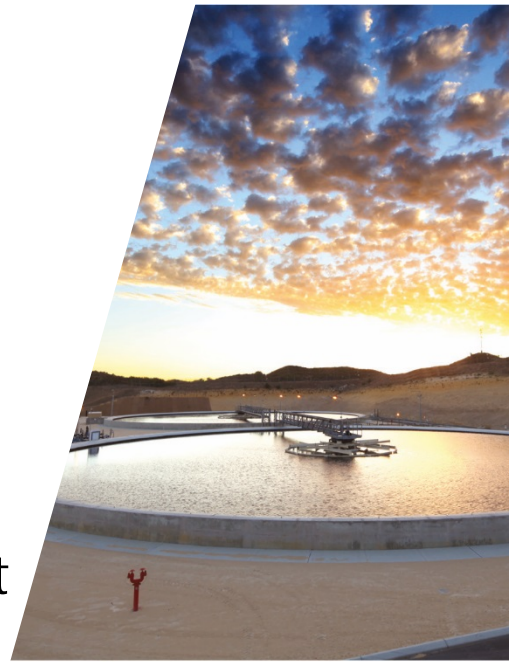




# Hydrogeological Assessment

811 Gladstone Avenue Complex  
Ottawa, Ontario

Ottawa Community Housing  
Corporation





## Executive Summary

GHD was retained by Ottawa Community Housing Corporation (OCHC or Client) represented by Mr. Meyerhoffer and Mr. MacNeil to complete a Hydrogeological Assessment for the proposed residential development to be located at 811 Gladstone Avenue in Ottawa, Ontario (Site or Property).

GHD has previously prepared the following reports for the Site:

- Geotechnical Investigation (Reference No: 11140575-RPT-1, dated May 1, 2019)
- Phase One Environmental Site Assessment (Phase One ESA) (Ref No: 11140575-RPT-2, dated August 25, 2017)
- Phase Two ESA for the Site (GHD, Report No. 11140575-RPT-3, dated December 11, 2017).

The previous investigations included the advancement of eight boreholes, the installation of three groundwater monitoring wells, and water quality analysis. The information collected in these previous investigations has been included in this investigation.

Based on GHD's understanding of the Site, the Owner is proposing to develop the Site with the following excavations:

- Excavation A | The northwest and northeast quarters of the Site will be developed with two multi-level townhouse buildings. These two buildings will have partially sunken basements, requiring excavations to approximately 64.4/65.1 metres above sea level (masl). It is not anticipated that these excavations will penetrate the local water table. There is a common service trench that connects the center points of the two buildings which extends to approximately 62.8 masl. This 2.0 metre (m) x 49 m trench excavation is anticipated to penetrate the local bedrock water table.
- Excavation B | The south half of the Site will be developed with a single multi-level building, consisting of six levels of residential occupancy above grade. While the east third of the structure will have no basement level (65.7 masl), the west two-thirds of the building will be equipped with underground parking (62.0 masl). The 50 m x 27 m west portion of the excavation is anticipated to penetrate the local bedrock water table.
- Excavation C | There will be a local subgrade storm water storage chamber on-Site that will extend to approximately 64.1 masl. This 17 m x 7.0 m excavation is anticipated to penetrate the local bedrock water table.

Groundwater elevations, measured in April 2019, revealed the groundwater table in the limestone bedrock to range from over 65.0 masl in the east portion of the Site, to less than 62.0 masl in the southwest corner of the Site. Accordingly, the proposed construction will require dewatering.

Based on the observed Site conditions, assuming simultaneous flow into all three excavations, and assuming no interference from the other open excavations, groundwater flows could approach 156,300 L/day. The initial flows from the excavation will be approximately two to three times greater than the steady state, or near 350,000 L/day.



These values do not include rainfall events and the associated accumulation into an open excavation nor surface sheet flow if exterior surface grades are such to allow inflow into an open excavation. For example, 1.0 cm of precipitation falling directly into three open excavations would contribute an additional 15,670 L/day. The effect of groundwater falling within the radius of influence was not included, as the vast majority of this water will fall on hardened surfaces (rooftops, paved streets, sidewalks, paved parking areas) and so be diverted to the municipal storm water collection system prior to entering the groundwater table.

Owners and contractors should account for large swings in the pumping requirements. Assuming a moderate safety factor, this report suggests that 400,000 Litres/day is an appropriate upset limit for the construction dewatering for the purposes of construction planning and filing of an Environmental Activity Site Registry (EASR) application under the Ontario Regulations.

Laboratory analysis of groundwater samples collected at the Site during this initial study suggest that the chemistry water quality, when compared to Ottawa Sewer Use Bylaw 2003-514, the groundwater is generally compliant with the City of Ottawa Sanitary Sewer criteria. However, the water quality is not compliant with City of Ottawa Storm Sewer criteria due to an exceedance in Total Suspended Solids, and possibly Ethylbenzene and Xylenes. Additional water testing is recommended during construction. The Client will be required to obtain a City of Ottawa Discharge Permit prior to discharging to the municipal sewer system and contractors will be responsible during construction to maintain adequate discharge water quality, including sediment control measures.

The following report suggests that there will be no adverse impact to surface water, existing groundwater use, or to proximate structures as a result of the proposed water taking.



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## 1. Introduction

GHD was retained by Ottawa Community Housing Corporation (OCHC, or Owner) to prepare this hydrogeological assessment in support of the proposed planning of a development at 811 Gladstone Avenue and the associated dewatering during the proposed construction excavation.

The proposed residential development is located in the City of Ottawa, Ontario, and bears the Civic Address of 811 Gladstone Avenue, Ottawa, Ontario (Site, or Property). The Property is a generally square shaped block of land, spanning approximately 0.47 hectares, bounded by Balsam Street to the north, an institutional development to the east, Gladstone Avenue to the south, and Rochester Street to the west. The attached Figure 1 and Figure 2 show the location of the Site.

Presently, the Property is in an area that has been developed since approximately 1889 and devoted primarily to residential development with some institutional use from 1918 to 1964. Municipal water and sewer services are present in the area. There are no natural surface water bodies on-Site. The nearest surface water body is Dows Lake which is located approximately 950 metres (m) to the southeast, with the Ottawa River being approximately 1.1 kilometres (km) north of the Site. The existing Site topography slopes down approximately 1 to 2 m from north to south and from east to west of the Site, regionally the Site is on a gentle slope down towards the southwest.

The Owner is proposing to develop the north half of the Site with two multi-level townhouse buildings, which will have raised/partially exposed basements requiring excavations of about 1 to 2 metres below existing grades (mbg), or above the local water table. These two buildings are connected by a mechanical service trench planned at approximately 1.5 m below the basement slabs. This service trench excavation (Excavation A, 2.0 m x 49 m, to 62.8 metres above sea level [masl]) is anticipated to penetrate the local bedrock water table.

The south half of the Site is to be developed with a residential apartment, consisting of six levels of residential occupancy above grade. The east third of the building will not be equipped with a basement, and is not anticipated to penetrate the local groundwater table. The west two-thirds of the building is to be developed with underground parking. This excavation (Excavation B, 50 m x 27 m, to 62.0 masl) is anticipated to penetrate the local bedrock water table. There will be an elevator pit, excavated 1.75 m below the floor slab in the basement portion of the building, the base of the elevator pit will be at approximately 60.25 masl.

Between Excavation A and Excavation B, there will a local subgrade storm water storage chamber constructed near the east portion of the Site. This excavation (Excavation C, 17 m x 7.0 m, to 64.1 masl) is anticipated to penetrate the local bedrock water table.

There will also be associated service trenches, surface parking areas, access roads, and landscaped areas.

Accordingly, the proposed construction will require dewatering.

Temporary sump and pump techniques are anticipated during construction and conventional permanent sumps will be placed in the basement. Both systems will be in the base of the excavation to passively collect water and then be discharged to the Ottawa Municipal Sewer System.



This report provides a description of the Site, anticipated construction methods, regional environmental setting, and the field activities and methodologies used to determine potential impacts associated with the undertaking. A summary of the geology and hydrogeology is presented, along with a hydrogeological impact assessment with respect to potential impacts on groundwater users and surface water, based on review of completed geotechnical studies and supporting field investigations. An outline of the monitoring and mitigation plans for the proposed construction water takings is also presented.

The elevations of the boreholes were determined by GHD field staff using a laser level; and related to a manhole for which GHD had a geodetic elevation, from a client provided survey plan. Therefore, all elevations presented in this report are geodetic.

## 1.1 Background

In January 2017, GHD completed a Phase One Environmental Site Assessment (Phase One ESA) for the Site (GHD Report No. 11140575-RPT-2). That report described a number of potentially contaminating activities (PCAs) on the Site and surrounding area, and identified the Contaminants of Concern (CoC) for on-Site areas of potential environmental concern (APECs) to include Metals, PHCs, VOCs, and PAHs. The report concluded "Following the completion of the Phase One ESA for the subject Property, it is our opinion that a Phase Two Environmental Site Assessment is required for the Site."

GHD has also prepared a geotechnical report for the Site (GHD Report No. 11140575-RPT-1).

Concurrent with the geotechnical investigation, GHD conducted a Phase Two Environmental Site Assessment (Phase Two ESA) for the Site (GHD Report No. 11140575-RPT-3) to investigate soil and groundwater quality at the property.

- The investigation involved the advancement of eight boreholes which were sampled for environmental and/or geotechnical purposes. Three of the boreholes were completed with groundwater monitoring well screens set within the unconfined upper aquifer, in the upper fractured layers of the limestone bedrock.
- Groundwater elevations collected in the monitoring wells identified that the water table was found in the upper surface of the bedrock, flowing towards the southwest.
- The boreholes identified that the overburden at the Site was mainly fill. Bedrock at the Site was encountered between 0.6 and 1.1 mbg, except at the southwest corner of the Site where a previous excavation extended to 2.6 mbg.
- Laboratory analysis of four soil samples for Metals, PHCs, VOCs, PAHs, and pH identified O. Reg. 153/04 Table 7 (residential land use, coarse soil texture) criteria exceedances in two of the four submitted soil samples, plus a duplicate QA/QC soil sample.
- Laboratory analysis of five groundwater samples plus a duplicate QA/QC sample for Metals, PHCs, VOCs, PAHs, and pH did not identify O. Reg. 153/03 Table 7 exceedances in the analysed groundwater samples.

Based on the results of the 2017 Phase Two ESA, the groundwater table was anticipated to be located within the shallow bedrock at the Site. While the Phase Two ESA groundwater testing did



not include all parameters listed in the Municipal sewer by-laws, all analysed parameters were in compliance with the City of Ottawa Sanitary Sewer Criteria.

## 1.2 Regional Geology

The following section presents a description of the geology and hydrogeology of the Site, based on surficial mapping of the study area, the GHD geotechnical report (11140575-RPT-1), the GHD Phase One ESA (11140575-RPT-2) and the GHD Phase Two ESA (11140575-RPT-3) which contains Site-specific stratigraphic information, and borehole logs (Appendix B).

A Topographic map was reviewed from the Ontario Ministry of Natural Resources and Forestry, and is provided in Figure 1. The mapping shows the Site is on relatively flat terrain, with general topography sloping towards the southwest. The nearest surface water body indicated on the mapping is Dows Lake which is located approximately 950 m to the southeast, with the Ottawa River being approximately 1.1 km north of the Site.

According to the information obtained from the Geological Survey of Canada Map 1425A titled 'Surficial Materials and Terrain features Ottawa-Hull' the natural soil conditions in the region appear to consist of "Pre-Champlain Sea Deposits consisting of glacial deposits of till; heterogeneous mixture of material ranging from clay to large boulders, generally sandy, grades downwards into unmodified till; surface is generally modified by wave or river action and the topography is flat to hummocky". The thickness of overburden is expected to be approximately 1.0 m and the bedrock in the general area of the Site is expected to be limestone. Similarly, the MNRF NRVIS map (attached as Figure 4) describes the area as consisting of till (glacial), predominantly sandy silt to silt matrix, commonly rich in clasts, often high in total matrix carbonate content.

According to the information obtained from the Ontario Geologic Survey Map P.2716 titled 'Paleozoic Geology Ottawa Area', the bedrock in the Study Area is described as the Middle Ordovician, Verulam Formation, consisting of interbedded bioclastic limestone, sublithographic to fine crystalline limestone, and shale. Similarly, the MNRF NRVIS mapping identifies the Site as being located in the Georgian Bay Formation (Blue Mountain or Billings Formation, Collingwood or Eastview Member), described as shales, limestones, dolostones, and siltstones, as attached in Figure 5.

## 1.3 Construction Methodology and Water Takings

Construction of the proposed excavation is recommended in the geotechnical report to be carried out by using shored excavation techniques where overburden or highly weathered rock are present, followed by excavation to allow construction of the building foundations and basement. Where sound rock is present, it may be excavated near vertically.

Bedrock elevations ranged from 64.7 masl (BH8) to 68.4 masl (BH5/MW3). Accordingly, bedrock excavation is expected for the foundations of the proposed buildings, based on the founding depth of foundations for the structures. The excavation of the bedrock is expected to extend to an approximate minimum elevation of 60.25 masl (6.0 mbg) and may require the use of line drilling in combination with pneumatic or hydraulic breakers such as hoe rams or heavy excavation equipment equipped for rock excavation.



Based on these observations, the excavations will extend below the water table, and will require dewatering to remove groundwater seepage as well as surface water runoff and precipitation to ensure safe and dry working conditions.

A summary of the relevant depths and corresponding elevations is provided as follows:

Table 1.1 Summary of Construction Details

		Excavation A	Excavation B	Excavation C
Grade	(masl)	66.2 - 67.1	65.3 - 66.5	66.0 - 66.5
Unconfined Water table	(masl)	63.5 - 64.5 (64.5)	61.5 - 64.5 (64.0)	64.5 - 65.5 (65.2)
Bedrock Elevation	(masl)	65.3 - 66.4	62.8 - 65.7	65.5
Bottom of Excavation	(masl)	62.8	62.0	64.1
Bottom Excavation (Base of Sump)	(masl)	62.2	60.25	63.5
Lowermost Dewatering	(masl)	62.6	60.25	64.0
Potential Water Table Drawdown	(m)	1.9 m	2.2 m	1.2 m
Excavation Dimensions	(m)	2.0 m x 49 m	50 m x 27 m	17 m x 7.0 m
Note:		Elevations are geodetic		

Under steady state conditions, the construction water takings will be expected to handle peak dewatering volumes during excavation and following precipitation events. Volumes are discussed in Section 4 of this report.

This report is not intended to be considered for use as a dewatering plan for the construction contractor, as the water takings are based on conservative calculations for the purposes of the regulatory submissions.

## 2. Investigative Activities

Investigative activities undertaken to study the hydrogeologic conditions at the Site and assess potential impacts of the construction dewatering include the following:

- Review existing borehole/and monitoring well installations, and advance additional monitoring wells
- Groundwater level monitoring
- Hydraulic testing (single well response tests)
- Groundwater chemistry testing
- Desktop study of MOE well records

The details of these investigations are summarized in the following sections.





## 2.1 Borehole/Monitoring Well Installations

The 2017 Phase Two ESA included the advancement of eight boreholes, with three of the boreholes being equipped with groundwater monitoring wells (MW1-17, MW2-17, MW3-17). The 2019 Hydrogeological investigation included the advancement of three additional groundwater monitoring wells.

The locations of the boreholes and monitoring wells advanced by GHD in 2017 and 2019 are shown in Figure 2, and the details of the monitoring wells are provided on Table 2.1. The Monitoring Well and Borehole Stratigraphic and Instrumentation Logs for all boreholes and wells are presented in Appendix B.

All boreholes were advanced to the bedrock surface with an 8" auger. Diamond coring in MW1-17, MW2-17, MW3-17 was conducted with a HQ barrel, while MW4-19, MW5-19, and MW6-19 was conducted with a NQ barrel.

Monitoring wells MW1-17, MW2-17, MW3-17 were constructed with 51 mm diameter PVC screen and riser whereas monitoring wells MW4-19, MW5-19, and MW6-19 were constructed with 32 mm diameter PVC screen and riser. All monitoring wells were installed with silica sand pack, bentonite seal, and flush mount style protective casings.

## 2.2 Groundwater Level Monitoring

Groundwater static levels were measured on September 8, 2017, April 25, 2019 and, May 2, 2019.

The measured elevations of the water table are detailed in Table 2.1, and illustrated in Figures 2b and 2c.

The groundwater levels measured in MW1-17, MW2-17, MW3-17, MW4-19, MW5-19 and, MW6-19 range between elevations 61.69 masl to 66.91 masl, indicating the ground water level is within the bedrock and is unconfined.

## 2.3 Hydraulic Testing

On April 25, 2019, Single Well Response Tests (SWRT) were completed on monitoring wells MW1-17, MW4-19, and MW6-19 (all of which were advanced to the depth of the excavations) and MW5-19 (which was advanced below the base of the proposed excavations).

The tests consisted of inducing a measurable change to the water level in the monitoring well and measuring the rate at which the water level recovers. In this case, the monitoring wells were pumped dry, or near dry, and then recovery measured. The rising head responses were measured over time, collected manually using water level meters until recovery of 90 percent or more, except for the case of MW1-17 which had slow recharge demonstrating only 24 percent recovery over a 260-minute period.



Table 2.1 Summary of Monitoring Well Observations

		MW1-17 (Bedrock)	MW2-17 (Bedrock)	MW3-17 (Bedrock)	MW4-19 (Bedrock)	MW5-19 (Bedrock)	MW6-19 (Bedrock)
Surface Grade	(masl)	66.0	66.21	67.06	65.66	66.06	66.54
Bedrock Surface	(masl)	65.6	65.6	66.4	64.8	64.8	65.5
Sand Pack elevations	(masl)	59.85 - 64.73	59.99 - 64.86	61.19 – 65.97	60.53 - 63.88	56.08 - 60.04	61.41 - 64.76
Groundwater elevation Sep. 8, 2017	(masl)	64.01	63.51	64.86			
Apr. 25, 2019		65.08			62.46	61.45	65.40
May 2, 2019		64.54	64.12	64.45	62.35	61.42	65.21
K (cm/s)	(cm/s)	0.366x10 <sup>-4</sup>	-	-	1.02x10 <sup>-4</sup>	2.01x10 <sup>-4</sup>	0.655x10 <sup>-4</sup>
<p>Note:</p> <p>MW2-17 and MW3-17 advanced 2017 P2ESA were noted in 2019 to be damaged during works at the Site. These wells could not be used for SWRT, but water level measurements could be collected.</p>							

It is noted that the hydraulic conductivities in MW1-17 and MW6-19 were nearly a magnitude lower than those calculated in MW4-19 and MW5-19. However, the combined sand pack elevations were similar (59.85 - 64.76 masl vs 56.08 - 63.88 masl, respectively). Accordingly, it is assumed that the hydraulic conductivities varies across the Site.

The results of the SWRT are discussed in Section 3, and are presented in Appendix C.

## 2.4 Groundwater Chemistry

As part of the 2017 Phase Two ESA, on September 8 and 12, 2017, groundwater samples were collected from MW1-17, MW2-17, MW3-17, a duplicate, and an existing monitoring well at the northwest corner of the Site which was formerly referred to as MW4 during the Phase Two ESA investigation. MW1-17, MW2-17, MW3-17, and the duplicate were analysed for PHC, VOCs, PAHs, metals and pH. The groundwater sample taken from the former MW4, was analysed for VOCs. The results were initially compared to O. Reg. 153/04 criteria, but have been reviewed and compared to City of Ottawa By law 2003-514 for this report. These results (Paracel Reports 1737017, 1737231, and summary Table A) are attached in Appendix E.

On April 25, 2019, groundwater samples were collected from MW4-19 and MW5-19 as part of the hydrogeological assessment. The sample was submitted to Paracel Laboratories in Ottawa, Ontario under Chain of Custody No. 47665, for analysis of metals and mercury, General Inorganics, oil and grease, VOCs, SVOCs, PAH, formaldehyde, Nonylphenols, Ethoxylates, Hexachlorobenzene (OC pesticides), microbiological (E. coli), and PCBs. The results were compared to criteria described in City of Ottawa By Law 2003-514, which addresses discharge to the Municipal sewage system. A laboratory error led to the resampling of MW4-19 and MW5-19 on May 2, 2019 for the microbiological (E. coli) parameter. These samples were submitted under COC No. 47973, for analysis of microbiological (E. coli). Analytical results (Paracel Reports 1917649 and 1918483, and summary Table B) are attached in Appendix E.



## 2.5 Desktop Well Record Survey

The MECP Ontario Water Well Record database maintains an inventory of water supply wells, observation wells, and monitoring wells. Within 500 meters of the Site limits, the database identifies one water supply well, 13 observation wells, 33 test holes, 15 monitoring and test holes. Also identified are one abandoned water supply well, 13 abandoned 'other' wells, and nine abandoned 'unknown' wells. The locations of the registered boreholes and monitoring wells in the region are illustrated in Figure 3, and summary well details included in Appendix D. A review of the wells described in the database suggests that:

- North of the Site, limestone bedrock was typically encountered within 1.0 mbg
- East or southeast of the Site, limestone bedrock was typically encountered within 2.0 mbg
- South of the Site, limestone bedrock was typically encountered within 2.5 mbg within 250 m of the Site limits, but at greater depths (5.0 – 9.0 mbg) towards the southwest
- West of the Site, limestone bedrock was typically encountered within 1.5 mbg within 250 m of the Site, but at greater depths (<11 mbg) farther to the west.

The reviewed well and borehole records indicate that conditions in the Study area is typically a thin layer of overburden, resting on limestone bedrock. This is in agreement with the regional geology anticipated in the Study area as described previously in Section 1.2.

There was only a single water supply well located within 500 m of the Site:

- Water Supply Well 1508877 is located approximately 330 m south of the Site. Advanced in 1963 as a supply of cooling water for an air conditioning system, the well advancement was described as 0.0 m < fill < 1.2 m < sand and gravel < 7.0 m < limestone < 94.5 m < EOH. Sulphur water was encountered between 24.4 - 94.5 mbg, with a static water table at 3.7 mbg.

A review of the well record suggests that this well draws from a separate (deeper) aquifer than the proposed Site excavations, and that this deeper aquifer is semi-confined. This information, combined with the separation distance, suggests that this well will not be adversely impacted by the proposed excavation dewatering activities.

## 3. Geology and Hydrogeology

### 3.1 Overburden Materials

Notes on boreholes are provided in Appendix B. Boreholes advanced on the Site reveal that in general, soils consisted of:

- Boreholes BH1, BH2, BH3, BH4 and BH5 were drilled in a paved area which had an asphaltic concrete surface approximately 90 mm thick at the borehole locations and was followed by a base course crushed limestone fill material. Boreholes BH5, BH6, BH7, and BH8 were located in a grass covered landscaped area of the Site. The grass was supported by a very thin topsoil layer.
- A layer of fill, which ranged from 0.5 to 2.6 m thick consisting of a silty sand with noted presence of clay and gravel. Groundwater was not encountered in this layer.



- In some locations, the fill layer overlays a native glacial till, silty sand or sandy gravel deposit transitioning to a sandy silt ranging from 0.1 to 0.6 m thick above bedrock. Groundwater was not encountered in this layer.

This is in agreement with the regional geology as described previously in Section 2.1.

### 3.2 Bedrock Materials

- Horizontally bedded Limestone bedrock underlays the fill and native material. This is in agreement with the regional geology as described previously in Section 2.1.
- Groundwater was found in the limestone bedrock.
- The bedrock was highly weathered and fractured at the borehole locations. The quality of this rock was very poor with moulded RQDs of 29 to 50 within the upper of the bedrock, becoming excellent (RQD of above 90) below a depth of approximately 1.28 m (BH3) to approximately 4.55 m (BH1).

### 3.3 Aquifers/Aquitards

Review of the water level measurements obtained in September 2017, and April and May 2019, and a review of well descriptions in the Ontario Water Well Database suggest that there are two separate water bearing layers present on-Site:

- An upper unconfined aquitard, located in the upper layers of the bedrock. This aquitard was subjected to SWRT in four monitoring wells as described previously in Section 2.3:
  - SWRT of MW1-17 and MW6-19 suggest a hydraulic conductivity (k) of  $(3.7 - 6.6) \times 10^{-5}$  cm/s
  - SWRT of MW4-19 and MW5-19 suggest a hydraulic conductivity (k) of  $(1.0 - 2.0) \times 10^{-4}$  cm/s
  - The water table measured in the monitoring wells at the Site slopes towards the southwest, with a hydraulic gradient of 15 percent. The static water table has been illustrated in Figures 2b and 2c. It should be noted that the elevation of this unconfined water table varies over time in response to precipitation.
- A deeper (semi) confined aquifer was suggested in the Ontario Water Well Records (as evidenced by Water Supply Well 1508877). This well encountered sulphur groundwater between 24.4 - 94.5 mbg (between 31.1 meters below sea level, to 39 masl), with a static water table at 3.7 mbg. At the time of construction, this well maintained a pumping rate of 50 Litres/minutes (L/min) for an 8-hour test period, and the recommended pump rate was 50 L/min. Data is not available as to the stability of this semi-confined water table. As the deepest excavation at the Site will be advanced to 60 masl, and given the confined nature of this basal aquifer, the contribution from this deep aquifer has not been considered in this investigation.

For the purposes of this evaluation, it was assumed that the excavations will be completed in the uppermost unconfined aquitard; therefore low water takings are anticipated. As the hydraulic gradient approaches 15 percent towards the southwest, the saturated aquifer static depth will vary between excavations. The base of this aquitard is estimated at 55.5 masl, and the more conservative hydraulic conductivity value of  $2.0 \times 10^{-4}$  cm/sec was applied in all calculations.



### 3.4 Groundwater Quality in Unconfined Aquitard

Groundwater samples collected from the (upper) unconfined aquitard that will be accessed by the excavations in both the 2017 Phase Two ESA, and samples collected in 2019 were compared to the City of Ottawa By Law 2003-514, which addresses discharge to the municipal sewer system. This comparison is summarized in Tables A and B, included in Appendix E.

When the analytical results are compared to the criteria listed in Schedule A Table 1 (Discharge to Sanitary or Combined Sewers), it is noted that:

- In 2017, all tested parameters collected from MW1-17, MW2-17, MW3-17, and MW4-17 were in compliance with the combined/sanitary sewer criteria.

Note that the 2017 sampling event was undertaken as part of the Phase Two ESA, with comparison to the identified Contaminants of Concern for the Site. Accordingly, the reported results of metals represent dissolved metals (a filtered groundwater sample) and laboratory reporting was in the appropriate units for comparison to O. Reg. 153/04, not for comparison to By-Law 2003-514. In addition, some of the parameters included in the sewer use by-law were not analysed as part of that sampling event, including CBOD, cyanide (total), fluoride, pH, phenolics, total phosphorus, sulphate, sulphide, TKN, TSS, Total PAH, a number of the Semi-VOCs, Dioxins & Furans (total), Formaldehyde, N-Nitrosodimethylamine (NDMA), Nonylphenols & Ethoxylates, and Hexachlorobenzene (OC Pesticides).

- In 2019, all tested parameters from MW4-19 and MW5-19, are in compliance with the combined/sanitary sewer criteria.

Note that analysis of the parameters Dioxins & Furans (total), Formaldehyde, N-Nitrosodimethylamine (NDMA), and Nonylphenols & Ethoxylates were not requested for analysis. As noted previously, a laboratory error led to the resampling of MW4-19 and MW5-19 on May 2, 2019 for the microbiological (E. coli) parameter.

Based on these observations, the sediment filtered discharge from the excavation to the municipal Sanitary/Combined sewers could be considered, pending approval from the City of Ottawa. The discharge would be a combination of groundwater, surface water runoff and precipitation into the excavation and would require further assessment to verify its quality. City of Ottawa approval, sewer-use discharge permit and pre-treatment will be required prior to discharge to the sewer.

When the analytical results are compared to the criteria listed in Schedule A Table 2 (Discharge to Storm Sewers), it is noted that:

- In 2017, both Ethylbenzene and Total Xylene was reported in excess of Storm Sewer Criteria in the duplicate sample of MW3-17.

Note that the 2017 sampling event was undertaken as part of the Phase Two ESA, with comparison to the identified Contaminants of Concern for the Site. Accordingly, the reported results of metals represent dissolved metals (a filtered groundwater sample) and laboratory reporting was in the appropriate units for comparison to O. Reg. 153/04, not for comparison to By-Law 2003-514. In addition, some of the parameters included in the sewer use by-law were not analysed as part of that sampling event, including the parameters E.coli, cyanide (total),





TSS, phenolics, total phosphorus, oil/grease, Total PAH, PCBs, Nonylphenols & Ethoxylates, and Hexachlorobenzene (OC Pesticides).

- In 2019, TSS was reported in excess of the Storm Sewer Criteria in MW4-19 and MW5-19.

Note that the parameters Nonylphenols & Ethoxylates were not included in the analysis.

In the event that water takings are required during development construction activities, the untreated groundwater discharge is not anticipated to meet the storm sewer use criteria.

All discharge from the proposed excavations would be a combination of groundwater, surface water runoff and precipitation into the excavation and would require further assessment to verify its quality. City of Ottawa approval, a sewer-use discharge permit, and pre-treatment will be required prior to discharge to the sewer.

## 4. Water Taking Evaluation

The Site specific borehole drilling data, results of the hydraulic testing (i.e., single well response tests) and groundwater water monitoring were utilized to determine the aquifer hydraulic properties (hydraulic conductivity) and conditions to provide the basis for estimating the construction water taking rates and area of influence. The water takings and area of influence were determined using the field test results and by employing analytical modelling methods, as presented below.

