARKHA CON 05(017)	17 634265 4860163^{W}	1969/03 4610	07	FR 0072		NU		6909440 () BRWN CLAY 0015 BLUE CLAY 0030 CLAY MSND 0063 MSND CLAY 0076 CLAY 0115 SHLE CLAY 0125
MARKHAM TOWN (MARKHA CON 05(017)	17 635203 4860588^{W}	1975/08 5459	06	FR 0070	028 / 070 020 / 2:0	DO	0070 04	6912887 () BRWN CLAY 0015 BLUE CLAY 0035 GREY SAND 0080
MARKHAM TOWN (MARKHA CON 05(017)	17 635314 4860366^{W}	1961/09 5420	34	FR 0019	004 / / :0	DO		6903528 () LOAM 0001 YLLW CLAY 0009 BLUE CLAY GRVL STNS 0015 MSND CLAY 0021
MARKHAM TOWN (MARKHA CON 05(017)	17 634895 4860253^{W}	1969/06 4610	07	FR 0052	012 / 043 018 / 5:0	NU	0056 14	6909444 () LOAM 0002 BRWN CLAY 0014 CLAY GRVL 0052 MSND GRVL 0062 MSND FSND 0070 CLAY 0073
MARKHAM TOWN (MARKHA CON 05(018)	17 633353 4860091^{W}	1999/06 1663	06	FR 0129	035 / 056 018 / 1:0	DO	0133 03	6925249 (213471) BLUE LOAM 0001 BRWN GRVL SAND 0009 BLUE CLAY SLTY SILT 0041 BLUE CLAY 0064 GREY SAND 0066 BLUE CLAY SAND 0129 GREY MSND 0137 GREY FSND 0148
MARKHAM TOWN (MARKHA CON 05(018)	17 634249 4860525^{L}	1996/08 1413	06	FR 0117	040 / 114 020 / 1:0	DO	0114 03	6923678 (166608) BRWN CLAY HARD 0017 GREY CLAY HARD 0109 GREY CGVL 0117
MARKHAM TOWN (MARKHA CON 05(018)	17 633407 4860155^{W}	1966/08 4305	04	FR 0105	032 / 095 015 / 13:0	DO	0105 07	6903536 () LOAM 0002 CSND 0035 FSND 0068 GREY CLAY 0105 MSND CLAY 0112
MARKHAM TOWN (MARKHA CON 05(018)	17 634395 4860503^{W}	1969/05 4610	06					6909443 () LOAM 0002 BRWN CLAY BLDR 0024 BLUE CLAY 0029 MSND BLDR 0032 CLAY MSND 0078 CLAY GRVL 0130
MARKHAM TOWN (MARKHA CON 05(018)	17 633483 4860457^{W}	1986/10 3903	06	FR 0134	031 / 087 015 / 3:0	DO	0129 04	6918614 () BRWN CLAY STNS DNSE 0017 GREY CLAY SILT LYRD 0034 GREY CLAY STNS HARD 0097 GREY CLAY SILT LYRD 0129 GREY CLAY SAND LOOS 0134
MARKHAM TOWN (MARKHA CON 05(018)	17 634035 4860438^{W}	1965/08 2801	02	FR 0050	/ 020 027 / 8:0	 NU	0066 22	6903813 () LOAM 0001 BLDR CLAY 0003 CLAY GRVL BLDR 0012 CLAY GRVL 0050 SILT FSND 0052 MSND GRVL 0053 CLAY 0056 SILT 0059 CLAY 0070 CLAY GRVL 0073 SILT CLAY 0087 CLAY GRVL BLDR 0092 CLAY 0187 SHLE 0189
MARKHAM TOWN (MARKHA CON 05(018)	17 633359 4860171^{W}	1963/08 1515	04	FR 0107	016 / 106 007 / 8:0	DO	0108 06	6903530 () LOAM 0001 MSND GRVL 0080 BLUE CLAY 0107 MSND 0114
MARKHAM TOWN (MARKHA CON 05(018)	17 633413 4860375^{W}	1964/04 3108	04	FR 0139	038 / 065 005 / 2:30	DO	0141 03	6903533 () LOAM 0001 BRWN CLAY STNS 0012 BLUE CLAY STNS 0025 BLUE CLAY MSND 0052 BLUE CLAY 0120 BLUE CLAY STNS 0139 MSND 0144

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(018)	17 634249 4860525^{L}	1965/05 3108	04	FR 0154	045 / 050 010 / 4:0	DO	0155 04	6903535 () LOAM 0001 YLLW CLAY 0052 BLUE CLAY 0126 MSND 0135 CLAY MSND 0142 MSND 0149 BLUE MSND CLAY 0154 MSND 0159
MARKHAM TOWN (MARKHA CON 05(018)	17 633334 4860402^{W}	1975/08 5459	06	FR 0114	050 / 060 030 / 3:0	DO	0115 03	6912788 () LOAM 0002 BRWN CLAY 0019 BLUE CLAY 0040 BLUE CLAY GRVL 0080 BLUE CLAY 0114 BLUE CSND 0118
MARKHAM TOWN (MARKHA CON 05(018)	17 634245 4860525^{L}	2000/09 5459	06	FR 0090	015 / 040 025 / 1:0		0090 09	6925588 (221537) BRWN CLAY SOFT 0018 GREY CLAY 0032 GREY CLAY SNDY 0070 GREY CLAY SAND SOFT 0081 GREY CLAY SNDY 0084 GREY MSND 0088 GREY CLAY SNDY 0090 GREY MSND 0094 GREY MSND 0100
MARKHAM TOWN (MARKHA CON 05(018)	17 634245 4860525^{L}	2000/09 5459	06 02				0127 05	6925590 (221536) BLCK LOAM 0001 BRWN CLAY 0013 GREY CLAY STNS SOFT 0028 GREY CLAY SAND 0070 GREY CLAY SAND SOFT 0079 GREY CSND 0081 GREY CLAY SILT 0083 GREY MSND 0094 GREY FSND 0099 GREY CLAY GRVL 0102 GREY CLAY GRVL 0126 GREY SAND CLAY SOFT 0134 GREY CLAY STNS 0142
MARKHAM TOWN (MARKHA CON 05(018)	17 633404 4860485^{W}	1996/08 1413	06	FR 0117	060 / 100 040 / 1:0	DO	0114 03	6923675 (166603) BRWN CLAY HARD 0017 GREY CLAY STNS HARD 0050 GREY CLAY DNSE 0105 GREY CSND 0110 GREY CGVL 0117
MARKHAM TOWN (MARKHA CON 05(018)	17 633385 4860282^{W}	1958/05 2527	02	FR 0104	034 / 003 / 8:0	DO	0103 05	6903529 () CLAY 0041 CLAY MSND 0052 BLUE CLAY 0078 MSND 0089 QSND 0093 WHIT CLAY 0103 MSND 0108
MARKHAM TOWN (MARKHA CON 05(018)	17 633461 4860364^{W}	1963/09 5420	34	FR 0012	012 / 004 / :0	DO		6903531 () LOAM 0001 YLLW CLAY 0010 MSND GRVL 0014 BLUE CLAY 0034
MARKHAM TOWN (MARKHA CON 05(018)	17 633494 4860189^{W}	1963/10 5420	34	FR 0025	022 / 002 / :0	DO		6903532 () LOAM 0001 YLLW CLAY 0010 BLUE CLAY 0025 MSND 0026 BLUE CLAY 0046
MARKHAM TOWN (MARKHA CON 05(018)	17 633463 4860228^{W}	1964/06 5420	05	FR 0146	031 / 045 020 / 7:0	DO	0146 04	6903534 () PRDG 0047 CLAY GRVL 0060 BLUE CLAY 0120 CLAY MSND 0141 MSND 0150
MARKHAM TOWN (MARKHA CON 05(018)	17 634035 4860493^{W}	1969/02 4610	06	FR 0049 FR 0070	/ 036 050 / 24:0	IR	0070 16	6909439 () LOAM 0002 BRWN CLAY STNS 0024 BLUE CLAY SILT 0033 MSND SILT GRVL 0049 CLAY MSND SILT 0070 CSND FSND CLAY 0076 FSND SILT 0080 FSND CSND CLAY 0085 FSND SILT CLAY 0093
MARKHAM TOWN (MARKHA CON 05(018)	17 633915 4860643^{W}	1969/04 4610	07	FR 0072	016 / 050 100 / 6:0	IR	0066 19	6909441 () CLAY MSND 0020 BLUE CLAY 0028 FSND CLAY 0072 CSND 0082 MSND CLAY 0086 HPAN 0096

TOWNSHIP CONCESSION (LOT)	UTM^1	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^7 RATE^8/TIME HR:MIN	WATER USE^9	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
MARKHAM TOWN (MARKHA CON 05(018)	17 633315 4860303^W	1980/04 5459	06	FR 0113	050 / 110 015 / :0	DO	0113 03	6915725 () BLCK LOAM 0002 BRWN CLAY SOFT 0019 BLUE CLAY SOFT 0031 BLUE CLAY STNS 0079 BLUE CLAY SOFT 0113 BLUE SAND 0116
MARKHAM TOWN (MARKHA CON 05(018)	17 633494 4860512^W	1985/10 3903	06 06	FR 0130	046 / 120 020 / 5:0	DO	0130 03	6917770 () BRWN CLAY SAND LYRD 0011 GREY CLAY STNS HARD 0031 GREY CLAY DNSE 0060 GREY CLAY STNS HARD 0116 BRWN CLAY SAND LYRD 0119 GREY CLAY DNSE 0129 BRWN CLAY SAND LYRD 0134 GREY CLAY DNSE 0144 GREY CLAY STNS HARD 0185 GREY CLAY SHLE HARD 0196 GREY SHLE DNSE 0207
MARKHAM TOWN (MARKHA CON 05(018)	17 633425 4860223^W	1970/07 4813	05	FR 0159	055 / 060 010 / 2:50	DO	0155 04	6909881 () BLCK LOAM 0002 BLUE CLAY STNS 0100 SILT 0111 GREY CLAY 0142 GRVL 0150 MSND 0159
MARKHAM TOWN (MARKHA CON 05(018)	17 633375 4860308^W	1968/08 5420	05	FR 0140	034 / 080 009 / 6:0	DO	0159 04	6908803 () BRWN CLAY STNS 0008 GRVL CLAY 0010 BRWN CLAY BLDR 0045 BLUE CLAY 0140 GRVL SILT CLAY 0155 GREY MSND 0163
MARKHAM TOWN (MARKHA CON 05(018)	17 633354 4860049^W	1965/09 2801	06	FR 0092				6903537 () LOAM 0002 GRVL 0006 CLAY 0025 CLAY SILT 0029 CLAY 0069 SILT 0073 CLAY SILT 0080 CLAY 0092 GRVL MSND 0096 SILT 0108 SILT FSND 0119 CLAY 0178 CLAY BLDR 0192 SHLE 0194
MARKHAM TOWN (MARKHA CON 05(018)	17 633305 4860268^W	1967/01 3519	05	FR 0125	040 / 080 010 / 6:0	DO	0126 04	6903538 () LOAM 0002 CLAY STNS 0050 HPAN 0110 WHIT CLAY 0125 BLCK CSND 0130
MARKHAM TOWN (MARKHA CON 05(018)	17 633399 4860327^W	1968/01 1104	06	FR 0105 FR 0134	039 / 136 004 / 48:0	DO	0138 04	6903539 () LOAM 0006 GRVL 0033 HPAN 0044 CLAY 0049 CLAY GRVL 0064 SILT CLAY 0105 MSND SILT 0112 SILT 0134 MSND 0144
MARKHAM TOWN (MARKHA CON 05(018)	17 633380 4860249^W	1967/11 5420	05	FR 0148	040 / 080 008 / 3:0	DO	0151 04	6903540 () LOAM 0001 BLDR CLAY 0035 CLAY MSND STNS 0148 MSND 0155
MARKHAM TOWN (MARKHA CON 05(018)	17 635121 4860921^W	1965/08 2801	06					6903814 () LOAM 0001 CLAY 0018 CLAY GRVL 0025 SILT 0030 CLAY 0091 CLAY BLDR 0150 SHLE 0152
MARKHAM TOWN (MARKHA CON 05(019)	17 635015 4861470^W	1996/09 3108						6923713 (166663)
MARKHAM TOWN (MARKHA CON 05(019)	17 633555 4860576^W	1966/09 5420	05	FR 0121	040 / 065 010 / 10:0	DO	0121 04	6903559 () PRDG 0005 BRWN CLAY STNS 0040 BLUE CLAY 0100 HPAN 0115 BLUE CLAY 0121 MSND GRVL 0125
MARKHAM TOWN (MARKHA CON 05(019)	17 633407 4860563^W	1965/07 5420	05	FR 0098	020 / 030 010 / 3:0	DO	0096 04	6903551 () CLAY BLDR 0060 BLUE CLAY MSND 0098 GRVL MSND 0100

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(019)	17 633215 4860643[W]	1968/09 2104	06	FR 0115	040 / 130 004 / 72:0	DO		6908692 () LOAM 0001 BRWN CLAY MSND 0020 GREY CLAY MSND STNS 0115 GRVL MSND CLAY 0137
MARKHAM TOWN (MARKHA CON 05(019)	17 633265 4860803[W]	1968/06 5420	05	FR 0120	031 / 110 004 / 8:0	DO	0120 08	6908769 () PRDG 0023 BLUE CLAY STNS 0038 BLUE CLAY 0110 BLUE CLAY BLDR 0120 MSND SILT GRVL 0130
MARKHAM TOWN (MARKHA CON 05(019)	17 633235 4860783[W]	1968/05 5420	34	FR 0030	/ / :0	DO		6908789 () LOAM 0001 BRWN CLAY 0011 BLUE CLAY BLDR 0034
MARKHAM TOWN (MARKHA CON 05(019)	17 634167 4860935[L]	1994/10 5459	06	FR 0148	050 / 080 025 / 1:0	DO	0153 03	6922923 (141542) BLCK LOAM 0002 BRWN CLAY STNS 0018 GREY CLAY STNS 0065 GREY CLAY SLTY 0115 GREY SAND GRVL CLAY 0127 GREY CLAY STNS 0148 GREY SAND MUCK 0156 GREY CLAY STNS
MARKHAM TOWN (MARKHA CON 05(019)	17 634166 4860935[L]	2000/04 5459	06	FR 0071	025 / 060 008 / 1:30	DO	0072 03	6925321 (211663) BLCK LOAM 0002 BRWN CLAY SAND STNS 0014 GREY CLAY SNDY 0058 GREY CLAY SAND SILT 0071 GREY MSND 0075 GREY CLAY SNDY 0075
MARKHAM TOWN (MARKHA CON 05(019)	17 635038 4861179[W]	1996/09 3108						6923714 (166662) CLAY 0010 FILL CLAY CMTD 0010
MARKHAM TOWN (MARKHA CON 05(019)	17 633545 4860638[W]	1974/08 5459	06	FR 0105	042 / 116 008 / 3:0	DO	0113 03	6912307 () BRWN CLAY 0020 BLUE CLAY STNS 0080 GREY SAND CLAY 0105 GREY SAND 0116
MARKHAM TOWN (MARKHA CON 05(019)	17 633395 4860583[W]	1976/11 2651	06	FR	028 / 114 002 / 4:0	DO	0107 04	6913796 () LOAM 0002 BRWN CLAY GRVL 0008 GREY CLAY GRVL 0104 SAND 0114 SAND CLAY 0114
MARKHAM TOWN (MARKHA CON 05(019)	17 633455 4860688[W]	1971/07 5459	06	FR 0118	041 / 075 006 / 5:0	DO	0120 05	6910650 () BLUE CLAY STNS MSND 0035 BLUE CLAY STNS 0118 MSND GRVL 0125
MARKHAM TOWN (MARKHA CON 05(019)	17 633855 4860943[W]	1977/07 3109	30	FR 0044	025 / / :0	DO		6914159 () LOAM 0002 BRWN CLAY STNY 0025 BLUE CLAY STNY 0043 SAND 0045 BLUE CLAY STNY 0052
MARKHAM TOWN (MARKHA CON 05(019)	17 633516 4860903[W]	1975/11 5459	06	UK 0145	070 / 150 012 / 3:0	DO	0147 06	6912994 () BRWN CLAY 0012 BRWN GRVL SAND 0027 BLUE CLAY STNS 0121 BLUE FSND 0124 BLUE CLAY 0145 BLUE CSND 0153
MARKHAM TOWN (MARKHA CON 05(019)	17 633785 4860963[W]	1969/07 4610	06	FR 0059	/ 039 007 / 11:0	DO	0056 04	6909421 () BRWN CLAY 0004 BRWN CLAY MSND GRVL 0007 BLUE CLAY MSND 0024 BLUE CLAY 0057 GREY MSND SILT 0059 GREY MSND GRVL 0063
MARKHAM TOWN (MARKHA CON 05(019)	17 633335 4860503[W]	1968/05 5420		FR 0109 FR 0145	028 / 150 002 / 6:0	NU		6908794 () BRWN CLAY 0008 YLLW CLAY MSND 0024 HPAN 0042 BLUE CLAY 0109 BLUE CLAY SILT 0113 BLUE CLAY 0145 GREY FSND SILT 0153 BLUE CLAY SILT 0167 SHLE 0180

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(019)	17 634818 4861336^W	1959/12 5420	30	FR 0014	010 / 002 / :0	ST		6903541 () YLLW CLAY 0007 BLUE CLAY 0012 GRVL STNS 0015 BLUE CLAY STNS 0027
MARKHAM TOWN (MARKHA CON 05(019)	17 633452 4860852^W	1960/09 5420	34	FR 0018	009 / 004 / :0	DO		6903542 () YLLW CLAY MSND 0006 YLLW CLAY 0012 BLUE CLAY 0034
MARKHAM TOWN (MARKHA CON 05(019)	17 633355 4860422^W	1960/12 2527	02					6903543 () PRDG 0004 BRWN CLAY STNS 0027
MARKHAM TOWN (MARKHA CON 05(019)	17 633352 4860424^W	1961/02 1622	04	FR 0156	100 / 156 006 / 8:0	DO	0156 04	6903544 () PRDG 0005 BLUE CLAY BLDR 0030 BLUE CLAY 0115 CSND 0155 FSND 0160
MARKHAM TOWN (MARKHA CON 05(019)	17 633292 4860941^W	1962/05 3414	04	FR 0047	012 / 044 005 / 8:0	DO		6903545 () CLAY MSND STNS 0001 GREY CLAY BLDR 0047 GRVL 0048
MARKHAM TOWN (MARKHA CON 05(019)	17 635038 4861317^W	1963/12 5420	34	FR 0014	014 / / :0	DO		6903546 () LOAM 0001 YLLW CLAY 0009 BLUE CLAY MSND 0036
MARKHAM TOWN (MARKHA CON 05(019)	17 633586 4860912^W	1964/01 5420	05	FR 0166	042 / 050 006 / 4:0	DO	0167 05	6903547 () PRDG 0034 BRWN CLAY MSND 0045 BRWN CLAY BLDR 0070 BLUE CLAY MSND 0110 GREY MSND 0135 BLUE CLAY MSND 0166 GREY MSND 0172
MARKHAM TOWN (MARKHA CON 05(019)	17 633407 4860681^W	1964/05 5420	05	FR 0118	025 / 115 006 / 24:0	DO	0118 04	6903548 () CLAY STNS MSND 0050 BLUE CLAY 0105 GRVL CLAY 0118 CSND 0122
MARKHAM TOWN (MARKHA CON 05(019)	17 633421 4860774^W	1965/06 5420	34	FR 0035	018 / / :0	DO		6903549 () LOAM 0001 YLLW CLAY 0012 BLUE CLAY STNS 0035 CLAY MSND STNS 0040
MARKHAM TOWN (MARKHA CON 05(019)	17 633240 4860635^W	1965/06 5420	05	FR 0105	039 / 100 006 / 5:0	DO	0105 04	6903550 () PRDG 0035 BLUE CLAY 0105 MSND CSND 0107 CLAY 0109
MARKHAM TOWN (MARKHA CON 05(019)	17 633482 4860995^W	1965/10 5420	05	FR 0094	022 / 090 012 / 4:0	DO	0092 04	6903552 () CLAY BLDR 0055 CLAY MSND STNS 0092 GRVL MSND 0096
MARKHAM TOWN (MARKHA CON 05(019)	17 633205 4860797^W	1966/02 5420	05	FR 0102	030 / 055 014 / 15:0	DO	0098 04	6903553 () CLAY BLDR 0045 CLAY STNS 0102 MSND 0104
MARKHAM TOWN (MARKHA CON 05(019)	17 633472 4860820^W	1966/04 5420	05	FR 0115	045 / 115 008 / 4:0	DO	0115 04	6903554 () LOAM 0002 YLLW CLAY MSND 0008 BRWN CLAY BLDR 0045 BLUE CLAY BLDR 0115 GREY FSND 0120
MARKHAM TOWN (MARKHA CON 05(019)	17 633252 4860525^W	1966/05 4305	04	FR 0103	031 / 085 008 / 8:0	DO	0100 06	6903555 () LOAM 0002 CSND STNS 0020 GREY CLAY 0100 GRVL CLAY 0102 FSND CLAY 0103 CSND 0106
MARKHAM TOWN (MARKHA CON 05(019)	17 633339 4860339^W	1966/07 5420	05	FR 0102	028 / 038 012 / 5:0	DO	0101 04	6903556 () BRWN MSND 0006 BLDR CLAY 0022 CLAY MSND 0040 BLUE CLAY 0102 GREY MSND 0105

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 05(019)	17 633241 4860735^{W}	1966/08 5420	05	FR 0111	045 / 105 007 / 20:0	DO	0109 04	6903557 () BRWN CLAY 0007 YLLW CLAY STNS 0028 BRWN CLAY STNS 0040 BLUE CLAY 0106 MSND CLAY 0111 GREY MSND 0113
MARKHAM TOWN (MARKHA CON 05(019)	17 633524 4860628^{W}	1966/09 5420	05	FR 0106	035 / 043 010 / 10:0	DO	0108 04	6903558 () PRDG 0046 CLAY 0106 MSND 0112
MARKHAM TOWN (MARKHA CON 05(019)	17 634979 4861462^{W}	1996/09 3108						6923715 (166661)
MARKHAM TOWN (MARKHA CON 05(020)	17 633315 4861213^{W}	1970/11 3903	06	UK 0138	030 / 090 008 / 4:0	DO	0138 04	6910100 () BLCK CLAY MSND STNS 0006 YLLW CLAY STNS 0021 BLUE CLAY STNS 0065 STNS MSND 0067 BLUE CLAY SILT STNS 0115 GREY MSND GRVL 0142
MARKHAM TOWN (MARKHA CON 05(020)	17 633195 4861023^{W}	1983/05 5459	06	FR 0217	035 / 217 010 / 2:0	DO	0217 03	6917027 () BRWN CLAY 0005 BLUE CLAY STNS 0093 BLUE CLAY SILT 0111 GREY SAND STNS SILT 0137 BLUE CLAY SILT 0184 GREY SAND SILT 0205 WHIT CLAY STNS 0209 GREY SAND STNS CLN 0221
MARKHAM TOWN (MARKHA CON 05(020)	17 634085 4861342^{L}	1991/03 5459	06	FR 0158	/ / 3:0	DO	0158 06	6921420 (85054) BRWN CLAY SNDY 0014 GREY CLAY SAND STNS 0067 GREY CLAY SILT 0113 GREY SAND STNS 0119 GREY CLAY SILT 0147 GREY CLAY SAND STNS 0158 GREY SAND FSND 0164 GREY CLAY SAND STNS 0168 GREY CLAY SILT 0175
MARKHAM TOWN (MARKHA CON 05(020)	17 633217 4860916^{W}	1974/05 5459	06	FR 0127	032 / 125 005 / 2:0	DO	0128 04	6912318 () BRWN CLAY 0018 BLUE CLAY SAND STNS 0122 SAND 0127 SAND 0132
MARKHAM TOWN (MARKHA CON 05(020)	17 633135 4861123^{W}	1976/04 5459	06	FR 0125	040 / 125 012 / :0	DO	0127 06	6913631 () BRWN CLAY 0016 BLUE CLAY STNS 0114 BLUE CLAY FSND 0125 BLUE MSND 0134
MARKHAM TOWN (MARKHA CON 05(020)	17 633175 4860843^{W}	1982/06 2407	06	FR 0051	006 / 030 004 / 10:0	DO		6916470 () BLUE HPAN STNS SAND 0051
MARKHAM TOWN (MARKHA CON 05(020)	17 634995 4861743^{W}	1977/07 3109	30 30	FR 0016	012 / / :0	DO		6914160 () LOAM 0002 BRWN CLAY STNY 0016 SAND GRVL 0036
MARKHAM TOWN (MARKHA CON 05(020)	17 633195 4861223^{W}	1973/09 5459	06	FR 0074	015 / 070 008 / 4:0	DO		6911860 () CLAY SAND 0020 CLAY STNS 0028 GRVL 0035 BLUE CLAY 0070 CLAY 0077
MARKHAM TOWN (MARKHA CON 05(020)	17 634935 4861823^{W}	1979/11 1350	06	FR 0065	005 / 035 010 / 2:0	DO		6915314 () GREY CLAY 0018 GREY SILT CLAY STNS 0065 GREY GRVL HPAN 0080
MARKHAM TOWN (MARKHA CON 05(020)	17 633995 4861293^{W}	1969/07 4610	06	FR 0093	-001 / 072 003 / 5:0	DO	0094 04	6909425 () PRDG 0036 BLUE CLAY MSND 0077 BLUE CLAY 0093 BLUE MSND 0097 BLUE CLAY GRVL MSND 0104
MARKHAM TOWN (MARKHA CON 05(020)	17 633235 4860823^{W}	1973/07 5459	06	FR 0154	020 / 135 010 / 2:30	DO	0155 08	6911526 () BRWN CLAY 0022 BLUE CLAY 0154 FSND 0163

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 06(014)	17 635965 4859378^W	1960/06 4610	01	FR 0050 FR 0043	006 / 012 020 / 6:0	NU	0127 10	6903791 () LOAM 0002 BRWN CLAY 0012 BLUE CLAY STNS 0042 MSND 0043 BLUE CLAY 0050 FSND 0100 MSND CLAY SILT 0110 FSND 0128 GRVL 0137 CLAY GRVL 0139 CLAY 0145 CLAY STNS 0205 SHLE 0215
MARKHAM TOWN (MARKHA CON 06(014)	17 635695 4859273^W	1960/07 4610	06	FR 0025	/ / :0	NU		6903792 () LOAM 0002 BLUE CLAY STNS 0025 FSND CLAY 0087 CLAY STNS 0175 CLAY BLDR 0177 CLAY STNS 0198 SHLE 0200
MARKHAM TOWN (MARKHA CON 06(014)	17 637546 4860054^W	1962/12 5420	05	FR 0105	016 / 020 007 / 12:0	DO		6903794 () PRDG 0030 BRWN MSND 0065 CLAY STNS MSND 0100 CLAY MSND 0108
MARKHAM TOWN (MARKHA CON 06(014)	17 635582 4859182^W	1966/07 2610	30	FR 0021	002 / 019 / :0	DO		6903796 () BRWN CLAY 0011 GREY CLAY 0021 GRVL 0026
MARKHAM TOWN (MARKHA CON 06(014)	17 636930 4859802^W	1962/03 1622	04	FR 0180	003 / 030 012 / 5:0	ST DO	0191 04	6903795 () BRWN CLAY 0018 GRVL BLDR 0050 GRVL CLAY 0180 CSND 0195
MARKHAM TOWN (MARKHA CON 06(014)	17 637555 4860003^W	1979/11 5206	06	FR 0105	020 / 100 005 / 4:30	DO	0114 03	6915260 () BRWN LOAM 0001 BRWN SAND CLAY 0048 GRVL CLAY HARD 0096 CLAY 0108 GREY SAND 0117
MARKHAM TOWN (MARKHA CON 06(014)	17 636160 4859483^W	1960/06 4610	05	FR 0032 FR 0003	-004 / 010 060 / 4:0	NU	0052 12	6903790 () LOAM 0002 BLUE CLAY 0005 GRVL 0006 BLUE CLAY 0032 MSND STNS 0050 MSND 0054 MSND STNS 0060 MSND CLAY 0061 FSND 0070 MSND CLAY 0074 GRVL HPAN 0086
MARKHAM TOWN (MARKHA CON 06(014)	17 635995 4859423^W	1960/07 4610	04	FR 0047	006 / 027 040 / 48:0	NU	0111 20	6903793 () LOAM 0001 BRWN CLAY 0002 BLUE CLAY 0047 MSND 0117 GRVL BLDR 0131 CLAY STNS 0175 GRVL CLAY 0177 CLAY MSND STNS 0201 SHLE 0205
MARKHAM TOWN (MARKHA CON 06(014)	17 636240 4859523^W	1960/06 4610	02	FR 0024 FR 0193	/ 020 006 / 10:0	IR	0193 13	6903789 () LOAM 0002 BLUE CLAY 0018 BLUE CLAY STNS 0024 GRVL CLAY 0036 CLAY STNS MSND 0040 CLAY BLDR 0043 BLUE CLAY 0100 GRVL CLAY 0137 BLDR 0139 GRVL CLAY 0170 GRVL CLAY BLDR 0193 GRVL CLAY 0206 CLAY STNS 0214 SHLE 0220
MARKHAM TOWN (MARKHA CON 06(015)	17 636471 4860003^L	2002/02 3903	12 10	FR 0112	/ 024 300 / 70:0	CO	0067 50	6926271 (227712) BRWN CLAY STNS HARD 0026 GREY CLAY SILT LYRD 0070 BRWN SAND CLAY LYRD 0112
MARKHAM TOWN (MARKHA CON 06(015)	17 635482 4859797^W	1995/05 3903	04 06		004 / / :0	DO		6923248 (26721) PRDG 0034
MARKHAM TOWN (MARKHA CON 06(016)	17 638041 4856420^W	2003/07 1663				NU		6927316 (253165)

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 06(016)	17 637355 4860943^{W}	1980/10 5459	06	FR 0121	025 / 121 030 / 2:0	DO	0121 03	6915749 () BRWN CLAY STNS 0039 BRWN SAND SILT 0059 GREY SAND STNS 0078 BLUE CLAY STNS 0092 BLUE CLAY SILT 0108 GREY SAND STNS 0127
MARKHAM TOWN (MARKHA CON 06(016)	17 637306 4861118^{W}	1998/11 3903				NU		6924751 (165712)
MARKHAM TOWN (MARKHA CON 06(016)	17 637232 4860506^{W}	1997/10 1663						6924242 (186409)
MARKHAM TOWN (MARKHA CON 06(016)	17 634978 4860184^{W}	 5459				NU		6927782 (Z05066) A004654
MARKHAM TOWN (MARKHA CON 06(016)	17 635445 4860478^{W}	1963/08 5420	05	FR 0058	016 / 025 008 / 4:0	DO ST	0058 04	6903798 () LOAM 0002 CLAY MSND 0055 MSND 0062
MARKHAM TOWN (MARKHA CON 06(016)	17 637347 4860927^{W}	1953/02 2419	02	FR 0038	033 / 033 003 / :0	 DO	0038 05	6903800 () GREY CLAY 0038 MSND 0043
MARKHAM TOWN (MARKHA CON 06(016)	17 636472 4860317^{W}	1964/04 5420	34	FR 0014	005 / / :0	DO		6903802 () LOAM 0001 YLLW CLAY 0008 BLUE CLAY 0014 CLAY MSND 0016
MARKHAM TOWN (MARKHA CON 06(016)	17 636783 4860448^{W}	1964/05 5420	34	FR 0021	021 / 002 / :0	 DO		6903803 () LOAM 0001 CLAY SILT 0012 FSND 0035
MARKHAM TOWN (MARKHA CON 06(016)	17 636443 4860402^{W}	1967/03 5420	34	FR 0025	014 / / :0	DO		6903805 () LOAM 0001 BRWN CLAY 0010 BLUE CLAY 0025 BLDR CLAY 0029
MARKHAM TOWN (MARKHA CON 06(016)	17 636445 4860373^{W}	1971/05 2407	05	FR 0082	008 / 090 005 / 2:0	DO	0088 03	6910688 () LOAM 0001 FILL 0009 BRWN MSND 0021 BLUE CLAY 0082 BLUE MSND 0091
MARKHAM TOWN (MARKHA CON 06(016)	17 637035 4860453^{W}	1968/08 5420	34	FR 0025	010 / / :0	 DO		6908810 () LOAM 0001 BRWN CLAY 0012 BLUE CLAY STNS 0023 BLUE CLAY MSND BLDR 0031
MARKHAM TOWN (MARKHA CON 06(016)	17 637404 4860612^{W}	1997/08 6926	01	FR 0010			0020 03	6924311 (174629) BRWN SILT CLAY SAND 0013 BRWN CLAY FSND DNSE 0023
MARKHAM TOWN (MARKHA CON 06(016)	17 636485 4860303^{W}	1969/06 2407	05	FR 0064	/ 088 030 / 12:0	ST	0092 04	6909188 () LOAM 0001 BRWN MSND 0024 BLUE CLAY MSND 0064 BLUE MSND 0096
MARKHAM TOWN (MARKHA CON 06(016)	17 637304 4861123^{W}	1998/11 3903				NU		6924750 (165713)
MARKHAM TOWN (MARKHA CON 06(016)	17 637220 4860500^{W}	1997/10 1663						6924241 (186408)
MARKHAM TOWN (MARKHA CON 06(016)	17 635485 4860229^{W}	2004/09 1413	06	FR 0197	072 / 164 007 / 1:0	DO ST		6928356 (Z19210) A006686 BRWN CLAY STNS HARD 0050 BRWN SAND PCKD 0097 GREY SAND MSND 0125 GREY CLAY STNS HARD 0164 GREY SHLE SOFT 0198

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 06(016)	17 635773 4860064^W	2004/09 1413	06	FR 0197	085 / 174 016 / 1:0	DO ST		6928357 (Z19211) A006687 BRWN CLAY STNS HARD 0040 GREY CLAY STNS HARD 0075 BRWN SAND LOOS 0137 GREY CLAY SILT GRVL 0177 GREY SHLE HARD 0198
MARKHAM TOWN (MARKHA CON 06(016)	17 637267 4860540^W	1960/12 1413	05	FR 0046	020 / 038 009 / 2:0	ST DO	0038 08	6903797 () CLAY STNS 0020 FSND 0046
MARKHAM TOWN (MARKHA CON 06(016)	17 637217 4860534^W	1960/10 5420	34	FR 0024	024 / 002 / :0	ST		6903799 () YLLW CLAY 0006 MSND 0032
MARKHAM TOWN (MARKHA CON 06(016)	17 636977 4860482^W	1964/01 5420	05	FR 0103	014 / 022 030 / 2:0	 DO	0114 04	6903801 () CLAY 0008 MSND SILT 0058 GREY CSND 0063 HPAN 0103 GREY MSND 0118
MARKHAM TOWN (MARKHA CON 06(016)	17 635859 4860281^W	1964/12 5420	05					6903804 () PRDG 0030 BLUE CLAY STNS 0075 BLUE FSND 0164 BLUE FSND CLAY 0192
MARKHAM TOWN (MARKHA CON 06(016)	17 635808 4860277^W	1990/04 4738	06	FR 0075	022 / 020 / 1:0	DO	0094 03	6920991 (78254) BRWN CLAY STNS 0027 GREY CLAY STNS 0075 GREY SAND VERY FSND 0090 GREY SAND MSND 0097
MARKHAM TOWN (MARKHA CON 06(018)	17 635268 4861523^W	1997/11 1663						6924245 (186425)
MARKHAM TOWN (MARKHA CON 06(018)	17 636234 4861213^L	2001/12 6418						6926232 (213180)
MARKHAM TOWN (MARKHA CON 06(018)	17 635267 4861523^W	1997/11 1663						6924236 (186427)
MARKHAM TOWN (MARKHA CON 06(018)	17 635267 4861523^W	1997/11 1663						6924243 (186426)
MARKHAM TOWN (MARKHA CON 06(018)	17 635846 4861104^W	1962/05 2113	06	FR 0060	018 / 040 012 / 8:0	DO	0059 05	6903808 () LOAM 0001 BRWN CLAY STNS 0030 GREY CLAY STNS 0060 GREY CLAY GRVL 0064
MARKHAM TOWN (MARKHA CON 06(018)	17 635690 4861041^W	1964/04 2113	06	FR 0041	/ 020 020 / 3:0	DO		6903810 () LOAM 0001 BRWN CLAY STNS 0012 GREY CLAY 0041 BRWN GRVL 0042
MARKHAM TOWN (MARKHA CON 06(018)	17 638185 4856899^W	1999/12 1663				NU		6925248 (213428)
MARKHAM TOWN (MARKHA CON 06(018)	17 635268 4861523^W	1997/11 1663						6924244 (186424)
MARKHAM TOWN (MARKHA CON 06(018)	17 637150 4861680^W	1962/03 5420	34	FR 0048	015 / / :0	 DO		6903807 () LOAM 0001 YLLW CLAY 0014 BLUE CLAY STNS 0048 CSND 0050
MARKHAM TOWN (MARKHA CON 06(018)	17 637031 4861480^W	1962/08 5420	34	FR 0028	030 / / :0	 DO		6903809 () LOAM 0001 YLLW CLAY 0017 CLAY MSND 0028 CSND 0042

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MARKHAM TOWN (MARKHA CON 06(018)	17 635458 4860962^{W}	1964/06 2113	06	FR 0045	/ 024 005 / 2:0	DO	0045 04	6903811 () LOAM 0001 BRWN CLAY 0009 BRWN GRVL MSND 0024 GREY CLAY STNS 0034 BRWN FSND 0040 BRWN FSND STNS 0045 BRWN FSND 0049
MARKHAM TOWN (MARKHA CON 06(018)	17 635438 4860992^{W}	1965/07 5420	34	FR 0020	/ 010 / :0	DO		6903812 () LOAM 0001 BRWN CLAY 0008 BLUE CLAY 0020 FSND 0024
MARKHAM TOWN (MARKHA CON 06(018)	17 635315 4861023^{W}	1981/06 3109	30	FR 0011	007 / / 12:0	DO		6915926 () LOAM 0001 BRWN CLAY SLTY 0011 BLUE CLAY STNY 0027
MARKHAM TOWN (MARKHA CON 06(019)	17 635275 4861183^{W}	1979/11 3109	30	FR 0027	012 / / 8:0	DO		6915257 () LOAM 0002 BRWN CLAY SLTY 0016 BLUE CLAY SLTY 0027 CSND 0030
MARKHAM TOWN (MARKHA CON 06(019)	17 636154 4861608^{L}	2001/01 1663				NU		6925824 (227400)
MARKHAM TOWN (MARKHA CON 06(019)	17 637175 4861743^{W}	1978/07 2651	06	FR 0112	043 / 020 / 2:0	DO	0116 04	6914959 () BRWN CLAY SAND 0017 GREN CLAY SAND GRVL 0111 GREN MSND 0124
MARKHAM TOWN (MARKHA CON 06(020)	17 636317 4862285^{W}	1962/10 5420	34	FR 0030 FR 0050	026 / / :0	DO ST		6903816 () LOAM 0001 YLLW CLAY 0012 BLUE CLAY STNS 0050 MSND CLAY 0051
MARKHAM TOWN (MARKHA CON 06(020)	17 635555 4861663^{W}	1979/12 3108	06	UK 0108	038 / 110 060 / 0:30	DO	0113 06	6915377 () YLLW CLAY 0015 CLAY GRVL 0061 BLUE CLAY SNDY 0081 BLUE CLAY GVLY 0108 BLUE SAND 0119
MARKHAM TOWN (MARKHA CON 06(020)	17 637003 4862529^{W}	1974/08 1413	05			NU		6912293 () BRWN SILT HPAN 0003 GREY SILT CLAY HPAN 0022 GREY SILT SAND STNS 0076 GREY SILT CLAY 0100 GREY FSND STNS 0187 GREY SAND SILT 0205 GREY SHLE 0210
MARKHAM TOWN (MARKHA CON 06(020)	17 635385 4861780^{W}	1962/09 5420	34	FR 0020	018 / / :0	ST DO		6903815 () LOAM 0001 YLLW CLAY STNS 0012 CLAY MSND 0020 GRVL 0029
MARKHAM TOWN (MARKHA CON 06(020)	17 635593 4861687^{W}	1998/06 1663				NU		6924562 (190437)
MARKHAM TOWN (MARKHA CON 06(020)	17 636494 4862297^{W}	1998/11 1663				NU		6924791 (198163) BRWN SAND CLAY 0000 YLLW SAND 0008 BRWN SAND CLAY 0009 YLLW SAND 0050
MARKHAM TOWN (MARKHA CON 06(020)	17 638274 4862986^{W}	2002/05 1663				NU		6926475 (240051)
MARKHAM TOWN (MARKHA CON 06(020)	17 638278 4862992^{W}	2002/05 1663				NU		6926474 (240050)
MARKHAM TOWN (MARKHA CON 06(020)	17 636075 4862011^{L}	2003/07 5459	36			NU		6927158 (264104)

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Borehole and Monitoring Well Logs

PROJECT: 1413472
LOCATION: SEE FIGURE 2

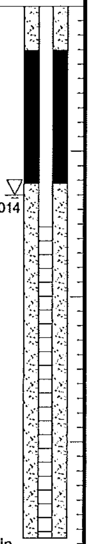
RECORD OF BOREHOLE: 14-1

BORING DATE: November 19, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		180.50							
0	CME 85 Truck Mount 203 mm O.D. Hollow Stem Augers	ASPHALT (100 mm)		0.00							Sand
		FILL - (SM) SILTY SAND, some clay, trace gravel; grey, trace organics, moist, loose		0.10	1	SS	9				
		(SP) SAND with clay, trace gravel, trace silt; brown with red iron mottling; non-cohesive, moist, compact		179.81 0.69	2	SS	11				Bentonite
1											Sand Nov. 19, 2014
		(SW) SAND, some silt; brown; wet, loose to compact		179.05 1.45	3	SS	7				
2					4	SS	14				Screen
3		(SW) SAND, some silt, some gravel; brown; wet, compact		177.53 2.97	5	SS	12				
		END OF BOREHOLE		176.84 3.66							1. Water level in piezometer measured at a depth of 1.30 m below ground surface (Elev. 178.7 m) on November 19, 2014.
4											
5											
6											
7											
8											
9											
10											



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-2

SHEET 1 OF 1

BORING DATE: November 18, 2014

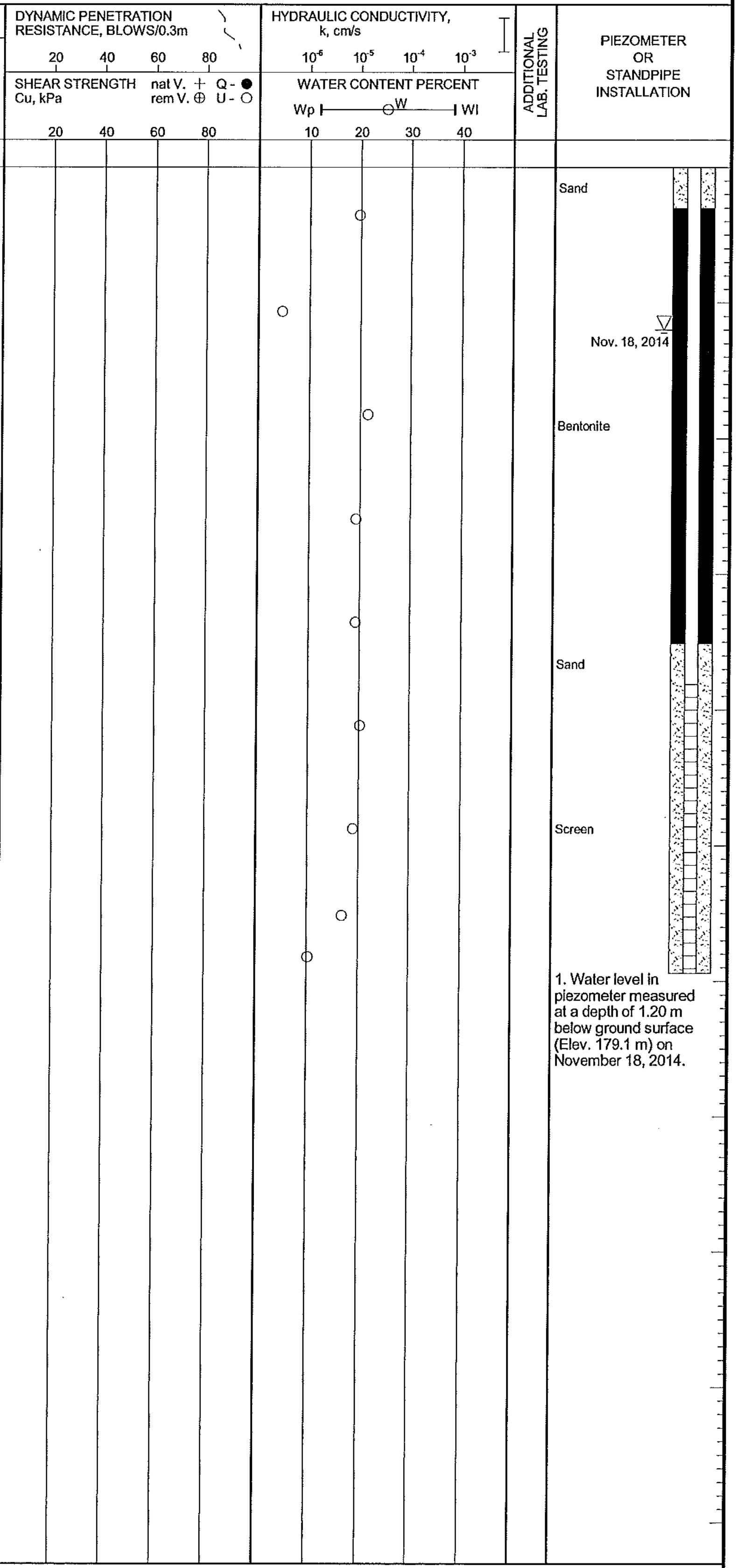
DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

BORING METHOD: CME 85 Truck Mount; 203 mm O.D. Hollow Stem Augers

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	180.30			
CONCRETE (100 mm)	0.00			
FILL - (SW) Gravelly SAND, angular, well graded; brown; non-cohesive	0.10	1	SS	5
		2	SS	14
(ML) SILT, some clay; brown; cohesive, wet, firm	178.85 1.45	3	SS	7
(SM) SILTY SAND, trace gravel; brown; non-cohesive, wet, loose to compact	178.01 2.29	4	SS	11
		5	SS	8
		6	SS	4
		7	SS	20
		8A	SS	32
(ML) Sandy SILT, some gravel; grey (TILL); non-cohesive, dense, wet	174.60 5.70	8B		
END OF BOREHOLE	174.36 5.94			



1. Water level in piezometer measured at a depth of 1.20 m below ground surface (Elev. 179.1 m) on November 18, 2014.

DEPTH SCALE
1 : 50

LOGGED: DG
CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-3

BORING DATE: November 18, 2014

SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

BORING METHOD: CME 85 Truck Mount, 203 mm O.D. Hollow Stem Augers

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

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

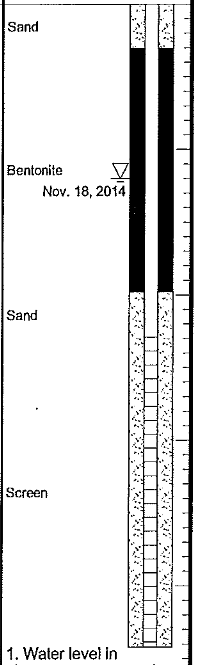
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ├──○W──┤ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	180.20			
0	CONCRETE (100 mm)	0.00			
	Hydro-vacuumed and unsampled	0.10			
	(ML) Sandy SILT, trace gravel; brown; non-cohesive, loose, wet	177.91 2.29	1	SS	7
			2	SS	5
	(SW) SAND, some gravel, brown; non-cohesive, wet, compact	176.54 3.66	3	SS	16
	END OF BOREHOLE	175.78 4.42			

PIEZOMETER OR STANDPIPE INSTALLATION



1. Water level in piezometer measured at a depth of 1.20 m below ground surface (Elev. 179.00 m) on November 18, 2014.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-4

BORING DATE: November 19, 2014

SHEET 1 OF 1

DATUM: Geodetic

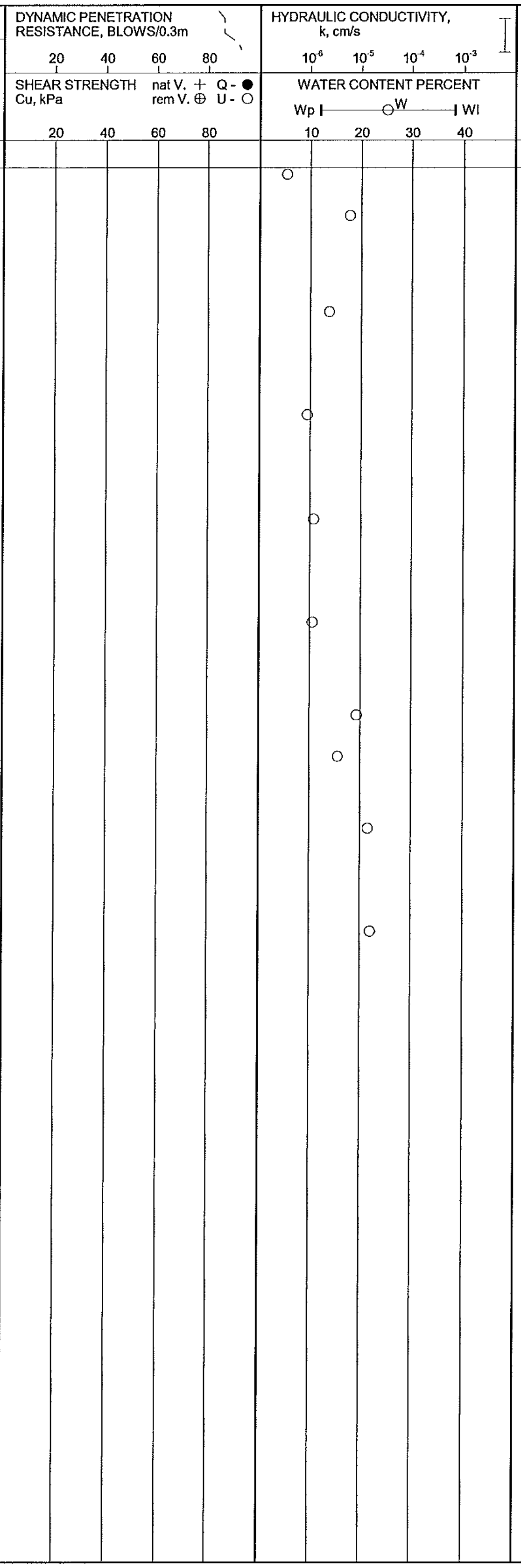
HAMMER TYPE: AUTOMATIC

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

BORING METHOD: CME 85 Truck Mount; 203 mm O.D. Hollow Stem Augers

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
	GROUND SURFACE	181.30
0	FILL - SAND and GRAVEL; grey; non-cohesive, dry	0.00
	(ML) CLAYEY SILT; brown; cohesive, w<PL, stiff	0.10
	(ML) CLAYEY SILT, some sand, some gravel; brown, (TILL-LIKE); cohesive, w~PL, firm	180.69 0.61
	(ML) CLAYEY SILT, some sand, some gravel; brown (TILL); cohesive, w~PL, stiff to very stiff	179.90 1.40
	(ML) SILT, some sand; brown; non-cohesive, wet, dense	177.57 3.73
	(SW) SAND, well graded, some silt; brown with orange mottling, stratified; non-cohesive, wet, dense	177.03 4.27
	(ML) SILT, some sand; brown, zones of silty fine sand; non-cohesive, wet, dense	4.42
6	END OF BOREHOLE	175.36 5.94

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1A	SS	
1B	SS	11
2	SS	6
3	SS	11
4	SS	24
5	SS	25
6A	SS	45
6B	SS	
7	SS	30
8	SS	22



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

LOGGED: DG

CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-5

BORING DATE: November 19, 2014

SHEET 1 OF 1

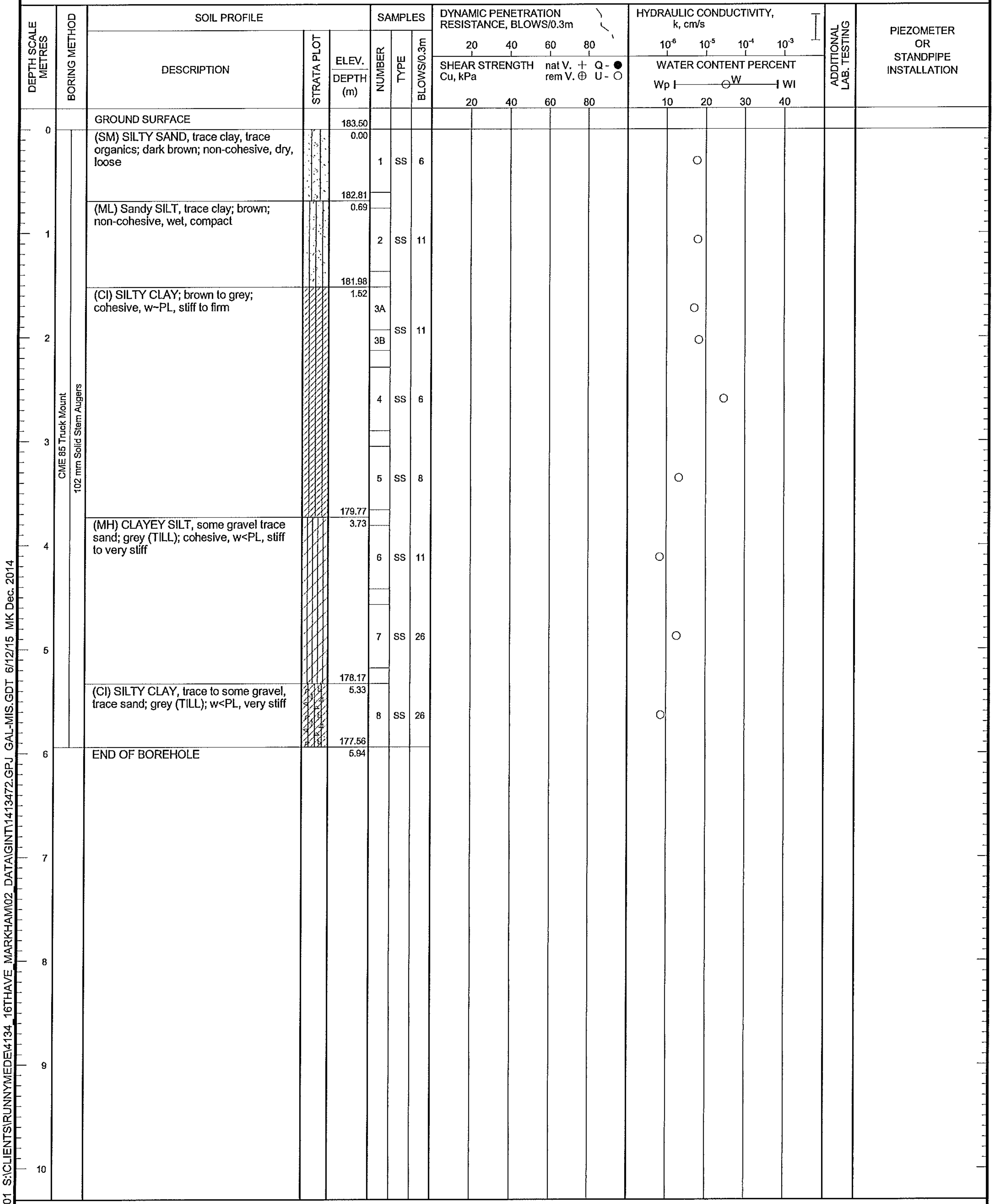
DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

BORING METHOD: CME 85 Truck Mount; 102 mm Solid Stem Augers

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE		183.50			
(SM) SILTY SAND, trace clay, trace organics; dark brown; non-cohesive, dry, loose		0.00	1	SS	6
(ML) Sandy SILT, trace clay; brown; non-cohesive, wet, compact		182.81 0.69	2	SS	11
(CI) SILTY CLAY; brown to grey; cohesive, w~PL, stiff to firm		181.98 1.52	3A 3B	SS	11
			4	SS	6
			5	SS	8
(MH) CLAYEY SILT, some gravel trace sand; grey (TILL); cohesive, w<PL, stiff to very stiff		179.77 3.73	6	SS	11
			7	SS	26
(CI) SILTY CLAY, trace to some gravel, trace sand; grey (TILL); w<PL, very stiff		178.17 5.33	8	SS	26
END OF BOREHOLE		177.56 5.94			



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-6

BORING DATE: November 19, 2014

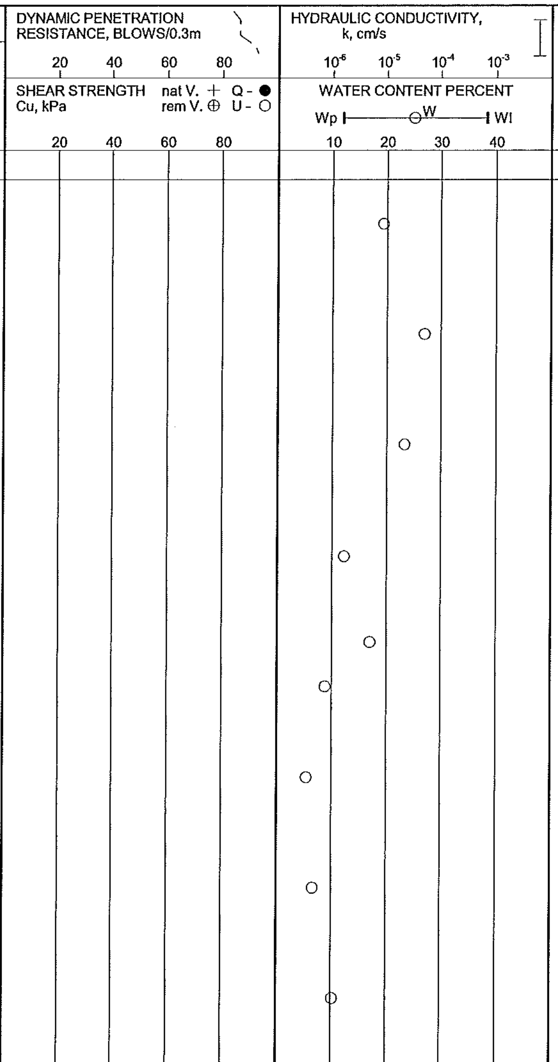
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		192.10			
0	CME 85 Truck Mount 102 mm Solid Stem Augers	(SM) SILTY SAND, trace to some gravel; mottled brown and orange; non-cohesive, loose		0.00	1	SS	4
				191.34			
1		(CL) SILTY CLAY; light brown to grey; cohesive, w>PL, soft to stiff		0.76	2	SS	4
2					3	SS	8
				189.89			
		(ML) CLAYEY SILT, some gravel; grey, with layers of silty clay (TILL-LIKE); cohesive, w<PL, stiff		2.21	4	SS	8
3				189.05			
		(ML) SILT, trace sand, trace gravel; grey; non-cohesive, wet, compact		3.05	5A 5B	SS	14
				188.29			
4		(SP) SAND, angular to sub-angular, poorly graded, trace gravel; grey; non-cohesive, dense, moist		3.81	6	SS	25
				187.60			
5		(SW) Gravelly SAND, trace silt; grey; non-cohesive, compact		4.50	7	SS	17
				186.77			
		(ML) CLAYEY SILT; grey, stratified; cohesive, w<PL, hard		5.33	8	SS	36
				186.16			
6		END OF BOREHOLE		5.94			
7							
8							
9							
10							



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-7

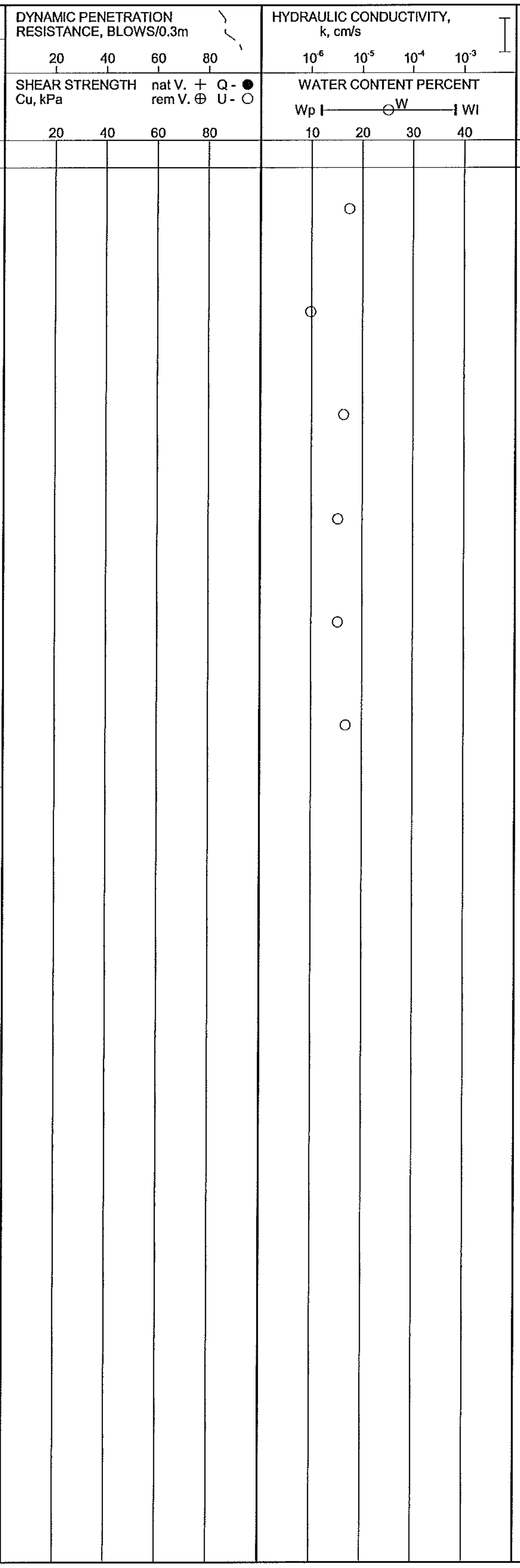
BORING DATE: November 20, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

BORING METHOD: Boomer Track Mount
102 mm Solid Stem Augers

SOIL PROFILE		SAMPLES		
DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	189.60 0.00			
FILL - (ML) CLAYEY SILT, some organics, trace gravel; brown; cohesive, w<PL, firm		1	SS	8
FILL - (CL) SILTY CLAY; grey-brown; cohesive, w~PL, stiff	188.84 0.76	2	SS	9
FILL - (ML) CLAYEY SILT, some sand, trace gravel; brown; cohesive, w<PL, stiff	188.08 1.52	3	SS	12
FILL - (SM) SILTY SAND, trace gravel; mottled brown; non-cohesive, moist, loose	187.39 2.21	4	SS	9
FILL - (ML) CLAYEY SILT, trace gravel; brown; cohesive, w<PL, firm	186.55 3.05	5	SS	7
FILL - (CL) SILTY CLAY; grey-brown; cohesive, w~PL, stiff	185.79 3.81	6	SS	11
END OF BOREHOLE ON CONCRETE PIPE	185.03 4.57			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

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

DEPTH SCALE
1 : 50

LOGGED: DG
CHECKED: SDK

GTA-BHS 001 S:\CLIENTS\RUNNYMEDE\4134 16THAVE_MARKHAM\02_DATA\GINT\1413472.GPJ GAL-MIS.GDT 6/12/15 MK Dec. 2014

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-8

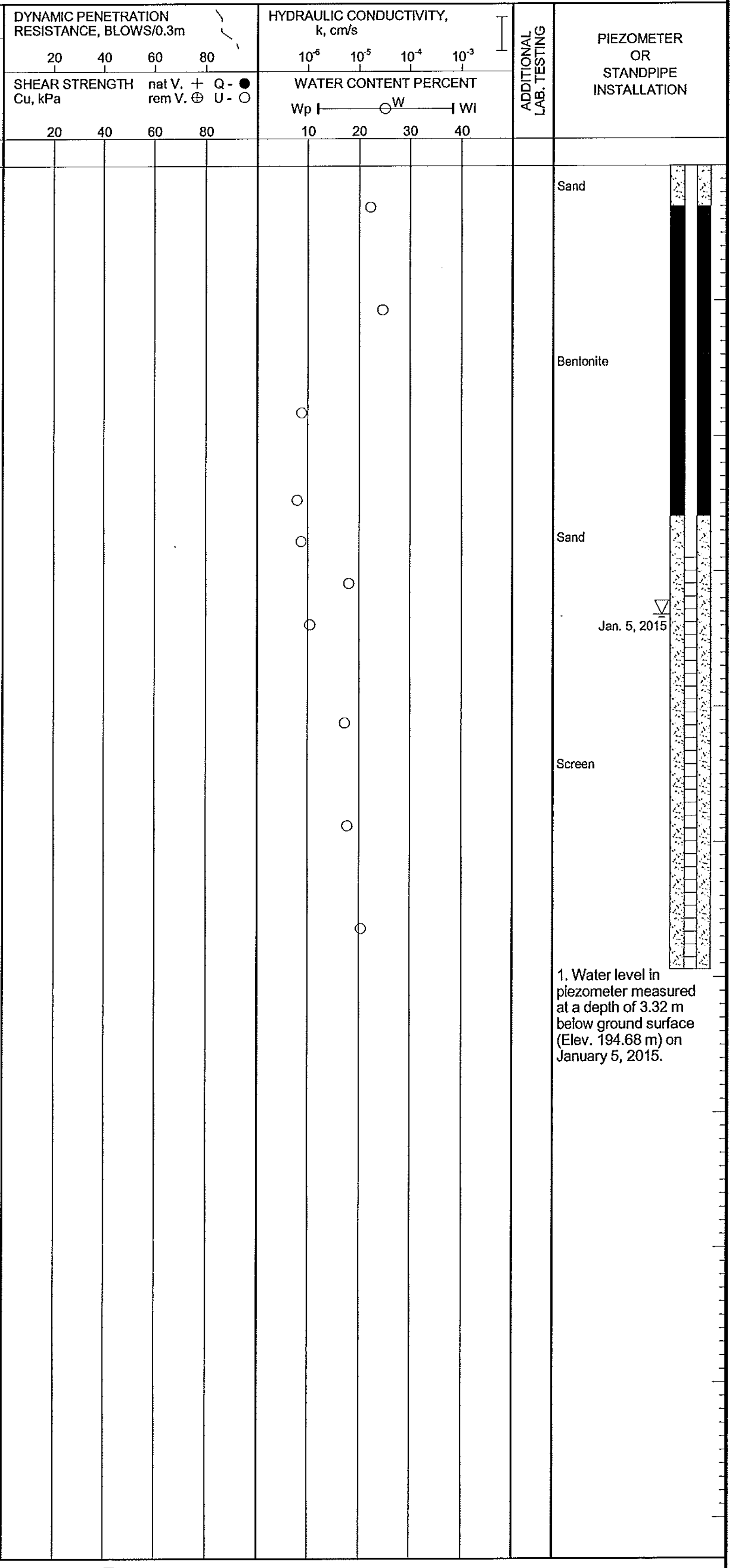
BORING DATE: November 20, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

BORING METHOD: Boomer Track Mount, 102 mm Solid Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	198.00			
(CL) SILTY CLAY, trace sand, trace gravel; mottled grey-brown, organic inclusions in upper 0.3 m, layers of sandy silt below a depth of 1.0 m; cohesive, w~PL, firm to stiff	0.00	1 2	SS SS	7 13
(SM) SILTY SAND, trace clay, trace gravel; brown to grey (TILL); non-cohesive, moist, compact	196.55 1.45	3 4A 4B	SS SS	13 16
(SW) SAND; grey; non-cohesive, moist, dense	195.03 2.97	5A	SS	
(ML) SILT, some clay, trace sand, trace gravel; grey (TILL); cohesive, moist, very stiff	3.12	5B		27
(SW) SAND; brown; non-cohesive, wet, compact	194.34 3.66	6 7	SS SS	19 23
(SM) SILTY SAND; brown; non-cohesive, compact, wet	192.74 5.26	8	SS	13
END OF BOREHOLE	192.06 5.94			



1. Water level in piezometer measured at a depth of 3.32 m below ground surface (Elev. 194.68 m) on January 5, 2015.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-9

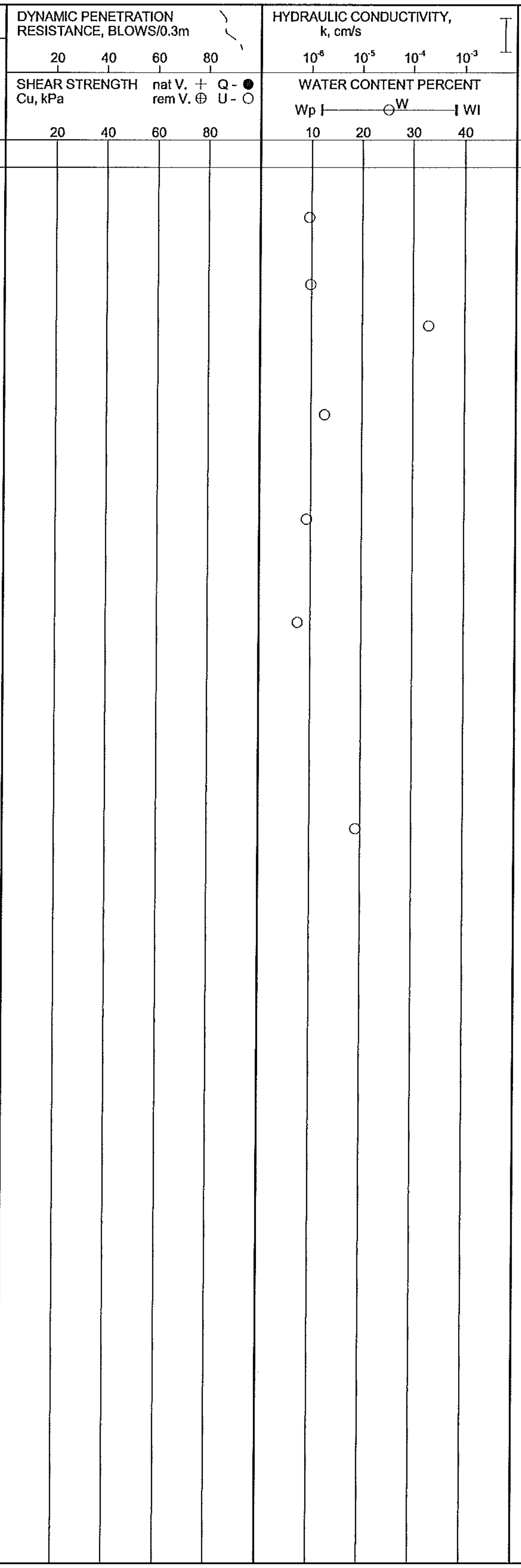
BORING DATE: December 10, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

BORING METHOD: Mini Mole; 102 mm Solid Stem Augers

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	181.70					
FILL-Topsoil (130 mm)	0.00	1A	SS			
FILL - (SM) SILT SAND, trace clay, trace to some gravel; trace organics; brown to grey, moist, compact	0.13	1B		23		
	180.73	2A	SS	9		
TOPSOIL	0.97	2B				
(ML) CLAYEY SILT, some sand, some gravel; brown, zones of fine sand and gravel (TILL); w<PL, very stiff	180.33 1.37	3	SS	26		
(ML) CLAYEY SAND, some gravel, some silt, brown to grey (TILL); cohesive, moist, very stiff to hard	179.34 2.36	4	SS	29	MH	
		5	SS	34		∇ Dec. 10, 2014
(CI) SILTY CLAY, trace sand, trace gravel; grey, zones of silt; cohesive, w<PL, very stiff	177.59 4.11	6	SS	28	MH	
END OF BOREHOLE	176.52 5.18					1. Water level in open borehole measured at a depth of 3.7 m below ground surface (Elev. 177.70 m) on December 10, 2014.



DEPTH SCALE 1 : 50

LOGGED: DG
CHECKED: SDK

Golder Associates

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PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-10

BORING DATE: December 10, 2014

SHEET 1 OF 1

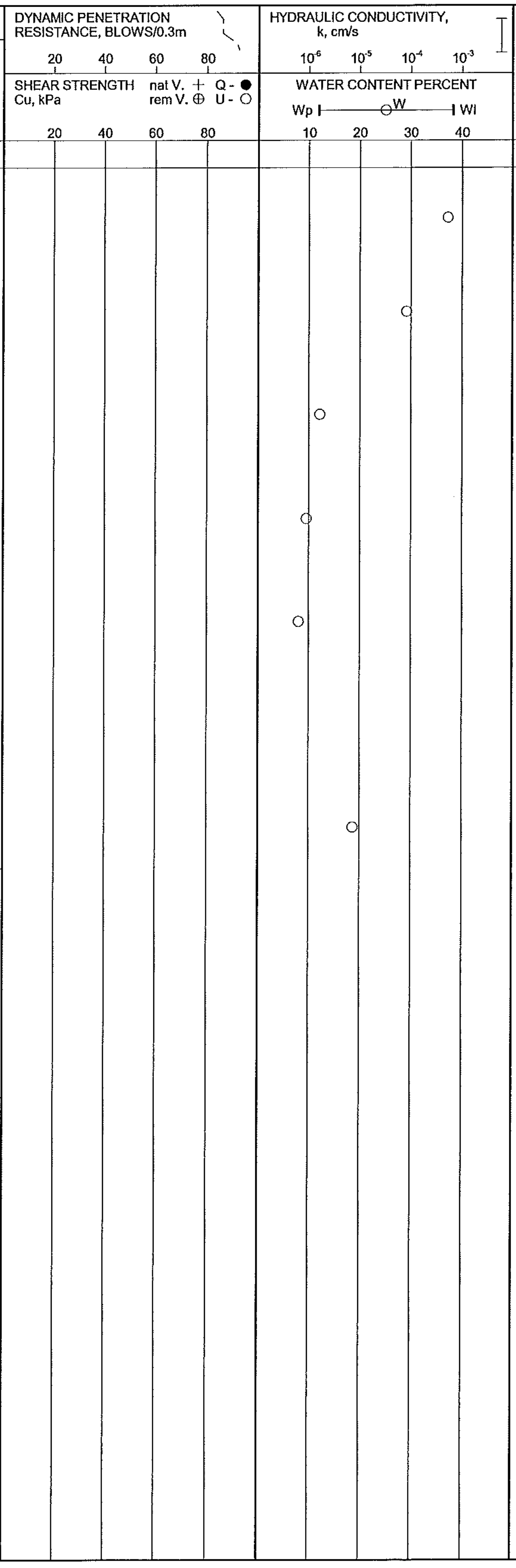
DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

BORING METHOD: Mini Mole, 102 mm Solid Stem Augers

SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	188.60				
TOPSOIL (130 mm)	0.00	1A			
(CI) SILTY CLAY; brown, stratified; cohesive, moist, stiff	0.13	1B	SS	11	
		2	SS	11	
(SM) SILTY SAND, some gravel, trace clay; brown, containing fissures with oxidation, containing cobbles and boulders (TILL); non-cohesive, moist to dry, compact to very dense	187.15 1.45	3	SS	12	MH
		4	SS	73	
		5	SS	76	
(SM) SILTY SAND, trace clay, trace gravel; brown; non-cohesive, moist, compact	184.49 4.11	6	SS	29	
END OF BOREHOLE	183.42 5.18				



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

PIEZOMETER OR STANDPIPE INSTALLATION

Dec. 10, 2014

1. Water level in open borehole measured at a depth of 4.6 m below ground surface (Elev. 184.61 m) on December 10, 2014.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-11

BORING DATE: December 10, 2014

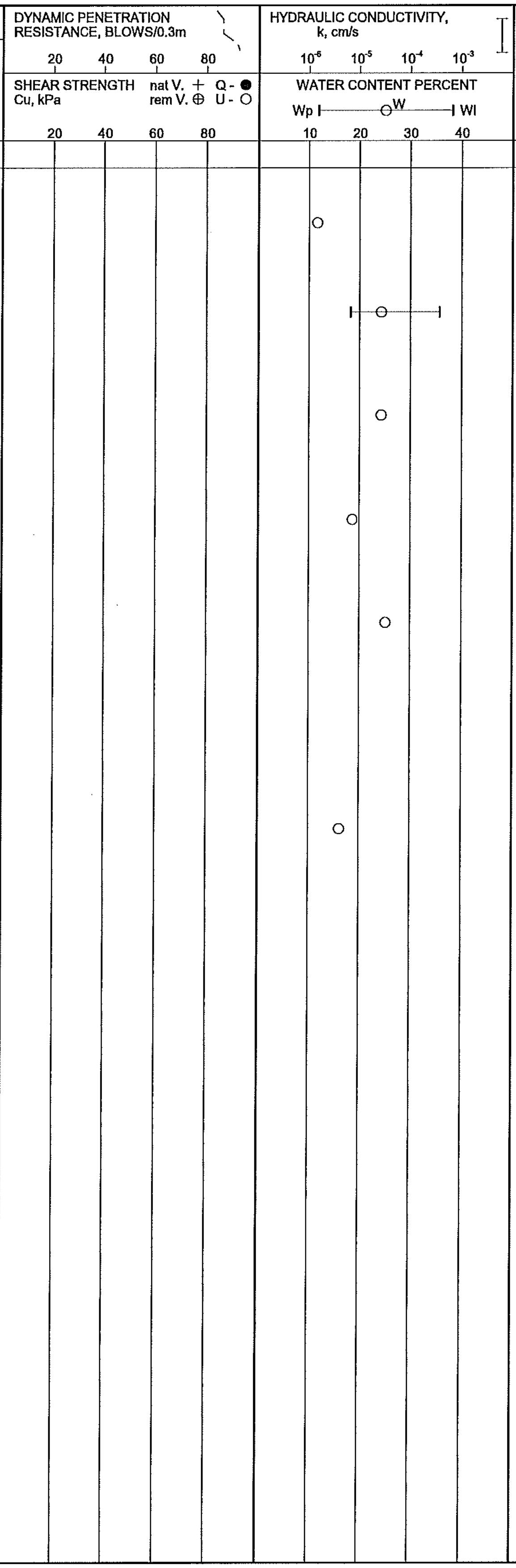
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		182.20					
0	Mini Mole 102 mm Solid Stem Augers	TOPSOIL		0.00 182.00	1A				
		(SM) SILTY SAND, trace gravel; brown, organic staining; non-cohesive, dry, compact		0.20	1B	SS	13		
1		(CI) SILTY CLAY, trace sand, trace to some gravel; brown to grey, some layering; cohesive, w<PL, stiff to very stiff		181.44 0.76	2	SS	17		
2		0.08 m sand seam at a depth of 1.83 m			3	SS	21		
					4	SS	22		
3					5	SS	22		
4		(SM) SILTY SAND, some gravel, trace clay; grey (TILL); non-cohesive, wet, compact		178.09 4.11					
5					6	SS	16	MH	
		END OF BOREHOLE		177.02 5.18					
6									
7									
8									
9									
10									



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

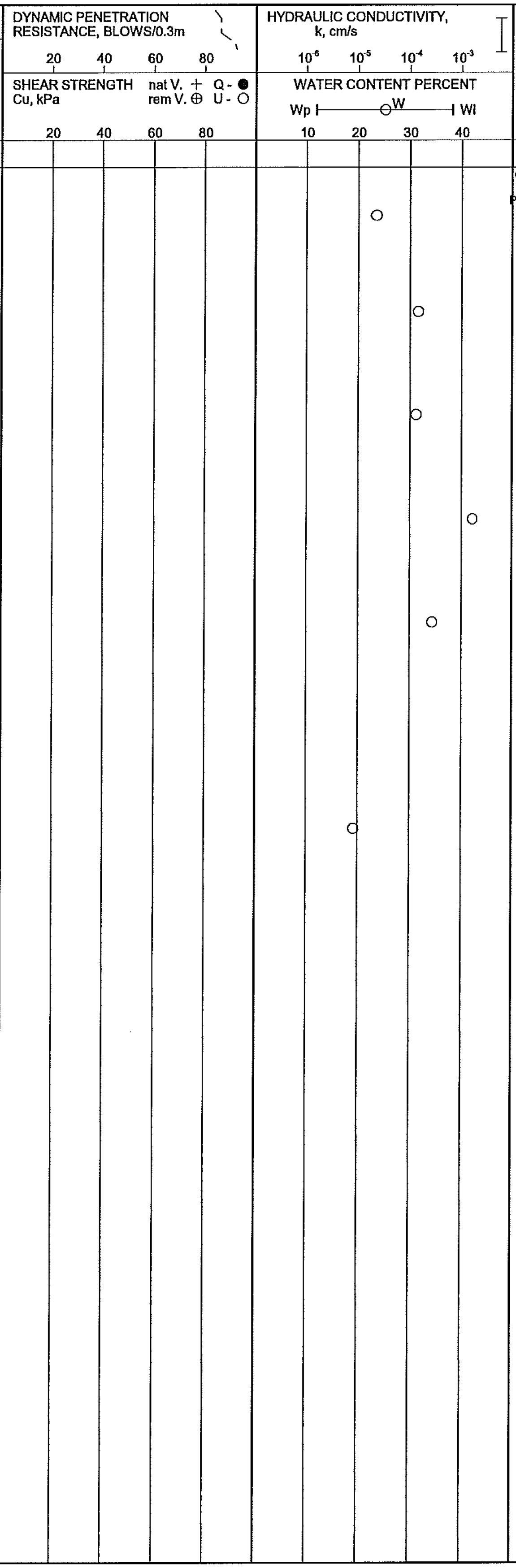
RECORD OF BOREHOLE: 14-12

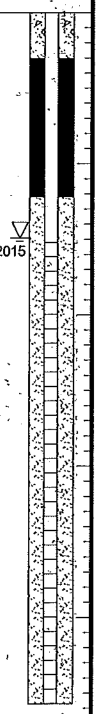
BORING DATE: December 16, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	180.80					
0	Mini Mole 102 mm Solid Stem Augers	TOPSOIL	0.00	1A			OP OC Nitrate Phospate	Cement
		(CI) SILTY CLAY; brown to grey, stratified; cohesive, w>PL, firm to soft	0.10	1B	SS	7		Sand
								Bentonite
1				2	SS	8	M&I	
								Sand
2				3	SS	4		
				4	SS	3		
3		(CI) SILTY CLAY, trace sand, trace gravel; (TILL-LIKE); cohesive, w>PL, soft	177.83 2.97	5	SS	4		Screen
4		(SW) SAND, some silt; grey; non-cohesive, wet, loose	176.69 4.11	6	SS	N/R		
5		END OF BOREHOLE *N/R - Not Recorded	175.62 5.18					





1. Water level in piezometer measured at a depth of 1.49 m below ground surface (Elev. 179.31 m) on January 5, 2015.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

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PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-13

BORING DATE: December 16, 2014

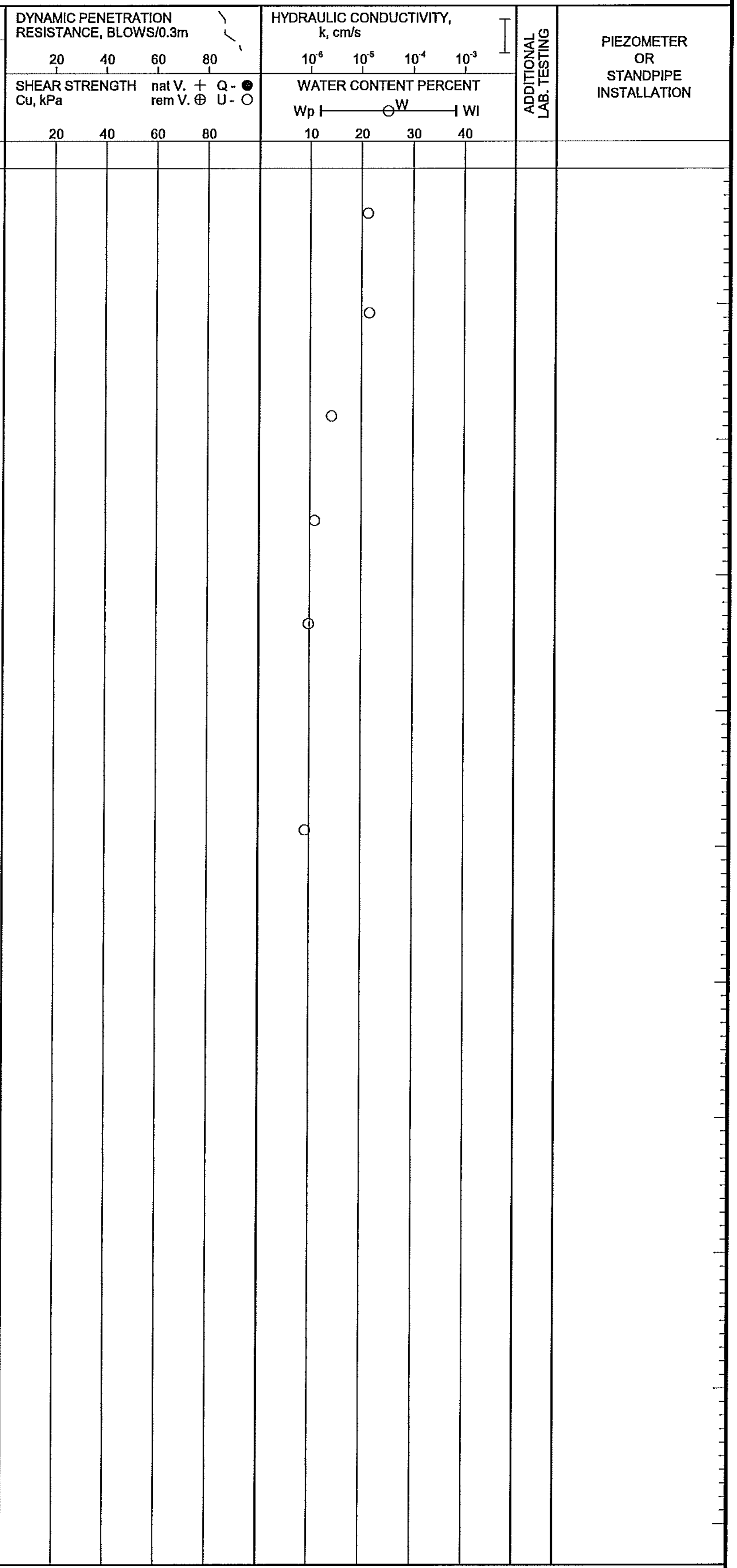
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	180.90			
TOPSOIL	0.00 0.05	1A	SS	
(CI) SILTY CLAY; mottled grey-brown; cohesive, w~PL, soft to firm		1B		3
		2	SS	8
(ML) CLAYEY SILT, some sand, some gravel; grey; cohesive, w<PL, stiff	179.45 1.45	3	SS	18
		4	SS	11
(ML) Sandy SILT, some clay; grey; non-cohesive, moist, dense	177.93 2.97	5	SS	46
		6	SS	38
END OF BOREHOLE	175.72 5.18			



DEPTH SCALE

1 : 50

LOGGED: EWB

CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-14

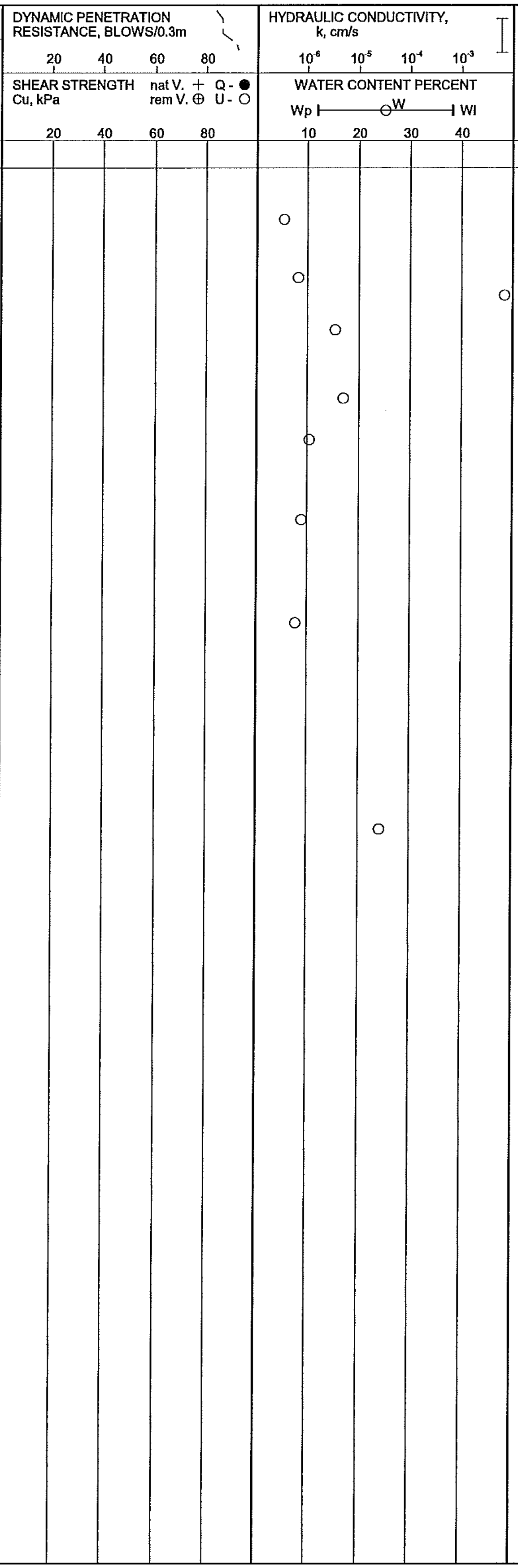
BORING DATE: December 9, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

BORING METHOD: Mini Mole
102 mm Solid Stem Augers

SOIL PROFILE			SAMPLES			ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m		
GROUND SURFACE		176.30					
FILL - TOPSOIL (150 mm)		0.00	1A				
FILL - (SM) SILTY SAND, some gravel, trace clay; mottled brown and grey; non-cohesive, moist, compact		0.15	1B	SS	22		
		175.44	2A				
TOPSOIL		0.86	2B	SS	12		
(SW) SAND, some gravel; brown; non-cohesive, wet, compact		1.02	2C				
			3A	SS	28		
(SM) SILTY SAND, some gravel, trace to some clay; brown to grey (TILL); moist, compact to dense		174.42 1.88	3B				
			4	SS	20		
			5	SS	40		
(ML) SILT, some sand, trace clay; grey; non-cohesive, w>PL, very stiff		172.19 4.11	6	SS	21	MH	
END OF BOREHOLE		171.12 5.18					



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

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-15

SHEET 1 OF 1

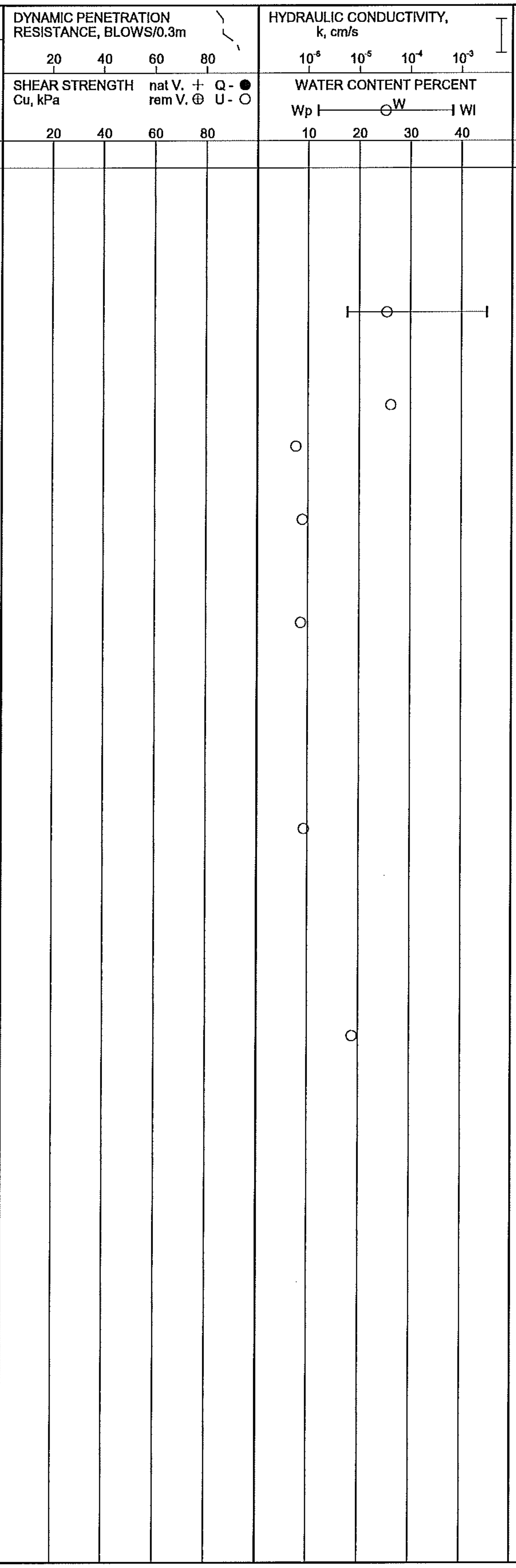
BORING DATE: December 9, 2014

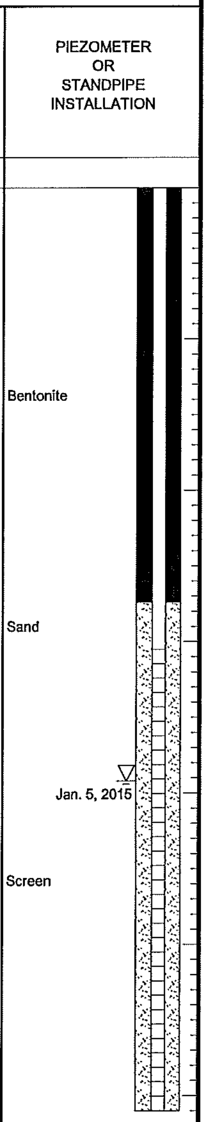
DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING
		GROUND SURFACE	179.70				
0	Mini Mole 102 mm Solid Stem Augers	TOPSOIL	0.00	1A			
		(SP) SAND, some gravel; brown; non-cohesive, dry, loose	0.15	1B	SS	7	
		(CI) SILTY CLAY, some sand, some gravel; mottled brown-grey, stratified; cohesive, w>PL, firm to very stiff	0.27	1C			
1				2	SS	13	
			177.72	3A	SS	34	
2		(SM) SILTY SAND, some gravel; brown to grey (TILL); non-cohesive, moist, compact to dense	1.98	3B			
				4	SS	17	
3				5	SS	31	
4							
5				6	SS	32	
			174.06				
		(SM) SILTY SAND; grey; non-cohesive, compact	5.64				
6				7	SS	20	MH
			172.99				
		END OF BOREHOLE	6.71				
7							
8							
9							
10							





1. Water level in piezometer measured at a depth of 3.92 m below ground surface (Elev. 175.78 m) on January 5, 2015.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

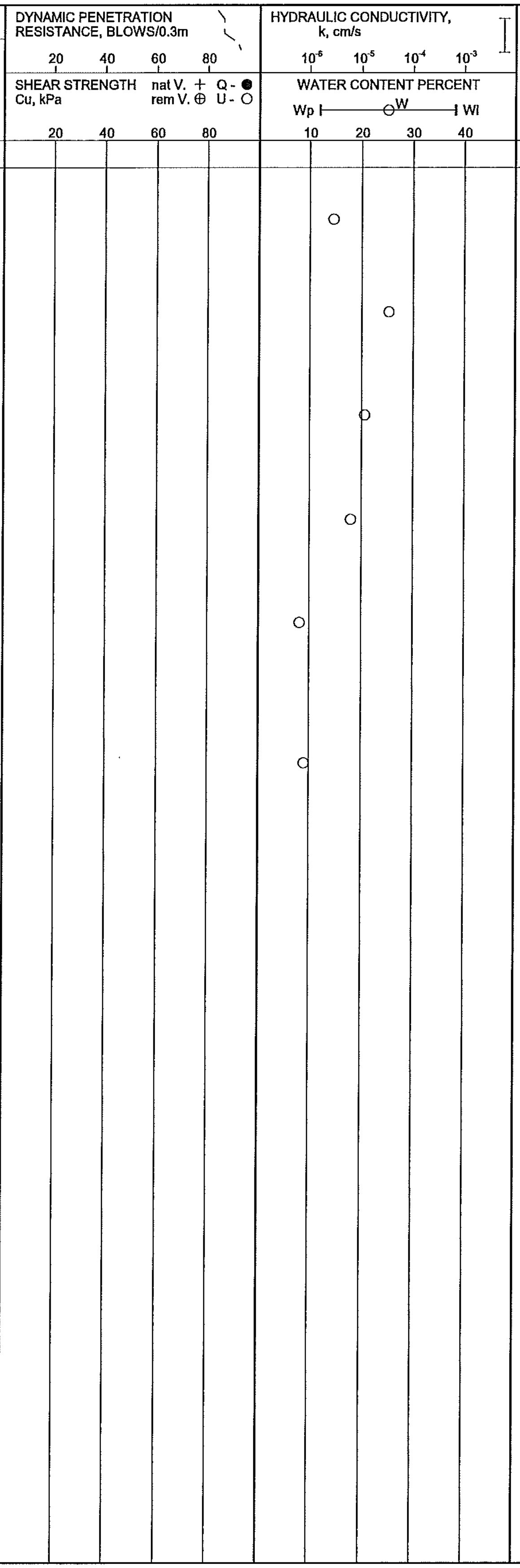
RECORD OF BOREHOLE: 14-16

BORING DATE: December 9, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	181.30			
Mini Mole 102 mm Solid Stem Augers	TOPSOIL	0.00	1A		
	(SP) SAND, trace gravel; brown; non-cohesive, dry, compact	0.15	1B	SS	11
	(CI) SILTY CLAY; brown, varved, containing sand seams at a depth of 1.07 m; cohesive, w>PL, stiff	180.61 0.69	2	SS	12
	(CL) SILTY CLAY, trace sand, trace gravel; brown, stratified; cohesive, w~PL, very stiff	179.85 1.45	3 4	SS SS	24 23
	(SM) SILTY SAND, some gravel; grey (TILL); non-cohesive, moist, compact	178.33 2.97	5	SS	17
	(ML) CLAYEY SILT, some sand, some gravel; grey (TILL); cohesive, w<PL, hard	177.19 4.11	6	SS	50/ 0.10
	END OF BOREHOLE	176.63 4.67			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

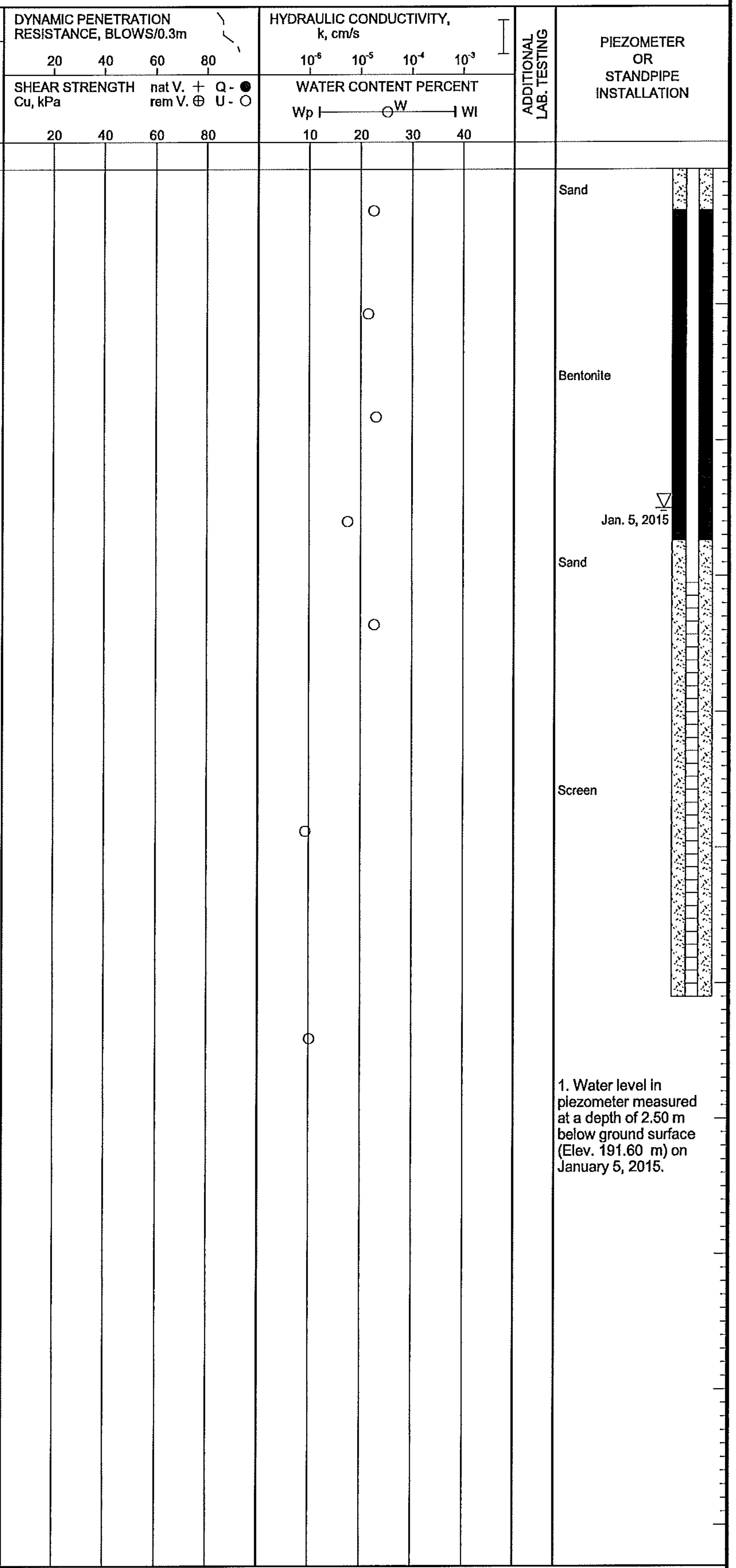
RECORD OF BOREHOLE: 14-17

BORING DATE: December 15, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m
		GROUND SURFACE		194.10			
0		FILL - (ML) CLAYEY SILT, trace sand, trace gravel, some organics; dark brown; cohesive, firm to very stiff		0.00	1	SS	6
1					2	SS	12
2					3	SS	22
					4	SS	22
3		(CI) SILTY CLAY; mottled brown-grey; cohesive, w>PL, very stiff		191.13 2.97	5	SS	24
4		(ML) Sandy SILT, some clay, some gravel; mottled grey-brown (TILL); non-cohesive, moist, very dense		189.99 4.11			
5					6	SS	50
6		(ML) CLAYEY SILT, some sand, some gravel; grey (TILL); cohesive, w<PL, very stiff		188.46 5.64	7	SS	26
		END OF BOREHOLE		187.39 6.71			
7							
8							
9							
10							



1. Water level in piezometer measured at a depth of 2.50 m below ground surface (Elev. 191.60 m) on January 5, 2015.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: EWB
CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

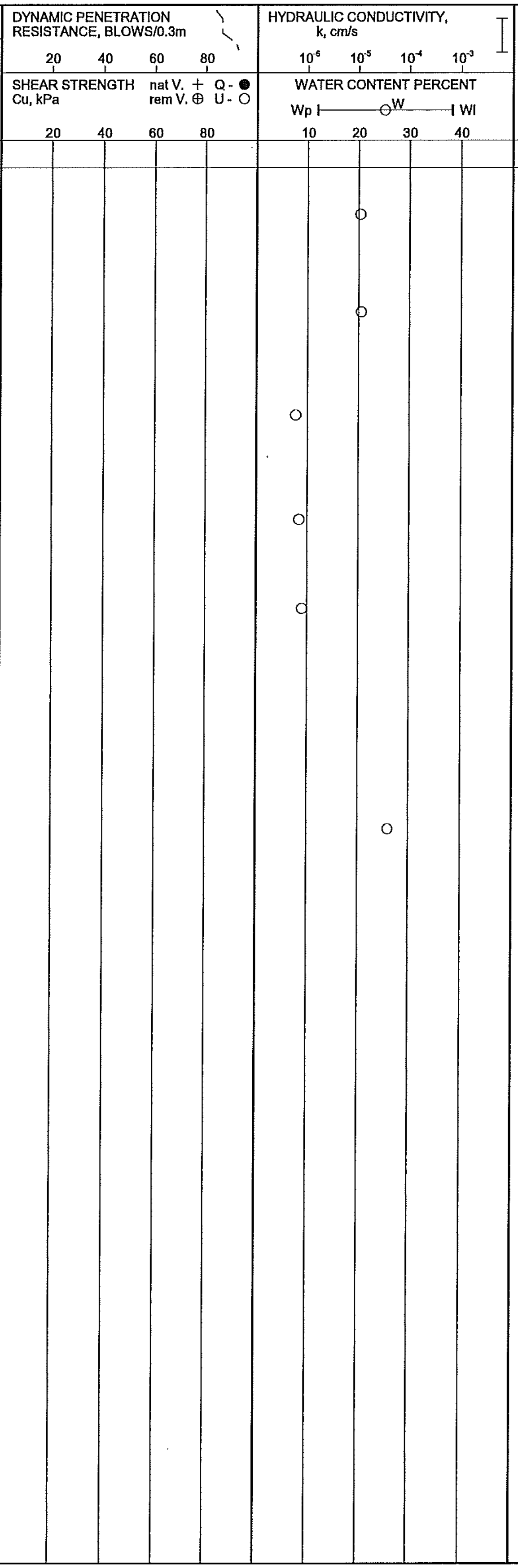
RECORD OF BOREHOLE: 14-18

BORING DATE: December 15, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		192.30					
0		TOPSOIL		0.00	1A				
		FILL - (ML) CLAYEY SILT, some sand, trace gravel, trace organics; brown; cohesive, w~PL, stiff		0.08	1B	SS	9		
1		(SM) SILTY SAND, fine grained; brown, stratified; non-cohesive, moist, compact		191.61 0.69	2	SS	14		
2		(SM) SILTY SAND, some gravel, trace clay; brown, with oxidation staining (TILL); non-cohesive, moist, dense to very dense		190.85 1.45	3 4	SS SS	48 65		
3		(ML) CLAYEY SILT, some gravel, trace sand; grey (TILL); cohesive, hard		189.33 2.97	5	SS	83/ 0.25		
4, 5		(ML) Sandy SILT; brown; non-cohesive, wet, dense		188.19 4.11	6	SS	45		
		END OF BOREHOLE		187.12 5.18					
6									
7									
8									
9									
10									



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: EWB
CHECKED: SDK

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PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-19

BORING DATE: December 15, 2014

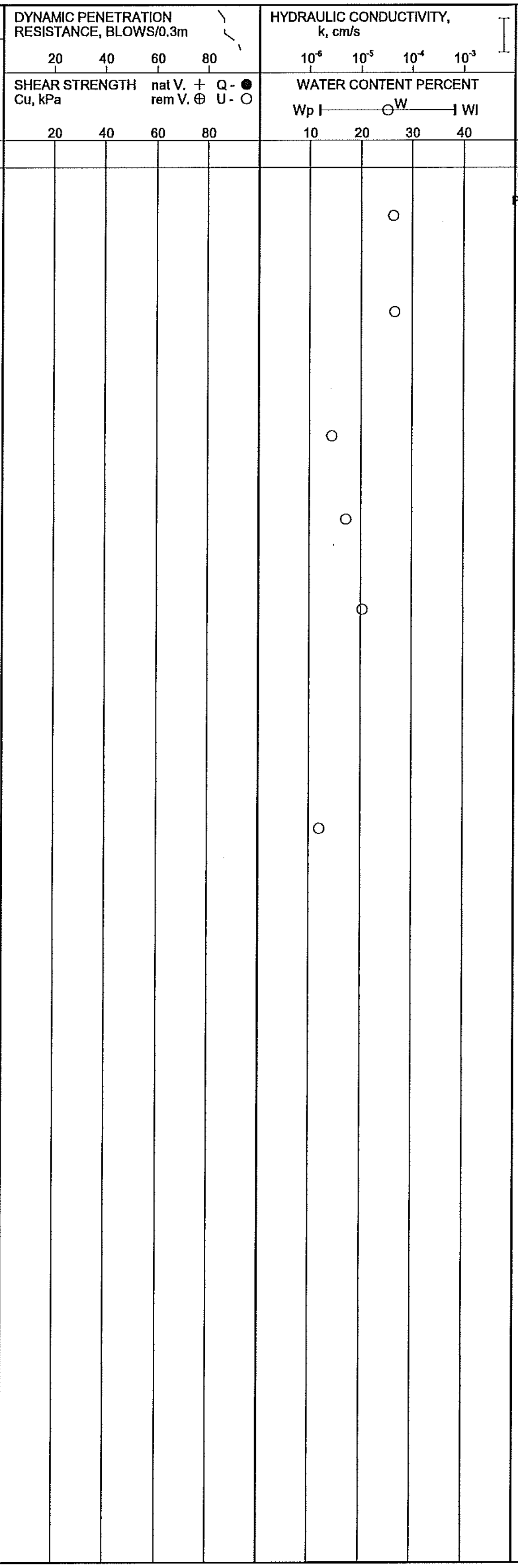
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	188.80					
0		TOPSOIL	0.00	1A				
		FILL - (ML) CLAYEY SILT, some sand, trace gravel, trace organics; brown to dark brown; cohesive, w>PL, firm	0.10	1B	SS	5	OP OC Nitrate Phospate	
		(CI) SILTY CLAY; brown, stratified; cohesive, w>PL, stiff	188.11 0.69	2	SS	9	M&I	
1		(ML) CLAYEY SILT, some sand, some gravel; brown (TILL); cohesive, w<PL, stiff to very stiff	187.35 1.45	3A 3B	SS	16		
2				4	SS	14		
3		(SW) SAND, some silt, trace clay; brown; wet, compact	185.83 2.97	5	SS	83/ 0.25		
4		(SM) SILTY SAND, some gravel, trace clay; brown (TILL); non-cohesive, very dense, wet	184.69 4.11	6	SS	45		
5		END OF BOREHOLE	183.62 5.18					
6								
7								
8								
9								
10								



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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: EWB

CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-20

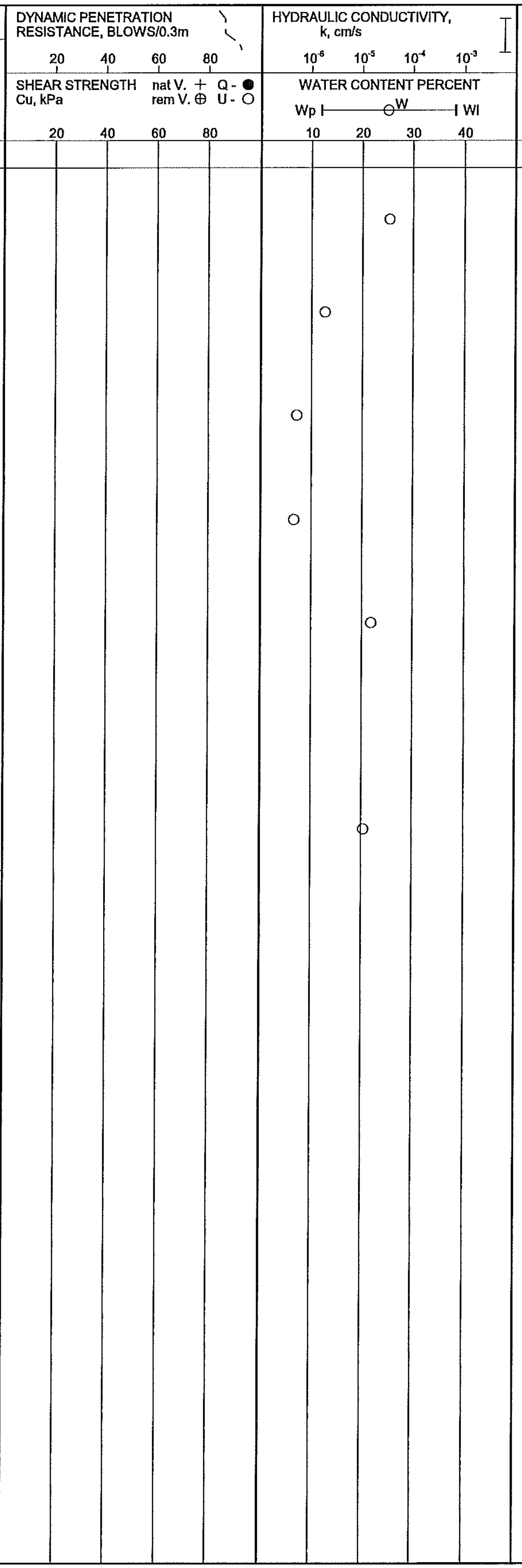
BORING DATE: December 15, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

BORING METHOD: Geoprobe 7822 DT Track Mount
83 mm Direct Push SVT

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	184.60			
TOPSOIL (150 mm)	0.00	1A	SS	6
(CI) SILTY CLAY; mottled grey-brown, some layering; cohesive, w>PL, firm	0.15	1B		
(SM) SILTY SAND, trace clay, trace gravel; brown (TILL-LIKE); non-cohesive, loose	183.91 0.69	2	SS	9
(SM) SILTY SAND, some gravel, trace clay; brown to grey (TILL); non-cohesive, dry to moist, very dense to dense	183.15 1.45	3	SS	67
		4	SS	46
(ML) SILT, trace to some clay; grey, containing seams of silty clay; non-cohesive, wet, dense	181.63 2.97	5	SS	32
(SW) SAND, fine grained, trace silt, trace gravel; grey, stratified; non-cohesive, wet, compact	180.49 4.11	6	SS	16
END OF BOREHOLE	179.42 5.18			



PIEZOMETER OR STANDPIPE INSTALLATION

∇ Dec. 15, 2014

1. Water level in open borehole measured at a depth of 3.7 m below ground surface (Elev. 180.90 m) on December 15, 2014.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-21

BORING DATE: December 15, 2014

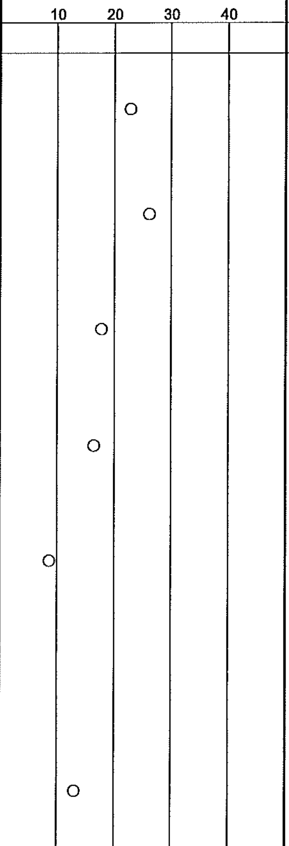
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa nat V. + rem V. ⊕ Q - ● U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		182.80							
0	Geoprobe 7822 DT Track Mount 83 mm Direct Push SVT	TOPSOIL (130 mm)		0.00	1A						
		(MH) CLAYEY SILT, trace gravel; mottled grey-brown, containing rootlets; cohesive, w>PL, firm to stiff		0.13	1B	SS	4				
1					2	SS	9				
		(CI) SILTY CLAY; mottled brown to grey, some varves; cohesive, w<PL, very stiff		181.35 1.45	3	SS	17				
2		(MH) CLAYEY SILT, some gravel, trace sand; brown (TILL); cohesive, w>PL, stiff		180.59 2.21	4	SS	14				
3		(ML) Sandy SILT, some gravel, trace clay; grey, with zones of clayey silt (TILL); non-cohesive, moist, compact		180.06 2.74	5	SS	16				
4											
5					6	SS	11				
		END OF BOREHOLE		177.62 5.18							1. Open borehole dry upon completion of drilling on Dec. 15, 2014.
6											
7											
8											
9											
10											



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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-22

SHEET 1 OF 1

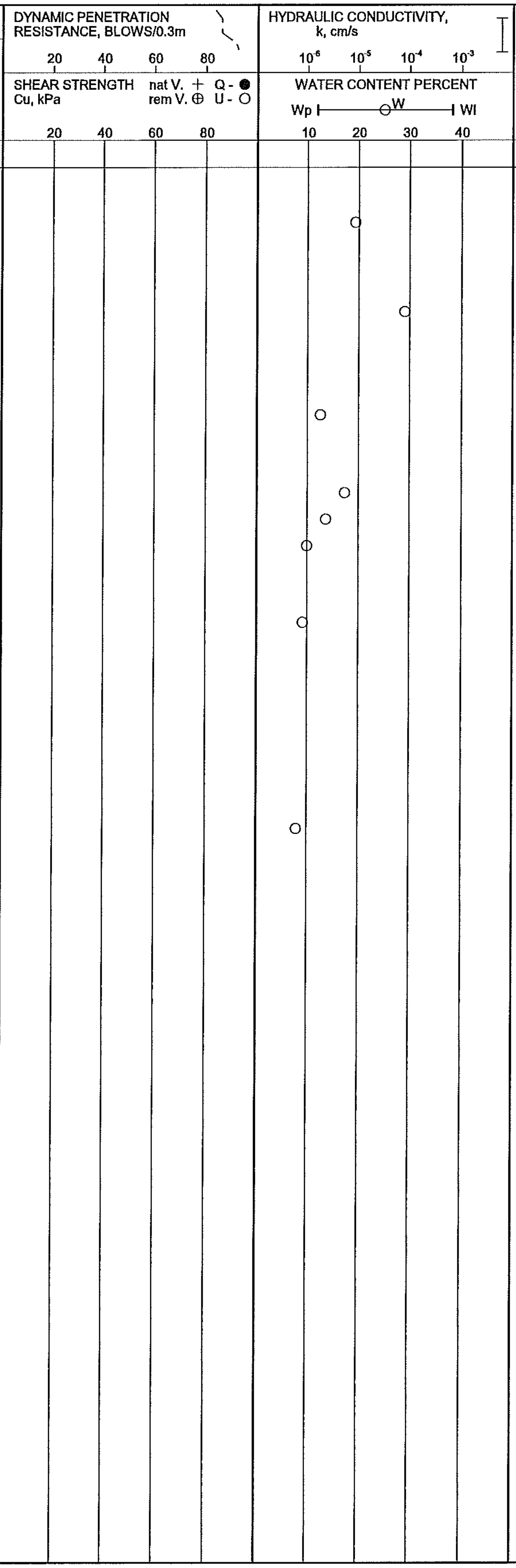
BORING DATE: December 15, 2014

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	184.20				
0	Geoprobe 7822 DT Track Mount 83 mm Direct Push SVT	TOPSOIL (200 mm)	0.00	1A			
		FILL - (CI) SILTY CLAY, some gravel, trace organics; brown to grey, containing rootlets; cohesive, w>PL, firm to soft	184.00 0.20	1B 2	SS SS	6 3	
		(MH) CLAYEY SILT, trace sand, trace gravel; brown, with oxidation staining, fissured (TILL); cohesive, w>PL, stiff	182.75 1.45	3	SS	11	
		(MH) CLAYEY SILT; brown, layered; cohesive, w>PL, stiff	181.99 2.21	4A			
		(SM) SILTY SAND, some gravel, trace clay; (TILL); wet, dense	181.69 2.51	4B	SS	34	
		(ML) Sandy SILT, some gravel, trace to some clay; brown to grey (TILL); non-cohesive, moist, dense to compact	2.68	4C 5 6	 SS SS	 20 27	
5		END OF BOREHOLE	179.02 5.18				1. Open borehole dry upon completion of drilling on Dec. 15, 2014.



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-23

BORING DATE: December 8, 2014

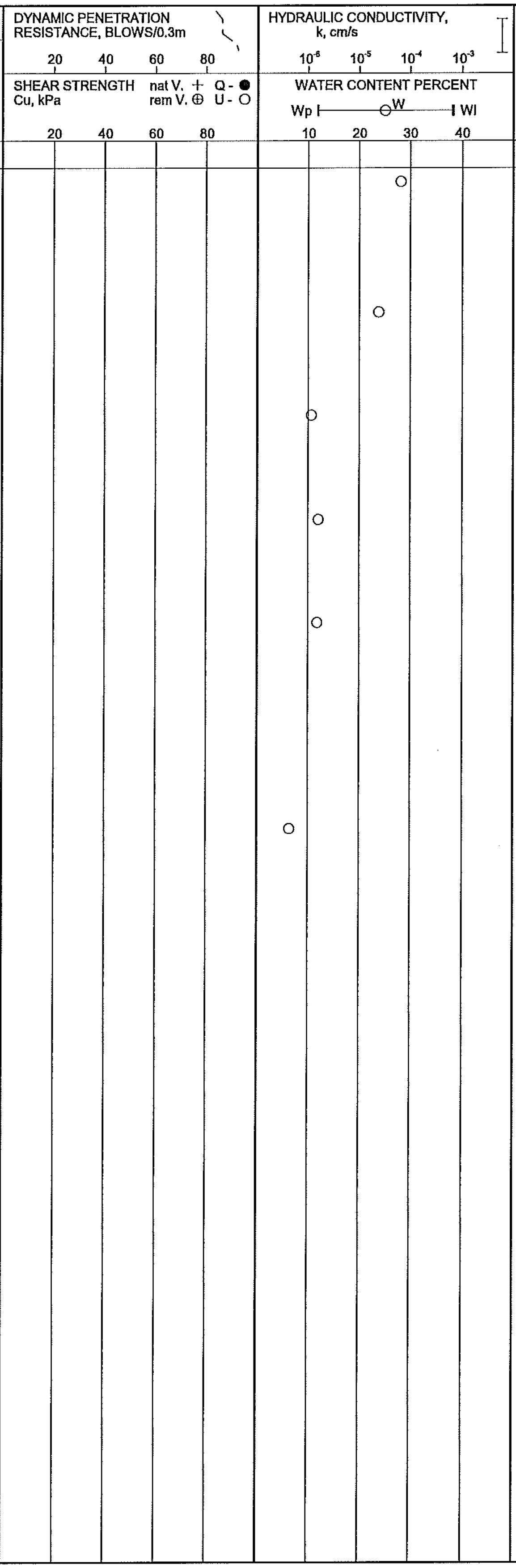
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		189.10					
0	B-45HD Track Mount 203 mm O.D. Hollow Stem Augers	TOPSOIL (200 mm)		0.00 188.90	1A	SS	6		
		(CI) SILTY CLAY, trace sand, trace gravel; brown, varved; cohesive, w>PL, firm to stiff		0.20	1B				
1					2	SS	11		
				187.80					
		(ML) CLAYEY SILT, some sand, some gravel; grey, with zones of fine sand (TILL); cohesive, w<PL, stiff		1.30	3	SS	14		
2				186.89					
		(ML) CLAYEY SILT, some sand, some gravel (TILL-LIKE); grey, with zones of fine sand; cohesive, w<PL, firm		2.21	4	SS	6		
3					5	SS	8		
4				184.99					
		(SM) SILTY SAND, some gravel, trace clay; grey (TILL); non-cohesive, moist, compact		4.11					
5				183.92	6	SS	27	MH	
		END OF BOREHOLE		5.18					1. Open borehole dry upon completion of drilling on Dec. 8, 2014.
6									
7									
8									
9									
10									



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-24

BORING DATE: December 8, 2014

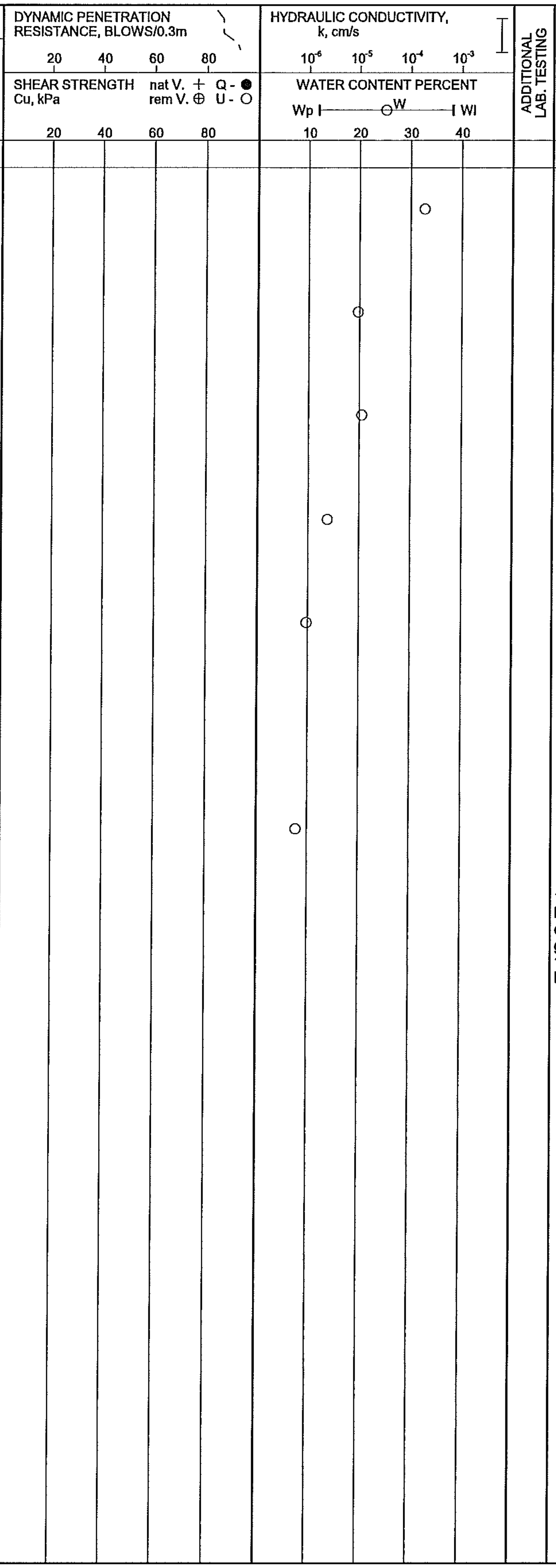
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	186.70				
0	B-45HD Track Mount 203 mm O.D. Hollow Stem Augers	FILL - TOPSOIL	0.00	1	SS	3	
1		(CI) SILTY CLAY, trace sand, trace gravel; mottled brown-grey, block structure; cohesive, w~PL, firm to stiff	186.01 0.69	2	SS	7	
2				3	SS	15	
		(ML) CLAYEY SILT, some sand, some gravel; grey; cohesive, w<PL, stiff	184.49 2.21	4	SS	10	
3		(ML) SILT, some sand, some gravel; grey, with zones of medium sand (TILL); non-cohesive, moist, compact	183.73 2.97	5	SS	15	∇ Dec 8, 2014
4		(ML) CLAYEY SILT, some sand, some gravel; grey (TILL); cohesive, w<PL, stiff	182.59 4.11				
5				6	SS	16	
		END OF BOREHOLE	181.37 5.33				1. Water level in open borehole measured at a depth of 3.7 m below ground surface (Elev. 182.00 m) on December 8, 2014.
6							
7							
8							
9							
10							



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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-25

BORING DATE: December 15, 2014

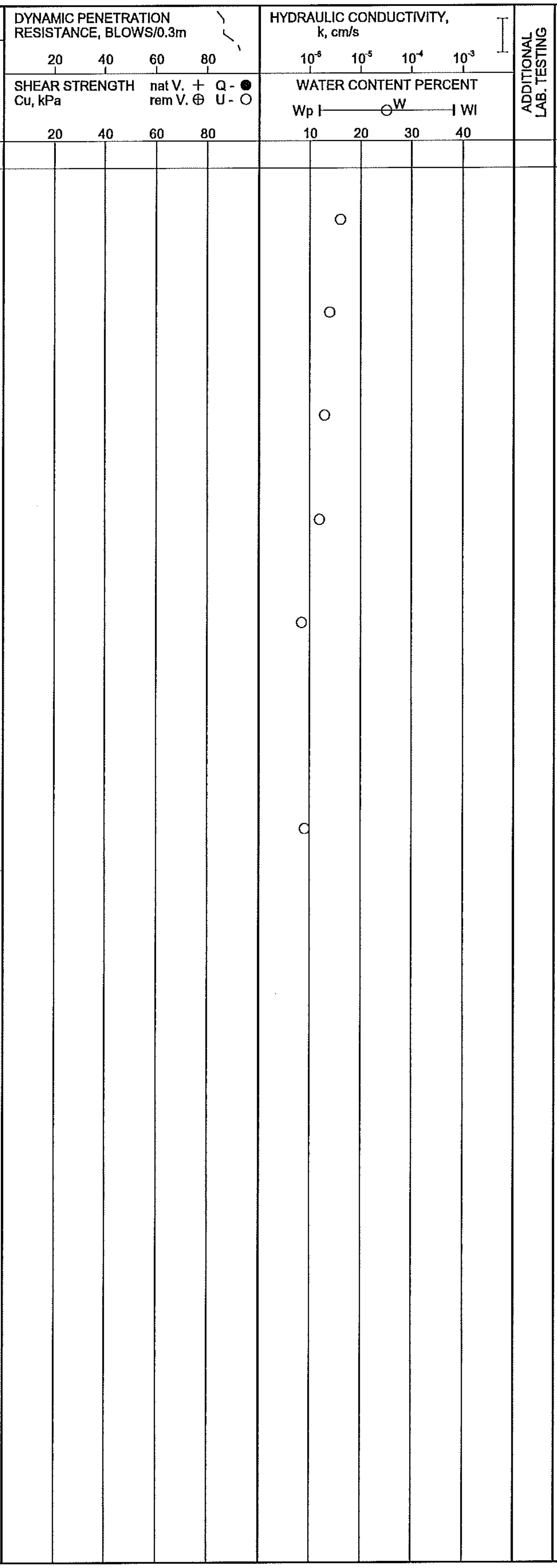
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	184.70			
Geoprobe 7822 DT Track Mount 83 mm Direct Push SVT	TOPSOIL (150 mm)	0.00	1A	SS	
	FILL - (SM) SILTY SAND, trace gravel, trace rootlets; dark brown; non-cohesive, moist, loose	0.15	1B		5
	(ML) CLAYEY SILT; mottled grey-brown; cohesive, w<PL, firm	184.01 0.69			
	(SM) SILTY SAND, some gravel, trace clay; brown (TILL-LIKE); moist, compact	0.84	2	SS	13
	(ML) CLAYEY SILT, some sand, some gravel; brown to grey (TILL); cohesive, w>PL, soft	183.25 1.45	3	SS	2
	(ML) Sandy SILT, some gravel, some clay; grey (TILL); non-cohesive, wet, compact	182.34 2.36	4	SS	18
	(ML) CLAYEY SILT, some sand, some gravel; grey, with zones of silt, layered (TILL); cohesive, dry to moist, very stiff	181.73 2.97	5	SS	27
			6	SS	27
	END OF BOREHOLE	179.52 5.18			



PIEZOMETER OR STANDPIPE INSTALLATION

▽ Dec. 15, 2014

1. Water level in open borehole measured at a depth of 4.7 m below ground surface (Elev. 180.80 m) on December 15, 2014.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-26

BORING DATE: December 16, 2014

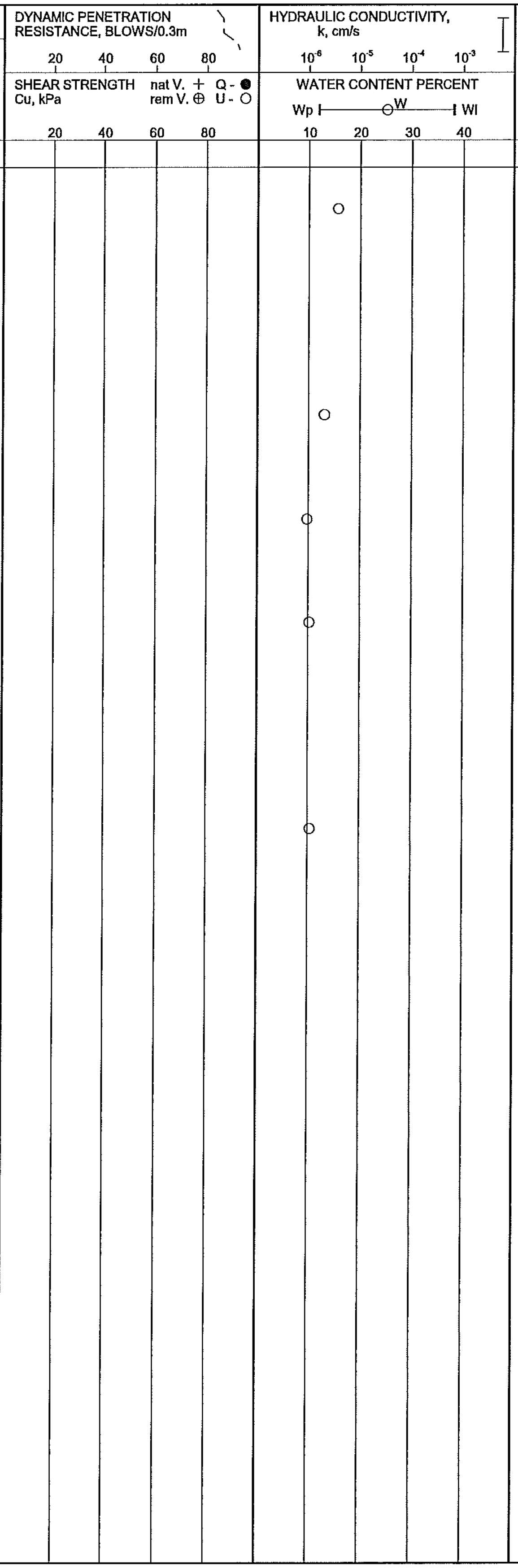
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	193.10			
TOPSOIL (50 mm)	0.00 0.05			
(CI) SILTY CLAY, some gravel, trace sand; brown (TILL); cohesive, w<PL, stiff to very stiff		1	SS	8
		2	SS	21
		3	SS	21
(ML) CLAYEY SILT, trace sand, some gravel; brown to grey (TILL); cohesive, w<PL, hard to very stiff	190.89 2.21	4	SS	34
		5	SS	32
		6	SS	29
END OF BOREHOLE	187.92 5.18			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

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

DEPTH SCALE

1 : 50

LOGGED: EWB

CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

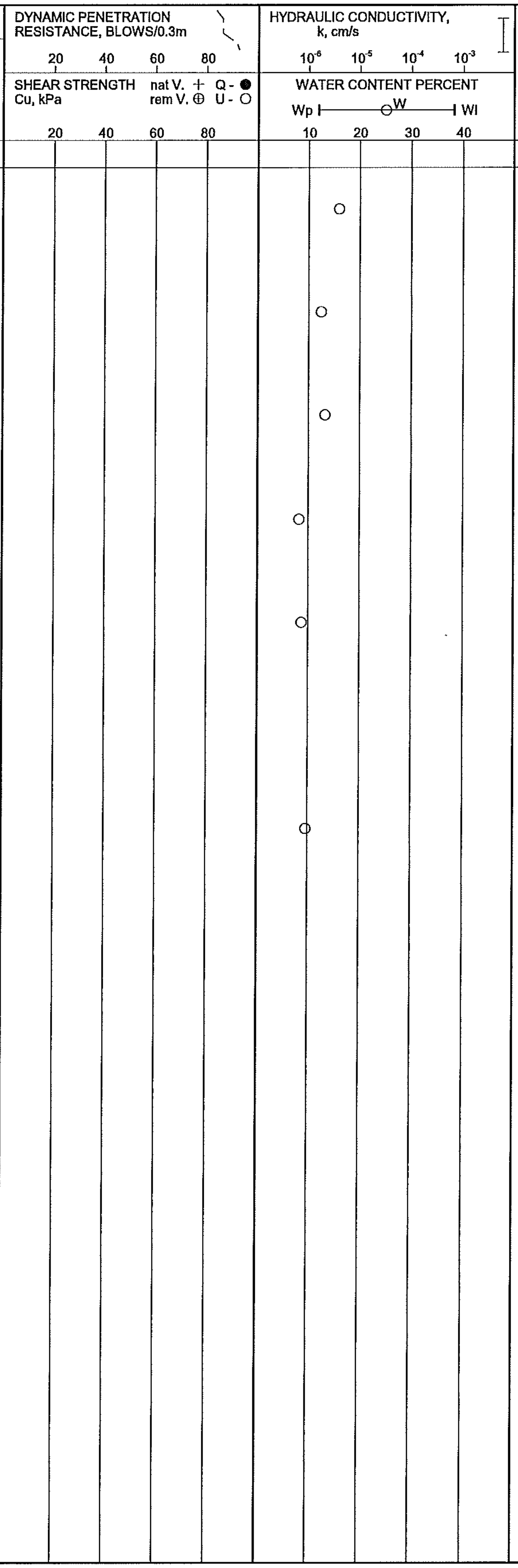
RECORD OF BOREHOLE: 14-27

BORING DATE: December 17, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		192.50					
0		TOPSOIL (25 mm)		0.00 0.03					
		FILL - (CI) SILTY CLAY, trace sand, trace gravel; cohesive, w<PL, firm	▨		1	SS	5		
		(ML) CLAYEY SILT, some gravel, trace sand; grey (TILL); w<PL, stiff to hard		191.81 0.69					
1					2	SS	13		
2					3	SS	27		
					4	SS	72		
3					5	SS	65		
4									
5					6	SS	84		
		END OF BOREHOLE		187.32 5.18					
6									
7									
8									
9									
10									



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DEPTH SCALE
1 : 50

Golder Associates

LOGGED: EWB
CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-28

BORING DATE: December 16, 2014

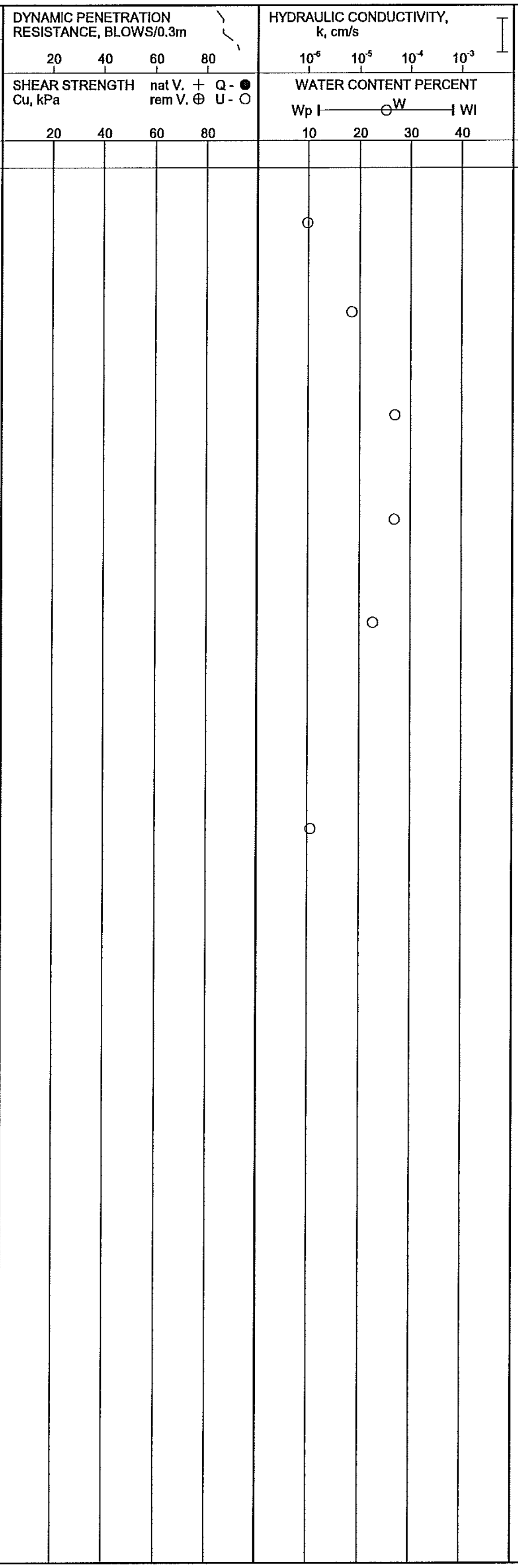
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m
		GROUND SURFACE		185.70			
0		TOPSOIL (200 mm)		0.00	1A		
		FILL - (ML) CLAYEY SILT, some gravel, trace sand, trace organics; brown; cohesive, moist, stiff to very stiff		185.50 0.20	1B	SS	9
1					2	SS	26
		(CI) SILTY CLAY, trace sand; brown to grey, varved; cohesive, w>PL, stiff to very stiff		184.25 1.45	3	SS	13
2					4	SS	21
3					5	SS	19
4		(ML) CLAYEY SILT, some gravel, trace sand; grey (TILL); cohesive, w<PL, very stiff		181.59 4.11	6	SS	20
5		END OF BOREHOLE		180.52 5.18			
6							
7							
8							
9							
10							



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: EWB

CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-29

BORING DATE: December 16, 2014

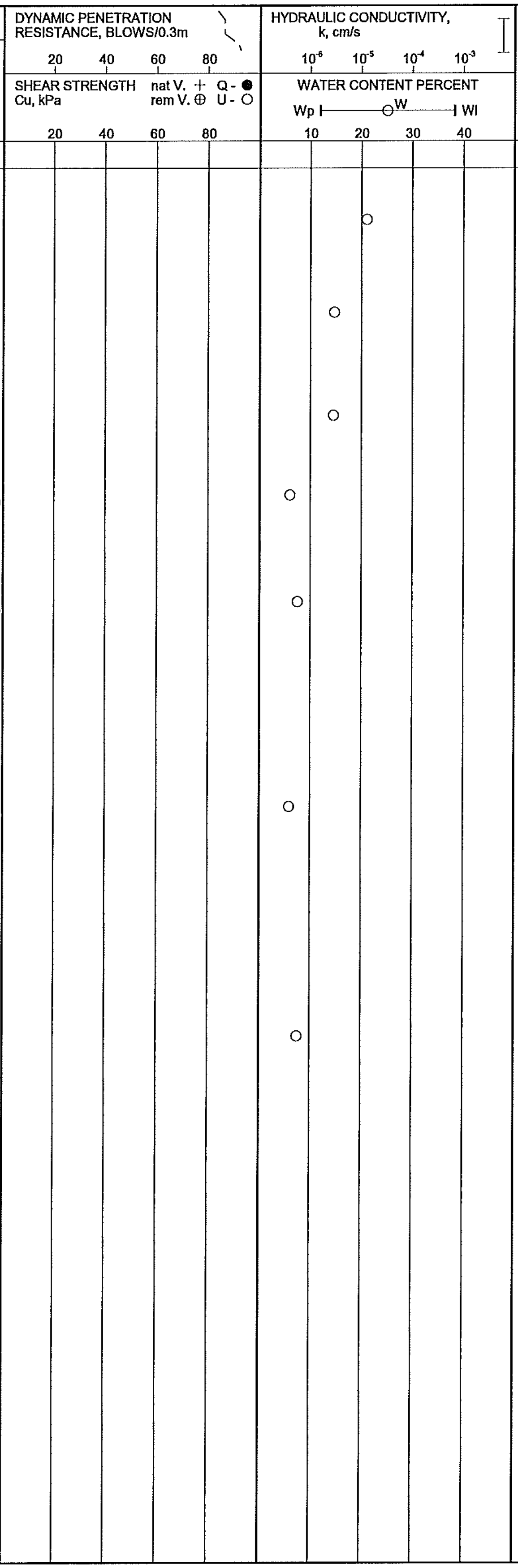
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