The projected drawdown was calculated as a partially penetrating excavation in an unconfined aquifer with the following conditions:

Table 4.1 Assumed Hydrogeologic Details for Dewatering

		Excavation A	Excavation B	Excavation C
Excavation Type		Trench	Well	Trench
Base of Aquifer	(masl)	55.5	55.5	55.5
Initial				
Groundwater elevation	(masl)	64.5	64.0	65.2
Groundwater Water Column	(m)	9.0	8.5	9.7
Target				
Groundwater elevation	(masl)	62.6	60.25	64.0
Groundwater Water Column	(m)	7.1	4.75	8.5
Water Table Drawdown	(m)	1.9	2.2	1.2
Excavation	(m)	2.0 x 49	50 x 27 (radius 20.8)	17 x 7.0
Base of Sump	(masl)	62.2	60.25	63.5
K (cm/s)	(cm/s)	$2.0 \times 10^{-4}$	$2.0 \times 10^{-4}$	$2.0 \times 10^{-4}$
Radius of influence	(m)	5.6	36.6	8.6
Estimated Q (no safety factor)	(m <sup>3</sup> /day)	36.1	47.4	20.7
Estimated Q (safety factor = 1.5)	(m <sup>3</sup> /day)	54.2	71.0	31.1



These 'worst case' parameters have been used in the flow calculations, included in Appendix F.

The radius of influence ( $R_o$ ) was estimated using an empirical relationship developed by Sichardt and Kryieleis that gives  $R_o$  as a function of drawdown and hydraulic conductivity (Powers et al., 2007). It is important to note that this equation gives a conservative estimate of  $R_o$ .

$$R_o = 3000(H - h)\sqrt{K} \quad (\text{For circular source})$$

$$R_o = 1750(H - h)\sqrt{K} \quad (\text{For line source})$$

Steady state dewatering ( $Q$ ) into Excavation A and C have been estimated using empirical relationships developed by Sichardt and Kryieleis that gives  $R_o$  as a function of drawdown and hydraulic conductivity (Powers et al., 2007 & Sichardt and Kryieleis, 1930):

$$Q = \frac{\pi K (H^2 - h_w^2)}{\ln R_o / r_w} + 2 \left[ \frac{xK (H^2 - h^2)}{2L} \right] \quad (\text{For steady state infiltration into a trench})$$

$$r_w = \frac{a + b}{\pi}$$

There are a number of assumptions to this method, including:

- Homogeneous material
- Steady state
- Initial horizontal potentiometric surface
- Unconfined aquifer
- Partially penetrating well
- Gravity flow
- Semi-circular source
- Effect of a large rectangular excavation is equivalent to circular excavation of same area

Similarly, the steady state dewatering ( $Q$ ) into Excavation B was estimated using:

$$Q = \frac{\pi K (H^2 - h_w^2)}{\ln R_o / r_w} \quad (\text{For steady state into a semi-penetrating shaft})$$

$$r_w = \sqrt{\frac{ab}{\pi}}$$

A safety factor of 1.5 was applied to the estimated infiltration rates. Based on the above assumptions, assuming simultaneous flow into all three excavations, and assuming no interference from the other open excavations, groundwater flows could approach 156,300 L/day. The initial flows from the excavation will be approximately two to three times greater than the steady state, or near 350,000 L/day.

The effect of precipitation falling directly into three open excavations would contribute an additional 15,670 L/1.0 cm of precipitation. The effect of groundwater falling within the radius of influence was



not included, as the vast majority of this water will fall on hardened surfaces (rooftops, paved streets, sidewalks, paved parking areas) and so be diverted to the municipal storm water collection system prior to entering the groundwater table.

It is important to note that these values are conservative and represent 'worst case' volumes during the construction period. In reality, the actual flows are anticipated to be significantly less than those described;

- The calculations have assumed simultaneous dewatering of all excavations on the Site. In actuality, the excavations will likely be staged across the Site.
- As evidenced in Figure 2c of this report, the hydraulic gradient in the observed groundwater table was 15 percent. The 'worst case' calculations used to generate the flow estimates have utilized the highest water table elevations measured in each excavation (in the northeast corner), while the water tables in the southwest corners of each excavation are anticipated to be substantially lower. Additionally, the water table measurements were collected during the spring, when unconfined water tables are at seasonal maximum.
- The calculations have not included the additive effect of dewatering multiple excavations in close proximity; as groundwater is removed from one excavation the radius of influence will intrude on the adjacent excavations, decreasing the starting water table elevations in those locations.
- The calculations have utilized the highest hydraulic conductivity of the completed SWRT completed at the Site. As indicated previously (in Section 2.2 of this report) the SWRT identified that the hydraulic conductivity ranges nearly a full magnitude across the Site.
- A safety factor of 1.5 has been applied to the calculated flow estimates.

Accordingly, the Owner should be aware of the limitations associated with the flow volume estimate contained in this report before utilizing the flow estimates for any use beyond their intended purpose (the generation of worst case estimates to assess the need for a Permit To Take Water or an EASR application for construction).

Based on the above assumptions, we suggest that that the Client should:

- Submit an EASR application to remove water from the Site, allowing for a water taking volume of 400,000 Litres/day (L/day) for the purposes of the submission.
- Obtain a City Ottawa Discharge Permit to allow discharge to the local municipal sewer system. Note that this application may have volume discharge restrictions placed on the Site by the municipality, based on the volumetric capacity of the surrounding City of Ottawa sewer systems.

## 5. Impact Assessment

This section provides an impact assessment with respect to the identified receptors of concern relevant to this PTTW submission. Construction methods will also be employed to reduce or eliminate the need for water takings where possible.



## 5.1 Private Wells

As illustrated in Figure 3, there is one water supply well identified within 500 metres of the Site. There are 15 observation wells, 15 monitoring and test holes, and nine unknown wells registered with the MECP for properties within approximately 500 m of the Site.

There is one well used as a groundwater supply well to supply water for an industrial air conditioning system, located 330 m to the south of the Site limits, in a separate aquifer. Given that the Site is located in an urban area within the City of Ottawa and that municipally treated water is available, it is not suspected that there are any active potable water wells remaining within the study area.

There will be no impact on groundwater use from the proposed water taking.

## 5.2 Surface Water Features

The nearest surface water body indicated on the mapping is Dows Lake which is located approximately 950 m to the southeast, with the Ottawa River being approximately 1.1 km north of the Site.

Due to the distance of the Site from these water bodies, and the volumes of the river and lake, there will be no impact to surface water from the proposed water taking.

## 5.3 Geotechnical Impacts

The boreholes encountered a thin layer of surficial fill, underlain in some locations by a native Glacial Till, Silty Sand or Sandy Gravel deposits followed by Limestone bedrock with a water table near 1.5 - 4.5 m below surface.

The Site is surrounded by existing buildings, it is assumed that these buildings are founded directly on the bedrock. A survey of the adjacent buildings has not been mandated to GHD as of the date of publishing of this report.

Geotechnical impacts are not anticipated, as buildings in the area are founded on shallow bedrock, and infrastructure is founded on unsaturated soils.

## 5.4 Dewatering Discharge

The construction water takings will require sediment filtration prior to discharge.

The sediment treated water will be directed to the municipal sewer system, pending approval from the City of Ottawa in the form of a Discharge Permit.

The Owner must be aware that the City of Ottawa may impose a daily volume cap on dewatering activities, to prevent the possible overloading of the municipal sewer system. This volume cap may require the Owner to stage the excavations to minimize dewatering.



## 6. Monitoring and Contingency Plan

Although no effects on private wells, surface water features or geotechnical issues are anticipated, the following section presents the monitoring and contingency plan that will be in place throughout the duration of the construction.

1. The volume and rate of the water takings will be recorded daily for each sump, and measured using a flow meter or other acceptable method.
2. The daily groundwater discharge shall be maintained below the limits identified in both the MECP permit, and the City of Ottawa Discharge Permit.
3. Based on water samples collected on April 25, and May 2, 2019, the discharge water chemical concentrations generally comply with the City of Ottawa Sewer By-Law (Sanitary/Combined Sewer). A sediment filter bag will be placed between the pump and the discharge to the municipal sanitary sewer, to prevent sediment from the excavation from overloading the municipal sanitary sewer. The contractor will ensure discharge water quality meets applicable limits as required in the City of Ottawa Discharge Permit.
4. During excavation, if the contractor observes that influent groundwater is washing aggregate into the excavation, the contractor will halt excavation. The excavation will immediately be reviewed to minimize the risk of possible settling of the adjoining streets, in a manner approved by the geotechnical engineer.
5. Discharge Water Quality will be monitored as required in the City of Ottawa Discharge Permit.
6. Similarly, if the contractor encounters a layer of bedrock that is presenting a very high rate of groundwater seepage, GHD should be contacted to determine if mitigation measures are required.

## 7. Summary and Conclusions

GHD requests on behalf of the Client that the MECP consider this hydrogeological assessment in support of an EASR submission for construction water takings anticipated to exceed 50,000 L/day and for a period of greater than 30 days.

It is assumed that temporary water takings are required for duration of one year.

The construction groundwater takings are estimated to be a maximum of 400,000 L/day for the purposes of submission, with typical water takings anticipated to be less than 100,000 L/day, based on construction mitigation methods that will be employed to reduce the water takings.

The upset limit of 400,000 L/day for this temporary water taking provides a conservative estimate of groundwater takings, allows for contingency takings to dewater quickly in the event of flooding due to a significant precipitation event, and provides a moderate safety factor.

It is proposed that three excavations will be advanced below the local water table; a 49 m x 2.0 m service trench, a 50 m x 27 m excavation for an underground parking garage equipped with an elevator pit, and a 17 m x 7.0 m excavation for an on-Site storm water storage chamber. Sumps will





be placed in the base of each excavation to passively collect water at various locations in the excavation. The water in these sumps will then be pumped through a filter bag that will reduce sediments. The discharge from the filter bag will be directed to the Ottawa Sewer System.

Based on the results of the hydrogeological study in support of the Ottawa Community Housing Corporation EASR Submission, the following conclusions are provided:

1. The proposed excavation construction is anticipated to fully penetrate the overburden, and extend into the bedrock.
2. The maximum water table drawdown required in the excavation for construction purposes ranges between 1.2 - 2.2 m, to ensure safe, dry working conditions.
3. The steady state water takings are estimated to be 156,300 L/day. Prior to achieving steady state, the initial flows could be expected to be two to three times steady state values, or up to 350,000 L/day. Using the analytical model, a water taking of this magnitude is predicted to result in an area of influence up to 37 m from the centreline excavations at steady state.
4. Where construction mitigation methods are employed, the maximum water taking (400 m<sup>3</sup>/day) allows for quickly lowering groundwater levels to the invert elevation or removal of precipitation and surface water runoff into the excavation, as may be needed. (A 1.0 cm precipitation event falling directly into the 1567 m<sup>2</sup> excavations would add 15,670 L to the daily dewatering volumes.)
5. There will be no impact of the construction dewatering to surface water features, given the distance to the nearest surface water body (Dows Lake which is located approximately 950 m to the southeast, with the Ottawa River being approximately 1.1 km north of the Site). No discharge water will be directed to surface water bodies.
6. There will be no impact of the construction dewatering to wells, given the municipal water use in the proposed area of influence, and the single groundwater well in the Ontario Water Well Records database being described as 330 m distant and in the confined deep aquifer. In the unlikely event of a well interference complaint, the issue will be investigated and verified, and mitigated as needed.
7. Geotechnical impacts to surrounding buildings are not anticipated, due to the shallow bedrock found at the Site.
8. During excavation, if the contractor observes that influent groundwater is washing aggregate into the excavation, the contractor will halt excavation and backfill to prevent further washout erosion. The excavation will immediately be reviewed to minimize the risk of possible settling of the adjoining area under the supervision of the geotechnical engineer.
9. During excavation, if the contractor observes water bearing layers of bedrock that is presenting a very high rate of groundwater seepage, GHD should be contacted to determine if mitigation measures are required.
10. Although no effects on private wells, surface water features or geotechnical issues are anticipated, monitoring water takings will be implemented throughout the duration of the construction to assess the area of influence. The monitoring program will assess and verify effects during the construction, and will be used to support mitigation if necessary.



We trust that this report meets with your requirements. Please do not hesitate to contact us, should any questions arise.

All of Which is Respectfully Submitted,

GHD

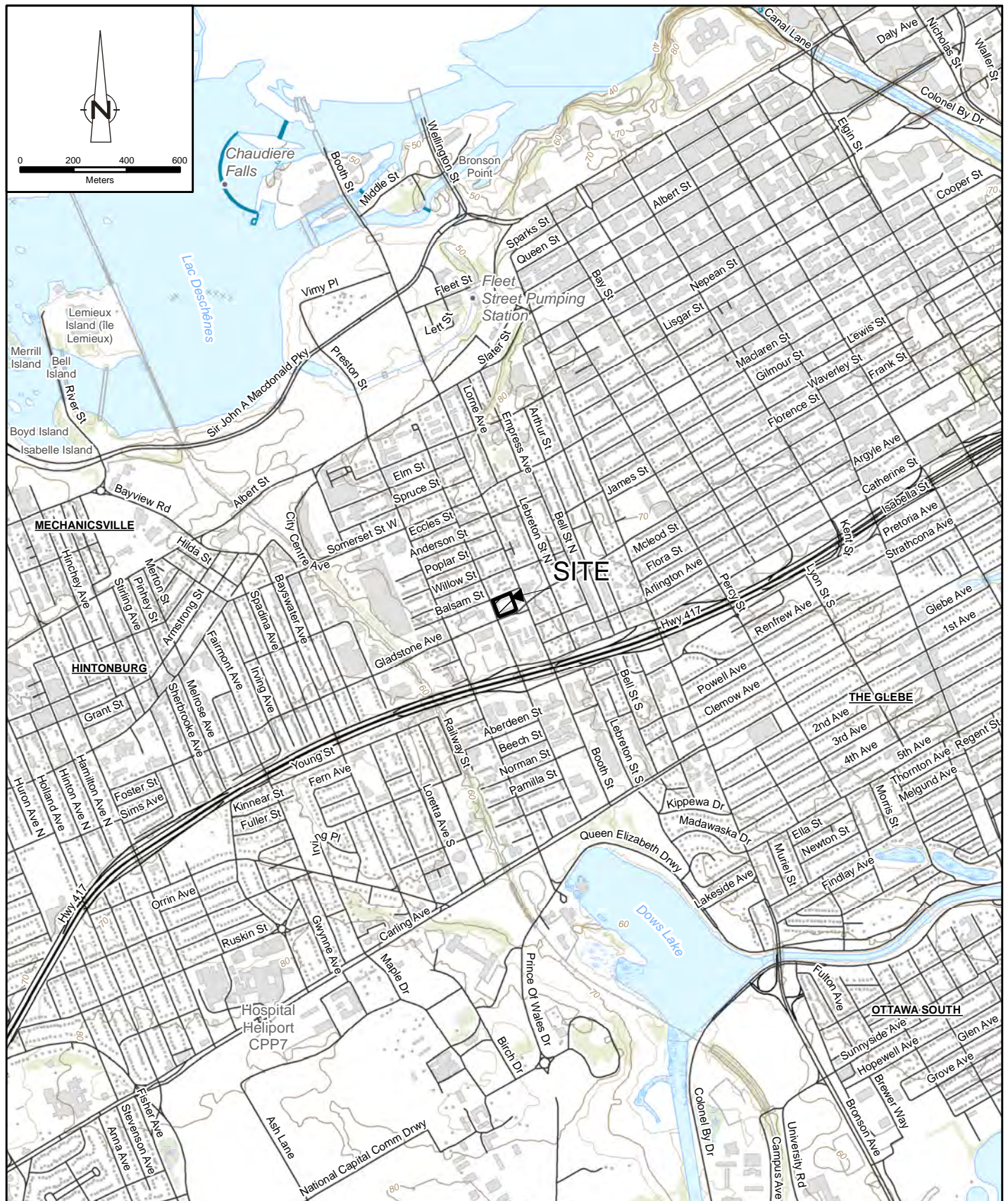
A handwritten signature in black ink that reads 'S Wallis'.

Scott Wallis, B.Sc.

A handwritten signature in blue ink that reads 'Philip Smart'.

Philip Smart, P. Geo





Source: MNRF NRVIS, 2015. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2019  
 Coordinate System: NAD 1983 UTM Zone 18N



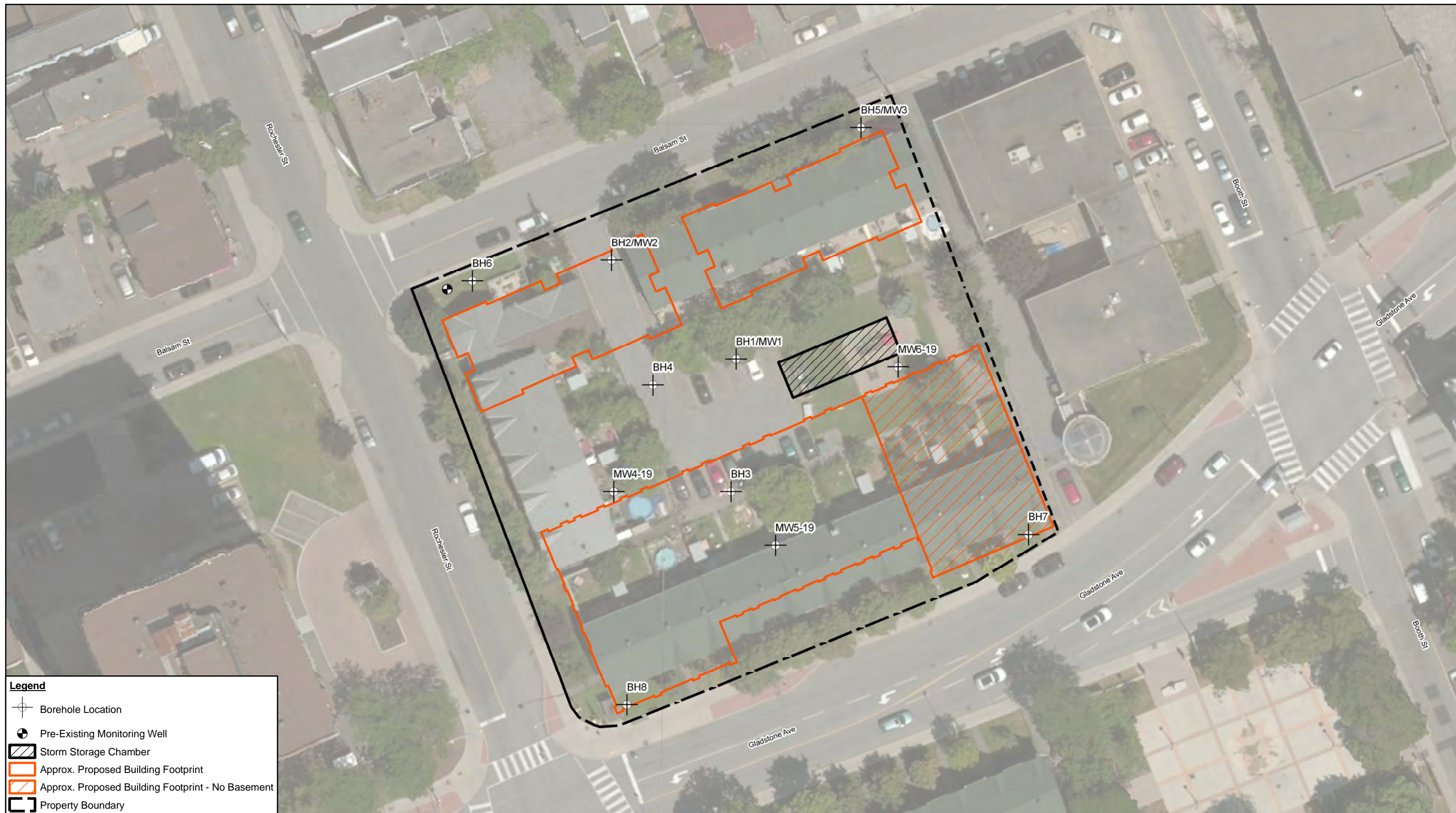
OTTAWA COMMUNITY HOUSING  
 811 GLADSTONE AVENUE, OTTAWA, ON  
 HYDROGEOLOGICAL ASSESSMENT

11140575-E3  
 May 1, 2019

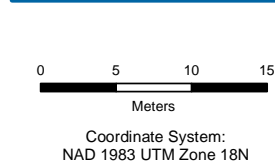
SITE LOCATION MAP

FIGURE 1





Source: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation, July 2013



OTTAWA COMMUNITY HOUSING  
811 GLADSTONE AVENUE, OTTAWA, ON  
HYDROGEOLOGICALASSESSMENT

BOREHOLE LOCATION PLAN

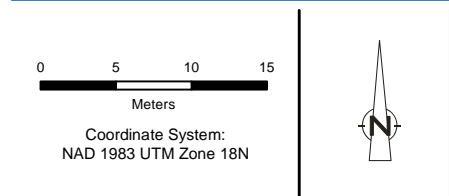
11140575-E3  
May 6, 2019

FIGURE 2a





Source: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation, July 2013



OTTAWA COMMUNITY HOUSING  
811 GLADSTONE AVENUE, OTTAWA, ON  
HYDROGEOLOGICAL ASSESSMENT

STATIC WATER TABLE 25 APRIL 2019

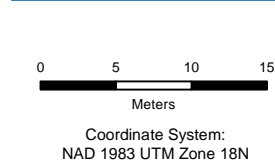
11140575-E3  
May 13, 2019

FIGURE 2b





Source: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation, July 2013



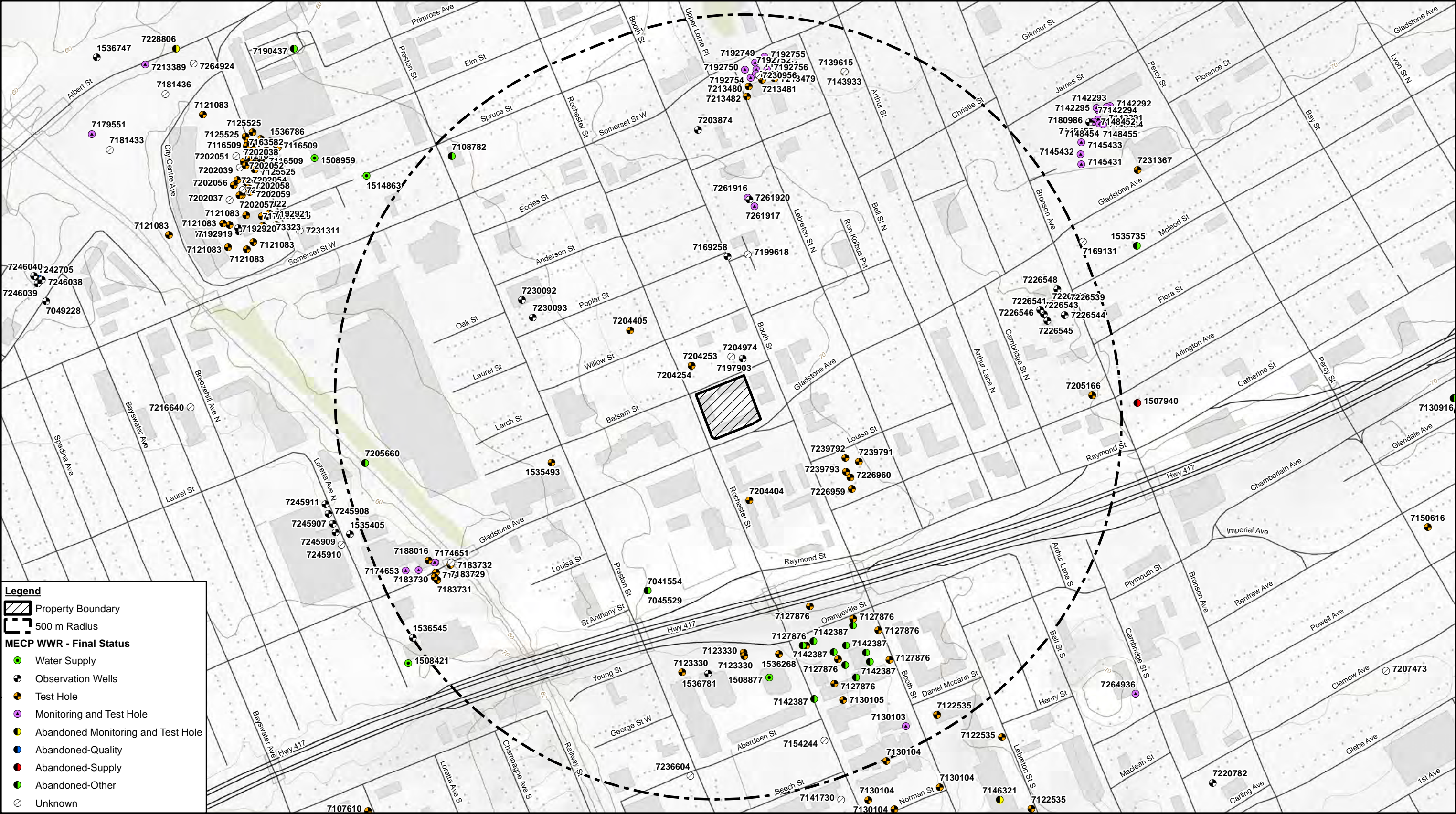
OTTAWA COMMUNITY HOUSING  
811 GLADSTONE AVENUE, OTTAWA, ON  
HYDROGEOLOGICAL ASSESSMENT

STATIC WATER TABLE 2 MAY 2019

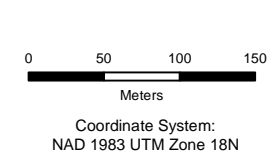
11140575-E3  
May 13, 2019

FIGURE 2c





Source: MNRF NRVIS, 2018. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2019; WWIS, 2017. Ontario Ministry of the Environment, Conservation and Parks. (Accessed January 2017).



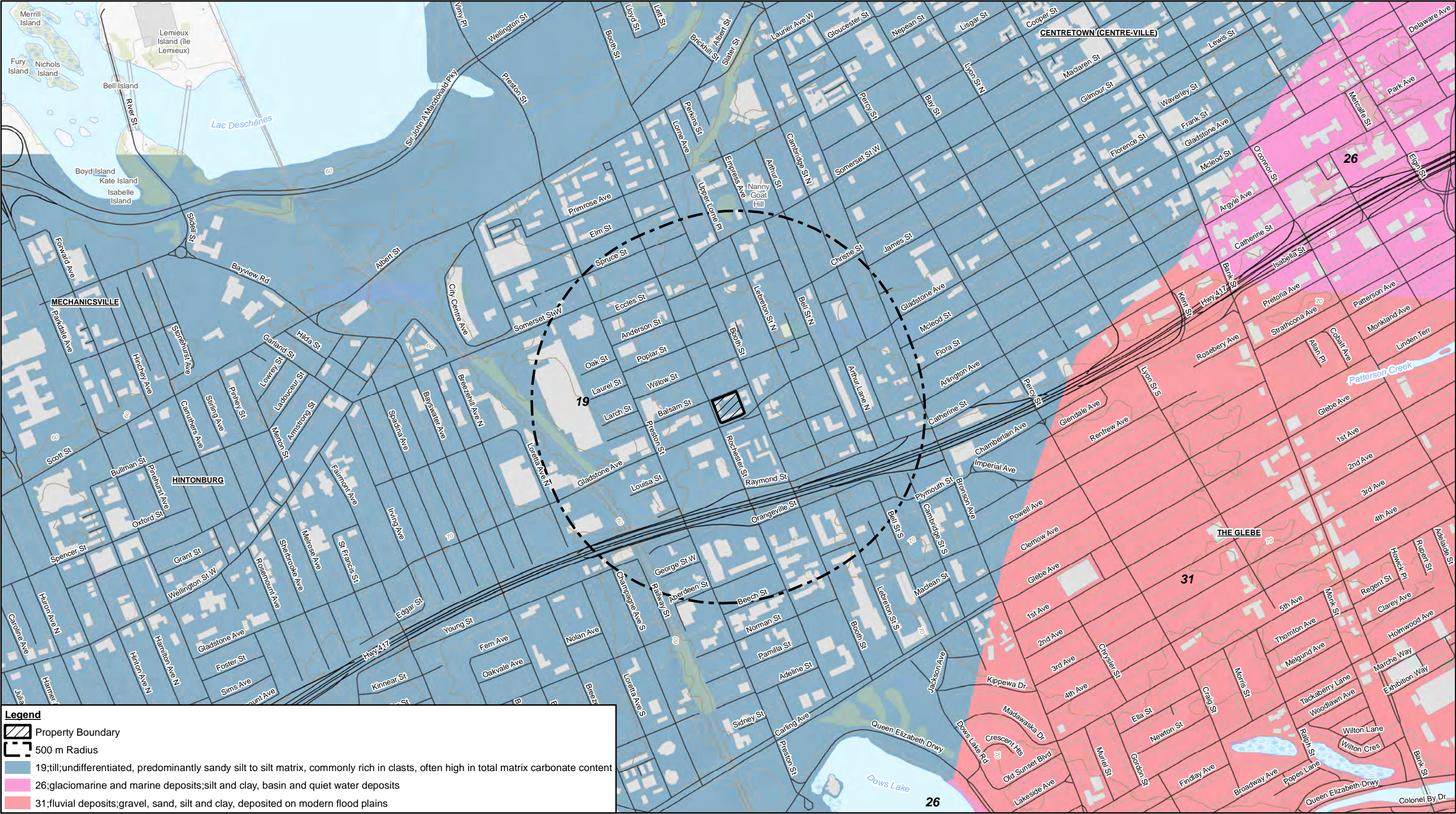
OTTAWA COMMUNITY HOUSING  
811 GLADSTONE AVENUE, OTTAWA, ON  
HYDROGEOLOGICAL ASSESSMENT

MECP WATER WELLS

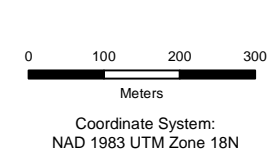
11140575-E3  
May 1, 2019

FIGURE 3





Source: MNRF NRVIS, 2018. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2019; WWIS, 2017. Ontario Ministry of the Environment, Conservation and Parks. (Accessed January 2017).



OTTAWA COMMUNITY HOUSING  
811 GLADSTONE AVENUE, OTTAWA, ON  
HYDROGEOLOGICAL ASSESSMENT

QUATERNARY GEOLOGY

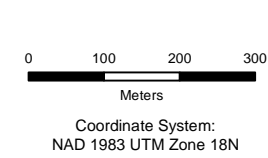
11140575-E3  
May 1, 2019

FIGURE 4





Source: MNRF NRVIS, 2018. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2019; WWIS, 2017. Ontario Ministry of the Environment, Conservation and Parks. (Accessed January 2017).



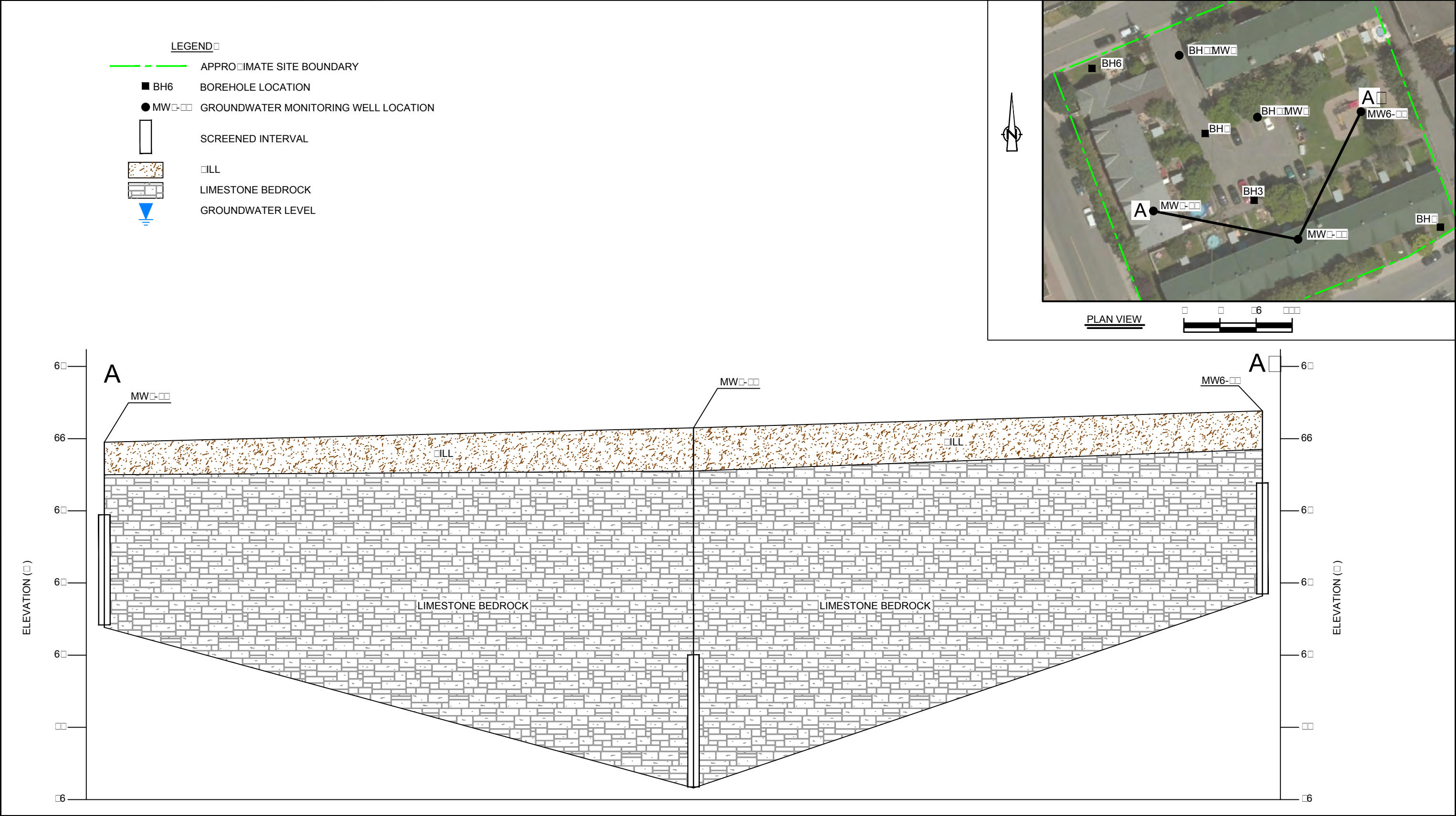
OTTAWA COMMUNITY HOUSING  
811 GLADSTONE AVENUE, OTTAWA, ON  
HYDROGEOLOGICAL ASSESSMENT

BEDROCK GEOLOGY

11140575-E3  
May 1, 2019

FIGURE 5





# Appendices

# Appendix A

## Provided Documents



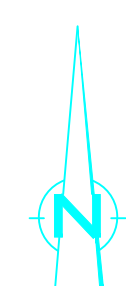


BALSAM STREET

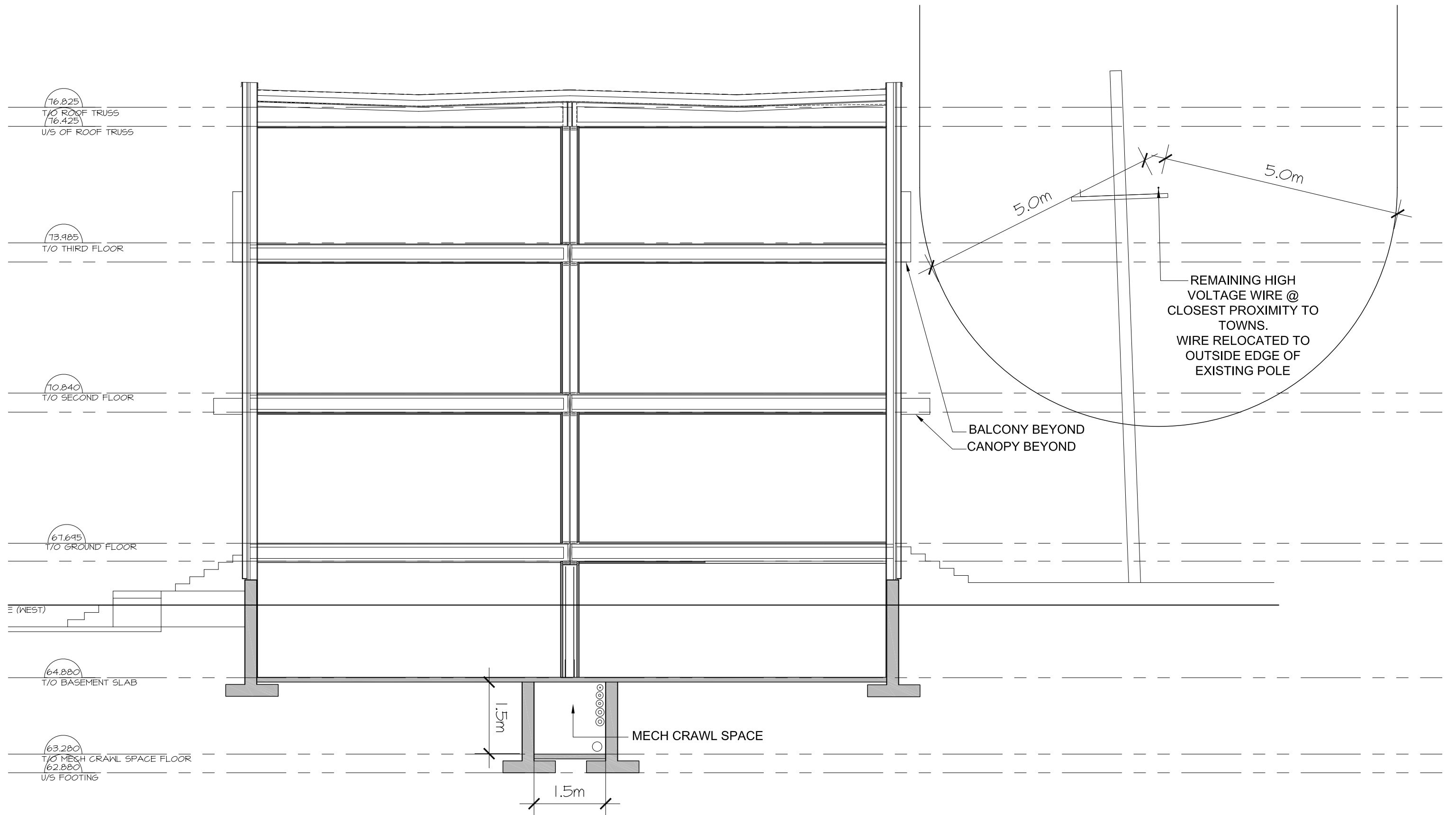
BOOTH STREET

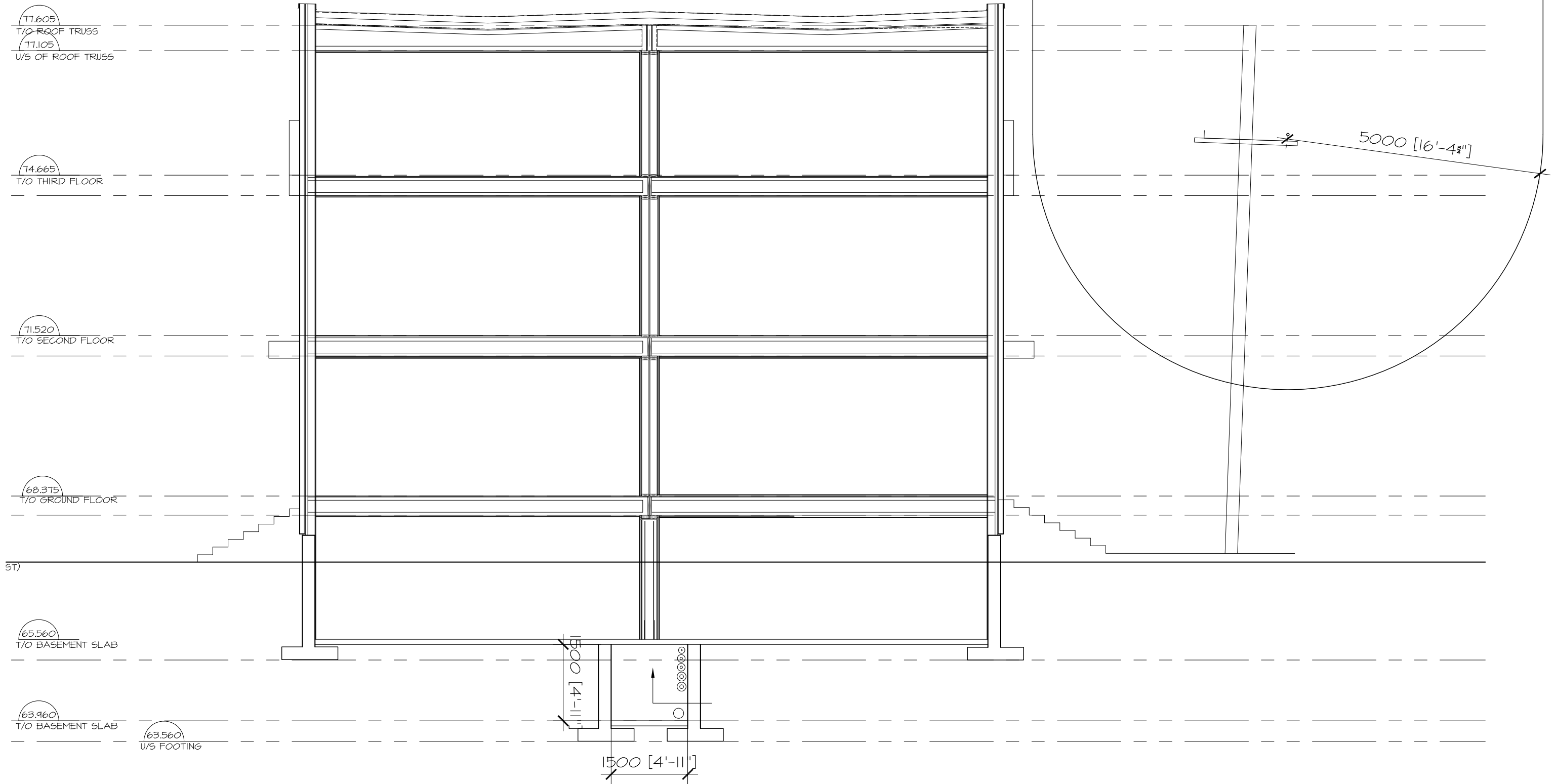
ROCHESTER STREET

GLADSTONE AVENUE













**HOBIN**  
ARCHITECTURE

REVISION NO  
#1792

D02-02-18-0107/ D07-12-18-0181

## Appendix B

### Borehole Logs

BOREHOLE No. **BH1-17/MW1-17**

ELEVATION: 66.00 m

## BOREHOLE LOG

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: S. Wallis

DATE (START): 22 August 2017

DATE (FINISH): 22 August 2017

## LEGEND

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- ☒ Water Level
- ☒ Water content (%)
- ☒ Atterberg limits (%)
- ☒ Penetration Index based on Split Spoon sample
- ☒ Penetration Index based on Dynamic Cone sample
- ☒ Shear Strength based on Field Vane
- ☒ Shear Strength based on Lab Vane
- ☒ Sensitivity Value of Soil
- ☒ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY		MONITOR WELL	SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK		Type and Number	Recovery	OVC	Penetration Index / RQD
meters	66.00		GROUND SURFACE			%	ppm	N
0.5	65.9 65.6 65.5		<b>ASPHALT</b> (Approximately 0.1 m thick)	0.05	Auger SS1	5/15		
1.0			<b>FILL</b> -Gravelly sand, dense, grey, damp.	0.66 Bentonite	RC1	36/41		60
1.5			<b>SAND AND GRAVEL</b> -Loose, brown, damp. *Auger refusal at 0.475 m, continued with rock coring	1.27 Riser 1.48 WL 1.50 05/02/2019	RC2	60/60		82
2.0			<b>LIMESTONE</b> -Grey, weathered and fractured, fair quality. Water level : 1.89 mbgs *Becoming good	Sand	RC3	57/60		89
2.5				Screen	RC4	60/60		93
3.0								
3.5								
4.0								
4.5								
5.0			*Becoming excellent					
5.5								
6.0	59.9		Borehole ended at approximately 6.15 m in limestone	6.05 6.15				
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:



BOREHOLE No. BH2-17/MW2-17

ELEVATION: 66.21 m

## BOREHOLE LOG

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: S. Wallis

DATE (START): 25 August 2017

DATE (FINISH): 25 August 2017

## LEGEND

- SS Split Spoon
- GS Auger Sample
- ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- Δ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY		MONITOR WELL	SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK		Type and Number	Recovery	OVC	Penetration Index / RQD
meters	66.21		GROUND SURFACE			%	ppm	N
0.5	66.1 65.8 65.6		ASPHALT (Approximately 0.1 m thick)	0.05 Sand 0.61	SS1	12/20		9
1.0			FILL - Gravelly sand, loose, grey, damp.	Bentonite	RC1	23/23		65
1.5			SILTY SAND - Some gravel, compact, grey with reddish-brown staining, damp. *Auger refusal at 0.6 m, continued with rock coring	1.35 Riser 1.55				
2.0			LIMESTONE - Grey, weathered and fractured, fair quality. *Water was whiteish at start, transitioning to grey. Water level : 2.74 mbgs	WL 2.10 05/02/2019	RC2	60/60		88
2.5			*Becoming good					
3.0			*Becoming excellent	Sand	RC3	58/58		98
3.5				Screen				
4.0					RC4	52/52		100
4.5								
5.0								
5.5								
6.0	60.0			6.13 6.22	RC5	28/28		100
6.5			Borehole ended at approximately 6.2 m in limestone					
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:





**BOREHOLE No.:** BH3-17  
**ELEVATION:** 65.80 m

**BOREHOLE LOG**

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: S. Wallis

DATE (START): 25 August 2017

DATE (FINISH): 25 August 2017

**LEGEND**

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY			SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	65.80		GROUND SURFACE			%	ppm	N
	65.7		ASPHALT (Approximately 0.1 m thick)	SS	11/25			9
0.5	65.4		FILL-Gravelly sand, loose, grey, damp.					
	65.0		SILTY SAND-some gravel, compact, grey, moist.					
1.0			*Auger refusal at 0.76 m, continued with rock coring					
1.5			LIMESTONE-Grey, weathered and fractured, fair quality.	RC1	22/22			64
2.0			*Becoming excellent					
2.5								
3.0	63.1		Borehole ended at approximately 2.7 m in limestone	RC2	57/57			93
3.5								
4.0								
4.5								
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:



**BOREHOLE No.:** BH4-17  
**ELEVATION:** 65.80 m

**BOREHOLE LOG**

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: S. Wallis

DATE (START): 25 August 2017

DATE (FINISH): 25 August 2017

**LEGEND**

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY			SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	65.80		GROUND SURFACE			%	ppm	N
	65.7		ASPHALT (Approximately 0.1 m thick)					
0.5	65.4		FILL - Gravelly sand, compact, grey, damp.		SS1	10/16		19
	65.3		TILL - Silty sand, some gravel, loose, greyish brown, damp.					
1.0	65.1		*Auger refusal at 0.5 m, continued with rock coring		RC1	27/27		78
1.5			LIMESTONE - Grey, weathered and fractured, good quality.					
2.0			Mudseam: 2.38 to 2.4m					
2.5					RC1	60/60		85
3.0	63.1		Borehole ended at approximately 2.7 m in limestone					
3.5								
4.0								
4.5								
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:

BOREHOLE No. **BH5-17/MW3-17**

ELEVATION: 67.06 m

## BOREHOLE LOG

Page: 1 of 1

CLIENT: Ottawa Community Housing CorporationPROJECT: Geotechnical InvestigationLOCATION: 811 Gladstone Avenue, Ottawa, OntarioDESCRIBED BY: R. VandentillaartCHECKED BY: S. WallisDATE (START): 28 August 2017DATE (FINISH): 28 August 2017

## LEGEND

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY		MONITOR WELL	SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK		Type and Number	Recovery	OVC	Penetration Index / RQD
meters	67.06		GROUND SURFACE			%	ppm	N
0.5	67.0 66.8 66.4		<b>TOPSOIL</b> -Silty sand, brown, loose, moist. (Approximately 0.1 m thick)	0.05	SS1	7/24		15
1.0			<b>FILL</b> -Sand and gravel, brown, loose, damp. Mudseam : 0.9 to 0.91m	0.61 Bentonite				
1.5			<b>LIMESTONE</b> -Grey, weathered and fractured, poor quality. Water level : 2.17 mbgs	1.09 Riser	RC1	60/60		50
2.0				1.30				
2.5			*Becoming good		RC2	30/30		80
3.0				WL 2.60 05/02/2019				
3.5			*Becoming excellent	Sand	RC3	45/45		92
4.0				Screen	RC4	27/27		100
4.5					RC5	47/47		100
5.0								
5.5								
6.0	61.2		Borehole ended at approximately 5.87 m in limestone	5.87				
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:



**BOREHOLE No.:** BH6-17  
**ELEVATION:** 66.42 m

**BOREHOLE LOG**

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: S. Wallis

DATE (START): 28 August 2017

DATE (FINISH): 28 August 2017

**LEGEND**

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY			SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	66.42		GROUND SURFACE			%	ppm	N
0.5	66.2		<b>TOPSOIL</b> -Silty sand with organics (grass), very loose, dark brown, moist. (Approximately 0.18 m thick)		SS1	7/24		4
1.0	65.3		<b>FILL</b> -Silty sand, trace organics, loose, dark brown, moist.		SS2	5/20		22
1.5			*Auger refusal at 1.1 m, continued with rock coring <b>LIMESTONE</b> -Grey, weathered and fractured, poor quality. *Becoming excellent		RC1	25/25		30
2.5					RC2	47/47		96
3.0	63.5		Borehole ended at approximately 2.9 m in limestone					
3.5								
4.0								
4.5								
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

SCALE FOR TEST RESULTS  
 50kPa 100kPa 150kPa 200kPa  
 10 20 30 40 50 60 70 80 90

NOTES:



**BOREHOLE No.:** BH7-17  
**ELEVATION:** 66.38 m

**BOREHOLE LOG**

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: S. Wallis

DATE (START): 29 August 2017

DATE (FINISH): 29 August 2017

**LEGEND**

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY			SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	66.38		GROUND SURFACE			%	ppm	N
0.5	66.3		<b>TOPSOIL</b> -Silty sand with organics (grass), very loose, dark brown, moist. (Approximately 0.1 m thick)		SS1	12/20		10
1.0	65.7		<b>FILL</b> - Sand some gravel, loose, light brown, moist. *Auger refusal at 0.66 m, continued with rock coring		RC1	14/19		29
1.5			<b>LIMESTONE</b> -Grey, weathered and fractured, poor quality.		RC2	15/15		40
2.0			*Becoming excellent					
2.5					RC3	57/56		93
3.0	63.4		Borehole ended at approximately 2.9 m in limestone					
3.5								
4.0								
4.5								
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:



**BOREHOLE No.:** BH8-17  
**ELEVATION:** 65.37 m

**BOREHOLE LOG**

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: S. Wallis

DATE (START): 29 August 2017

DATE (FINISH): 29 August 2017

**LEGEND**

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY			SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	65.37		GROUND SURFACE			%	ppm	N
0.5	65.2		<b>TOPSOIL</b> -Silty sand with organics (grass), loose, dark brown, moist. (Approximately 0.18 m thick)		SS1	10/24		4
1.0	64.3		<b>FILL</b> - Sand and gravel, loose, dark brown, moist.		SS2	6/24		10
1.5			<b>FILL</b> - Gravel some sand trace silt and clay, loose, greyish brown, damp.		SS3	3/24		34
2.0					SS4	3/18		
2.5	63.1		<b>CONCRETE</b>					
3.0	62.8		<b>LIMESTONE</b> -Grey, weathered and fractured, poor quality. *Becoming good		RC1	12/24		25
3.5					RC2	39/39		82
4.0	61.5		Borehole ended at approximately 3.9 m in limestone					
4.5								
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

SCALE FOR TEST RESULTS  
 50kPa 100kPa 150kPa 200kPa  
 10 20 30 40 50 60 70 80 90

NOTES:



**BOREHOLE No.:** MW4-19  
**ELEVATION:** 65.66 m

**BOREHOLE LOG**

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: J. Bennett

DATE (START): 16 April 2019

DATE (FINISH): 16 April 2019

**LEGEND**

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY		MONITOR WELL	SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	65.66		GROUND SURFACE			%	ppm	N
0.5	64.8		<b>FILL</b> - Sand, brown, moist *Becoming Sand and gravel, grey *Auger refusal at 0.86 m, continued with rock coring	0.12 0.30				
1.0			<b>LIMESTONE</b> - shale laminations, grey, weathered and fractured, poor to fair quality, medium strong, close to moderately close, closed to gapped joints, some fossiliferous beds throughout 10 mm thick infilled seam at 1.4 mbgs *Becoming good quality	Bentonite	RC1	100		56
1.5				1.78 Riser	RC2	100		48
2.0				2.08				
2.5				Sand				
3.0				WL 3.30 05/02/2019 Screen	RC3	100		80
3.5								
4.0					RC4	100		87
4.5								
5.0	60.5		Borehole ended at approximately 5.1 m in limestone	5.13				
5.5								
6.0								
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:





BOREHOLE No.: MW5-19

ELEVATION: 66.06 m

## BOREHOLE LOG

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart


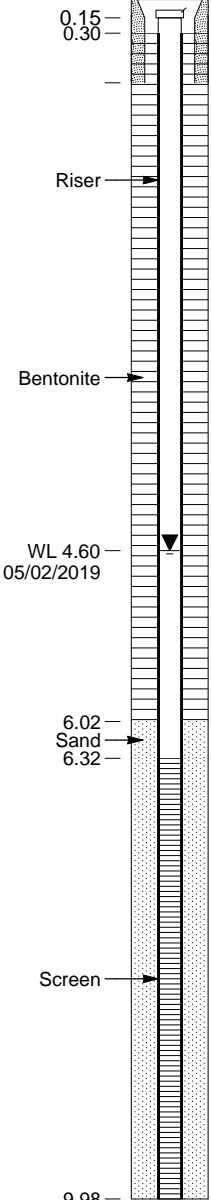
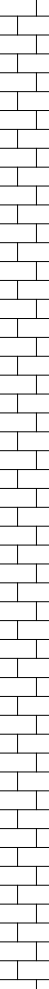
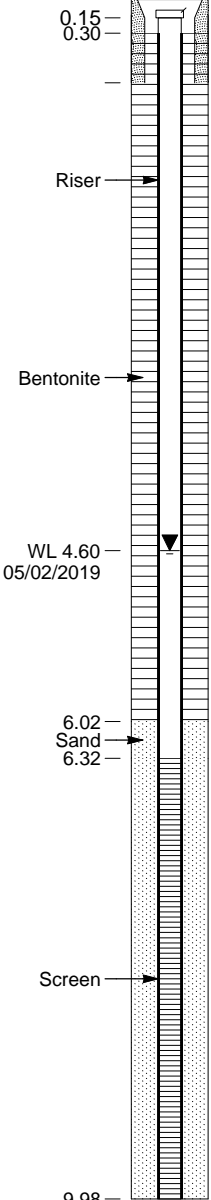
CHECKED BY: J. Bennett

DATE (START): 16 April 2019

DATE (FINISH): 16 April 2019

## LEGEND

- SS Split Spoon
- GS Auger Sample
- ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- Penetration Index based on Split Spoon sample
- Penetration Index based on Dynamic Cone sample
- Shear Strength based on Field Vane
- Shear Strength based on Lab Vane
- Sensitivity Value of Soil
- Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY		MONITOR WELL	SAMPLE DATA				
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK						
meters	66.06		GROUND SURFACE						
0.5	64.8		<b>FILL</b> - Sand, brown, moist  *Becoming Sand and gravel, grey, damp *Auger refusal at 1.22 m, continued with rock coring						
1.0				RC1	91	66			
1.5									
2.0									
2.5									
3.0									
3.5									
4.0									
4.5									
5.0									
5.5	56.1		<b>LIMESTONE</b> - shale laminations, grey, weathered and fractured, fair quality, medium strong, close to moderately close, closed to gapped joints, some fossiliferous beds starting at 1.8 mbgs *Becoming good quality  *Becoming excellent quality  *Becoming good quality  *Becoming excellent quality						
6.0				RC2	100	76			
6.5									
7.0									
7.5									
8.0									
8.5									
9.0									
9.5									
10.0									
10.5									

NOTES:



BOREHOLE No.: MW6-19

ELEVATION: 66.54 m

## BOREHOLE LOG

Page: 1 of 1

CLIENT: Ottawa Community Housing Corporation

PROJECT: Geotechnical Investigation

LOCATION: 811 Gladstone Avenue, Ottawa, Ontario

DESCRIBED BY: R. Vandentillaart

CHECKED BY: J. Bennett

DATE (START): 16 April 2019

DATE (FINISH): 16 April 2019

## LEGEND

- ☒ SS Split Spoon
- ☒ GS Auger Sample
- ☒ ST Shelby Tube
- ☒ Water Level
- ☒ Water content (%)
- ☒ Atterberg limits (%)
- ☒ N Penetration Index based on Split Spoon sample
- ☒ N Penetration Index based on Dynamic Cone sample
- ☒ Δ Cu Shear Strength based on Field Vane
- ☒ □ Cu Shear Strength based on Lab Vane
- ☒ S Sensitivity Value of Soil
- ☒ ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY		MONITOR WELL	SAMPLE DATA			
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	66.54		GROUND SURFACE			%	ppm	N
0.5	65.5		<b>FILL</b> - Sand, brown, moist *Becoming Sand and gravel, grey, damp	0.10 0.30				
1.0			*Auger refusal at 1.1 m, continued with rock coring	Bentonite				
1.5			<b>LIMESTONE</b> - shale laminations, grey, weathered and fractured, poor to fair quality, medium strong, close to moderately close, closed to gapped joints	WL 1.30 05/02/2019				
2.0			Sub-horizontal bedding from 2.0 to 2.4 mbgs	1.78 Riser	RC1	100		56
2.5			*Becoming good quality	2.08				
3.0	61.4			Sand				
3.5				Screen	RC2	100		86
4.0								
4.5					RC3	100		73
5.0				5.13				
5.5			Borehole ended at approximately 5.1 m in limestone					
6.0								
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								

NOTES:

# Appendix C

## Single Well Response Testing

# MW1 Rising Head test

Prepared By:

GHD

Prepared For:

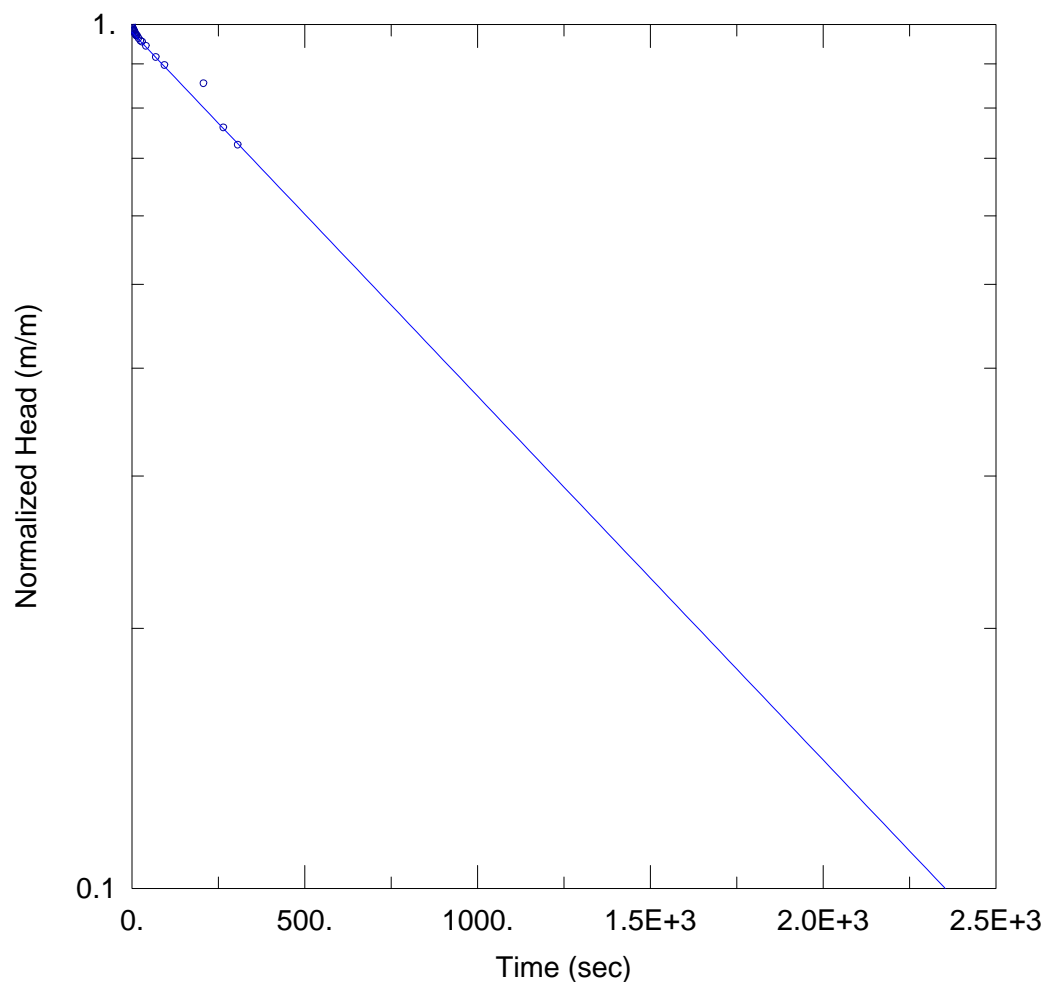
Ottawa Community Housing

Project:

11140575

Location:

811 Gladstone Avenue



Data Set: I:\...\MW1 Rising.aqt

Date: 05/01/19

Time: 12:51:54

## SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 3.657E-5 cm/sec

y0 = 4.563 m

## AQUIFER DATA

Saturated Thickness: 5.02 m Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW1)

Initial Displacement: 4.66 m

Static Water Column Height: 5.02 m

Total Well Penetration Depth: 5.02 m

Screen Length: 4.47 m

Casing Radius: 0.0254 m

Well Radius: 0.0379 m

Gravel Pack Porosity: 0.32





# MW4 Rising Head test

Prepared By:

GHD

Prepared For:

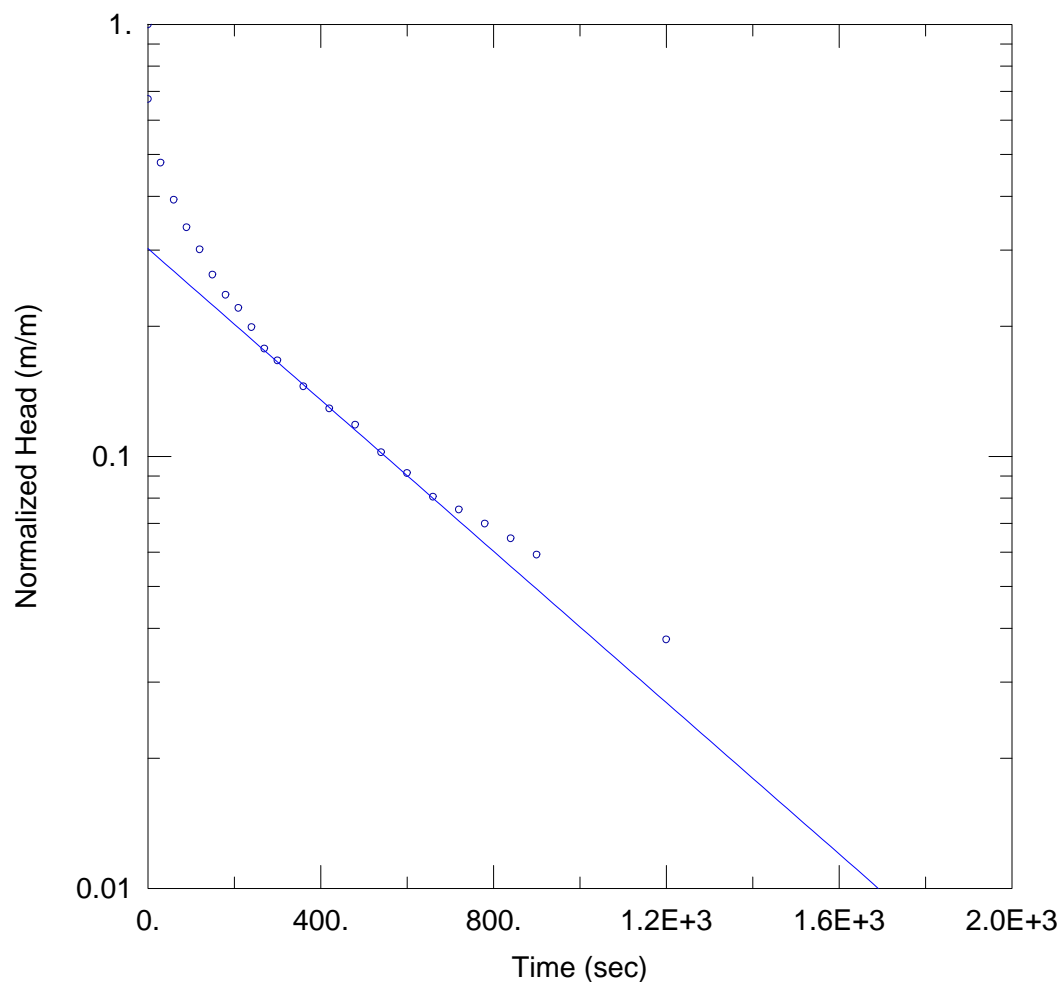
Ottawa Community Housing

Project:

11140575

Location:

811 Gladstone Avenue



Data Set: I:\...\MW4 Rising.aqt

Date: 05/01/19

Time: 12:51:48

## SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.0001019 cm/sec      y0 = 0.5629 m

## AQUIFER DATA

Saturated Thickness: 1.86 m Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW4)

Initial Displacement: 1.86 m

Static Water Column Height: 1.25 m

Total Well Penetration Depth: 1.86 m

Screen Length: 1.86 m

Casing Radius: 0.01588 m

Well Radius: 0.0379 m

Gravel Pack Porosity: 0.32



# MW5 Rising Head Test 1

Prepared By:

GHD

Prepared For:

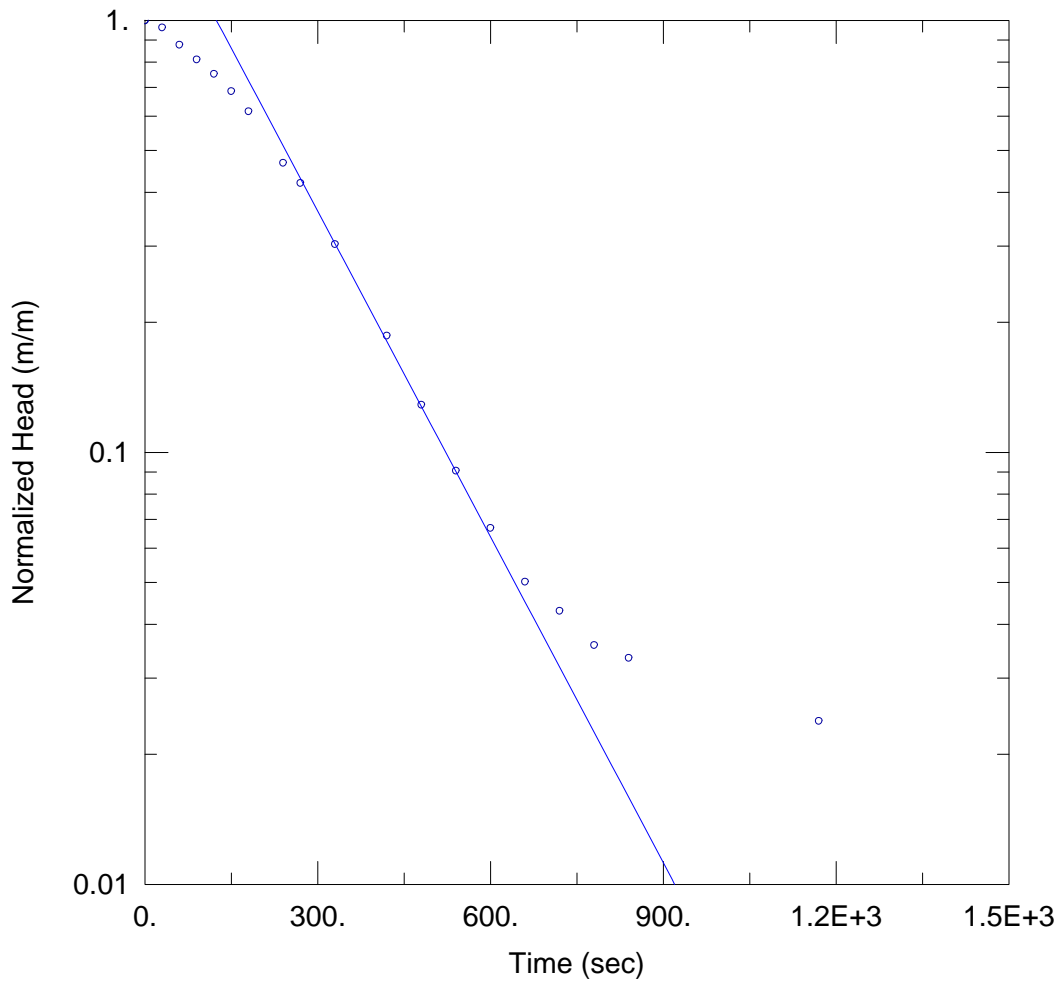
Ottawa Community Housing

Project:

11140575

Location:

811 Gladstone Avenue



Data Set: I:\...\MW5 Rising 1.aqt

Date: 05/01/19

Time: 12:51:41

## SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.0001876 cm/sec      y0 = 8.604 m

## AQUIFER DATA

Saturated Thickness: 5.34 m Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW5)

Initial Displacement: 4.19 m

Static Water Column Height: 5.34 m

Total Well Penetration Depth: 5.34 m

Screen Length: 3.66 m

Casing Radius: 0.01588 m

Well Radius: 0.0379 m

Gravel Pack Porosity: 0.32



## MW5 Rising Head Test 2

Prepared By:

**GHD**

Prepared For:

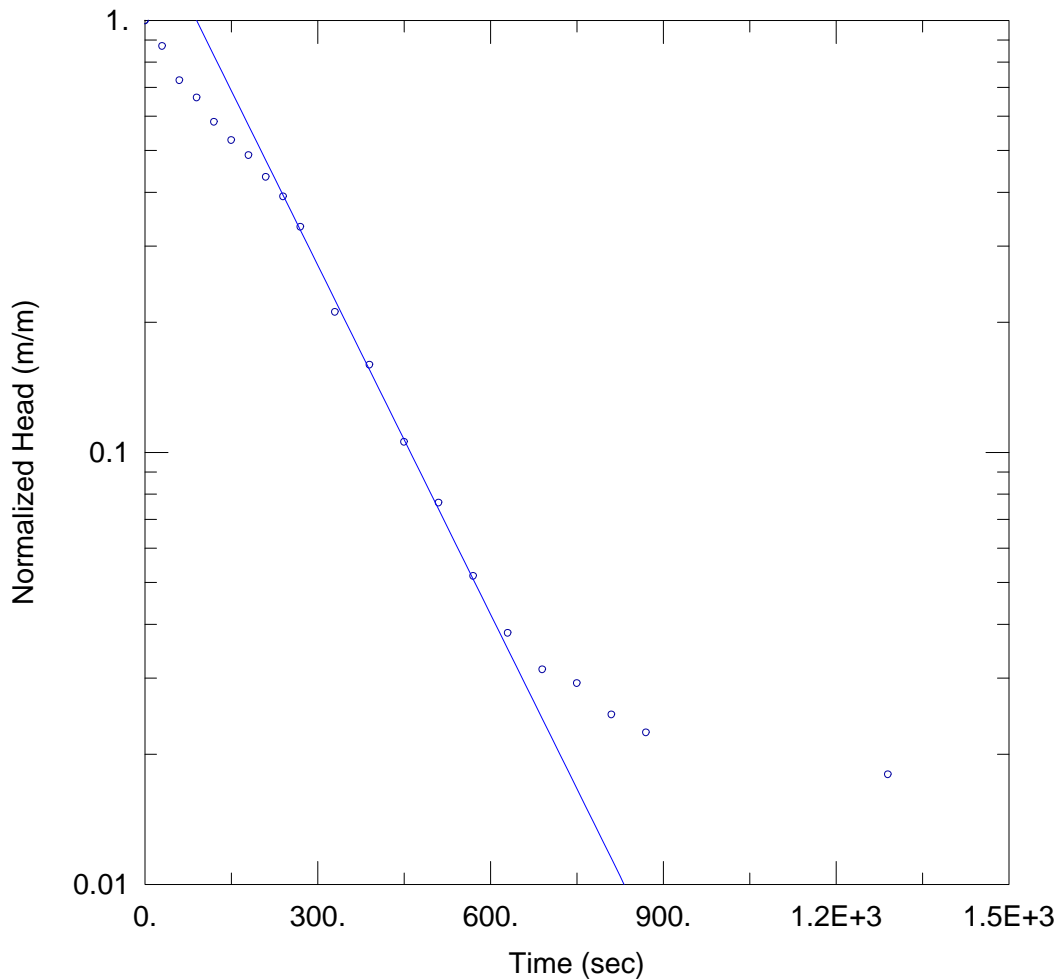
**Ottawa Community Housing**

Project:

**11140575**

Location:

**811 Gladstone Avenue**



Data Set: I:\...\MW5 Rising 2.aqt

Date: 05/01/19

Time: 12:50:57

### SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.000201 cm/sec      y0 = 7.75 m

### AQUIFER DATA

Saturated Thickness: 5.34 m Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (MW5)

Initial Displacement: 4.45 m

Static Water Column Height: 5.34 m

Total Well Penetration Depth: 5.34 m

Screen Length: 3.66 m

Casing Radius: 0.01588 m

Well Radius: 0.0379 m

Gravel Pack Porosity: 0.32



# MW6 Rising Head test

Prepared By:

GHD

Prepared For:

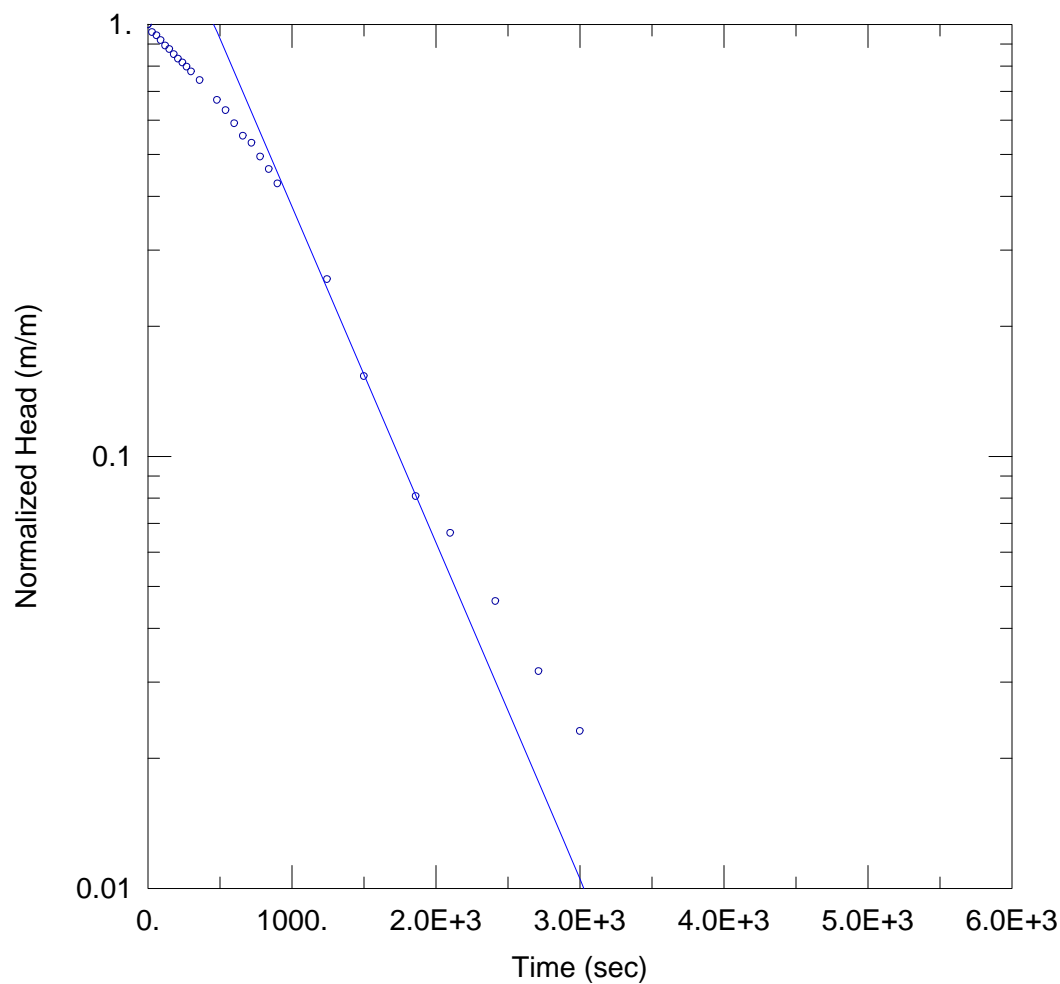
Ottawa Community Housing

Project:

11140575

Location:

811 Gladstone Avenue



Data Set: I:\...\MW6 Rising.aqt

Date: 05/01/19

Time: 12:50:45

## SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 6.545E-5 cm/sec

y0 = 7.853 m

## AQUIFER DATA

Saturated Thickness: 3.91 m Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW6)

Initial Displacement: 3.46 m

Static Water Column Height: 3.91 m

Total Well Penetration Depth: 3.91 m

Screen Length: 3.05 m

Casing Radius: 0.01588 m

Well Radius: 0.0379 m

Gravel Pack Porosity: 0.32





# Appendix D

## Ontario Water Well Records

# MECP Water Well Record - Formation Report



Well ID: <b>1508877</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 8/9/1963 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444540.7,5027902) [5]	Primary Use: Commerical
Depth to bedrock (m): 7.01039	Secondary Use: <null>
Elevation (masl): 63.434883	Final Status: Water Supply

Layer	Colour	Description	Top - Bottom Depth (m)	
		<i>FILL</i>	0	1.22
		<i>MEDIUM SAND GRAVEL</i>	1.22	7.01
		<i>LIMESTONE</i>	7.01	94.49

Well ID: <b>1535493</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 5/3/2005 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444239,5028200) [4]	Primary Use: <null>
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): 59.354789	Final Status: Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BROWN</i>	<i>SAND GRAVEL FILL</i>	0	1.4
	<i>BROWN</i>	<i>SAND FILL CLAY</i>	1.4	1.7
	<i>GREY</i>	<i>BOULDERS SAND GRAVEL</i>	1.7	4.65

Well ID: <b>1536268</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 11/10/2005 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444554,5027934) [3]	Primary Use: <null>
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): 64.73571	Final Status: Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BROWN</i>	<i>SAND</i>	0	2.41
			2.41	5.44

Well ID: <b>1536545</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 6/12/2006 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444047,5027957) [3]	Primary Use: <null>
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): 69.239585	Final Status: Observation Wells

Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BROWN</i>	<i>SAND GRAVEL FILL</i>	0	0.5

<i>BROWN</i>	<i>TILL</i>	0.5	1.2
<i>BROWN</i>	<i>TILL</i>	1.2	4.9
Well ID: <b>1536781</b> County / Township: OTTAWA-CARLETON / OTTAWA CITY			
Concession (Lot): A(036)		Completion Date: 8/10/2006 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444456,5027907) [3]		Primary Use: <null>	
Depth to bedrock (m): 9.14399		Secondary Use: <null>	
Elevation (masl): 63.524879		Final Status: Observation Wells	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BROWN</i>	<i>SAND BOULDERS</i>	0 9.27
	<i>GREY</i>	<i>LIMESTONE ROCK</i>	9.27 17
Well ID: <b>7108782</b> County / Township: OTTAWA-CARLETON / OTTAWA CITY			
Concession (Lot): ()		Completion Date: 7/2/2008 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444101,5028624) [3]		Primary Use: Not Used	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): 59.697109		Final Status: Abandoned-Other	
Layer	Colour	Description	Top - Bottom Depth (m)
			0 9.6
			9.6 6
			6 6.4
			6.4 10
			10 10
			10 7.5
Well ID: <b>7122535</b> County / Township: OTTAWA-CARLETON / OTTAWA CITY			
Concession (Lot): ()		Completion Date: 3/10/2009 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444773,5027850) [3]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): 65.971084		Final Status: Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BROWN</i>	<i>SAND TOPSOIL</i>	0 0.6
	<i>BROWN</i>	<i>FILL</i>	0.6 4.2
	<i>GREY</i>	<i>LIMESTONE ROCK</i>	4.2 8.8

Well ID: <b>7123330</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 7/9/2008 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444505,5027936) [4]	Primary Use: Monitoring
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): 64.385971	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	<i>BROWN</i>	<i>TILL</i>	0	4.88	
			4.88	7.8	
	<i>BROWN</i>	<i>TILL</i>	0	4.88	
			4.88	7.8	
	<i>BROWN</i>	<i>TILL</i>	0	4.88	
			4.88	7.8	

Well ID: <b>7127876</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 4/27/2009 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444657,5027983) [4]	Primary Use: Monitoring
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): 66.666816	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	<i>BROWN</i>	<i>FILL SAND LOOSE</i>	0	0.91	
	<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	0.91	4.57	
	<i>BROWN</i>	<i>FILL SAND LOOSE</i>	0	0.91	
	<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	0.91	4.57	
	<i>BROWN</i>	<i>FILL SAND LOOSE</i>	0	0.91	
	<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	0.91	4.57	
	<i>BROWN</i>	<i>FILL SAND LOOSE</i>	0	0.91	
	<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	0.91	4.57	
	<i>BROWN</i>	<i>FILL SAND LOOSE</i>	0	0.91	
	<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	0.91	4.57	
	<i>BROWN</i>	<i>FILL SAND LOOSE</i>	0	0.91	

<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	0.91	4.57
<i>BROWN</i>	<i>FILL SAND LOOSE</i>	0	0.91
<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	0.91	4.57

Well ID: <b>7130103</b>		County / Township: OTTAWA-CARLETON / OTTAWA CITY	
Concession (Lot): ()		Completion Date: 8/11/2009 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444730,5027834) [4]		Primary Use: Monitoring and Test Hole	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): 65.919372		Final Status: Monitoring and Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>GREY</i>	<i>GRAVEL FILL LOOSE</i>	0 0.61
	<i>GREY</i>	<i>ROCK LIMESTONE HARD</i>	0.61 7.62

Well ID: <b>7130105</b>		County / Township: OTTAWA-CARLETON / OTTAWA CITY	
Concession (Lot): ()		Completion Date: 8/14/2009 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444643,5027871) [4]		Primary Use: Monitoring and Test Hole	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): 64.715827		Final Status: Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BROWN</i>	<i>GRAVEL FILL LOOSE</i>	0 1.22
	<i>GREY</i>	<i>LIMESTONE ROCK</i>	1.22 7.62

Well ID: <b>7139615</b>		County / Township: OTTAWA-CARLETON / OTTAWA CITY	
Concession (Lot): ()		Completion Date: 10/9/2009 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444645,5028741) [4]		Primary Use: Test Hole	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): 76.17369		Final Status: Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)
		<i>OTHER</i>	0 0.02
	<i>BROWN</i>	<i>FILL SAND SILTY</i>	0.02 0.63
	<i>GREY</i>	<i>LIMESTONE ROCK</i>	0.63 2.05
			2.05 <null>



Well ID: <b>7143933</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 4/21/2010 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444645,5028741) [3]	Primary Use: <null>
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: <null>

Layer	Colour	Description	Top	Bottom	Depth (m)
			0		0.02
	BROWN	SILT SILTY SAND	0.02		0.63
	GREY	LIMESTONE ROCK	0.63		2.05

Well ID: <b>7169258</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date:
UTM Zone (Easting, Northing) [RC]: 18 (444483,5028485) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Observation Wells

Layer	Colour	Description	Top	Bottom	Depth (m)
	BROWN	CLAY GRAVEL PACKED	0		0.61
	GREY	LIMESTONE CLAY LAYERED	0.61		10.67

Well ID: <b>7174650</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 11/17/2011 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444078,5028061) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	BROWN	GRAVEL SAND HARD	0		3.1
	BROWN	SAND SILT CLAY	3.1		4.27
	GREY	CLAY SILT SOFT	4.27		5.18

Well ID: <b>7174651</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 11/17/2011 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444077,5028061) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	BROWN	FILL HARD DRY	0		2.74
	BROWN	CLAY FILL HARD	2.74		4.57
	GREY	CLAY FINE SAND WATER-BEARING	4.57		5.49

Well ID: <b>7174652</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 11/17/2011 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444055,5028051) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom	Depth (m)
	BROWN	GRAVEL SAND FILL	0	2.44
	GREY	SILT SAND CLAY	2.44	4.57

Well ID: <b>7174653</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 11/17/2011 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444037,5028050) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom	Depth (m)
	BROWN	FILL HARD	0	3.66
	BROWN	SAND SILT SOFT	3.66	4.27
	GREY	SILT FINE SAND SOFT	4.27	4.88

Well ID: <b>7183728</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 6/11/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444079,5028047) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top - Bottom	Depth (m)
	BROWN	FILL GRAVEL PACKED	0	1.83
	GREY	CLAY SAND SOFT	1.83	2.74
	GREY	CLAY SAND SOFT	2.74	4.57

Well ID: <b>7183729</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 6/11/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444099,5028058) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top - Bottom	Depth (m)
	BROWN	FILL GRAVEL PACKED	0	1.5
	GREY	CLAY SILTY GRAVEL	1.5	2.74

<i>GREY</i>	<i>CLAY SAND SOFT</i>		2.74	4.27
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Well ID: <b>7183730</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP		
Concession (Lot): ()		Completion Date: 6/11/2012 12:00 AM		
UTM Zone (Easting, Northing) [RC]: 18 (444077,5028041) [4]		Primary Use: Monitoring and Test Hole		
Depth to bedrock (m):		Secondary Use: <null>		
Elevation (masl): <null>		Final Status: Test Hole		
Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BROWN</i>	<i>SAND GRAVEL PACKED</i>	0	0.91
	<i>BROWN</i>	<i>TILL HARD</i>	0.91	2.13
	<i>GREY</i>	<i>CLAY SAND SOFT</i>	2.13	5.18

Well ID: <b>7183731</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP		
Concession (Lot): ()		Completion Date: 6/11/2012 12:00 AM		
UTM Zone (Easting, Northing) [RC]: 18 (444081,5028037) [4]		Primary Use: Monitoring and Test Hole		
Depth to bedrock (m):		Secondary Use: <null>		
Elevation (masl): <null>		Final Status: Test Hole		
Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BROWN</i>	<i>SAND GRAVEL PACKED</i>	0	1.22
	<i>GREY</i>	<i>CLAY SAND SOFT</i>	1.22	2.44
	<i>GREY</i>	<i>CLAY SAND SOFT</i>	2.44	5.18

Well ID: <b>7183732</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP		
Concession (Lot): ()		Completion Date: 6/11/2012 12:00 AM		
UTM Zone (Easting, Northing) [RC]: 18 (444100,5028061) [4]		Primary Use: Monitoring and Test Hole		
Depth to bedrock (m):		Secondary Use: <null>		
Elevation (masl): <null>		Final Status: <null>		
Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BROWN</i>	<i>FILL GRAVEL PACKED</i>	0	1.83
	<i>BROWN</i>	<i>FILL GRAVEL PACKED</i>	1.83	3.1
	<i>GREY</i>	<i>CLAY SAND SOFT</i>	3.1	4.88

Well ID: <b>7188016</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP		
Concession (Lot): ()		Completion Date: 8/13/2012 12:00 AM		
UTM Zone (Easting, Northing) [RC]: 18 (444069,5028064) [4]		Primary Use: Monitoring and Test Hole		
Depth to bedrock (m):		Secondary Use: <null>		
Elevation (masl): <null>		Final Status: Test Hole		
Layer	Colour	Description	Top - Bottom Depth (m)	
			0	4.1

Well ID: <b>7192749</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 11/8/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444521,5028754) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	BLACK	GRAVEL LOOSE	0	0.31
	BROWN	SAND GRAVEL SOFT	0.31	1.5
	BROWN	SAND SILT SOFT	1.5	2.74
	BROWN	SAND CLAY SOFT	2.74	3.91

Well ID: <b>7192750</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 11/8/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444507,5028744) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	BLACK	GRAVEL LOOSE	0	0.31
	BROWN	SAND GRAVEL LOOSE	0.31	1.5
	BROWN	SAND SILT SOFT	1.5	2.74
	BROWN	SAND CLAY SOFT	2.74	3.86

Well ID: <b>7192751</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 11/8/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444534,5028738) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	BLACK	GRAVEL HARD	0	0.31
	BROWN	SAND GRAVEL LOOSE	0.31	1.5
	BROWN	SAND SILT SOFT	1.5	2.74
	BROWN	SAND CLAY SOFT	2.74	3.96

Well ID: <b>7192752</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 11/9/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444523,5028744) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	BLACK	GRAVEL HARD	0	0.31
	BROWN	SAND GRAVEL SOFT	0.31	1.5
	BROWN	SAND SILT SOFT	1.5	2.74
	BROWN	SAND CLAY SOFT	2.74	4.11

Well ID: <b>7192753</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 11/9/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444522,5028738) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	BROWN	SAND GRAVEL LOOSE	0	1.5
	BROWN	SAND SILT SOFT	1.5	2.79
	BROWN	SAND CLAY SOFT	2.79	4.11

Well ID: <b>7192754</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 11/9/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444515,5028733) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	BROWN	SAND GRAVEL LOOSE	0	1.5
	BROWN	SAND SILT SOFT	1.5	3.1

Well ID: <b>7192755</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 11/8/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444534,5028762) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	BLACK	GRAVEL HARD	0	0.31
	BROWN	SAND GRAVEL SOFT	0.31	1.5



<i>BROWN</i>	<i>SAND SILT SOFT</i>	1.5	2.74
<i>BROWN</i>	<i>SAND CLAY SOFT</i>	2.74	3.81

Well ID: <b>7192756</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 11/8/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444538,5028744) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Monitoring and Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BLACK</i>	<i>GRAVEL HARD</i>	0 0.31
	<i>BROWN</i>	<i>SAND GRAVEL SOFT</i>	0.31 1.5
	<i>BROWN</i>	<i>SAND SILT SOFT</i>	1.5 2.74
	<i>BROWN</i>	<i>SAND CLAY SOFT</i>	2.74 4.11