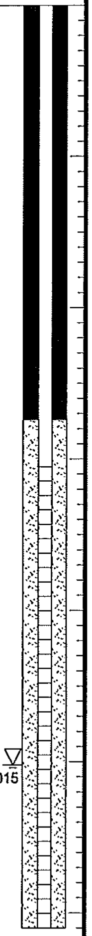
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE	191.00			
0	Geoprobe 7822 DT Track Mount 83 mm Direct Push SVT	TOPSOIL (150 mm)	0.00	1A	SS	8
		(CI) SILTY CLAY, trace sand, trace gravel; mottled grey-brown (TILL-Like); cohesive, w~PL, firm	0.15	1B		
		(MH) CLAYEY SILT, some gravel, trace sand; mottled grey-brown (TILL); cohesive, w<PL, very stiff to hard	190.31 0.69	2	SS	18
				3	SS	32
	Geoprobe 7822 DT Track Mount 150 mm Hollow Stem Augers	(ML) Sandy SILT, some gravel, trace clay; brown to grey (TILL); dry to moist, very dense	188.79 2.21	4	SS	50/ 0.10
				5	SS	50/ 0.15
				6	SS	50/ .125
		(CI) SILTY CLAY, trace sand, trace gravel; grey (TILL); cohesive, w<PL, hard	185.36 5.64	7	SS	73
		END OF BOREHOLE	184.29 6.71			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Bentonite

Sand

Screen

Jan. 5, 2015

1. Water level in open borehole measured at a depth of 5.0 m below ground surface (Elev. 186.00 m) on January 5, 2015.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-30

BORING DATE: December 16, 2014

SHEET 1 OF 1

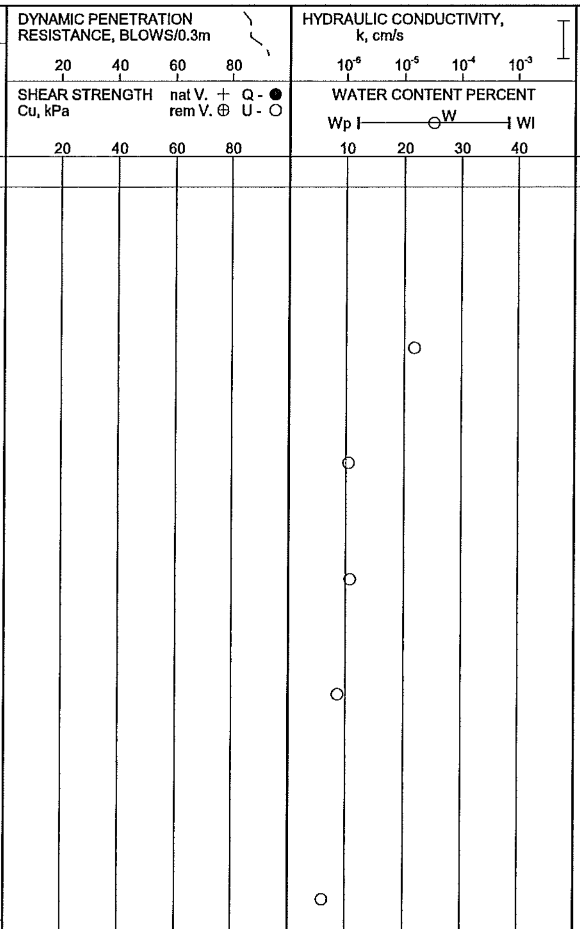
DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

BORING METHOD: Geoprobe 7822 DT Track Mount; 83 mm Direct Push SVT

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	194.40			
TOPSOIL (250 mm)	0.00	1A	SS	3
(MH) CLAYEY SILT, some gravel, trace sand; brown (TILL-LIKE); cohesive, w>PL, soft	194.15 0.25	1B		
(MH) CLAYEY SILT, some gravel, trace to some sand; (TILL); cohesive, w<PL, stiff	193.71 0.69	2	SS	12
(ML) Sandy SILT, some clay, some gravel; brown to grey (TILL); non-cohesive, moist to dry, dense to very dense	192.95 1.45	3	SS	17
		4	SS	28
		5	SS	26
		6	SS	50/.125
END OF BOREHOLE	189.55 4.85			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

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

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

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PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-31

BORING DATE: December 16, 2014

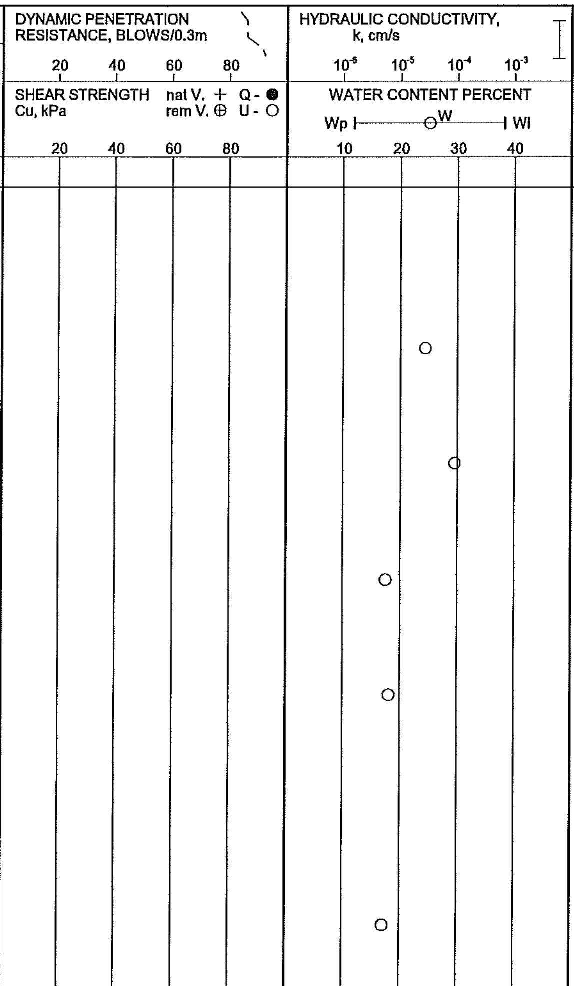
SHEET 1 OF 1

DATUM: Geodetic

HAMMER TYPE: AUTOMATIC

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		182.70					
0		(CL) SILTY CLAY; brown to grey, varved; cohesive, w<PL, firm to stiff		0.00	1	SS	6		
1					2	SS	11		
2					3	SS	11		
		(CI) SILTY CLAY, trace sand, trace gravel; grey (TILL-LIKE); cohesive, w>PL, firm		180.49 2.21	4	SS	8		
3		(CI) SILTY CLAY; grey, massive; cohesive, w>PL to a depth of 4.27 m, w<PL below a depth of 4.27 m, very stiff to hard		179.73 2.97	5	SS	26		
5					6	SS	N/R		
		END OF BOREHOLE *N/R - Not Recorded		177.52 5.18					



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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: EWB

CHECKED: SDK

PROJECT: 1413472
LOCATION: SEE FIGURE 2

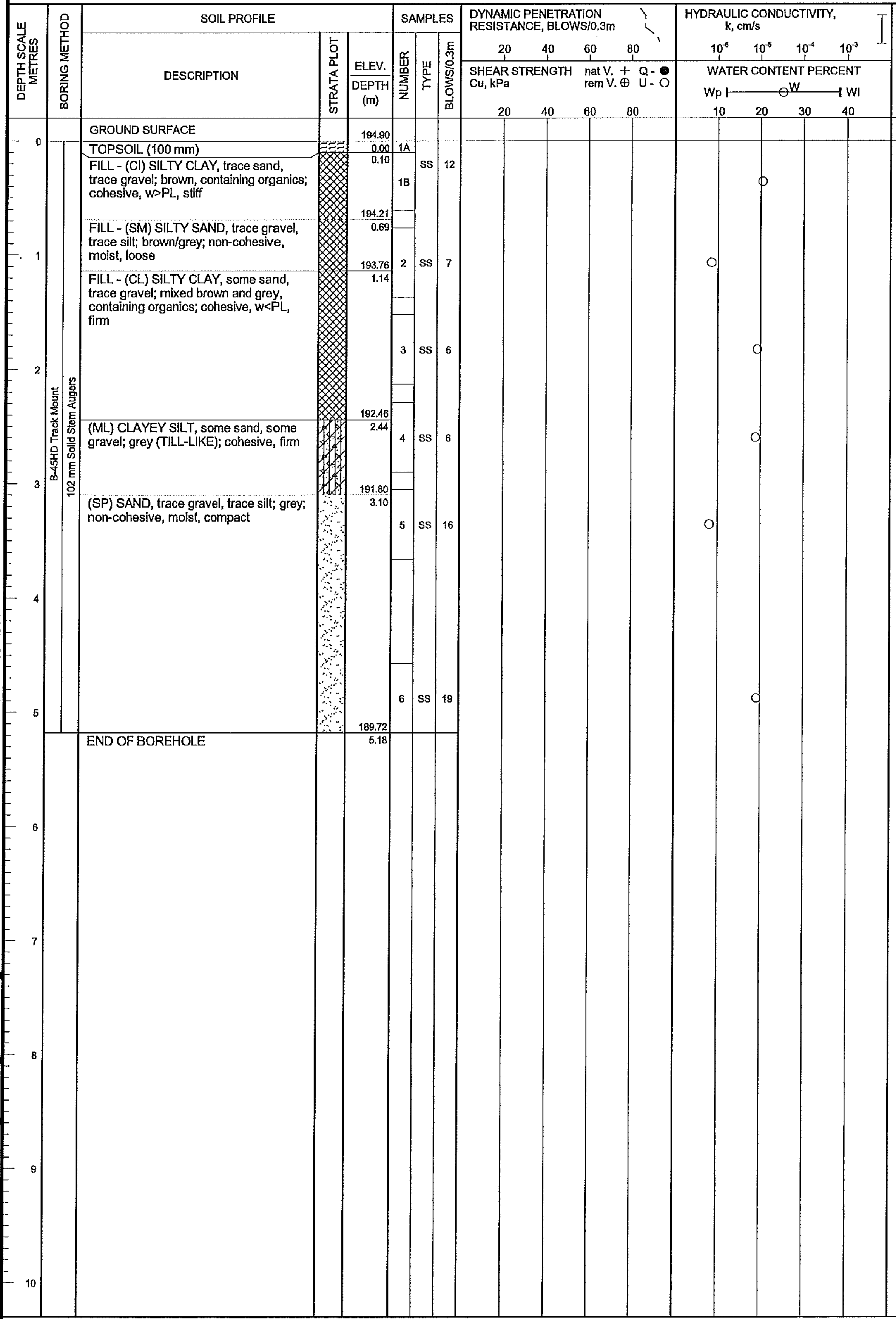
RECORD OF BOREHOLE: 14-32

BORING DATE: December 5, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

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

BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE		194.90					
B-45HD Track Mount 102 mm Solid Stem Augers	TOPSOIL (100 mm)		0.00	1A				
	FILL - (CI) SILTY CLAY, trace sand, trace gravel; brown, containing organics; cohesive, w>PL, stiff		0.10	1B	SS	12		
	FILL - (SM) SILTY SAND, trace gravel, trace silt; brown/grey; non-cohesive, moist, loose		194.21 0.69	2	SS	7		
	FILL - (CL) SILTY CLAY, some sand, trace gravel; mixed brown and grey, containing organics; cohesive, w<PL, firm		193.76 1.14	3	SS	6		
	(ML) CLAYEY SILT, some sand, some gravel; grey (TILL-LIKE); cohesive, firm		192.46 2.44	4	SS	6		
	(SP) SAND, trace gravel, trace silt; grey; non-cohesive, moist, compact		191.80 3.10	5	SS	16		
				6	SS	19	MH	
	END OF BOREHOLE		189.72 5.18					1. Open borehole dry upon completion of drilling on Dec. 5, 2014.



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

PROJECT: 1413472

LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-33

BORING DATE: December 5, 2014

SHEET 1 OF 1

DATUM: Geodetic

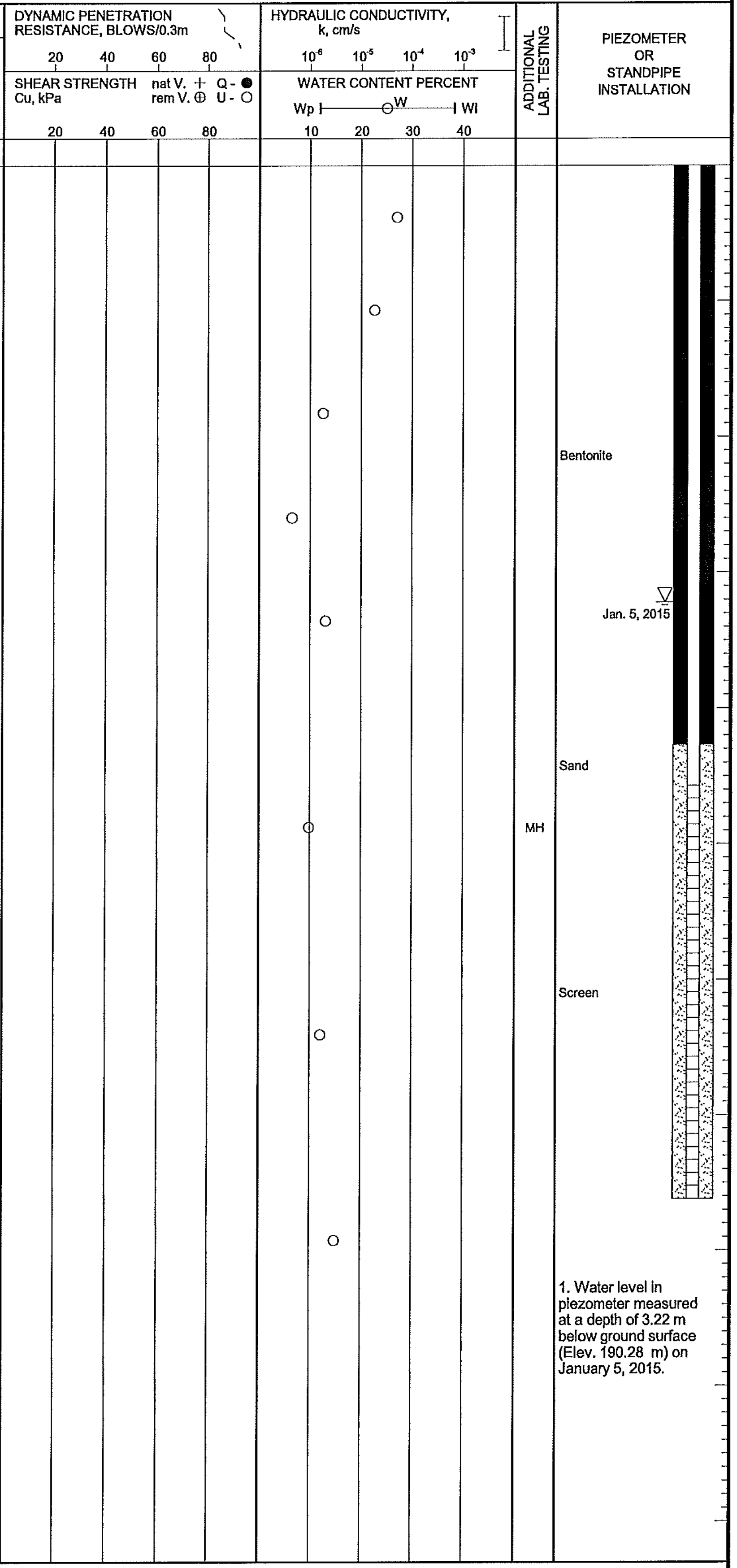
HAMMER TYPE: AUTOMATIC

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

BORING METHOD: B-45HD Track Mount, 203 mm O.D. Hollow Stem Augers

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	193.50
TOPSOIL (150 mm)	0.00
(CL) SILTY CLAY, trace gravel; mottled grey-brown;, containing rootlets in upper zones; cohesive, w>PL, stiff	0.15
(SC) CLAYEY SAND, some silt, some gravel; mottled grey-brown to grey; cohesive, wet, compact	192.05 1.45
(ML) CLAYEY SILT, some sand, some gravel; grey (TILL); cohesive, moist, stiff to hard	190.53 2.97
(SP) SAND, fine grained, trace silt; grey, with layers of clayey silt; moist, compact	186.34 7.16
END OF BOREHOLE	185.27 8.23

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1A			
1B	SS	10	
2	SS	12	
3	SS	12	
4	SS	21	
5	SS	12	
6	SS	16	MH
7	SS	66	
8	SS	21	



1. Water level in piezometer measured at a depth of 3.22 m below ground surface (Elev. 190.28 m) on January 5, 2015.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AVR

CHECKED: SDK

GTA-BHS 001 S:\CLIENTS\RUNNYMEDE\4134_16THAVE_MARKHAM\02_DATA\GINT\1413472.GPJ GAL-MIS.GDT 6/12/15 MK Dec. 2014

PROJECT: 1413472
LOCATION: SEE FIGURE 2

RECORD OF BOREHOLE: 14-34

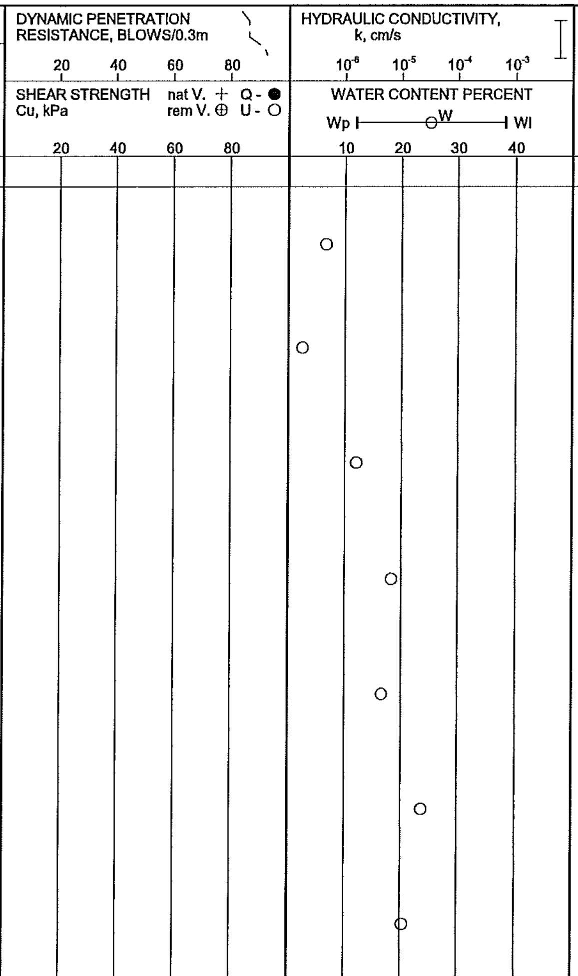
BORING DATE: December 8, 2014

SHEET 1 OF 1
DATUM: Geodetic
HAMMER TYPE: AUTOMATIC

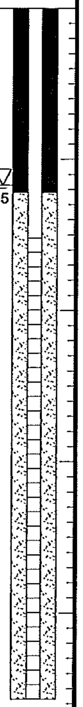
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

BORING METHOD: B-45HD Track Mount, 203 mm O.D. Hollow Stem Augers

DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE		180.40				
ASPHALT	■	0.00	1A		10	
GRANULAR FILL	▩	0.15	1B	SS		
(SW) Gravelly SAND, trace silt; brown; non-cohesive, moist to wet, compact		179.56 0.84	2	SS	11	
			3	SS	25	
(SM) SILTY SAND, fine grained, some gravel, trace clay; grey; non-cohesive, wet, compact to very loose		178.04 2.36	4	SS	12	
			5	SS	WR	
(SM) SILTY SAND, fine grained, trace clay; grey; non-cohesive, wet, compact		176.67 3.73	6	SS	17	MH
			7	SS	14	
END OF BOREHOLE		175.22 5.18				



PIEZOMETER OR STANDPIPE INSTALLATION



1. Water level in piezometer measured at a depth of 1.17 m below ground surface (Elev. 179.23 m) on January 5, 2015.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AVR
CHECKED: SDK

GTA-BHS 001 S:\CLIENTS\RUNNYMEDE\4134 16THAVE_MARKHAM\02 DATA\GINT\1413472.GPJ GAL-MIS.GDT 6/12/15 MK Dec. 2014

PROJECT: 1413472
LOCATION: N 4860422.01; E 633976.14

RECORD OF BOREHOLE: 16-1

BORING DATE: February 29 to March 1, 2016

SHEET 1 OF 2
DATUM: Geodetic

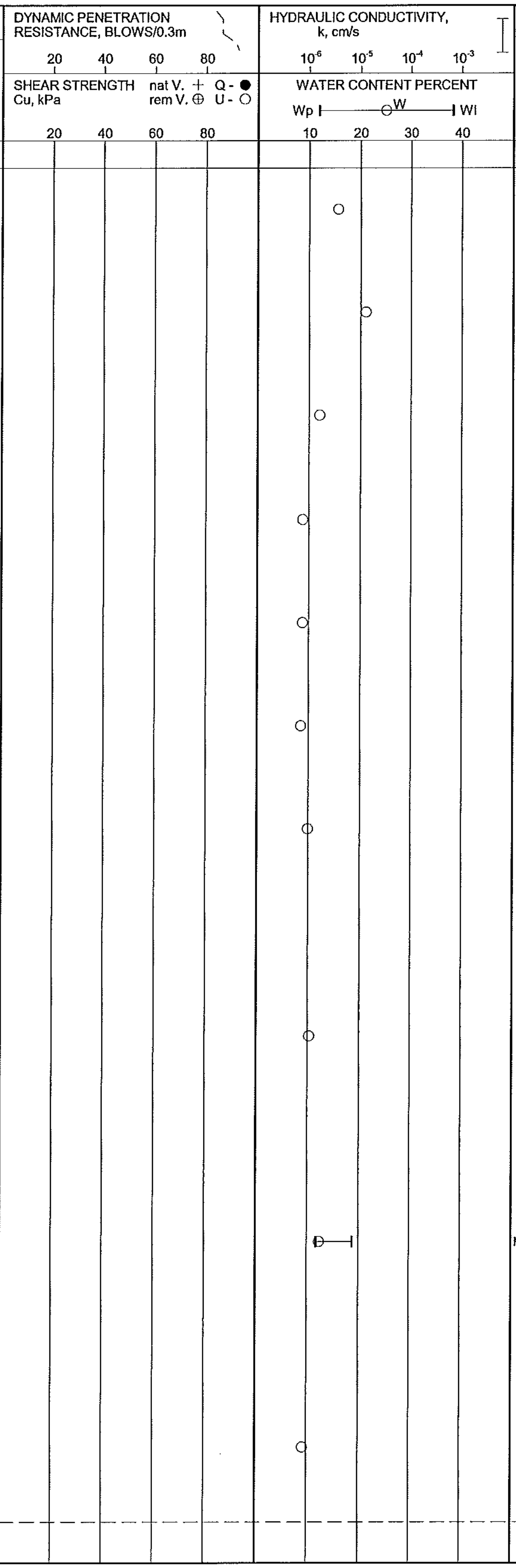
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 100 mm O.D. Solid Stem Augers

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
	GROUND SURFACE	187.38
0	TOPSOIL	0.00
	(CL-ML) Sandy CLAYEY SILT, trace gravel; brown to dark brown to grey; cohesive, w>PL, stiff to very stiff	187.00 0.38
1.52	(SM) SILTY SAND, trace gravel, some cohesive fines; brown, becoming grey below a depth of 3.8 m, oxidation staining to a depth of 3.8 m (TILL); moist, non-cohesive, very dense - Fibrous organics noted to a depth of 2.1 m	185.86 1.52
4.50	(CL-ML) Sandy SILTY CLAY to Sandy CLAYEY SILT, trace to some gravel; grey (TILL); cohesive, w<PL to w~PL, very stiff to hard	182.88 4.50
10	*CONTINUED NEXT PAGE*	

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	8	
2	SS	17	
3	SS	49	
4	SS	62	
5	SS	69	
6	SS	53	
7	SS	24	
8	SS	25	
9	SS	23	MH/AL
10	SS	57	



PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

GTA-BHS 001 S:\CLIENTS\RUNNYMEDE\YORK_DOWN_GOLF_COURSE\02_DATA\GINT\1413472.GPJ GAL-MIS.GDT 3/28/16

PROJECT: 1413472
LOCATION: N 4860422.01; E 633976.14

RECORD OF BOREHOLE: 16-1

BORING DATE: February 29 to March 1, 2016

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	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp I—○W—I Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —									
10	CME-85 TRUCK MOUNTED - POWER AUGER 100 mm O.D. Solid Stem Augers	(CL-ML) Sandy SILTY CLAY to Sandy CLAYEY SILT, trace to some gravel; grey (TILL); cohesive, w<PL to w~PL, very stiff to hard	▨								
11			▨		11	SS	48		○		∇ March 1, 2016
12			▨		12	SS	37		○		
				174.58 12.80							
13		END OF BOREHOLE NOTES: 1. Water level measured in open borehole at a depth of 11.2 m upon completion of drilling.									
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

PROJECT: 1413472

LOCATION: N 4860347.14; E 634037.23

RECORD OF BOREHOLE: 16-2

BORING DATE: March 1, 2016

SHEET 1 OF 2

DATUM: Geodetic

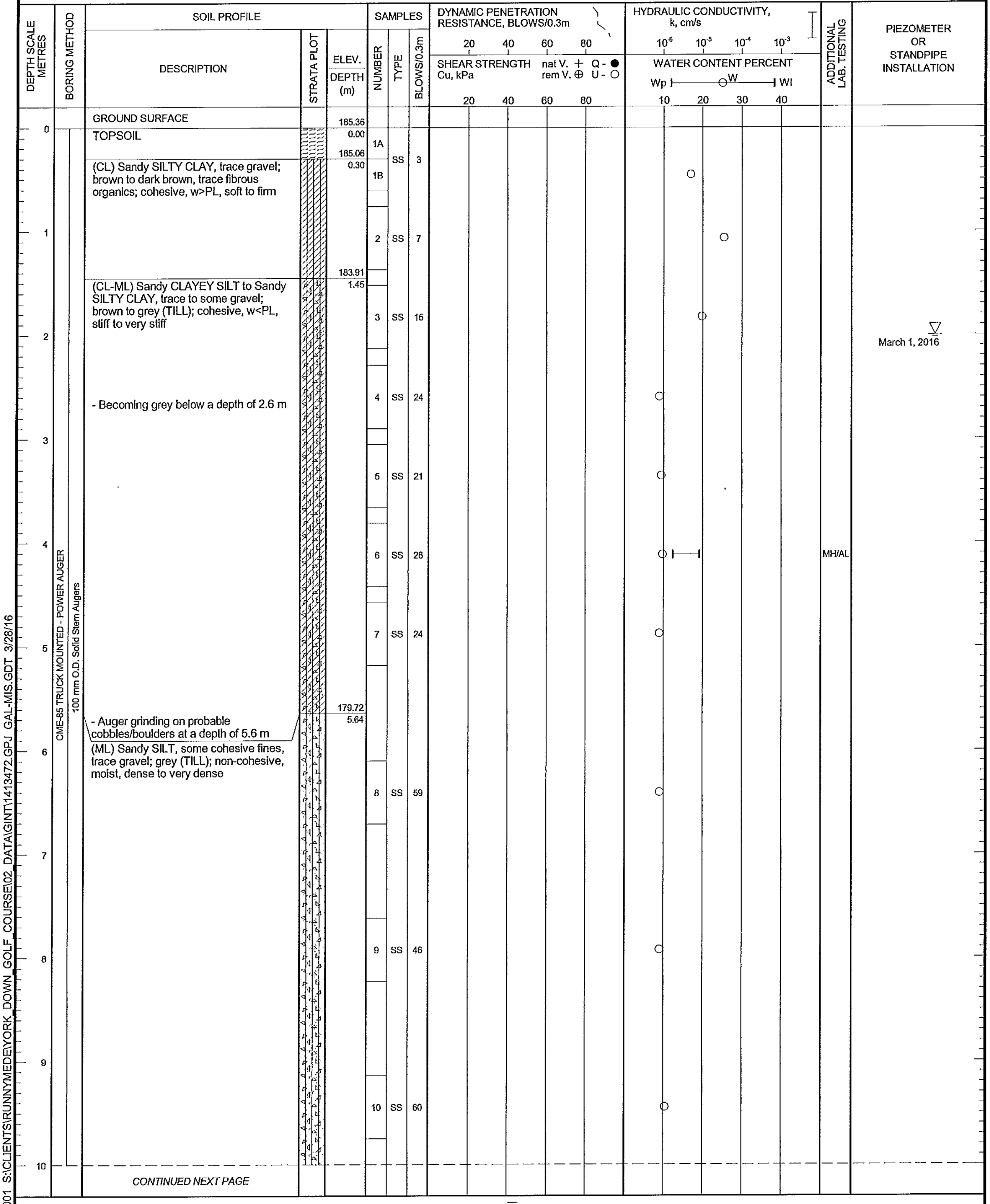
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 100 mm O.D. Solid Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	185.36
TOPSOIL	0.00
(CL) Sandy SILTY CLAY, trace gravel; brown to dark brown, trace fibrous organics; cohesive, w>PL, soft to firm	185.06 0.30
(CL-ML) Sandy CLAYEY SILT to Sandy SILTY CLAY, trace to some gravel; brown to grey (TILL); cohesive, w<PL, stiff to very stiff	183.91 1.45
- Becoming grey below a depth of 2.6 m	
- Auger grinding on probable cobbles/boulders at a depth of 5.6 m	
(ML) Sandy SILT, some cohesive fines, trace gravel; grey (TILL); non-cohesive, moist, dense to very dense	179.72 5.64

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1A 1B	SS	3	
2	SS	7	
3	SS	15	
4	SS	24	
5	SS	21	
6	SS	28	MH/AL
7	SS	24	
8	SS	59	
9	SS	46	
10	SS	60	



CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472
LOCATION: N 4860347.14; E 634037.23

RECORD OF BOREHOLE: 16-2

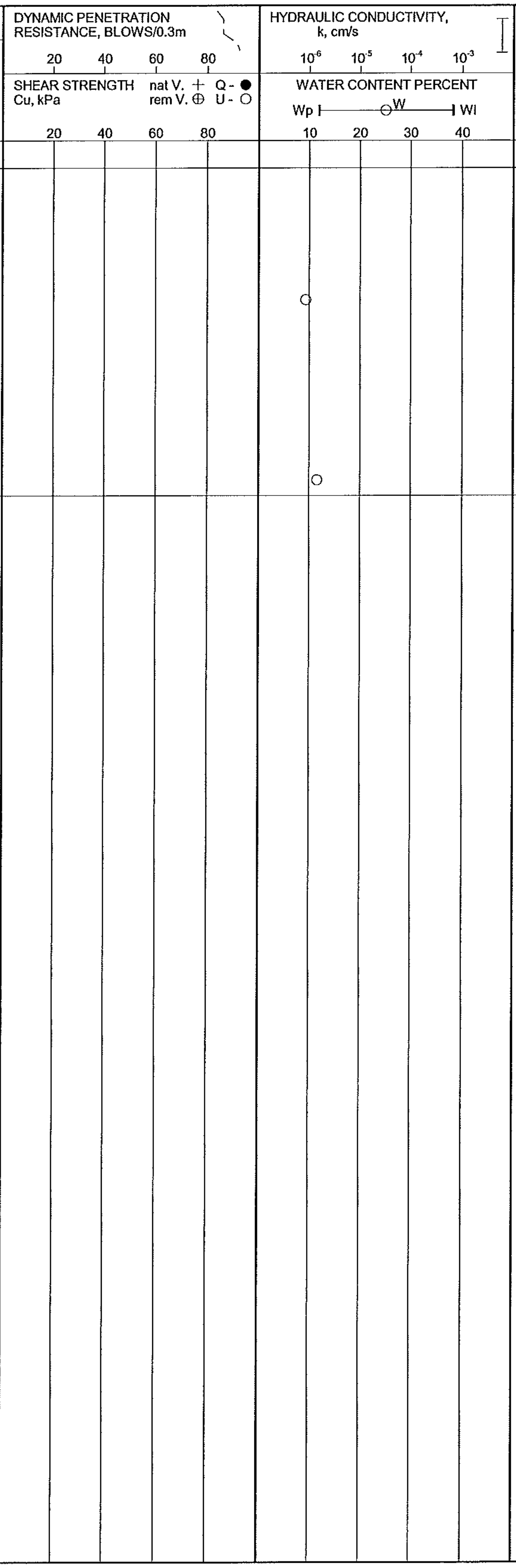
BORING DATE: March 1, 2016

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	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —							
10	CME-85 TRUCK MOUNTED - POWER AUGER 100 mm O.D. Solid Stem Augers	(ML) Sandy SILT, some cohesive fines, trace gravel; grey (TILL); non-cohesive, moist, dense to very dense							
11					11	SS	54		
				173.63					
		(ML) Sandy SILT, trace gravel, trace cohesive fines; grey (TILL); non-cohesive, moist, very dense		11.73					
12									
				172.94	12	SS	50/ 0.08		
		END OF BOREHOLE		12.42					
13		NOTES: 1. Water level measured in open borehole at a depth of 2.0 m upon completion of drilling, March 1, 2016							
14									
15									
16									
17									
18									
19									
20									



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

PROJECT: 1413472

LOCATION: N 4861018.31; E 635094.77

RECORD OF BOREHOLE: 16-3

BORING DATE: February 24, 2016

SHEET 1 OF 1

DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

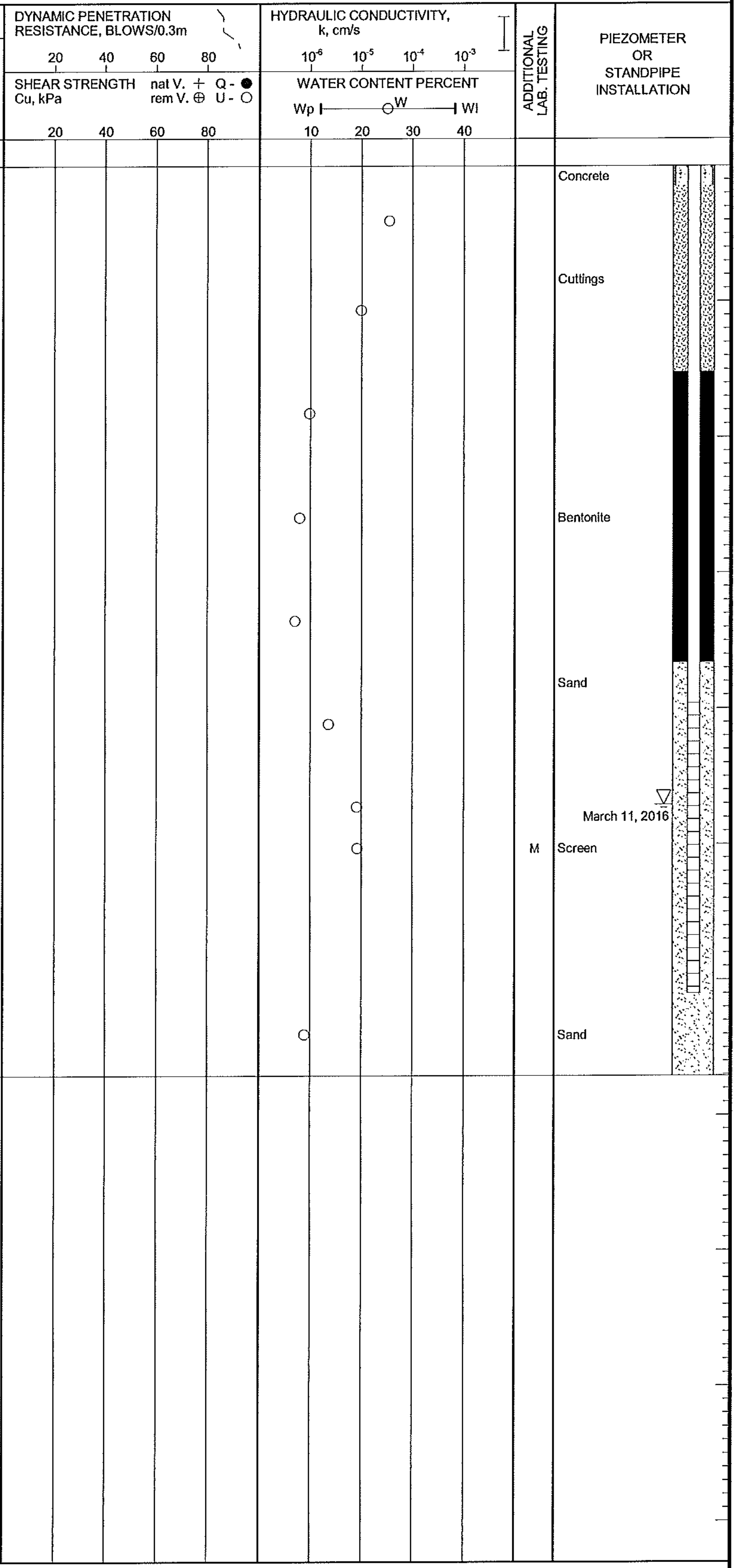
BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 110 mm I.D. 200 mm O.D. Hollow Stem Augers

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
0	GROUND SURFACE	197.56			
	TOPSOIL	0.00 197.36	1A		
	(CL) SILTY CLAY, some sand to sandy, trace to some gravel; light brown to light brown mottled grey, oxidation staining, fibrous organics; cohesive, w~PL, stiff	0.20	1B	SS	9
1			2	SS	9
	(SM) SILTY SAND, some gravel, trace to some cohesive fines; brown to grey, oxidation staining (TILL); non-cohesive, moist, compact to dense - Auger grinding on probable cobbles/boulders from depths of 1.5 m to 2.1 m	196.11 1.45	3	SS	28
2			4	SS	48
3			5	SS	30
	(ML/SM) Sandy SILT to SILTY SAND; grey; non-cohesive, moist to wet, dense - 50 mm thick sand seam at a depth of 4.3 m	193.83 3.73	6	SS	33
4			7A	SS	36
	(SP) SAND, fine, some fines; grey; non-cohesive, wet, dense	192.68 4.88	7B		
5					
6	(SM) SILTY SAND, some gravel, some cohesive fines; grey (TILL); non-cohesive, moist, compact	191.46 6.10	8	SS	25
	END OF BOREHOLE	190.85 6.71			
7					
8					
9					
10					

NOTE:

1. Water level measured in open borehole at a depth of 5.9 m upon completion of drilling, February 24, 2016.

2. Water level measured in monitoring well at a depth of 4.71 m, March 11, 2016.



DEPTH SCALE

1 : 50

LOGGED: DM

CHECKED: OS

PROJECT: 1413472

LOCATION: N 4860382.52; E 634929.27

RECORD OF BOREHOLE: 16-4

BORING DATE: February 23, 2016

SHEET 1 OF 1

DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

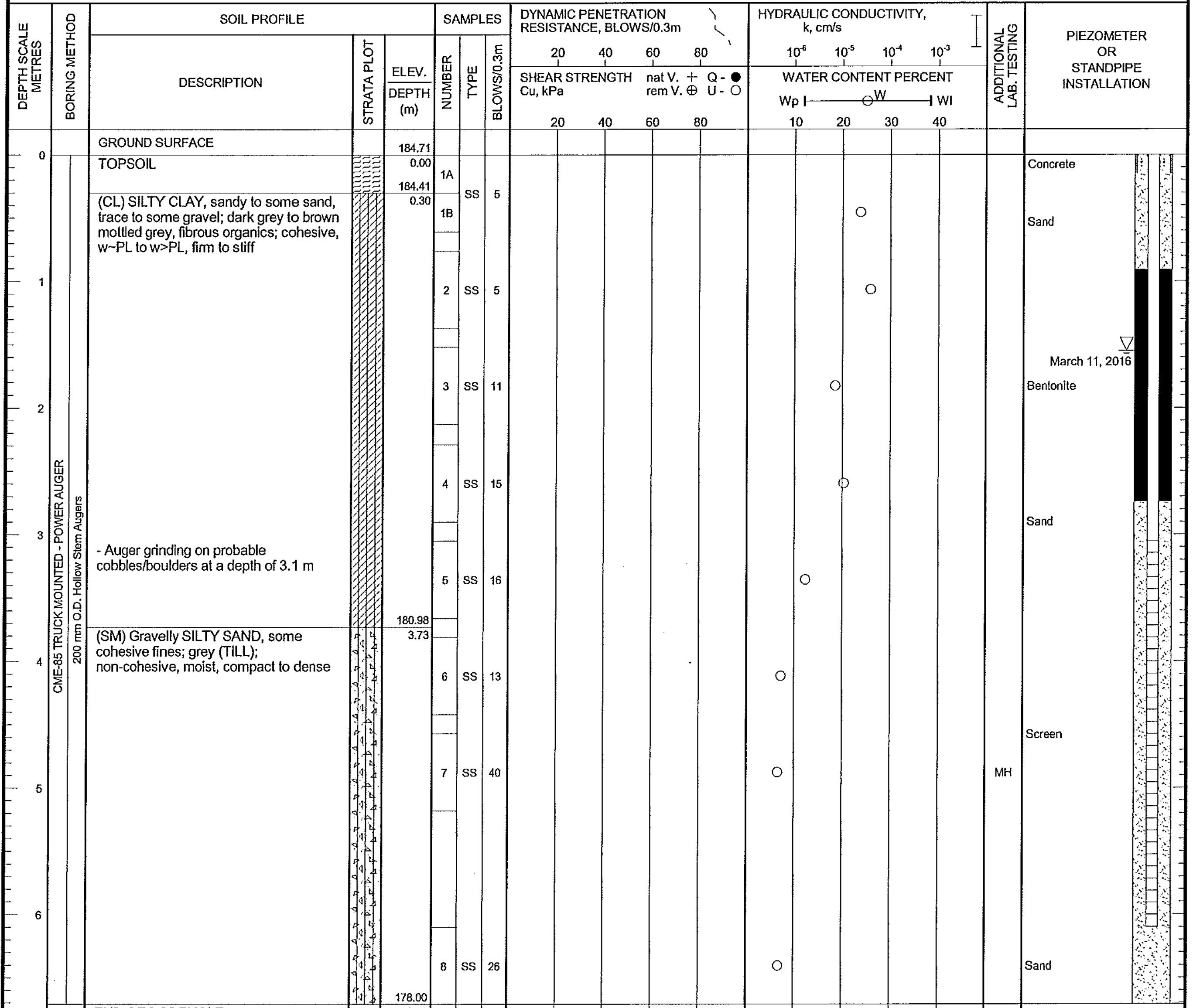
BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 200 mm O.D. Hollow Stem Augers

SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	184.71				
TOPSOIL	0.00	1A	SS	5	
(CL) SILTY CLAY, sandy to some sand, trace to some gravel; dark grey to brown mottled grey, fibrous organics; cohesive, w~PL to w>PL, firm to stiff	184.41 0.30	1B			
		2	SS	5	
		3	SS	11	
		4	SS	15	
- Auger grinding on probable cobbles/boulders at a depth of 3.1 m		5	SS	16	
(SM) Gravelly SILTY SAND, some cohesive fines; grey (TILL); non-cohesive, moist, compact to dense	180.98 3.73	6	SS	13	
		7	SS	40	MH
		8	SS	26	
END OF BOREHOLE	178.00 6.71				

NOTE:

1. Water level measured in open borehole at a depth of 5.5 m upon completion of drilling, February 23, 2016.

2. Water level measured in monitoring well at a depth of 1.55 m, March 11, 2016.



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472

LOCATION: N 4860647.72; E 634606.69

RECORD OF BOREHOLE: 16-5

SHEET 1 OF 1

BORING DATE: February 24, 2016

DATUM: Geodetic

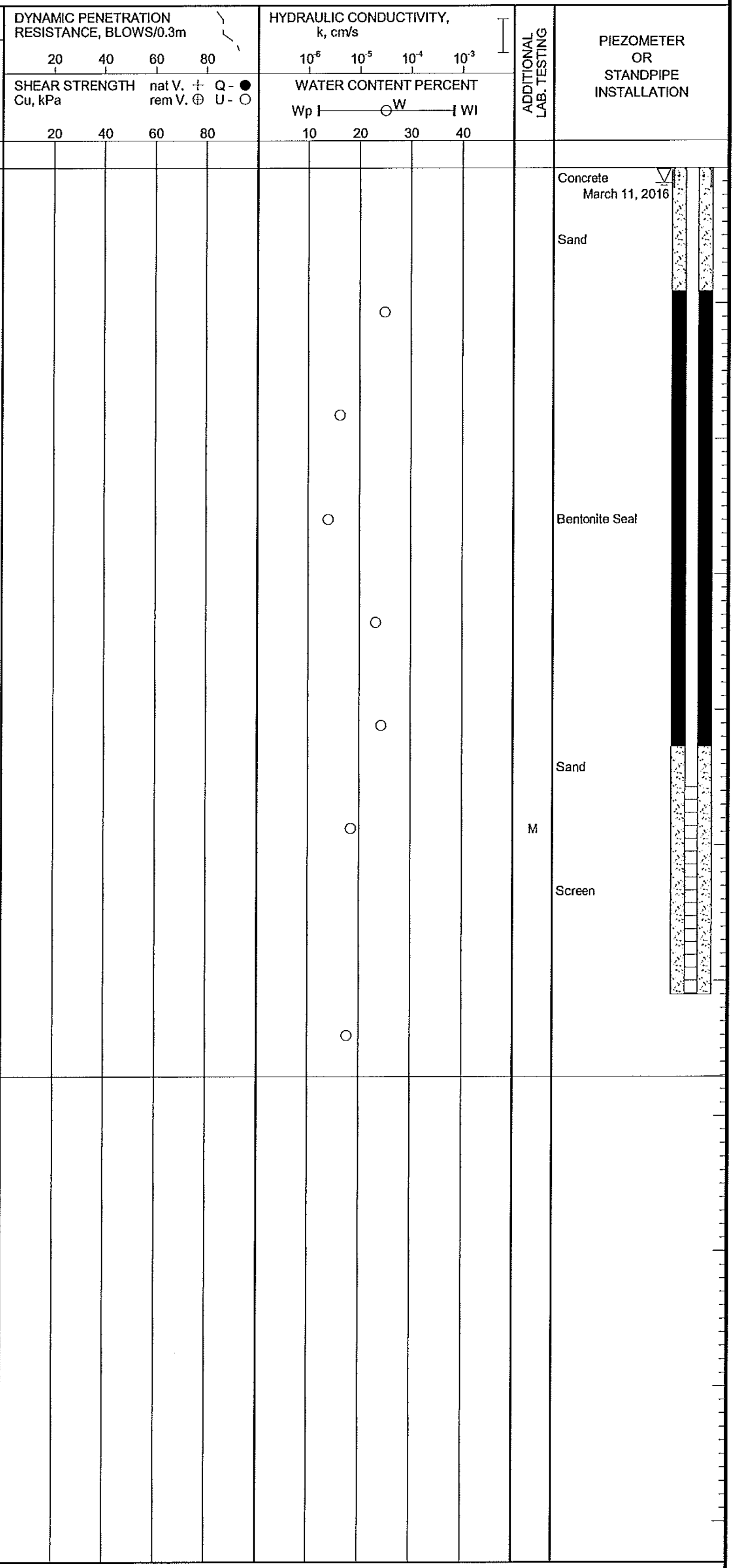
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 200 mm O.D. Hollow Stem Augers

DESCRIPTION	ELEV.	DEPTH (m)
GROUND SURFACE	186.08	
TOPSOIL		0.00
(CL-ML) CLAYEY SILT to CLAYEY SILT and SAND, trace to some gravel; brown mottled grey, becoming grey below a depth of 2.3 m, trace fibrous organics; cohesive, w~PL to w>PL, soft to stiff	185.47	0.61
(CL) SILTY CLAY, trace sand; light brown; cohesive, w>PL, firm	183.11	2.97
(SW) SAND, trace to some gravel, trace fines; brown; non-cohesive, wet, very loose to dense	182.35	3.73
END OF BOREHOLE	179.37	6.71

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	6	
2	SS	12	
3	SS	13	
4	SS	4	
5	SS	6	
6	SS	6	
7	SS	4	M
8	SS	35	



NOTE:

1. Water level measured in monitoring well at a depth of 0.5 m, February 25, 2016.

2. Water level measured in monitoring well at a depth of 0.11 m, March 11, 2016.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472

RECORD OF BOREHOLE: 16-6

SHEET 1 OF 1

LOCATION: N 4860589.30; E 634092.95

BORING DATE: March 2, 2016

DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

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

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

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

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	186.88					
0	CME-85 TRUCK MOUNTED - POWER AUGER 100 mm O.D. Solid Stem Augers	TOPSOIL	0.00					Concrete
		(CL-ML) Gravelly CLAYEY SILT and SAND; brown, trace fibrous organics, oxidation staining; cohesive w>PL to w~PL, soft to very stiff	186.68 0.20	1 2	SS SS	4 18		▽ March 11, 2016 Bentonite
1		(SM/ML) SILTY SAND to Sandy SILT, some gravel, trace to some cohesive fines; brown, becoming grey below a depth of 3.5 m, oxidation staining; non-cohesive, moist to wet, compact to dense	185.43 1.45	3 4 5 6 7A	SS SS SS SS	26 39 39 41	MH (sample 4)	Sand Screen
5		(ML) Sandy CLAYEY SILT; grey; cohesive, w<PL, hard	182.00 4.88	7B	SS	38		
		(SM/ML) SILTY SAND to Sandy SILT, some gravel, trace cohesive fines; brown, becoming grey below a depth of 3.5 m, oxidation staining; non-cohesive, moist to wet, dense to very dense	181.70 5.18	8	SS	88/ 0.28		Cave
		END OF BOREHOLE	180.35 6.53					

NOTE:

1. Water level measured in open borehole at a depth of 0.9 m upon completion of drilling, March 2, 2016

2. Water level measured in monitoring well at a depth of 0.42 m, March 11, 2016.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472
LOCATION: N 4860439.38; E 633967.65

RECORD OF BOREHOLE: 16-7

BORING DATE: February 29, 2016

SHEET 1 OF 1
DATUM: Geodetic

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

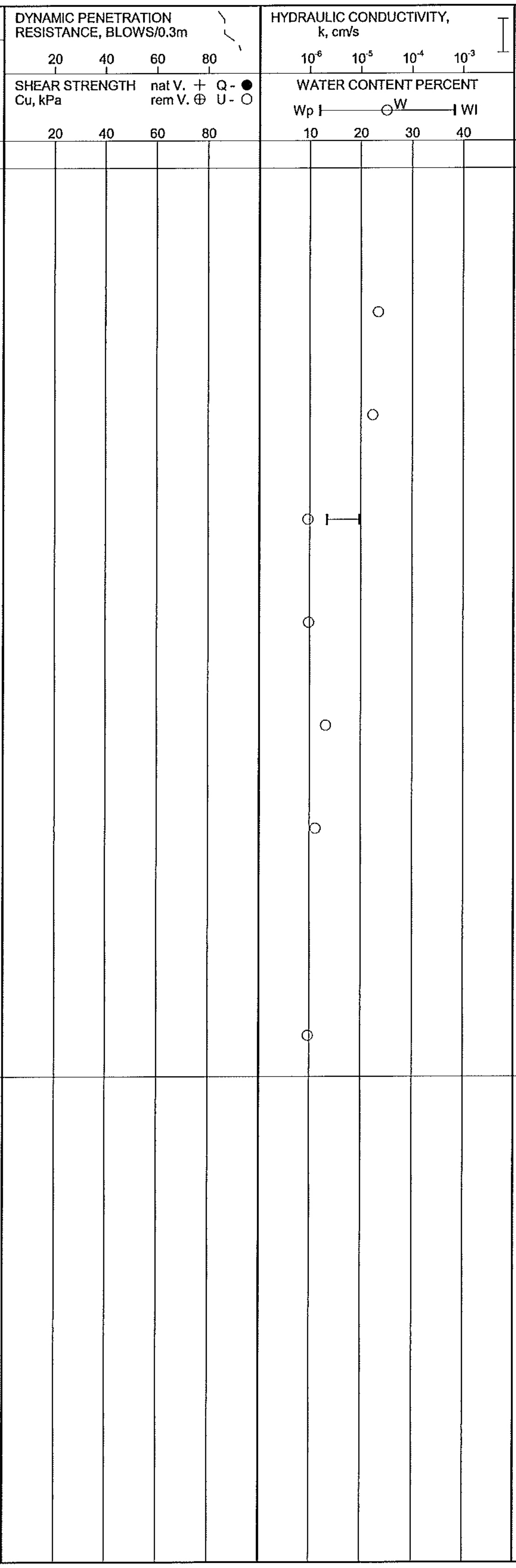
HAMMER TYPE: AUTOMATIC

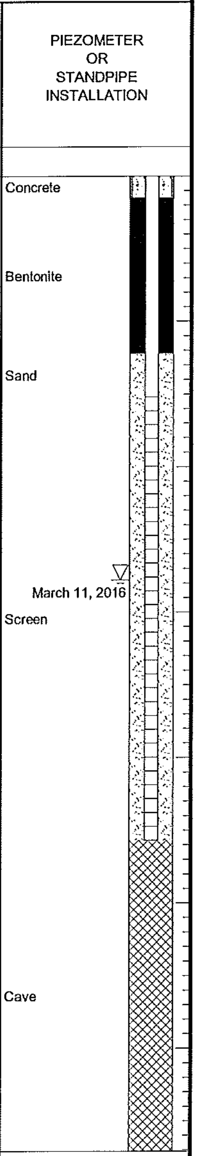
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING
		GROUND SURFACE	187.59				
0	CME-85 TRUCK MOUNTED - POWER AUGER 100 mm O.D. Solid Stem Augers	TOPSOIL	0.00	1	SS	4	
		(CL-ML) Sandy CLAYEY SILT, trace gravel; brown, trace fibrous organics; cohesive, w<PL to w~PL, soft to very stiff	187.18 0.41	2	SS	12	
				3	SS	19	
2		(ML-CL) Sandy CLAYEY SILT to Sandy SILTY CLAY, trace to some gravel; light brown, oxidation staining (TILL); cohesive, w<PL, hard	185.38 2.21	4	SS	41	AL/MH
				5	SS	41	
		(SW) Gravelly SAND, some fines; brown; non-cohesive, moist, dense	184.08 3.51				
		(ML/CL) Sandy CLAYEY SILT to SILTY CLAY, trace to some gravel; grey, oxidation staining (TILL); cohesive, w<PL to w~PL, stiff to very stiff	3.66	6	SS	14	
				7	SS	17	
				8	SS	22	
		END OF BOREHOLE	180.88 6.71				

NOTE:

1. Water level measured in open borehole at a depth of 4.3 m upon completion of drilling, February 29, 2016.

2. Water level measured in monitoring well at a depth of 2.78 m, March 11, 2016.





DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

PROJECT: 1413472

LOCATION: N 4860234.20; E 634189.57

RECORD OF BOREHOLE: 16-8

BORING DATE: February 29, 2016

SHEET 1 OF 1

DATUM: Geodetic

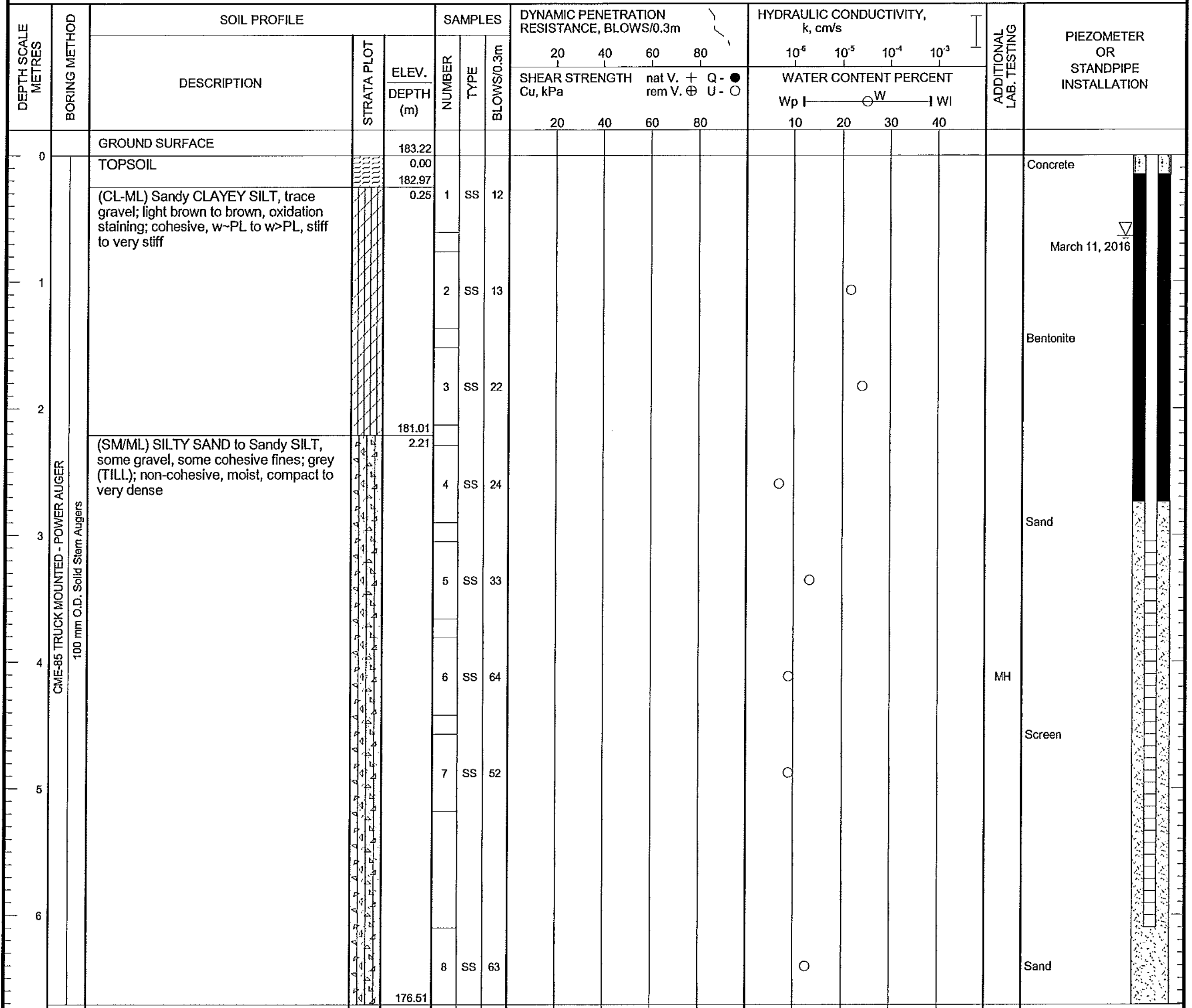
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 100 mm O.D. Solid Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	183.22 0.00
TOPSOIL	
(CL-ML) Sandy CLAYEY SILT, trace gravel; light brown to brown, oxidation staining; cohesive, w~PL to w>PL, stiff to very stiff	182.97 0.25
(SM/ML) SILTY SAND to Sandy SILT, some gravel, some cohesive fines; grey (TILL); non-cohesive, moist, compact to very dense	181.01 2.21
END OF BOREHOLE	176.51 6.71

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	12	
2	SS	13	
3	SS	22	
4	SS	24	
5	SS	33	
6	SS	64	MH
7	SS	52	
8	SS	63	



NOTE:

1. Water level measured in open borehole at a depth of 6.0 m upon drilling completion, February 29, 2016.

2. Water level measured in monitoring well at a depth of 0.64 m, March 11, 2016.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472

LOCATION: N 4859910.90; E 634082.19

RECORD OF BOREHOLE: 16-9

BORING DATE: February 29, 2016

SHEET 1 OF 1

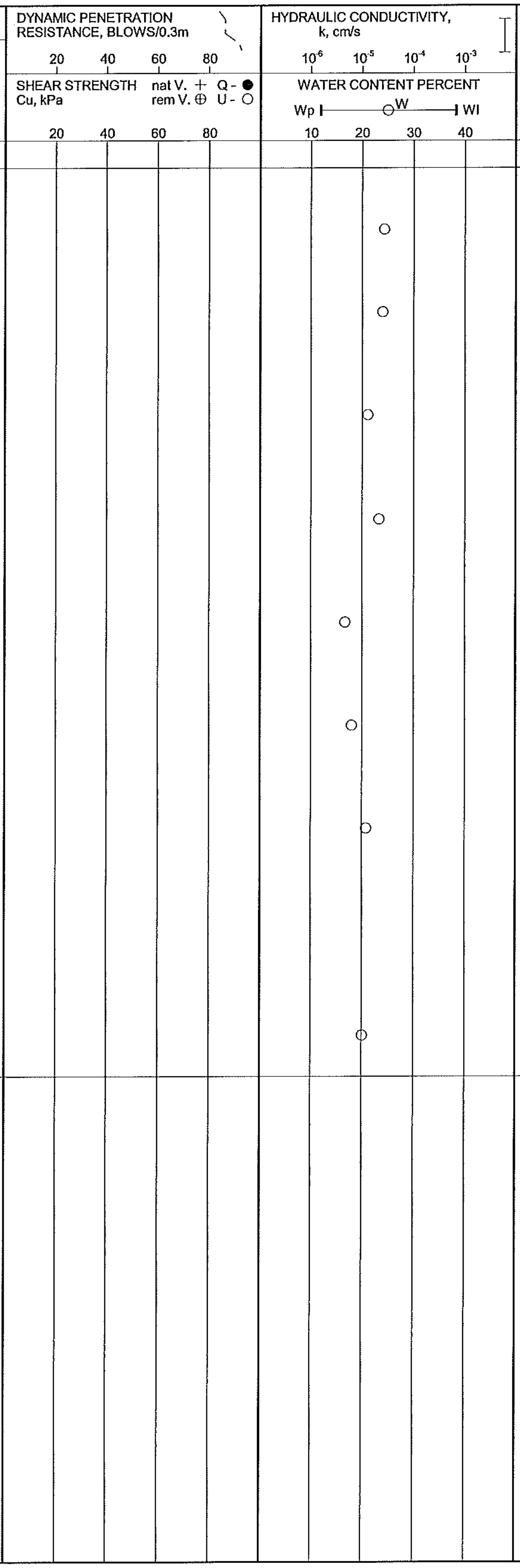
DATUM: Geodetic

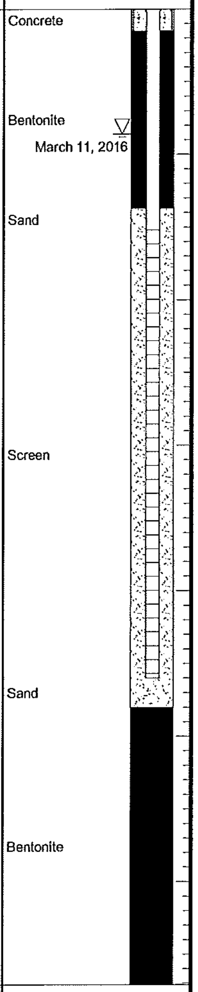
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER, 100 mm O.D. Solid Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	183.30				
TOPSOIL	0.00	1A	SS	9	
(CL-ML) Sandy CLAYEY SILT; brown, some fibrous organics; cohesive, w~PL, stiff	183.00 0.30	1B			
(CL) SILTY CLAY, sandy to trace sand, varved; brown to light brown, becoming grey below a depth of 1.8 m; cohesive, w~PL to w<PL, firm to very stiff	182.61 0.69	2	SS	5	
		3	SS	21	
		4	SS	15	
		5	SS	21	
(CI) SILTY CLAY, trace sand; grey; cohesive, w~PL, very stiff to hard	179.57 3.73	6	SS	19	MH
		7	SS	40	
		8	SS	43	
END OF BOREHOLE	176.59 6.71				





NOTE:

1. Borehole dry upon completion of drilling, February 29, 2016.

2. Water level measured in monitoring well at a depth of 0.86 m, March 11, 2016.

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472
LOCATION: N 4859988.01; E 633603.68

RECORD OF BOREHOLE: 16-10

BORING DATE: February 29, 2016

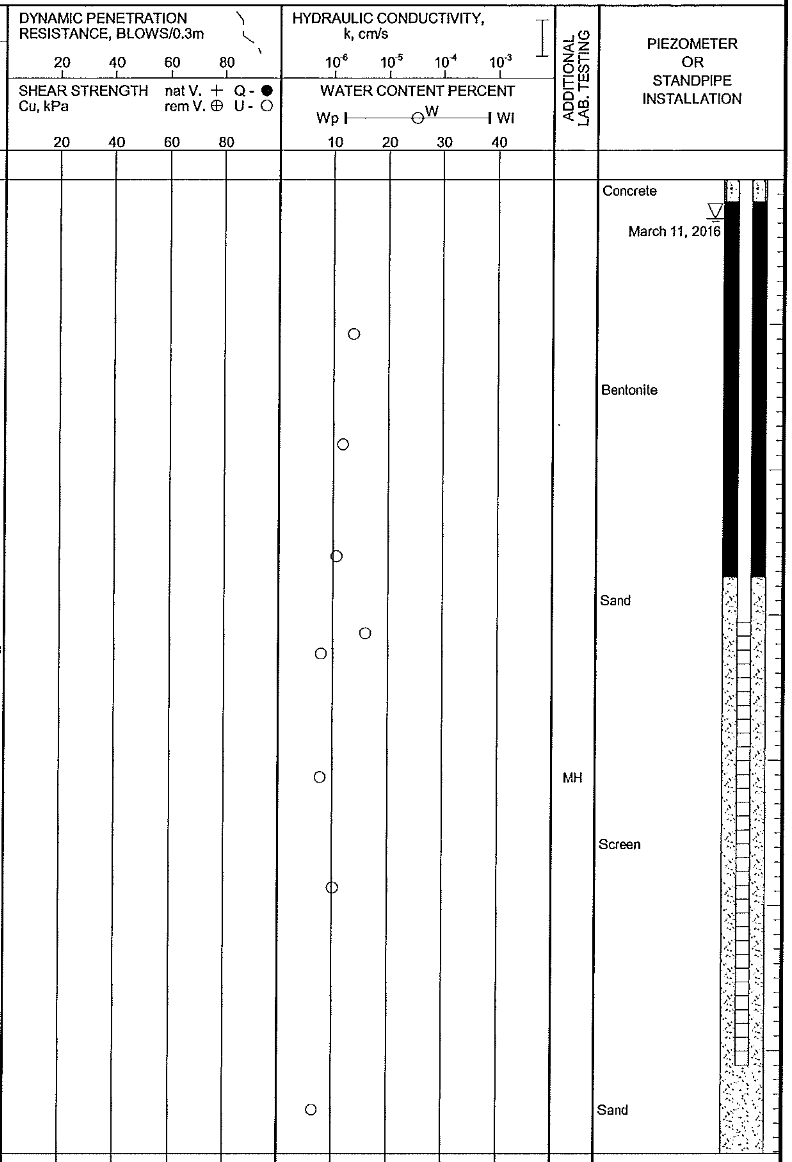
SHEET 1 OF 1
DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER
100 mm O.D. Solid Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	190.66				
TOPSOIL	0.00				
(CL-ML) Sandy CLAYEY SILT, trace gravel; light brown; cohesive, w~PL, firm to very stiff	190.41 0.25	1	SS	6	
		2	SS	7	
		3	SS	19	
(ML) Sandy SILT to SILT and SAND, some gravel, trace to some cohesive, fines; brown, oxidation staining (TILL); non-cohesive, moist, compact	188.45 2.21	4	SS	23	
(SM) SILTY SAND, trace gravel; brown; non-cohesive, wet, very dense	187.69 2.97	5A	SS	50/ 0.13	
(ML) Sandy SILT to SILT and SAND, some gravel, trace to some cohesive, fines; brown, becoming grey below a depth of 4.1 m, oxidation staining (TILL); non-cohesive, moist, compact to very dense	187.46 3.20	5B			
		6	SS	40	MH
		7	SS	28	
- Auger grinding on probable cobbles and boulders at a depth of about 5.5 m					
		8	SS	51	
END OF BOREHOLE	183.95 6.71				



NOTE:

1. Water level measured in open borehole at a depth of 2.0 m upon drilling completion, February 29, 2016.

2. Water level measured in monitoring well at a depth of 0.27 m, March 11, 2016.

DEPTH SCALE
1 : 50

LOGGED: DM
CHECKED: OS

PROJECT: 1413472

LOCATION: N 4859797.82; E 634643.69

RECORD OF BOREHOLE: 16-11

BORING DATE: February 25, 2016

SHEET 1 OF 1

DATUM: Geodetic

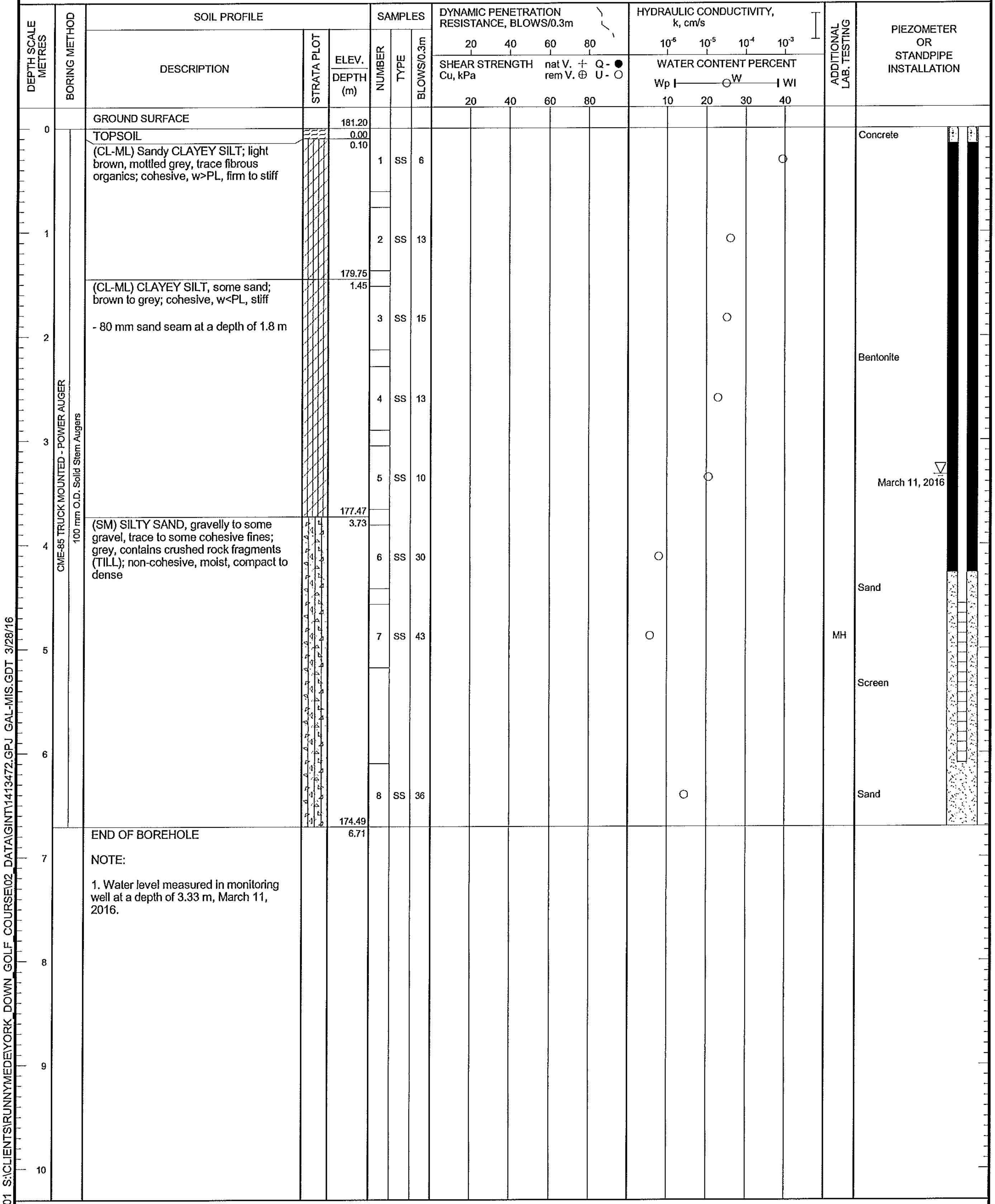
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 100 mm O.D. Solid Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	181.20
TOPSOIL	0.00
(CL-ML) Sandy CLAYEY SILT; light brown, mottled grey, trace fibrous organics; cohesive, w>PL, firm to stiff	0.10
(CL-ML) CLAYEY SILT, some sand; brown to grey; cohesive, w<PL, stiff - 80 mm sand seam at a depth of 1.8 m	179.75 1.45
(SM) SILTY SAND, gravelly to some gravel, trace to some cohesive fines; grey, contains crushed rock fragments (TILL); non-cohesive, moist, compact to dense	177.47 3.73
END OF BOREHOLE	174.49 6.71