Well ID: <b>7197903</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 7/26/2012 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444504,5028344) [4]	Primary Use: Monitoring
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Observation Wells

Layer	Colour	Description	Top - Bottom Depth (m)
			0 0.02
	<i>BROWN</i>	<i>SAND GRAVEL FILL</i>	0.02 0.85
	<i>GREY</i>	<i>LIMESTONE DRY</i>	0.85 1.3
	<i>GREY</i>	<i>LIMESTONE</i>	1.3 5.7

Well ID: <b>7203874</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 5/2/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444442,5028661) [4]	Primary Use: Monitoring
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Observation Wells

Layer	Colour	Description	Top - Bottom Depth (m)
			0 <null>
	<i>BROWN</i>	<i>SILT SAND GRAVEL</i>	<null> 1.91
	<i>GREY</i>	<i>ROCK</i>	1.91 7.72

Well ID: <b>7204253</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 5/22/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444433,5028334) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Observation Wells

Layer	Colour	Description	Top	Bottom	Depth (m)
	<i>BROWN</i>	<i>FILL</i>	0	0.31	
	<i>GREY</i>	<i>LIMESTONE</i>	0.31	2.74	
	<i>GREY</i>	<i>LIMESTONE</i>	2.74	4.88	

Well ID: <b>7204254</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 5/26/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444433,5028334) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	<i>GREY</i>	<i>LIMESTONE</i>	0	4.57	

Well ID: <b>7204404</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 6/4/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444513,5028147) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	<i>BROWN</i>	<i>TOPSOIL LOOSE</i>	0	0.31	
	<i>BROWN</i>	<i>CLAY SAND SOFT</i>	0.31	2.44	
	<i>GREY</i>	<i>LIMESTONE LAYERED HARD</i>	2.44	15.24	

Well ID: <b>7204405</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 6/4/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444348,5028383) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	<i>BROWN</i>	<i>TOPSOIL SOFT</i>	0	0.31	
	<i>BROWN</i>	<i>CLAY STONES SOFT</i>	0.31	1.22	
	<i>GREY</i>	<i>LIMESTONE LAYERED HARD</i>	1.22	15.24	

Well ID: <b>7205166</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 7/5/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444988,5028293) [4]	Primary Use: Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	BLACK	GRAVEL LOOSE	0		0.09
	BROWN	SAND GRAVEL SOFT	0.09		0.37
	GREY	LIMESTONE LAYERED	0.37		2.32

Well ID: <b>7213479</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 10/23/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444548,5028732) [3]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	BLACK	HARDPAN	0		0.09
	BROWN	SAND GRAVEL SOFT	0.09		0.56
	GREY	LIMESTONE HARD	0.56		1.86

Well ID: <b>7213480</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 10/23/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444512,5028721) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	BROWN	GRAVEL HARD	0		0.31
	BROWN	SAND GRAVEL SOFT	0.31		2.44
	BROWN	SAND SOFT	2.44		3.35

Well ID: <b>7213481</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 10/23/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444531,5028730) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	BLACK	HARD	0		0.09
	BROWN	SAND GRAVEL SOFT	0.09		0.74

GREY Limestone Hard

0.74 1.86

Well ID: **7213482** County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP  
Concession (Lot): () Completion Date: 10/24/2013 12:00 AM  
UTM Zone (Easting, Northing) [RC]: 18 (444510,5028707) [4] Primary Use: Monitoring and Test Hole  
Depth to bedrock (m): Secondary Use: <null>  
Elevation (masl): <null> Final Status: Test Hole

Layer	Colour	Description	Top	Bottom	Depth (m)
	BLACK	GRAVEL HARD	0		0.31
	BROWN	SAND GRAVEL SOFT	0.31		0.96
	GREY	SAND SILT GRAVEL	0.96		5.18
	GREY	LIMESTONE SHALE LAYERED	5.18		12.19

Well ID: **7226543** County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP  
Concession (Lot): () Completion Date: 5/20/2014 12:00 AM  
UTM Zone (Easting, Northing) [RC]: 18 (444921,5028405) [4] Primary Use: Monitoring  
Depth to bedrock (m): Secondary Use: <null>  
Elevation (masl): <null> Final Status: Observation Wells

Layer	Colour	Description	Top	Bottom	Depth (m)
			0		0.1
	GREY	GRAVEL	0.1		0.4
	BLUE	SILT SAND	0.4		1.5
	GREY	LIMESTONE GRAVEL DRY	1.5		4.6

Well ID: **7226544** County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP  
Concession (Lot): () Completion Date: 5/13/2014 12:00 AM  
UTM Zone (Easting, Northing) [RC]: 18 (444950,5028404) [4] Primary Use: Monitoring  
Depth to bedrock (m): Secondary Use: <null>  
Elevation (masl): <null> Final Status: Observation Wells

Layer	Colour	Description	Top	Bottom	Depth (m)
			0		0.05
	GREY	GRAVEL	0.05		0.45
	BLUE	SILT SAND	0.45		1.45
	GREY	LIMESTONE GRAVEL DRY	1.45		4.6

Well ID: <b>7226545</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 5/13/2014 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444926,5028396) [4]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): <null>		Final Status: Observation Wells	
Layer	Colour	Description	Top - Bottom Depth (m)
	GREY	GRAVEL	0 0.95
	BROWN	SILT GRAVEL DRY	0.95 1.45
	BLACK	LIMESTONE	1.45 4.6

Well ID: <b>7226546</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 5/12/2014 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444916,5028411) [4]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): <null>		Final Status: Observation Wells	
Layer	Colour	Description	Top - Bottom Depth (m)
	GREY	GRAVEL	0 0.15
	BROWN	SILT GRAVEL CLAY	0.15 1.05
	GREY	LIMESTONE	1.05 4.6

Well ID: <b>7226547</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 5/13/2014 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444933,5028417) [4]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): <null>		Final Status: Observation Wells	
Layer	Colour	Description	Top - Bottom Depth (m)
	GREY	GRAVEL	0 0.1
	BROWN	SILT SAND DRY	0.1 1.45
	GREY	LIMESTONE	1.45 4.6

Well ID: <b>7226548</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 5/12/2014 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444940,5028440) [4]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): <null>		Final Status: Observation Wells	
Layer	Colour	Description	Top - Bottom Depth (m)
			0 0.05
	BROWN	SILT GRAVEL DRY	0.05 1.4

GREY Limestone

1.4

4.6

Well ID: **7226959** County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP  
Concession (Lot): () Completion Date: 7/25/2014 12:00 AM  
UTM Zone (Easting, Northing) [RC]: 18 (444655,5028163) [4] Primary Use: Monitoring and Test Hole  
Depth to bedrock (m): Secondary Use: <null>  
Elevation (masl): <null> Final Status: Test Hole

Layer	Colour	Description	Top	Bottom Depth (m)
	BLACK	GRAVEL SOFT	0	0.31
	BROWN	FILL GRAVEL SOFT	0.31	1.5
	GREY	SHALE HARD	1.5	5.49

Well ID: **7226960** County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP  
Concession (Lot): () Completion Date: 7/25/2014 12:00 AM  
UTM Zone (Easting, Northing) [RC]: 18 (444653,5028179) [4] Primary Use: Monitoring and Test Hole  
Depth to bedrock (m): Secondary Use: <null>  
Elevation (masl): <null> Final Status: Test Hole

Layer	Colour	Description	Top	Bottom Depth (m)
	BLACK	GRAVEL SOFT	0	0.31
	BROWN	FILL GRAVEL SOFT	0.31	1.5
	GREY	SHALE HARD	1.5	4.88

Well ID: **7230092** County / Township: OTTAWA-CARLETON / OTTAWA CITY  
Concession (Lot): () Completion Date: 1/17/2014 12:00 AM  
UTM Zone (Easting, Northing) [RC]: 18 (444198,5028425) [4] Primary Use: Monitoring  
Depth to bedrock (m): Secondary Use: <null>  
Elevation (masl): <null> Final Status: Observation Wells

Layer	Colour	Description	Top	Bottom Depth (m)
		OTHER	0	0.05
	BROWN	FILL LIMESTONE SAND	0.05	1.01
	BROWN	SILT SAND FILL	1.01	1.6
	BROWN	SILT SAND	1.6	3.9
	RED	SAND FINE GRAVEL	3.9	7.2
			7.2	8.5



Well ID: <b>7230093</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 1/17/2014 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444213,5028401) [4]	Primary Use: Monitoring
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: Observation Wells

Layer	Colour	Description	Top - Bottom Depth (m)	
		<i>OTHER</i>	0	0.05
	<i>GREY</i>	<i>FILL LIMESTONE SAND</i>	0.05	0.6
	<i>BROWN</i>	<i>SILT SAND FILL</i>	0.6	1.6
	<i>BROWN</i>	<i>SILT SAND TILL</i>	1.6	3.9
	<i>BROWN</i>	<i>SAND GRAVEL BOULDERS</i>	3.9	10.9

Well ID: <b>7230956</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 10/8/2014 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444526,5028736) [4]	Primary Use: Monitoring and Test Hole
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: <null>

Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BLACK</i>	<i>GRAVEL</i>	0	0.31
	<i>BROWN</i>	<i>SAND GRAVEL</i>	0.31	3.96
	<i>GREY</i>	<i>LIMESTONE LAYERED</i>	3.96	19.809999

Well ID: <b>7236604</b>	County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP
Concession (Lot): ()	Completion Date: 5/24/2013 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444431,5027765) [4]	Primary Use: Monitoring
Depth to bedrock (m):	Secondary Use: <null>
Elevation (masl): <null>	Final Status: <null>

Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BROWN</i>	<i>FILL SAND GRAVEL</i>	0	3.07
	<i>GREY</i>	<i>LIMESTONE</i>	3.07	6.12

Well ID: <b>7239791</b>	County / Township: OTTAWA-CARLETON / OTTAWA CITY
Concession (Lot): ()	Completion Date: 3/20/2015 12:00 AM
UTM Zone (Easting, Northing) [RC]: 18 (444665,5028201) [4]	Primary Use: Test Hole
Depth to bedrock (m):	Secondary Use: Monitoring
Elevation (masl): <null>	Final Status: Test Hole

Layer	Colour	Description	Top - Bottom Depth (m)	
	<i>BLACK</i>	<i>GRAVEL DENSE</i>	0	0.31

<i>BROWN</i>	<i>SAND FILL SOFT</i>	0.31	1.52
<i>GREY</i>	<i>LIMESTONE SHALE LAYERED</i>	1.52	9.14

Well ID: <b>7239792</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 3/20/2015 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444646,5028206) [4]		Primary Use: Test Hole	
Depth to bedrock (m):		Secondary Use: Monitoring	
Elevation (masl): <null>		Final Status: Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BROWN</i>	<i>SAND GRAVEL LOOSE</i>	0 1.52
	<i>GREY</i>	<i>LIMESTONE SHALE LAYERED</i>	1.52 5.48

Well ID: <b>7239793</b>		County / Township: OTTAWA-CARLETON / OTTAWA CITY	
Concession (Lot): ()		Completion Date: 3/20/2015 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444647,5028187) [4]		Primary Use: Test Hole	
Depth to bedrock (m):		Secondary Use: Monitoring	
Elevation (masl): <null>		Final Status: Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BLACK</i>	<i>GRAVEL DENSE</i>	0 0.31
	<i>BROWN</i>	<i>SAND FILL SOFT</i>	0.31 1.52
	<i>GREY</i>	<i>LIMESTONE SHALE LAYERED</i>	1.52 5.48

Well ID: <b>7261916</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 4/8/2016 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444511,5028567) [4]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): <null>		Final Status: Monitoring and Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BROWN</i>	<i>SAND GRAVEL SOFT</i>	0 1.22
	<i>GREY</i>	<i>SILT SAND WATER-BEARING</i>	1.22 2.13
	<i>GREY</i>	<i>LIMESTONE</i>	2.13 4.88

Well ID: <b>7261917</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 4/8/2016 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444520,5028555) [4]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): <null>		Final Status: Monitoring and Test Hole	
Layer	Colour	Description	Top - Bottom Depth (m)

<i>BROWN</i>	<i>SAND GRAVEL</i>	0	1.5
<i>GREY</i>	<i>LIMESTONE FRACTURED</i>	1.5	4.88

Well ID: <b>7261920</b>		County / Township: OTTAWA-CARLETON / NEPEAN TOWNSHIP	
Concession (Lot): ()		Completion Date: 4/8/2016 12:00 AM	
UTM Zone (Easting, Northing) [RC]: 18 (444513,5028564) [4]		Primary Use: Monitoring	
Depth to bedrock (m):		Secondary Use: <null>	
Elevation (masl): <null>		Final Status: Observation Wells	
Layer	Colour	Description	Top - Bottom Depth (m)
	<i>BROWN</i>	<i>SAND GRAVEL SOFT</i>	0 1.5
	<i>GREY</i>	<i>LIMESTONE</i>	1.5 4.88

# Appendix E

## Groundwater Quality

Table A  
Summary Of Groundwater Analysis  
September 2017  
811 Gladstone Complex, Ottawa, ON

Parameter	Units	MDL	Regulation	Regulation	BH1/MW1	BH2/MW2	BH5/MW3	Dup (BH5/MW3)	Trip Blank	MW4	Trip Blank
Sample Date (m/d/y)			Sewer Use By-Law, Ottawa Storm	Sewer Use By-Law, Ottawa Sanitary/Combined	9/8/2017	9/8/2017	9/8/2017	9/8/2017	9/7/2017	9/12/2017	9/11/2017
<b>General Inorganics</b>											
pH	pH Units	0.1			8.0	8.3	7.3	7.3	N/A	N/A	N/A
<b>Metals</b>											
Antimony	ug/L	0.5		5 mg/L (5000 ug/L)	ND (0.5)	ND (0.5)	0.7	0.7	N/A	N/A	N/A
Arsenic	ug/L	1	0.02 mg/L (20 ug/L)	1 mg/L (1000 ug/L)	ND (1)	2	ND (1)	ND (1)	N/A	N/A	N/A
Barium	ug/L	1			65	43	75	71	N/A	N/A	N/A
Beryllium	ug/L	0.5			ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	N/A	N/A	N/A
Boron	ug/L	10		25 mg/L (25000 ug/L)	394	454	117	97	N/A	N/A	N/A
Cadmium	ug/L	0.1	0.008 mg/L (8 ug/L)	0.02 mg/L (20 ug/L)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	N/A	N/A	N/A
Chromium	ug/L	1	0.08 mg/L (80 ug/L)	5 mg/L (5000 ug/L)	ND (1)	ND (1)	ND (1)	ND (1)	N/A	N/A	N/A
Cobalt	ug/L	0.5		5 mg/L (5000 ug/L)	ND (0.5)	ND (0.5)	0.6	ND (0.5)	N/A	N/A	N/A
Copper	ug/L	0.5	0.04 mg/L (40 ug/L)	3 mg/L (3000 ug/L)	1.5	2.7	2.3	5.8	N/A	N/A	N/A
Lead	ug/L	0.1	0.12 mg/L (120 ug/L)	5 mg/L (5000 ug/L)	0.3	0.1	ND (0.1)	ND (0.1)	N/A	N/A	N/A
Molybdenum	ug/L	0.5		5 mg/L (5000 ug/L)	4.9	39.9	3.9	1.5	N/A	N/A	N/A
Nickel	ug/L	1	0.08 mg/L (80 ug/L)	3 mg/L (3000 ug/L)	ND (1)	2	2	2	N/A	N/A	N/A
Selenium	ug/L	1	0.02 mg/L (20 ug/L)	5 mg/L (5000 ug/L)	ND (1)	ND (1)	ND (1)	ND (1)	N/A	N/A	N/A
Silver	ug/L	0.1	0.12 mg/L (120 ug/L)	5 mg/L (5000 ug/L)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	N/A	N/A	N/A
Sodium	ug/L	200			329000	257000	87200	50000	N/A	N/A	N/A
Thallium	ug/L	0.1			ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	N/A	N/A	N/A
Uranium	ug/L	0.1			1.8	1.9	1.0	0.7	N/A	N/A	N/A
Vanadium	ug/L	0.5		5 mg/L (5000 ug/L)	ND (0.5)	0.6	ND (0.5)	ND (0.5)	N/A	N/A	N/A
Zinc	ug/L	5	0.04 mg/L (40 ug/L)	3 mg/L (3000 ug/L)	ND (5)	ND (5)	16	6	N/A	N/A	N/A
<b>Volatiles</b>											
Acetone	ug/L	5.0			ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)
Benzene	ug/L	0.5	0.002 mg/L (2 ug/L)	0.01 mg/L (10 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Bromodichloromethane	ug/L	0.5		0.35 mg/L (350 ug/L)	ND (0.5)	ND (0.5)	2.9	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Bromoform	ug/L	0.5		0.63 mg/L (630 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Bromomethane	ug/L	0.5		0.11 mg/L (110 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Carbon Tetrachloride	ug/L	0.2		0.057 mg/L (57 ug/L)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)
Chlorobenzene	ug/L	0.5		0.057 mg/L (57 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Chloroform	ug/L	0.5	0.002 mg/L (2 ug/L)	0.08 mg/L (80 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Dibromochloromethane	ug/L	0.5		0.057 mg/L (57 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Dichlorodifluoromethane	ug/L	1.0			ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
1,2-Dichlorobenzene	ug/L	0.5	0.0056 mg/L (5.6 ug/L)	0.088 mg/L (88 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,3-Dichlorobenzene	ug/L	0.5		0.036 mg/L (36 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,4-Dichlorobenzene	ug/L	0.5	0.0068 mg/L (6.8 ug/L)	0.017 mg/L (17 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,1-Dichloroethane	ug/L	0.5		0.2 mg/L (200 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,2-Dichloroethane	ug/L	0.5		0.21 mg/L (210 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,1-Dichloroethylene	ug/L	0.5		0.04 mg/L (40 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
cis-1,2-Dichloroethylene	ug/L	0.5	0.0056 mg/L (5.6 ug/L)	0.2 mg/L (200 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
trans-1,2-Dichloroethylene	ug/L	0.5		0.2 mg/L (200 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,2-Dichloropropane	ug/L	0.5		0.85 mg/L (850 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
cis-1,3-Dichloropropylene	ug/L	0.5		0.07 mg/L (70 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
trans-1,3-Dichloropropylene	ug/L	0.5	0.0056 mg/L (5.6 ug/L)	0.07 mg/L (70 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,3-Dichloropropene, total	ug/L	0.5			ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
<b>Ethylbenzene</b>	ug/L	0.5	<b>0.002 mg/L (2 ug/L)</b>	0.057 mg/L (57 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	<b>3.5</b>	ND (0.5)	ND (0.5)	ND (0.5)
Ethylene dibromide (dibromoethane, 1,2-)	ug/L	0.2		0.028 mg/L (28 ug/L)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)
Hexane	ug/L	1.0			ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Methyl Ethyl Ketone (2-Butanone)	ug/L	5.0			ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)
Methyl Isobutyl Ketone	ug/L	5.0			ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)
Methyl tert-butyl ether	ug/L	2.0			ND (2.0)	ND (2.0)	ND (2.0)	ND (2.0)	ND (2.0)	ND (2.0)	ND (2.0)
Methylene Chloride	ug/L	5.0	0.0052 mg/L (5.2 ug/L)	0.211 mg/L (211 ug/L)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)
Styrene	ug/L	0.5		0.04 mg/L (40 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,1,1,2-Tetrachloroethane	ug/L	0.5			ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,1,2,2-Tetrachloroethane	ug/L	0.5	0.017 mg/L (17 ug/L)	0.04 mg/L (40 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Tetrachloroethylene	ug/L	0.5	0.0044 mg/L (4.4 ug/L)	0.05 mg/L (50 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Toluene	ug/L	0.5	0.002 mg/L (2 ug/L)	0.08 mg/L (80 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,1,1-Trichloroethane	ug/L	0.5		0.054 mg/L (54 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
1,1,2-Trichloroethane	ug/L	0.5		0.8 mg/L (800 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Trichloroethylene	ug/L	0.5	0.0076 mg/L (7.6 ug/L)	0.054 mg/L (54 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Trichlorofluoromethane	ug/L	1.0		0.02 mg/L (20 ug/L)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Vinyl Chloride	ug/L	0.5		0.4 mg/L (400 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
m/p-Xylene	ug/L	0.5			ND (0.5)	ND (0.5)	ND (0.5)	13.6	ND (0.5)	ND (0.5)	ND (0.5)
o-Xylene	ug/L	0.5			ND (0.5)	ND (0.5)	ND (0.5)	3.5	ND (0.5)	ND (0.5)	ND (0.5)
<b>Xylenes, total</b>	ug/L	0.5	<b>0.0044 mg/L (4.4 ug/L)</b>	0.32 mg/L (320 ug/L)	ND (0.5)	ND (0.5)	ND (0.5)	<b>17.1</b>	ND (0.5)	ND (0.5)	ND (0.5)
<b>Hydrocarbons</b>											
F1 PHCs (C6-C10)	ug/L	25			ND (25)	ND (25)	ND (25)	ND (25)	N/A	N/A	N/A
F2 PHCs (C10-C16)	ug/L	100			ND (100)	ND (100)	ND (100)	ND (100)	N/A	N/A	N/A
F3 PHCs (C16-C34)	ug/L	100			ND (100)	ND (100)	203	ND (100)	N/A	N/A	N/A
F4 PHCs (C34-C50)	ug/L	100			ND (100)	ND (100)	ND (100)	ND (100)	N/A	N/A	N/A
<b>Semi-Volatiles</b>											
Acenaphthene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Acenaphthylene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Anthracene	ug/L	0.01			ND (0.01)	ND (0.02)	ND (0.01)	ND (0.01)	N/A	N/A	N/A
Benzo[a]anthracene	ug/L	0.01			ND (0.01)	ND (0.02)	ND (0.01)	ND (0.01)	N/A	N/A	N/A
Benzo[a]pyrene	ug/L	0.01			ND (0.01)	ND (0.02)	ND (0.01)	ND (0.01)	N/A	N/A	N/A
Benzo[b]fluoranthene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Benzo[g,h,i]perylene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Benzo[k]fluoranthene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Chrysene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Dibenzo[a,h]anthracene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Fluoranthene	ug/L	0.01			ND (0.01)	0.12	ND (0.01)	ND (0.01)	N/A	N/A	N/A
Fluorene	ug/L	0.05		0.059 mg/L (59 ug/L)	ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Indeno[1,2,3-cd]pyrene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
1-Methylnaphthalene	ug/L	0.05		0.032 mg/L (32 ug/L)	ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
2-Methylnaphthalene	ug/L	0.05		0.022 mg/L (22 ug/L)	ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Methylnaphthalene (1&2)	ug/L	0.10			ND (0.10)	ND (0.20)	ND (0.10)	ND (0.10)	N/A	N/A	N/A
Naphthalene	ug/L	0.05	0.0064 mg/L (6.4 ug/L)	0.059 mg/L (59 ug/L)	ND (0.05)	0.16	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Phenanthrene	ug/L	0.05			ND (0.05)	ND (0.10)	ND (0.05)	ND (0.05)	N/A	N/A	N/A
Pyrene	ug/L	0.01			ND (0.01)	0.10	ND (0.01)	ND (0.01)	N/A	N/A	N/A
					8Sep2017 1737017-01	8Sep2017 1737017-02	8Sep2017 1737017-03	8Sep2017 1737017-04	7Sep2017 1737017-05	12Sep2017 1737231-01	11Sep2017 1737231-02

Table B  
Summary Of Groundwater Analysis  
April and May, 2019  
811 Gladstone Complex, Ottawa, ON

	Units	MDL	Regulation	Regulation	GW-MW4-04- 25-2019	GW-MW5-04- 25-2019	GW-MW4-05- 02-2019	GW-MW5-05- 02-2019
Parameter Sample Date (m/d/y)			Sewer Use By-Law, Ottawa Storm	Sewer Use By-Law, Ottawa Sanitary/Combined				
Microbiological Parameters								
E. Coli	CFU/100 mL	1	CTS/100 mL (200 CFU/100 mL)		2	2	<10	<10
General Inorganics								
CBOD	mg/L	2			3	ND (2)	N/A	N/A
Cyanide, total	mg/L	0.01	0.02 mg/L	2 mg/L	ND (0.01)	ND (0.01)	N/A	N/A
pH	pH Units	0.1			7.7	8.2	N/A	N/A
Phenolics	mg/L	0.001	0.008 mg/L	1 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Phosphorus, total	mg/L	0.01	0.4 mg/L	10 mg/L	0.07	0.09	N/A	N/A
Total Suspended Solids	mg/L	2	15 mg/L	350 mg/L	90	133	N/A	N/A
Sulphide	mg/L	0.02		2 mg/L	ND (0.02)	ND (0.02)	N/A	N/A
Total Kjeldahl Nitrogen	mg/L	0.1		100 mg/L	0.6	1.0	N/A	N/A
Anions								
Fluoride	mg/L	0.1		10 mg/L	ND (0.1)	0.3	N/A	N/A
Sulphate	mg/L	1		1500 mg/L	244	220	N/A	N/A
Metals - Total								
Aluminum	mg/L	0.01		50 mg/L	ND (0.01)	ND (0.01)	N/A	N/A
Antimony	mg/L	0.001		5 mg/L	0.001	0.001	N/A	N/A
Arsenic	mg/L	0.01	0.02 mg/L	1 mg/L	ND (0.01)	ND (0.01)	N/A	N/A
Bismuth	mg/L	0.005		5 mg/L	ND (0.005)	ND (0.005)	N/A	N/A
Boron	mg/L	0.05		25 mg/L	0.1	0.2	N/A	N/A
Cadmium	mg/L	0.001	0.008 mg/L	0.02 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Chromium	mg/L	0.05	0.08 mg/L	5 mg/L	ND (0.05)	ND (0.05)	N/A	N/A
Cobalt	mg/L	0.001		5 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Copper	mg/L	0.005	0.04 mg/L	3 mg/L	ND (0.005)	ND (0.005)	N/A	N/A
Lead	mg/L	0.001	0.12 mg/L	5 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Manganese	mg/L	0.05	0.05 mg/L	5 mg/L	ND (0.05)	ND (0.05)	N/A	N/A
Mercury	mg/L	0.0001	0.0004 mg/L	0.001 mg/L	ND (0.0001)	ND (0.0001)	N/A	N/A
Molybdenum	mg/L	0.005		5 mg/L	0.010	0.011	N/A	N/A
Nickel	mg/L	0.005	0.08 mg/L	3 mg/L	ND (0.005)	ND (0.005)	N/A	N/A
Selenium	mg/L	0.005	0.02 mg/L	5 mg/L	ND (0.005)	ND (0.005)	N/A	N/A
Silver	mg/L	0.001	0.12 mg/L	5 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Tin	mg/L	0.01		5 mg/L	ND (0.01)	ND (0.01)	N/A	N/A
Titanium	mg/L	0.01		5 mg/L	ND (0.01)	ND (0.01)	N/A	N/A
Vanadium	mg/L	0.001		5 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Zinc	mg/L	0.02	0.04 mg/L	3 mg/L	ND (0.02)	ND (0.02)	N/A	N/A
Volatiles								
Benzene	mg/L	0.0005	0.002 mg/L	0.01 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Bromodichloromethane	mg/L	0.0005		0.35 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Bromoform	mg/L	0.0005		0.63 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Bromomethane	mg/L	0.0005		0.11 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Carbon Tetrachloride	mg/L	0.0002		0.057 mg/L	ND (0.0002)	ND (0.0002)	N/A	N/A
Chlorobenzene	mg/L	0.0005		0.057 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Chloroethane	mg/L	0.0010		0.27 mg/L	ND (0.0010)	ND (0.0010)	N/A	N/A
Chloroform	mg/L	0.0005	0.002 mg/L	0.08 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Chloromethane	mg/L	0.0030		0.19 mg/L	ND (0.0030)	ND (0.0030)	N/A	N/A
Dibromochloromethane	mg/L	0.0005		0.057 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Ethylene dibromide (dibromoethane, 1,2)	mg/L	0.0002		0.028 mg/L	ND (0.0002)	ND (0.0002)	N/A	N/A
1,2-Dichlorobenzene	mg/L	0.0005	0.0056 mg/L	0.088 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,3-Dichlorobenzene	mg/L	0.0005		0.036 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,4-Dichlorobenzene	mg/L	0.0005	0.0068 mg/L	0.017 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,1-Dichloroethane	mg/L	0.0005		0.2 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,2-Dichloroethane	mg/L	0.0005		0.21 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,1-Dichloroethylene	mg/L	0.0005		0.04 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
cis-1,2-Dichloroethylene	mg/L	0.0005	0.0056 mg/L	0.2 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
trans-1,2-Dichloroethylene	mg/L	0.0005		0.2 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,2-Dichloropropane	mg/L	0.0005		0.85 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
cis-1,3-Dichloropropylene	mg/L	0.0005		0.07 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
trans-1,3-Dichloropropylene	mg/L	0.0005	0.0056 mg/L	0.07 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Ethylbenzene	mg/L	0.0005	0.002 mg/L	0.057 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Methylene Chloride	mg/L	0.0050	0.0052 mg/L	0.211 mg/L	ND (0.0050)	ND (0.0050)	N/A	N/A
Styrene	mg/L	0.0005		0.04 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,1,2,2-Tetrachloroethane	mg/L	0.0005	0.017 mg/L	0.04 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Tetrachloroethylene	mg/L	0.0005	0.0044 mg/L	0.05 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Toluene	mg/L	0.0005	0.002 mg/L	0.08 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,1,1-Trichloroethane	mg/L	0.0005		0.054 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
1,1,2-Trichloroethane	mg/L	0.0005		0.8 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Trichloroethylene	mg/L	0.0005	0.0076 mg/L	0.054 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Trichlorofluoromethane	mg/L	0.0010		0.02 mg/L	ND (0.0010)	ND (0.0010)	N/A	N/A
1,3,5-Trimethylbenzene	mg/L	0.0005		0.003 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Vinyl Chloride	mg/L	0.0005		0.4 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Xylenes, total	mg/L	0.0005	0.0044 mg/L	0.32 mg/L	ND (0.0005)	ND (0.0005)	N/A	N/A
Hydrocarbons								
Oil & Grease, animal/vegetable	mg/L	0.5		150 mg/L	ND (0.5)	ND (0.5)	N/A	N/A
Oil & Grease, mineral/synthetic	mg/L	0.5		15 mg/L	ND (0.5)	ND (0.5)	N/A	N/A
Oil & Grease, total	mg/L	0.5			ND (0.5)	ND (0.5)	N/A	N/A
Semi-Volatiles								
7H-Dibenzo[c,g]carbazole	mg/L	0.0005			ND (0.0005)	ND (0.0005)	N/A	N/A
Benzo[e]pyrene	mg/L	0.0005			ND (0.0005)	ND (0.0005)	N/A	N/A
Benzo[j]fluoranthene	mg/L	0.0005			ND (0.0005)	ND (0.0005)	N/A	N/A
Dibenzo[a,i]pyrene	mg/L	0.0005			ND (0.0005)	ND (0.0005)	N/A	N/A
Dibenzo [a,j] acradine	mg/L	0.0005			ND (0.0005)	ND (0.0005)	N/A	N/A
Perylene	mg/L	0.0005			ND (0.0005)	ND (0.0005)	N/A	N/A
1-Methylnaphthalene	mg/L	0.00005		0.032 mg/L	ND (0.00005)	0.00005	N/A	N/A
2-Methylnaphthalene	mg/L	0.00005		0.022 mg/L	ND (0.00005)	ND (0.00005)	N/A	N/A
Anthracene	mg/L	0.00001			ND (0.00001)	ND (0.00001)	N/A	N/A
Benzo[a]anthracene	mg/L	0.00001			ND (0.00001)	ND (0.00001)	N/A	N/A
Benzo[a]pyrene	mg/L	0.00001			ND (0.00001)	ND (0.00001)	N/A	N/A
Benzo[b]fluoranthene	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
Benzo[g,h,i]perylene	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
Benzo[k]fluoranthene	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
1,1-Biphenyl	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
Chrysene	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
Dibenzo[a,h]anthracene	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
Fluoranthene	mg/L	0.00001			ND (0.00001)	ND (0.00001)	N/A	N/A
Fluorene	mg/L	0.00005		0.059 mg/L	ND (0.00005)	ND (0.00005)	N/A	N/A
Indeno[1,2,3-cd]pyrene	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
Naphthalene	mg/L	0.00005	0.0064 mg/L	0.059 mg/L	ND (0.00005)	ND (0.00005)	N/A	N/A
Phenanthrene	mg/L	0.00005			ND (0.00005)	ND (0.00005)	N/A	N/A
Pyrene	mg/L	0.00001			ND (0.00001)	ND (0.00001)	N/A	N/A
PAHs, total	mg/L	0.00340	0.006 mg/L	0.015 mg/L	ND (0.00340)	ND (0.00340)	N/A	N/A
Benzylbutylphthalate	mg/L	0.001		0.017 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
BIS(2-Chloroethoxy)methane	mg/L	0.001		0.036 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Bis(2-ethylhexyl)phthalate	mg/L	0.001		0.28 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Diethylphthalate	mg/L	0.001		0.2 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Di-n-butylphthalate	mg/L	0.001		0.057 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Di-n-octylphthalate	mg/L	0.001		0.03 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Indole	mg/L	0.001		0.05 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
2,4-Dichlorophenol	mg/L	0.001		0.044 mg/L	ND (0.001)	ND (0.001)	N/A	N/A
Pesticides, OC								
Hexachlorobenzene	mg/L	0.00001			ND (0.00001)	ND (0.00001)	N/A	N/A
PCBs								
PCBs, total	ug/L	0.05	0.0004 mg/L (0.4 ug/L)	0.001 mg/L (1 ug/L)	ND (0.05)	ND (0.05)	N/A	N/A
Sample Date					25Apr2019	25Apr2019	2May2019	2May2019
Lab ID					1917649-01	1917649-02	1918483-01	1918483-02



## Certificate of Analysis

### GHD Limited (Ottawa)

179 Colonnade Road Suite 400  
Ottawa, ON K2E7S4  
Attn: Luke Lopers

Client PO: 73508783  
Project: 11140575-E2  
Custody: 112293

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017

**Order #: 1737017**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1737017-01	BH1/MW1
1737017-02	BH2/MW2
1737017-03	BH5/MW3
1737017-04	Dup
1737017-05	Trip Blank

Approved By:



Dale Robertson, BSc  
Laboratory Director

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
Project Description: 11140575-E2

## Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Metals, ICP-MS	EPA 200.8 - ICP-MS	12-Sep-17	12-Sep-17
pH	EPA 150.1 - pH probe @25 °C	12-Sep-17	12-Sep-17
PHC F1	CWS Tier 1 - P&T GC-FID	12-Sep-17	13-Sep-17
PHCs F2 to F4	CWS Tier 1 - GC-FID, extraction	12-Sep-17	12-Sep-17
REG 153: PAHs by GC-MS	EPA 625 - GC-MS, extraction	12-Sep-17	12-Sep-17
REG 153: VOCs by P&T GC/MS	EPA 624 - P&T GC-MS	12-Sep-17	13-Sep-17

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73508783**

Report Date: 14-Sep-2017

Order Date: 8-Sep-2017

Project Description: **11140575-E2**

	<b>Client ID:</b>	BH1/MW1	BH2/MW2	BH5/MW3	Dup
	<b>Sample Date:</b>	08-Sep-17	08-Sep-17	08-Sep-17	08-Sep-17
	<b>Sample ID:</b>	1737017-01	1737017-02	1737017-03	1737017-04
	<b>MDL/Units</b>	Water	Water	Water	Water

#### General Inorganics

pH	0.1 pH Units	8.0	8.3	7.3	7.3
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#### Metals

Antimony	0.5 ug/L	<0.5	<0.5	0.7	0.7
Arsenic	1 ug/L	<1	2	<1	<1
Barium	1 ug/L	65	43	75	71
Beryllium	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Boron	10 ug/L	394	454	117	97
Cadmium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Chromium	1 ug/L	<1	<1	<1	<1
Cobalt	0.5 ug/L	<0.5	<0.5	0.6	<0.5
Copper	0.5 ug/L	1.5	2.7	2.3	5.8
Lead	0.1 ug/L	0.3	0.1	<0.1	<0.1
Molybdenum	0.5 ug/L	4.9	39.9	3.9	1.5
Nickel	1 ug/L	<1	2	2	2
Selenium	1 ug/L	<1	<1	<1	<1
Silver	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Sodium	200 ug/L	329000	257000	87200	50000
Thallium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Uranium	0.1 ug/L	1.8	1.9	1.0	0.7
Vanadium	0.5 ug/L	<0.5	0.6	<0.5	<0.5
Zinc	5 ug/L	<5	<5	16	6

#### Volatiles

Acetone	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane	0.5 ug/L	<0.5	<0.5	2.9	<0.5
Bromoform	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromomethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride	0.2 ug/L	<0.2	<0.2	<0.2	<0.2
Chlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Chloroform	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Dichlorodifluoromethane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,3-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5

Certificate of Analysis  
 Client: GHD Limited (Ottawa)  
 Client PO: 73508783

Report Date: 14-Sep-2017

Order Date: 8-Sep-2017

Project Description: 11140575-E2

	Client ID: Sample Date: Sample ID:	BH1/MW1 08-Sep-17 1737017-01 Water	BH2/MW2 08-Sep-17 1737017-02 Water	BH5/MW3 08-Sep-17 1737017-03 Water	Dup 08-Sep-17 1737017-04 Water
	MDL/Units				
1,1-Dichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
cis-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
trans-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
cis-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
trans-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,3-Dichloropropene, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	3.5
Ethylene dibromide (dibromoethane)	0.2 ug/L	<0.2	<0.2	<0.2	<0.2
Hexane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone (2-Butanone)	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Methyl Isobutyl Ketone	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Methyl tert-butyl ether	2.0 ug/L	<2.0	<2.0	<2.0	<2.0
Methylene Chloride	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Styrene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,1,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Tetrachloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,1-Trichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Trichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Trichlorofluoromethane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	13.6
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	3.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	17.1
4-Bromofluorobenzene	Surrogate	102%	103%	104%	103%
Dibromofluoromethane	Surrogate	79.3%	93.6%	119%	96.2%
Toluene-d8	Surrogate	85.2%	85.4%	85.7%	83.8%

**Hydrocarbons**

F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
F2 PHCs (C10-C16)	100 ug/L	<100	<100	<100	<100
F3 PHCs (C16-C34)	100 ug/L	<100	<100	203	<100
F4 PHCs (C34-C50)	100 ug/L	<100	<100	<100	<100

Certificate of Analysis  
 Client: GHD Limited (Ottawa)  
 Client PO: 73508783

Report Date: 14-Sep-2017

Order Date: 8-Sep-2017

Project Description: 11140575-E2

	Client ID:	BH1/MW1	BH2/MW2	BH5/MW3	Dup
	Sample Date:	08-Sep-17	08-Sep-17	08-Sep-17	08-Sep-17
	Sample ID:	1737017-01	1737017-02	1737017-03	1737017-04
	MDL/Units	Water	Water	Water	Water

**Semi-Volatiles**

Acenaphthene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Acenaphthylene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Anthracene	0.01 ug/L	<0.01	<0.02 [2]	<0.01	<0.01
Benzo [a] anthracene	0.01 ug/L	<0.01	<0.02 [2]	<0.01	<0.01
Benzo [a] pyrene	0.01 ug/L	<0.01	<0.02 [2]	<0.01	<0.01
Benzo [b] fluoranthene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Benzo [k] fluoranthene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Chrysene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Fluoranthene	0.01 ug/L	<0.01	0.12 [2]	<0.01	<0.01
Fluorene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
1-Methylnaphthalene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
2-Methylnaphthalene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Methylnaphthalene (1&2)	0.10 ug/L	<0.10	<0.20 [2]	<0.10	<0.10
Naphthalene	0.05 ug/L	<0.05	0.16 [2]	<0.05	<0.05
Phenanthrene	0.05 ug/L	<0.05	<0.10 [2]	<0.05	<0.05
Pyrene	0.01 ug/L	<0.01	0.10 [2]	<0.01	<0.01
2-Fluorobiphenyl	Surrogate	94.4%	82.3% [2]	106%	99.2%
Terphenyl-d14	Surrogate	111%	112% [2]	107%	119%

Certificate of Analysis  
**Client: GHD Limited (Ottawa)**  
**Client PO: 73508783**

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
**Project Description: 11140575-E2**

	<b>Client ID:</b>	Trip Blank	-	-	-
	<b>Sample Date:</b>	07-Sep-17	-	-	-
	<b>Sample ID:</b>	1737017-05	-	-	-
	<b>MDL/Units</b>	Water	-	-	-
<b>Volatiles</b>					
Acetone	5.0 ug/L	<5.0	-	-	-
Benzene	0.5 ug/L	<0.5	-	-	-
Bromodichloromethane	0.5 ug/L	<0.5	-	-	-
Bromoform	0.5 ug/L	<0.5	-	-	-
Bromomethane	0.5 ug/L	<0.5	-	-	-
Carbon Tetrachloride	0.2 ug/L	<0.2	-	-	-
Chlorobenzene	0.5 ug/L	<0.5	-	-	-
Chloroform	0.5 ug/L	<0.5	-	-	-
Dibromochloromethane	0.5 ug/L	<0.5	-	-	-
Dichlorodifluoromethane	1.0 ug/L	<1.0	-	-	-
1,2-Dichlorobenzene	0.5 ug/L	<0.5	-	-	-
1,3-Dichlorobenzene	0.5 ug/L	<0.5	-	-	-
1,4-Dichlorobenzene	0.5 ug/L	<0.5	-	-	-
1,1-Dichloroethane	0.5 ug/L	<0.5	-	-	-
1,2-Dichloroethane	0.5 ug/L	<0.5	-	-	-
1,1-Dichloroethylene	0.5 ug/L	<0.5	-	-	-
cis-1,2-Dichloroethylene	0.5 ug/L	<0.5	-	-	-
trans-1,2-Dichloroethylene	0.5 ug/L	<0.5	-	-	-
1,2-Dichloropropane	0.5 ug/L	<0.5	-	-	-
cis-1,3-Dichloropropylene	0.5 ug/L	<0.5	-	-	-
trans-1,3-Dichloropropylene	0.5 ug/L	<0.5	-	-	-
1,3-Dichloropropene, total	0.5 ug/L	<0.5	-	-	-
Ethylbenzene	0.5 ug/L	<0.5	-	-	-
Ethylene dibromide (dibromoethar	0.2 ug/L	<0.2	-	-	-
Hexane	1.0 ug/L	<1.0	-	-	-
Methyl Ethyl Ketone (2-Butanone)	5.0 ug/L	<5.0	-	-	-
Methyl Isobutyl Ketone	5.0 ug/L	<5.0	-	-	-
Methyl tert-butyl ether	2.0 ug/L	<2.0	-	-	-
Methylene Chloride	5.0 ug/L	<5.0	-	-	-
Styrene	0.5 ug/L	<0.5	-	-	-
1,1,1,2-Tetrachloroethane	0.5 ug/L	<0.5	-	-	-
1,1,2,2-Tetrachloroethane	0.5 ug/L	<0.5	-	-	-
Tetrachloroethylene	0.5 ug/L	<0.5	-	-	-
Toluene	0.5 ug/L	<0.5	-	-	-
1,1,1-Trichloroethane	0.5 ug/L	<0.5	-	-	-

Certificate of Analysis  
**Client: GHD Limited (Ottawa)**  
**Client PO: 73508783**

Report Date: 14-Sep-2017

Order Date: 8-Sep-2017

**Project Description: 11140575-E2**

	Client ID:	Trip Blank 07-Sep-17 1737017-05 Water	-	-	-
	Sample Date:		-	-	-
	Sample ID:		-	-	-
	MDL/Units		-	-	-
1,1,2-Trichloroethane	0.5 ug/L	<0.5	-	-	-
Trichloroethylene	0.5 ug/L	<0.5	-	-	-
Trichlorofluoromethane	1.0 ug/L	<1.0	-	-	-
Vinyl chloride	0.5 ug/L	<0.5	-	-	-
m,p-Xylenes	0.5 ug/L	<0.5	-	-	-
o-Xylene	0.5 ug/L	<0.5	-	-	-
Xylenes, total	0.5 ug/L	<0.5	-	-	-
4-Bromofluorobenzene	Surrogate	104%	-	-	-
Dibromofluoromethane	Surrogate	114%	-	-	-
Toluene-d8	Surrogate	84.7%	-	-	-



Certificate of Analysis  
**Client: GHD Limited (Ottawa)**  
**Client PO: 73508783**

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
**Project Description: 11140575-E2**

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Hydrocarbons</b>									
F1 PHCs (C6-C10)	ND	25	ug/L						
F2 PHCs (C10-C16)	ND	100	ug/L						
F3 PHCs (C16-C34)	ND	100	ug/L						
F4 PHCs (C34-C50)	ND	100	ug/L						
<b>Metals</b>									
Antimony	ND	0.5	ug/L						
Arsenic	ND	1	ug/L						
Barium	ND	1	ug/L						
Beryllium	ND	0.5	ug/L						
Boron	ND	10	ug/L						
Cadmium	ND	0.1	ug/L						
Chromium	ND	1	ug/L						
Cobalt	ND	0.5	ug/L						
Copper	ND	0.5	ug/L						
Lead	ND	0.1	ug/L						
Molybdenum	ND	0.5	ug/L						
Nickel	ND	1	ug/L						
Selenium	ND	1	ug/L						
Silver	ND	0.1	ug/L						
Sodium	ND	200	ug/L						
Thallium	ND	0.1	ug/L						
Uranium	ND	0.1	ug/L						
Vanadium	ND	0.5	ug/L						
Zinc	ND	5	ug/L						
<b>Semi-Volatiles</b>									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	17.3		ug/L		86.4	50-140			
Surrogate: Terphenyl-d14	19.6		ug/L		97.8	50-140			
<b>Volatiles</b>									
Acetone	ND	5.0	ug/L						
Benzene	ND	0.5	ug/L						
Bromodichloromethane	ND	0.5	ug/L						
Bromoform	ND	0.5	ug/L						
Bromomethane	ND	0.5	ug/L						
Carbon Tetrachloride	ND	0.2	ug/L						
Chlorobenzene	ND	0.5	ug/L						
Chloroform	ND	0.5	ug/L						
Dibromochloromethane	ND	0.5	ug/L						
Dichlorodifluoromethane	ND	1.0	ug/L						
1,2-Dichlorobenzene	ND	0.5	ug/L						
1,3-Dichlorobenzene	ND	0.5	ug/L						

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
Project Description: 11140575-E2

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
1,4-Dichlorobenzene	ND	0.5	ug/L						
1,1-Dichloroethane	ND	0.5	ug/L						
1,2-Dichloroethane	ND	0.5	ug/L						
1,1-Dichloroethylene	ND	0.5	ug/L						
cis-1,2-Dichloroethylene	ND	0.5	ug/L						
trans-1,2-Dichloroethylene	ND	0.5	ug/L						
1,2-Dichloropropane	ND	0.5	ug/L						
cis-1,3-Dichloropropylene	ND	0.5	ug/L						
trans-1,3-Dichloropropylene	ND	0.5	ug/L						
1,3-Dichloropropene, total	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Ethylene dibromide (dibromoethane)	ND	0.2	ug/L						
Hexane	ND	1.0	ug/L						
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L						
Methyl Isobutyl Ketone	ND	5.0	ug/L						
Methyl tert-butyl ether	ND	2.0	ug/L						
Methylene Chloride	ND	5.0	ug/L						
Styrene	ND	0.5	ug/L						
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L						
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L						
Tetrachloroethylene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
1,1,1-Trichloroethane	ND	0.5	ug/L						
1,1,2-Trichloroethane	ND	0.5	ug/L						
Trichloroethylene	ND	0.5	ug/L						
Trichlorofluoromethane	ND	1.0	ug/L						
Vinyl chloride	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: 4-Bromofluorobenzene	85.6		ug/L		107	50-140			
Surrogate: Dibromofluoromethane	80.7		ug/L		101	50-140			
Surrogate: Toluene-d8	72.9		ug/L		91.2	50-140			

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73508783**

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
Project Description: **11140575-E2**

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>General Inorganics</b>									
pH	7.4	0.1	pH Units	7.3			2.5	10	
<b>Hydrocarbons</b>									
F1 PHCs (C6-C10)	ND	25	ug/L	ND				30	
<b>Metals</b>									
Antimony	ND	0.5	ug/L	ND			0.0	20	
Arsenic	ND	1	ug/L	ND			0.0	20	
Barium	ND	1	ug/L	ND			0.0	20	
Beryllium	ND	0.5	ug/L	ND			0.0	20	
Boron	ND	10	ug/L	ND			0.0	20	
Cadmium	ND	0.1	ug/L	ND			0.0	20	
Chromium	ND	1	ug/L	ND			0.0	20	
Cobalt	ND	0.5	ug/L	ND			0.0	20	
Copper	ND	0.5	ug/L	ND				20	
Lead	ND	0.1	ug/L	ND			0.0	20	
Molybdenum	ND	0.5	ug/L	ND			0.0	20	
Nickel	ND	1	ug/L	ND				20	
Selenium	ND	1	ug/L	ND			0.0	20	
Silver	ND	0.1	ug/L	ND			0.0	20	
Sodium	ND	200	ug/L	ND			0.0	20	
Thallium	ND	0.1	ug/L	ND			0.0	20	
Uranium	ND	0.1	ug/L	ND			0.0	20	
Vanadium	ND	0.5	ug/L	ND				20	
Zinc	ND	5	ug/L	ND			0.0	20	
<b>Volatiles</b>									
Acetone	ND	5.0	ug/L	ND				30	
Benzene	ND	0.5	ug/L	ND				30	
Bromodichloromethane	ND	0.5	ug/L	ND				30	
Bromoform	ND	0.5	ug/L	ND				30	
Bromomethane	ND	0.5	ug/L	ND				30	
Carbon Tetrachloride	ND	0.2	ug/L	ND				30	
Chlorobenzene	ND	0.5	ug/L	ND				30	
Chloroform	ND	0.5	ug/L	ND				30	
Dibromochloromethane	ND	0.5	ug/L	ND				30	
Dichlorodifluoromethane	ND	1.0	ug/L	ND				30	
1,2-Dichlorobenzene	ND	0.5	ug/L	ND				30	
1,3-Dichlorobenzene	ND	0.5	ug/L	ND				30	
1,4-Dichlorobenzene	ND	0.5	ug/L	ND				30	
1,1-Dichloroethane	ND	0.5	ug/L	ND				30	
1,2-Dichloroethane	ND	0.5	ug/L	ND				30	
1,1-Dichloroethylene	ND	0.5	ug/L	ND				30	
cis-1,2-Dichloroethylene	ND	0.5	ug/L	ND				30	
trans-1,2-Dichloroethylene	ND	0.5	ug/L	ND				30	
1,2-Dichloropropane	ND	0.5	ug/L	ND				30	
cis-1,3-Dichloropropylene	ND	0.5	ug/L	ND				30	
trans-1,3-Dichloropropylene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Ethylene dibromide (dibromoethane)	ND	0.2	ug/L	ND				30	
Hexane	ND	1.0	ug/L	ND				30	
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L	ND				30	
Methyl Isobutyl Ketone	ND	5.0	ug/L	ND				30	
Methyl tert-butyl ether	ND	2.0	ug/L	ND				30	
Methylene Chloride	ND	5.0	ug/L	ND				30	
Styrene	ND	0.5	ug/L	ND				30	
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L	ND				30	
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L	ND				30	
Tetrachloroethylene	ND	0.5	ug/L	ND				30	
Toluene	ND	0.5	ug/L	ND				30	

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 14-Sep-2017

Order Date: 8-Sep-2017

Project Description: 11140575-E2

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
1,1,1-Trichloroethane	ND	0.5	ug/L	ND				30	
1,1,2-Trichloroethane	ND	0.5	ug/L	ND				30	
Trichloroethylene	ND	0.5	ug/L	ND				30	
Trichlorofluoromethane	ND	1.0	ug/L	ND				30	
Vinyl chloride	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: 4-Bromofluorobenzene	81.3		ug/L		102	50-140			
Surrogate: Dibromofluoromethane	87.4		ug/L		109	50-140			
Surrogate: Toluene-d8	68.3		ug/L		85.4	50-140			



Certificate of Analysis  
**Client: GHD Limited (Ottawa)**  
**Client PO: 73508783**

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
**Project Description: 11140575-E2**

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Hydrocarbons</b>									
F1 PHCs (C6-C10)	2010	25	ug/L		100	68-117			
F2 PHCs (C10-C16)	1950	100	ug/L		108	60-140			
F3 PHCs (C16-C34)	3880	100	ug/L		104	60-140			
F4 PHCs (C34-C50)	2400	100	ug/L		96.8	60-140			
<b>Metals</b>									
Antimony	43.3		ug/L	ND	86.6	80-120			
Arsenic	49.3		ug/L	ND	98.7	80-120			
Barium	47.6		ug/L	ND	95.2	80-120			
Beryllium	48.5		ug/L	ND	96.9	80-120			
Boron	46		ug/L	ND	88.8	80-120			
Cadmium	47.0		ug/L	ND	93.9	80-120			
Chromium	50.4		ug/L	ND	100	80-120			
Cobalt	49.0		ug/L	ND	97.9	80-120			
Copper	45.6		ug/L	ND	91.2	80-120			
Lead	46.0		ug/L	ND	92.0	80-120			
Molybdenum	44.6		ug/L	ND	89.1	80-120			
Nickel	46.6		ug/L	ND	93.1	80-120			
Selenium	49.9		ug/L	ND	99.7	80-120			
Silver	44.8		ug/L	ND	89.5	80-120			
Sodium	1040		ug/L	ND	103	80-120			
Thallium	45.6		ug/L	ND	91.2	80-120			
Uranium	46.6		ug/L	ND	93.2	80-120			
Vanadium	50.6		ug/L	ND	101	80-120			
Zinc	49		ug/L	ND	97.3	80-120			
<b>Semi-Volatiles</b>									
Acenaphthene	4.30	0.05	ug/L		85.9	50-140			
Acenaphthylene	3.93	0.05	ug/L		78.5	50-140			
Anthracene	4.13	0.01	ug/L		82.6	50-140			
Benzo [a] anthracene	3.73	0.01	ug/L		74.6	50-140			
Benzo [a] pyrene	4.21	0.01	ug/L		84.2	50-140			
Benzo [b] fluoranthene	6.27	0.05	ug/L		125	50-140			
Benzo [g,h,i] perylene	4.32	0.05	ug/L		86.5	50-140			
Benzo [k] fluoranthene	6.06	0.05	ug/L		121	50-140			
Chrysene	4.33	0.05	ug/L		86.6	50-140			
Dibenzo [a,h] anthracene	4.52	0.05	ug/L		90.4	50-140			
Fluoranthene	4.18	0.01	ug/L		83.5	50-140			
Fluorene	4.05	0.05	ug/L		80.9	50-140			
Indeno [1,2,3-cd] pyrene	4.62	0.05	ug/L		92.4	50-140			
1-Methylnaphthalene	3.77	0.05	ug/L		75.5	50-140			
2-Methylnaphthalene	4.09	0.05	ug/L		81.9	50-140			
Naphthalene	3.84	0.05	ug/L		76.7	50-140			
Phenanthrene	3.82	0.05	ug/L		76.4	50-140			
Pyrene	4.30	0.01	ug/L		85.9	50-140			
Surrogate: 2-Fluorobiphenyl	16.0		ug/L		79.9	50-140			
<b>Volatiles</b>									
Acetone	62.0	5.0	ug/L		62.0	50-140			
Benzene	36.7	0.5	ug/L		91.6	60-130			
Bromodichloromethane	49.0	0.5	ug/L		122	60-130			
Bromoform	47.4	0.5	ug/L		119	60-130			
Bromomethane	49.1	0.5	ug/L		123	50-140			
Carbon Tetrachloride	51.3	0.2	ug/L		128	60-130			

Certificate of Analysis  
**Client: GHD Limited (Ottawa)**  
**Client PO: 73508783**

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
**Project Description: 11140575-E2**

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Chlorobenzene	34.4	0.5	ug/L		86.0	60-130			
Chloroform	40.1	0.5	ug/L		100	60-130			
Dibromochloromethane	48.9	0.5	ug/L		122	60-130			
Dichlorodifluoromethane	35.8	1.0	ug/L		89.6	50-140			
1,2-Dichlorobenzene	34.8	0.5	ug/L		87.0	60-130			
1,3-Dichlorobenzene	36.0	0.5	ug/L		90.0	60-130			
1,4-Dichlorobenzene	34.6	0.5	ug/L		86.6	60-130			
1,1-Dichloroethane	38.5	0.5	ug/L		96.2	60-130			
1,2-Dichloroethane	37.9	0.5	ug/L		94.7	60-130			
1,1-Dichloroethylene	38.5	0.5	ug/L		96.2	60-130			
cis-1,2-Dichloroethylene	41.5	0.5	ug/L		104	60-130			
trans-1,2-Dichloroethylene	37.3	0.5	ug/L		93.3	60-130			
1,2-Dichloropropane	42.2	0.5	ug/L		106	60-130			
cis-1,3-Dichloropropylene	51.0	0.5	ug/L		128	60-130			
trans-1,3-Dichloropropylene	50.2	0.5	ug/L		126	60-130			
Ethylbenzene	41.4	0.5	ug/L		104	60-130			
Ethylene dibromide (dibromoethane)	35.4	0.2	ug/L		88.4	60-130			
Hexane	31.7	1.0	ug/L		79.2	60-130			
Methyl Ethyl Ketone (2-Butanone)	93.5	5.0	ug/L		93.5	50-140			
Methyl Isobutyl Ketone	116	5.0	ug/L		116	50-140			
Methyl tert-butyl ether	100	2.0	ug/L		100	50-140			
Methylene Chloride	28.6	5.0	ug/L		71.5	60-130			
Styrene	47.6	0.5	ug/L		119	60-130			
1,1,1,2-Tetrachloroethane	48.5	0.5	ug/L		121	60-130			
1,1,2,2-Tetrachloroethane	32.5	0.5	ug/L		81.2	60-130			
Tetrachloroethylene	33.4	0.5	ug/L		83.6	60-130			
Toluene	35.3	0.5	ug/L		88.2	60-130			
1,1,1-Trichloroethane	42.6	0.5	ug/L		106	60-130			
1,1,2-Trichloroethane	42.5	0.5	ug/L		106	60-130			
Trichloroethylene	45.5	0.5	ug/L		114	60-130			
Trichlorofluoromethane	37.0	1.0	ug/L		92.5	60-130			
Vinyl chloride	48.6	0.5	ug/L		122	50-140			
m,p-Xylenes	80.2	0.5	ug/L		100	60-130			
o-Xylene	39.5	0.5	ug/L		98.8	60-130			

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 14-Sep-2017  
Order Date: 8-Sep-2017  
Project Description: 11140575-E2

**Qualifier Notes:**

***Sample Qualifiers :***

2 : Elevated Reporting Limits due to limited sample volume.

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable  
ND: Not Detected  
MDL: Method Detection Limit  
Source Result: Data used as source for matrix and duplicate samples  
%REC: Percent recovery.  
RPD: Relative percent difference.