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	6	
2	SS	13	
3	SS	15	
4	SS	13	
5	SS	10	
6	SS	30	
7	SS	43	MH
8	SS	36	



NOTE:

1. Water level measured in monitoring well at a depth of 3.33 m, March 11, 2016.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472

LOCATION: N 4860771.27; E 634894.00

RECORD OF BOREHOLE: 16-12

BORING DATE: February 25, 2016

SHEET 1 OF 3

DATUM: Geodetic

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

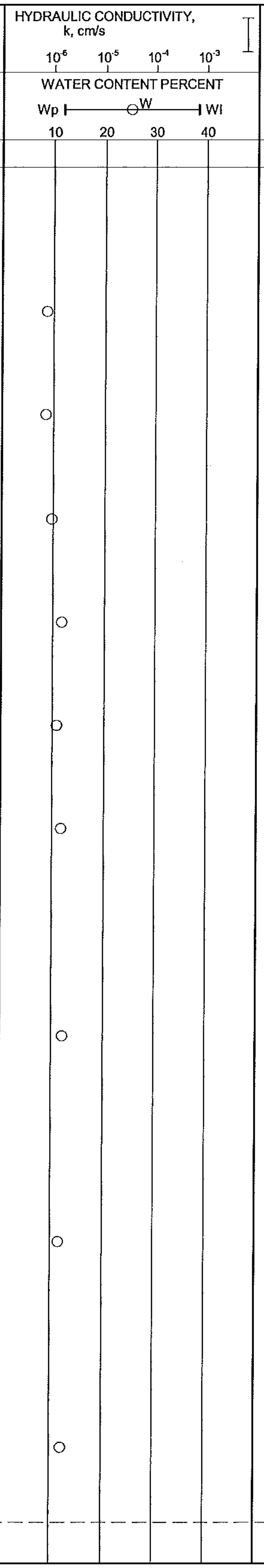
HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER, 200 mm O.D. Hollow Stem Augers

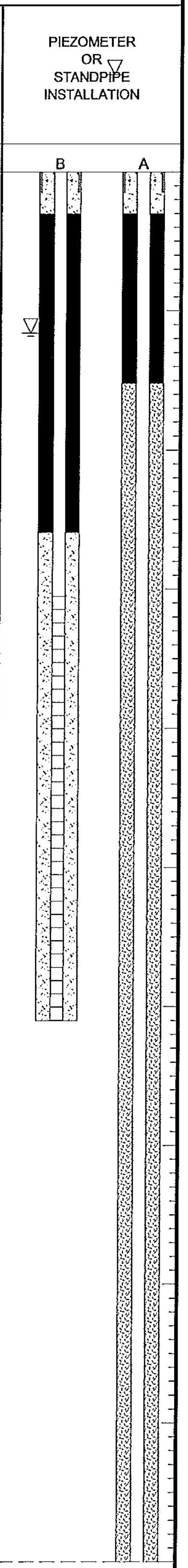
DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	190.11			
0	TOPSOIL	0.00			
	(SM/ML) SAND and SILT to Sandy SILT, some gravel, trace to some cohesive fines; grey (TILL); non-cohesive, moist, dense to very dense	189.88 0.23	1	SS	4
1			2	SS	45
	- Auger grinding on probable cobbles/boulders at a depth of 1.2 m				
2			3	SS	48
			4	SS	49
3			5	SS	32
4			6	SS	38
5			7	SS	40
6			8	SS	35
7					
8			9	SS	46
9			10	SS	63
10					

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

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



ADDITIONAL LAB. TESTING



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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472
LOCATION: N 4860771.27; E 634894.00

RECORD OF BOREHOLE: 16-12

BORING DATE: February 25, 2016

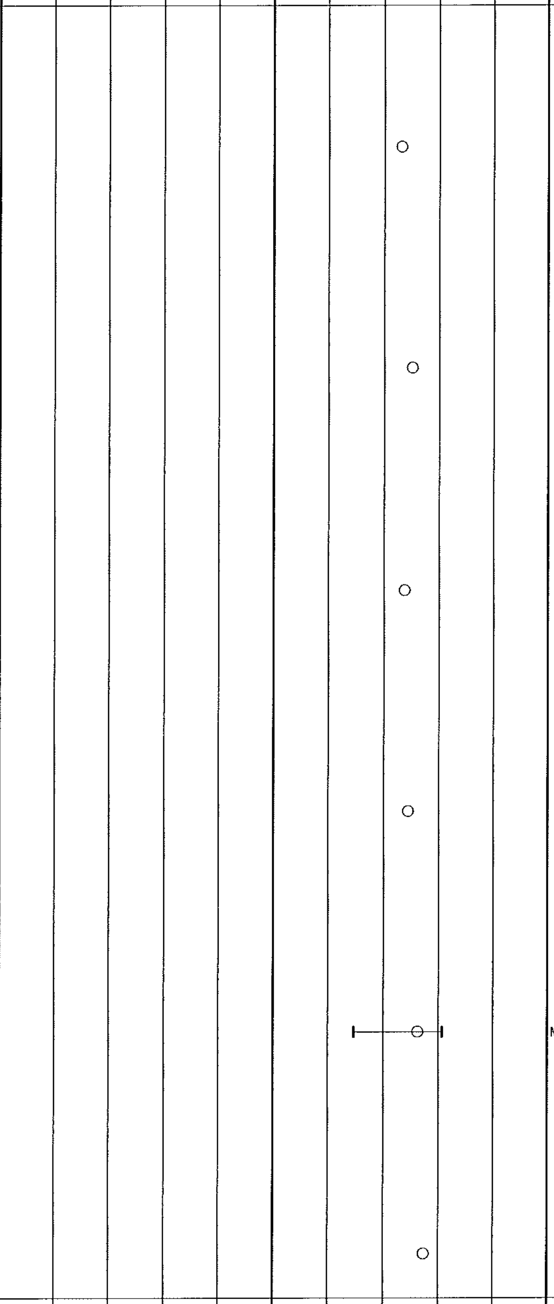
SHEET 2 OF 3
DATUM: Geodetic

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

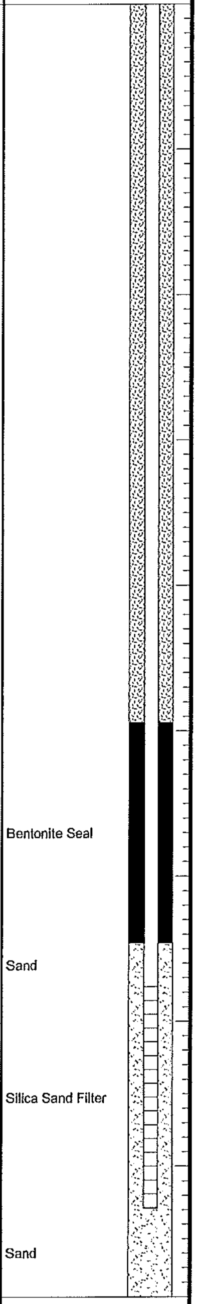
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING
10		— CONTINUED FROM PREVIOUS PAGE —						
	CME-85 TRUCK MOUNTED - POWER AUGER 200 mm O.D. Hollow Stem Augers	(CI) SILTY CLAY, trace to some sand, varved; grey; cohesive, w>PL, stiff to hard		179.90 10.21				
11					11	SS	37	
12					12	SS	45	
14					13	SS	27	
15					14	SS	12	
17		- 50 mm sand seam at a depth of 16.9 m			15	SS	32	MH/AL
18				171.21	16	SS	22	
19		END OF BOREHOLE		18.90				

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



NOTE:

1. Water level measured in monitoring well A at a depth of -0.70 m (above ground surface), March 11, 2016.

2. Water level measured in monitoring

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

PROJECT: 1413472
LOCATION: N 4860771.27; E 634894.00

RECORD OF BOREHOLE: 16-12

BORING DATE: February 25, 2016

SHEET 3 OF 3
DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			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
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m				
		— CONTINUED FROM PREVIOUS PAGE —									
20		well B at a depth of 0.41 m, March 11, 2016.									
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

GTA-BHS 001 S:\CLIENTS\RUNNYMEDE\YORK_DOWN_GOLF_COURSE\02_DATA\GINT\1413472.GPJ GAL-MIS.GDT 3/28/16

PROJECT: 1413472

LOCATION: N 4860121.00; E 635100.28

RECORD OF BOREHOLE: 16-13

BORING DATE: February 22, 2016

SHEET 1 OF 2

DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER
110 mm I.D. 200 mm O.D. Hollow Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	184.14				
TOPSOIL	0.00	1A			
(CL-ML) Sandy SILTY CLAY to CLAYEY SILT, trace gravel; brown to brown mottled grey, fibrous organics, oxidation staining; cohesive, w~PL, firm to very stiff	0.08	1B	SS	6	
		2	SS	16	
		3	SS	21	
(SP) SAND, trace fines; grey; non-cohesive, moist to wet, compact	181.93 2.21	4A	SS	15	
(ML/SM) Sandy SILT to SILTY SAND, gravelly to some gravel, trace to some cohesive fines; grey (TILL); non-cohesive, moist to wet, compact	181.55 2.59	4B			
		5	SS	22	
- Auger grinding on probable cobbles/boulders at a depth of 3.8 m		6	SS	18	
- Auger grinding on probable cobbles/boulders at a depth of 4.6 m		7	SS	22	MH
(SM) SILTY SAND; grey; non-cohesive, wet, compact	177.89 6.25	8A 8B	SS	17	
(SM) SILTY SAND, trace to some gravel, trace cohesive fines; grey (TILL); moist to wet, compact to dense - Auger grinding on probable cobbles/boulders from depths of 6.9 m to 7.5 m	177.49 6.65	8C			
		9	SS	32	
(ML) Sandy SILT; grey; non-cohesive, wet, loose	175.45 8.69	10A 10B	SS	9	

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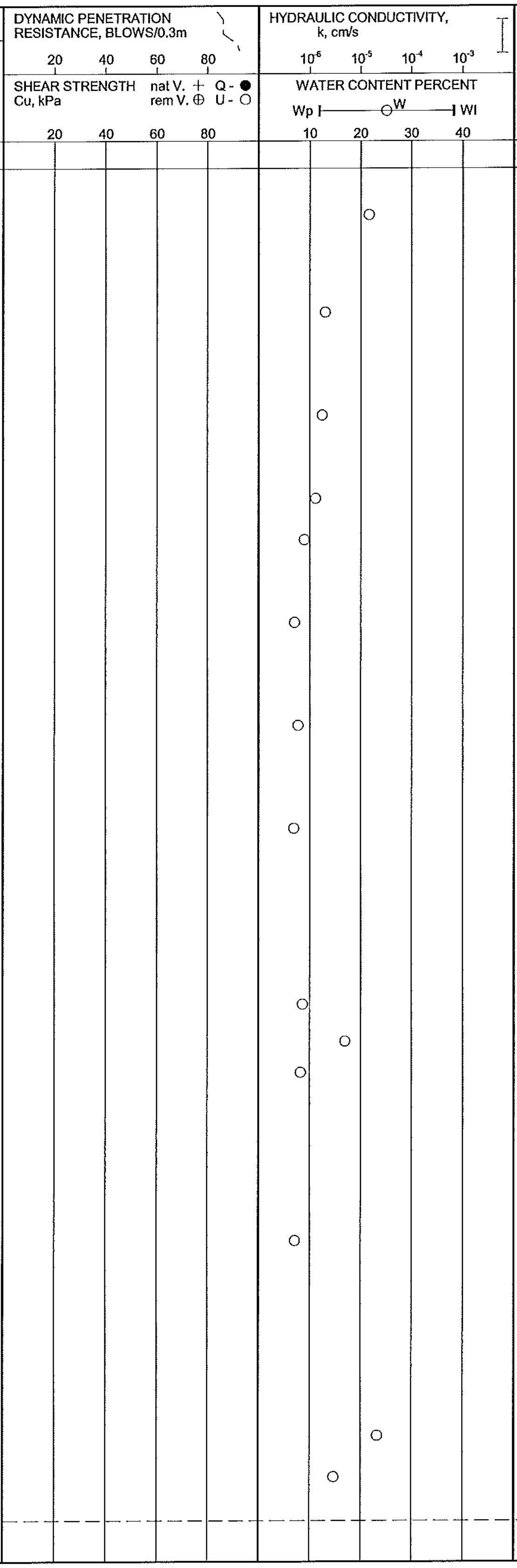
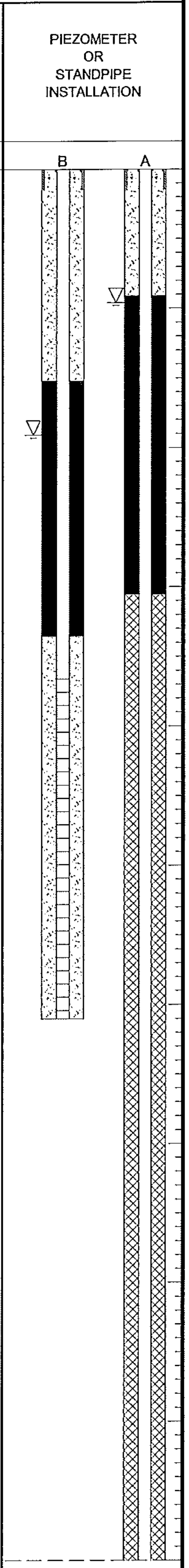




DEPTH SCALE 0 – 10 m

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

PROJECT: 1413472

LOCATION: N 4860121.00; E 635100.28

RECORD OF BOREHOLE: 16-13

SHEET 2 OF 2

BORING DATE: February 22, 2016

DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 110 mm I.D. 200 mm O.D. Hollow Stem Augers

— CONTINUED FROM PREVIOUS PAGE —

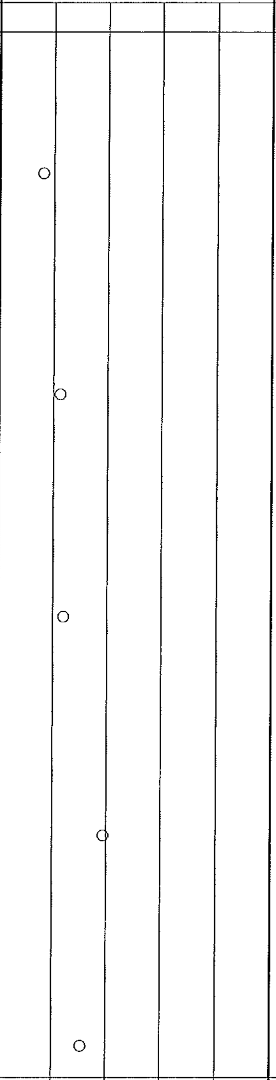
DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
10	(SM) SILTY SAND trace to some gravel, trace cohesive fines; grey (TILL); non-cohesive, moist, dense	173.93 10.21			
11			11	SS	38
	(SM) SILTY SAND, some gravel; grey; non-cohesive, wet, loose	172.41 11.73			
12			12	SS	5
13	(SW) SAND, trace gravel; grey; non-cohesive, wet, very dense - Auger grinding on probable cobbles/boulders at a depth of 13.6 m	170.88 13.26			
14			13	SS	56
	(ML) Sandy SILT to SILT and SAND; grey; non-cohesive, moist to wet, very dense	169.81 14.33			
15			14	SS	80
16					
17			15	SS	94/ 0.28
	END OF BOREHOLE	166.94 17.20			
18					
19					
20					

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

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

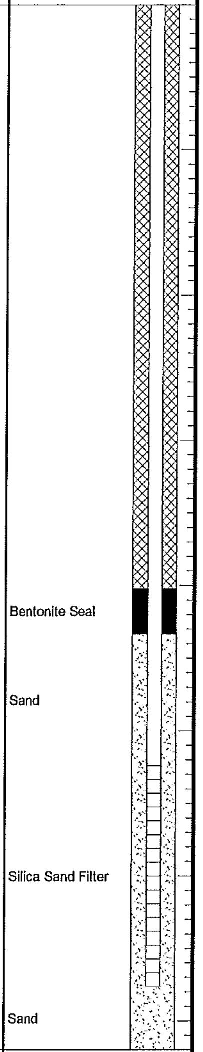
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

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



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



NOTE:

1. Water level measured in hollow stems at a depth of 3.9 m after advance augers to a depth of 3.8 m.

2. Water level measured in open borehole at a depth of 7.5 m upon completion of drilling, February 22, 2016.

3. Water level measured in monitoring well A at a depth of 0.96 m, March 11, 2016.

4. Water level measured in monitoring well B at a depth of 1.91 m, March 11, 2016.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472
LOCATION: N 4859941.64; E 634905.52

RECORD OF BOREHOLE: 16-14

BORING DATE: February 26, 2016

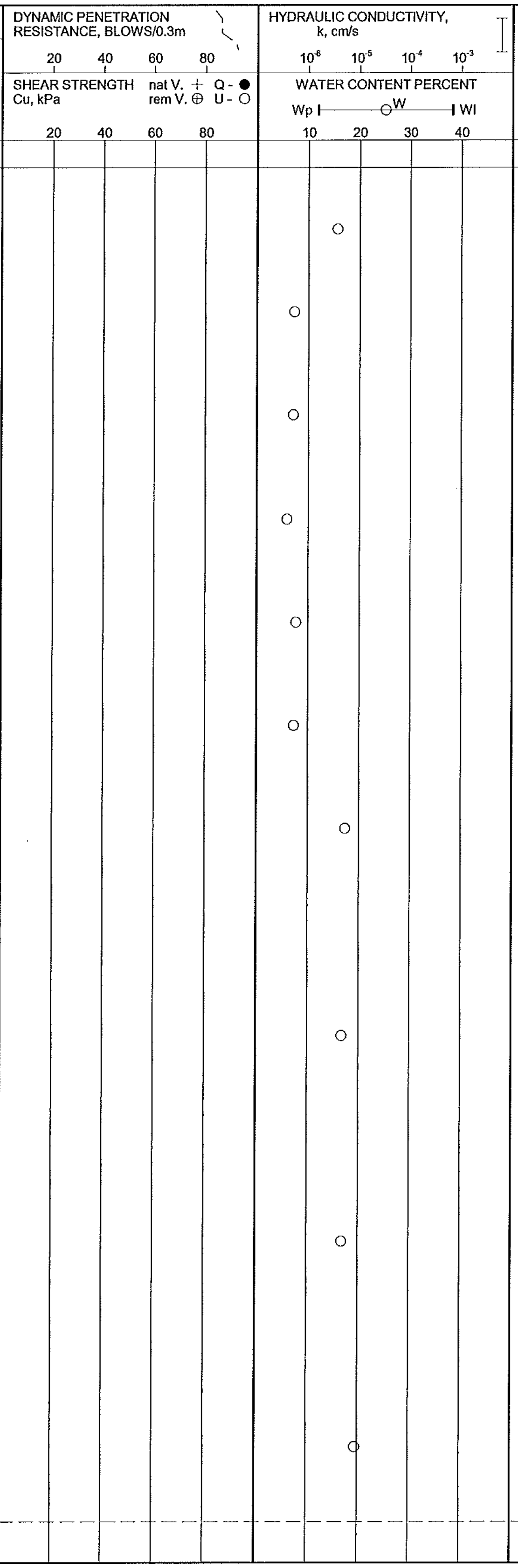
SHEET 1 OF 2
DATUM: Geodetic

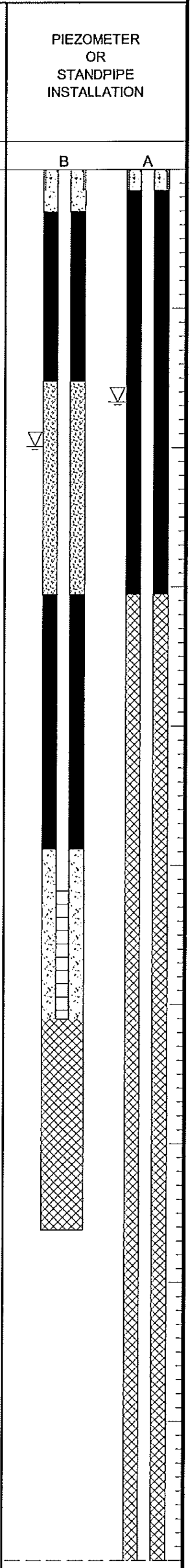
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 110 mm I.D. 200 mm O.D. Hollow Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	177.45				
TOPSOIL	0.00	1A	SS	7	
(SM) SILTY SAND, some gravel, trace cohesive fines; brown to light brown, fibrous organics, oxidation staining; non-cohesive, moist, loose	177.15 0.30	1B			
(SM) SILTY SAND, some gravel, trace cohesive fines; light brown to brown, becoming grey below a depth of 2.3 m, oxidation staining (TILL); non-cohesive, moist, compact to dense - Auger grinding on probable cobbles/boulders at a depth of 1.4 m	176.76 0.69	2	SS	15	
		3	SS	38	
- Auger grinding on probable cobbles/boulders at a depth of 2.0 m					
		4	SS	40	
		5	SS	27	
		6	SS	24	
(SM/SW) SILTY SAND to SAND, trace to some gravel, trace clay; grey; non-cohesive, wet, loose to compact	172.95 4.50	7	SS	19	MH
		8	SS	8	
		9	SS	14	
		10	SS	31	





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DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

PROJECT: 1413472

LOCATION: N 4859941.64; E 634905.52

RECORD OF BOREHOLE: 16-14

BORING DATE: February 26, 2016

SHEET 2 OF 2

DATUM: Geodetic

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

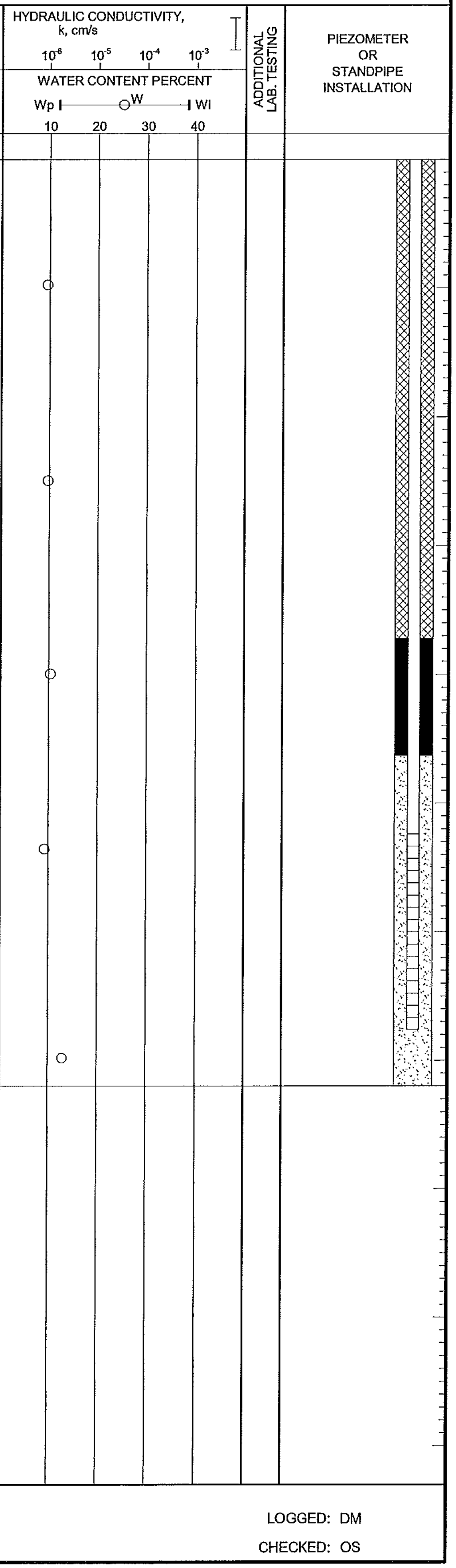
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
10	CME-85 TRUCK MOUNTED - POWER AUGER 110 mm I.D. 200 mm O.D. Hollow Stem Augers	— CONTINUED FROM PREVIOUS PAGE — (SM/SW) SILTY SAND to SAND, trace to some gravel, trace clay; grey; non-cohesive, wet, loose to compact				
11				11	SS	29
		(CL-ML) Sandy CLAYEY SILT, trace gravel; grey (TILL); cohesive, w<PL, hard	165.72 11.73			
12				12	SS	92/ 0.25
13						
14				13	SS	69
15	TRICONE 100 mm Diameter			14	SS	50/ 0.08
16						
17				15	SS	95/ 0.28
		END OF BOREHOLE:	160.25 17.20			
18						
19						
20						

NOTE:

1. Water level measured in monitoring well A at a depth of 1.67 m, March 11, 2016.

3. Water level measured in monitoring well B at a depth of 1.99 m, March 11, 2016.



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472
LOCATION: N 4859619.51; E 634368.01

RECORD OF BOREHOLE: 16-15

BORING DATE: March 4, 2016

SHEET 1 OF 2

DATUM: Geodetic

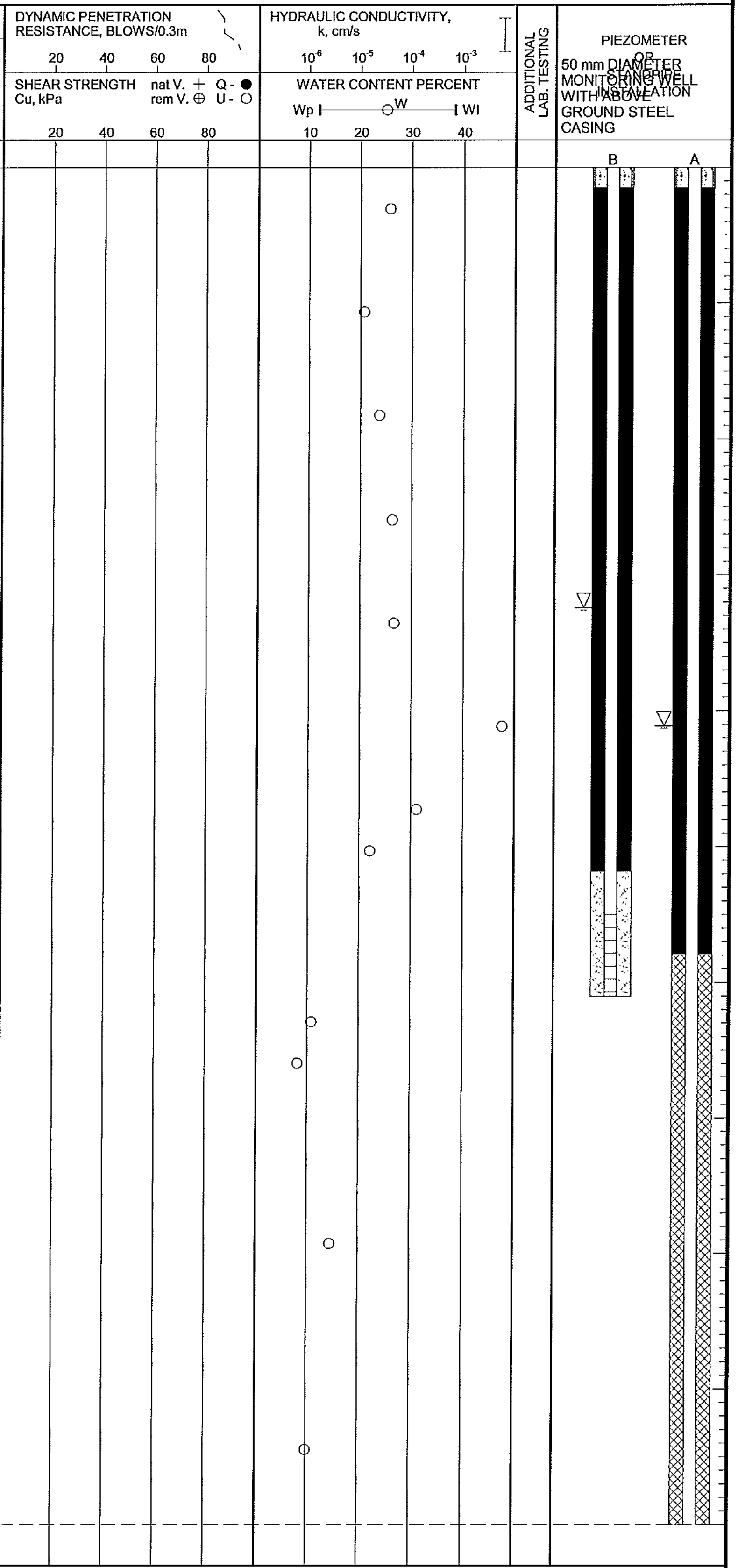
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 200 mm O.D. Hollow Stem Augers

DEPTH SCALE METRES: 0 – 10

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE		180.87			
TOPSOIL		0.00			
(CL-ML) CLAYEY SILT, trace to some sand; grey, oxidation staining; cohesive, w<PL to w~PL, firm to stiff		0.15	1	SS	4
			2	SS	10
			3	SS	12
(CL-ML) SILTY CLAY, trace sand, trace gravel; grey; cohesive, w>PL, stiff to very soft		178.66 2.21	4	SS	11
			5	SS	5
			6	SS	WH
			7A	SS	6
(SM/SW) SAND and SILT to SAND, some gravel; grey; non-cohesive, wet, loose to compact		175.99 4.88	7B		
- Auger grinding on probable cobbles/boulders at a depth of 6.1 m			8A	SS	10
(SM) SILTY SAND, trace to some gravel, some cohesive fines; grey; non-cohesive, wet, compact to dense		174.39 6.48	8B		
			9	SS	38
- 150 mm sand and silt seam at a depth of 8.1 m					
(ML-CL) Sandy CLAYEY SILT, trace gravel; grey (TILL); cohesive, w<PL, hard		172.18 8.69			
			10	SS	92/ 0.28



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DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

PROJECT: 1413472

RECORD OF BOREHOLE: 16-15

SHEET 2 OF 2

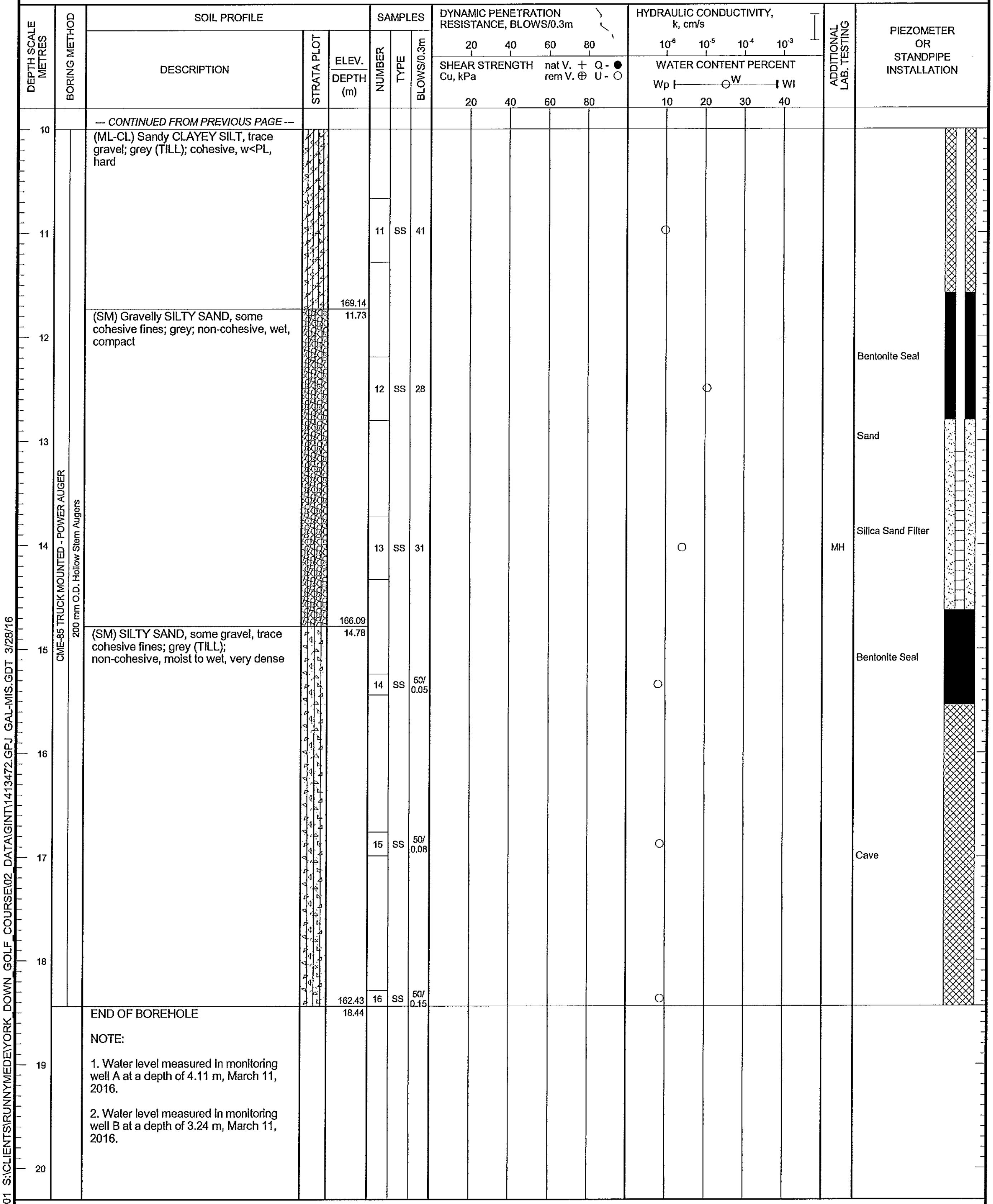
LOCATION: N 4859619.51; E 634368.01

BORING DATE: March 4, 2016

DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —						
10	CME-85 TRUCK MOUNTED - POWER AUGER 200 mm O.D. Hollow Stem Augers	(ML-CL) Sandy CLAYEY SILT, trace gravel; grey (TILL); cohesive, w<PL, hard						
11				11	SS	41		
			169.14 11.73					
12		(SM) Gravelly SILTY SAND, some cohesive fines; grey; non-cohesive, wet, compact						Bentonite Seal
				12	SS	28		
13								Sand
14				13	SS	31	MH	Silica Sand Filter
			166.09 14.78					
15		(SM) SILTY SAND, some gravel, trace cohesive fines; grey (TILL); non-cohesive, moist to wet, very dense						Bentonite Seal
				14	SS	50/ 0.05		
16								
17				15	SS	50/ 0.08		Cave
18								
			162.43	16	SS	50/ 0.15		
		END OF BOREHOLE	18.44					
19								
20								

NOTE:

1. Water level measured in monitoring well A at a depth of 4.11 m, March 11, 2016.

2. Water level measured in monitoring well B at a depth of 3.24 m, March 11, 2016.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: OS

PROJECT: 1413472
LOCATION: N 4860097.78; E 634583.69

RECORD OF BOREHOLE: 16-16

BORING DATE: February 22, 2016

SHEET 1 OF 2
DATUM: Geodetic

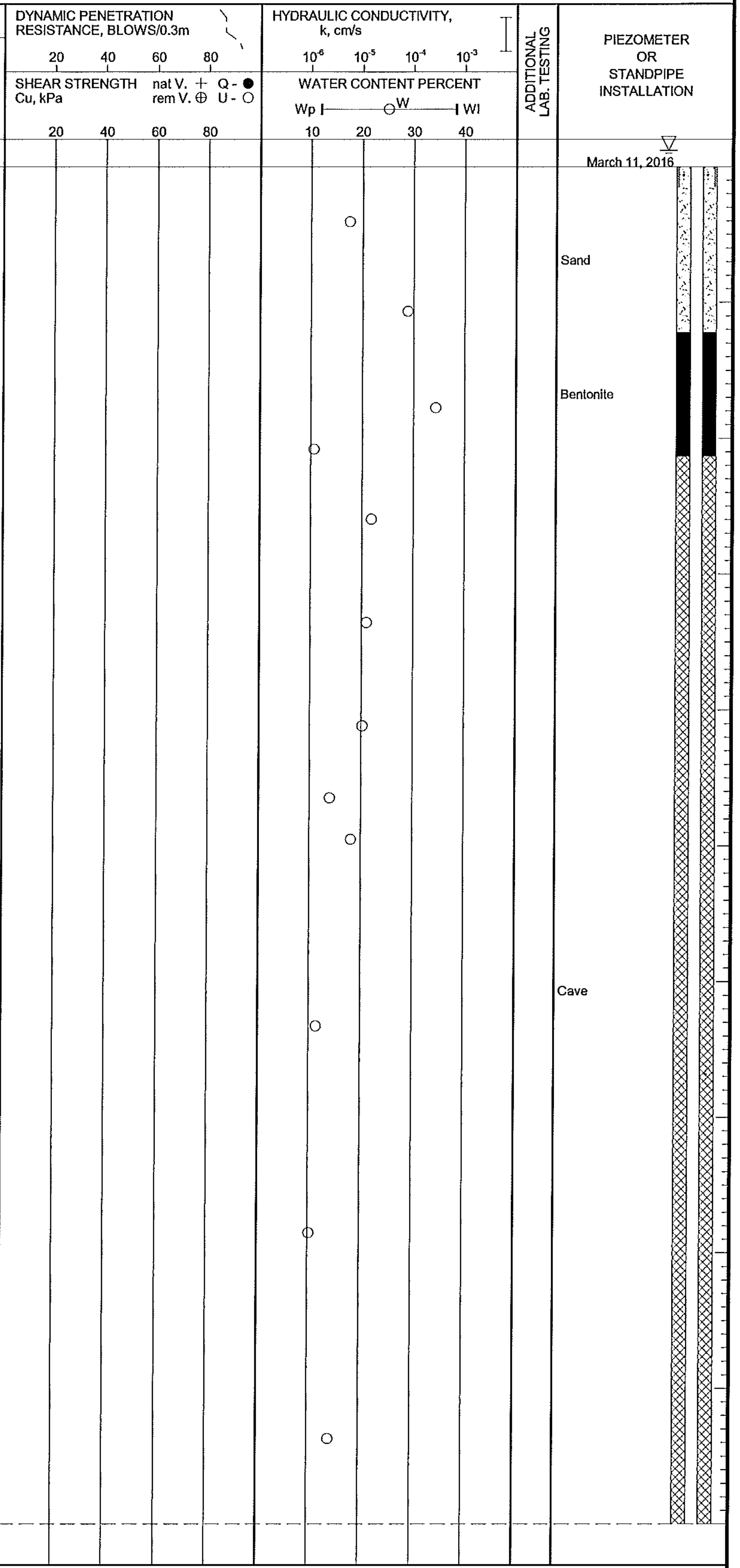
SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME-85 TRUCK MOUNTED - POWER AUGER; 200 mm O.D. Hollow Stem Augers

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	179.60			
0	TOPSOIL	0.00	1A		
	FILL - (CL) Sandy SILTY CLAY, some gravel; dark brown to brown; cohesive, w<PL, soft to firm	179.40 0.20	1B	SS	8
1			2	SS	4
	(OL) ORGANIC SILT, some sand; black	178.15 1.45	3A	SS	13
2	(SW) SAND and GRAVEL, trace fines, trace gravel; brown; non-cohesive, moist, compact	177.57 2.03	3B		
	(SM) SILTY SAND; grey; non-cohesive, wet, loose to compact	177.39 2.21	4	SS	24
3			5	SS	6
4	- 80 mm thick gravelly sand seam noted at a depth of 4.0 m		6	SS	6
	(SW) SAND, trace silt, trace gravel; grey; non-cohesive, wet, compact	175.10 4.50	7A	SS	19
5			7B		
	(SM/ML) SAND and SILT to Sandy SILT, trace gravel, trace to some cohesive fines; grey (TILL); non-cohesive, wet to moist, very dense	173.96 5.64			
6			8	SS	63
7					
8			9	SS	100
9			10	SS	76
10					

CONTINUED NEXT PAGE



DEPTH SCALE
1 : 50

LOGGED: DM
CHECKED: OS

PROJECT: 1413472
LOCATION: N 4860097.78; E 634583.69

RECORD OF BOREHOLE: 16-16

BORING DATE: February 22, 2016

SHEET 2 OF 2
DATUM: Geodetic

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

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT PERCENT (Wp —○W— Wl) 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —							
10	CME-85 TRUCK MOUNTED - POWER AUGER 200 mm O.D. Hollow Stem Augers	- Auger grinding on probable cobbles/boulders at a depth of 9.9 m and at a depth of 10.2 m	169.39 10.21						Bentonite
		(SM/GW) SILTY SAND to Sandy GRAVEL, some fines; grey; non-cohesive, wet, compact to very dense							Sand
11				11	SS	16	○	M	Screen
12			167.26 12.34	12	SS	50	○		Sand
		- Auger grinding on probable cobbles/boulders at a depth of 12.3 m							
		END OF BOREHOLE:							
		NOTE:							
13		1. Water level measured in hollow stem augers at a depth of 3.10 m after advancing to a depth of 3.8 m.							
		2. Water level measured monitoring well at a depth of -0.12 m (above ground surface), March 11, 2016.							
14									
15									
16									
17									
18									
19									
20									

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}

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DM
CHECKED: OS

BURNSIDE

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Appendix C

Grain-Size Analyses

Appendix C

TABLE C-1:
4134 16th Avenue, Markham
Summary of Grain-size Analyses

Borehole	Sediment Sample				Sample Description	Estimated K (cm/s)	
	No.	Depth (m)	Elevation (masl)	d_{10} (mm)		Sample	Geometric Mean
14-09	6	4.6-5.2	176.8	<0.001	Silty Clay	<0.001	<0.001
16-12	15	16.8-17.4	173.04	<0.001	Silty Clay	<0.001	
16-9	6	3.7-4.3	178.42	<0.001	Silty Clay	<0.001	
14-33	6	4.6-5.2	187.7	<0.001	Sandy, Clayey Silt, trace sand (Till)	<0.001	2.1E-06
16-7	4	2.2-2.8	185	<0.001	sandy Silty Clay to sandy Clayey Silt (Till)	<0.001	
16-2	6	4-4.6	181.24	<0.001	sandy Silty Clay to sandy Clayey Silt (Till)	<0.001	
16-1	9	8-8.6	179.45	<0.001	sandy Silty Clay to sandy Clayey Silt (Till)	<0.001	
14-23	4	2.3-2.9	186.5	0.001	Clayey Silt, some sand, trace gravel (Till-like)	2.0E-06	
14-09	4	2.3-2.9	179.3	0.002	Clayey Sand Till	2.3E-06	
14-14	6	4.6-5.2	171.5	0.005	Silt, trace clay, some sand	2.2E-05	3.2E-06
14-23	6	4.6-5.2	184.2	0.002	Silty Sand, some sand, trace clay (Till)	2.3E-06	
14-10	3	1.5-2.1	186.7	0.003	Silty Sand Till	6.3E-06	
14-11	6	4.6-5.2	177.5	0.005	Silty Sand Till	2.5E-05	
16-11	7	4.6-5.2	177.08	0.001	Silty Sand (Till)	2.0E-06	
16-13	7	4.6-5.2	179.26	0.001	Silty Sand (Till)	1.0E-06	
16-4	7	5-5.6	174.96	0.002	Silty Sand (Till)	4.0E-06	
16-10	6	3.8-4.4	186.54	0.001	sandy Silt (Till)	1.0E-06	
16-8	6	4.4.6	179.10	0.001	sandy Silt (Till)	1.0E-06	
16-6	4	2.5-3.1	184.29	0.001	sandy Silt	2.0E-06	
14-34	6	3.8-4.4	176.4	0.016	Silty Sand, fine grained sand, trace clay	2.6E-04	2.1E-03
16-16	11	10.7-11.1	168.7	0.045	Silty Sand	2.0E-03	
16-15	13	13.7-14.3	166.84	0.035	Silty Sand	1.2E-03	
16-14	7	4.6-5.2	172.57	0.043	Silty Sand	1.8E-03	
14-15	7	6.1-6.7	173.5	0.058	Silty Sand	3.4E-03	
16-5	7	5-5.6	176.33	0.091	Sand	8.3E-03	
16-3	7B	4.9-5.5	192.56	0.078	Sand	6.1E-03	
14-32	6	4.6-5.2	189.4	0.046	Sand	2.1E-03	

Notes:

m - metres

masl - metres above sea level

NA - Not applicable

Borehole locations are shown in ***Figure 4*** .

K values estimated using the Hazen correlation

Grain-size distributions are based on the Unified Soil Classification.

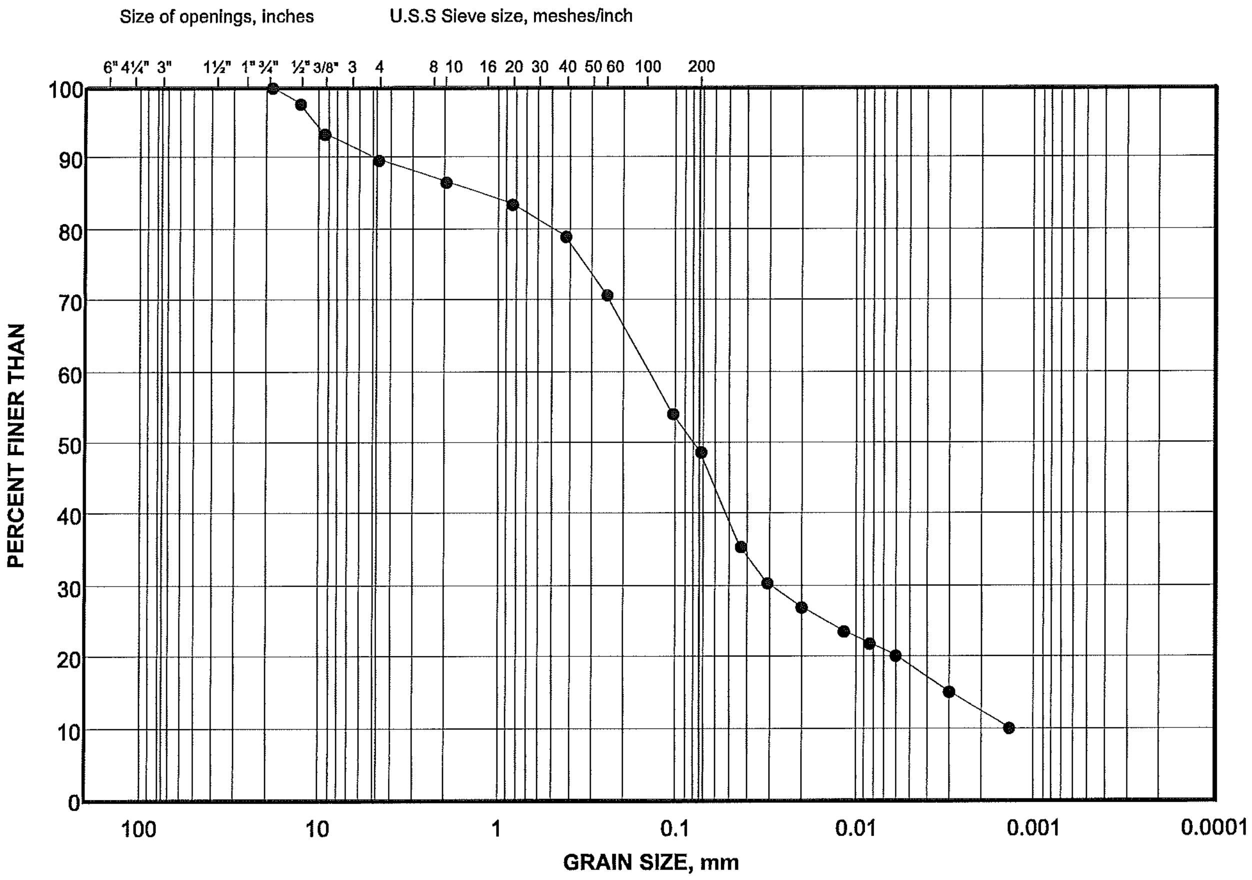
D_{10} values are from Grain-size analyses or estimated by Burnside

Geometric mean values do not include <0.001 values

GRAIN SIZE DISTRIBUTION

CLAYEY SAND TILL

FIGURE 3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-09	4	

Project Number: 14-13472

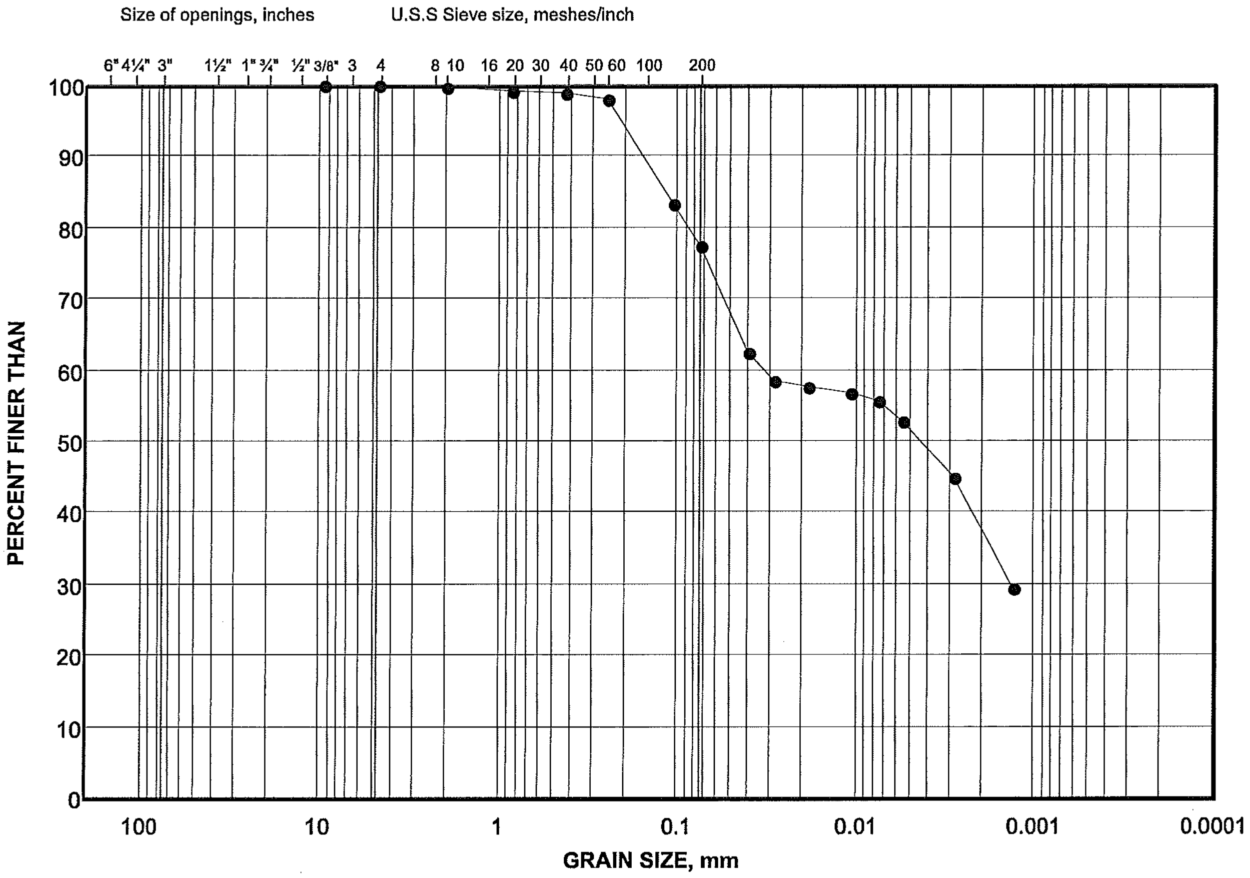
Checked By: SDK

Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION
SILTY CLAY

FIGURE 4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-09	6	

Project Number: 14-13472

Checked By: SDK

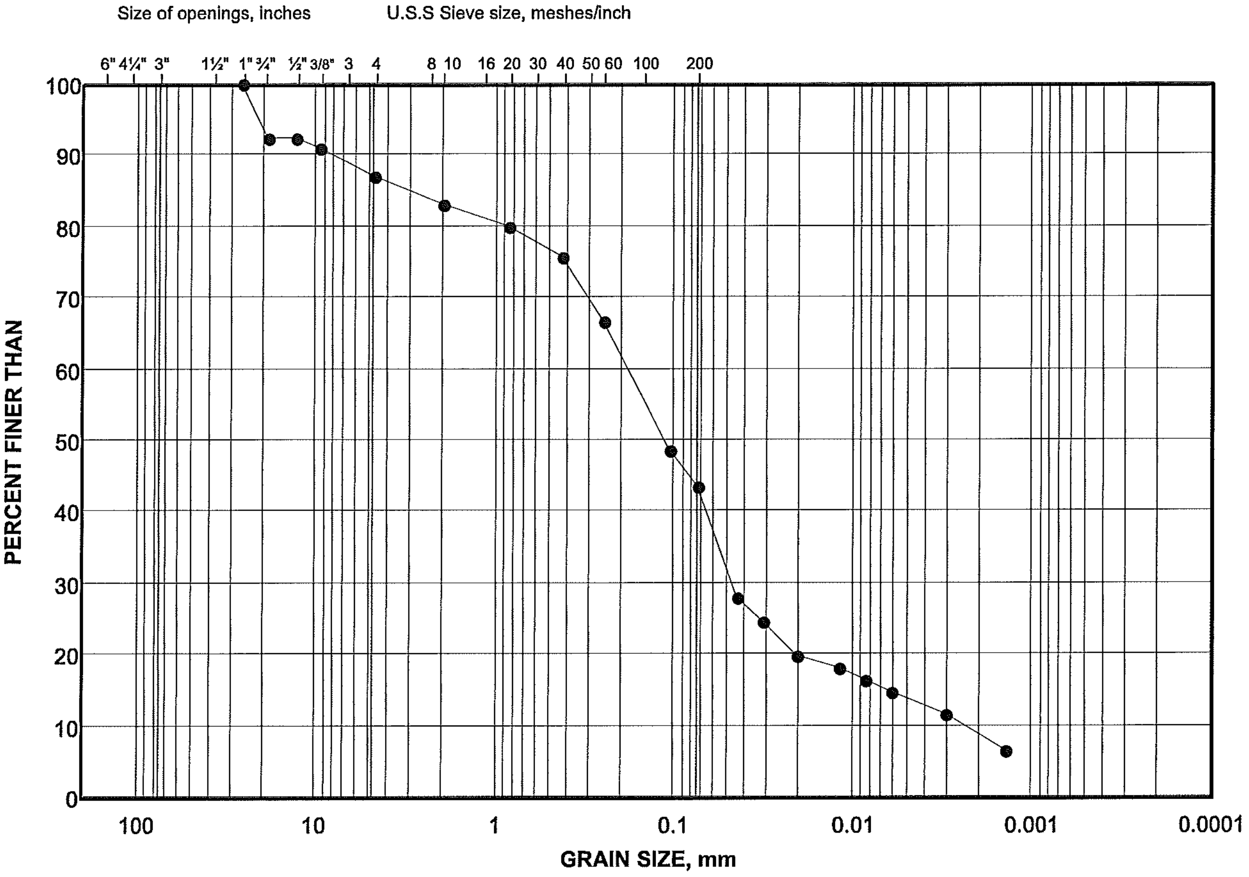
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND TILL

FIGURE 5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-10	3	

Project Number: 14-13472

Checked By: SDK

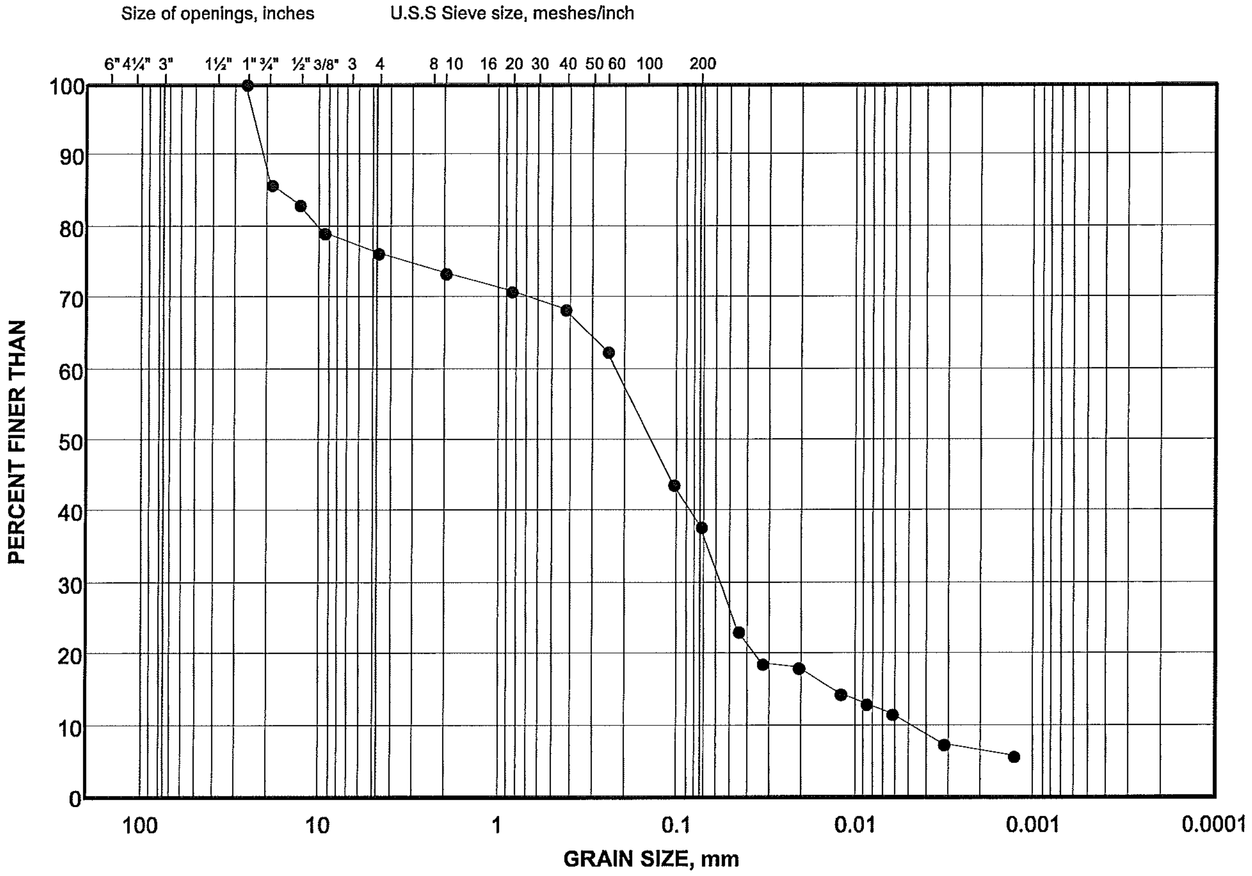
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND TILL

FIGURE 6



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-11	6	

Project Number: 14-13472

Checked By: SDK

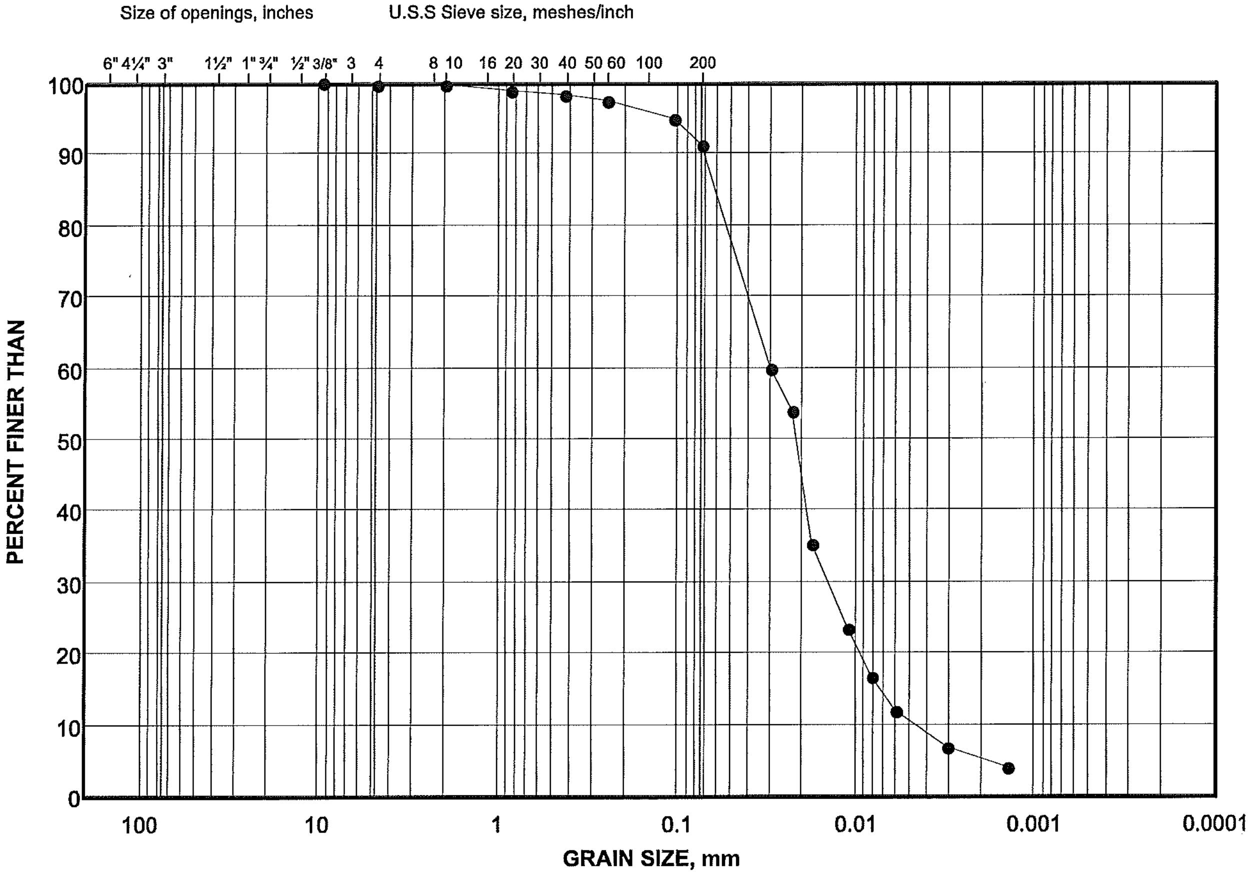
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(ML) SILT, trace clay, some sand

FIGURE 7



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-14	6	

Project Number: 14-13472

Checked By: SDK

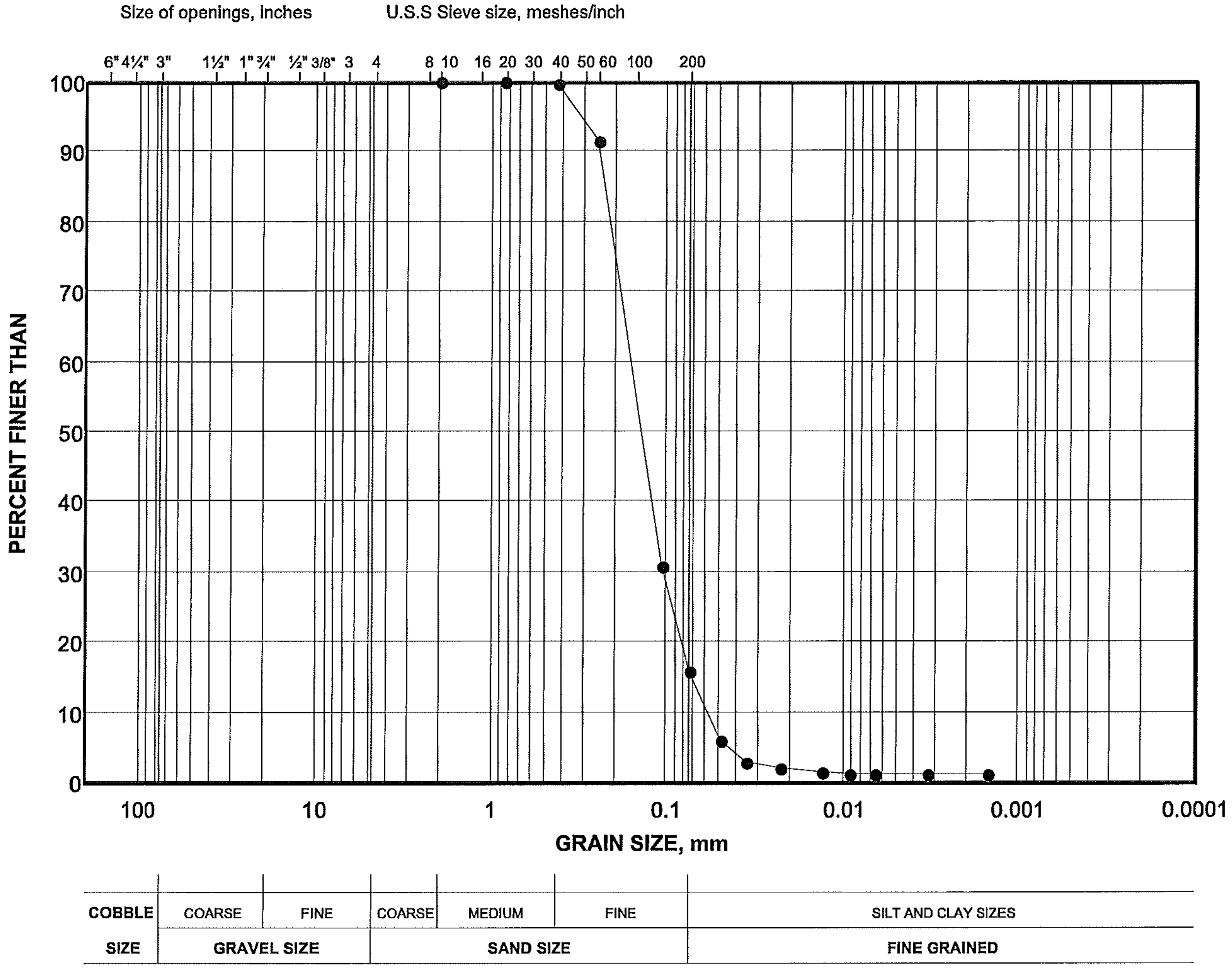
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND

FIGURE 8



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-15	7	

Project Number: 14-13472

Checked By: SDK

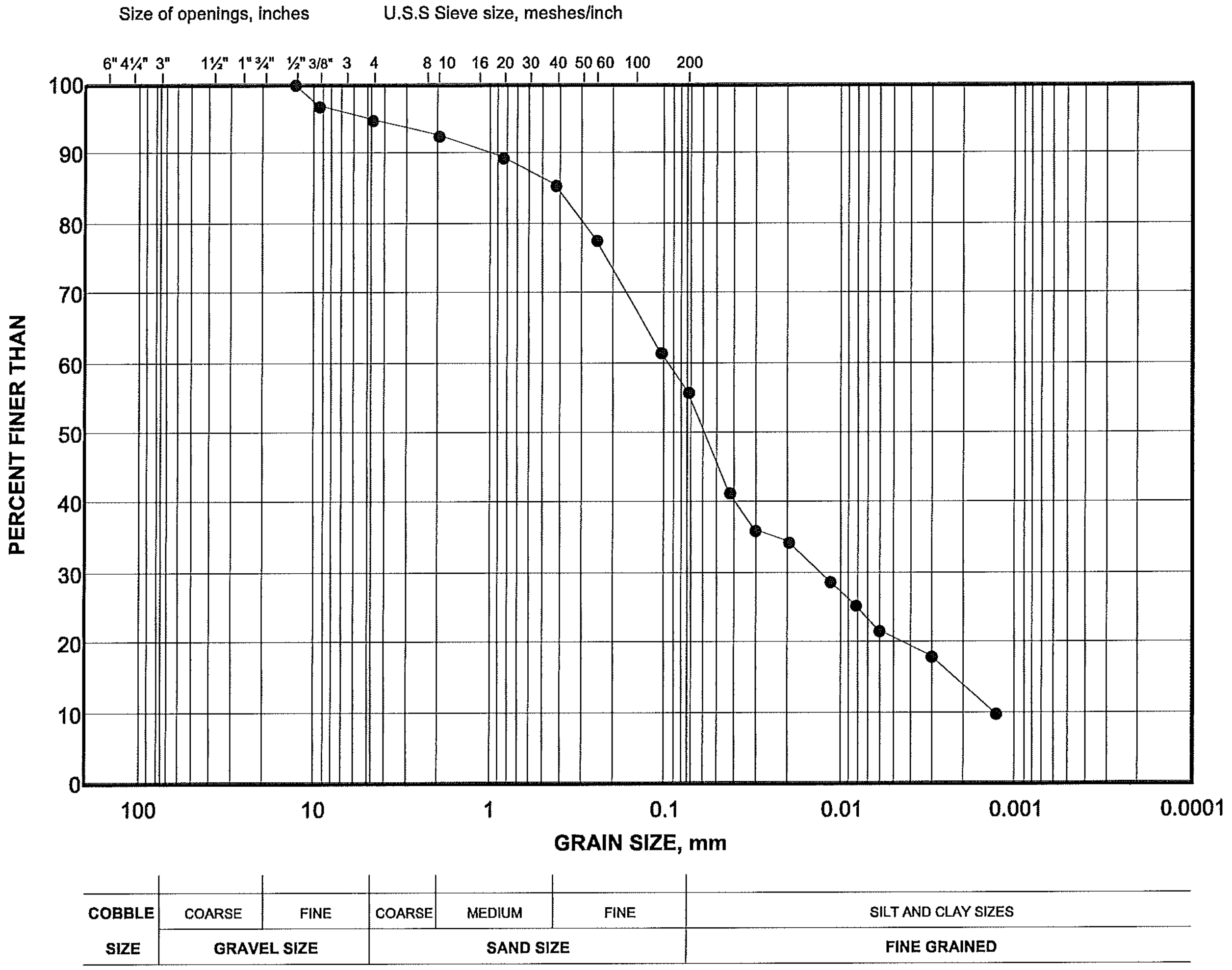
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(ML) CLAYEY SILT, some sand, trace gravel (Till-like)

FIGURE 9



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-23	4	

Project Number: 14-13472

Checked By: SDK

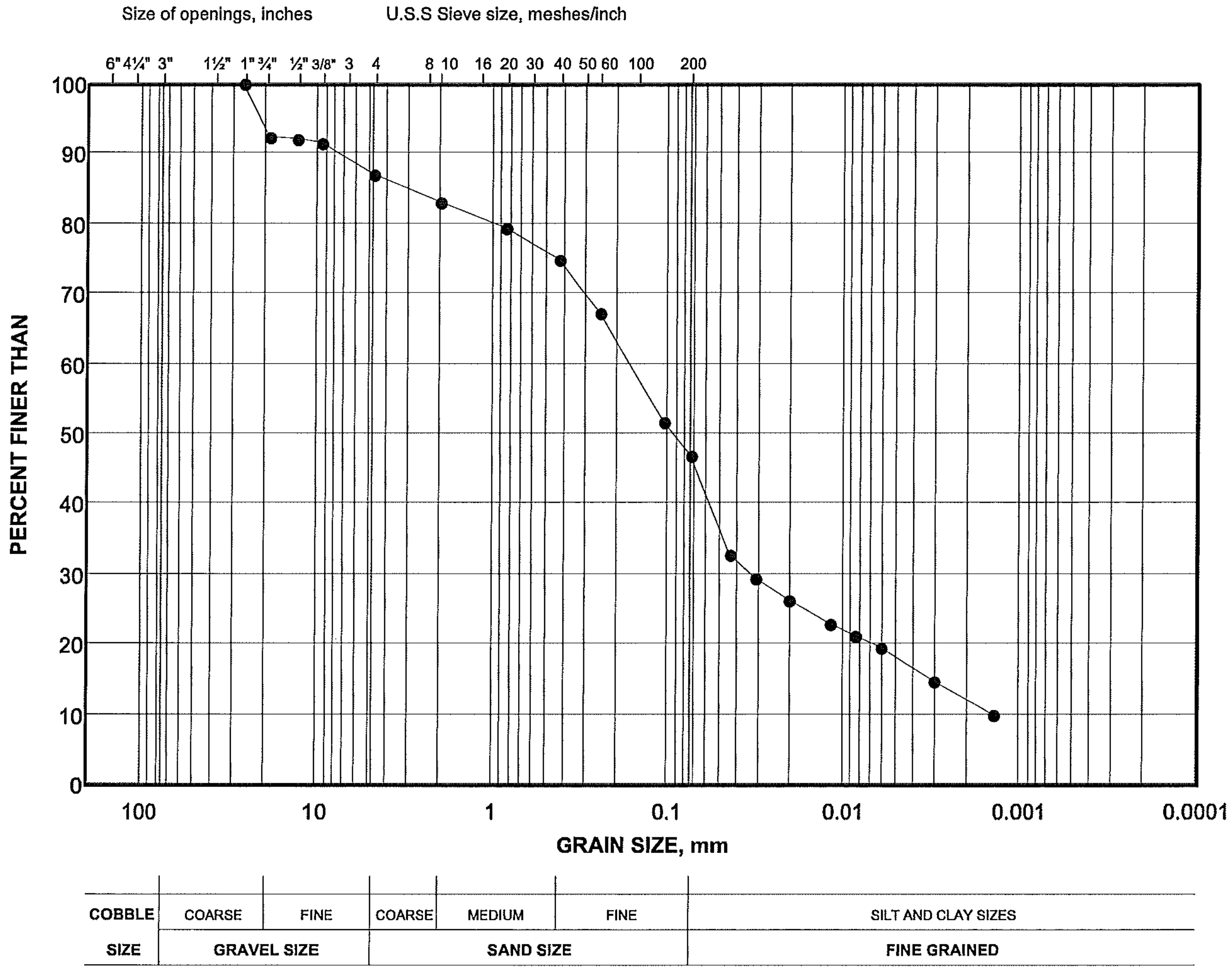
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND, some sand, trace clay (Till)

FIGURE 10



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-23	6	

Project Number: 14-13472

Checked By: SDK

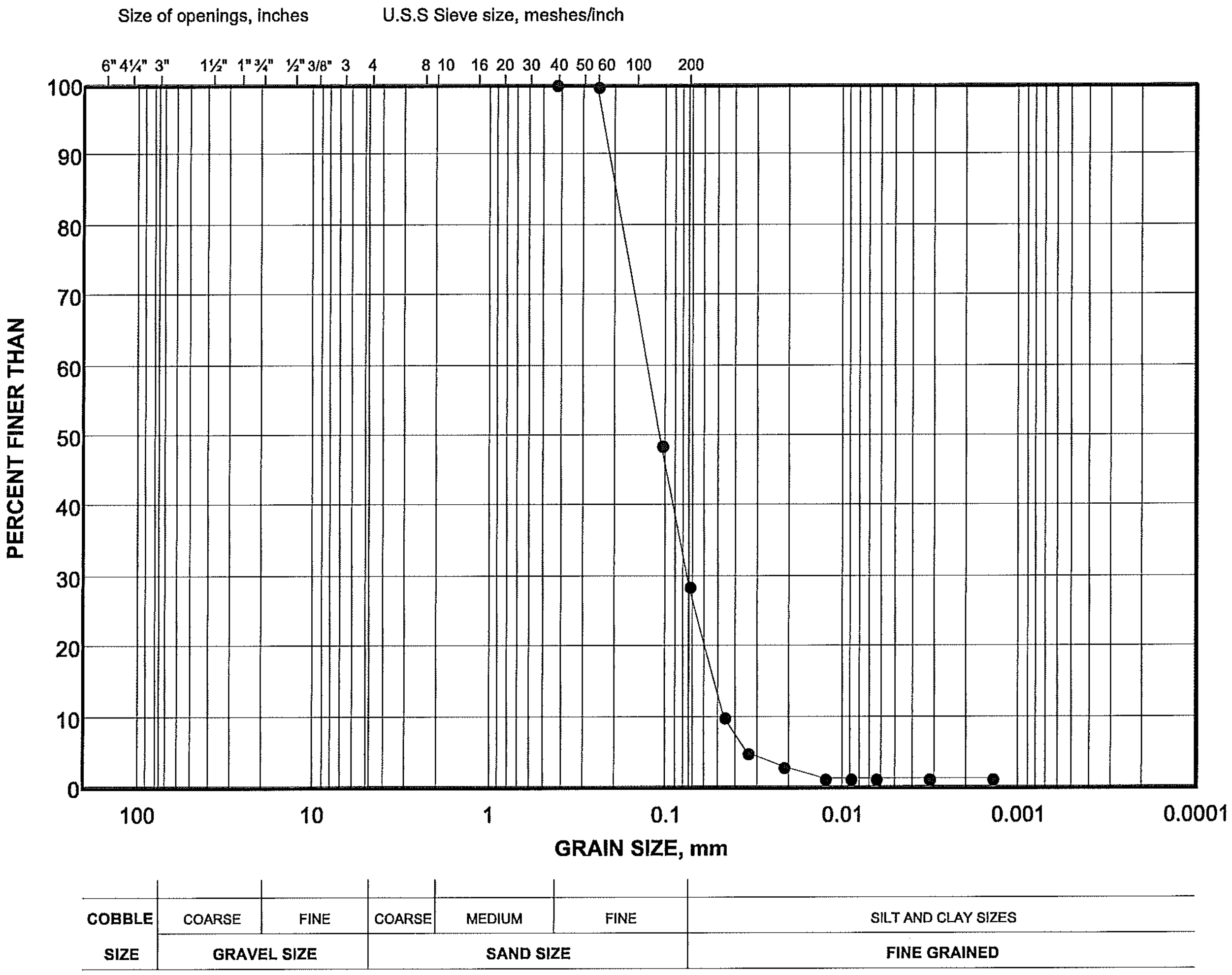
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(SP) SAND

FIGURE 11



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-32	6	

Project Number: 14-13472

Checked By: SDK

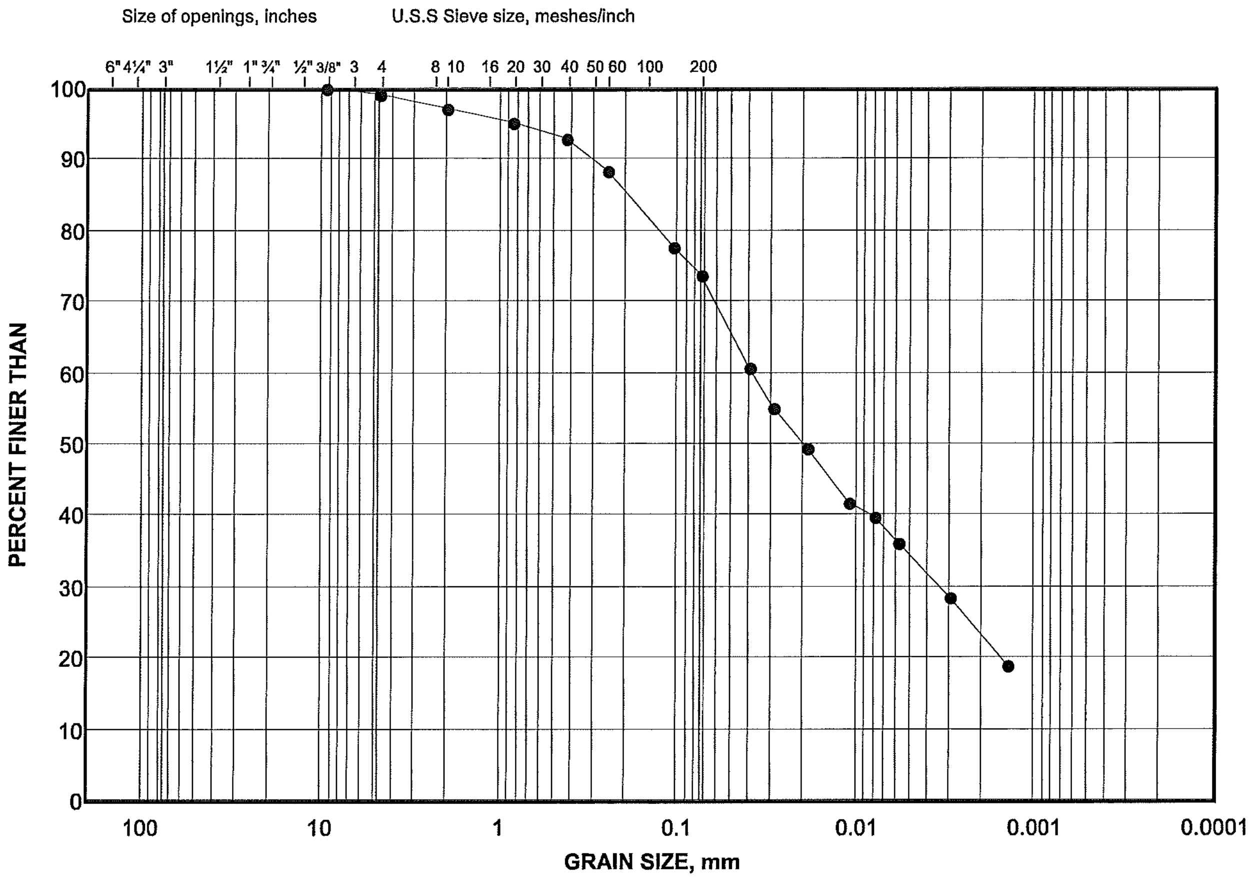
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(ML) Sandy, CLAYEY SILT, trace sand (Till)

FIGURE 12



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-33	6	

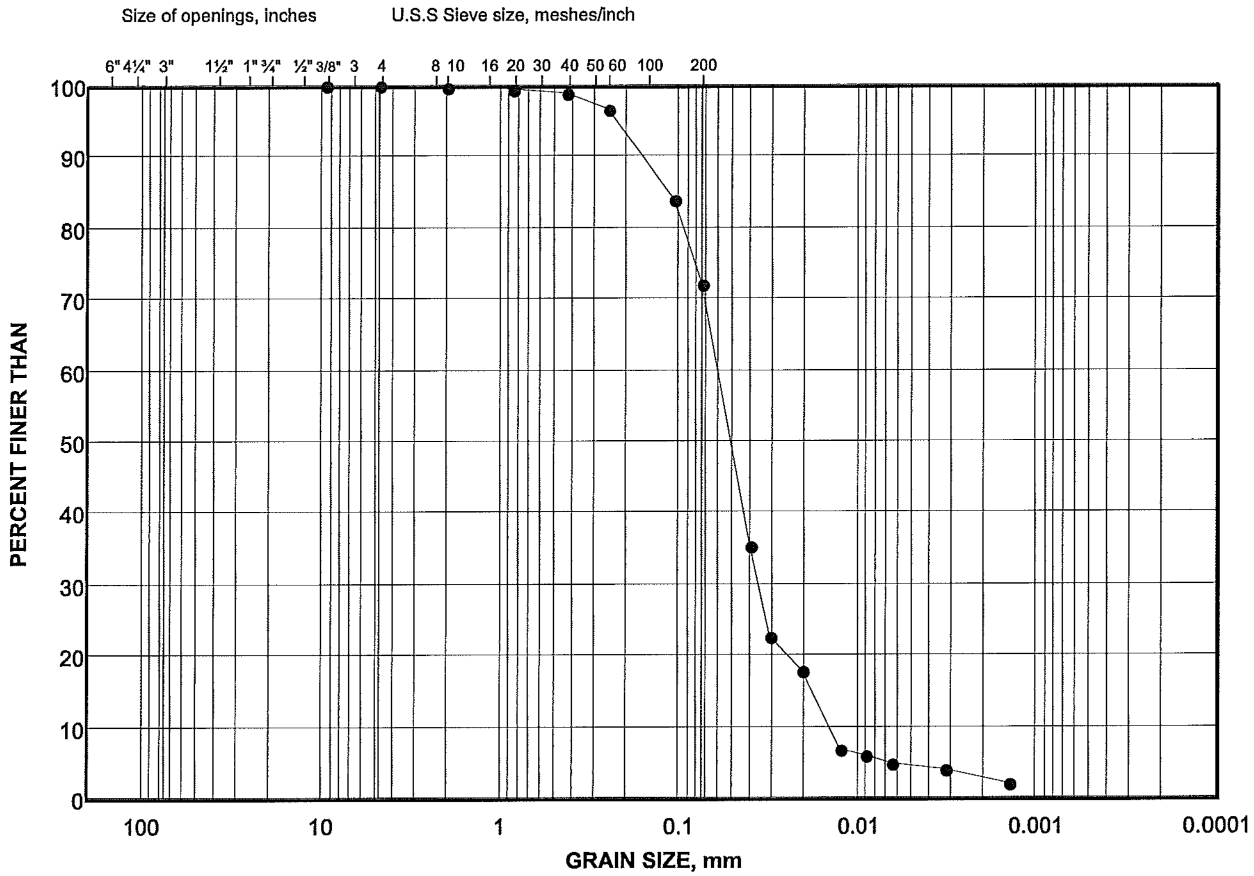
Project Number: 14-13472

Checked By: SDK

Golder Associates

Date: 05-Jan-15

# GRAIN SIZE DISTRIBUTION (SM) SILTY SAND, fine grained sand, trace clay	FIGURE 13



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	14-34	6	

Project Number: 14-13472

Checked By: SDK

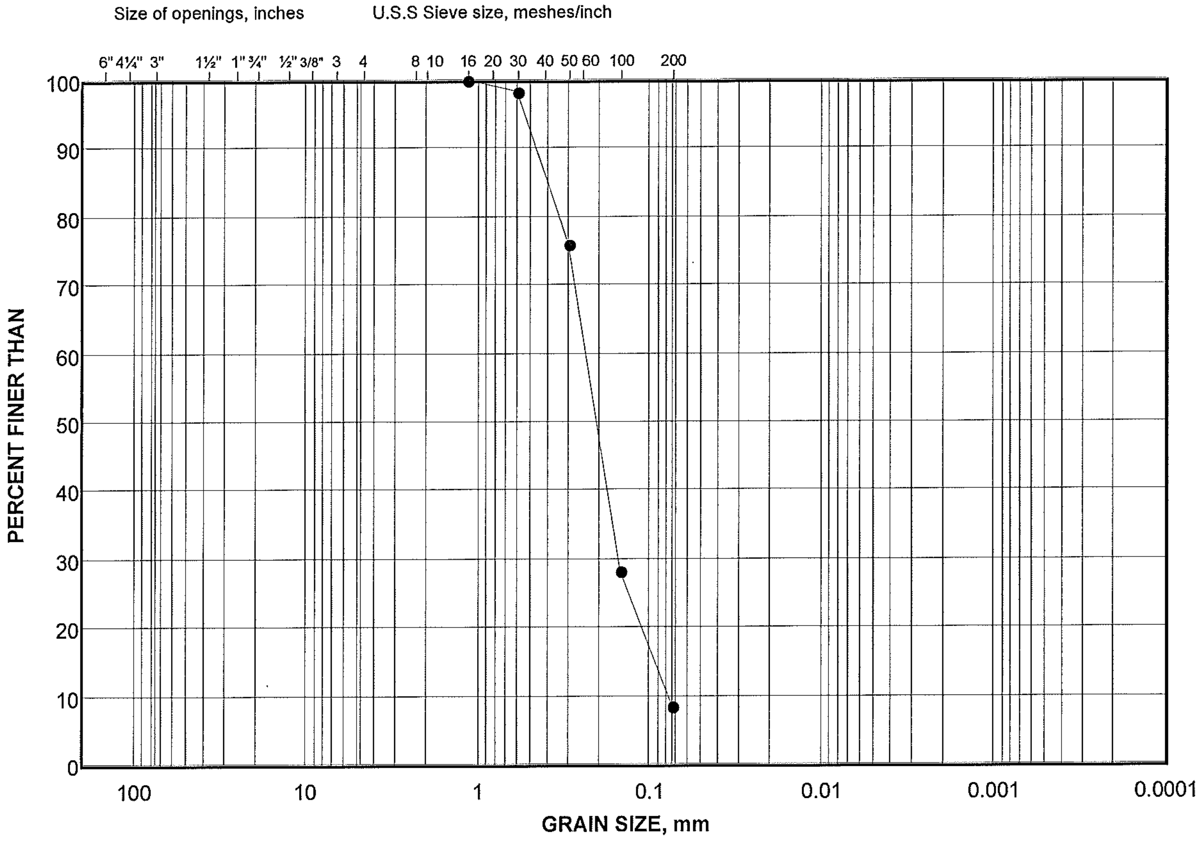
Golder Associates

Date: 05-Jan-15

GRAIN SIZE DISTRIBUTION

(SP) SAND

FIGURE 10



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-3	7B	192.56

Project Number: 1413472 (8000)

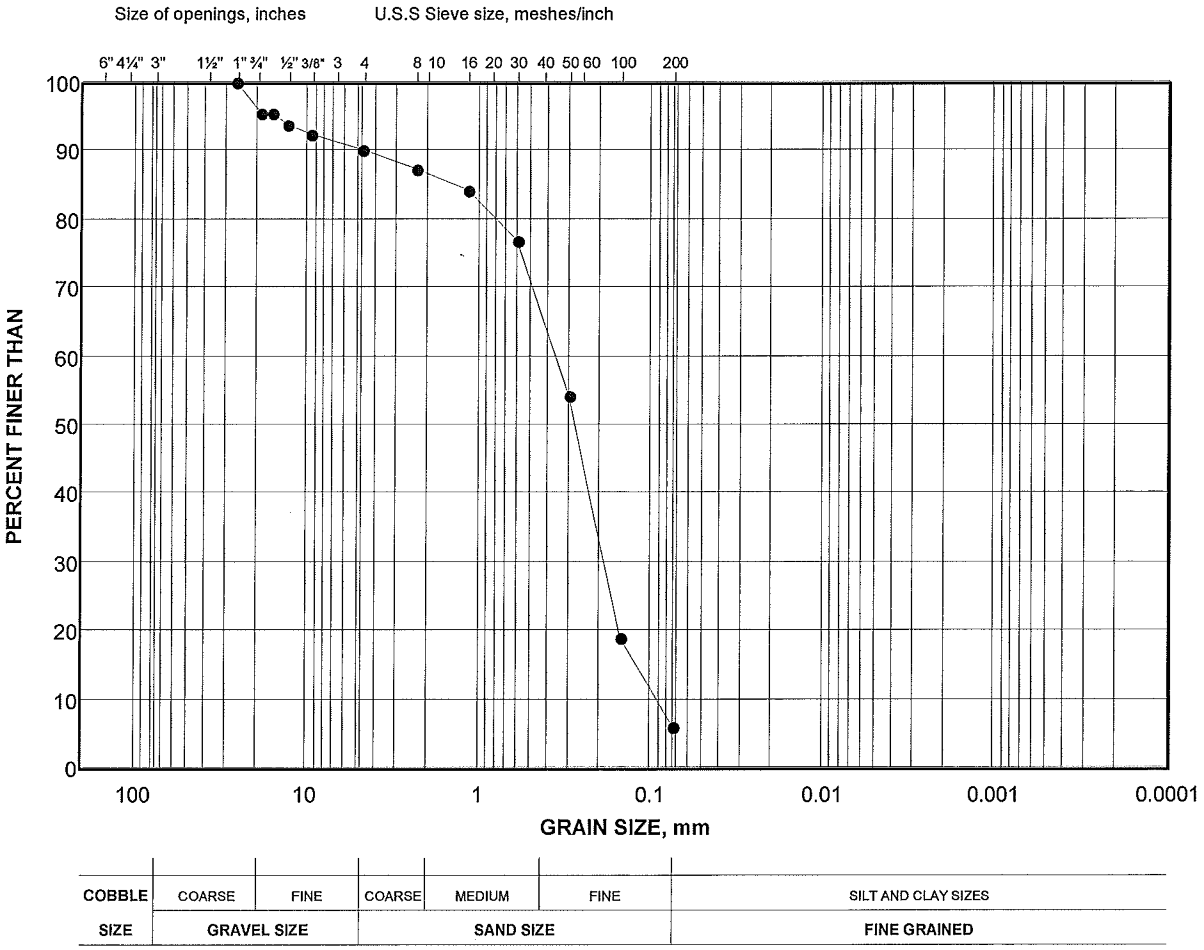
Checked By: OS

Golder Associates

Date: 24-Mar-16

GRAIN SIZE DISTRIBUTION
(SW) SAND

FIGURE 9



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-5	7	176.33

Project Number: 1413472 (8000)

Checked By: OS

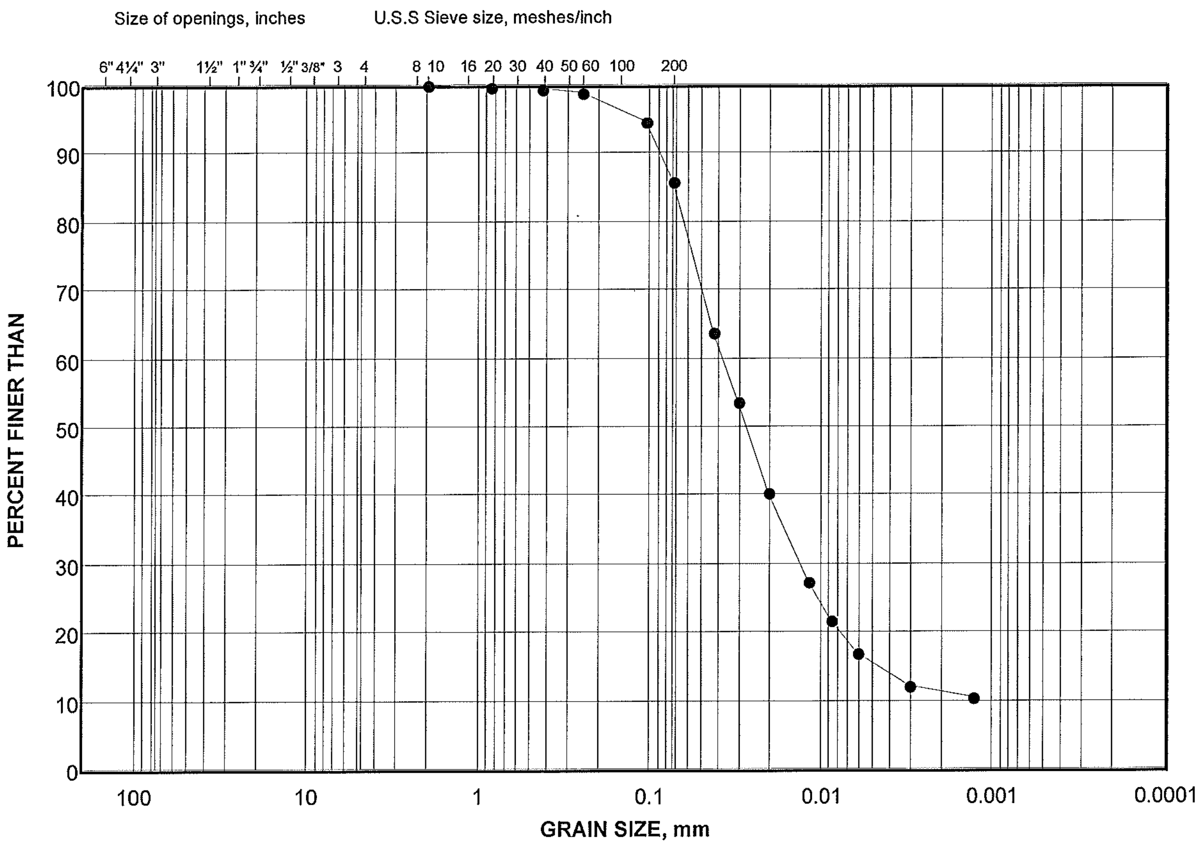
Golder Associates

Date: 24-Mar-16

GRAIN SIZE DISTRIBUTION

(ML) sandy SILT

FIGURE 8



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-6	4	184.29

Project Number: 1413472 (8000)

Checked By: OS

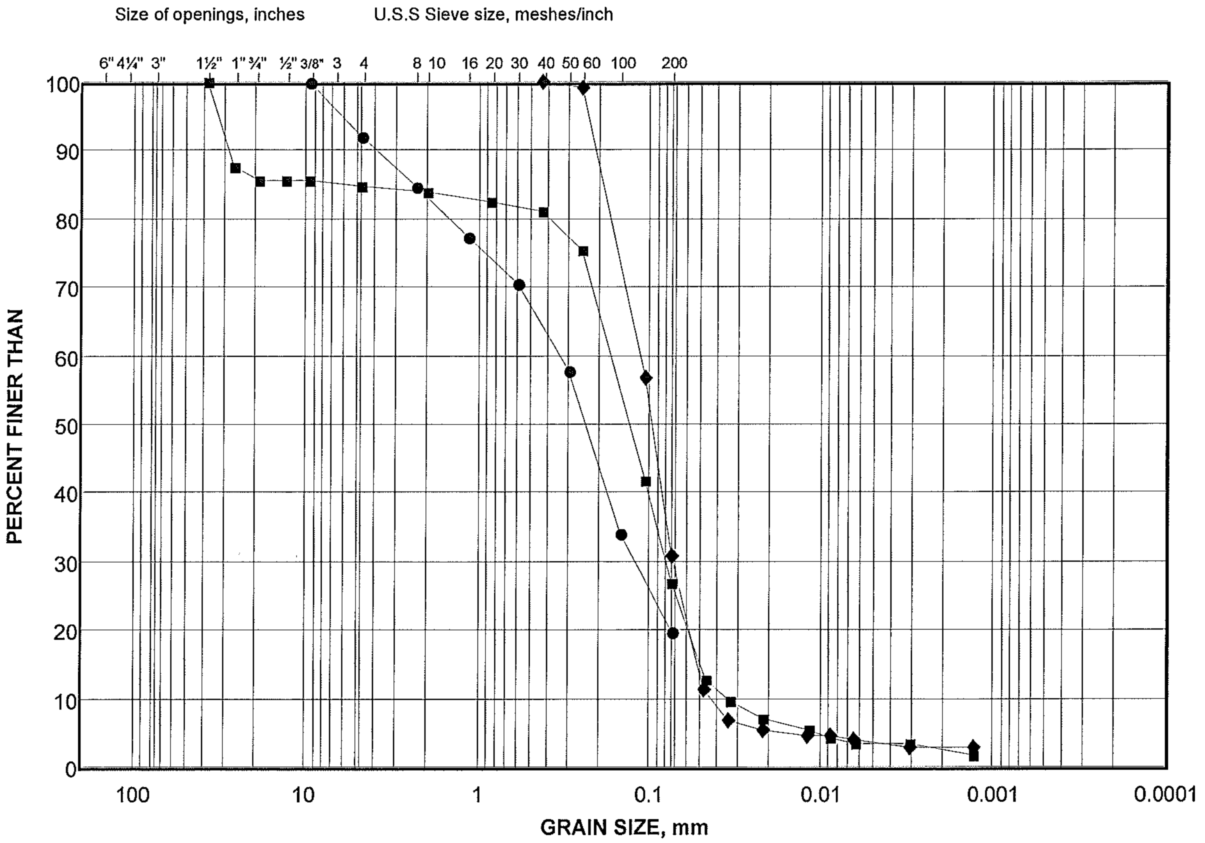
Golder Associates

Date: 24-Mar-16

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND

FIGURE 7



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-16	11	168.70
■	16-15	13	166.84
◆	16-14	7	172.57

Project Number: 1413472 (8000)

Checked By: OS

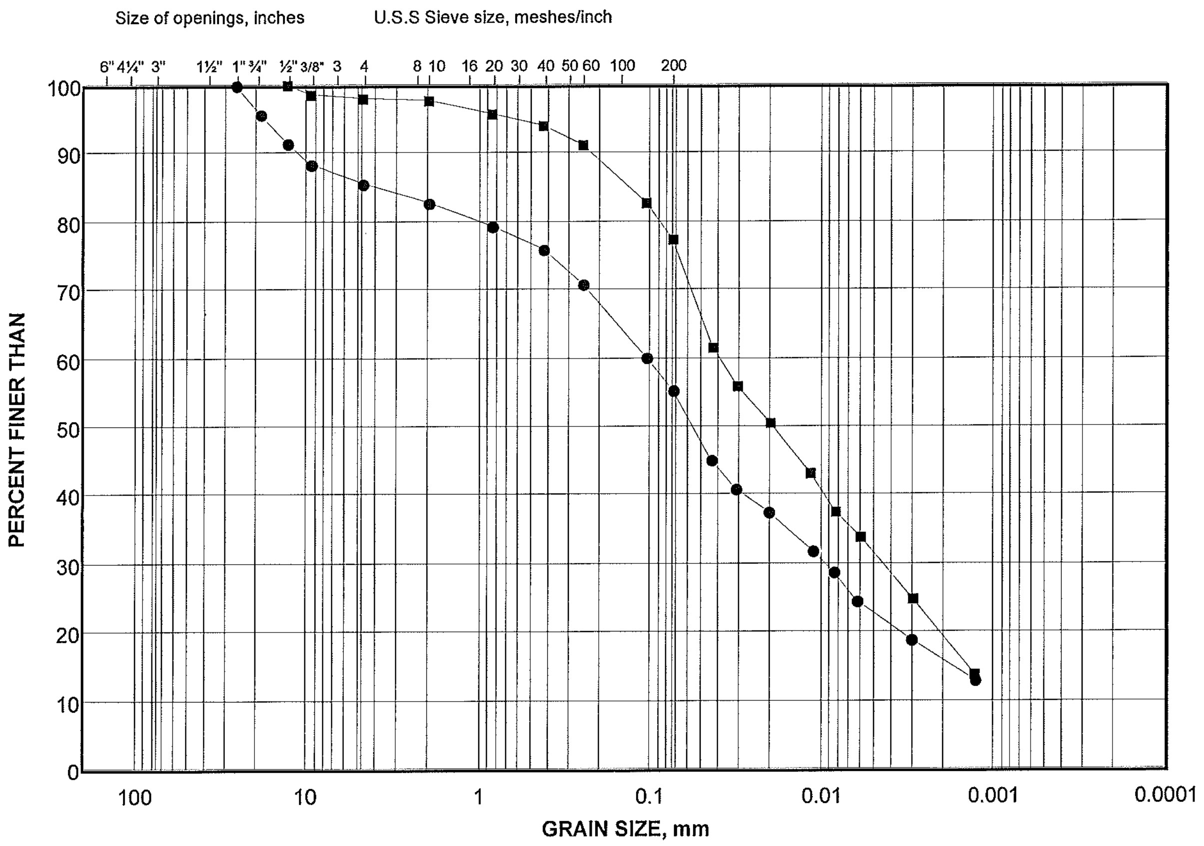
Golder Associates

Date: 24-Mar-16

GRAIN SIZE DISTRIBUTION

(ML) sandy SILT (TILL)

FIGURE 6



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-10	6	186.54
■	16-8	6	179.10

Project Number: 1413472 (8000)

Checked By: OS

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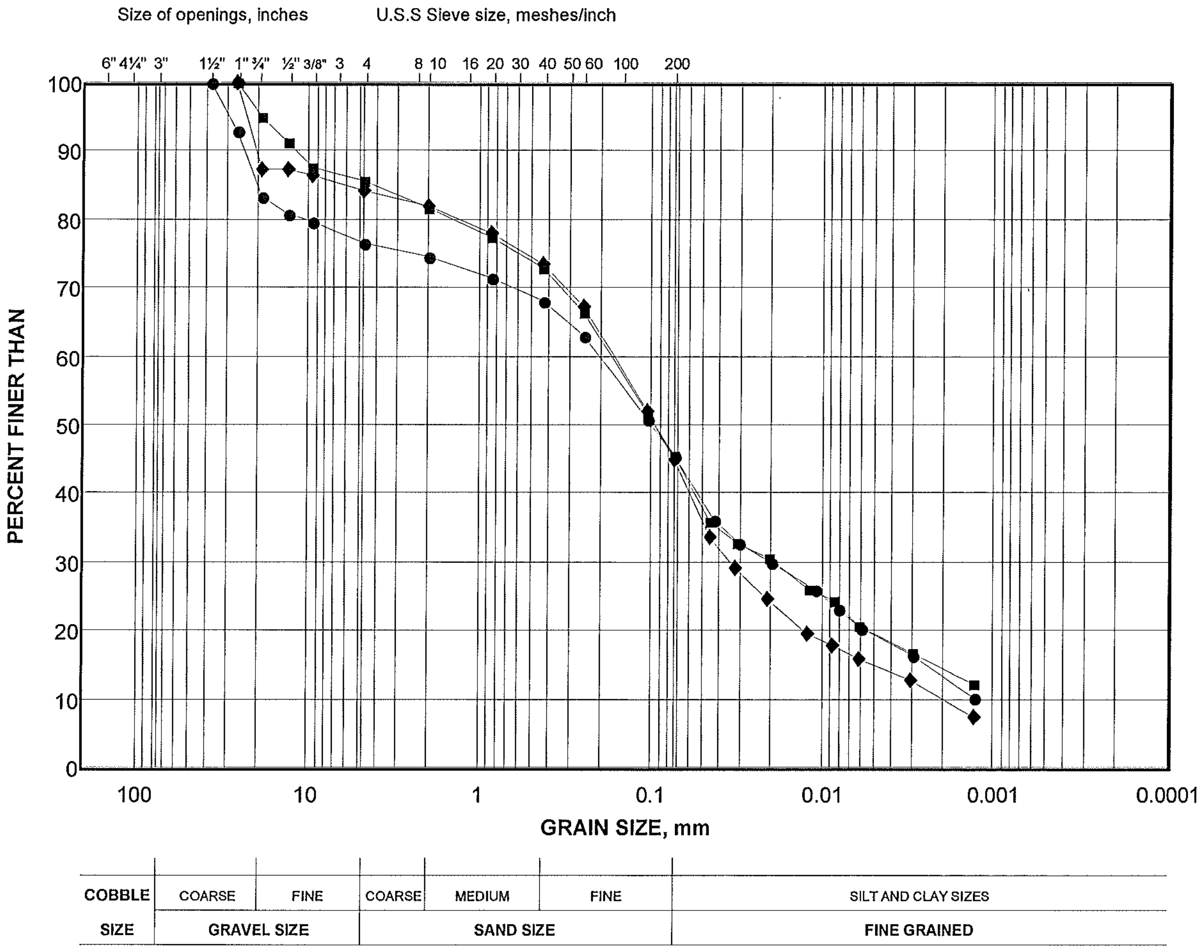
Date: 24-Mar-16

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND (TILL)

FIGURE 5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-11	7	177.08
■	16-13	7	179.26
◆	16-4	7	174.96

Project Number: 1413472 (8000)

Checked By: OS

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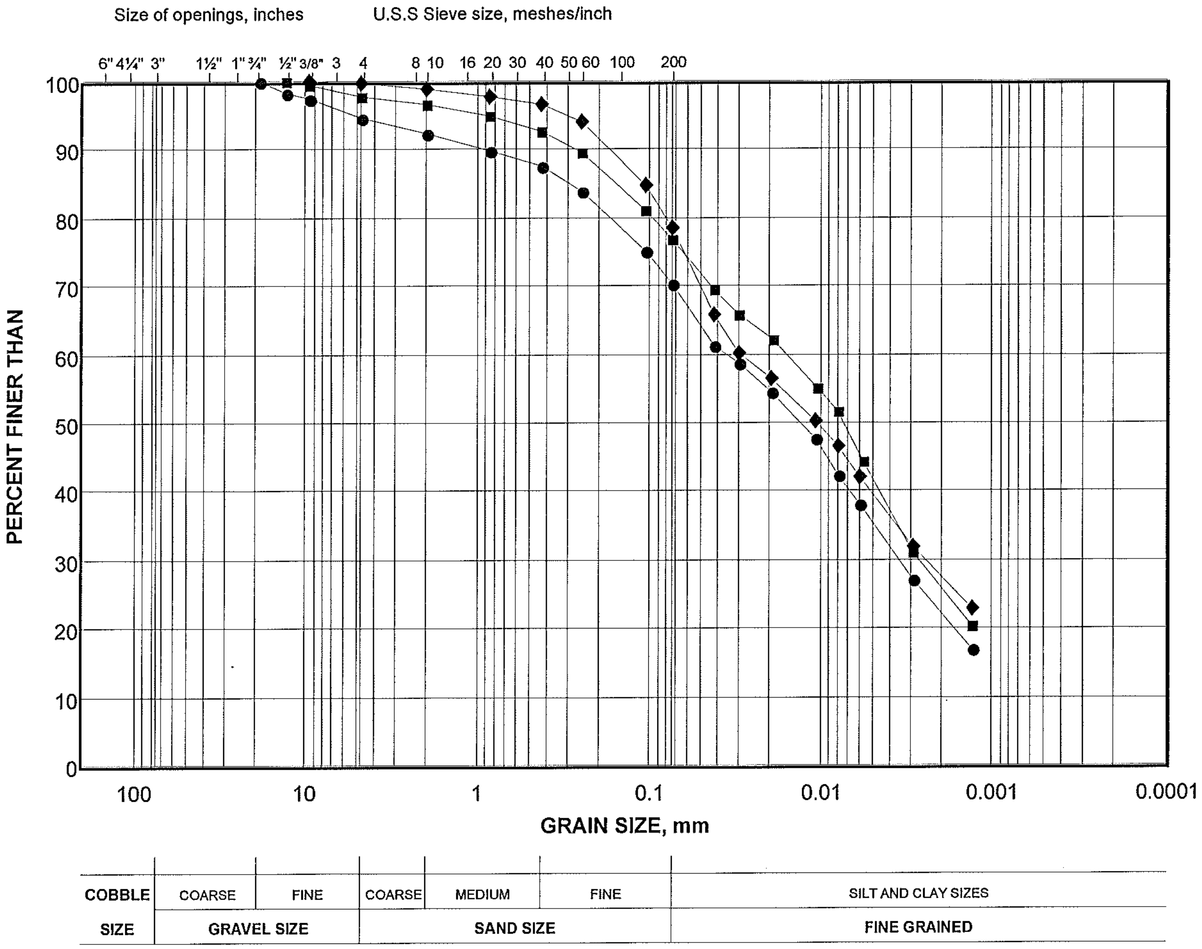
Date: 24-Mar-16

GRAIN SIZE DISTRIBUTION

(CL-ML) sandy SILTY CLAY to sandy CLAYEY SILT (TILL)

FIGURE 4



LEGEND

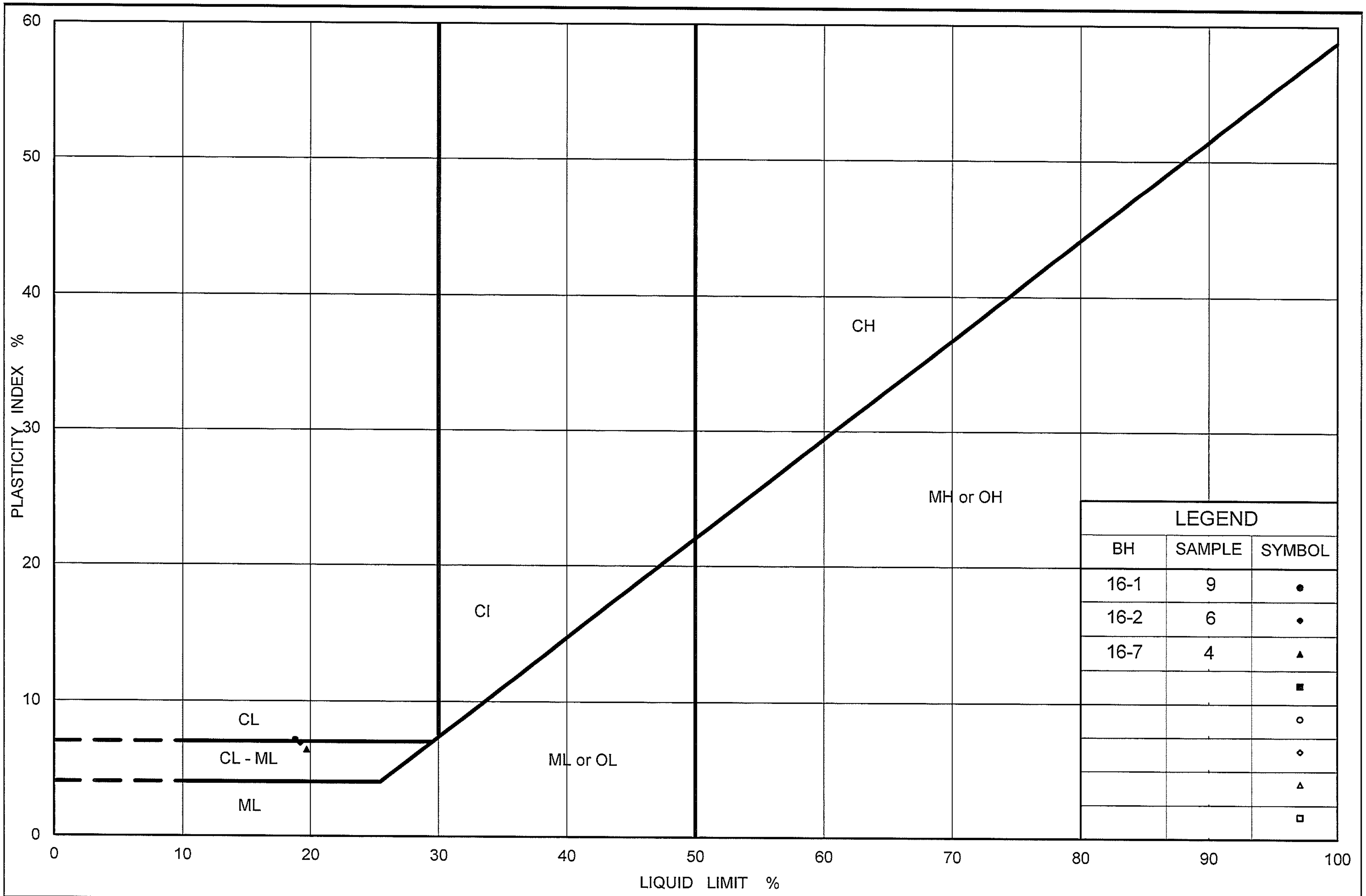
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-7	4	185.00
■	16-2	6	181.24
◆	16-1	9	179.45

Project Number: 1413472 (8000)

Checked By: OS

Golder Associates

Date: 24-Mar-16



BH	SAMPLE	SYMBOL
16-1	9	●
16-2	6	◆
16-7	4	▲
		■
		○
		◇
		△
		□

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PLASTICITY CHART
(CL-ML) SILTY CLAY TO CLAYEY SILT (TILL)

Figure No. 3

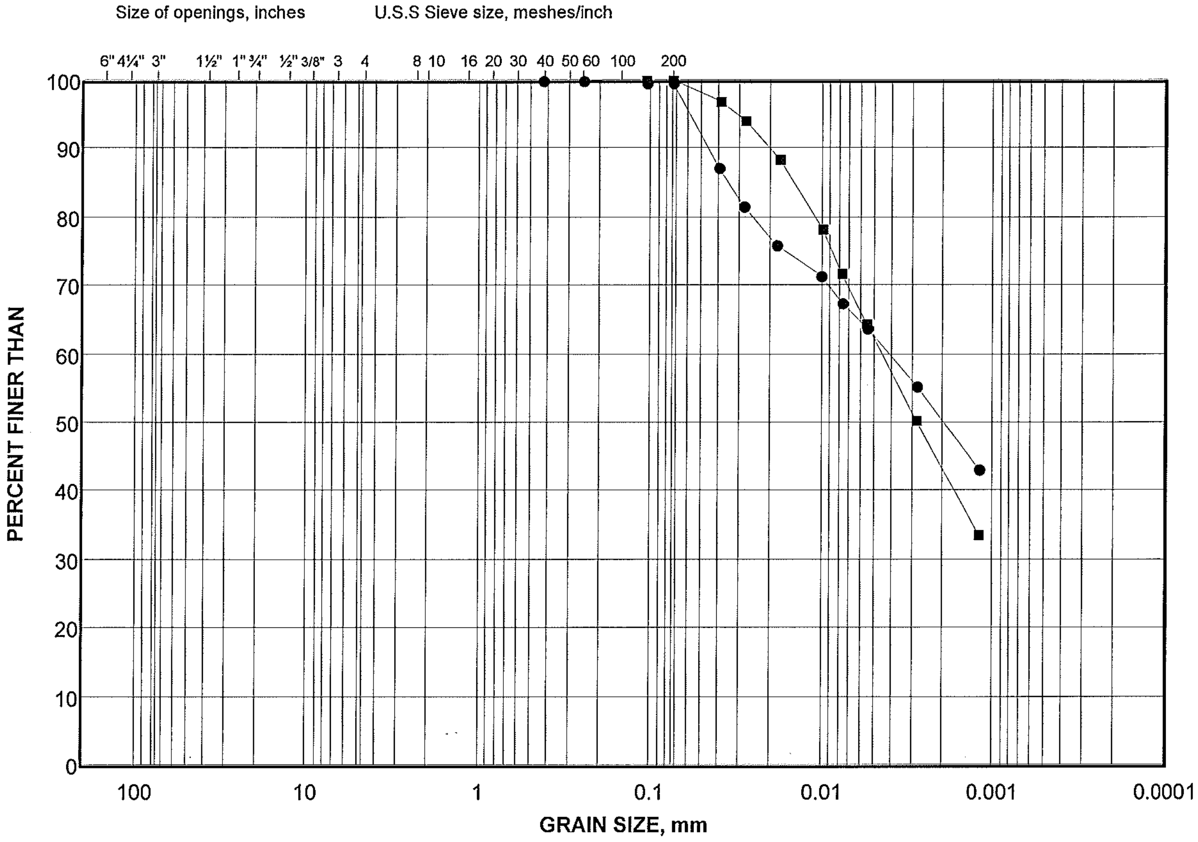
Project No. 1413472 (8000)

Checked By: OS

GRAIN SIZE DISTRIBUTION

(CI) SILTY CLAY

FIGURE 2



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

LEGEND

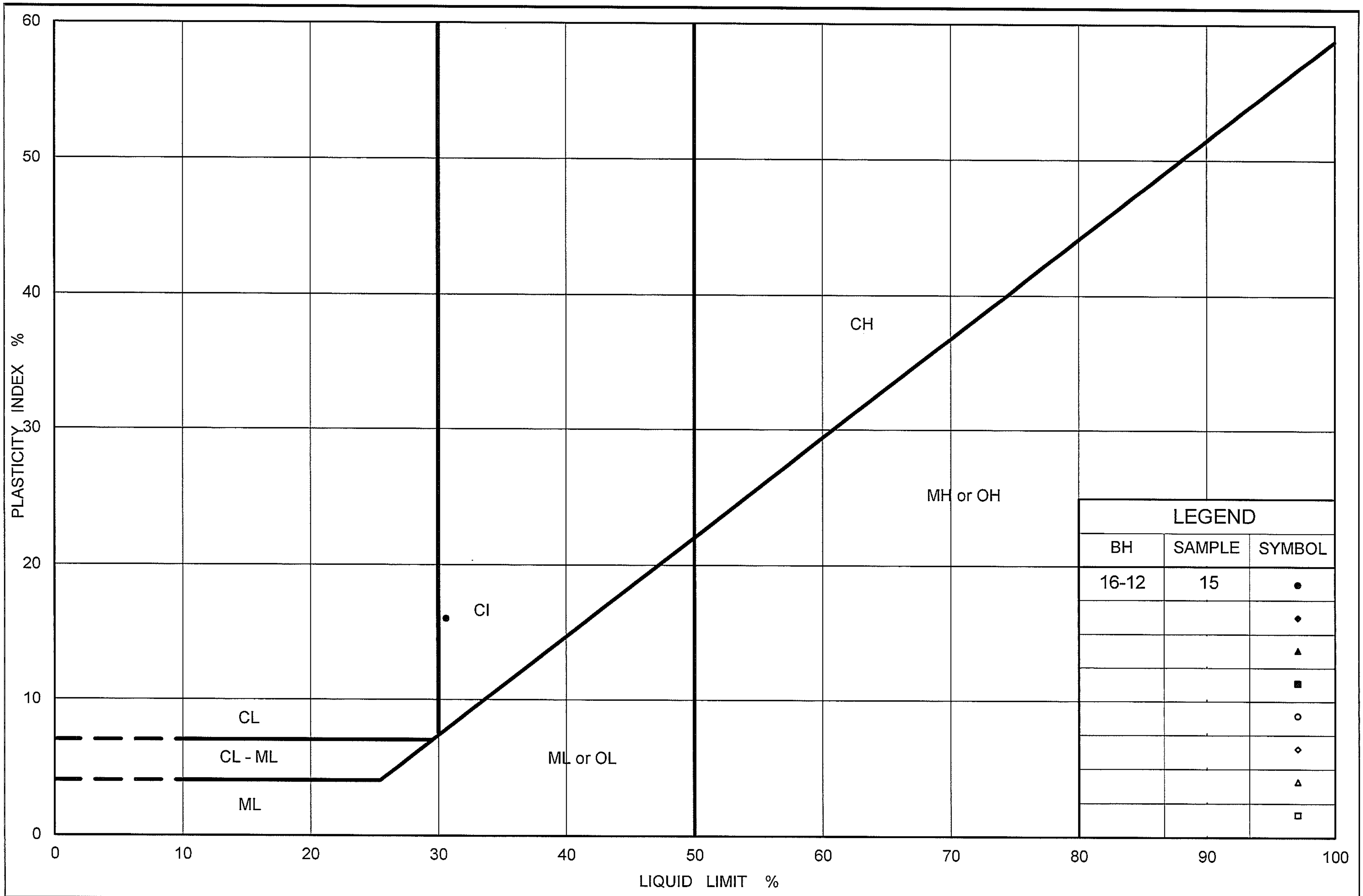
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-12	15	173.04
■	16-9	6	178.42

Project Number: 1413472 (8000)

Checked By: OS

Golder Associates

Date: 28-Mar-16



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PLASTICITY CHART
(CI) SILTY CLAY

Figure No. 1

Project No. 1413472 (8000)

Checked By: OS

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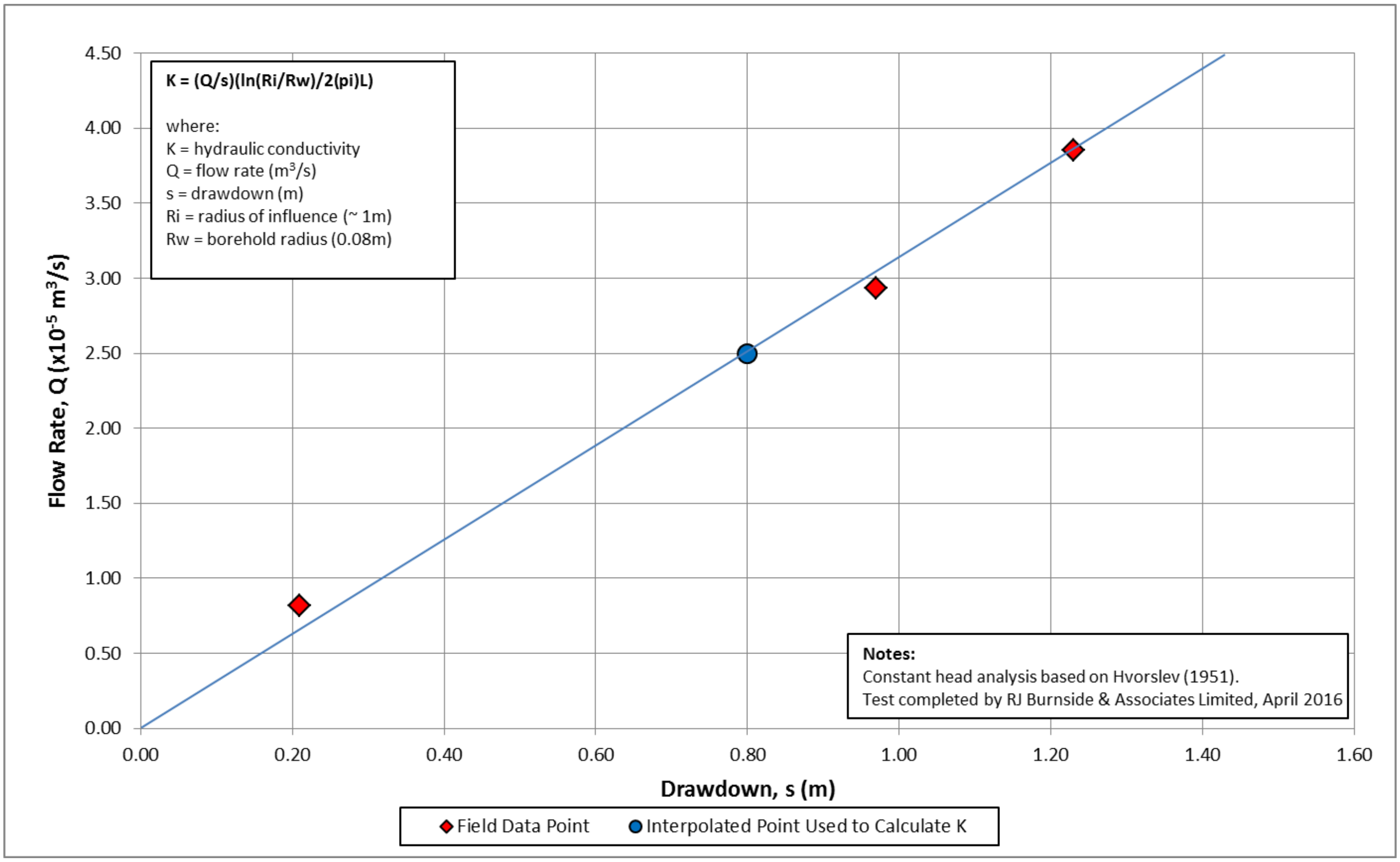
Appendix D

Hydraulic Conductivity and Infiltration Tests

Figure D-1



K = (Q/s)(ln(Ri/Rw)/2(pi)L)

where:
K = hydraulic conductivity
Q = flow rate (m^3/s)
s = drawdown (m)
Ri = radius of influence (~ 1m)
Rw = borehold radius (0.08m)

Notes:
Constant head analysis based on Hvorslev (1951).
Test completed by RJ Burnside & Associates Limited, April 2016

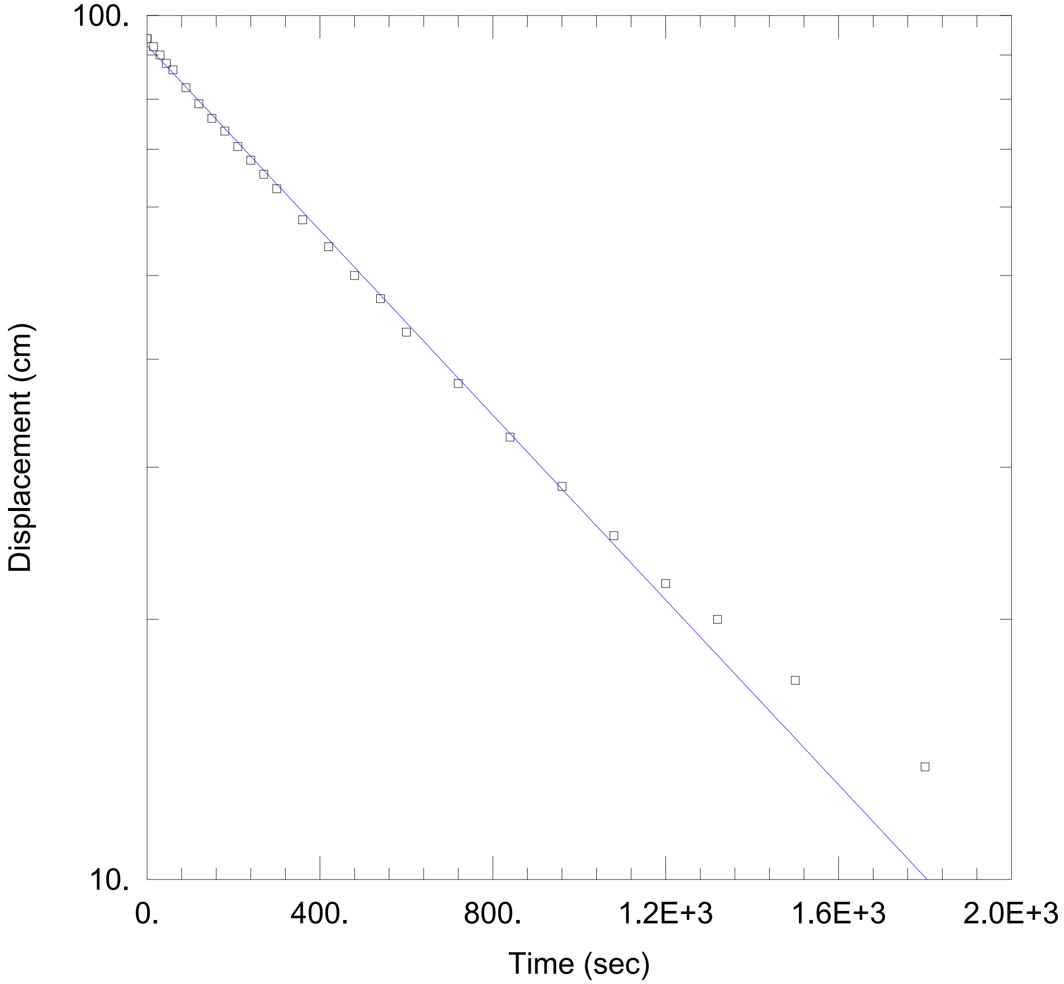
HYDRAULIC CONDUCTIVITY ANALYSIS OF CONSTANT HEAD TEST AT

BH16-5 – SCREENED IN SAND

Well	Test Type	Test Date	Test Time	SWL Depth (mbtoc)	Flow Rate, Q		PWL Depth (mbtoc)	Drawdown (m)
					(L/min)	(x10^{-5} m^3/s)		
BH16-5	Constant Head	6-Apr-16	9:00 AM	0.53	0.49	0.82	0.74	0.21
					1.76	2.93	1.50	0.97
					2.31	3.85	1.76	1.23

Selected Data Point for K Calculation (Constant Head Tests)						Geological Material	In-Situ K (m/sec)	In-Situ K (cm/sec)
Flow Rate (m^3/s)	Drawdown (m)	Saturated Interval Length, L (m)						
		SWL Elev. (masl)	PWL Elev. (masl)	Well Bottom Elev. (masl)	L (m)			
2.50E-05	0.8	186.37	185.57	180.20	1.52	Sand	8.3E-06	8.3E-04

Figure D-2



HYDRAULIC CONDUCTIVITY TEST AT BH16-6 - SCREENED IN SILTY SAND TO SANDY SILT

PROJECT INFORMATION

Company: R.J. Burnside and Associates
Client: York Downs
Project: 300038247
Location: Markham, ON
Test Well: BH16-6
Test Date: April 7, 2016

AQUIFER DATA

Saturated Thickness: 423. cm

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH16-6)

Initial Displacement: 94. cm
Total Well Penetration Depth: 423. cm
Casing Radius: 2.54 cm

Static Water Column Height: 423. cm
Screen Length: 300. cm
Well Radius: 7.62 cm

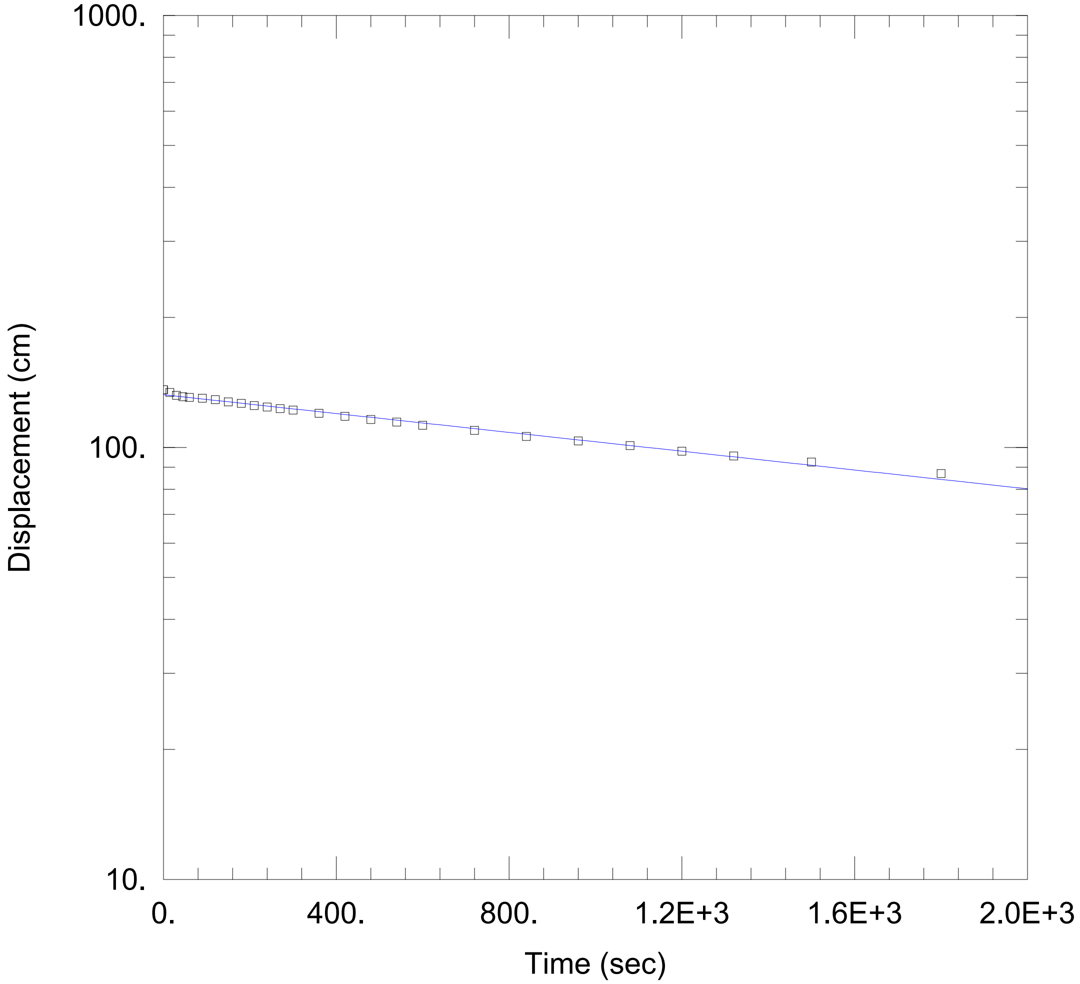
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 5.782E-5 cm/sec

y0 = 92.31 cm



HYDRAULIC CONDUCTIVITY TEST AT BH16-9 - SCREENED IN SILTY CLAY

PROJECT INFORMATION

Company: R.J. Burnside and Associates
Client: York Downs
Project: 300038247
Location: Markham, ON
Test Well: BH16-9
Test Date: April 7, 2016

AQUIFER DATA

Saturated Thickness: 429. cm
Anisotropy Ratio (Kz/Kr): 1.

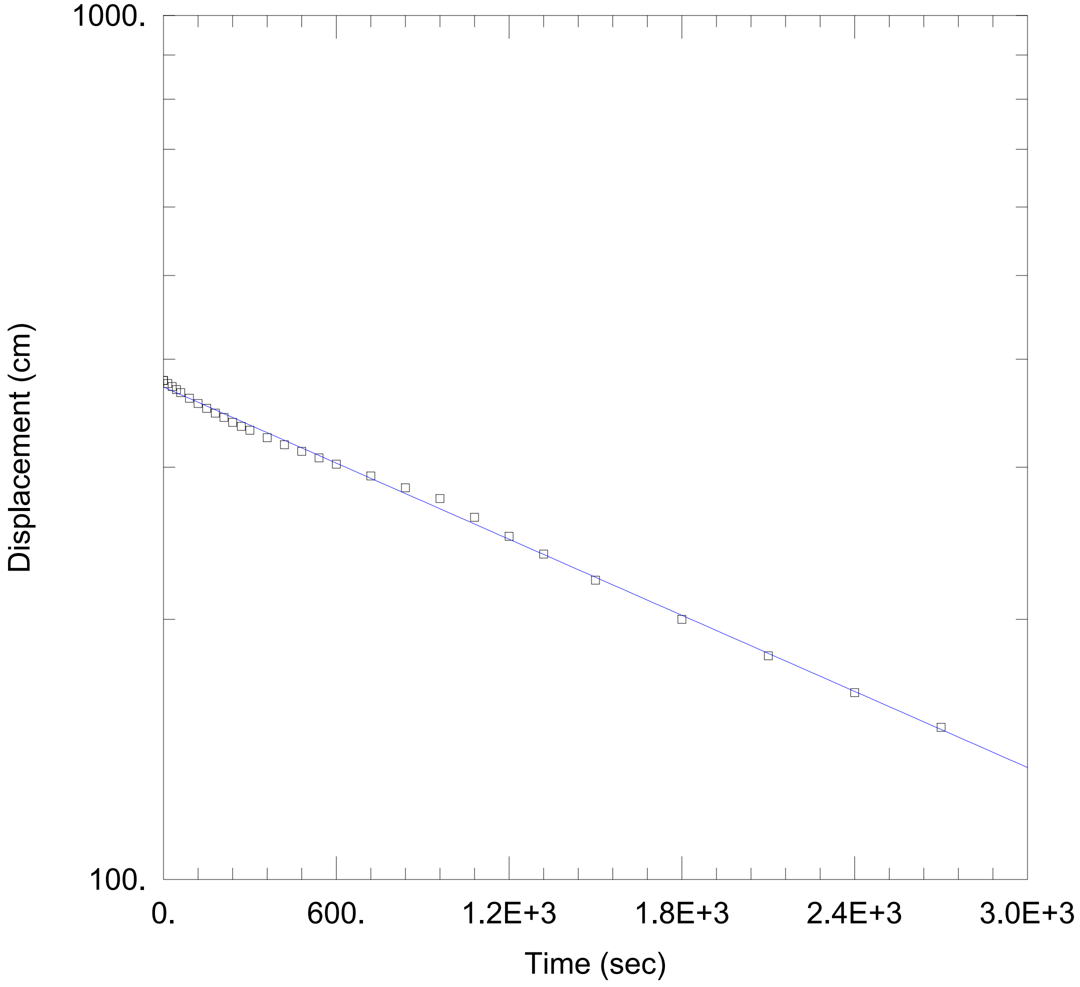
WELL DATA (BH16-9)

Initial Displacement: 136. cm
Total Well Penetration Depth: 429. cm
Casing Radius: 2.54 cm
Static Water Column Height: 429. cm
Screen Length: 300. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 1.177E-5 cm/sec
y0 = 132.4 cm



HYDRAULIC CONDUCTIVITY TEST AT BH16-12S - SCREENED IN SANDY SILT

PROJECT INFORMATION

Company: R.J. Burnside and Associates
Client: York Downs
Project: 300038247
Location: Markham, ON
Test Well: BH16-12s
Test Date: April 6, 2016

AQUIFER DATA

Saturated Thickness: 560. cm

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH16-12s)

Initial Displacement: 378. cm
Total Well Penetration Depth: 560. cm
Casing Radius: 2.54 cm

Static Water Column Height: 560. cm
Screen Length: 300. cm
Well Radius: 7.62 cm

SOLUTION

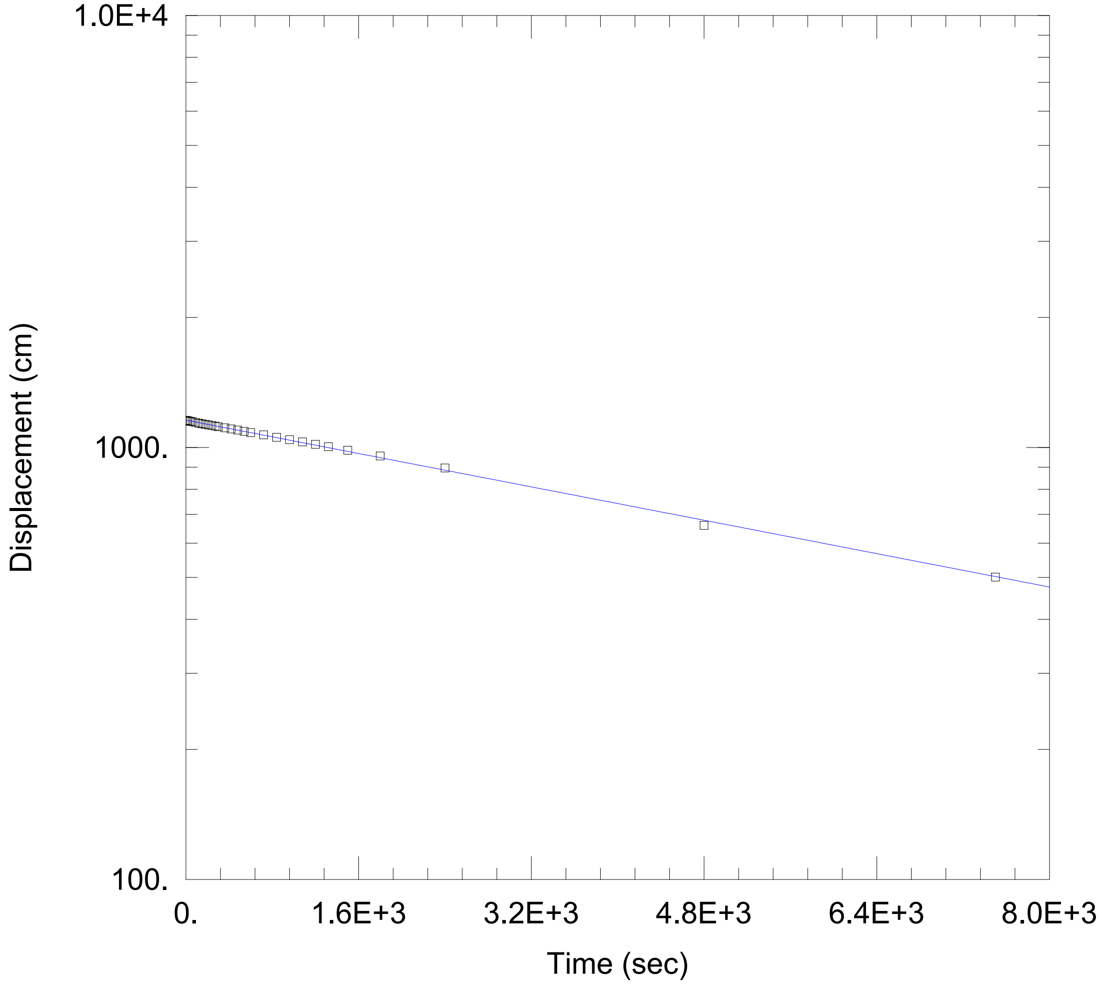
Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 1.587E-5 cm/sec

y0 = 371.4 cm

Figure D-5



HYDRAULIC CONDUCTIVITY TEST AT BH16-13D - SCREENED IN SANDY SILT TO SILT/SAND

PROJECT INFORMATION

Company: R.J. Burnside and Associates
Client: York Downs
Project: 300038247
Location: Markham, ON
Test Well: BH16-13d
Test Date: April 7, 2016

AQUIFER DATA

Saturated Thickness: 1572. cm
Anisotropy Ratio (Kz/Kr): 1.