***CCME PHC additional information:***

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

Parcel ID: 1737017



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No 112293

Page \_\_\_\_ of \_\_\_\_

Client Name: <u>640 Limited</u>	Project Reference: <u>811 Gladstone 1140575-62</u>	<b>Turnaround Time:</b> <input type="checkbox"/> 1 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input checked="" type="checkbox"/> Regular Date Required: _____
Contact Name: <u>Luke Lopers</u>	Quote #	
Address: <u>179 Glenade Road</u>	PO # <u>73508783</u>	
Telephone: <u>615-325-2044</u>	Email Address: <u>Luke.Lopers@640.com</u>	

 Criteria: ☒ O. Reg. 153/04 (As Amended) Table \_\_\_\_ ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☐ SUB (Storm) ☐ SUB (Sanitary) Municipality: \_\_\_\_\_ ☐ Other: \_\_\_\_\_

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Parcel Order Number:			Sample Taken		PHCs F1-F4+BTX	VOCs	PAHs	Metals by ICP	Hg	CrVI	B (HWS)										
Sample ID/Location Name			Matrix	Air Volume	# of Containers	Date	Time														
1	BH1 / MW1		GW		6	Sept 8	13:30	x	x	x								X			✓
2	BH2 / MW2		GW		6	Sept 8	14:00	x	x	x								X			✓
3	BH5 / MW3		GW		6	Sept 8	15:00	x	x	x								X			✓
4	DUP		GW		6	Sept 8	<del>15:00</del>	x	x	x								X			✓
5	Trip Blank		GW		①	Sept 8	7	x	x	x											✓
6																					
7	Low volume received in PAH bottle. KW - proceed regardless per Luke.																				
8																					
9																					
10																					

Comments: <u>All metal samples filtered on site -</u>		<u>Extra bottle received - Gen Chem in each set.</u>		Method of Delivery: <u>Walk-in</u>
Relinquished By (Sign): <u>[Signature]</u>	Received by Driver/Depot:	Received at Lab: <u>[Signature]</u>	Verified By: <u>[Signature]</u>	
Relinquished By (Print): <u>Ryan Vander Millan</u>	Date/Time:	Date/Time: <u>09/08/17 5:54pm</u>	Date/Time: <u>09/12/17 9:55am</u>	
Date/Time: <u>Sept 8, 2017</u>	Temperature: _____ °C	Temperature: <u>16.9</u> °C	pH Verified   By:	



## Certificate of Analysis

**GHD Limited (Ottawa)**

179 Colonnade Road Suite 400  
Ottawa, ON K2E7S4  
Attn: Luke Lopers

Client PO: 73508783  
Project: 11140575-G2  
Custody: 38677

Report Date: 18-Sep-2017  
Order Date: 12-Sep-2017

**Order #: 1737231**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1737231-01	MW4
1737231-02	Trip Blank

Approved By:



Dale Robertson, BSc  
Laboratory Director

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 18-Sep-2017  
Order Date: 12-Sep-2017  
Project Description: 11140575-G2

### Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
REG 153: VOCs by P&T GC/MS	EPA 624 - P&T GC-MS	15-Sep-17	16-Sep-17

Certificate of Analysis  
 Client: GHD Limited (Ottawa)  
 Client PO: 73508783

Report Date: 18-Sep-2017  
 Order Date: 12-Sep-2017  
 Project Description: 11140575-G2

Client ID:	MW4	Trip Blank	-	-
Sample Date:	12-Sep-17	11-Sep-17	-	-
Sample ID:	1737231-01	1737231-02	-	-
MDL/Units	Water	Water	-	-

**Volatiles**

Acetone	5.0 ug/L	<5.0	<5.0	-	-
Benzene	0.5 ug/L	<0.5	<0.5	-	-
Bromodichloromethane	0.5 ug/L	<0.5	<0.5	-	-
Bromoform	0.5 ug/L	<0.5	<0.5	-	-
Bromomethane	0.5 ug/L	<0.5	<0.5	-	-
Carbon Tetrachloride	0.2 ug/L	<0.2	<0.2	-	-
Chlorobenzene	0.5 ug/L	<0.5	<0.5	-	-
Chloroform	0.5 ug/L	<0.5	<0.5	-	-
Dibromochloromethane	0.5 ug/L	<0.5	<0.5	-	-
Dichlorodifluoromethane	1.0 ug/L	<1.0	<1.0	-	-
1,2-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	-	-
1,3-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	-	-
1,4-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	-	-
1,1-Dichloroethane	0.5 ug/L	<0.5	<0.5	-	-
1,2-Dichloroethane	0.5 ug/L	<0.5	<0.5	-	-
1,1-Dichloroethylene	0.5 ug/L	<0.5	<0.5	-	-
cis-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	-	-
trans-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	-	-
1,2-Dichloropropane	0.5 ug/L	<0.5	<0.5	-	-
cis-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	-	-
trans-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	-	-
1,3-Dichloropropene, total	0.5 ug/L	<0.5	<0.5	-	-
Ethylbenzene	0.5 ug/L	<0.5	<0.5	-	-
Ethylene dibromide (dibromoethane)	0.2 ug/L	<0.2	<0.2	-	-
Hexane	1.0 ug/L	<1.0	<1.0	-	-
Methyl Ethyl Ketone (2-Butanone)	5.0 ug/L	<5.0	<5.0	-	-
Methyl Isobutyl Ketone	5.0 ug/L	<5.0	<5.0	-	-
Methyl tert-butyl ether	2.0 ug/L	<2.0	<2.0	-	-
Methylene Chloride	5.0 ug/L	<5.0	<5.0	-	-
Styrene	0.5 ug/L	<0.5	<0.5	-	-
1,1,1,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	-	-
1,1,2,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	-	-
Tetrachloroethylene	0.5 ug/L	<0.5	<0.5	-	-
Toluene	0.5 ug/L	<0.5	<0.5	-	-
1,1,1-Trichloroethane	0.5 ug/L	<0.5	<0.5	-	-

Certificate of Analysis  
**Client: GHD Limited (Ottawa)**  
**Client PO: 73508783**

Report Date: 18-Sep-2017  
 Order Date: 12-Sep-2017  
**Project Description: 11140575-G2**

	MDL/Units	Client ID:	MW4	Trip Blank		
		Sample Date:	12-Sep-17	11-Sep-17	-	-
		Sample ID:	1737231-01	1737231-02	-	-
			Water	Water	-	-
1,1,2-Trichloroethane	0.5 ug/L		<0.5	<0.5	-	-
Trichloroethylene	0.5 ug/L		<0.5	<0.5	-	-
Trichlorofluoromethane	1.0 ug/L		<1.0	<1.0	-	-
Vinyl chloride	0.5 ug/L		<0.5	<0.5	-	-
m,p-Xylenes	0.5 ug/L		<0.5	<0.5	-	-
o-Xylene	0.5 ug/L		<0.5	<0.5	-	-
Xylenes, total	0.5 ug/L		<0.5	<0.5	-	-
4-Bromofluorobenzene	Surrogate		102%	104%	-	-
Dibromofluoromethane	Surrogate		78.7%	98.0%	-	-
Toluene-d8	Surrogate		99.9%	98.7%	-	-



Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 18-Sep-2017  
Order Date: 12-Sep-2017  
Project Description: 11140575-G2

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Volatiles</b>									
Acetone	ND	5.0	ug/L						
Benzene	ND	0.5	ug/L						
Bromodichloromethane	ND	0.5	ug/L						
Bromoform	ND	0.5	ug/L						
Bromomethane	ND	0.5	ug/L						
Carbon Tetrachloride	ND	0.2	ug/L						
Chlorobenzene	ND	0.5	ug/L						
Chloroform	ND	0.5	ug/L						
Dibromochloromethane	ND	0.5	ug/L						
Dichlorodifluoromethane	ND	1.0	ug/L						
1,2-Dichlorobenzene	ND	0.5	ug/L						
1,3-Dichlorobenzene	ND	0.5	ug/L						
1,4-Dichlorobenzene	ND	0.5	ug/L						
1,1-Dichloroethane	ND	0.5	ug/L						
1,2-Dichloroethane	ND	0.5	ug/L						
1,1-Dichloroethylene	ND	0.5	ug/L						
cis-1,2-Dichloroethylene	ND	0.5	ug/L						
trans-1,2-Dichloroethylene	ND	0.5	ug/L						
1,2-Dichloropropane	ND	0.5	ug/L						
cis-1,3-Dichloropropylene	ND	0.5	ug/L						
trans-1,3-Dichloropropylene	ND	0.5	ug/L						
1,3-Dichloropropene, total	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Ethylene dibromide (dibromoethane)	ND	0.2	ug/L						
Hexane	ND	1.0	ug/L						
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L						
Methyl Isobutyl Ketone	ND	5.0	ug/L						
Methyl tert-butyl ether	ND	2.0	ug/L						
Methylene Chloride	ND	5.0	ug/L						
Styrene	ND	0.5	ug/L						
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L						
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L						
Tetrachloroethylene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
1,1,1-Trichloroethane	ND	0.5	ug/L						
1,1,2-Trichloroethane	ND	0.5	ug/L						
Trichloroethylene	ND	0.5	ug/L						
Trichlorofluoromethane	ND	1.0	ug/L						
Vinyl chloride	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: 4-Bromofluorobenzene	82.2		ug/L		103	50-140			
Surrogate: Dibromofluoromethane	72.3		ug/L		90.3	50-140			
Surrogate: Toluene-d8	81.2		ug/L		102	50-140			

Certificate of Analysis  
**Client: GHD Limited (Ottawa)**  
**Client PO: 73508783**

Report Date: 18-Sep-2017  
Order Date: 12-Sep-2017  
**Project Description: 11140575-G2**

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Volatiles</b>									
Acetone	ND	5.0	ug/L	ND				30	
Benzene	ND	0.5	ug/L	ND				30	
Bromodichloromethane	1.35	0.5	ug/L	1.26			6.9	30	
Bromoform	ND	0.5	ug/L	ND				30	
Bromomethane	ND	0.5	ug/L	ND				30	
Carbon Tetrachloride	ND	0.2	ug/L	ND				30	
Chlorobenzene	ND	0.5	ug/L	ND				30	
Chloroform	11.3	0.5	ug/L	10.8			4.0	30	
Dibromochloromethane	ND	0.5	ug/L	ND				30	
Dichlorodifluoromethane	ND	1.0	ug/L	ND				30	
1,2-Dichlorobenzene	ND	0.5	ug/L	ND				30	
1,3-Dichlorobenzene	ND	0.5	ug/L	ND				30	
1,4-Dichlorobenzene	ND	0.5	ug/L	ND				30	
1,1-Dichloroethane	ND	0.5	ug/L	ND				30	
1,2-Dichloroethane	ND	0.5	ug/L	ND				30	
1,1-Dichloroethylene	ND	0.5	ug/L	ND				30	
cis-1,2-Dichloroethylene	ND	0.5	ug/L	ND				30	
trans-1,2-Dichloroethylene	ND	0.5	ug/L	ND				30	
1,2-Dichloropropane	ND	0.5	ug/L	ND				30	
cis-1,3-Dichloropropylene	ND	0.5	ug/L	ND				30	
trans-1,3-Dichloropropylene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND			0.0	30	
Ethylene dibromide (dibromoethane)	ND	0.2	ug/L	ND				30	
Hexane	ND	1.0	ug/L	ND				30	
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L	ND				30	
Methyl Isobutyl Ketone	ND	5.0	ug/L	ND				30	
Methyl tert-butyl ether	ND	2.0	ug/L	ND				30	
Methylene Chloride	ND	5.0	ug/L	ND				30	
Styrene	ND	0.5	ug/L	ND				30	
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L	ND				30	
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L	ND				30	
Tetrachloroethylene	4.37	0.5	ug/L	4.79			9.2	30	
Toluene	5.51	0.5	ug/L	5.73			3.9	30	
1,1,1-Trichloroethane	ND	0.5	ug/L	ND				30	
1,1,2-Trichloroethane	ND	0.5	ug/L	ND				30	
Trichloroethylene	ND	0.5	ug/L	ND				30	
Trichlorofluoromethane	ND	1.0	ug/L	ND				30	
Vinyl chloride	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: 4-Bromofluorobenzene	71.5		ug/L		89.3	50-140			
Surrogate: Dibromofluoromethane	72.6		ug/L		90.7	50-140			
Surrogate: Toluene-d8	80.4		ug/L		101	50-140			

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73508783**

Report Date: 18-Sep-2017  
Order Date: 12-Sep-2017  
Project Description: **11140575-G2**

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Volatiles</b>									
Acetone	80.9	5.0	ug/L	ND	80.9	50-140			
Benzene	37.1	0.5	ug/L	ND	92.8	50-140			
Bromodichloromethane	41.9	0.5	ug/L	3.60	95.7	50-140			
Bromoform	33.0	0.5	ug/L	ND	82.5	50-140			
Bromomethane	33.9	0.5	ug/L	ND	84.8	50-140			
Carbon Tetrachloride	34.9	0.2	ug/L	ND	87.3	50-140			
Chlorobenzene	35.5	0.5	ug/L	ND	88.7	50-140			
Chloroform	40.4	0.5	ug/L	7.57	82.1	50-140			
Dibromochloromethane	34.6	0.5	ug/L	2.30	80.7	50-140			
Dichlorodifluoromethane	30.8	1.0	ug/L	ND	76.9	50-140			
1,2-Dichlorobenzene	28.2	0.5	ug/L	ND	70.4	50-140			
1,3-Dichlorobenzene	26.4	0.5	ug/L	ND	66.0	50-140			
1,4-Dichlorobenzene	27.8	0.5	ug/L	ND	69.6	50-140			
1,1-Dichloroethane	38.6	0.5	ug/L	ND	96.5	50-140			
1,2-Dichloroethane	35.7	0.5	ug/L	ND	89.2	50-140			
1,1-Dichloroethylene	34.6	0.5	ug/L	ND	86.4	50-140			
cis-1,2-Dichloroethylene	42.6	0.5	ug/L	ND	106	50-140			
trans-1,2-Dichloroethylene	36.1	0.5	ug/L	ND	90.3	50-140			
1,2-Dichloropropane	41.7	0.5	ug/L	ND	104	50-140			
cis-1,3-Dichloropropylene	38.7	0.5	ug/L	ND	96.8	50-140			
trans-1,3-Dichloropropylene	36.6	0.5	ug/L	ND	91.5	50-140			
Ethylbenzene	36.3	0.5	ug/L	ND	90.8	50-140			
Ethylene dibromide (dibromoethane)	35.3	0.2	ug/L	ND	88.2	50-140			
Hexane	39.6	1.0	ug/L	ND	99.0	50-140			
Methyl Ethyl Ketone (2-Butanone)	97.1	5.0	ug/L	ND	97.1	50-140			
Methyl Isobutyl Ketone	89.4	5.0	ug/L	ND	89.4	50-140			
Methyl tert-butyl ether	103	2.0	ug/L	ND	103	50-140			
Methylene Chloride	33.5	5.0	ug/L	ND	83.8	50-140			
Styrene	31.0	0.5	ug/L	ND	77.6	50-140			
1,1,1,2-Tetrachloroethane	32.2	0.5	ug/L	ND	80.6	50-140			
1,1,1,2,2-Tetrachloroethane	32.5	0.5	ug/L	ND	81.3	50-140			
Tetrachloroethylene	34.4	0.5	ug/L	ND	85.9	50-140			
Toluene	34.0	0.5	ug/L	ND	85.1	50-140			
1,1,1-Trichloroethane	32.6	0.5	ug/L	ND	81.6	50-140			
1,1,2-Trichloroethane	38.2	0.5	ug/L	ND	95.6	50-140			
Trichloroethylene	40.6	0.5	ug/L	ND	102	50-140			
Trichlorofluoromethane	30.8	1.0	ug/L	ND	77.0	50-140			
Vinyl chloride	33.5	0.5	ug/L	ND	83.7	50-140			
m,p-Xylenes	69.2	0.5	ug/L	ND	86.5	50-140			
o-Xylene	33.7	0.5	ug/L	ND	84.2	50-140			
Surrogate: 4-Bromofluorobenzene	85.0		ug/L		106	50-140			

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 18-Sep-2017  
Order Date: 12-Sep-2017  
Project Description: 11140575-G2

**Qualifier Notes:**

None

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable  
ND: Not Detected  
MDL: Method Detection Limit  
Source Result: Data used as source for matrix and duplicate samples  
%REC: Percent recovery.  
RPD: Relative percent difference.



Parcel ID: 1737231



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Chain of Custody  
(Lab Use Only)

Nº 38677

Page 1 of 1

Turnaround Time:

☐ 1 Day

☐ 3 Day

☐ 2 Day

☒ Regular

Date Required: \_\_\_\_\_

Client Name: <u>GHD Limited</u>	Project Reference: <u>11140575-62</u>
Contact Name: <u>Luke Lopez</u>	Quote #
Address: <u>179 Colorado Road</u>	PO # <u>73508783</u>
Telephone: <u>613-325-2094</u>	Email Address: <u>Luke.Lopez@ghd.com</u>

Criteria: ☒ O. Reg. 153/04 (As Amended) Table \_\_ ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☐ SUB (Storm) ☐ SUB (Sanitary) Municipality: \_\_\_\_\_ ☐ Other: \_\_\_\_\_

Matrix Type: S (Soil Sed.) GW (Ground Water) SW (Surface Water) SS (Storm Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Parcel Order Number:		Matrix	Air Volume	# of Containers	Sample Taken		VOCs												
Sample ID/Location Name					Date	Time													
1	MW4	GW		2	Sept 12	13:30	X												
2	trip Blank	GW		2	<del>Sept 12</del>		X												
3					Sept 11														
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Method of Delivery:

Comments:

Method of Delivery

Walk in

Relinquished By (Sign): <u>[Signature]</u>	Received by Driver/Depot:	Received at Lab: <u>[Signature]</u>	Verified By: <u>[Signature]</u>
Relinquished By (Print): <u>Ryan Vanden Pijper</u>	Date/Time:	Date/Time: <u>Sept 12/17</u>	Date/Time: <u>09:20 4.09</u>
Date/Time: <u>Sept 12, 2017</u>	Temperature: _____ °C	Temperature: <u>25.4 °C</u>	pH Verified   By: _____

## Certificate of Analysis

### GHD Limited (Ottawa)

179 Colonnade Road Suite 400

Ottawa, ON K2E7S4

Attn: Luke Lopers

Client PO: 73508783

Project: 11140575-E2

Custody: 37955

Report Date: 31-Oct-2017

Order Date: 30-Oct-2017

**Order #: 1744078**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
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1744078-01	BH5
------------	-----

1744078-02	BH6
------------	-----

Approved By:



Dale Robertson, BSc  
Laboratory Director

Any use of these results implies your agreement that our total liability in connection with this work, however arising shall be limited to the amount paid by you for this work, and that our employees or agents shall not under circumstances be liable to you in connection with this work

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 31-Oct-2017  
Order Date: 30-Oct-2017  
Project Description: 11140575-E2

### Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	31-Oct-17	31-Oct-17

### Sample and QC Qualifiers Notes

1- LG-SMP Sample - One or more parameter received past hold time - pH

### Sample Data Revisions

None

### Work Order Revisions/Comments:

None

### Other Report Notes:

n/a: not applicable  
ND: Not Detected  
MDL: Method Detection Limit  
Source Result: Data used as source for matrix and duplicate samples  
%REC: Percent recovery.  
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73508783

Report Date: 31-Oct-2017  
Order Date: 30-Oct-2017  
Project Description: 11140575-E2

## Sample Results

pH				Matrix: Soil
				Sample Date: 29-Aug-17
Paracel ID	Client ID	Units	MDL	Result
1744078-01	BH5	pH Units	0.05	7.36
1744078-02	BH6	pH Units	0.05	7.38

## Laboratory Internal QA/QC

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Matrix Duplicate									
pH	7.92	0.05	pH Units	7.94			0.3	10	





Client Name: <u>GHD</u>	Project Reference: <u>11140575-E2</u>	<b>Turnaround Time:</b> <input checked="" type="checkbox"/> 1 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input type="checkbox"/> Regular Date Required: _____
Contact Name: <u>Luke Lopez</u>	Quote # _____	
Address: <u>179 Colonnade Road, Ottawa, ON</u>	PO # <u>73508783</u>	
Telephone: <u>613-288-1723</u>	Email Address: <u>luke.lopez@GHD.com</u>	

Criteria: ☒ O. Reg. 153/04 (As Amended) Table \_\_\_ ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☐ SUB (Storm) ☐ SUB (Sanitary) Municipality: \_\_\_\_\_ ☐ Other: \_\_\_\_\_

Matrix Type: S (Soil Sed.) GW (Ground Water) SW (Surface Water) SS (Storm Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Parcel Order Number:		Matrix	Air Volume	# of Containers	Sample Taken		PH										
Sample ID/Location Name					Date	Time											
1	BH5	S		1	Aug 29/17		X										
2	BH6	S		1	AUG 29/17		X										
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Comments: Samples received past hold time for pH. KW  
Proceed as per Luke. DRUM  
 Method of Delivery: Paracel

Relinquished By (Sign): <u>[Signature]</u>	Received by Driver/Depot: <u>[Signature]</u>	Received at Lab: <u>SINCEPORN DEKMAI</u>	Verified By: <u>[Signature]</u>
Relinquished By (Print): <u>Luke Lopez</u>	Date/Time: <u>30/10/17 3:16</u>	Date/Time: <u>Oct 30, 2017 04:05</u>	Date/Time: <u>Oct 30, 2017 04:05</u>
Date/Time: <u>October 30, 2017 / 2:00 PM</u>	Temperature: _____ °C	Temperature: <u>8.4</u> °C	pH Verified   By: _____

## Certificate of Analysis

### GHD Limited (Ottawa)

179 Colonnade Road Suite 400  
Ottawa, ON K0A 2W0  
Attn: Steven Wheeler

Client PO: 73515533  
Project: 11140575-E3  
Custody: 47665

Report Date: 3-May-2019  
Order Date: 25-Apr-2019

**Order #: 1917649**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1917649-01	GW-MW4-04-25-2019
1917649-02	GW-MW5-04-25-2019

Approved By:



Dale Robertson, BSc  
Laboratory Director

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73515533**

Report Date: 03-May-2019

Order Date: 25-Apr-2019

**Project Description: 11140575-E3**

## Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	30-Apr-19	30-Apr-19
CBOD	SM 5210B - DO Probe	26-Apr-19	1-May-19
Cyanide, total	MOE E3015 - Auto Colour	29-Apr-19	29-Apr-19
E. coli	MOE E3407	26-Apr-19	30-Apr-19
Hexachlorobenzene	EPA 8081B - GC-ECD	2-May-19	2-May-19
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	29-Apr-19	29-Apr-19
Metals, ICP-MS	EPA 200.8 - ICP-MS	29-Apr-19	29-Apr-19
Oil & Grease, mineral/synthetic	SM5520F - Gravimetric	29-Apr-19	1-May-19
Oil & Grease, total	SM5520B - Gravimetric, hexane soluble	1-May-19	1-May-19
Ottawa - San/Comb: O&G AV/MS	SM5520 - Gravimetric	1-May-19	1-May-19
Ottawa - San/Comn: SVOCs w/o PAHs	EPA 625	29-Apr-19	30-Apr-19
PAHs by GC-MS, SU Addnl	based on EPA 8270 - GC-MS, extraction	29-Apr-19	1-May-19
PAHs by GC-MS, Sewer Use	based on EPA 8270 - GC-MS, extraction	29-Apr-19	1-May-19
PCBs, total	EPA 608 - GC-ECD	2-May-19	2-May-19
pH	EPA 150.1 - pH probe @25 °C	1-May-19	1-May-19
Phenolics	EPA 420.2 - Auto Colour, 4AAP	30-Apr-19	30-Apr-19
Phosphorus, total, water	EPA 365.4 - Auto Colour, digestion	30-Apr-19	30-Apr-19
Sulphide	SM 4500SE - Colourimetric	30-Apr-19	30-Apr-19
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	30-Apr-19	30-Apr-19
Total Suspended Solids	SM 2540D - Gravimetric	29-Apr-19	1-May-19
VOCs, Sewer Use	EPA 624 - P&T GC-MS	29-Apr-19	30-Apr-19

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73515533**

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: **11140575-E3**

<b>Client ID:</b>	GW-MW4-04-25-2019	GW-MW5-04-25-2019	-	-
<b>Sample Date:</b>	04/25/2019 14:00	04/25/2019 15:00	-	-
<b>Sample ID:</b>	1917649-01	1917649-02	-	-
<b>MDL/Units</b>	Water	Water	-	-

#### Microbiological Parameters

E. coli	1 CFU/100 mL	2 [1] [4]	2 [1] [4]	-	-
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#### General Inorganics

CBOD	2 mg/L	3	<2	-	-
Cyanide, total	0.01 mg/L	<0.01	<0.01	-	-
pH	0.1 pH Units	7.7	8.2	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-
Phosphorus, total	0.01 mg/L	0.07	0.09	-	-
Total Suspended Solids	2 mg/L	90	133	-	-
Sulphide	0.02 mg/L	<0.02	<0.02	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	0.6	1.0	-	-

#### Anions

Fluoride	0.1 mg/L	<0.1	0.3	-	-
Sulphate	1 mg/L	244	220	-	-

#### Metals - Total

Aluminum	0.01 mg/L	<0.01	<0.01	-	-
Antimony	0.001 mg/L	0.001	0.001	-	-
Arsenic	0.01 mg/L	<0.01	<0.01	-	-
Bismuth	0.005 mg/L	<0.005	<0.005	-	-
Boron	0.05 mg/L	0.1	0.2	-	-
Cadmium	0.001 mg/L	<0.001	<0.001	-	-
Chromium	0.05 mg/L	<0.05	<0.05	-	-
Cobalt	0.001 mg/L	<0.001	<0.001	-	-
Copper	0.005 mg/L	<0.005	<0.005	-	-
Lead	0.001 mg/L	<0.001	<0.001	-	-
Manganese	0.05 mg/L	<0.05	<0.05	-	-
Mercury	0.0001 mg/L	<0.0001	<0.0001	-	-
Molybdenum	0.005 mg/L	0.010	0.011	-	-
Nickel	0.005 mg/L	<0.005	<0.005	-	-
Selenium	0.005 mg/L	<0.005	<0.005	-	-
Silver	0.001 mg/L	<0.001	<0.001	-	-
Tin	0.01 mg/L	<0.01	<0.01	-	-
Titanium	0.01 mg/L	<0.01	<0.01	-	-
Vanadium	0.001 mg/L	<0.001	<0.001	-	-
Zinc	0.02 mg/L	<0.02	<0.02	-	-

#### Volatiles



Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73515533**

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: **11140575-E3**

		Client ID:	GW-MW4-04-25-2019	GW-MW5-04-25-2019	-	-
		Sample Date:	04/25/2019 14:00	04/25/2019 15:00	-	-
		Sample ID:	1917649-01	1917649-02	-	-
		MDL/Units	Water	Water	-	-
Benzene	0.0005 mg/L	<0.0005	<0.0005	-	-	
Bromodichloromethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
Bromoform	0.0005 mg/L	<0.0005	<0.0005	-	-	
Bromomethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
Carbon Tetrachloride	0.0002 mg/L	<0.0002	<0.0002	-	-	
Chlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	
Chloroethane	0.0010 mg/L	<0.0010	<0.0010	-	-	
Chloroform	0.0005 mg/L	<0.0005	<0.0005	-	-	
Chloromethane	0.0030 mg/L	<0.0030	<0.0030	-	-	
Dibromochloromethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,2-Dibromoethane	0.0002 mg/L	<0.0002	<0.0002	-	-	
1,2-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,3-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,4-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,1-Dichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,2-Dichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,1-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	
cis-1,2-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	
trans-1,2-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,2-Dichloropropane	0.0005 mg/L	<0.0005	<0.0005	-	-	
cis-1,3-Dichloropropylene	0.0005 mg/L	<0.0005	<0.0005	-	-	
trans-1,3-Dichloropropylene	0.0005 mg/L	<0.0005	<0.0005	-	-	
Ethylbenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	
Methylene Chloride	0.0050 mg/L	<0.0050	<0.0050	-	-	
Styrene	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,1,2,2-Tetrachloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
Tetrachloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	
Toluene	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,1,1-Trichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
1,1,2-Trichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	
Trichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	
Trichlorofluoromethane	0.0010 mg/L	<0.0010	<0.0010	-	-	
1,3,5-Trimethylbenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	
Vinyl chloride	0.0005 mg/L	<0.0005	<0.0005	-	-	
Xylenes, total	0.0005 mg/L	<0.0005	<0.0005	-	-	

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73515533**

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: **11140575-E3**

		Client ID:	GW-MW4-04-25-2019	GW-MW5-04-25-2019	-	-
		Sample Date:	04/25/2019 14:00	04/25/2019 15:00	-	-
		Sample ID:	1917649-01	1917649-02	-	-
		MDL/Units	Water	Water	-	-
4-Bromofluorobenzene	Surrogate		92.7%	97.6%	-	-
Dibromofluoromethane	Surrogate		118%	122%	-	-
Toluene-d8	Surrogate		101%	97.3%	-	-

#### Hydrocarbons

Oil & Grease, Animal/Vegetable	0.5 mg/L	<0.5	<0.5	-	-
Oil & Grease, mineral/synthetic	0.5 mg/L	<0.5	<0.5	-	-
Oil & Grease, total	0.5 mg/L	<0.5	<0.5	-	-

#### Semi-Volatiles

1-Methylnaphthalene	0.00005 mg/L	<0.00005	0.00005	-	-
2-Methylnaphthalene	0.00005 mg/L	<0.00005	<0.00005	-	-
7H-Dibenzo[c,g]carbazole	0.0005 mg/L	<0.0005	<0.0005	-	-
Anthracene	0.00001 mg/L	<0.00001	<0.00001	-	-
Benzo [a] anthracene	0.00001 mg/L	<0.00001	<0.00001	-	-
Benzo [a] pyrene	0.00001 mg/L	<0.00001	<0.00001	-	-
Benzo [b] fluoranthene	0.00005 mg/L	<0.00005	<0.00005	-	-
Benzo [e] pyrene	0.0005 mg/L	<0.0005	<0.0005	-	-
Benzo [g,h,i] perylene	0.00005 mg/L	<0.00005	<0.00005	-	-
Benzo [j] fluoranthene	0.0005 mg/L	<0.0005	<0.0005	-	-
Benzo [k] fluoranthene	0.00005 mg/L	<0.00005	<0.00005	-	-
Biphenyl	0.00005 mg/L	<0.00005	<0.00005	-	-
Chrysene	0.00005 mg/L	<0.00005	<0.00005	-	-
Dibenzo [a,h] anthracene	0.00005 mg/L	<0.00005	<0.00005	-	-
Dibenzo [a,i] pyrene	0.0005 mg/L	<0.0005	<0.0005	-	-
Dibenzo [a,j] acridine	0.0005 mg/L	<0.0005	<0.0005	-	-
Fluoranthene	0.00001 mg/L	<0.00001	<0.00001	-	-
Fluorene	0.00005 mg/L	<0.00005	<0.00005	-	-
Indeno [1,2,3-cd] pyrene	0.00005 mg/L	<0.00005	<0.00005	-	-
Naphthalene	0.00005 mg/L	<0.00005	<0.00005	-	-
Perylene	0.0005 mg/L	<0.0005	<0.0005	-	-
Phenanthrene	0.00005 mg/L	<0.00005	<0.00005	-	-
Pyrene	0.00001 mg/L	<0.00001	<0.00001	-	-
PAHs, Total	0.00340 mg/L	<0.00340	<0.00340	-	-
2-Fluorobiphenyl	Surrogate	82.8%	109%	-	-
Terphenyl-d14	Surrogate	119%	119%	-	-
Benzybutylphthalate	0.001 mg/L	<0.001	<0.001	-	-
bis(2-Chloroethoxy)methane	0.001 mg/L	<0.001	<0.001	-	-