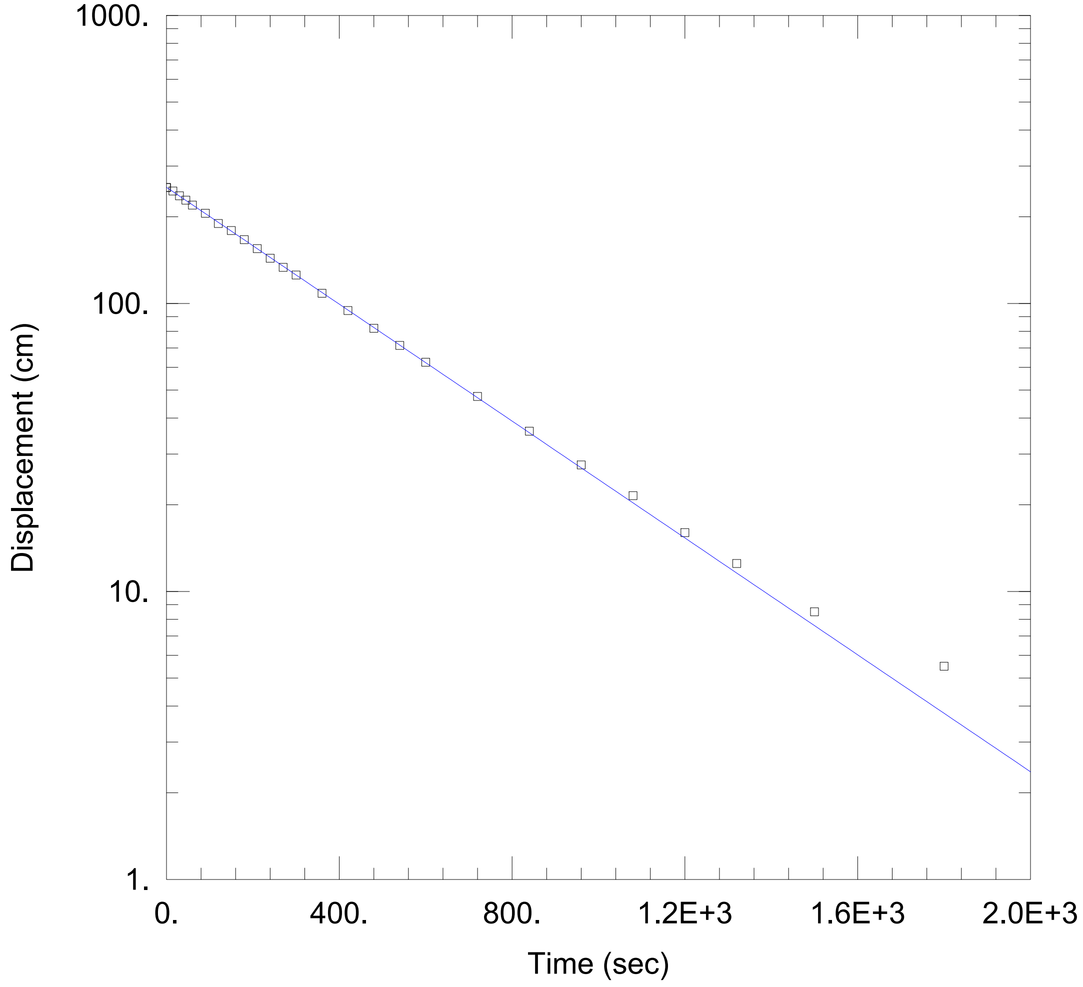
WELL DATA (BH16-13d)

Initial Displacement: 1156. cm
Static Water Column Height: 1572. cm
Total Well Penetration Depth: 1572. cm
Screen Length: 150. cm
Casing Radius: 2.54 cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 8.784E-6 cm/sec
y0 = 1156.6 cm



HYDRAULIC CONDUCTIVITY TEST AT BH16-14S - SCREENED IN SILTY SAND TO SAND

PROJECT INFORMATION

Company: R.J. Burnside and Associates
Client: York Downs
Project: 300038247
Location: Markham, ON
Test Well: BH16-14s
Test Date: April 7, 2016

AQUIFER DATA

Saturated Thickness: 396.5 cm

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH16-14s)

Initial Displacement: 252.5 cm
Total Well Penetration Depth: 396.5 cm
Casing Radius: 2.54 cm

Static Water Column Height: 396.5 cm
Screen Length: 90. cm
Well Radius: 7.62 cm

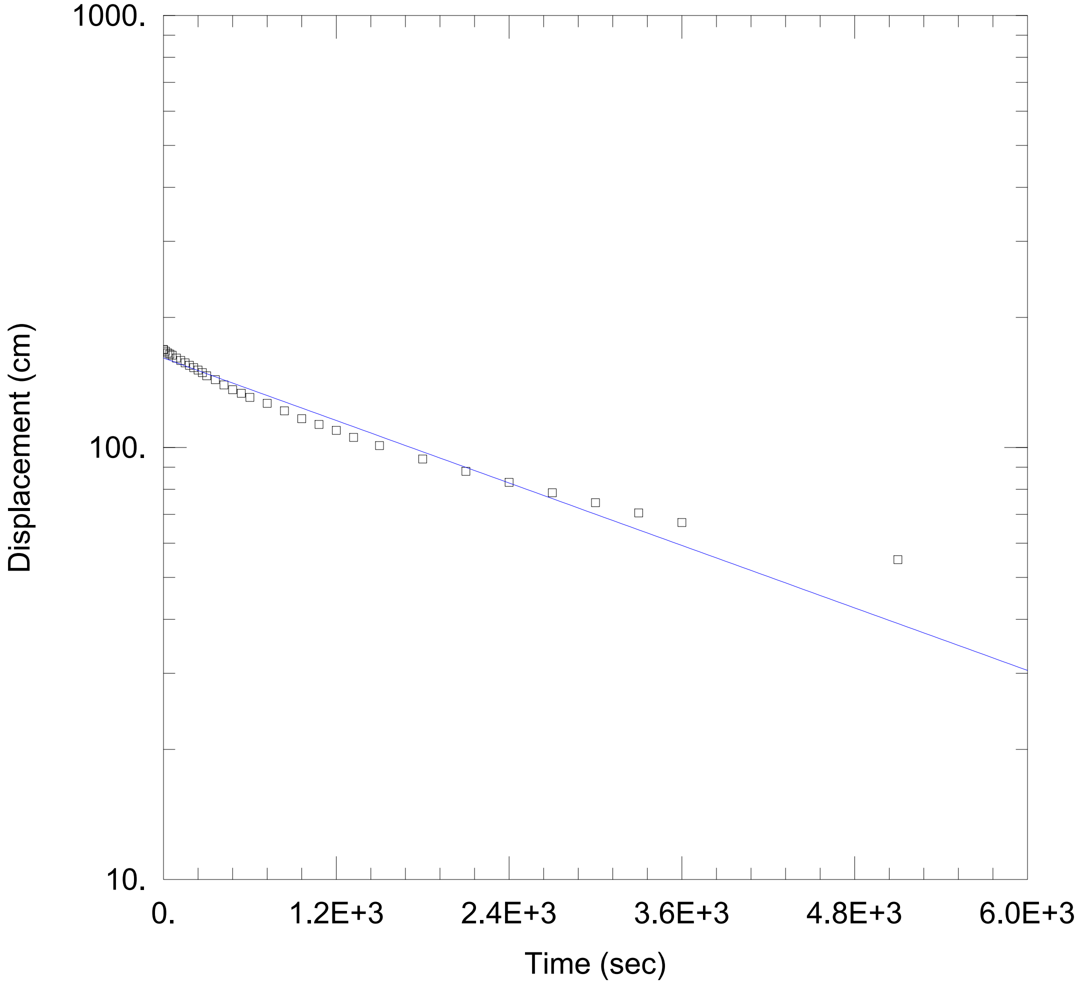
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 0.000265 cm/sec

y0 = 253. cm



HYDRAULIC CONDUCTIVITY TEST AT BH16-15S - SCREENED IN SAND/SILT TO SAND

PROJECT INFORMATION

Company: R.J. Burnside and Associates
Client: York Downs
Project: 300038247
Location: Markham, ON
Test Well: BH16-15s
Test Date: April 6, 2016

AQUIFER DATA

Saturated Thickness: 233.5 cm

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH16-15s)

Initial Displacement: 168.5 cm
Total Well Penetration Depth: 233.5 cm
Casing Radius: 2.54 cm

Static Water Column Height: 233.5 cm
Screen Length: 60. cm
Well Radius: 7.62 cm

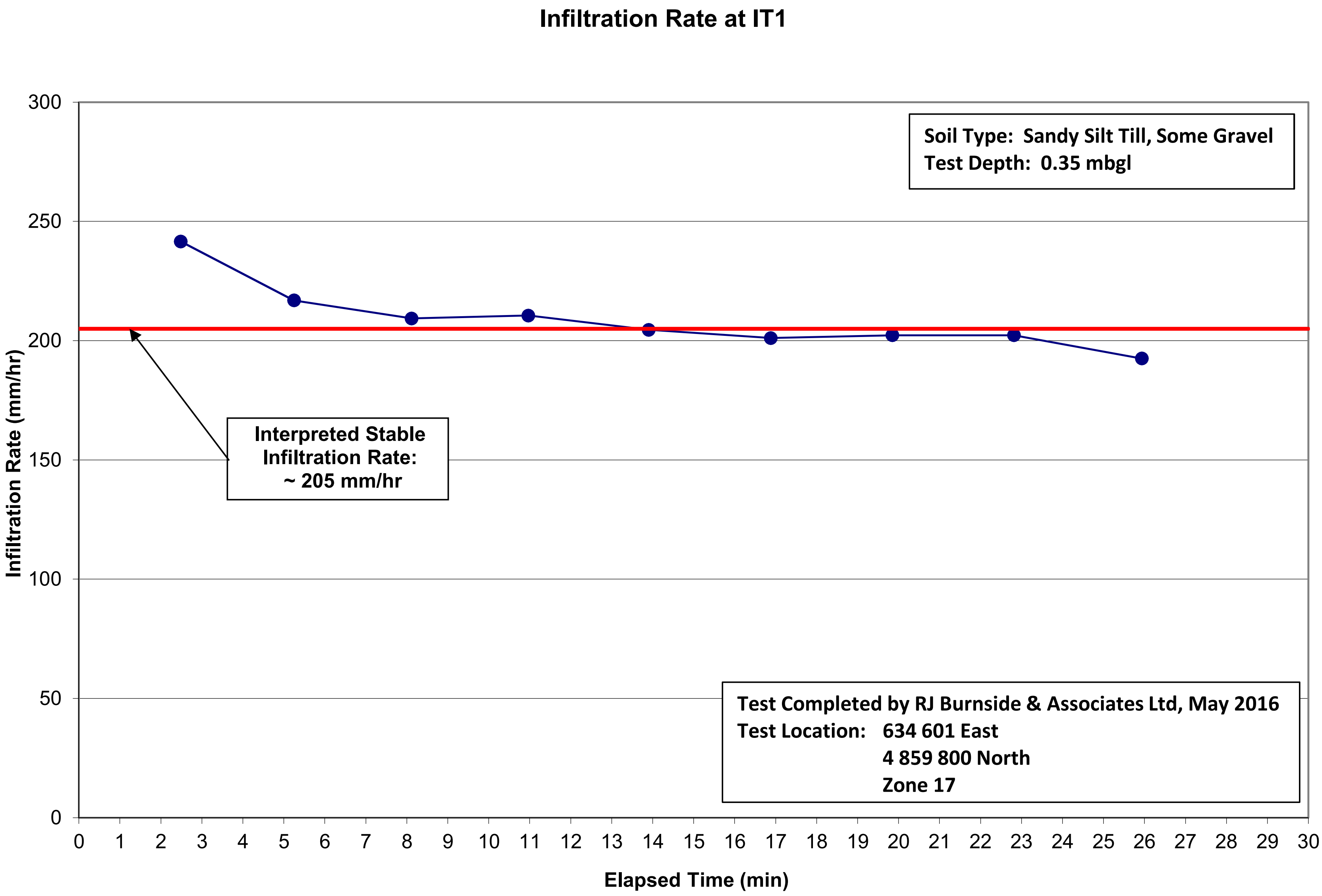
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 4.118E-5 cm/sec

y0 = 161. cm



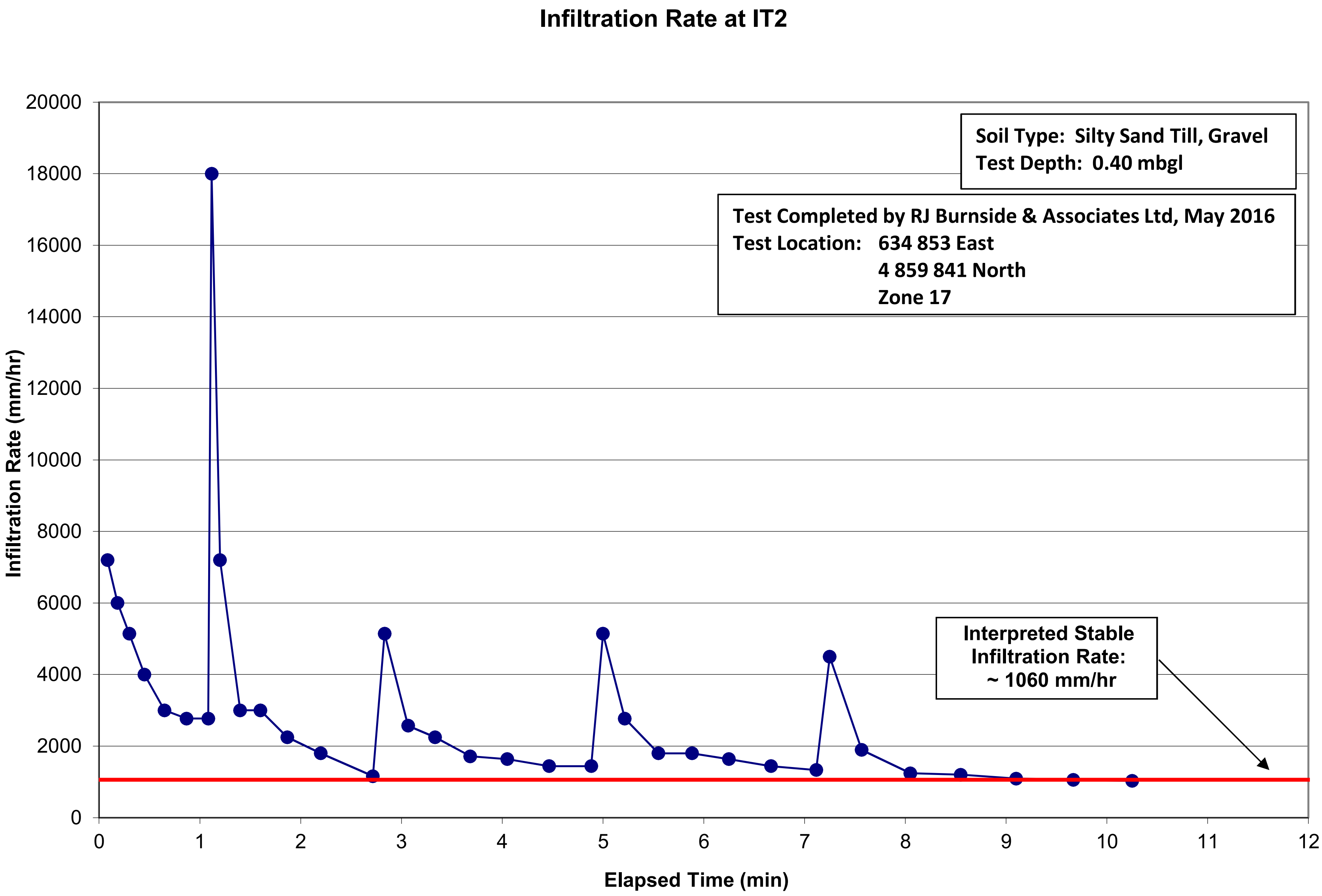
Soil Type: Sandy Silt Till, Some Gravel
Test Depth: 0.35 mbgl

Interpreted Stable Infiltration Rate:
~ 205 mm/hr

Test Completed by RJ Burnside & Associates Ltd, May 2016
Test Location: 634 601 East
4 859 800 North
Zone 17

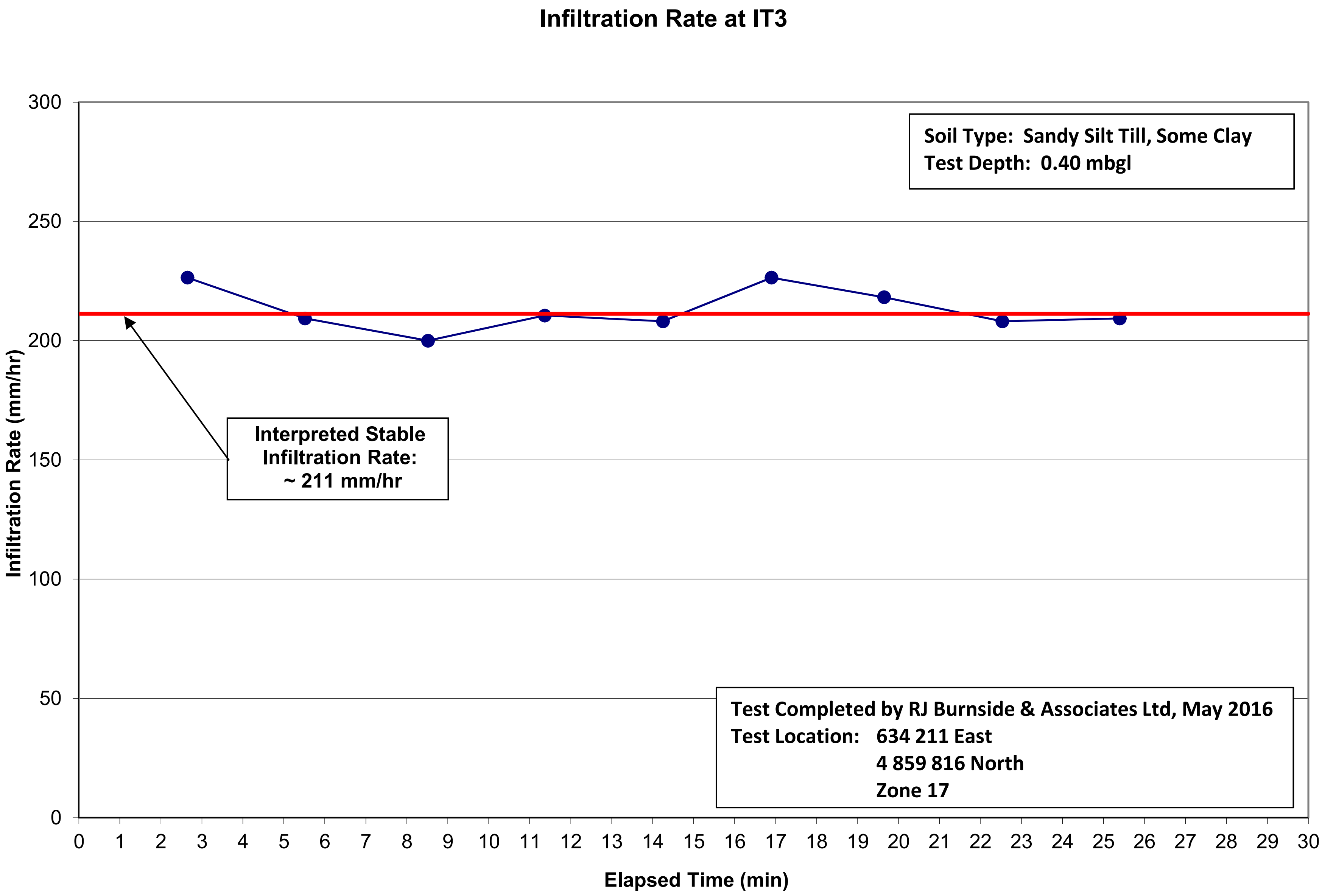
R.J. Burnside & Associates Limited
File: 038247_Infiltration Test Analysis.xlsx
Date: 8/25/2016
Prepared By: JJM

Figure D-8



R.J. Burnside & Associates Limited
File: 038247_Infiltration Test Analysis.xlsx
Date: 8/29/2016
Prepared By: JJM

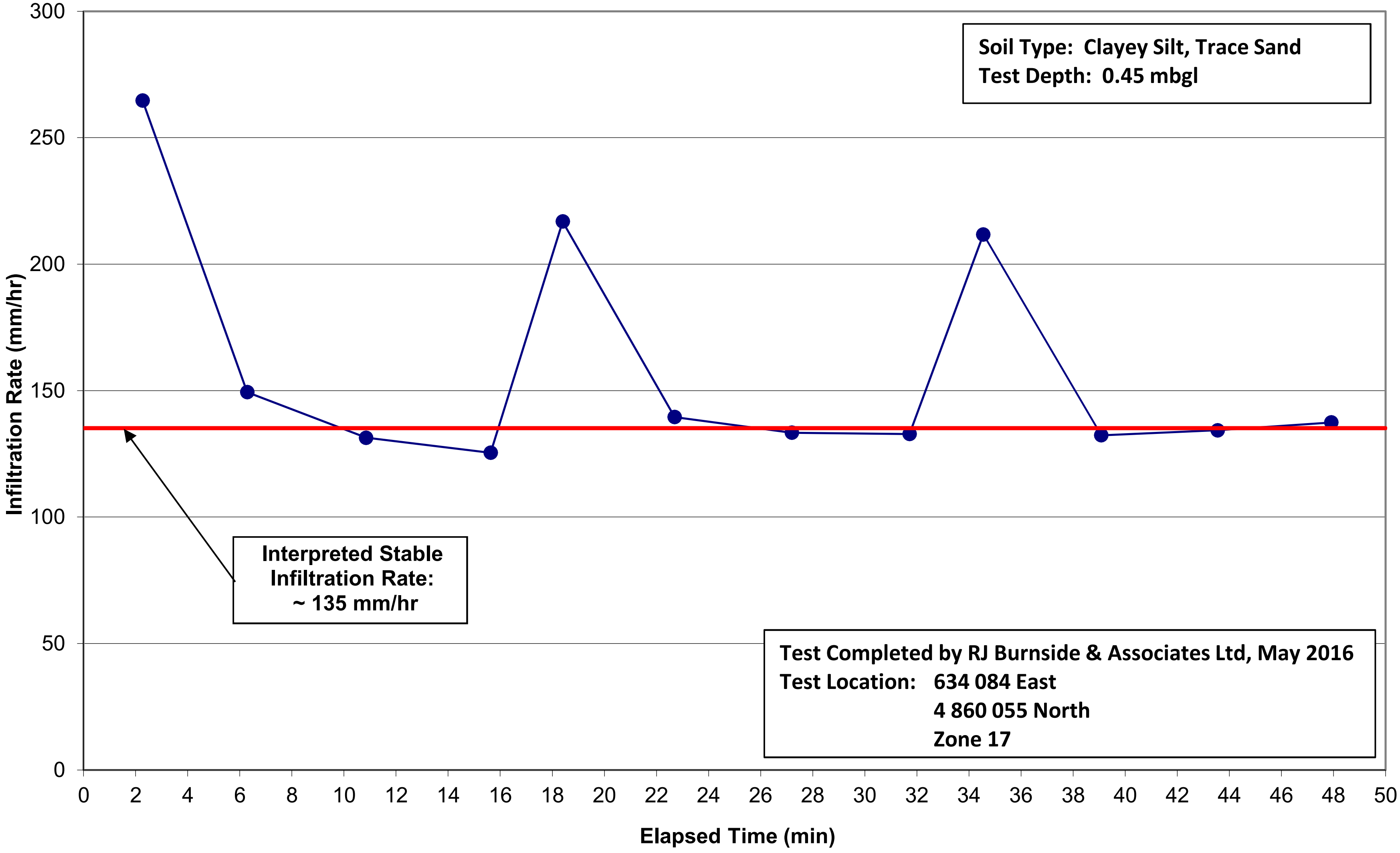
Figure D-9



R.J. Burnside & Associates Limited
File: 038247_Infiltration Test Analysis.xlsx
Date: 8/25/2016
Prepared By: JJM

Figure D-10

Infiltration Rate at IT4



Soil Type: Clayey Silt, Trace Sand
Test Depth: 0.45 mbgl

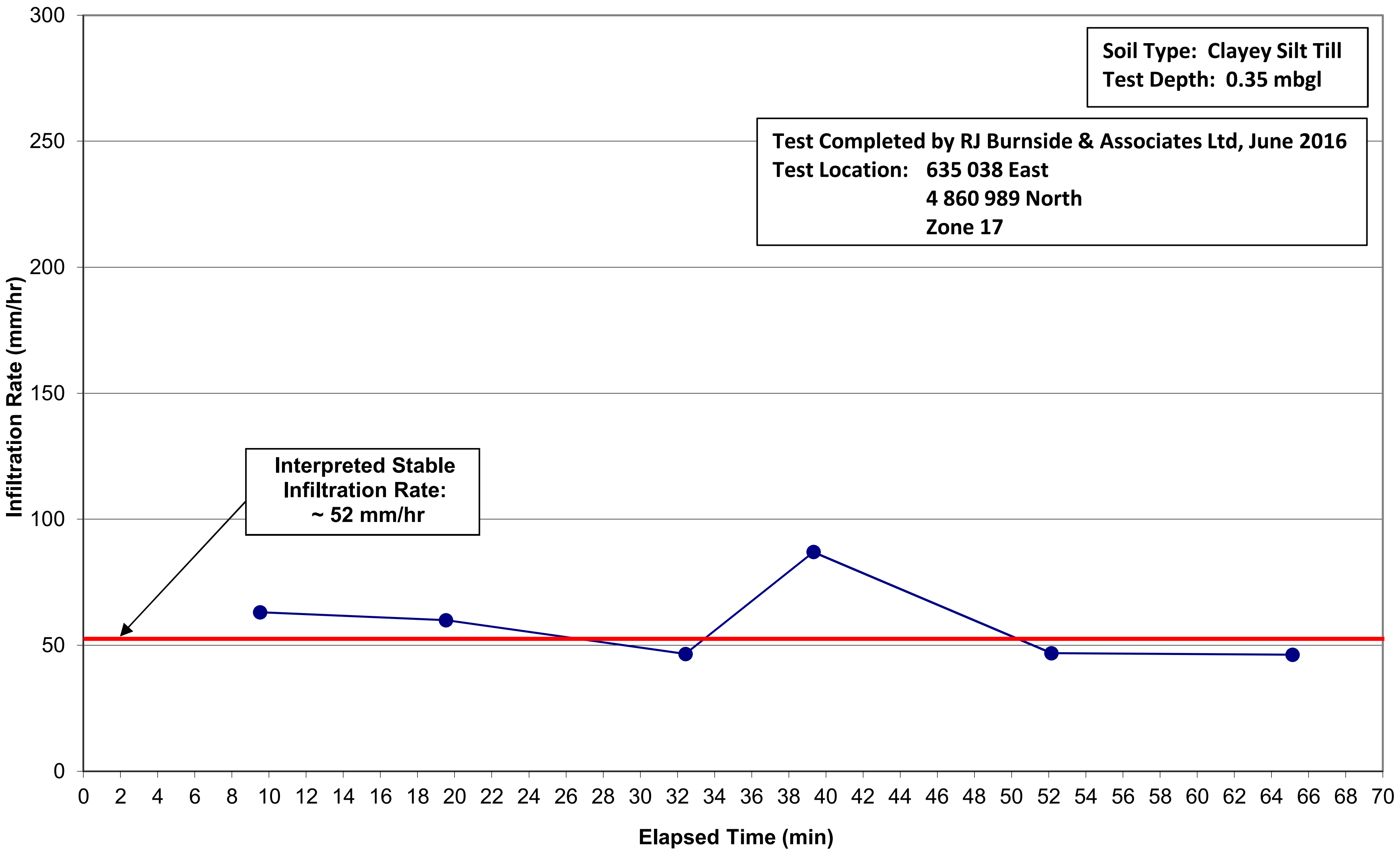
Interpreted Stable Infiltration Rate: ~ 135 mm/hr

Test Completed by RJ Burnside & Associates Ltd, May 2016
Test Location: 634 084 East
4 860 055 North
Zone 17

R.J. Burnside & Associates Limited
File: 038247_Infiltration Test Analysis.xlsx
Date: 8/25/2016
Prepared By: JJM

Figure D-11

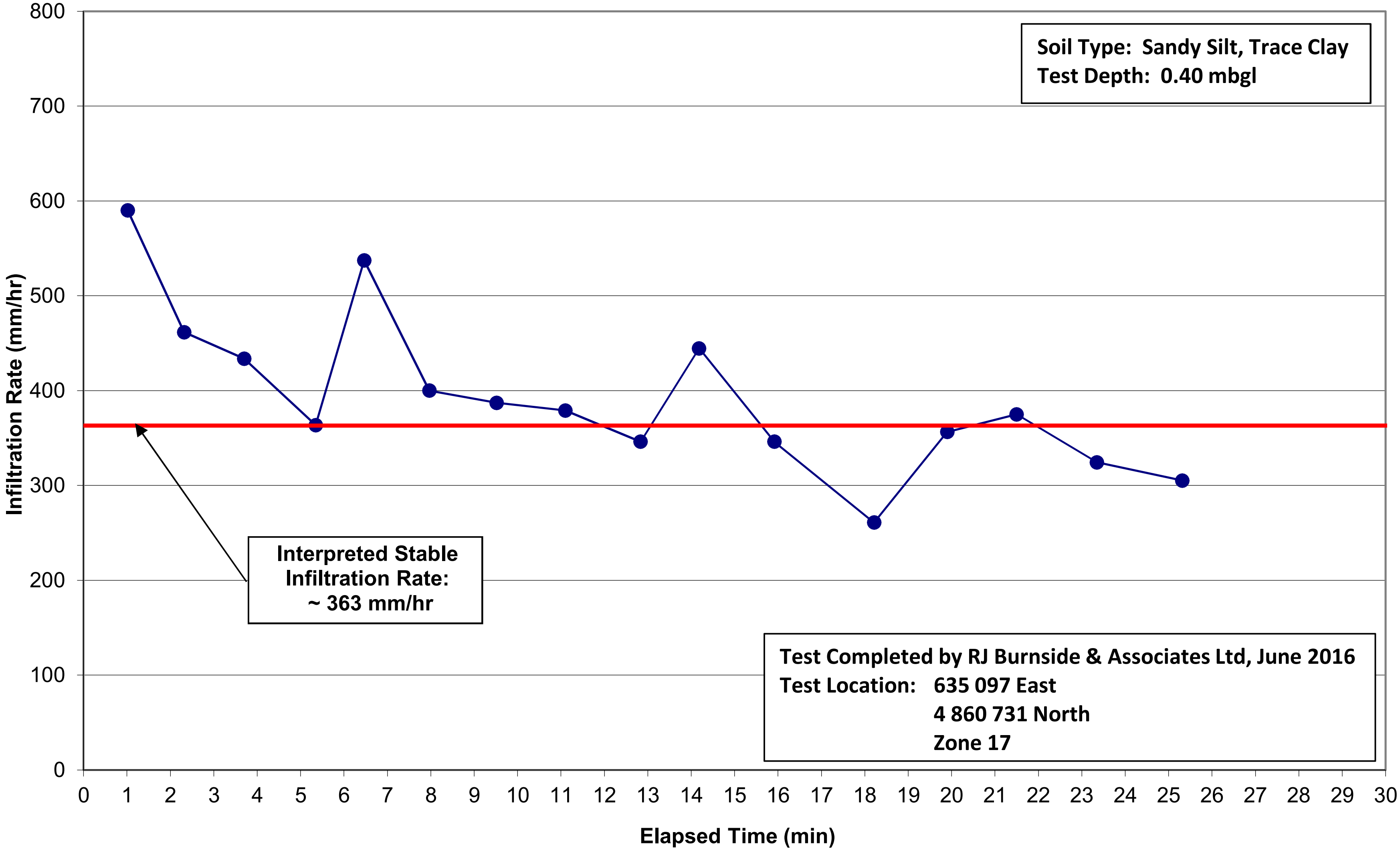
Infiltration Rate at IT5



R.J. Burnside & Associates Limited
File: 038247_Infiltration Test Analysis.xlsx
Date: 8/25/2016
Prepared By: JJM

Figure D-12

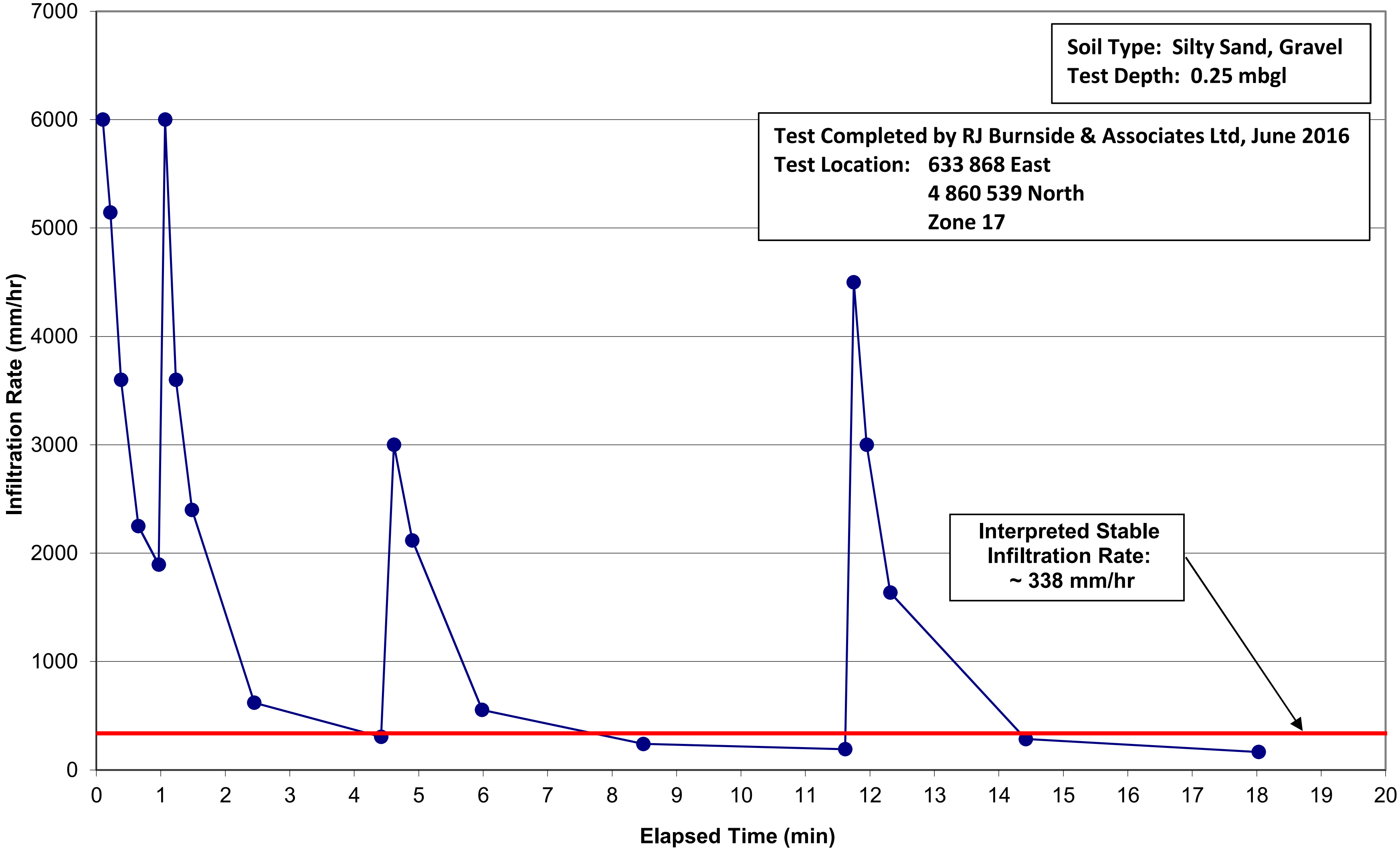
Infiltration Rate at IT6



R.J. Burnside & Associates Limited
File: 038247_Infiltration Test Analysis.xlsx
Date: 8/25/2016
Prepared By: JJM

Figure D-13

Infiltration Rate at IT7



Soil Type: Silty Sand, Gravel
Test Depth: 0.25 mbgl

Test Completed by RJ Burnside & Associates Ltd, June 2016
Test Location: 633 868 East
4 860 539 North
Zone 17

Interpreted Stable Infiltration Rate:
~ 338 mm/hr

R.J. Burnside & Associates Limited
File: 038247_Infiltration Test Analysis.xlsx
Date: 8/29/2016
Prepared By: JJM

Figure D-14

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix E

Groundwater Elevation Data

Table E-1
Monitoring Well Groundwater Elevations

Well	Measured Well Depth (mbmp)	Well Depth (mbgl)	Casing Stick up (m)	Estimated Ground Elevation (masl)	Measuring Point Elevation (masl)	29-Mar-16		22-Apr-16		20-May-16		29-Jun-16		29-Jul-16	
						Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)
BH16-3	**6.75**	**5.87**	**0.88**	**197.56**	**198.44**	4.54	193.02	4.36	193.20	4.55	193.01	4.75	192.81	4.92	192.64
BH16-4	**6.85**	**6.02**	**0.83**	**184.71**	**185.54**	1.39	183.32	1.17	183.54	1.35	183.36	1.52	183.19	1.61	183.10
BH16-5	**6.70**	**5.88**	**0.82**	**186.08**	**186.90**	-0.29	186.37	-0.25	186.33	0.31	185.78	0.69	185.39	0.70	185.38
BH16-6	**5.11**	**4.39**	**0.72**	**186.88**	**187.60**	0.38	186.50	0.59	186.29	0.87	186.02	1.47	185.42	1.31	185.57
BH16-7	**5.06**	**4.33**	**0.74**	**187.59**	**188.33**	2.72	184.88	2.88	184.72	2.95	184.64	3.00	184.60	2.92	184.68
BH16-8	**6.83**	**6.03**	**0.81**	**183.22**	**184.03**	0.52	182.70	1.17	182.06	1.49	181.74	1.78	181.45	1.79	181.44
BH16-9	**5.60**	**4.76**	**0.84**	**183.30**	**184.14**	0.61	182.69	0.72	182.58	0.92	182.39	1.10	182.20	1.17	182.13
BH16-10	**6.56**	**5.78**	**0.78**	**190.66**	**191.44**	0.15	190.51	0.67	190.00	0.81	189.85	1.47	189.19	1.97	188.69
BH16-11	**6.64**	**5.91**	**0.74**	**181.20**	**181.94**	3.17	178.03	3.25	177.95	3.44	177.77	3.64	177.56	3.84	177.37
BH16-12s	**6.57**	**5.82**	**0.75**	**190.11**	**190.86**	0.39	189.72	0.97	189.14	1.40	188.71	1.78	188.33	2.00	188.12
BH16-12d	**16.45**	**15.72**	**0.73**	**190.08**	**190.81**	-0.70	190.78	-0.65	190.73	-0.53	190.61	-0.31	190.39	-0.21	190.29
BH16-13s	**7.03**	**6.20**	**0.83**	**184.14**	**184.97**	1.68	182.47	1.79	182.35	2.32	181.83	2.63	181.51	3.20	180.94
BH16-13d	**17.02**	**16.10**	**0.93**	**184.07**	**185.00**	0.54	183.54	0.78	183.30	1.21	182.87	1.34	182.74	1.04	183.04
BH16-14s	**6.50**	**5.73**	**0.77**	**177.45**	**178.22**	1.86	175.59	2.07	175.39	2.17	175.28	2.33	175.12	2.33	175.12
BH16-14d	**16.25**	**15.51**	**0.74**	**177.45**	**178.19**	1.71	175.74	1.85	175.60	1.94	175.51	2.11	175.35	2.11	175.34
BH16-15s	**5.85**	**5.07**	**0.78**	**180.87**	**181.65**	2.91	177.96	3.22	177.65	3.47	177.40	3.80	177.07	4.12	176.75
BH16-15d	**15.02**	**14.29**	**0.73**	**180.87**	**181.60**	3.99	176.88	4.00	176.87	4.26	176.61	4.49	176.39	4.58	176.29
BH16-16	**13.24**	**12.43**	**0.81**	**179.60**	**180.41**	-0.32	179.92	-0.32	179.92	0.17	179.43	0.48	179.13	0.51	179.09
BH14-1	**3.50**	**3.50**	**0.00**	**178.59**	**178.59**	-	-	0.70	177.89	-	-	1.01	177.58	1.02	177.57
BH14-2	**3.60**	**3.60**	**0.00**	**178.74**	**178.74**	-	-	1.19	177.55	-	-	1.49	177.25	1.72	177.02
BH14-3	**3.70**	**3.70**	**0.00**	**178.67**	**178.67**	-	-	1.12	177.55	-	-	1.40	177.27	1.50	177.17
BH14-8	**5.82**	**5.01**	**0.81**	**196.19**	**197.00**	2.87	193.32	3.18	193.01	3.68	192.51	3.97	192.22	4.23	191.97
BH14-12	**4.55**	**4.55**	**0.00**	**179.48**	**179.48**	-	-	1.66	177.83	1.87	177.61	2.42	177.06	2.45	177.03
BH14-15	**6.85**	**5.80**	**1.06**	**179.83**	**180.89**	3.79	176.04	3.96	175.88	4.06	175.77	4.30	175.54	4.34	175.50
BH14-17	**7.15**	**6.13**	**1.02**	**194.43**	**195.45**	2.17	192.26	2.57	191.87	2.79	191.65	3.99	190.44	4.65	189.79
BH14-29	**6.81**	**6.14**	**0.68**	**190.39**	**191.07**	0.71	189.69	0.55	189.85	0.64	189.75	0.95	189.45	1.43	188.97
BH14-33	**8.39**	**7.46**	**0.93**	**194.67**	**195.60**	3.17	191.50	2.89	191.78	3.21	191.47	3.33	191.35	3.49	191.18
BH14-34	**-**	**-**	**-**	**-**	**-**	-	-	-	-	-	-	-	-	-	-

mbgl - metres below ground level
masl - metres above sea level
"-" denotes unavailable data

Table E-2
Piezometer Groundwater Elevations

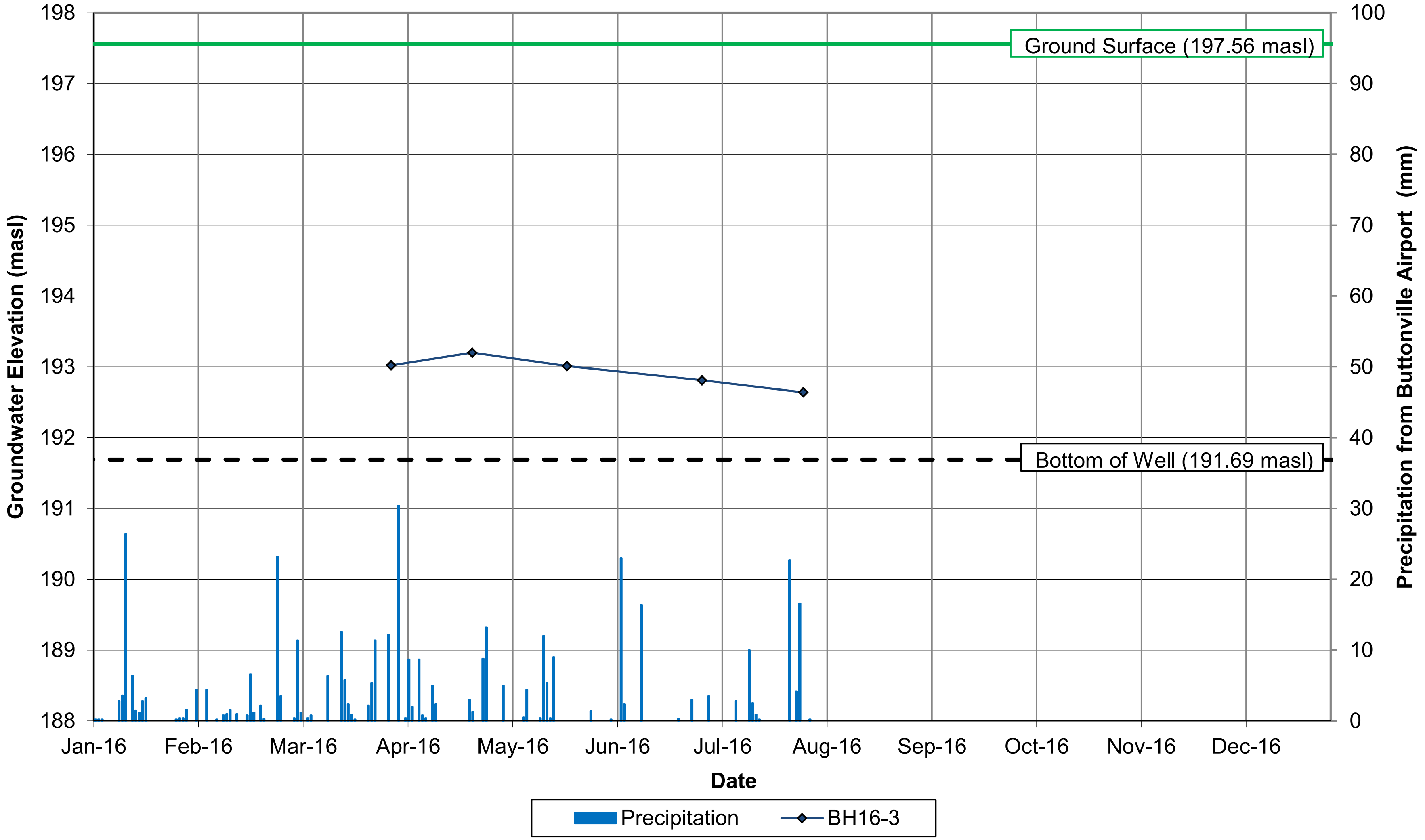
Piezometer	Measured Depth (mbmp)	Depth (mbgl)	Casing Stick up (m)	Measured Ground Elevation (masl)	Measuring Point Elevation (masl)	22-Mar-16		29-Mar-16		22-Apr-16		20-May-16		29-Jun-16		29-Jul-16		05-Aug-16	
						Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)	Water Level Depth (mbgl)	Estimated Elevation (masl)
PZ1	**1.60**	**0.99**	**0.61**	**182.24**	**182.85**	0.97	181.27	0.86	181.38	0.93	181.32	0.85	181.39	0.74	181.50	0.69	181.55	-	-
PZ2	**2.82**	**1.67**	**1.15**	**181.53**	**182.68**	1.13	180.40	0.98	180.55	0.84	180.70	0.70	180.83	0.58	180.96	0.62	180.91	-	-
PZ3s	**1.91**	**1.34**	**0.57**	**180.83**	**181.40**	1.16	179.67	0.29	180.54	0.54	180.29	0.62	180.21	0.68	180.15	0.64	180.19	-	-
PZ3d	**2.82**	**1.78**	**1.04**	**180.75**	**181.79**	0.62	180.13	0.16	180.59	0.50	180.25	0.59	180.16	0.65	180.10	0.62	180.13	-	-
PZ4s	**1.91**	**1.11**	**0.80**	**181.43**	**182.23**	1.10	180.33	-0.15	181.58	0.44	180.99	0.19	181.24	0.57	180.86	0.50	180.93	-	-
PZ4d	**2.82**	**1.63**	**1.19**	**181.46**	**182.65**	1.26	180.20	1.47	179.99	1.10	180.36	0.78	180.68	0.57	180.89	0.59	180.87	-	-
PZ5s	**1.91**	**1.22**	**0.69**	**184.39**	**185.08**	0.89	183.50	0.66	183.73	0.65	183.74	0.51	183.88	0.42	183.97	0.50	183.89	-	-
PZ5d	**2.82**	**1.73**	**1.09**	**184.38**	**185.47**	1.36	183.02	1.43	182.95	0.84	183.54	0.58	183.81	0.39	184.00	0.44	183.95	-	-
PZ6	**1.91**	**1.19**	**0.72**	**175.35**	**176.07**	1.18	174.17	0.95	174.40	0.81	174.55	0.68	174.67	0.61	174.75	0.78	174.57	-	-
PZ7s	**1.91**	**1.24**	**0.67**	**177.30**	**177.97**	0.92	176.38	0.24	177.06	0.49	176.81	0.54	176.76	0.63	176.68	0.51	176.79	-	-
PZ7d	**2.82**	**1.71**	**1.11**	**177.41**	**178.52**	1.34	176.07	1.26	176.15	1.13	176.28	1.01	176.40	0.89	176.52	0.86	176.55	-	-
PZ8s	**1.91**	**1.35**	**0.56**	**187.59**	**188.15**	-	-	-	-	-	-	-	-	0.97	186.62	0.69	186.90	-	-
PZ8d	**2.82**	**1.88**	**0.94**	**187.57**	**188.51**	-	-	-	-	-	-	-	-	1.57	186.01	1.27	186.30	-	-
PZ9s	**1.91**	**0.96**	**0.95**	**188.95**	**189.90**	-	-	-	-	-	-	-	-	-	-	-	-	0.96	187.99
PZ9d	**2.82**	**1.57**	**1.25**	**188.86**	**190.11**	-	-	-	-	-	-	-	-	-	-	-	-	1.51	187.35

mbgl - metres below ground level

masl - metres above sea level

"-" denotes not part of monitoring round or unavailble data

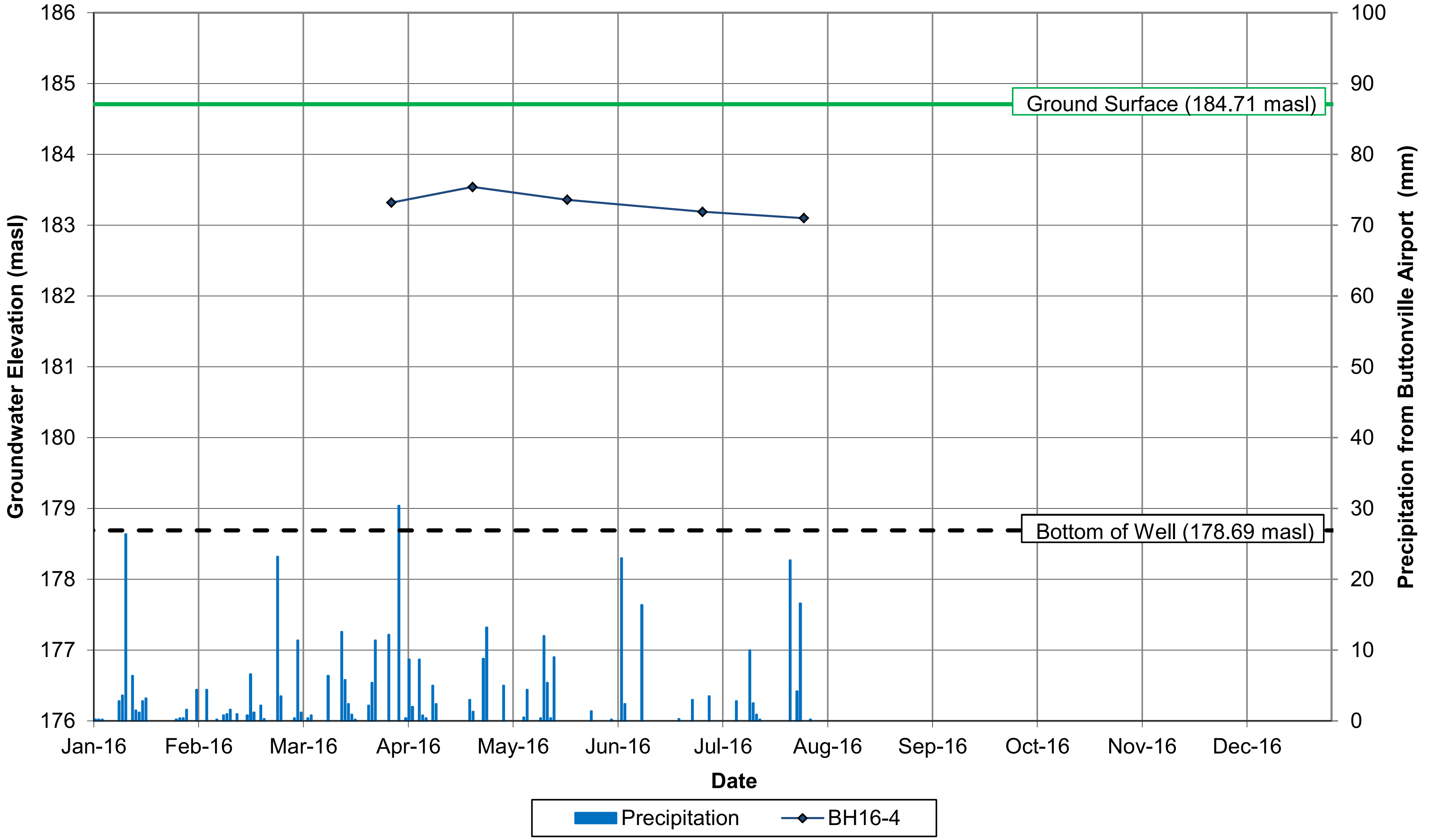
Groundwater Elevations
BH16-3



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

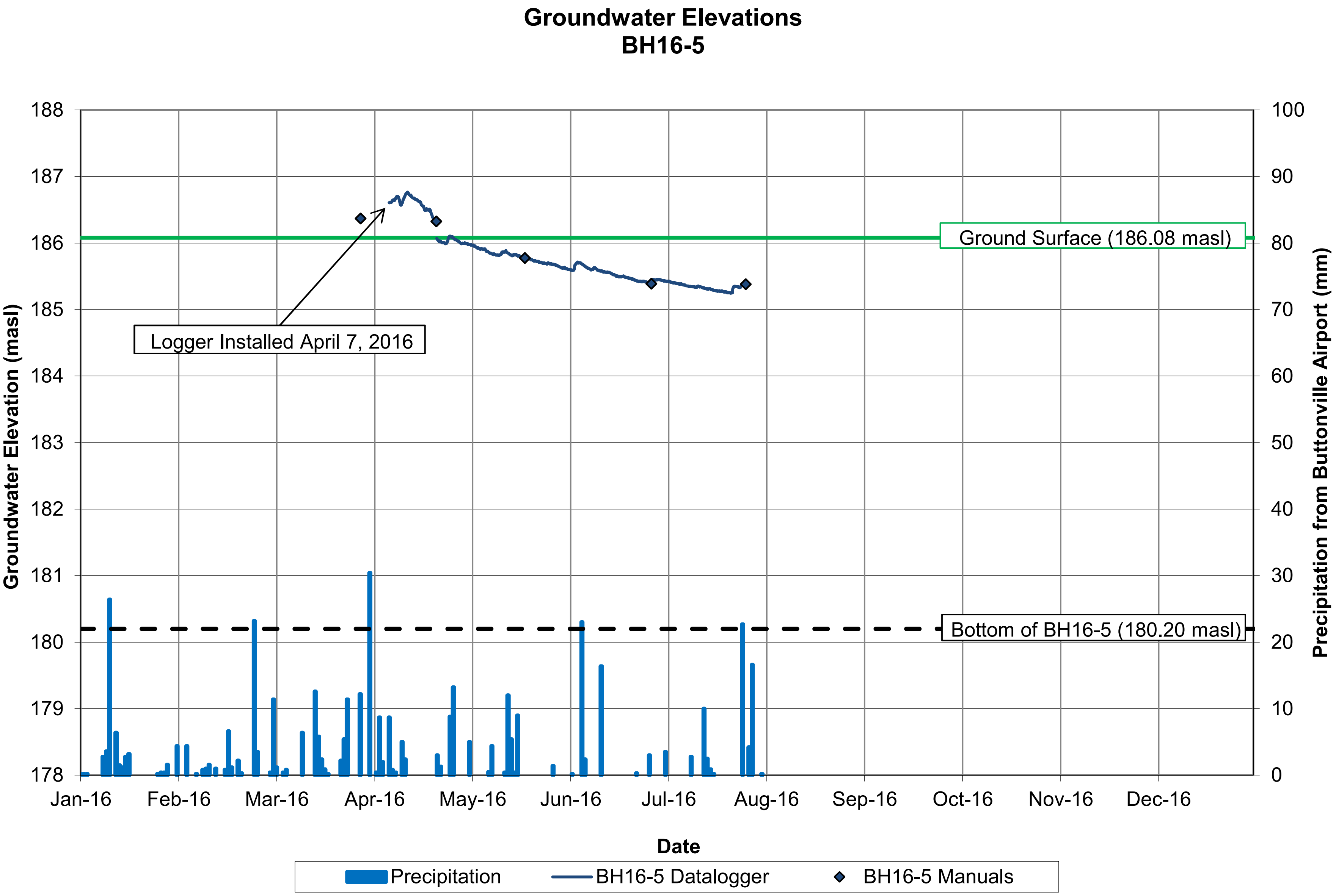
Figure E-1

Groundwater Elevations
BH16-4



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

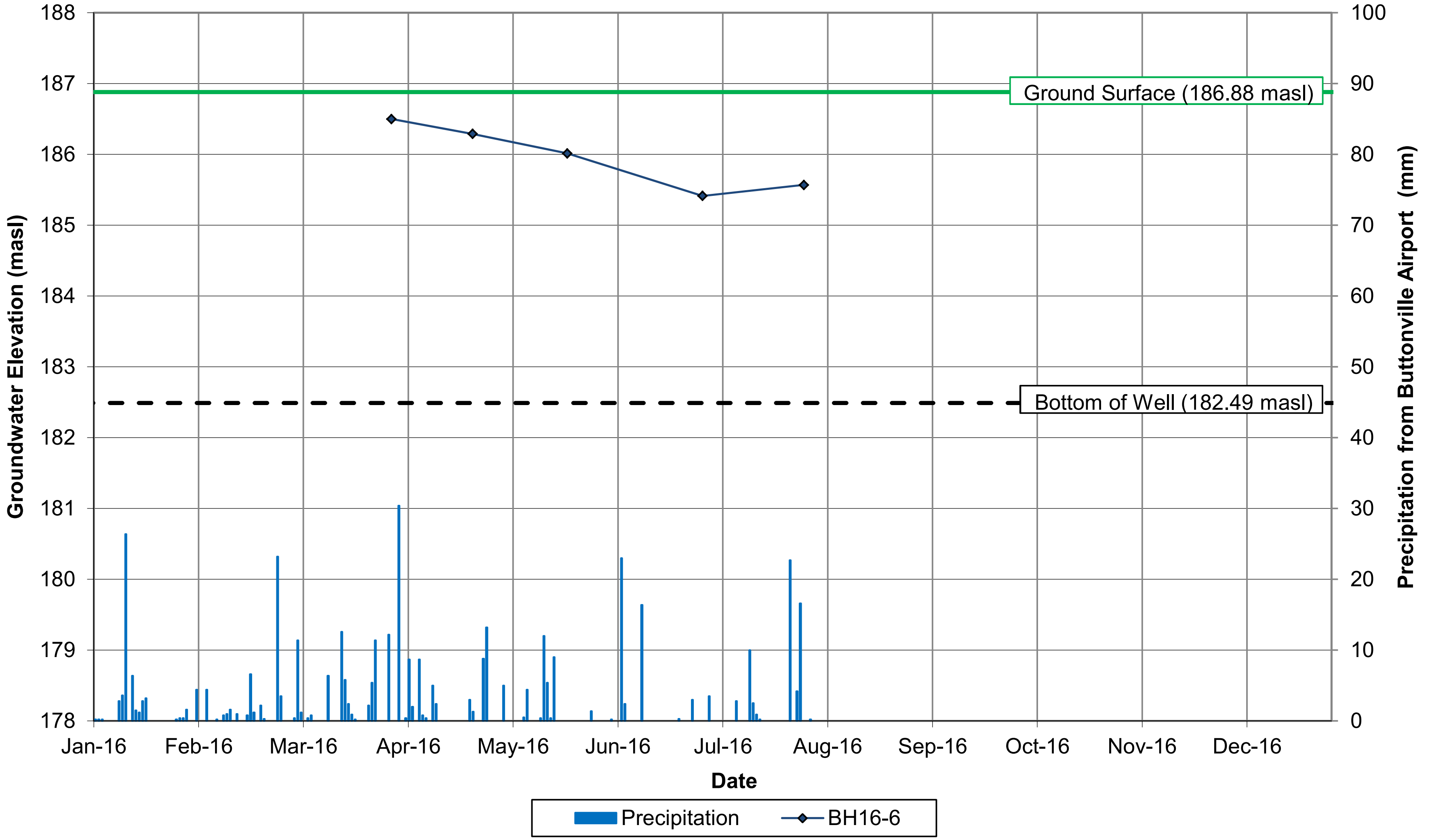
Figure E-2



R.J. Burnside & Associates Limited
File: 038247_BH16-5 Hydrograph.xlsx
Date: 8/22/2016
Prepared By: JJM

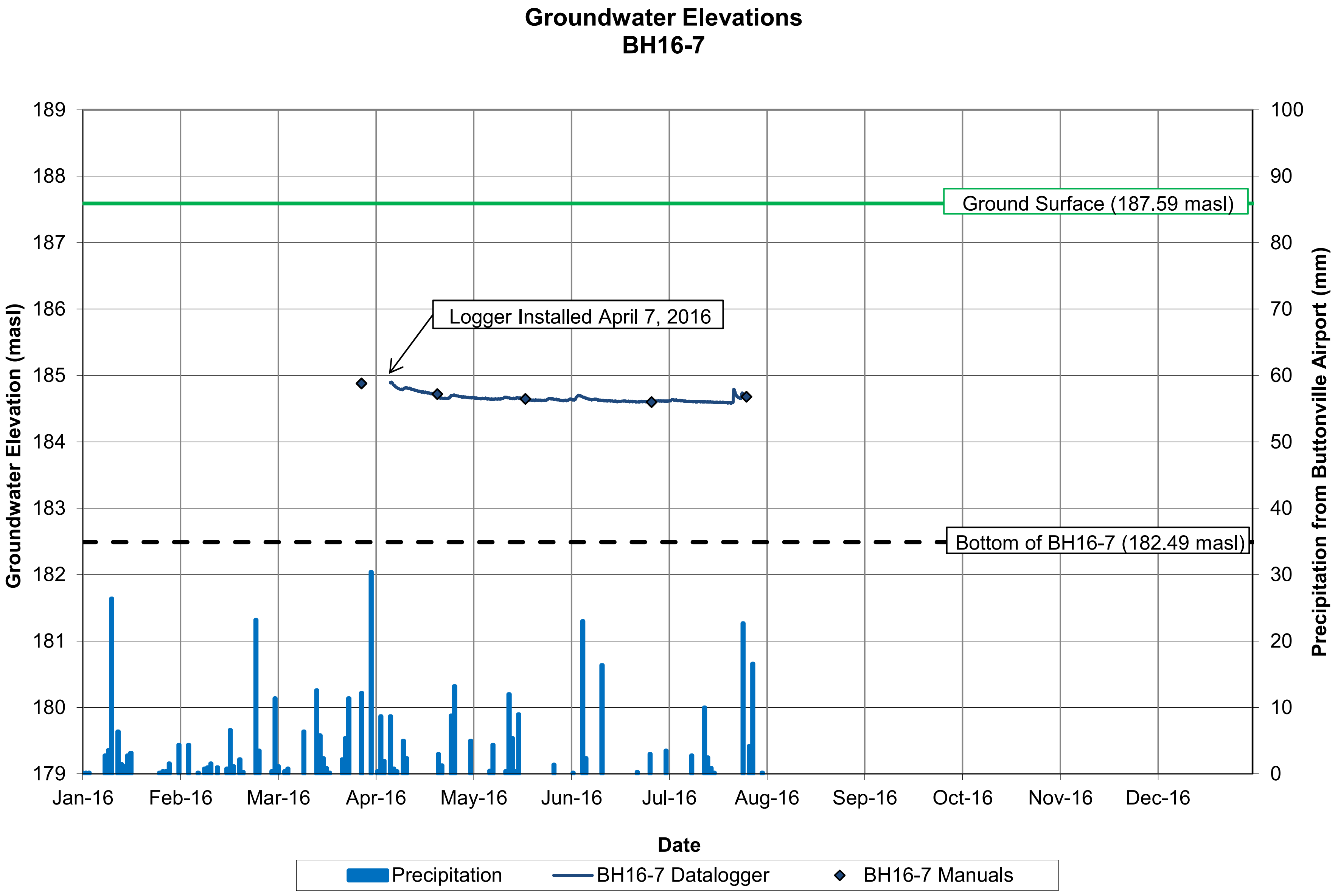
Figure E-3

Groundwater Elevations
BH16-6



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

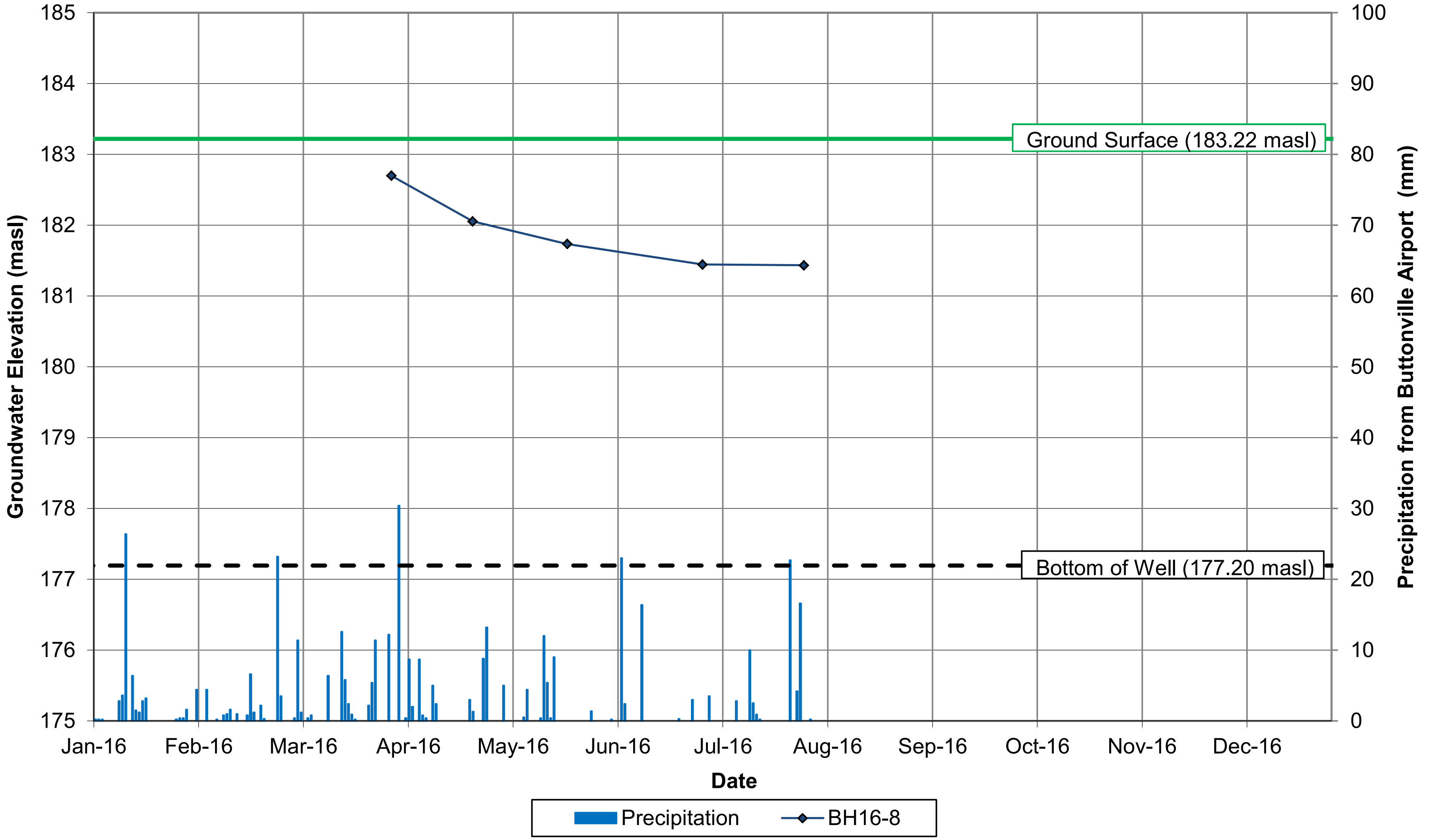
Figure E-4



R.J. Burnside & Associates Limited
File: 038247_BH16-7 Hydrograph.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-5

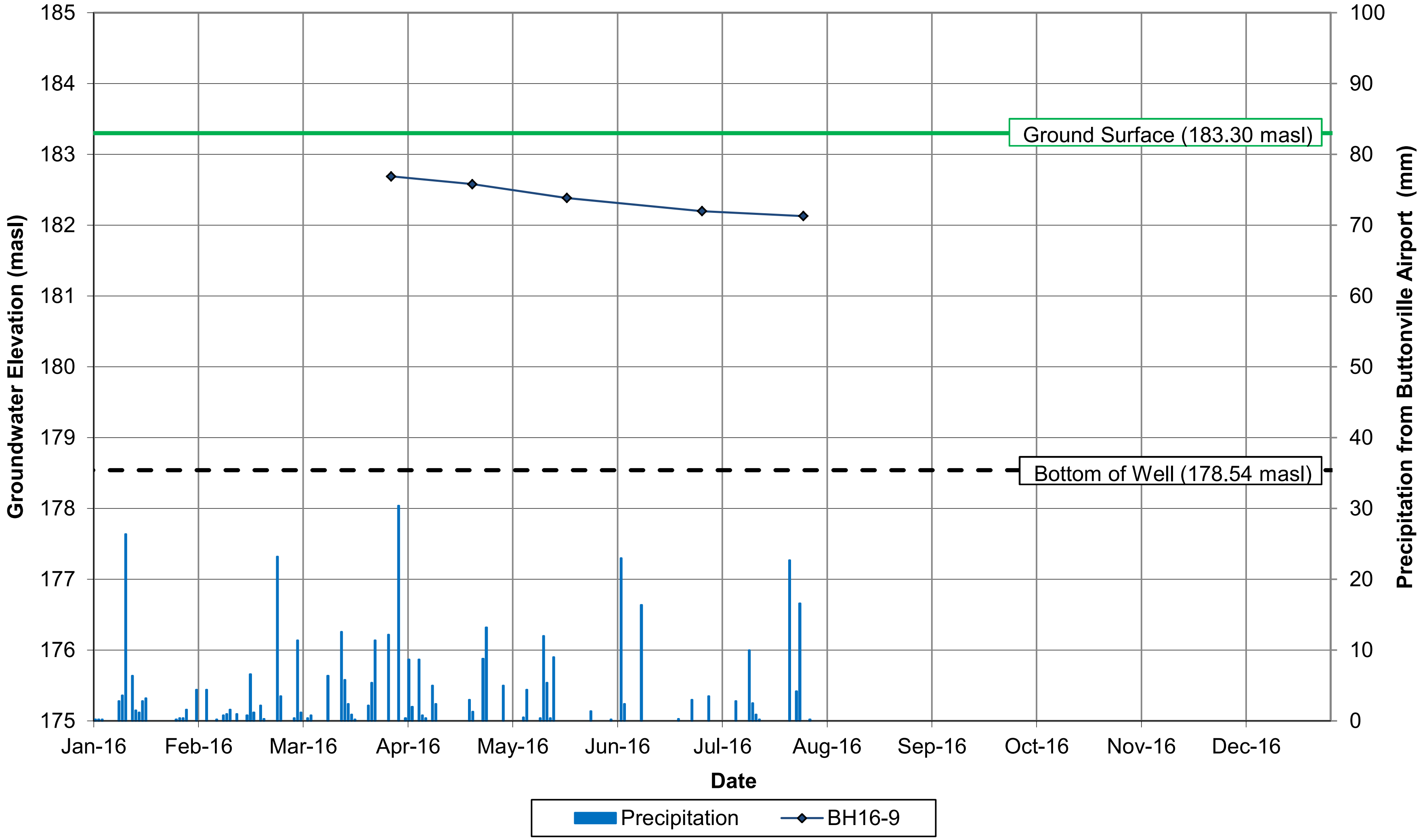
Groundwater Elevations
BH16-8



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-6

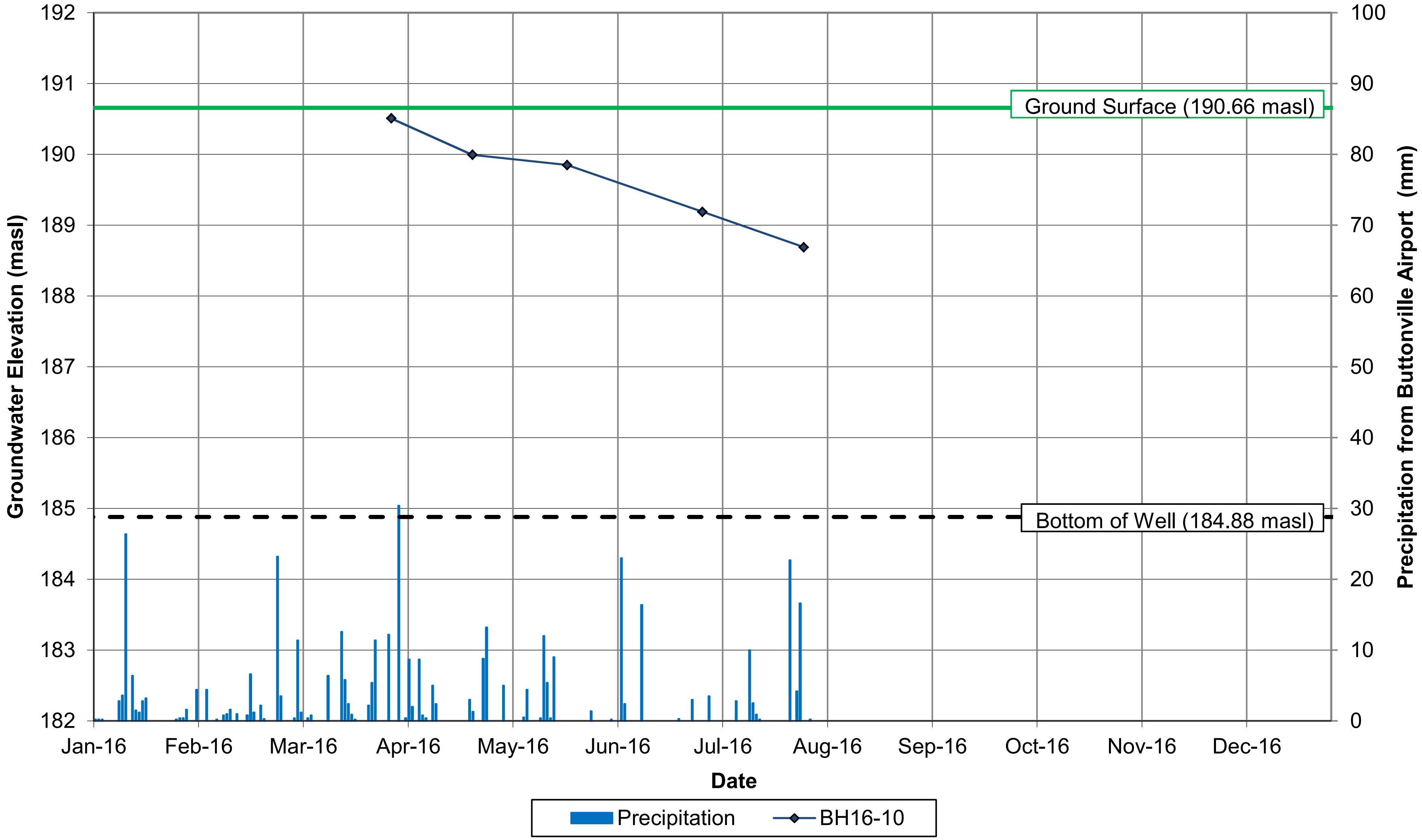
Groundwater Elevations
BH16-9



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-7

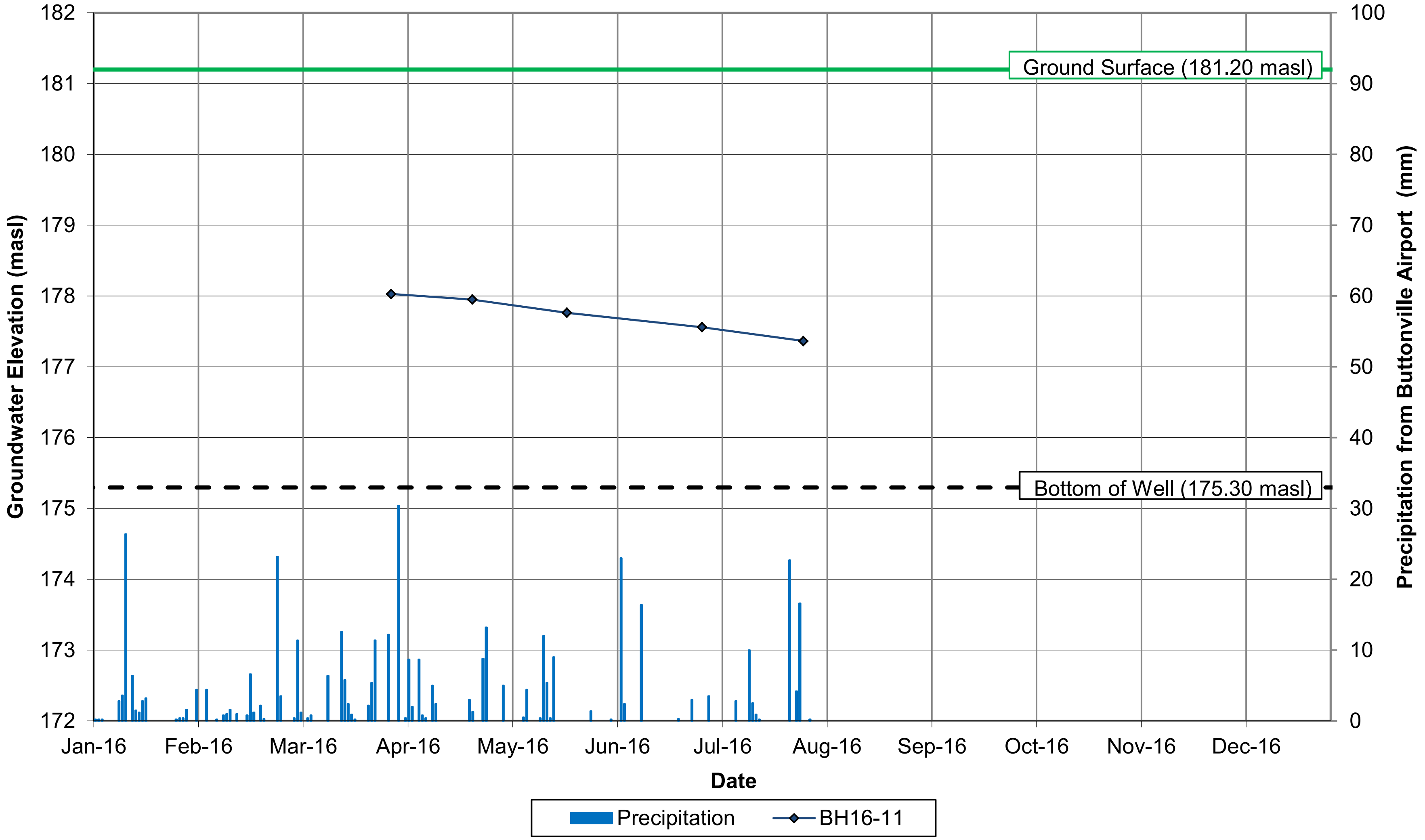
Groundwater Elevations
BH16-10



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-8

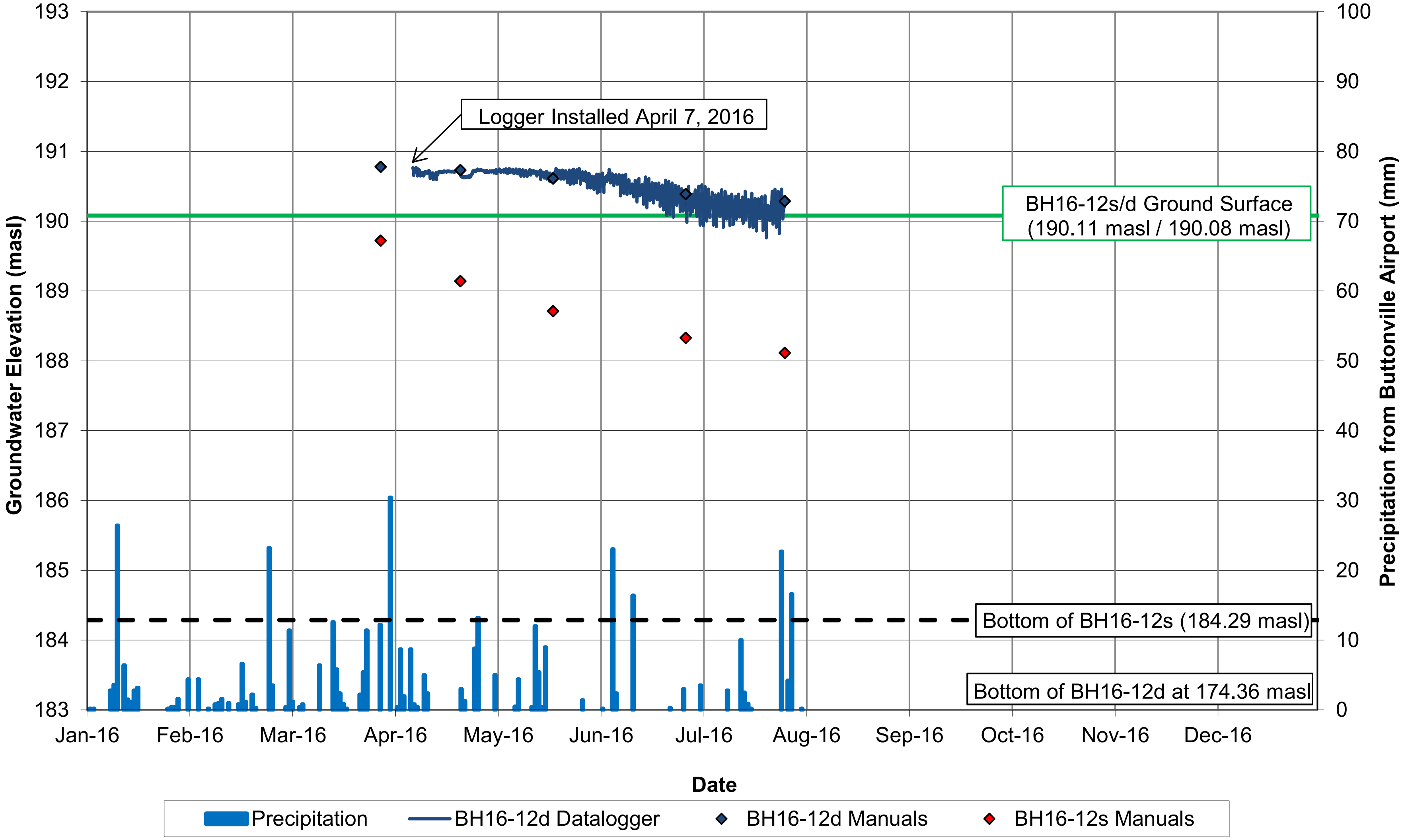
Groundwater Elevations
BH16-11



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-9

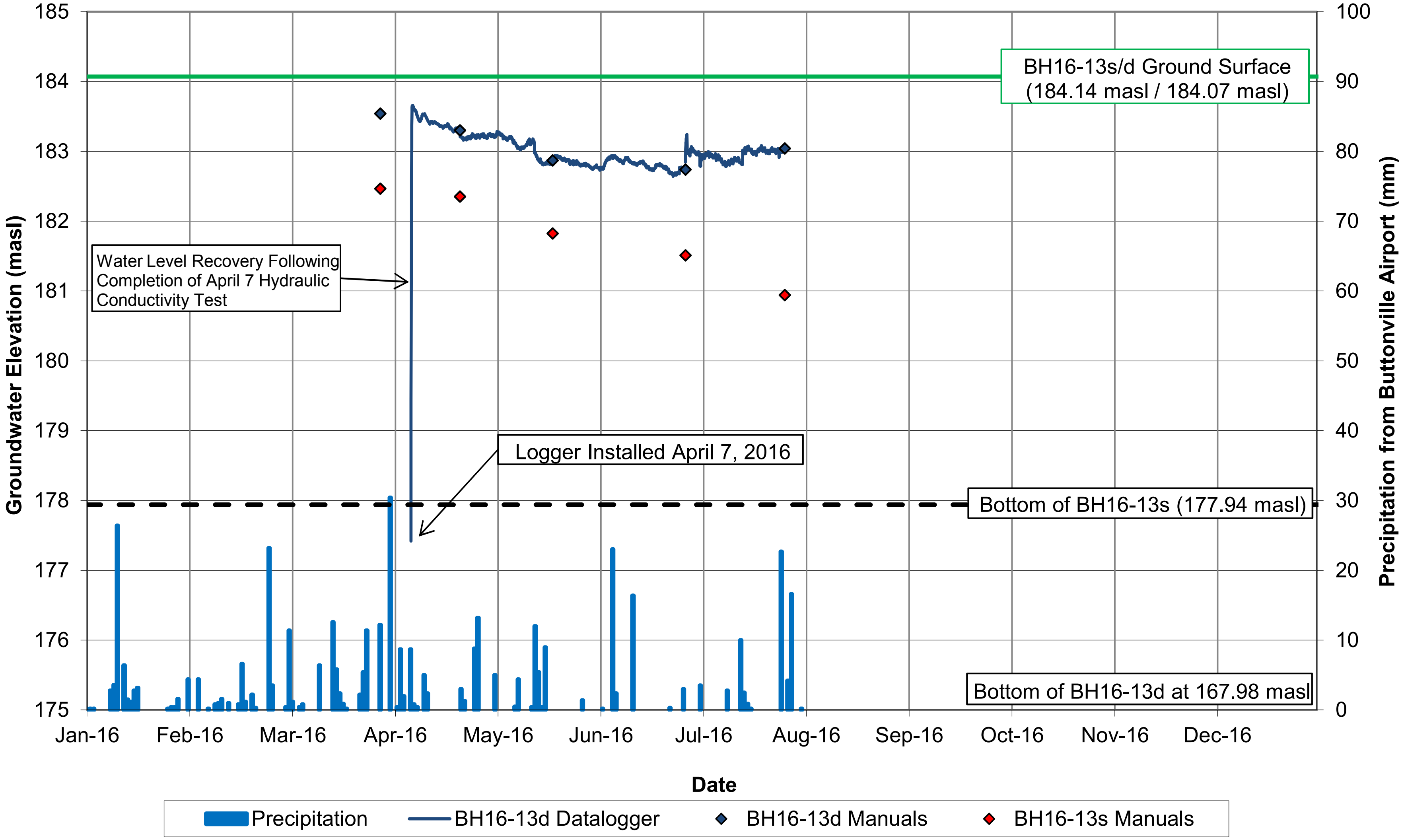
Groundwater Elevations
BH16-12s/d



R.J. Burnside & Associates Limited
File: 038247_BH16-12sd Hydrograph.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-10

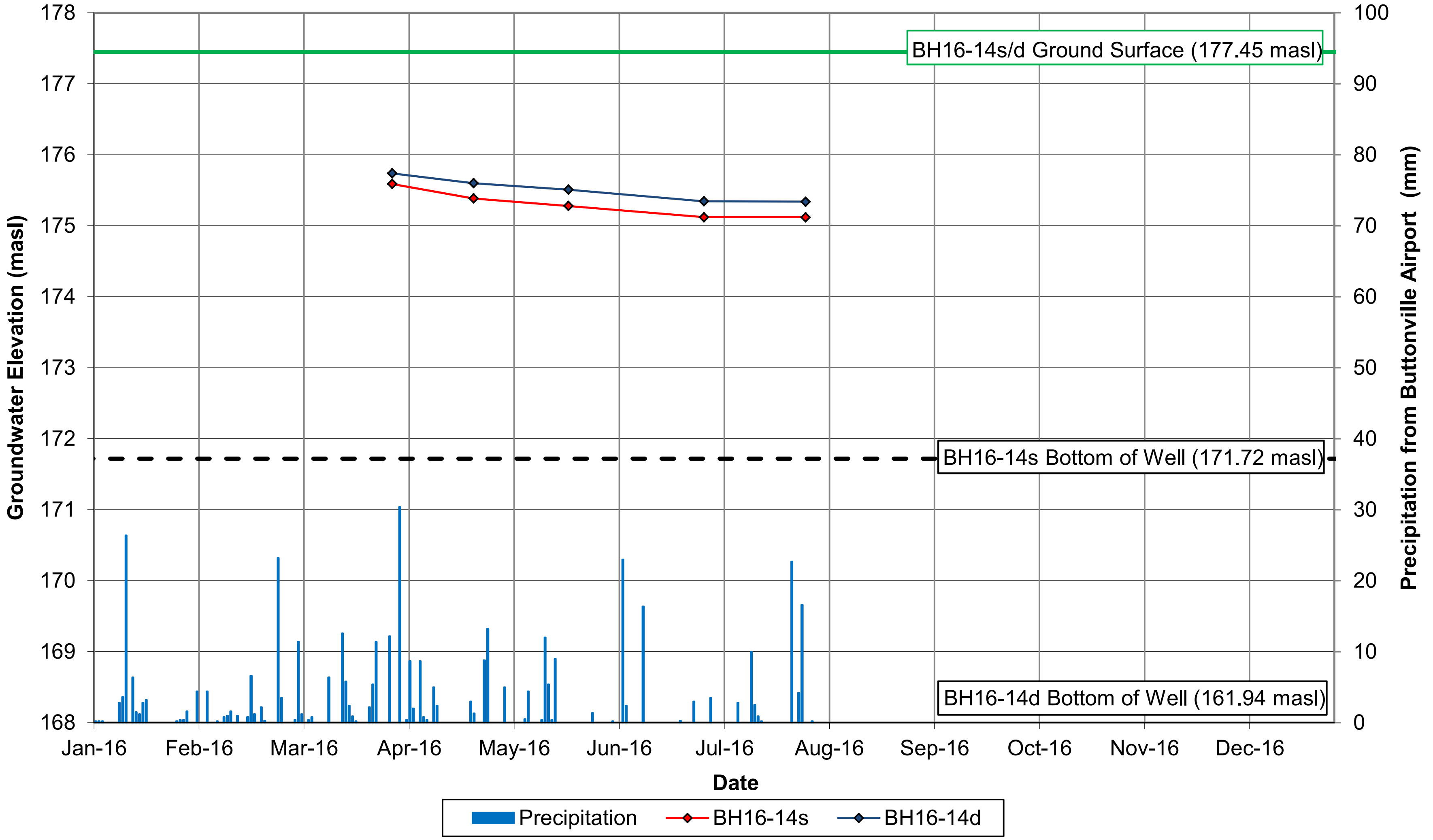
Groundwater Elevations
BH16-13s/d



R.J. Burnside & Associates Limited
File: 038247_BH16-13sd Hydrograph.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-11

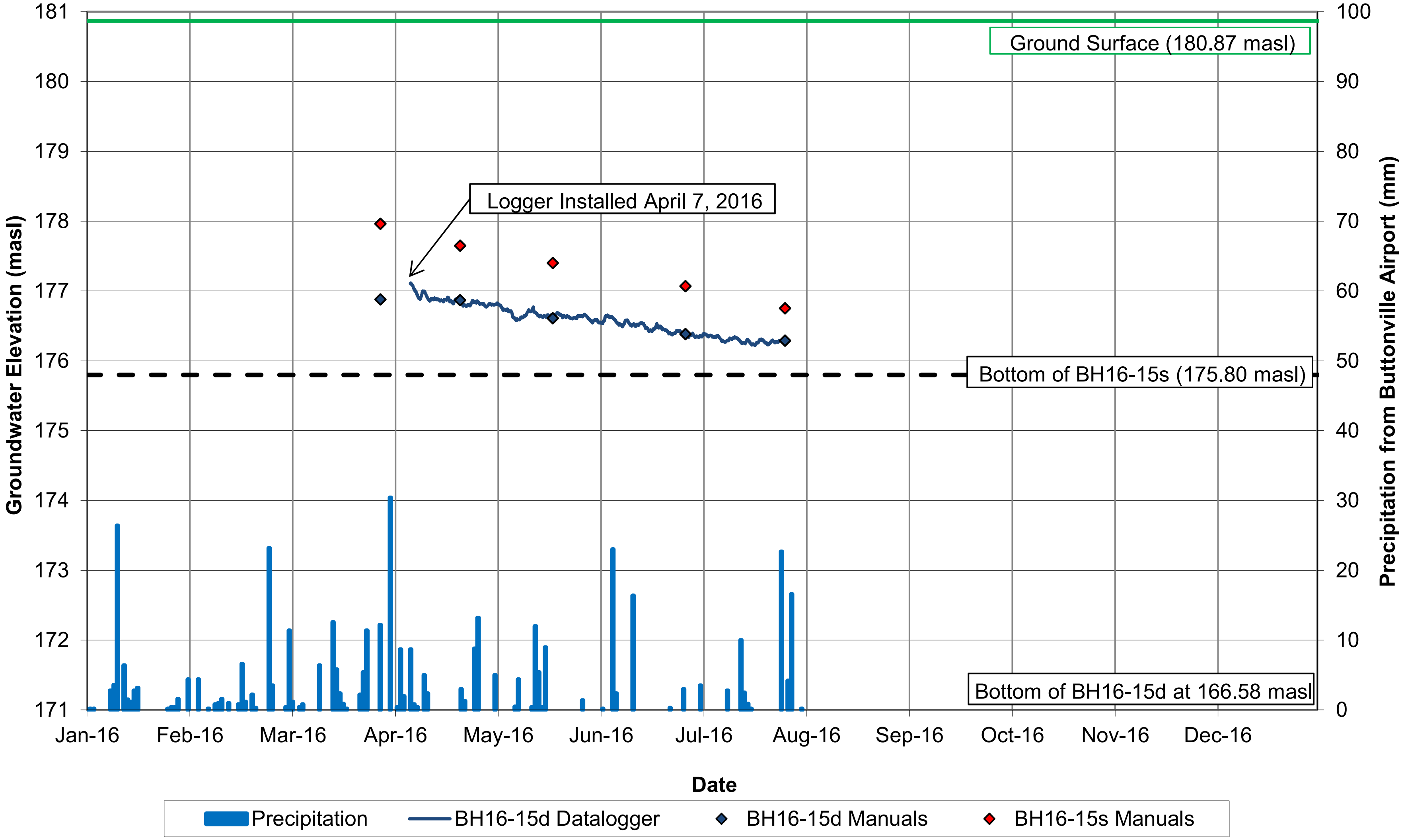
Groundwater Elevations
BH16-14s/d



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/25/2016
Prepared By: JJM

Figure E-12

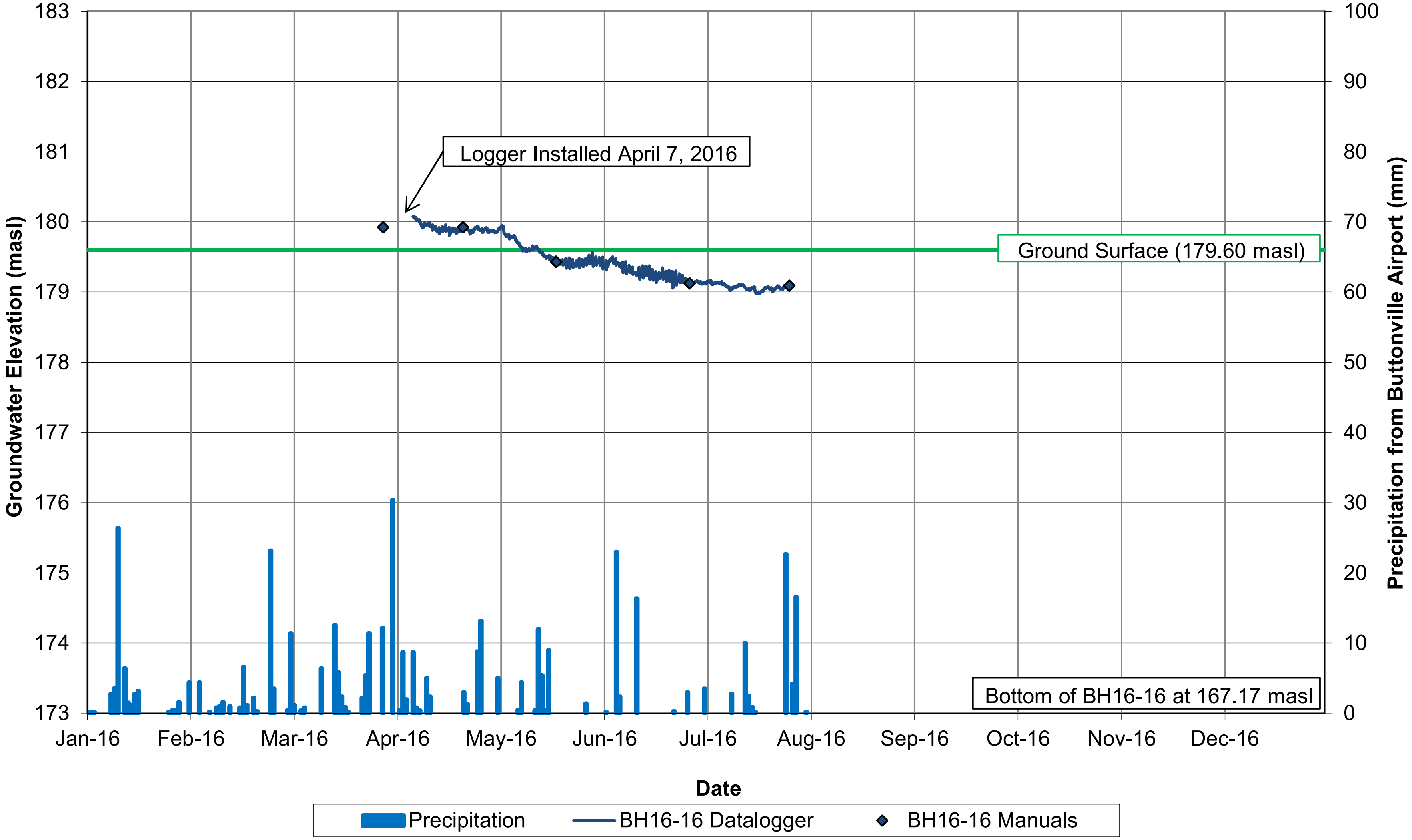
Groundwater Elevations
BH16-15s/d



R.J. Burnside & Associates Limited
File: 038247_BH16-15sd Hydrograph.xlsx
Date: 8/22/2016
Prepared By: JJM

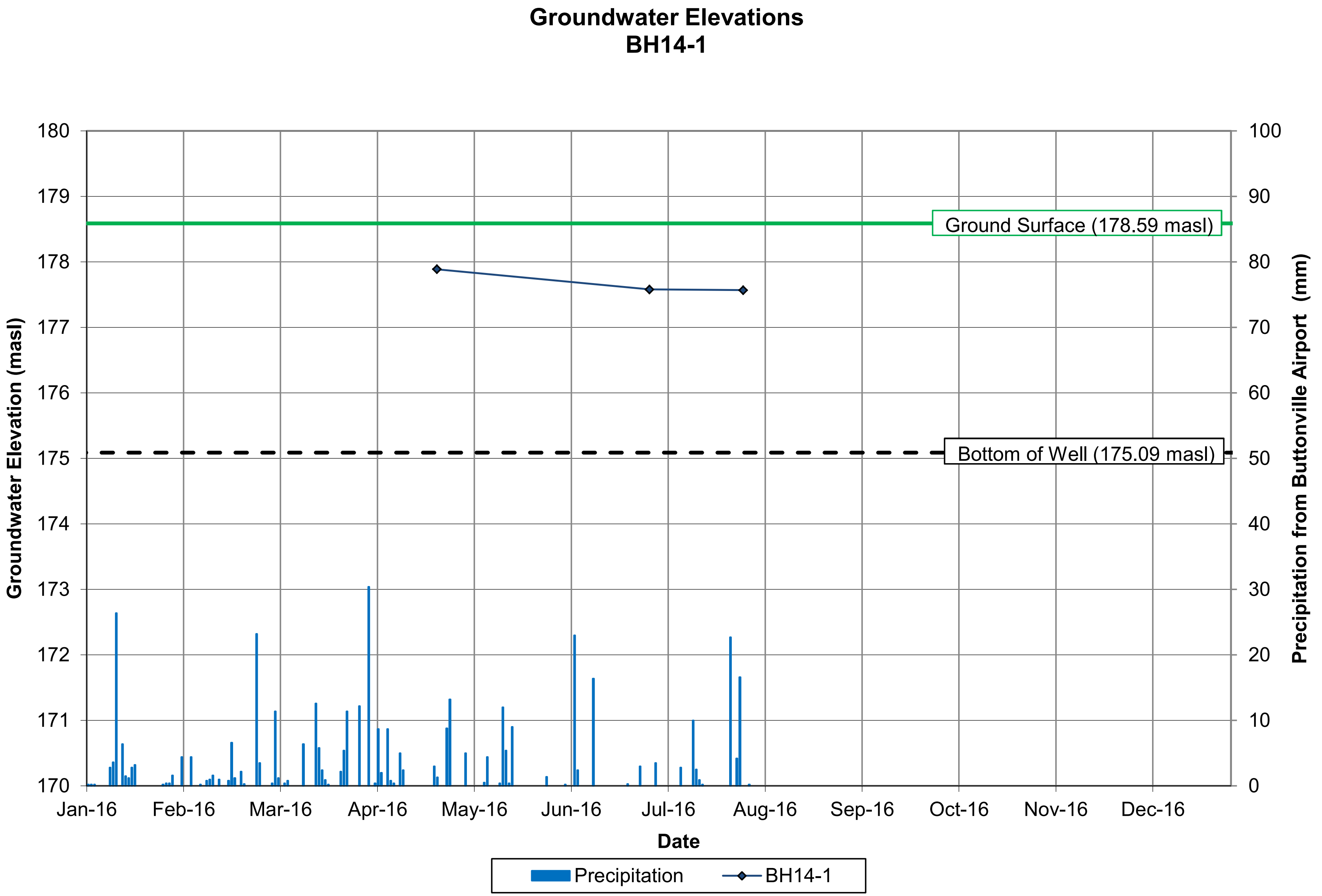
Figure E-13

Groundwater Elevations
BH16-16



R.J. Burnside & Associates Limited
File: 038247_BH16-16 Hydrograph.xlsx
Date: 8/22/2016
Prepared By: JJM

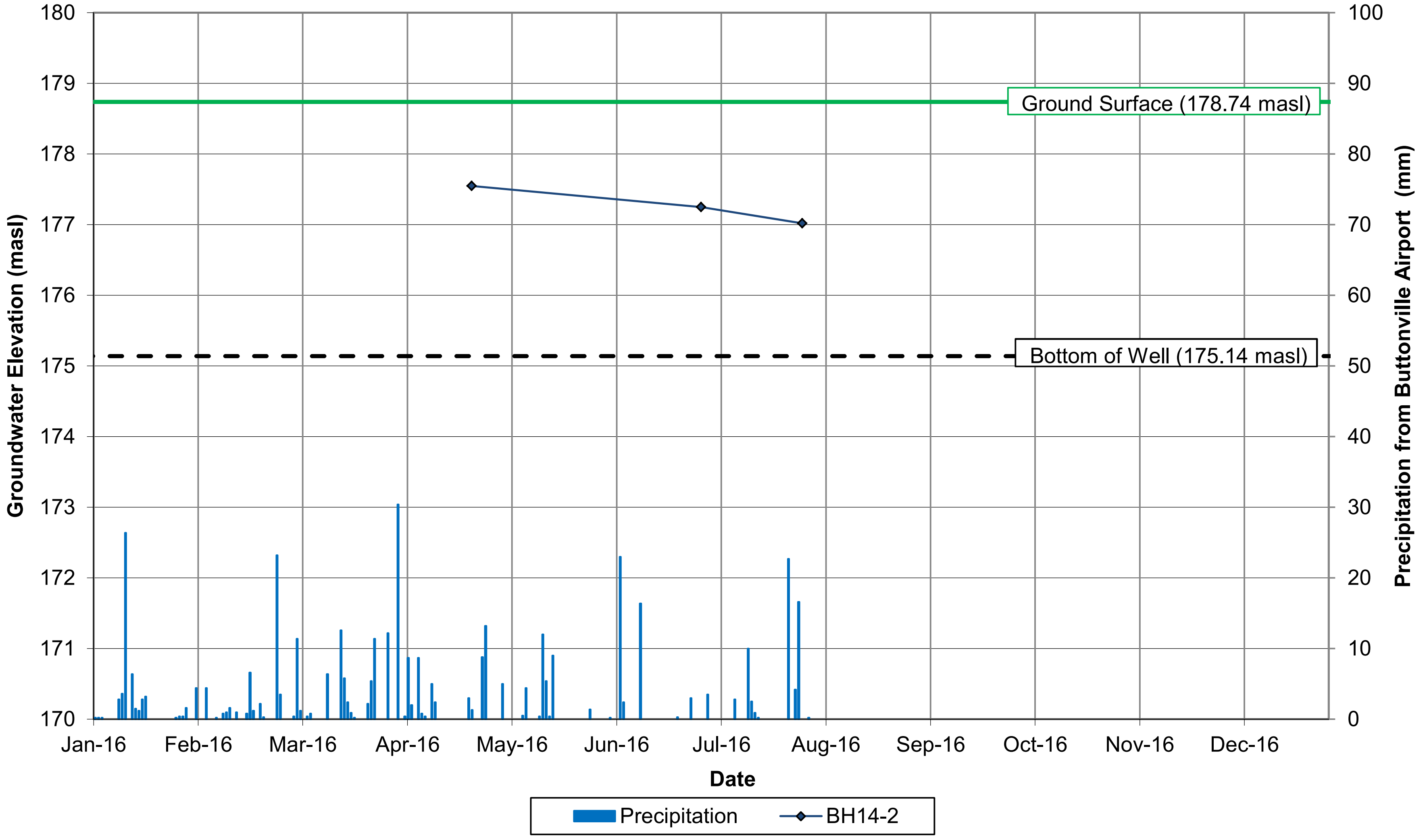
Figure E-14



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-15

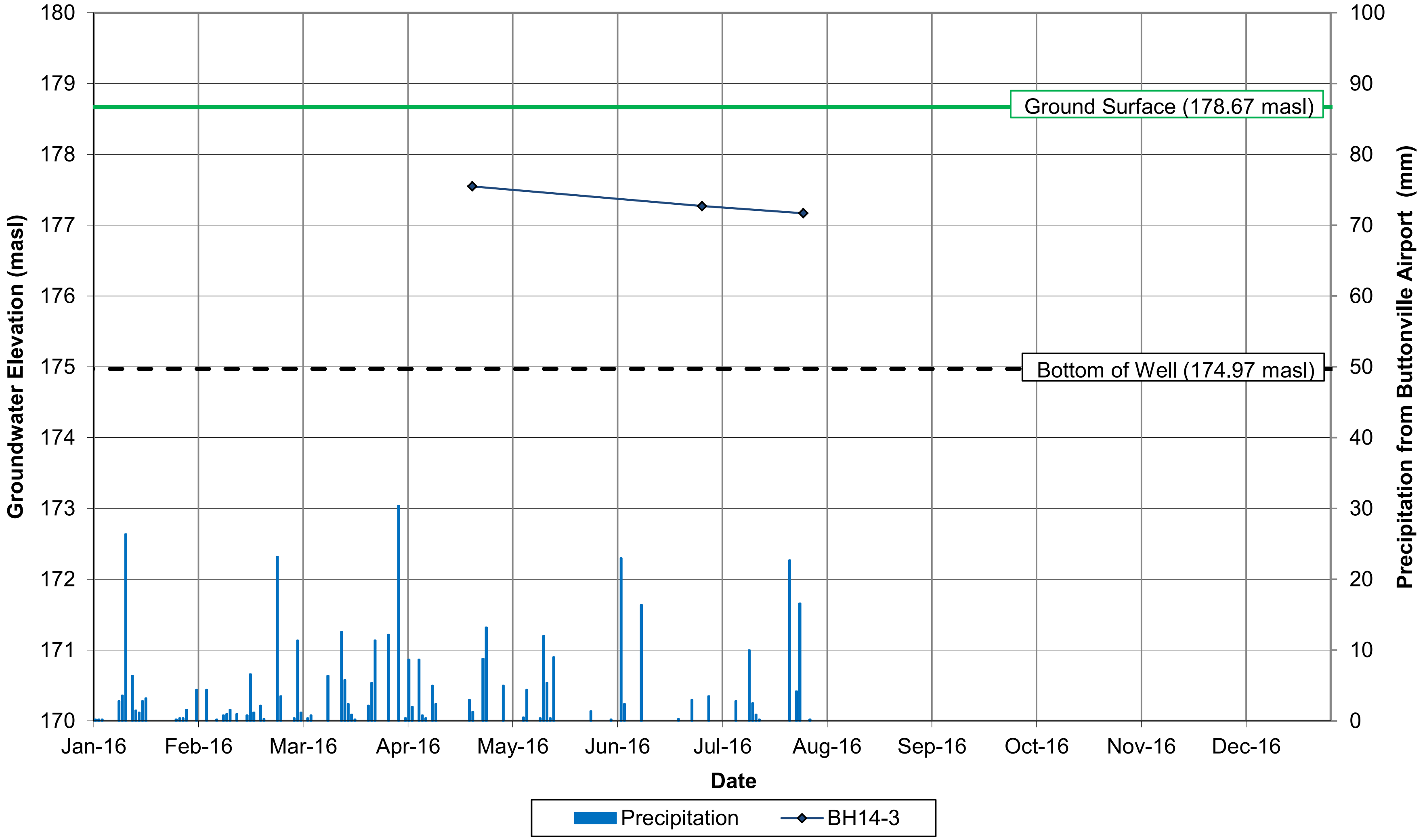
Groundwater Elevations
BH14-2



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-16

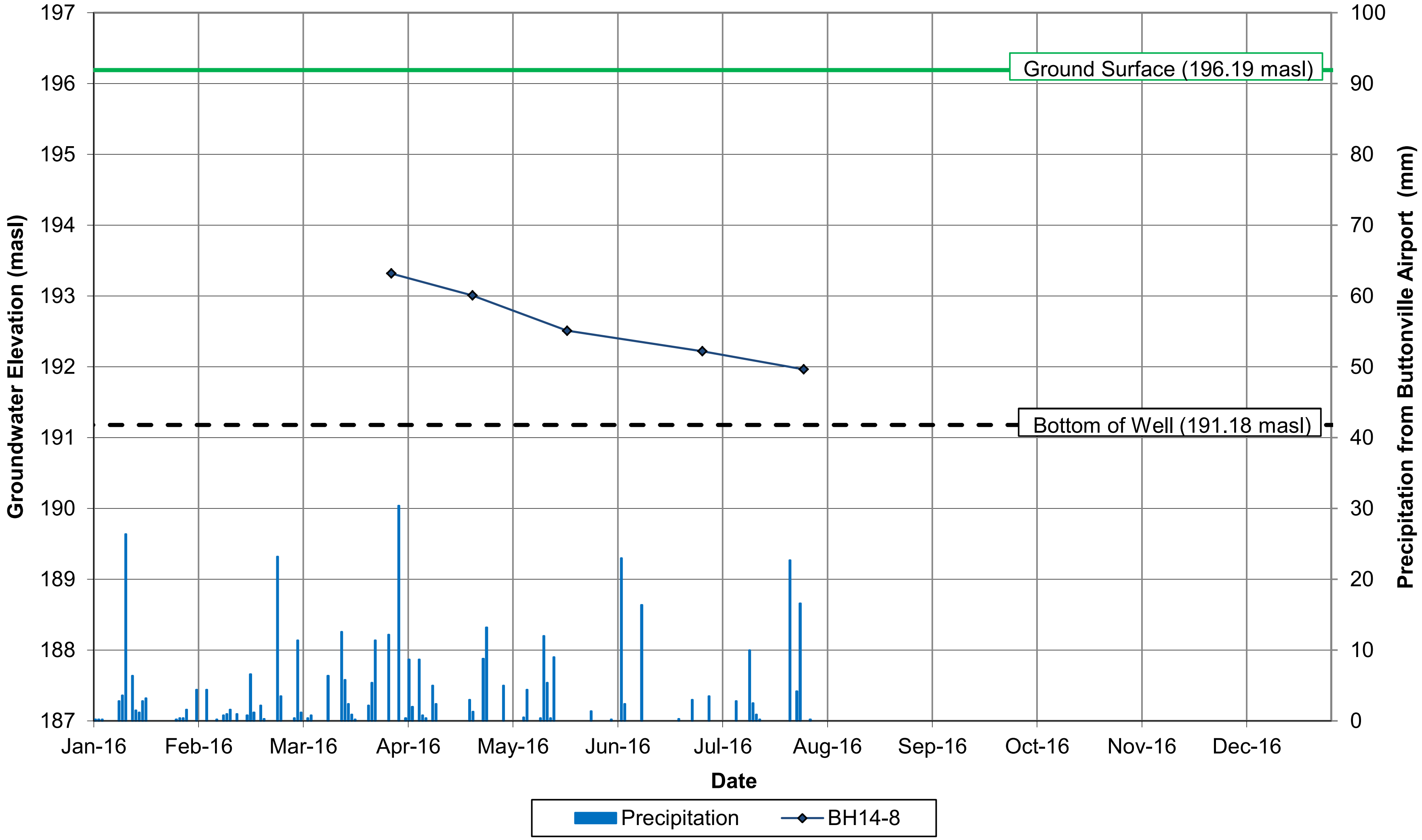
Groundwater Elevations
BH14-3



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-17

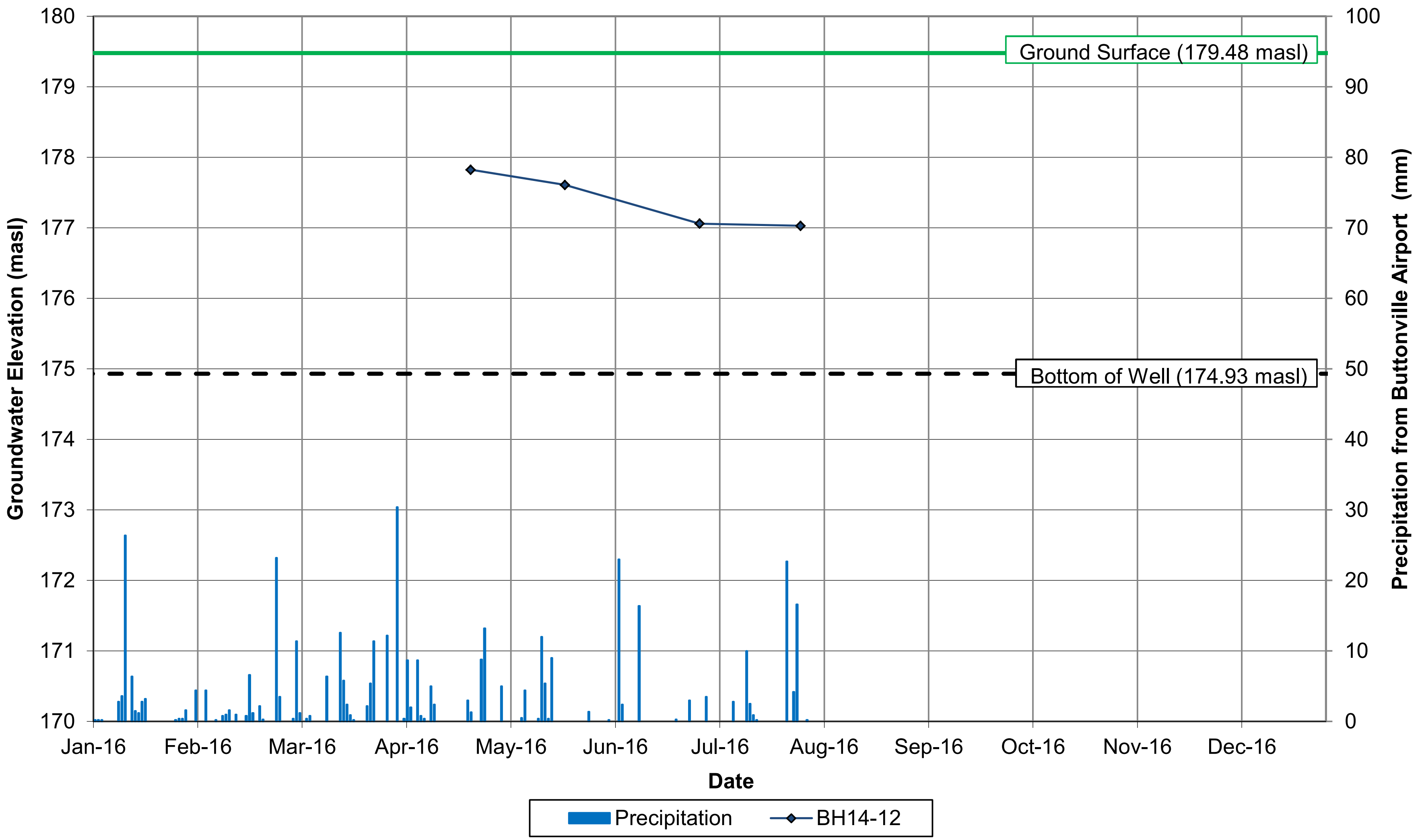
Groundwater Elevations
BH14-8



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-18

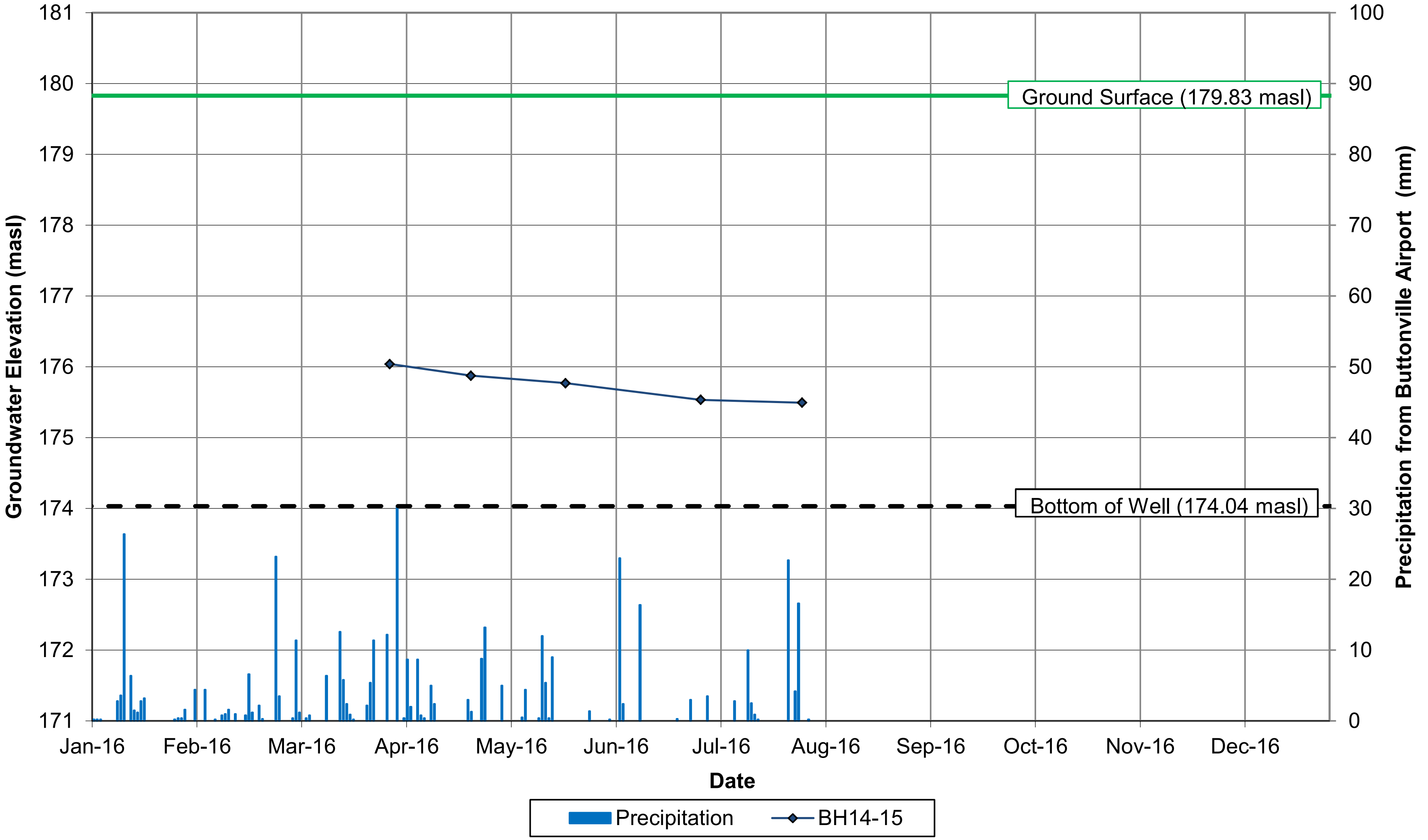
Groundwater Elevations
BH14-12



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-19

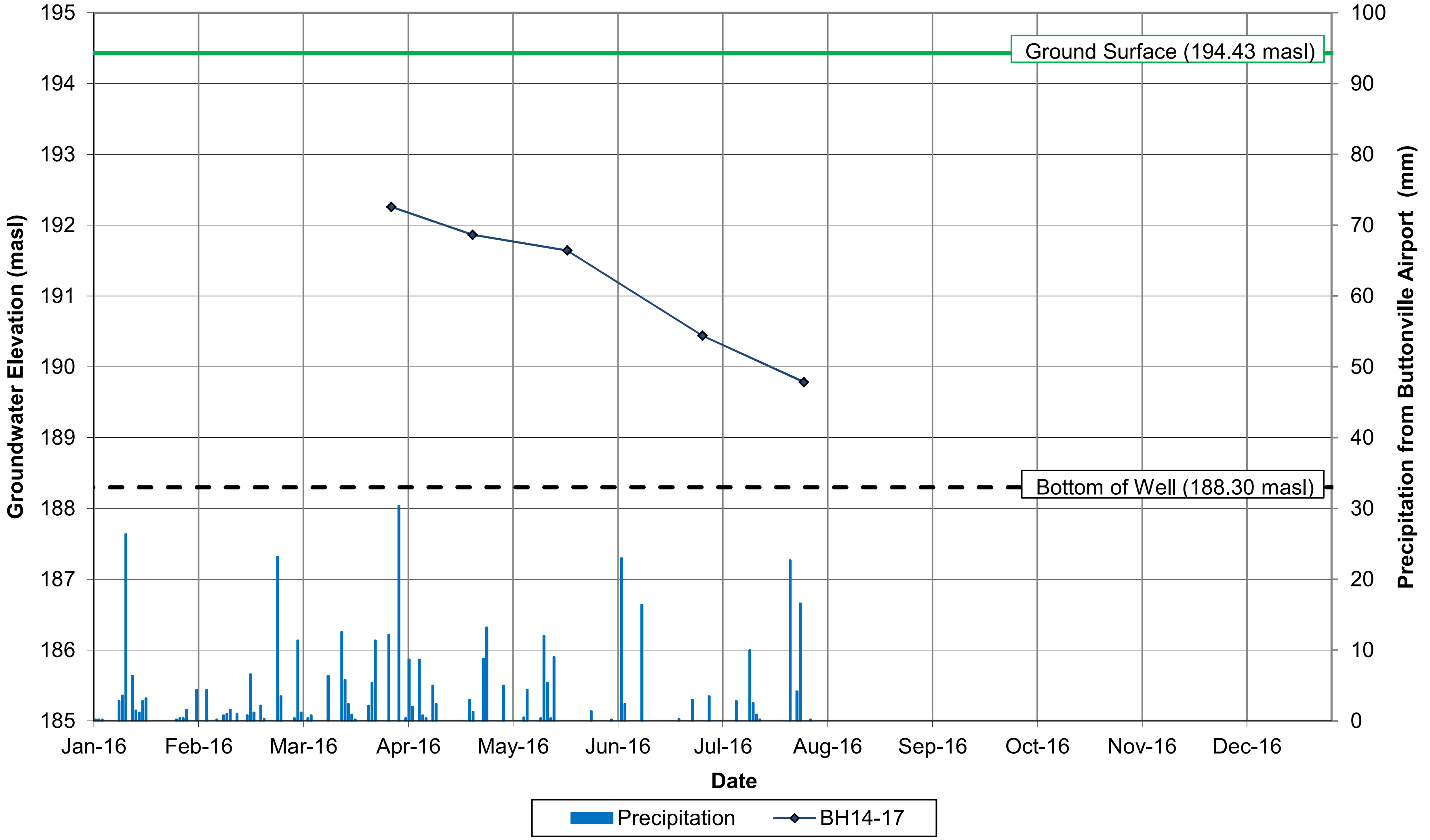
Groundwater Elevations
BH14-15



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-20

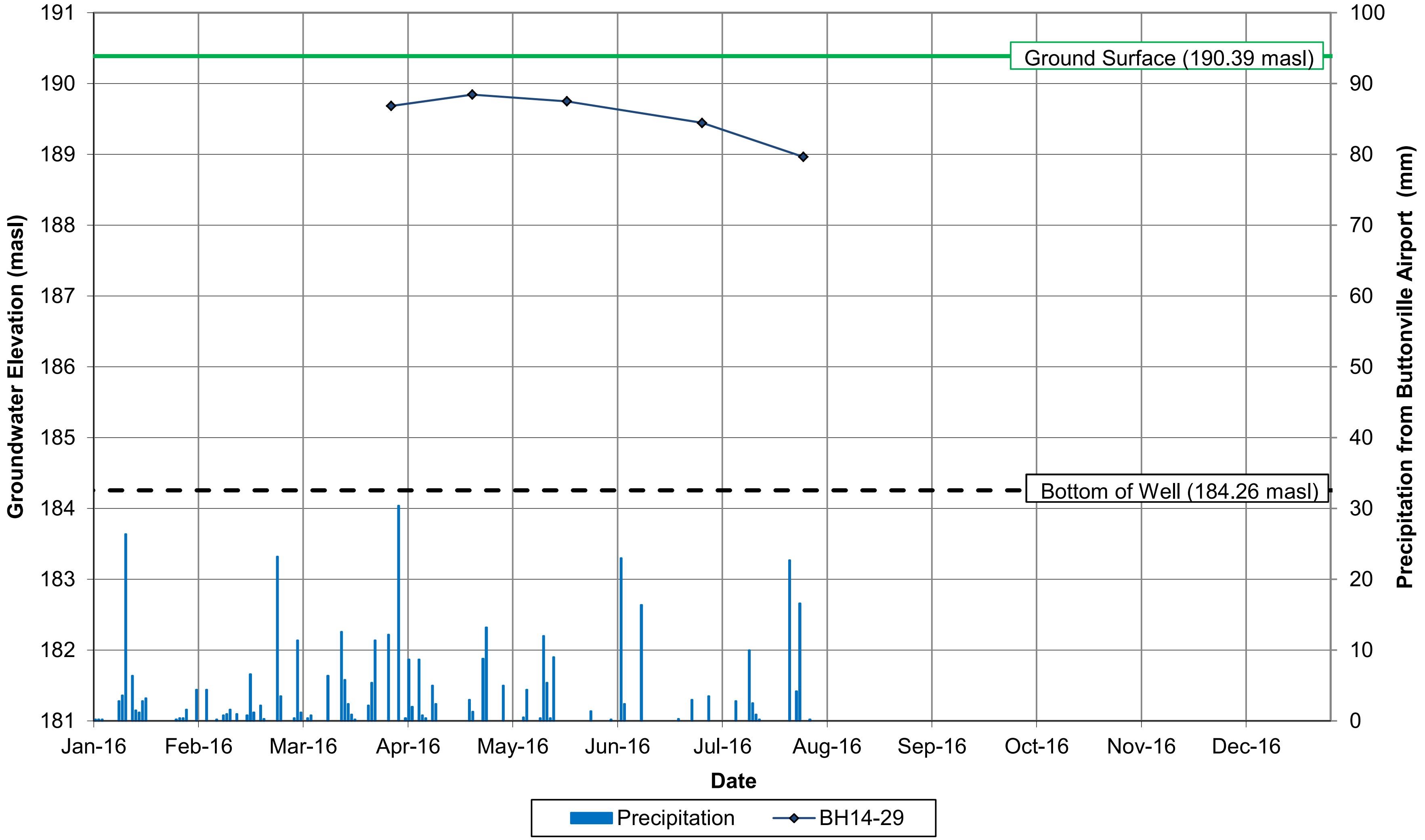
Groundwater Elevations
BH14-17



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-21

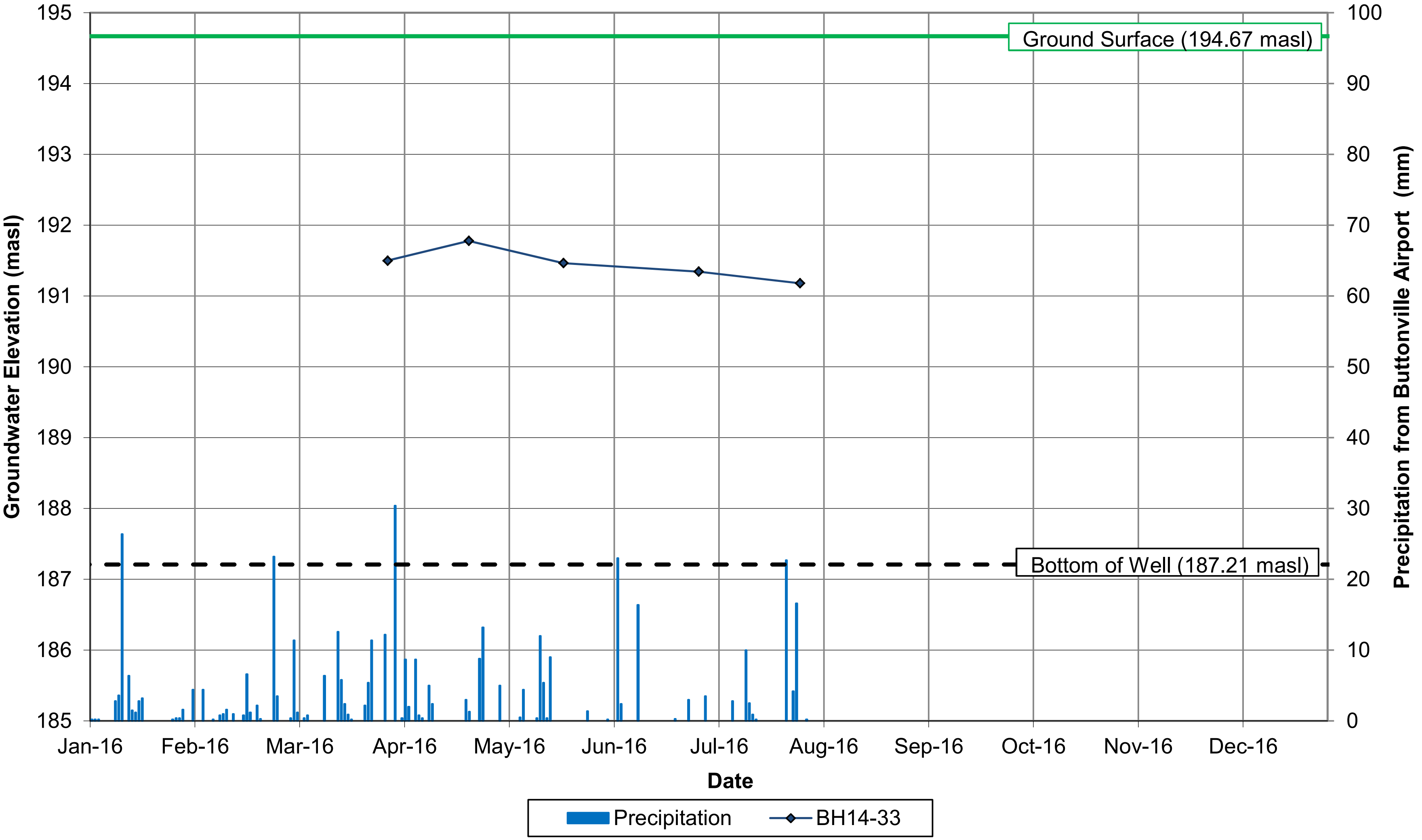
Groundwater Elevations
BH14-29



R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

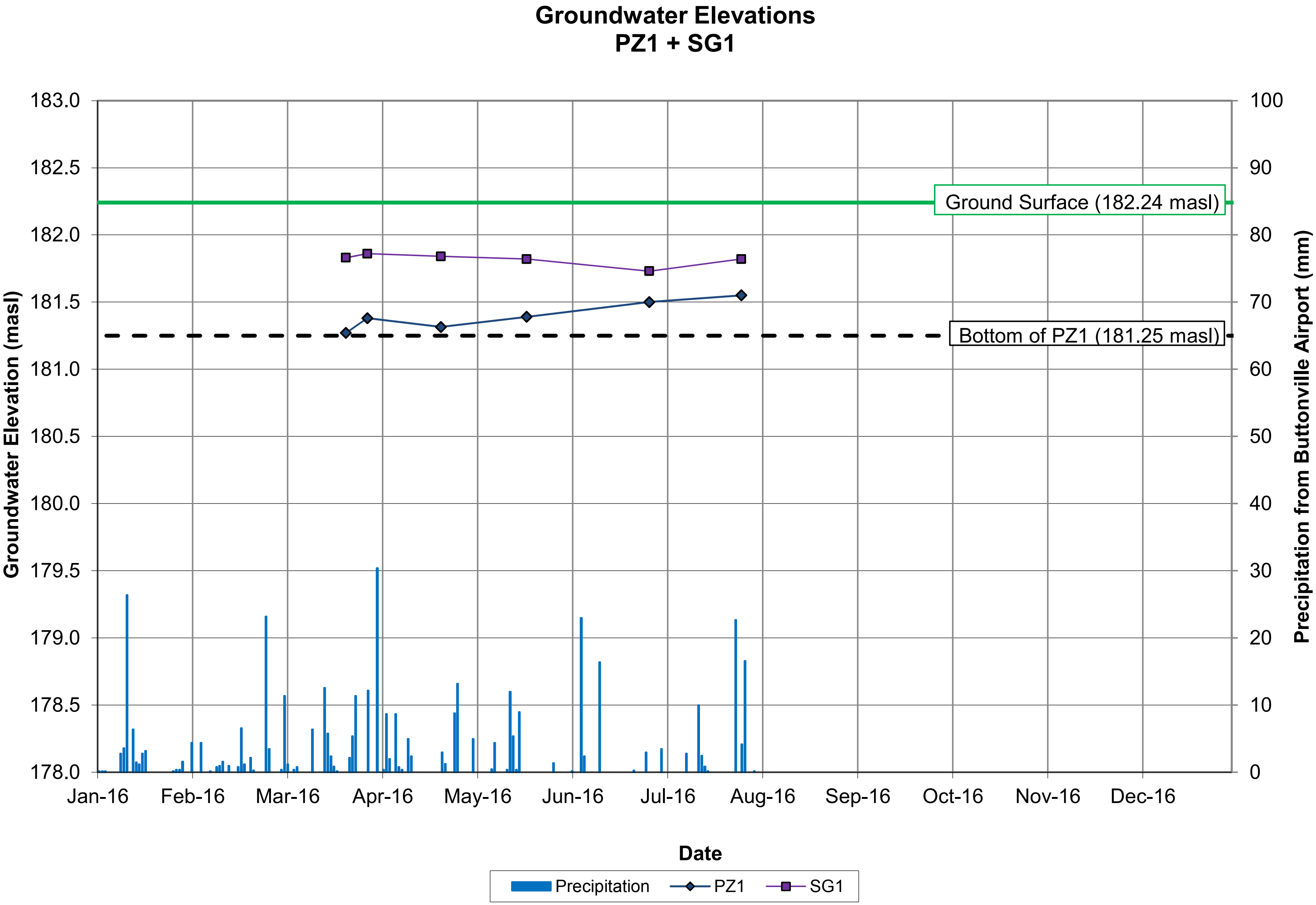
Figure E-22

Groundwater Elevations
BH14-33



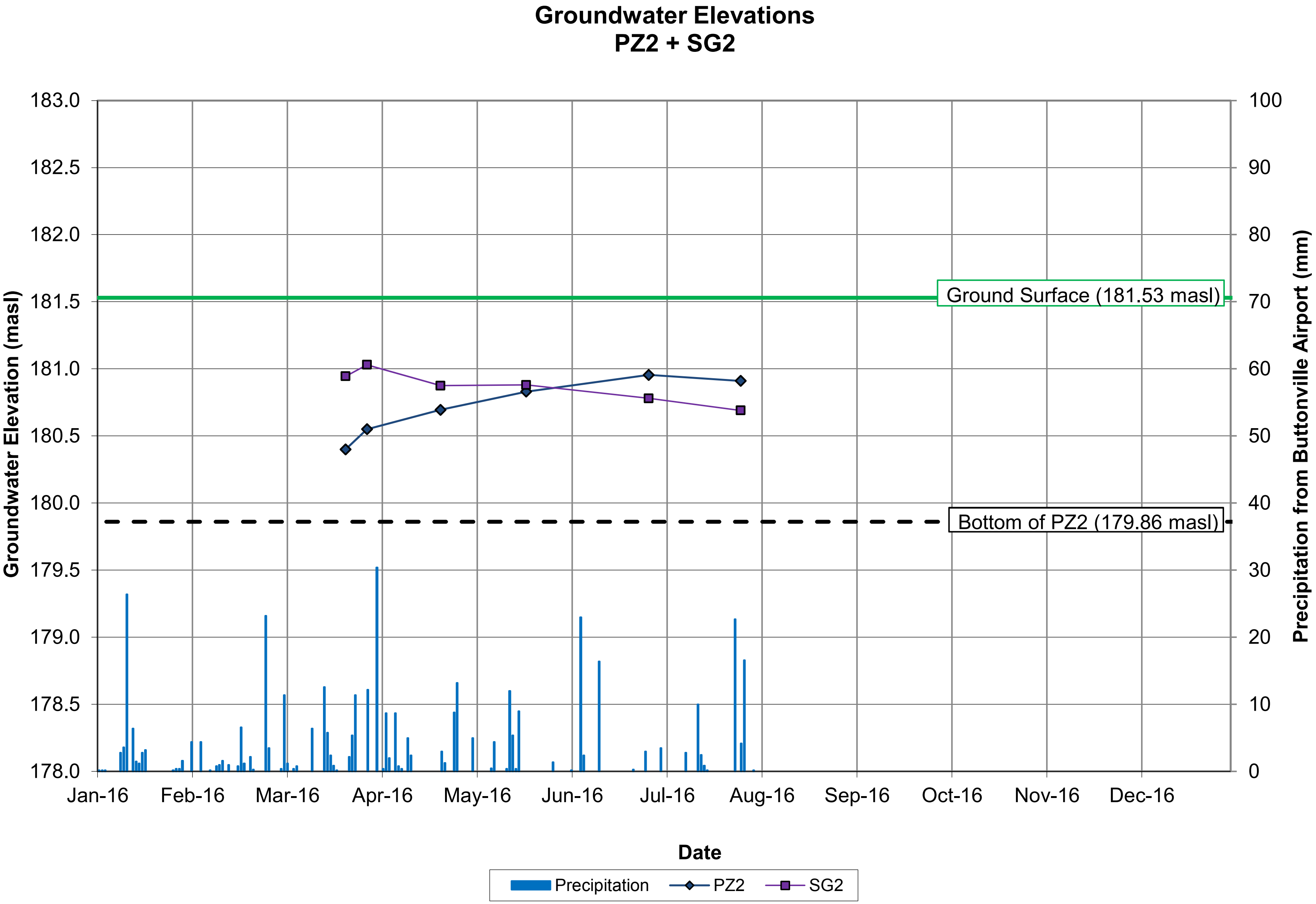
R.J. Burnside & Associates Limited
File: 038247_York Downs GW Monitoring Data.xlsx
Date: 8/22/2016
Prepared By: JJM

Figure E-23



R.J. Burnside & Associates Limited
File: 038247_York Downs PZ and SG Monitoring Data.xlsx
Date: 8/29/2016
Prepared By: JJM

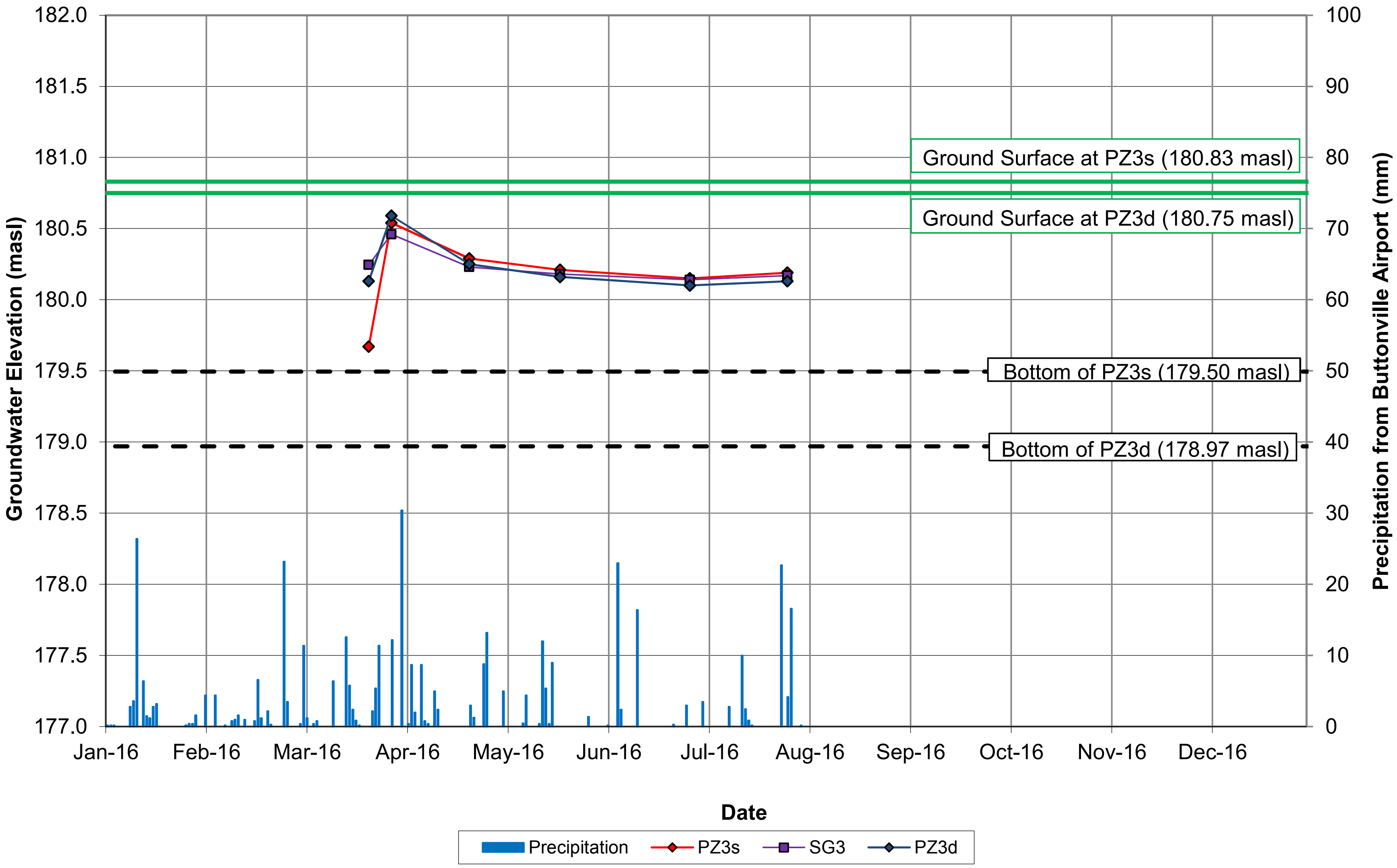
Figure E-24



R.J. Burnside & Associates Limited
File: 038247_York Downs PZ and SG Monitoring Data.xlsx
Date: 8/29/2016
Prepared By: JJM

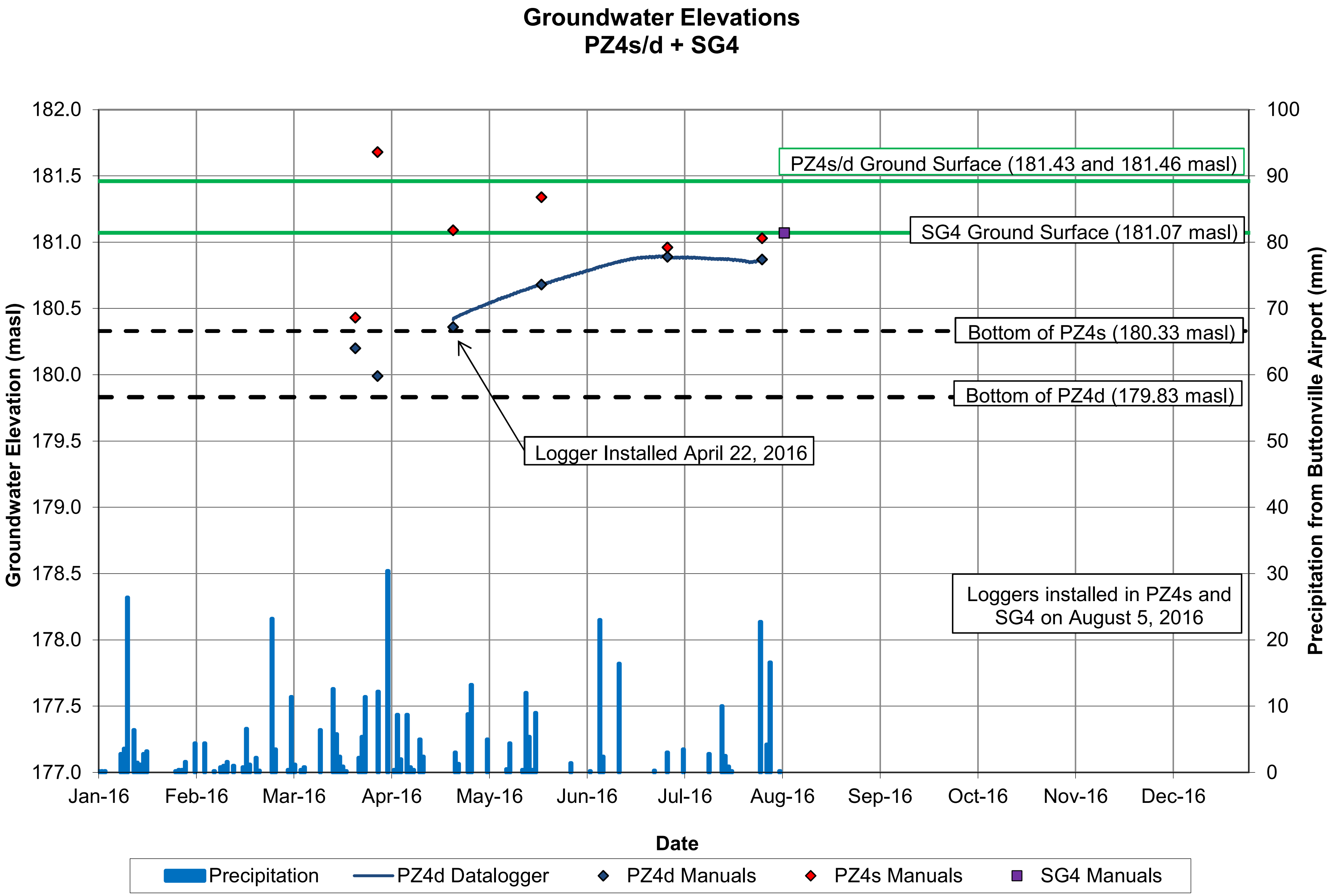
Figure E-25

Groundwater Elevations
PZ3s/d + SG3



R.J. Burnside & Associates Limited
File: 038247_York Downs PZ and SG Monitoring Data.xlsx
Date: 8/29/2016
Prepared By: JJM

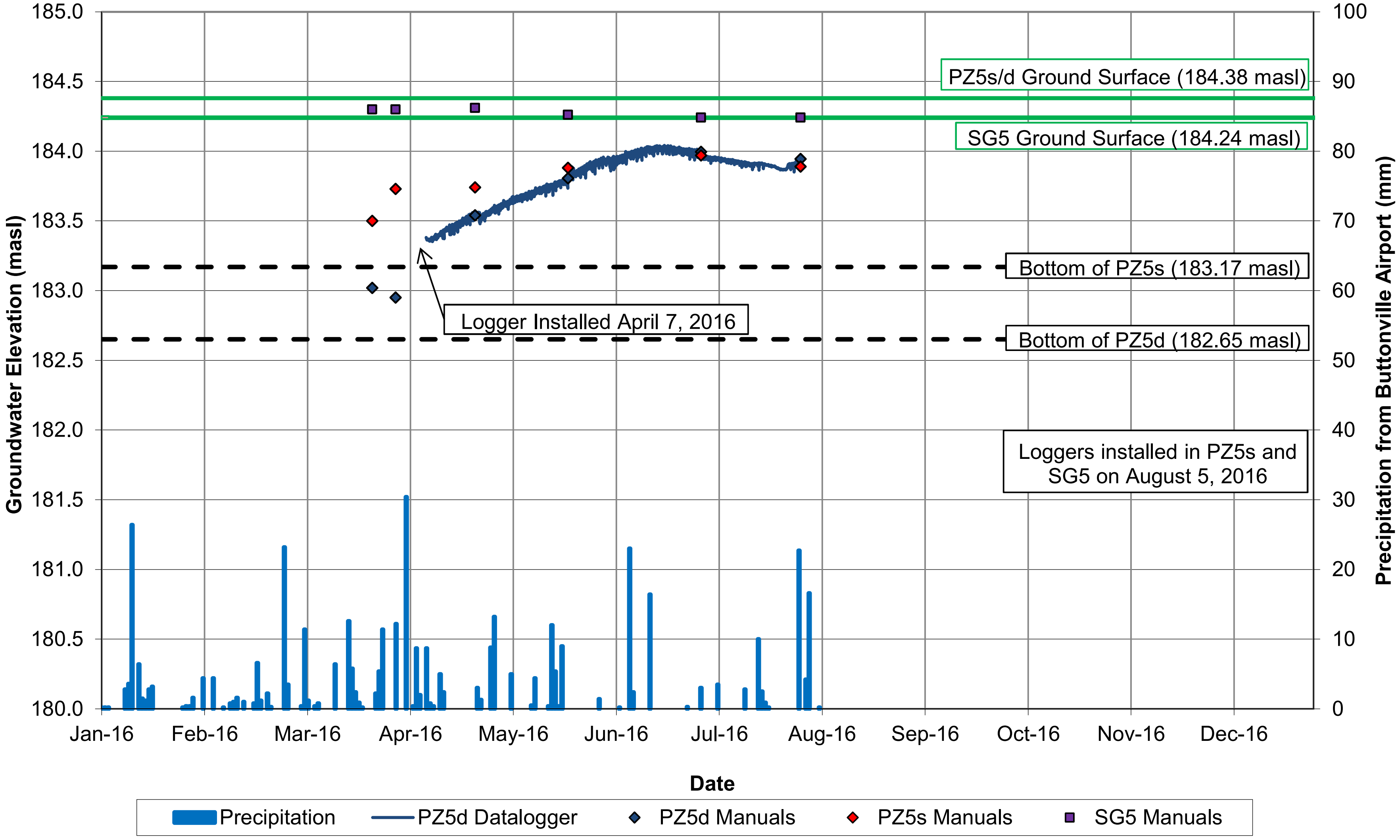
Figure E-26



R.J. Burnside & Associates Limited
File: 038247_PZ4sd Hydrograph.xlsx
Date: 8/29/2016
Prepared By: JJM

Figure E-27

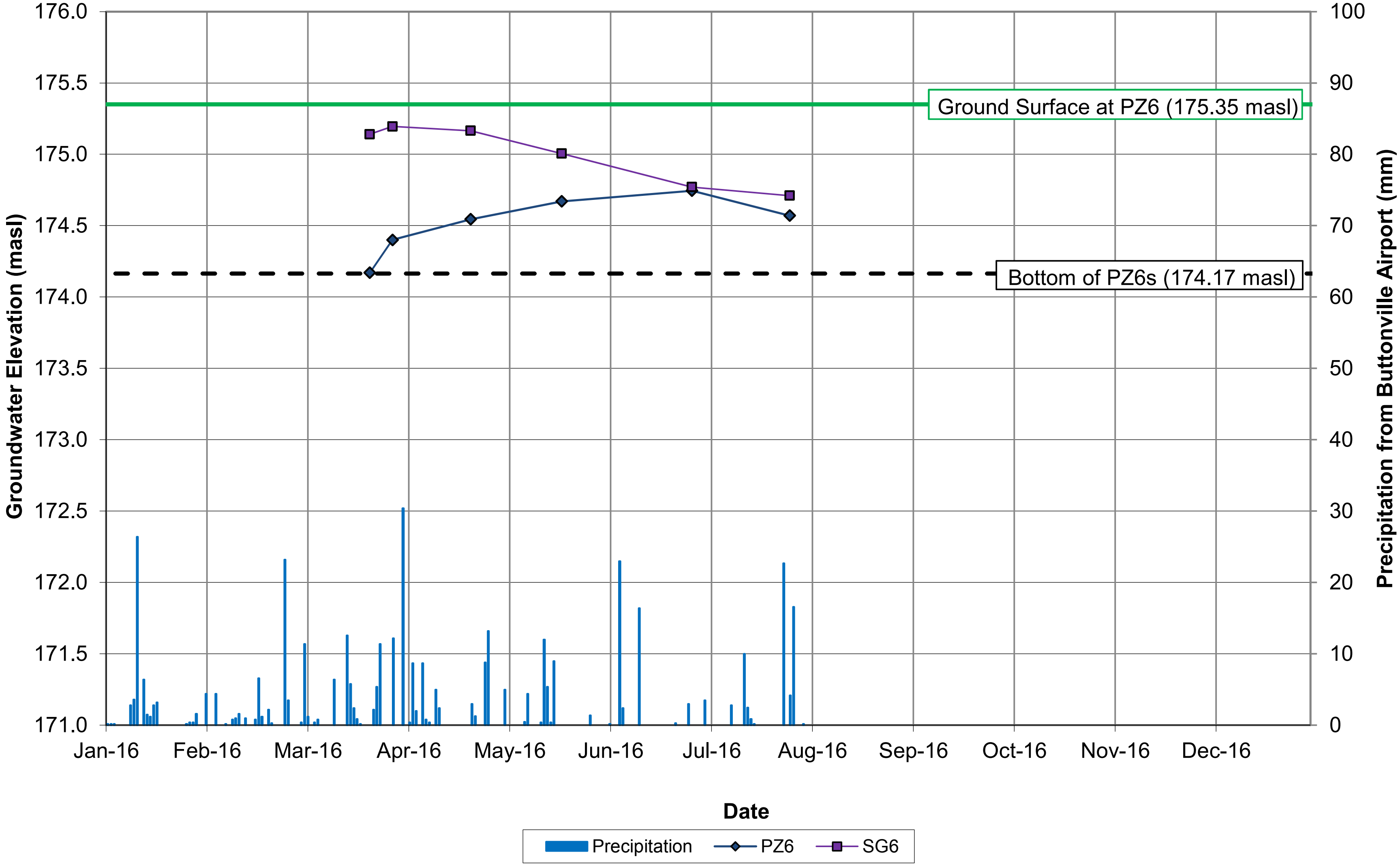
Groundwater Elevations
PZ5s/d + SG5



R.J. Burnside & Associates Limited
File: 038247_PZ5sd Hydrograph.xlsx
Date: 8/29/2016
Prepared By: JJM

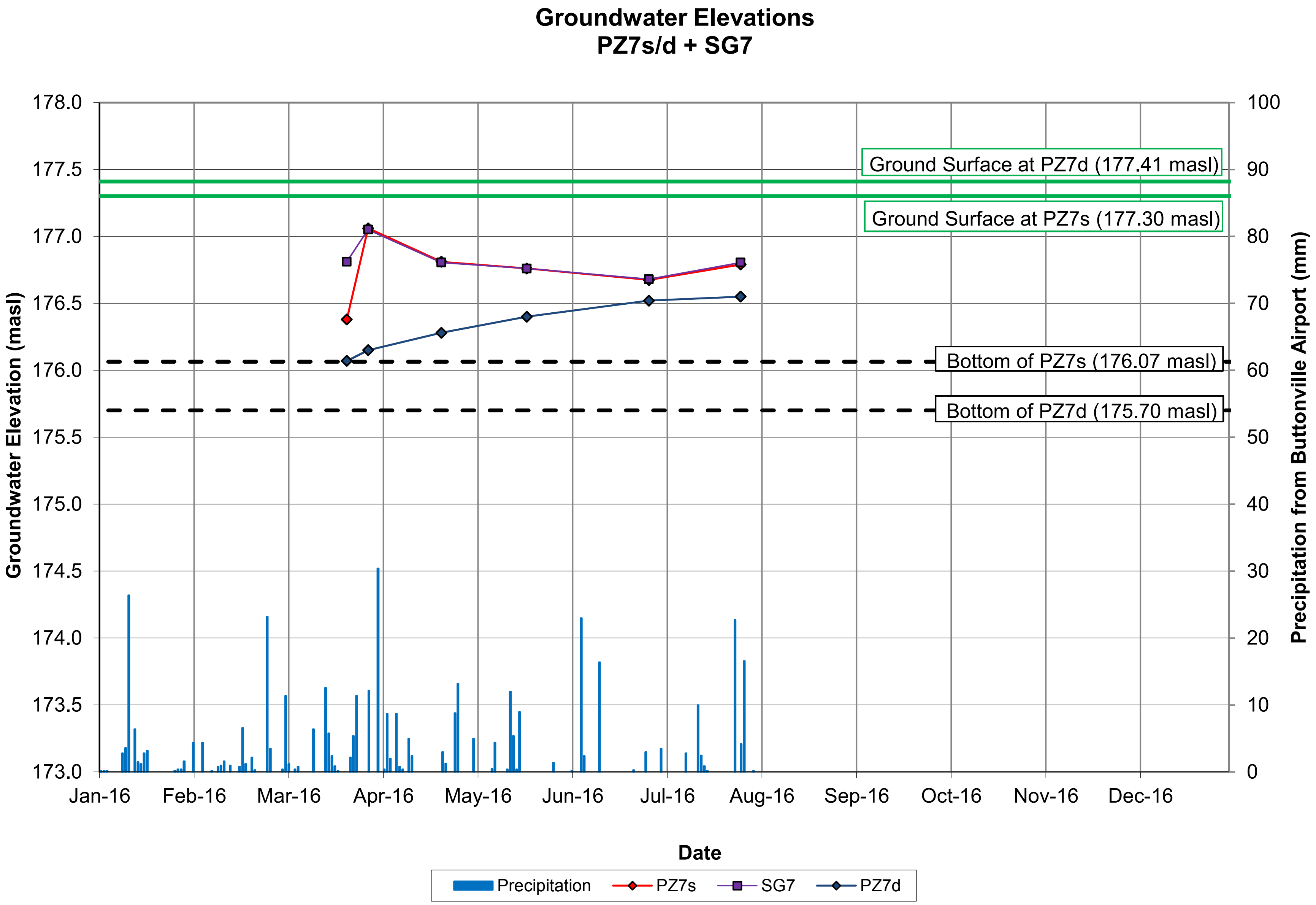
Figure E-28

Groundwater Elevations
PZ6 + SG6



R.J. Burnside & Associates Limited
File: 038247_York Downs PZ and SG Monitoring Data.xlsx
Date: 8/29/2016
Prepared By: JJM

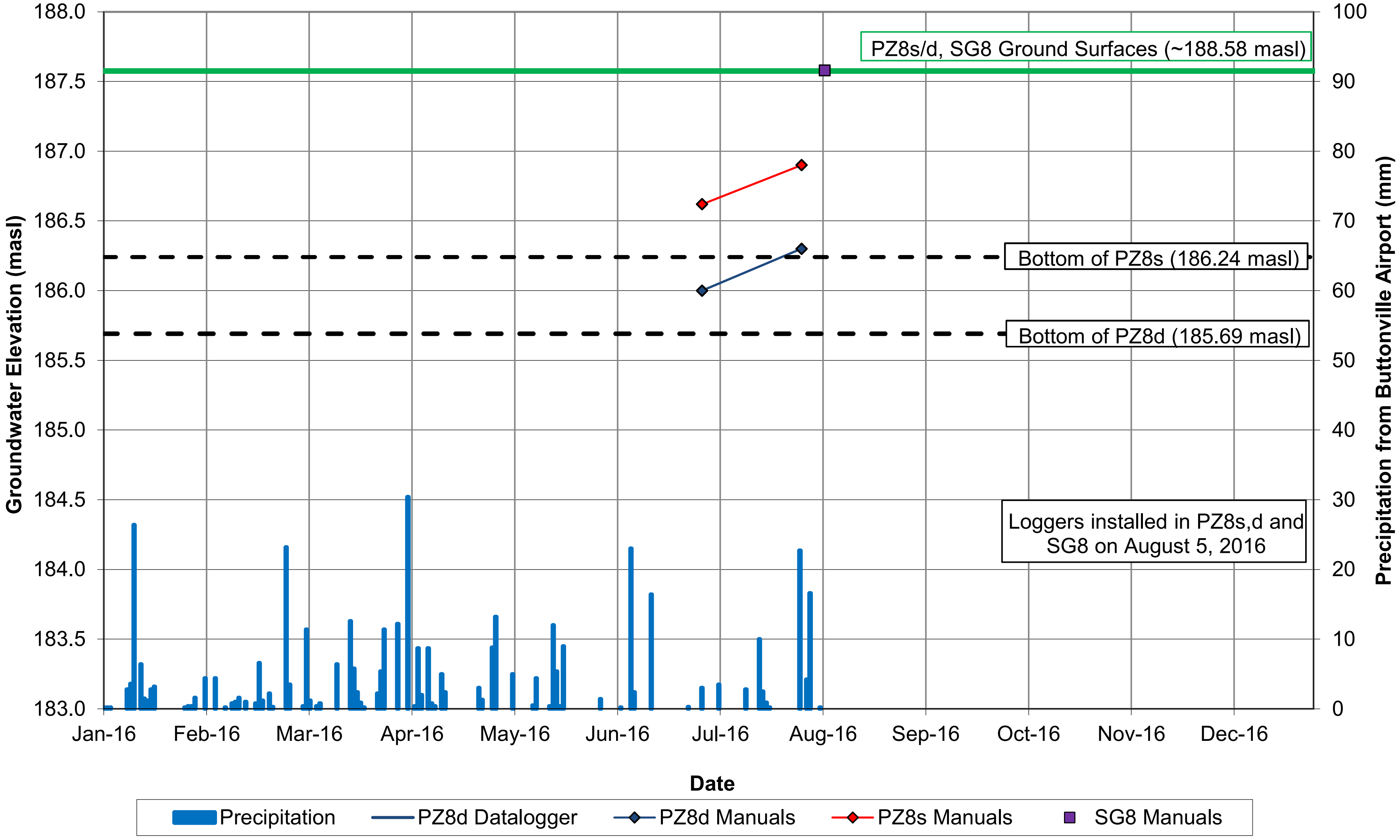
Figure E-29



R.J. Burnside & Associates Limited
File: 038247_York Downs PZ and SG Monitoring Data.xlsx
Date: 8/29/2016
Prepared By: JJM

Figure E-30

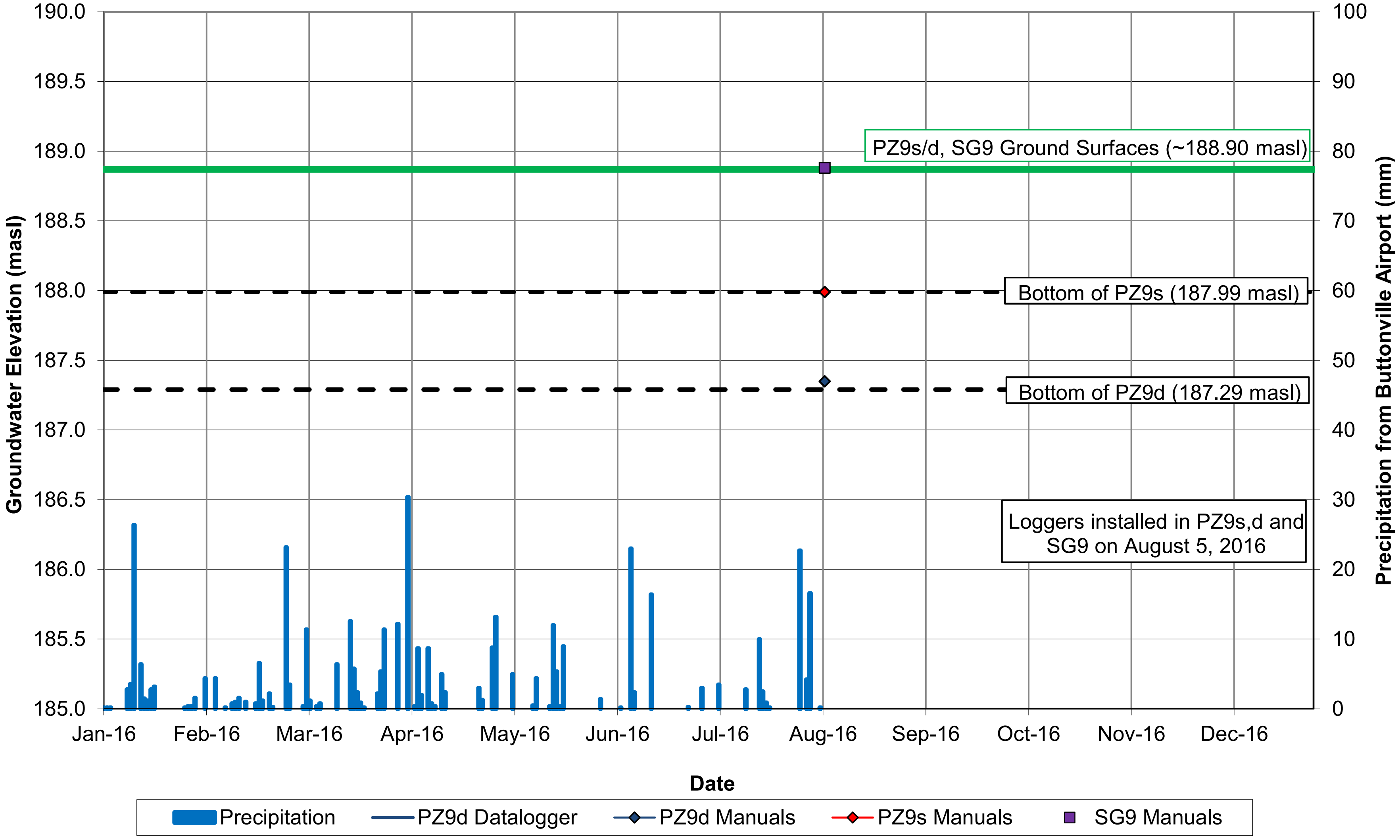
Groundwater Elevations
PZ8s/d + SG8



R.J. Burnside & Associates Limited
File: 038247_PZ8sd Hydrograph.xlsx
Date: 8/29/2016
Prepared By: JJM

Figure E-31

Groundwater Elevations
PZ9s/d + SG9



R.J. Burnside & Associates Limited
File: 038247_PZ9sd Hydrograph.xlsx
Date: 8/29/2016
Prepared By: JJM

Figure E-32

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix F

Surface Water Data

Appendix F

Table F-1:
Surface Water Elevations

Staff Gauge Number:	**SG1**	**SG2**	**SG3**	**SG4**	**SG5**	**SG6**
Ground Elev. (masl):	**181.42**	**180.55**	**180.00**	**181.07**	**184.24**	**174.71**
Date	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**
23-Mar-16	181.83	180.95	180.25		184.30	175.14
29-Mar-16	181.86	181.03	180.46		184.30	175.20
22-Apr-16	181.84	180.88	180.23	Installed Aug 5, 2016	184.31	175.17
20-May-16	181.82	180.88	180.18		184.26	175.01
29-Jun-16	181.73	180.78	180.14		dry	174.77
29-Jul-16	181.82	180.69	180.17		dry	dry
5-Aug-16	-	-	-	dry	-	-

Cont…

Staff Gauge Number:	**SG7**	**SG8**	**SG9**	**SG C-1**	**SG C-2**
Ground Elev. (masl):	**176.51**	**187.58**	**188.88**	**180.39**	**179.52**
Date	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**	**Water Level Elev. (masl)**
23-Mar-16	176.81				
29-Mar-16	177.05				
22-Apr-16	176.81	Installed Aug 5, 2016	Installed Aug 5, 2016	Installed Aug 5, 2016	Installed Aug 5, 2016
20-May-16	176.76				
29-Jun-16	176.68				
29-Jul-16	176.81				
5-Aug-16	-	dry	dry	180.65	179.73

Table F-2
Surface Water Flows

Date	Days Since Precipitiation:	Surface Water Station:				
		SS1	SS2	SS3	SS4	SS5
22-Apr-16	**1**	387	375	437	271	234
20-May-16	**4**	228	238	216	131	C.N.A
29-Jun-16	**3**	89	82	92	43	33
29-Jul-16	**1**	168	132	174	181	111

Flow measurements are in L/s
"C.N.A." denotes Could Not Access

Table F-3:
Surface Water Quality

Surface Water Station	Time	Salinity (ppm)	Dissolved Oxygen (mg/L)	Temperature (^oC)	pH	Conductivity (μS/cm)	TDS (g/L)	TSS (mg/L)
Bruce Creek:								
SS1								
22-Apr-16	10:15 AM	426	N/A	12.9	9.08	927	0.655	8
20-May-16	8:45 AM	401	N/A	12.3	8.86	872	0.617	11
29-Jun-16	9:00 AM	339	N/A	18	8.80	730	0.516	20
29-Jul-16	10:30 AM	330	N/A	22.6	8.58	701	0.500	28
SS2								
22-Apr-16	1:15 PM	397	N/A	16.4	9.12	849	0.605	10
20-May-16	8:30 AM	397	N/A	11.3	8.98	863	0.616	11
29-Jun-16	8:45 AM	338	N/A	17.9	8.87	731	0.519	18
29-Jul-16	8:45 AM	329	N/A	21.1	8.57	705	0.500	19
SS3								
22-Apr-16	2:30 PM	420	N/A	17.9	9.15	900	0.635	11
20-May-16	10:45 AM	424	N/A	14.5	8.91	917	0.648	11
29-Jun-16	11:30 AM	340	N/A	20.3	8.78	727	0.516	18
29-Jul-16	11:45 AM	327	N/A	23.9	8.67	700	0.496	16
Berczy Creek:								
SS4								
22-Apr-16	3:00 PM	668	N/A	17.1	8.95	1409	0.997	10
20-May-16	9:30 AM	684	N/A	14.1	8.74	1445	0.999	10
29-Jun-16	10:30 AM	602	N/A	18.7	8.63	1278	0.903	14
29-Jul-16	11:00 AM	389	N/A	22.8	8.70	827	0.586	18
SS5								
22-Apr-16	3:30 PM	595	N/A	11.1	8.88	1261	0.860	7
20-May-16	-	-	-	-	-	-	-	-
29-Jun-16	1:00 PM	577	N/A	23.1	8.45	1101	0.789	13
29-Jul-16	1:00 PM	398	N/A	21.1	8.79	845	0.603	14

R.J. Burnside & Associates Limited
File: 038247_York Downs SW Monitoring Data.xlsx
Date: 8/26/2016
Prepared By: JJM

Appendix G

Water Quality Data

Table G-1
Groundwater Quality
4134 16th Avenue

Sample Description					**MW16-5**	**MW16-15s**
				Date Sampled	**06-Apr-16**	**06-Apr-16**
Parameter	**Unit**	**ODWS**	**A/O**	**RDL**		
Electrical Conductivity	uS/cm			2	1120	824
pH	pH Units		6.5-8.5	0.05	7.88	8.05
Total Suspended Solids	mg/L			2	355	2580
Total Hardness (as CaCO3)	mg/L		80-100	2	512	491
Total Dissolved Solids	mg/L	500		30	**760**	**697**
Colour	TCU		5	3	7	3
Alkalinity (as CaCO3)	mg/L		30-500	2	342	271
Chloride	mg/L	250		1	150	16
Total Kjeldahl Nitrogen	as N mg/L			0.5	< 0.5	< 0.5
Total Organic Carbon	mg/L			1	1.8	2.1
Dissolved Organic Carbon	mg/L		5	1	1.7	2.3
Nitrate as N	mg/L	10		0.06	0.22	< 0.06
Nitrite as N	mg/L	1		0.03	< 0.03	< 0.03
Ammonia+Ammonium (N)	mg/L			0.1	< 0.1	0.2
Sulphate	mg/L	500		1	72	210
Calcium (dissolved)	mg/L			0.01	176	160
Magnesium (dissolved)	mg/L			0.001	17.8	22
Sodium (dissolved)	mg/L	20	200	0.01	**68.8**	9.57
Potassium (dissolved)	mg/L			0.003	1.66	1.1
Aluminum (dissolved)	µg/L		100	1	< 1	< 1
Antimony (dissolved)	µg/L	6		0.2	< 0.2	< 0.2
Arsenic (dissolved)	µg/L	25		0.2	0.2	0.9
Barium (dissolved)	µg/L	1000		0.02	81.3	69.0
Beryllium (dissolved)	µg/L			0.007	< 0.007	< 0.007
Bismuth (dissolved)	µg/L			0.007	< 0.007	< 0.007
Boron (dissolved)	µg/L	5000		2	29	11
Cadmium (dissolved)	µg/L	5		0.003	0.009	0.008
Chromium (dissolved)	µg/L	50		0.03	0.35	0.22
Cobalt (dissolved)	µg/L			0.004	1.7	0.11
Copper (dissolved)	µg/L		1000	0.02	0.33	0.08
Iron (dissolved)	µg/L		300	7	42	1220
Lead (dissolved)	µg/L	10		0.01	< 0.01	0.02
Lithium (dissolved)	µg/L			0.006	3.4	4.32
Manganese (dissolved)	µg/L		50	0.01	486.00	70.10
Mercury (dissolved)	µg/L	0.001		0.01	< 0.01	< 0.01
Molybdenum (dissolved)	µg/L			0.01	0.8	0.6
Nickel (dissolved)	µg/L			0.1	4.8	0.4
Phosphorus (dissolved)	µg/L			3	< 3	10
Selenium (dissolved)	µg/L	10		0.04	0.04	< 0.04
Silicon (dissolved)	µg/L			20	6590	10700
Silver (dissolved)	µg/L			0.002	< 0.002	< 0.002
Strontium (dissolved)	µg/L			0.02	421	288
Thallium (dissolved)	µg/L			0.005	0.03	< 0.005
Tin (dissolved)	µg/L			0.01	0.04	0.06
Titanium (dissolved)	µg/L			0.05	< 0.05	< 0.05
Uranium (dissolved)	µg/L	20		0.002	2.02	0.063
Vanadium (dissolved)	µg/L			0.01	0.09	0.1
Zinc (dissolved)	µg/L		5000	2	2	3
Anion Sum	meq/L			NA	12.6	10.2
Cation Sum	meq/L			NA	13.3	10.2
% Difference/ Ion Balance	%			NA	2.80	0.01

RDL - Reported Detection Limit
ODWS - Ontario Drinking Water Standard Maximum Acceptable Concentration
Chemical/Physical Objectives [A/O] - Not Health Related
NA - Not Applicable
Bold results indicate exceedances in ODWS criteria
Shaded results indicate exceedances in aesthetic objectives (A/O)

Table G-2
Surface Water Quality
4134 16th Avenue

Sample Description				**Berczy (SG7)**	**Bruce (SS1)**
			Date Sampled	**06-Apr-16**	**06-Apr-16**
Parameter	**Unit**	**PWQO**	**RDL**		
Electrical Conductivity	uS/cm		2	858	1680
pH	pH Units	6.5-8.5	0.05	8.15	8.23
Total Hardness (as CaCO3)	mg/L as CaCO3		2	324	346
Total Suspended Solids	mg/L		2	3	2
Total Dissolved Solids	mg/L		30	500	946
Alkalinity (as CaCO3)	mg/L		2	238	218
Chloride	mg/L		1	120	380
Nitrate as N	as N mg/L		0.06	1.70	1.99
Nitrite as N	as N mg/L		0.03	< 0.03	< 0.03
Ammonia+Ammonium (N)	as N mg/L		0.1	< 0.1	< 0.1
Sulphate	mg/L		1	35	48
Total Phosphorus	µg/L		3	32	16
Calcium	mg/L		0.01	108	115
Magnesium	mg/L		0.001	13.3	14.1
Sodium	mg/L		0.01	69.6	241
Potassium	mg/L		0.003	2.71	2.81
Aluminum (total)	µg/L		1	116	71
Aluminum-dissolved	µg/L	75	1	1.0	2
Antimony	µg/L	20	0.2	< 0.2	0.2
Arsenic	µg/L	5	0.2	0.3	0.3
Barium	µg/L		0.02	64.3	54.8
Beryllium	µg/L	1100	0.007	0.019	< 0.007
Boron	µg/L	200	2	18	23
Cadmium	µg/L	0.5	0.003	0.006	0.008
Chromium	µg/L		0.03	0.54	0.67
Cobalt	µg/L	0.9	0.004	0.123	0.146
Copper	µg/L	5	0.02	0.8	1.55
Iron	µg/L	300	7	260	148
Lead	µg/L	5	0.01	0.12	0.16
Manganese	µg/L		0.01	28.4	29.8
Dissolved Mercury	µg/L	0.2	0.01	0.00003	< 0.00001
Molybdenum	µg/L	40	0.01	0.5	0.66
Nickel	µg/L	25	0.1	0.6	0.8
Selenium	µg/L	100	0.04	0.14	0.14
Silicon	µg/L		20	4510	3530
Silver	µg/L	0.1	0.002	< 0.002	0.004
Strontium	µg/L		0.02	266	384
Thallium	µg/L	0.3	0.005	0.019	< 0.005
Tin	µg/L		0.01	0.19	0.19
Titanium	µg/L		0.05	4.07	2.9
Uranium	µg/L	5	0.002	0.793	0.824
Vanadium	µg/L	6	0.01	0.49	0.46
Zinc	µg/L	20	2	< 2	4
Cation Sum	meq/L			9.58	17.40
Anion Sum	meq/L			8.87	16.10
% Difference Cation/Anion	% difference			3.84	4.10

RDL - Reported Detection Limit
PWQO - Provincial Water Quality Objective
NA - Not Applicable
NR - Non Reportable
Bold results indicate exceedances in criteria

Table G-3
Surface Water Field Chemistry

Surface Water Station	Time	Salinity (ppm)	Temperature (°C)	pH	Conductivity (µS/cm)	TDS (g/L)	TSS (mg/L)
SS1							
22-Apr-16	10:15 AM	426	12.9	9.08	927	0.655	8
20-May-16	8:45 AM	401	12.3	8.86	872	0.617	11
29-Jun-16	9:00 AM	339	18	8.8	730	0.516	20
29-Jul-16	10:30 AM	330	22.6	8.58	701	0.5	28
SS2							
22-Apr-16	1:30 PM	397	16.4	9.12	849	0.605	10
20-May-16	8:30 AM	397	11.3	8.98	863	0.616	11
29-Jun-16	8:45 AM	338	17.9	8.87	731	0.519	18
29-Jul-16	8:45 AM	329	21.1	8.57	705	0.5	19
SS3							
22-Apr-16	2:30 PM	420	17.9	9.15	900	0.635	11
20-May-16	10:45 AM	424	14.5	8.91	917	0.648	11
29-Jun-16	11:30 AM	340	20.3	8.78	727	0.516	18
29-Jul-16							
SS4							
22-Apr-16	3:30 PM	668	17.1	8.95	1409	0.997	10
20-May-16	9:30 AM	684	14.1	8.74	1445	0.999	10
29-Jun-16	10:30 AM	602	18.7	8.63	1278	0.903	14
29-Jul-16	11:15 AM	389	22.8	8.7	827	0.586	18

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix H

Water Balance Calculations

WATER BALANCE CALCULATIONS
4134 16th Avenue, Markham

PROJECT No.300038247

TABLE H-1

Pre- and Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 125 mm (urban lawns in silt soils)

Precipitation data from Toronto Buttonville Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Average Temperature (Degree C)	-5.80	-5.60	-0.40	6.70	13.00	18.60	21.20	20.20	15.70	8.90	3.10	-2.90	**7.7**	<--From Environment Canada
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.56	4.25	7.31	8.91	8.28	5.65	2.39	0.48	0.00	**38.8**	
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	29.28	61.03	90.77	104.93	99.46	75.23	40.11	12.46	0.00	**513**	
Adjusting Factor for U (Latitude 43° 52' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77		<--From J. M. Lorente (1961). pp. 206
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Precipitation (P)	62	51	53	74	80	83	79	76	82	68	80	66	**853**	<--From Environment Canada
Potential Evapotranspiration (PET)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
P - PET	62	51	53	41	3	-33	-56	-43	4	30	70	66	**246**	
Change in Soil Moisture Storage	0	0	0	0	0	-33	-56	-35	4	30	70	22	**0**	
Soil Moisture Storage max 125 mm	125	125	125	125	125	92	35	0	4	33	103	125		
Actual Evapotranspiration (AET)	0	0	0	33	77	116	135	111	78	38	10	0	**599**	
Soil Moisture Deficit max 125 mm	0	0	0	0	0	33	90	125	121	92	22	0		
Water Surplus - available for infiltration or runoff	62	51	53	41	3	0	0	0	0	0	0	44	**254**	
Potential Infiltration (based on MOECC metholodogy*; independent of temperature)	28	23	24	19	1	0	0	0	0	0	0	20	**114**	
Potential Direct Surface Water Runoff (independent of temperature)	34	28	29	23	1	0	0	0	0	0	0	24	**140**	
IMPERVIOUS AREA WATER SURPLUS														
Precipitation (P)	853	mm/year												
15%)	128	mm/year												
P-PE (surplus available for runoff from impervious areas)	725	mm/year												

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	125 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOECC SWM infiltration calculations

topography - hilly land	0.15	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - silt soils	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - lawns	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.45**	

Latitude of site (or climate station) 43 ° N.

TABLE H-2

Pre- and Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 400 mm (mature forest in silt soils)

Precipitation data from Toronto Buttonville Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Average Temperature (Degree C)	-5.80	-5.60	-0.40	6.70	13.00	18.60	21.20	20.20	15.70	8.90	3.10	-2.90	**7.7**	<--From Environment Canada
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.56	4.25	7.31	8.91	8.28	5.65	2.39	0.48	0.00	**38.8**	
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	29.28	61.03	90.77	104.93	99.46	75.23	40.11	12.46	0.00	**513**	
Adjusting Factor for U (Latitude 43° 52' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77		<--From J. M. Lorente (1961). pp. 206
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Precipitation (P)	62	51	53	74	80	83	79	76	82	68	80	66	**853**	<--From Environment Canada
Potential Evapotranspiration (PET)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
P - PET	62	51	53	41	3	-33	-56	-43	4	30	70	66	**246**	
Change in Soil Moisture Storage	0	0	0	0	0	-33	-56	-43	4	30	70	30	**0**	
Soil Moisture Storage max 400 mm	400	400	400	400	400	367	310	267	271	301	370	400		
Actual Evapotranspiration (AET)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
Soil Moisture Deficit max 400 mm	0	0	0	0	0	33	90	133	129	99	30	0		
Water Surplus - available for infiltration or runoff	62	51	53	41	3	0	0	0	0	0	0	36	**246**	
Potential Infiltration (based on MOECC metholodogy*; independent of temperature)	34	28	29	23	1	0	0	0	0	0	0	20	**135**	
Potential Direct Surface Water Runoff (independent of temperature)	28	23	24	19	1	0	0	0	0	0	0	16	**111**	
IMPERVIOUS AREA WATER SURPLUS														
Precipitation (P)	853	mm/year												
15%)	128	mm/year												
P-PE (surplus available for runoff from impervious areas)	725	mm/year												

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	400 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOECC SWM infiltration calculations

topography - hilly land	0.15	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - silt soils	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - wooded lands	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.55**	

Latitude of site (or climate station) 43 ° N.

TABLE H-3

Pre- and Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 125 mm (urban lawns in silt soils) with Grading

Precipitation data from Toronto Buttonville Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Average Temperature (Degree C)	-5.80	-5.60	-0.40	6.70	13.00	18.60	21.20	20.20	15.70	8.90	3.10	-2.90	**7.7**	<--From Environment Canada
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.56	4.25	7.31	8.91	8.28	5.65	2.39	0.48	0.00	**38.8**	
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	29.28	61.03	90.77	104.93	99.46	75.23	40.11	12.46	0.00	**513**	
Adjusting Factor for U (Latitude 43° 52' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77		<--From J. M. Lorente (1961). pp. 206
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Precipitation (P)	62	51	53	74	80	83	79	76	82	68	80	66	**853**	<--From Environment Canada
Potential Evapotranspiration (PET)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
P - PET	62	51	53	41	3	-33	-56	-43	4	30	70	66	**246**	
Change in Soil Moisture Storage	0	0	0	0	0	-33	-56	-35	4	30	70	22	**0**	
Soil Moisture Storage max 125 mm	125	125	125	125	125	92	35	0	4	33	103	125		
Actual Evapotranspiration (AET)	0	0	0	33	77	116	135	111	78	38	10	0	**599**	
Soil Moisture Deficit max 125 mm	0	0	0	0	0	33	90	125	121	92	22	0		
Water Surplus - available for infiltration or runoff	62	51	53	41	3	0	0	0	0	0	0	44	**254**	
Potential Infiltration (based on MOECC metholodogy*; independent of temperature)	31	25	27	21	1	0	0	0	0	0	0	22	**127**	
Potential Direct Surface Water Runoff (independent of temperature)	31	25	27	21	1	0	0	0	0	0	0	22	**127**	
IMPERVIOUS AREA WATER SURPLUS														
Precipitation (P)	853	mm/year												
15%)	128	mm/year												
P-PE (surplus available for runoff from impervious areas)	725	mm/year												

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	125 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOECC SWM infiltration calculations

topography - graded land	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - silt soils	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawns	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.5**	

Latitude of site (or climate station) 43 ° N.

WATER BALANCE CALCULATIONS
4134 16th Avenue, Markham

PROJECT No.300038247

TABLE H-4

Water Balance - EAST DRAFT PLAN AREA- Existing Conditions and Post-Development (no mitigation)
4134 16th Avenue, Markham

Catchment Area		Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area*** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area*** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area*** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
East Draft Plan - Existing Land Use													
Grass Area		661,600	0.00	0	0.725	0	661,600	0.140	92,380	0.114	75,583	92,380	75,583
Solid Path		27,000	1.00	27,000	0.725	19,576	0	0.140	0	0.114	0	19,576	0
Building		3,700	1.00	3,700	0.725	2,683	0	0.140	0	0.114	0	2,683	0
Gravel Area		4,300	0.50	2,150	0.725	1,559	2,150	0.140	300	0.114	246	1,859	246
Ponds		21,900	1.00	21,900	0.725	15,879	0	0.140	0	0.114	0	15,879	0
Woodlot Wetland Feature	Wetland	11,100	0.00	0	0.725	0	11,100	0.140	1,550	0.114	1,268	1,550	1,268
	Woodlot	32,100	0.00	0	0.725	0	32,100	0.111	3,553	0.135	4,342	3,553	4,342
TOTAL PRE-DEVELOPMENT		**761,700**		**54,750**		**39,696**	**706,950**		**97,783**		**81,440**	**137,479**	**81,440**
East Draft Plan - Post-Development Land Use													
Residential - Single Detached/Laneway Homes		303,600	0.62	188,232	0.725	136,478	115,368	0.127	14,644	0.127	14,644	151,122	14,644
Residential - Town Homes		66,100	0.77	50,897	0.725	36,903	15,203	0.127	1,930	0.127	1,930	38,833	1,930
Residential - Stacked Towns Block		14,100	0.92	12,972	0.725	9,405	1,128	0.127	143	0.127	143	9,549	143
School		25,100	0.77	19,327	0.725	14,013	5,773	0.127	733	0.127	733	14,746	733
Stormwater Management Pond Blocks		68,600	0.90	61,740	0.725	44,765	6,860	0.127	871	0.127	871	45,635	871
ROW		199,700	0.62	123,952	0.725	89,871	75,748	0.127	9,615	0.127	9,615	99,487	9,615
Parks		39,200	0.00	0	0.725	0	39,200	0.127	4,976	0.127	4,976	4,976	4,976
Open Space		1,300	0.00	0	0.725	0	1,300	0.127	165	0.127	165	165	165
Reserved Block		800	1.00	800	0.725	580	0	0.140	0	0.114	0	580	0
Woodlot Wetland Feature	Wetland	11,100	0.00	0	0.725	0	11,100	0.140	1,550	0.114	1,268	1,550	1,268
	Woodlot	32,100	0.00	0	0.725	0	32,100	0.111	3,553	0.135	4,342	3,553	4,342
TOTAL POST-DEVELOPMENT		**761,700**		**457,920**		**332,015**	**303,780**		**38,180**		**38,688**	**370,195**	**38,688**
											% Change from Pre to Post	269	52
											Effect of development (with no mitigation)	2.7 times increase in runoff	52% reduction in infiltration

* data provided by the mbtw group

** data provided by Stantec

*** figures from Tables H-1 and H-2

To balance pre- to post-,
the infiltration target (m^3/a)= **42,752**

WATER BALANCE CALCULATIONS
4134 16th Avenue, Markham

PROJECT No.300038247

TABLE H-5a

Water Balance - WEST DRAFT PLAN BERCZY CATCHMENT AREA - Existing Conditions and Post-Development (no mitigation)
4134 16th Avenue, Markham

Catchment Area	Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area*** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area*** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area*** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
West Draft Plan Berczy Catchment Area - Existing Land Use												
Grass Area	371,300	0.00	0	0.725	0	371,300	0.140	51,845	0.114	42,419	51,845	42,419
Solid Path	7,500	1.00	7,500	0.725	5,438	0	0.140	0	0.114	0	5,438	0
Gravel Area	800	0.50	400	0.725	290	400	0.140	56	0.114	46	346	46
Ponds	1,100	1.00	1,100	0.725	798	0	0.140	0	0.114	0	798	0
TOTAL PRE-DEVELOPMENT	**380,700**		**9,000**		**6,525**	**371,700**		**51,901**		**42,464**	**58,426**	**42,464**
West Draft Plan Berczy Catchment Area - Post-Development Land Use												
Residential - Single Detached/Laneway Homes	146,700	0.62	90,954	0.725	65,946	55,746	0.127	7,076	0.127	7,076	73,022	7,076
Residential - Town Homes or Laneway Homes	24,800	0.77	19,096	0.725	13,846	5,704	0.127	724	0.127	724	14,570	724
Residential - Mid-rise or Town Homes	14,300	0.92	13,156	0.725	9,539	1,144	0.127	145	0.127	145	9,684	145
Stormwater Management Pond Blocks	15,800	0.90	14,220	0.725	10,310	1,580	0.127	201	0.127	201	10,511	201
ROW	86,700	0.63	54,621	0.725	39,603	32,079	0.127	4,072	0.127	4,072	43,675	4,072
Parks	27,400	0.00	0	0.725	0	27,400	0.127	3,478	0.127	3,478	3,478	3,478
Open Space	65,000	0.00	0	0.725	0	65,000	0.127	8,251	0.127	8,251	8,251	8,251
TOTAL POST-DEVELOPMENT	**380,700**		**192,047**		**139,244**	**188,653**		**23,947**		**23,947**	**163,191**	**23,947**
										% Change from Pre to Post	279	44
										Effect of development (with no mitigation)	2.8 times increase in runoff	44% reduction in infiltration

* data provided by the mbtw group

** data provided by Stantec

*** figures from Tables H-1 and H-2

To balance pre- to post-,
the infiltration target (m^3/a)= **18,517**

WATER BALANCE CALCULATIONS
4134 16th Avenue, Markham

PROJECT No.300038247

TABLE H-5b

Water Balance - WEST DRAFT PLAN BRUCE CATCHMENT AREA - Existing Conditions and Post-Development (no mitigation)
4134 16th Avenue, Markham

Catchment Area	Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area*** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area*** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area*** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
West Draft Plan Bruce Catchment Area - Existing Land Use												
Grass Area	462,780	0.00	0	0.725	0	462,780	0.140	64,618	0.114	52,869	64,618	52,869
Solid Path	10,500	1.00	10,500	0.725	7,613	0	0.140	0	0.114	0	7,613	0
Buildings	120	1.00	120	0.725	87	0	0.140	0	0.114	0	87	0
Gravel Area	800	0.50	400	0.725	290	400	0.140	56	0.114	46	346	46
Ponds	23,600	1.00	23,600	0.725	17,111	0	0.140	0	0.114	0	17,111	0
Woodlot	48,000	0.00	0	0.725	0	48,000	0.111	5,313	0.135	6,493	5,313	6,493
TOTAL PRE-DEVELOPMENT	**545,800**		**34,620**		**25,101**	**511,180**		**69,987**		**59,409**	**95,088**	**59,409**
West Draft Plan Bruce Catchment Area - Post-Development Land Use												
Residential - Single Detached/Laneway Homes	92,500	0.62	57,350	0.725	41,582	35,150	0.127	4,462	0.127	4,462	46,043	4,462
Residential - Town Homes or Laneway Homes	19,200	0.77	14,784	0.725	10,719	4,416	0.127	561	0.127	561	11,280	561
Residential - Mid-rise or Town Homes	34,900	0.92	32,108	0.725	23,280	2,792	0.127	354	0.127	354	23,634	354
Stormwater Management Pond Blocks	17,900	0.90	16,110	0.725	11,681	1,790	0.127	227	0.127	227	11,908	227
ROW	60,800	0.63	38,195	0.725	27,693	22,605	0.127	2,869	0.127	2,869	30,563	2,869
Parks	3,000	0.00	0	0.725	0	3,000	0.127	381	0.127	381	381	381
Open Space	264,900	0.00	0	0.725	0	264,900	0.127	33,626	0.127	33,626	33,626	33,626
Ponds	4,600	1.00	4,600	0.725	3,335	0	0.127	0	0.127	0	3,335	0
Woodlot	48,000	0.00	0	0.725	0	48,000	0.111	5,313	0.135	6,493	5,313	6,493
TOTAL POST-DEVELOPMENT	**545,800**		**163,147**		**118,290**	**382,653**		**47,793**		**48,973**	**166,082**	**48,973**
										% Change from Pre to Post	175	18
										Effect of development (with no mitigation)	1.8 times increase in runoff	18% reduction in infiltration

* data provided by the mbtw group

** data provided by Stantec

*** figures from Tables H-1 and H-2

To balance pre- to post-,
the infiltration target (m^3/a)= **10,435**

WATER BALANCE CALCULATIONS
4134 16th Avenue, Markham

PROJECT No.300038247

TABLE H-6

Pre- and Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 125 mm (urban lawns in silt soils) with Amended Soils

Precipitation data from Toronto Buttonville Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Average Temperature (Degree C)	-5.80	-5.60	-0.40	6.70	13.00	18.60	21.20	20.20	15.70	8.90	3.10	-2.90	**7.7**	<--From Environment Canada
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.56	4.25	7.31	8.91	8.28	5.65	2.39	0.48	0.00	**38.8**	
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	29.28	61.03	90.77	104.93	99.46	75.23	40.11	12.46	0.00	**513**	
Adjusting Factor for U (Latitude 43^{o} 52' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77		<--From J. M. Lorente (1961). pp. 206
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**	
Precipitation (P)	62	51	53	74	80	83	79	76	82	68	80	66	**853**	<--From Environment Canada
Potential Evapotranspiration (PET)	0	0	0	33	77	116	135	119	78	38	10	0	**607**	
P - PET	62	51	53	41	3	-33	-56	-43	4	30	70	66	**246**	
Change in Soil Moisture Storage	0	0	0	0	0	-33	-56	-35	4	30	70	22	**0**	
Soil Moisture Storage max 125 mm	125	125	125	125	125	92	35	0	4	33	103	125		
Actual Evapotranspiration (AET)	0	0	0	33	77	116	135	111	78	38	10	0	**599**	
Soil Moisture Deficit max 125 mm	0	0	0	0	0	33	90	125	121	92	22	0		
Water Surplus - available for infiltration or runoff	62	51	53	41	3	0	0	0	0	0	0	44	**254**	
Potential Infiltration (based on MOECC metholodogy*; independent of temperature)	34	28	29	23	1	0	0	0	0	0	0	24	**140**	
Potential Direct Surface Water Runoff (independent of temperature)	28	23	24	19	1	0	0	0	0	0	0	20	**114**	
IMPERVIOUS AREA WATER SURPLUS														
Precipitation (P)	853	mm/year												
15%)	128	mm/year												
P-PE (surplus available for runoff from impervious areas)	725	mm/year												

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	125 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOECC SWM infiltration calculations

topography - graded land	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - silt soils + additional topsoil depth	0.25	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawns	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.55**	

Latitude of site (or climate station) 43 ^{O} N.

TABLE H-7

Water Balance - EAST DRAFT PLAN AREA - Existing Conditions and Post-Development with Mitigation (LIDs)
4134 16th Avenue, Markham

Catchment Area		Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area*** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area*** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area*** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
East Draft Plan - Existing Land Use													
Grass Area		661,600	0.00	0	0.725	0	661,600	0.140	92,380	0.114	75,583	92,380	75,583
Solid Path		27,000	1.00	27,000	0.725	19,576	0	0.140	0	0.114	0	19,576	0
Building		3,700	1.00	3,700	0.725	2,683	0	0.140	0	0.114	0	2,683	0
Gravel Area		4,300	0.50	2,150	0.725	1,559	2,150	0.140	300	0.114	246	1,859	246
Ponds		21,900	1.00	21,900	0.725	15,879	0	0.140	0	0.114	0	15,879	0
Woodlot Wetland Feature	Wetland	11,100	0.00	0	0.725	0	11,100	0.140	1,550	0.114	1,268	1,550	1,268
	Woodlot	32,100	0.00	0	0.725	0	32,100	0.111	3,553	0.135	4,342	3,553	4,342
TOTAL PRE-DEVELOPMENT		**761,700**		**54,750**		**39,696**	**706,950**		**97,783**		**81,440**	**137,479**	**81,440**
East Draft Plan - Post-Development Land Use													
Residential - Single Detached or Laneway Homes	Less Rear Yards and Roof Areas (described below)	223,700	0.64	143,446	0.725	104,005	80,254	0.127	10,187	0.127	10,187	114,193	10,187
	Rear Yard Amended Soils	35,100	0.00	0	0.725	0	35,100	0.114	4,010	0.140	4,901	4,010	4,901
	Roof to Grass - 25% infiltration	33,100	1.00	33,100	0.725	23,999	NA	NA	NA	NA	NA	17,999	6,000
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	7,600	1.00	7,600	0.725	5,510	NA	NA	NA	NA	NA	386	5,125
	Roof to Enclave - designed for 25 mm storm (~ 93% of total rainfall)	900	1.00	900	0.725	653	NA	NA	NA	NA	NA	46	607
	Roof to Area E in West Draft Plan	3,200	1.00	3,200	0.725	2,320	NA	NA	NA	NA	NA	0	0
Residential - Town Homes	Less Rear Yards and Roof Areas (described below)	53,400	0.73	38,982	0.725	28,264	14,418	0.127	1,830	0.127	1,830	30,094	1,830
	Rear Yard Amended Soils	800	0.00	0	0.725	0	800	0.114	91	0.140	112	91	112
	Roof to Grass - 25% infiltration	1,300	1.00	1,300	0.725	943	NA	NA	NA	NA	NA	707	236
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total	10,600	1.00	10,600	0.725	7,686	NA	NA	NA	NA	NA	538	7,148
Residential - Stacked Towns Block	Less Roof Areas (described below)	3,850	0.71	2,729	0.725	1,978	1,121	0.127	142	0.127	142	2,121	142
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	8,400	1.00	8,400	0.725	6,090	NA	NA	NA	NA	NA	426	5,664
	Roof to Area E in West Draft Plan	1,850	1.00	1,850	0.725	1,341	NA	NA	NA	NA	NA	0	0
School	Less Roof Areas (described below)	12,600	0.54	6,827	0.725	4,950	5,773	0.127	733	0.127	733	5,683	733
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total	12,500	1.00	12,500	0.725	9,063	NA	NA	NA	NA	NA	634	8,429
Stormwater Management Pond Blocks		68,600	0.90	61,740	0.725	44,765	6,860	0.127	871	0.127	871	45,635	871
ROW		199,700	0.62	123,952	0.725	89,871	75,748	0.127	9,615	0.127	9,615	99,487	9,615
Parks		39,200	0.00	0	0.725	0	39,200	0.127	4,976	0.127	4,976	4,976	4,976
Open Space		1,300	0.00	0	0.725	0	1,300	0.127	165	0.127	165	165	165
Reserved Block		800	1.00	800	0.725	580	0	0.140	0	0.114	0	580	0
Woodlot Wetland Feature	Wetland	11,100	0.00	0	0.725	0	11,100	0.140	1,550	0.114	1,268	1,550	1,268
	Woodlot	32,100	0.00	0	0.725	0	32,100	0.111	3,553	0.135	4,342	3,553	4,342
TOTAL POST-DEVELOPMENT		**761,700**		**457,925**		**332,019**	**303,775**		**37,724**		**39,143**	**332,874**	**72,350**
											% Change from Pre to Post	242	11
											Effect of development (with mitigation)	2.4 times increase in runoff	11% reduction in infiltration

* data provided by the mbtw group

** data provided by Stantec

*** figures from Tables H-1 and H-2

To balance pre- to post-,
the infiltration target (m^3/a)= **9,089**

WATER BALANCE CALCULATIONS
4134 16th Avenue, Markham

PROJECT No.300038247

TABLE H-8a

Water Balance - WEST DRAFT PLAN BERCZY CATCHMENT AREA - Existing Conditions and Post-Development with Mitigation (LIDs)
4134 16th Avenue, Markham

Catchment Area		Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area*** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area*** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area*** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
West Draft Plan Berczy Catchment Area - Exising Land Use													
Grass Area		371,300	0.00	0	0.725	0	371,300	0.140	51,845	0.114	42,419	51,845	42,419
Solid Path		7,500	1.00	7,500	0.725	5,438	0	0.140	0	0.114	0	5,438	0
Gravel Area		800	0.50	400	0.725	290	400	0.140	56	0.114	46	346	46
Ponds		1,100	1.00	1,100	0.725	798	0	0.140	0	0.114	0	798	0
TOTAL PRE-DEVELOPMENT		**380,700**		**9,000**		**6,525**	**371,700**		**51,901**		**42,464**	**58,426**	**42,464**
West Draft Plan Berczy Catchment Area - Post-Development Land Use													
Residential - Single Detached or Laneway Homes	Less Rear Yards and Roof Areas (described below)	94,600	0.58	54,784	0.725	39,721	39,816	0.127	5,054	0.127	5,054	44,775	5,054
	Rear Yard Amended Soils	15,900	0.00	0	0.725	0	15,900	0.114	1,816	0.140	2,220	1,816	2,220
	Roof to Grass - 25% infiltration	17,400	1.00	17,400	0.725	12,616	NA	NA	NA	NA	NA	9,462	3,154
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	11,150	1.00	11,150	0.725	8,084	NA	NA	NA	NA	NA	566	7,518
	Roof to Enclave - designed for 25 mm storm (~ 93% of total rainfall)	7,600	1.00	7,600	0.725	5,510	NA	NA	NA	NA	NA	386	5,125
Residential - Town Homes or Laneway Homes	Less Rear Yards and Roof Areas (described below)	12,000	0.67	8,065	0.725	5,848	3,935	0.127	499	0.127	499	6,347	499
	Rear Yard Amended Soils	1,800	0.00	0	0.725	0	1,800	0.114	206	0.140	251	206	251
	Roof to Grass - 25% infiltration	3,100	1.00	3,100	0.725	2,248	NA	NA	NA	NA	NA	1,686	562
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	7,950	1.00	7,950	0.725	5,764	NA	NA	NA	NA	NA	403	5,361
Residential - Stacked Towns Block	Less Roof Areas (described below)	6,400	0.82	5,249	0.725	3,806	1,151	0.127	146	0.127	146	3,952	146
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	7,900	1.00	7,900	0.725	5,728	NA	NA	NA	NA	NA	401	5,327
Stormwater Management Pond Blocks		15,800	0.90	14,220	0.725	10,310	1,580	0.127	201	0.127	201	10,511	201
ROW		86,700	0.63	54,621	0.725	39,603	32,079	0.127	4,072	0.127	4,072	43,675	4,072
Parks		27,400	0.00	0	0.725	0	27,400	0.127	3,478	0.127	3,478	3,478	3,478
Open Space		65,000	0.00	0	0.725	0	65,000	0.127	8,251	0.127	8,251	8,251	8,251
TOTAL POST-DEVELOPMENT		**380,700**		**192,039**		**139,238**	**188,661**		**23,723**		**24,173**	**135,915**	**51,219**
											% Change from Pre to Post	233	-21
											Effect of development (with mitigation)	2.3 times increase in runoff	21% increase in infiltration

* data provided by the mbtw group

** data provided by Stantec

*** figures from Tables H-1 and H-2

To balance pre- to post-,
the infiltration target (m^3/a)= **-8,755**

WATER BALANCE CALCULATIONS
4134 16th Avenue, Markham

PROJECT No.300038247

TABLE H-8b

Water Balance - WEST DRAFT PLAN BRUCE CATCHMENT AREA - Existing Conditions and Post-Development with Mitigation (LIDs)
4134 16th Avenue, Markham

Catchment Area		Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area*** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area*** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area*** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
West Draft Plan Bruce Catchment Area - Exising Land Use													
Grass Area		462,780	0.00	0	0.725	0	462,780	0.140	64,618	0.114	52,869	64,618	52,869
Solid Path		10,500	1.00	10,500	0.725	7,613	0	0.140	0	0.114	0	7,613	0
Buildings		120	1.00	120	0.725	87	0	0.140	0	0.114	0	87	0
Gravel Area		800	0.50	400	0.725	290	400	0.140	56	0.114	46	346	46
Ponds		23,600	1.00	23,600	0.725	17,111	0	0.140	0	0.114	0	17,111	0
Woodlot		48,000	0.00	0	0.725	0	48,000	0.111	5,313	0.135	6,493	5,313	6,493
TOTAL PRE-DEVELOPMENT		**545,800**		**34,620**		**25,101**	**511,180**		**69,987**		**59,409**	**95,088**	**59,409**
West Draft Plan Bruce Catchment Area - Post-Development Land Use													
Residential - Single Detached or Laneway Homes	Less Rear Yards and Roof Areas (described below)	54,000	0.54	29,069	0.725	21,077	24,931	0.127	3,165	0.127	3,165	24,241	3,165
	Rear Yard Amended Soils	10,200	0.00	0	0.725	0	10,200	0.114	1,165	0.140	1,424	1,165	1,424
	Roof to Grass - 25% infiltration	11,300	1.00	11,300	0.725	8,193	NA	NA	NA	NA	NA	6,145	2,048
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	17,000	1.00	17,000	0.725	12,326	NA	NA	NA	NA	NA	863	11,463
Residential - Town Homes or Laneway Homes	Less Rear Yards and Roof Areas (described below)	7,200	0.44	3,184	0.725	2,309	4,016	0.127	510	0.127	510	2,818	510
	Rear Yard Amended Soils	400	0.00	0	0.725	0	400	0.114	46	0.140	56	46	56
	Roof to Grass - 25% infiltration	700	1.00	700	0.725	508	NA	NA	NA	NA	NA	381	127
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	10,900	1.00	10,900	0.725	7,903	NA	NA	NA	NA	NA	553	7,350
Residential - Stacked Towns Block	Less Roof Areas (described below)	23,500	0.88	20,702	0.725	15,010	2,798	0.127	355	0.127	355	15,365	355
	Roof to Infiltration - designed for 25 mm storm (~ 93% of total rainfall)	11,400	1.00	11,400	0.725	8,266	NA	NA	NA	NA	NA	579	7,687
Stormwater Management Pond Blocks		17,900	0.90	16,110	0.725	11,681	1,790	0.127	227	0.127	227	11,908	227
ROW		60,800	0.63	38,195	0.725	27,693	22,605	0.127	2,869	0.127	2,869	30,563	2,869
Parks		3,000	0.00	0	0.725	0	3,000	0.127	381	0.127	381	381	381
Open Space	West Draft Plan	264,900	0.00	0	0.725	0	264,900	0.127	33,626	0.127	33,626	33,626	33,626
	Roof Runoff from East Draft Plan to Area E	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,831	1,831
Ponds		4,600	1.00	4,600	0.725	3,335	0	0.127	0	0.127	0	3,335	0
Woodlot		48,000	0.00	0	0.725	0	48,000	0.111	5,313	0.135	6,493	5,313	6,493
TOTAL POST-DEVELOPMENT		**545,800**		**163,160**		**118,300**	**382,640**		**47,656**		**49,106**	**139,112**	**79,612**
% Change from Pre to Post												146	-34
Effect of development (with mitigation)												1.5 times increase in runoff	34% increase in infiltration

* data provided by the mbtw group

** data provided by Stantec

*** figures from Tables H-1 and H-2

To balance pre- to post-,
the infiltration target (m^3/a)= **-20,203**

TABLE H-9

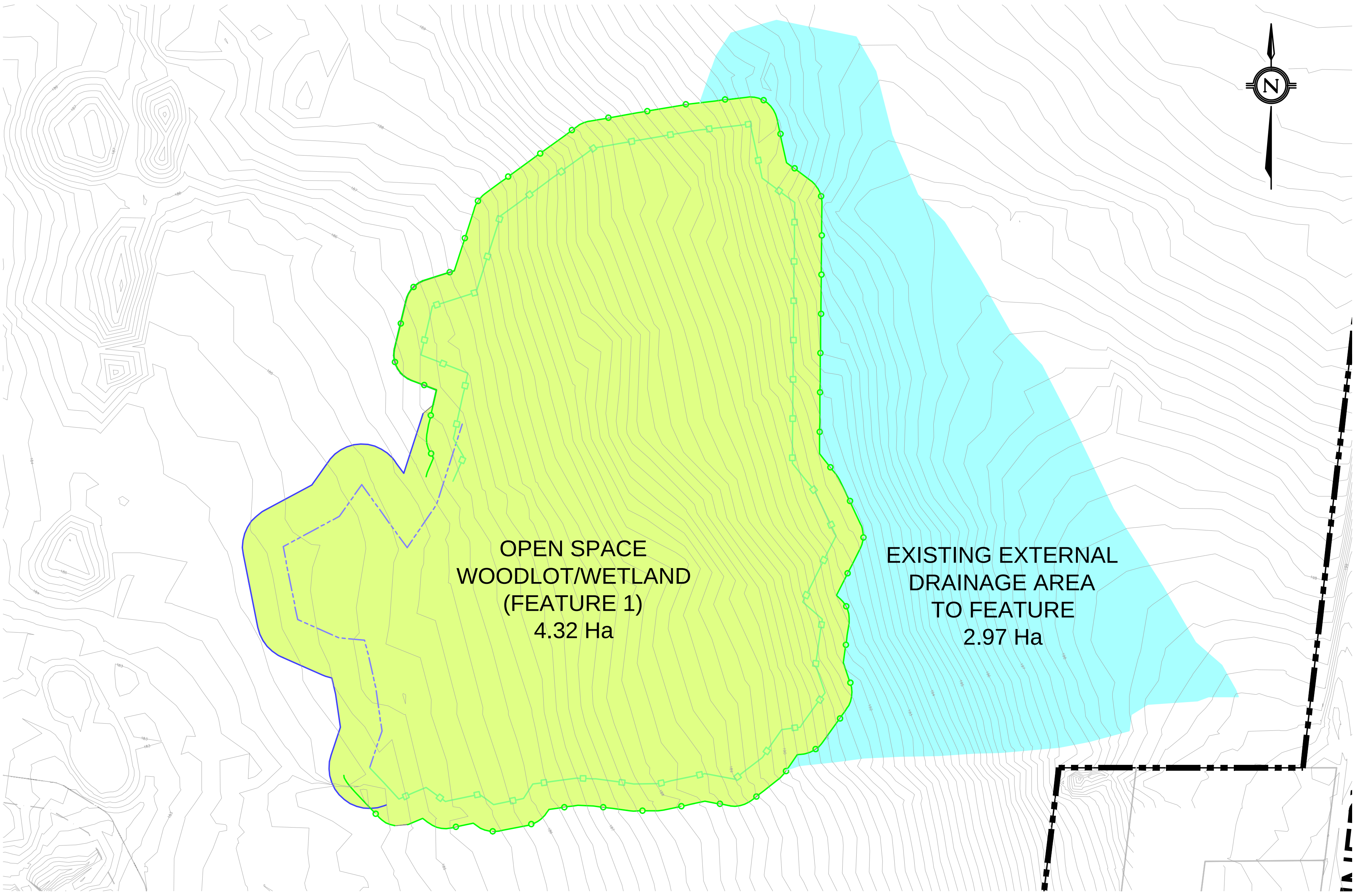
Feature Based Water Balance - WOODLOT/WETLAND FEATURE - Existing Conditions and Post-Development with LIDs
4134 16th Avenue, Markham

Catchment Area		**Approx. Land Area* (m^2)**	**Estimated Impervious Fraction for Land Use****	**Estimated Impervious Area (m^2)**	**Runoff from Impervious Area*** (m/a)**	**Runoff Volume from Impervious Area (m^3/a)**	**Estimated Pervious Area (m^2)**	**Runoff from Pervious Area*** (m/a)**	**Runoff Volume from Pervious Area (m^3/a)**	**Infiltration from Pervious Area*** (m/a)**	**Infiltration Volume from Pervious Area (m^3/a)**	**Total Runoff Volume to Feature (m^3/a)**
Woodlot/Wetland Feature - Existing Land Use												
Woodlot Wetland Feature	Wetland	11,100	0.00	0	0.725	0	11,100	0.140	1,550	0.114	1,268	1,550
	Woodlot	32,100	0.00	0	0.725	0	32,100	0.111	3,553	0.135	4,342	3,553
Existing External Drainage Area to Feature		29,700	0.00	0	0.725	0	29,700	0.140	4,147	0.114	3,393	4,147
TOTAL PRE-DEVELOPMENT		**72,900**		**0**		**0**	**72,900**		**9,250**		**9,004**	**9,250**
Woodlot/Wetland Feature - Post-Development Land Use												
Woodlot Wetland Feature	Wetland	11,100	0.00	0	0.725	0	11,100	0.140	1,550	0.114	1,268	1,550
	Woodlot	32,100	0.00	0	0.725	0	32,100	0.111	3,553	0.135	4,342	3,553
Type B Lots	Rear Yard Amended Soils	1,784	0.00	0	0.725	0	1,784	0.114	204	0.140	249	204
	Roof to Grass - 75% runoff	4,465	1.00	4,465	0.725	3,237	NA	NA	NA	NA	NA	2,428
Type C Lots	Rear Yard Amended Soils	835	0.00	0	0.725	0	835	0.114	95	0.140	117	95
	Roof to Grass - 75% runoff	2,129	1.00	2,129	0.725	1,544	NA	NA	NA	NA	NA	1,158
Type E Lots	Rear Yard Amended Soils	83	0.00	0	0.725	0	83	0.114	9	0.140	12	9
	Roof to Grass - 75% runoff	337	1.00	337	0.725	244	NA	NA	NA	NA	NA	183
TOTAL POST-DEVELOPMENT		**52,833**		**6,931**		**5,025**	**45,902**		**5,412**		**5,988**	**9,181**
											% Change from Pre to Post	99
											Effect of development (with no mitigation)	1% decrease in runoff

* data provided by the mbtw group

** data provided by Stantec

*** figures from Tables H-1 and H-2



EXISTING DRAINAGE PLAN

PROPOSED DRAINAGE PLAN

Stantec
BEACON
ENVIRONMENTAL
BURNSIDE

0 20 40 60 80 100
1:2000

Legend

SUBJECT PROPERTY
STAKED DRIPLINE
STAKED DRIPLINE +10.0m
STAKED WETLAND
STAKED WETLAND +15.0m
PROPOSED CULVERT
RLC TO WOODLOT/WETLAND FEATURE

🟦 EXISTING DRAINAGE AREA TO FEATURE
🟥 PROPOSED DRAINAGE AREA TO FEATURE
🟨 WOODLOT/WETLAND AREA
● FULL ROOF TO WOODLOT/WETLAND FEATURE
X HALF ROOF TO AMMENDED SOIL

MESP
SERVICING AND GRADING REPORT
4134 16TH AVENUE
RESIDENTIAL DEVELOPMENT

FIGURE 2.14

WOODLOT / WETLAND
FEATURE 1 DRAINAGE PLAN

August 2016

File: V:\01606\Active\160622264\Drawing\sheet_files [MESP]\Figure 2.14 – Woodlot-Wetland Drainage Plan.dwg – Revised by <Luk, James> , Fri, Sep 02, 2016 , 12:00 PM