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73515533**

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: **11140575-E3**

		Client ID:	GW-MW4-04-25-2019	GW-MW5-04-25-2019	-	-
		Sample Date:	04/25/2019 14:00	04/25/2019 15:00	-	-
		Sample ID:	1917649-01	1917649-02	-	-
		MDL/Units	Water	Water	-	-
Bis(2-ethylhexyl)phthalate	0.001 mg/L		<0.001	<0.001	-	-
Diethylphthalate	0.001 mg/L		<0.001	<0.001	-	-
Di-n-butylphthalate	0.001 mg/L		<0.001	<0.001	-	-
Di-n-octylphthalate	0.001 mg/L		<0.001	<0.001	-	-
Indole	0.001 mg/L		<0.001	<0.001	-	-
2,4-Dichlorophenol	0.001 mg/L		<0.001	<0.001	-	-
2-Fluorobiphenyl	Surrogate		84%	65% [3]	-	-
Nitrobenzene-d5	Surrogate		96%	94%	-	-
Terphenyl-d14	Surrogate		86%	75%	-	-
2,4,6-Tribromophenol	Surrogate		96%	89%	-	-
2-Fluorophenol	Surrogate		23%	30%	-	-
Phenol-d6	Surrogate		11%	15%	-	-

**Pesticides, OC**

Hexachlorobenzene	0.00001 mg/L		<0.00001	<0.00001	-	-
Decachlorobiphenyl	Surrogate		79.0%	92.0%	-	-

**PCBs**

PCBs, total	0.05 ug/L		<0.05	<0.05	-	-
Decachlorobiphenyl	Surrogate		87.5%	94.4%	-	-

Certificate of Analysis  
 Client: **GHD Limited (Ottawa)**  
 Client PO: **73515533**

Report Date: 03-May-2019  
 Order Date: 25-Apr-2019  
 Project Description: **11140575-E3**

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Fluoride	ND	0.1	mg/L						
Sulphate	ND	1	mg/L						
<b>General Inorganics</b>									
CBOD	ND	2	mg/L						
Cyanide, total	ND	0.01	mg/L						
Phenolics	ND	0.001	mg/L						
Phosphorus, total	ND	0.01	mg/L						
Total Suspended Solids	ND	2	mg/L						
Sulphide	ND	0.02	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
<b>Hydrocarbons</b>									
Oil & Grease, mineral/synthetic	ND	0.5	mg/L						
Oil & Grease, total	ND	0.5	mg/L						
<b>Metals - Total</b>									
Aluminum	ND	0.01	mg/L						
Antimony	ND	0.001	mg/L						
Arsenic	ND	0.01	mg/L						
Bismuth	ND	0.005	mg/L						
Boron	ND	0.05	mg/L						
Cadmium	ND	0.001	mg/L						
Chromium	ND	0.05	mg/L						
Cobalt	ND	0.001	mg/L						
Copper	ND	0.005	mg/L						
Lead	ND	0.001	mg/L						
Mercury	ND	0.0001	mg/L						
Manganese	ND	0.05	mg/L						
Molybdenum	ND	0.005	mg/L						
Nickel	ND	0.005	mg/L						
Selenium	ND	0.005	mg/L						
Silver	ND	0.001	mg/L						
Tin	ND	0.01	mg/L						
Titanium	ND	0.01	mg/L						
Vanadium	ND	0.001	mg/L						
Zinc	ND	0.02	mg/L						
<b>Microbiological Parameters</b>									
E. coli	ND	1	CFU/100 mL						Z-01
<b>PCBs</b>									
PCBs, total	ND	0.05	ug/L						
Surrogate: Decachlorobiphenyl	0.443		ug/L		88.6	60-140			
<b>Pesticides, OC</b>									
Hexachlorobenzene	ND	0.00001	mg/L						
Surrogate: Decachlorobiphenyl	0.00044		mg/L		88.0	50-140			
<b>Semi-Volatiles</b>									
1-Methylnaphthalene	ND	0.00005	mg/L						
2-Methylnaphthalene	ND	0.00005	mg/L						
7H-Dibenzo[c,g]carbazole	ND	0.0005	mg/L						
Anthracene	ND	0.00001	mg/L						
Benzo [a] anthracene	ND	0.00001	mg/L						
Benzo [a] pyrene	ND	0.00001	mg/L						
Benzo [b] fluoranthene	ND	0.00005	mg/L						
Benzo [e] pyrene	ND	0.0005	mg/L						
Benzo [g,h,i] perylene	ND	0.00005	mg/L						
Benzo [j] fluoranthene	ND	0.0005	mg/L						
Benzo [k] fluoranthene	ND	0.00005	mg/L						
Biphenyl	ND	0.00005	mg/L						
Chrysene	ND	0.00005	mg/L						



Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73515533

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: 11140575-E3

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Dibenzo [a,h] anthracene	ND	0.00005	mg/L						
Dibenzo [a,i] pyrene	ND	0.0005	mg/L						
Dibenzo [a,j] acridine	ND	0.0005	mg/L						
Fluoranthene	ND	0.00001	mg/L						
Fluorene	ND	0.00005	mg/L						
Indeno [1,2,3-cd] pyrene	ND	0.00005	mg/L						
Naphthalene	ND	0.00005	mg/L						
Perylene	ND	0.0005	mg/L						
Phenanthrene	ND	0.00005	mg/L						
Pyrene	ND	0.00001	mg/L						
Surrogate: 2-Fluorobiphenyl	0.0245		mg/L		122	76-125			
Surrogate: Terphenyl-d14	0.0237		mg/L		119	70-125			

Certificate of Analysis  
Client: **GHD Limited (Ottawa)**  
Client PO: **73515533**

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: **11140575-E3**

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Fluoride	ND	0.1	mg/L	ND				10	
Sulphate	5.34	1	mg/L	5.35			0.1	10	
<b>General Inorganics</b>									
CBOD	704	2	mg/L	730			3.6	20	
Cyanide, total	ND	0.01	mg/L	ND				11	
pH	7.1	0.1	pH Units	7.1			0.0	10	
Phenolics	ND	0.001	mg/L	ND				10	
Phosphorus, total	4.82	0.10	mg/L	4.48			7.4	15	
Total Suspended Solids	12.0	2	mg/L	11.0			8.7	10	
Sulphide	0.02	0.02	mg/L	0.02			8.7	10	
Total Kjeldahl Nitrogen	27.2	1.0	mg/L	24.0			12.6	16	
<b>Hydrocarbons</b>									
Oil & Grease, mineral/synthetic	ND	0.5	mg/L	ND				30	
Oil & Grease, total	ND	0.5	mg/L	ND				30	
<b>Metals - Total</b>									
Aluminum	0.05	0.01	mg/L	0.06			12.8	20	
Antimony	0.004	0.001	mg/L	0.004			8.2	20	
Arsenic	ND	0.01	mg/L	ND			0.0	20	
Bismuth	ND	0.005	mg/L	ND			0.0	20	
Boron	0.1	0.05	mg/L	0.1			3.6	20	
Cadmium	ND	0.001	mg/L	ND			0.0	20	
Chromium	ND	0.05	mg/L	ND			0.0	20	
Cobalt	0.004	0.001	mg/L	0.004			6.0	20	
Copper	0.007	0.005	mg/L	0.007			0.7	20	
Lead	ND	0.001	mg/L	ND			0.0	20	
Mercury	ND	0.0001	mg/L	ND			0.0	20	
Manganese	1.68	0.05	mg/L	1.65			1.8	20	
Molybdenum	0.014	0.005	mg/L	0.013			6.0	20	
Nickel	0.013	0.005	mg/L	0.012			0.8	20	
Selenium	ND	0.005	mg/L	ND			0.0	20	
Silver	ND	0.001	mg/L	ND			0.0	20	
Tin	ND	0.01	mg/L	ND			0.0	20	
Titanium	ND	0.01	mg/L	ND			0.0	20	
Vanadium	ND	0.001	mg/L	ND			0.0	20	
Zinc	ND	0.02	mg/L	ND			0.0	20	
<b>Volatiles</b>									
Benzene	ND	0.0005	mg/L	ND				30	
Bromodichloromethane	ND	0.0005	mg/L	ND				30	
Bromoform	ND	0.0005	mg/L	ND				30	
Bromomethane	ND	0.0005	mg/L	ND				30	
Carbon Tetrachloride	ND	0.0002	mg/L	ND				30	
Chlorobenzene	ND	0.0005	mg/L	ND				30	
Chloroethane	ND	0.0010	mg/L	ND				30	
Chloroform	ND	0.0005	mg/L	ND				30	
Chloromethane	ND	0.0030	mg/L	ND				30	
Dibromochloromethane	ND	0.0005	mg/L	ND				30	
1,2-Dibromoethane	ND	0.0002	mg/L	ND				30	
1,2-Dichlorobenzene	ND	0.0005	mg/L	ND				30	
1,3-Dichlorobenzene	ND	0.0005	mg/L	ND				30	
1,4-Dichlorobenzene	ND	0.0005	mg/L	ND				30	
1,1-Dichloroethane	ND	0.0005	mg/L	ND				30	
1,2-Dichloroethane	ND	0.0005	mg/L	ND				30	
1,1-Dichloroethylene	ND	0.0005	mg/L	ND				30	
cis-1,2-Dichloroethylene	ND	0.0005	mg/L	ND				30	
trans-1,2-Dichloroethylene	ND	0.0005	mg/L	ND				30	
1,2-Dichloropropane	ND	0.0005	mg/L	ND				30	

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73515533

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: 11140575-E3

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
cis-1,3-Dichloropropylene	ND	0.0005	mg/L	ND				30	
trans-1,3-Dichloropropylene	ND	0.0005	mg/L	ND				30	
Ethylbenzene	ND	0.0005	mg/L	ND				30	
Methylene Chloride	ND	0.0050	mg/L	ND				30	
Styrene	ND	0.0005	mg/L	ND				30	
1,1,2,2-Tetrachloroethane	ND	0.0005	mg/L	ND				30	
Tetrachloroethylene	ND	0.0005	mg/L	ND				30	
Toluene	ND	0.0005	mg/L	ND				30	
1,1,1-Trichloroethane	ND	0.0005	mg/L	ND				30	
1,1,2-Trichloroethane	ND	0.0005	mg/L	ND				30	
Trichloroethylene	ND	0.0005	mg/L	ND				30	
Trichlorofluoromethane	ND	0.0010	mg/L	ND				30	
1,3,5-Trimethylbenzene	ND	0.0005	mg/L	ND				30	
Vinyl chloride	ND	0.0005	mg/L	ND				30	
m,p-Xylenes	ND	0.0005	mg/L	ND				30	
o-Xylene	ND	0.0005	mg/L	ND				30	
Surrogate: 4-Bromofluorobenzene	0.0892		mg/L		111	50-140			
Surrogate: Dibromofluoromethane	0.0819		mg/L		102	50-140			
Surrogate: Toluene-d8	0.0777		mg/L		97.1	50-140			

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73515533

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: 11140575-E3

## Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Fluoride	0.83	0.1	mg/L	ND	83.1	79-121			
Sulphate	15.4	1	mg/L	5.35	100	74-126			
<b>General Inorganics</b>									
CBOD	125		mg/L		62.5	62-129			
Cyanide, total	0.086	0.01	mg/L	ND	85.9	53-130			
Phenolics	0.023	0.001	mg/L	ND	90.2	69-132			
Phosphorus, total	0.448	0.01	mg/L		89.6	80-120			
Total Suspended Solids	21.0	2	mg/L		105	75-125			
Sulphide	0.56	0.02	mg/L	0.02	107	79-115			
Total Kjeldahl Nitrogen	2.00	0.1	mg/L		100	81-126			
<b>Hydrocarbons</b>									
Oil & Grease, mineral/synthetic	7.25	0.5	mg/L		72.5	65-110			
Oil & Grease, total	18.8	0.5	mg/L		94.0	85-110			
<b>Metals - Total</b>									
Aluminum	52.2		ug/L	6.13	92.1	80-120			
Antimony	40.1		ug/L	0.379	79.5	80-120			QM-07
Arsenic	47.2		ug/L	0.345	93.8	80-120			
Bismuth	39.1		ug/L	0.266	77.7	80-120			QM-07
Boron	49.5		ug/L	11.5	76.0	80-120			QM-07
Cadmium	43.2		ug/L	0.015	86.3	80-120			
Chromium	49.7		ug/L	0.230	98.9	80-120			
Cobalt	47.2		ug/L	0.357	93.7	80-120			
Copper	47.0		ug/L	0.692	92.7	80-120			
Lead	42.0		ug/L	0.060	83.9	80-120			
Mercury	0.0029	0.0001	mg/L	ND	97.7	70-130			
Manganese	217		ug/L	165	103	80-120			
Molybdenum	47.7		ug/L	1.32	92.7	80-120			
Nickel	45.6		ug/L	1.24	88.7	80-120			
Selenium	43.8		ug/L	0.097	87.3	80-120			
Silver	43.7		ug/L	0.024	87.4	80-120			
Tin	44.7		ug/L	0.173	89.0	80-120			
Titanium	53.9		ug/L	0.215	107	80-120			
Vanadium	50.7		ug/L	0.079	101	80-120			
Zinc	42.9		ug/L	0.823	84.1	80-120			
<b>PCBs</b>									
PCBs, total	0.620	0.05	ug/L		62.0	60-140			
Surrogate: Decachlorobiphenyl	0.470		ug/L		94.0	60-140			
<b>Pesticides, OC</b>									
Hexachlorobenzene	0.00047	0.00001	mg/L		94.0	50-140			
<b>Semi-Volatiles</b>									
1-Methylnaphthalene	0.00344	0.00005	mg/L		68.8	25-127			
2-Methylnaphthalene	0.00384	0.00005	mg/L		76.7	21-119			
7H-Dibenzo[c,g]carbazole	0.00577	0.0005	mg/L		115	30-130			
Anthracene	0.00355	0.00001	mg/L		70.9	29-126			
Benzo [a] anthracene	0.00368	0.00001	mg/L		73.6	29-126			
Benzo [a] pyrene	0.00358	0.00001	mg/L		71.5	29-111			
Benzo [b] fluoranthene	0.00528	0.00005	mg/L		106	26-111			
Benzo [e] pyrene	0.00375	0.0005	mg/L		75.0	30-130			
Benzo [g,h,i] perylene	0.00374	0.00005	mg/L		74.9	23-128			



Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73515533

Report Date: 03-May-2019

Order Date: 25-Apr-2019

Project Description: 11140575-E3

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Benzo [j] fluoranthene	0.00569	0.0005	mg/L		114	30-130			
Benzo [k] fluoranthene	0.00510	0.00005	mg/L		102	23-135			
Biphenyl	0.00326	0.00005	mg/L		65.2	50-140			
Chrysene	0.00425	0.00005	mg/L		85.0	29-137			
Dibenzo [a,h] anthracene	0.00425	0.00005	mg/L		84.9	20-131			
Dibenzo [a,i] pyrene	0.00568	0.0005	mg/L		114	30-130			
Dibenzo [a,j] acridine	0.00605	0.0005	mg/L		121	30-130			
Fluoranthene	0.00386	0.00001	mg/L		77.3	24-131			
Fluorene	0.00362	0.00005	mg/L		72.3	28-123			
Indeno [1,2,3-cd] pyrene	0.00420	0.00005	mg/L		84.0	20-128			
Naphthalene	0.00389	0.00005	mg/L		77.9	29-118			
Perylene	0.00420	0.0005	mg/L		84.0	30-130			
Phenanthrene	0.00352	0.00005	mg/L		70.3	34-108			
Pyrene	0.00386	0.00001	mg/L		77.2	29-131			

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO: 73515533

Report Date: 03-May-2019  
Order Date: 25-Apr-2019  
Project Description: 11140575-E3

**Qualifier Notes:**

***Sample Qualifiers :***

- 1 : Confluent background colonies on filter: may interfere with target reactions and the analysts' ability to count E. coli & Total Coliform. The target colonies may be under-represented.
- 3 : Surrogate recovery outside of control limits. The data was accepted based on valid recovery of the remaining surrogate.
- 4 : Bacteria plates were read outside of the allowed timeframe. Data is suspect and should not be used for comparison against any Regulation.

***QC Qualifiers :***

- QM-07 : The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.
- S-GC : Surrogate recovery outside of control limits. The data was accepted based on valid recovery of the remaining surrogate.

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable  
ND: Not Detected  
MDL: Method Detection Limit  
Source Result: Data used as source for matrix and duplicate samples  
%REC: Percent recovery.  
RPD: Relative percent difference.



TRUST  
RESPO  
RELIABLE



3rd.  
4JB  
S.com

Chain of Custody  
(Lab Use Only)

No 47665

Page 1 of 1

Client Name: <u>GHD Limited</u>	Project Reference: <u>11140575-E3</u>	Turnaround Time:  <input type="checkbox"/> 1 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input checked="" type="checkbox"/> Regular Date Required: _____
Contact Name: <u>Steven Wheeler</u>	Quote #	
Address: <u>179 Colonnade Road, Ottawa, Ontario</u>	PO #	
Telephone: <u>613-219-7426</u>	Email Address: <u>Steven.Wheeler@GHD.com</u> <u>Scott.Wallis@GHD.com</u>	

Criteria: ☐ O. Reg. 153/04 (As Amended) Table \_\_ ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☒ SUB (Storm) ☒ SUB (Sanitary) Municipality: Ottawa ☐ Other: \_\_\_\_\_

Matrix Type: S (Soil Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

### Required Analyses

Paracel Order Number:

1917649

Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken		Metals + Hg	General Inorganics - Oil + Grease	VOC + SVOC	PAH	Formaldehyde	Aromatic Phenols and Phenoxylates	Hexachlorobenzene (Col. Fats) (Col. Pastilles)	Microbiological (E. coli)	PCBs
				Date	Time									
1 GW-MW4-04-25-2019	GW		10	04/25/2019	14:00	X	X	X	X	X	X	X	X	X
2 GW-MW5-04-25-2019	GW		↓	04/25/2019	15:00	X	X	X	X	X	X	X	X	X
3														
4														
5														
6														
7														
8														
9														
10														

Comments:

Comparing to both storm & sanitary per Steven. SC.

Method of Delivery:

Walk-in

Relinquished By (Sign): <u>Steven Wheeler</u>	Received by Driver/Depot: <u>[Signature]</u>	Received at Lab: <u>Superior DCM</u>	Verified By: <u>[Signature]</u>
Relinquished By (Print): <u>Steven Wheeler</u>	Date/Time: <u>04/25/19 4:56pm</u>	Date/Time: <u>Apr 26, 2019 02:29</u>	Date/Time: <u>Apr 26/19</u>
Date/Time:	Temperature: <u>12.8°C</u>	Temperature: <u>9.1°C</u>	pH Verified: <u>SC</u>

3:57pm

## Certificate of Analysis

### GHD Limited (Ottawa)

179 Colonnade Road Suite 400  
Ottawa, ON K0A 2W0  
Attn: Steven Wheeler

Client PO:  
Project: 11140575-E3  
Custody: 47973

Report Date: 3-May-2019  
Order Date: 2-May-2019

**Order #: 1918483**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1918483-01	GW-MW4-05-02-2019
1918483-02	GW-MW5-05-02-2019

Approved By:



Dale Robertson, BSc  
Laboratory Director

Any use of these results implies your agreement that our total liability in connection with this work, however arising shall be limited to the amount paid by you for this work, and that our employees or agents shall not under circumstances be liable to you in connection with this work



Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO:

Report Date: 03-May-2019  
Order Date: 2-May-2019  
Project Description: 11140575-E3

### Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
E. coli	MOE E3407	2-May-19	2-May-19

### Sample and QC Qualifiers Notes

- 1- BAC13 : Please note that bacteria reporting limits are raised due to dilutions (expected elevated concentrations based on source of water sample).
- 2- BAC14 : A2C - Background counts greater than 200

### Sample Data Revisions

None

### Work Order Revisions/Comments:

None

### Other Report Notes:

n/a: not applicable  
ND: Not Detected  
MDL: Method Detection Limit  
Source Result: Data used as source for matrix and duplicate samples  
%REC: Percent recovery.  
RPD: Relative percent difference.

Certificate of Analysis  
Client: GHD Limited (Ottawa)  
Client PO:

Report Date: 03-May-2019  
Order Date: 2-May-2019  
Project Description: 11140575-E3

## Sample Results

E. coli				Matrix: Water
				Sample Date: 02-May-19
Paracel ID	Client ID	Units	MDL	Result
1918483-01	GW-MW4-05-02-2019	CFU/100 mL	1	<10 [1] [2]
1918483-02	GW-MW5-05-02-2019	CFU/100 mL	1	<10 [1] [2]

## Laboratory Internal QA/QC

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Matrix Blank									
E. coli	ND	10	CFU/100 mL						



Client Name: <u>GHD Ltd.</u>	Project Reference: <u>11140575-E3</u>	<b>Turnaround Time:</b> <input type="checkbox"/> 1 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input checked="" type="checkbox"/> Regular Date Required: _____
Contact Name: <u>Steven Wheeler</u>	Quote # _____	
Address: <u>179 Colonnade Road, Ottawa, ON</u>	PO # _____	
Telephone: <u>613-219-7426</u>	Email Address: <u>Steven.Wheeler@GHD.com</u>	

Criteria: ☐ O. Reg. 153/04 (As Amended) Table \_\_\_ ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☐ SUB (Storm) ☐ SUB (Sanitary) Municipality: \_\_\_\_\_ ☐ Other: \_\_\_\_\_

Matrix Type: S (Soil Sed.) GW (Ground Water) SW (Surface Water) SS (Storm Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Paracel Order Number:		Matrix	Air Volume	# of Containers	Sample Taken		Micro bio (E. coli)												
Sample ID/Location Name					Date	Time													
1	GW-MW4-05-02-2019	GW		1	05/02/19	9:35	1												
2	GW-MW5-05-02-2019	GW		1	11	9:45	1												
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Comments:

Method of Delivery:

Paracel

Relinquished By (Sign): <u>Steven Wheeler</u>	Received by Driver/Depot: <u>A. J. JONES</u>	Received at Lab: <u>SUMMITERN OILWELL</u>	Verified By: <u>D. Gagne</u>
Relinquished By (Print): <u>Steven Wheeler</u>	Date/Time: <u>02/05/19 11:10</u>	Date/Time: <u>MAY 02 2019 12:49</u>	Date/Time: <u>2 May 19 13:0</u>
Date/Time: <u>5/2/2019 /</u>	Temperature: <u>°C</u> <u>AM</u>	Temperature: <u>9.6 °C</u>	pH Verified   By:

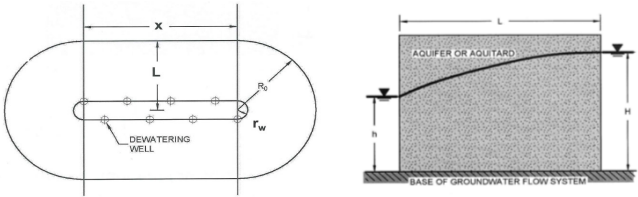
# Appendix F

## Flow Calculations



Flow to a Trench for a *Unconfined Aquifer*

Information

Steady State flow to a trench for an unconfined aquifer.  
Use this equation when  $a/b > 1.5$ .  
Equation 4.0  
$$Q = \frac{\pi K(H^2 - h^2)}{\ln R_0/r_w} + 2 \left[ \frac{xK(H^2 - h^2)}{2L} \right]$$
  
Equation 4.1  
$$r_w = \frac{a+b}{\pi}$$
  
Ro is determined by the Siechardt Equation:  $R_0 = 3000(H-hw)K^{0.5}$  when K is in m/s  


Enter Parameters

Shaft or Trench Eq'n Check:

1.0

This number must be greater than 1.5; if not, then use a Shaft equation.

K=

2.00E-04

cm/s

Input Hydraulic Conductivity in cm/s

=>

0.1728

m/day

Hydraulic Conductivity converted to m/day

H=

9

m

Input height of groundwater pressure

h=

7.1

m

Input dewatering height

x=

49

m

Input length of trench

a=

2

m

Input length of excavation

b=

2

m

Input width of excavation

r\_w=

1.00

m

Input/calculate radius of trench

pi=

3.141592654

pi

\*Note: L and Ro are the same distance\*

\*Note: Height measurements are relative to base of active groundwater

Calculating L and Ro using:

$R_0 = 1.5(Tt/S)^{0.5}$

T=

1.5552

m²/day

Input transmissivity in m²/day

t=

10

days

Input pumping duration in days

S=

0.19

Input storage coefficient

L=Ro=

13.57

m

Line source distance; distance of influence

Alternative equation by Bear (Bear, J., 1979. **Hydraulics of Groundwater**, McGraw-Hill, New York, 569p)  $R_0 = 1.5(Tt/S)^{0.5}$  where T is transmissivity in m²/day, t is pumping duration in days.  $R_0$  will be in metres.

\*Note: The above Ro is for comparison. It is not the Ro used to calculate Q below.

Enter additional K values (optional)

K=

2.00E-04

cm/s

K=

0.1728

m/day

K2=

1.00E-06

cm/s

K2=

0.000864

m/day

K3=

1.00E-05

cm/s

K3=

0.00864

m/day

K4=

1.00E-04

cm/s

K4=

0.0864

m/day

K5=

1.00E-03

cm/s

K5=

0.864

m/day

K6=

1.00E-02

cm/s

K6=

8.64

m/day

K7=

1.00E-01

cm/s

K7=

86.4

m/day

K8=

1.00E+00

cm/s

K8=

864

m/day

K9=

1.00E+01

cm/s

K9=

8640

m/day

K10=

1.00E+02

cm/s

K10=

86400

m/day

Calculated flow rate using Equation 4.0

Results for Ro (radius of influence)

L= Ro=

9.06

m

L2= Ro2=

1.57

m

L3= Ro3=

2.80

m

L4= Ro4=

6.70

m

L5= Ro5=

19.02

m

L6= Ro6=

58.00

m

L7= Ro7=

181.25

m

L8= Ro8=

571.00

m

L9= Ro9=

1803.50

m

L10= R10=

5701.00

m

Flow Results in m³/day

Q=

36.12

m³/day

Q2=

1.01

m³/day

Q3=

5.43

m³/day

Q4=

23.69

m³/day

Q5=

96.26

m³/day

Q6=

427.77

m³/day

Q7=

2,311.31

m³/day

Q8=

15,349.26

m³/day

Q9=

117,926.69

m³/day

Q10=

982,796.46

m³/day

Flow Results in L/min

Q=

25.08

L/min

Q2=

0.70

L/min

Q3=

3.77

L/min

Q4=

16.45

L/min

Q5=

66.84

L/min

Q6=

297.05

L/min

Q7=

1,604.98

L/min

Q8=

10,658.53

L/min

Q9=

81,888.29

L/min

Q10=

682,453.86

L/min

Flow Results in gal/min

Q=

5.52

gal/min

Q2=

0.15

gal/min

Q3=

0.83

gal/min

Q4=

3.62

gal/min

Q5=

14.70

gal/min

Q6=

65.34

gal/min

Q7=

353.05

gal/min

Q8=

2,344.55

gal/min

Q9=

18,012.89

gal/min

Q10=

150,118.69

gal/min

Additional Information:

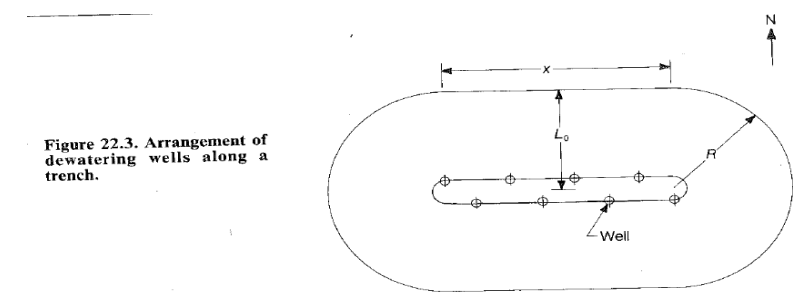


Figure 4.2 (Driscoll, 1986)

Flow to a Shaft in an Unconfined Aquifer

Information

Steady State flow to a shaft within an unconfined aquifer.  
Use this equation when  $a/b < 1.5$ .  
Equation 1.0

$$Q = \frac{\pi K (H^2 - h_w^2)}{\ln R_0 / r_w}$$

Equation 1.1

$$r_w = \sqrt{\frac{ab}{\pi}}$$

Ro is determined by the Siechardt Equation:  $R_o = 3000(H-h_w)K^{0.5}$  when K is in m/s

Enter Parameters

Shaft or Trench Eq'n Check: 1.851851852

This number must be less than 1.5; if not, then use a Trench equation.

K=>2.00E-04

0.1728

cm/s

m/day

Input Hydraulic Conductivity in cm/s  
Hydraulic Conductivity converted to m/d

H=8.5

m

Input height of groundwater

h\_w=4.75

m

Input dewatering height

a=50

m

Input length of excavation

b=27

m

Input width of excavation

r\_w=20.73

m

Input/calculate radius of shaft

pi=3.141592654

Pi

\*Note: Height measurements are relative to base of active groundwater\*

Calculating Ro using:  $R_o = 1.5(Tv/S)^{0.5}$

T=1.4688

30

m²/day

days

Input transmissivity in m²/day  
Input pumping duration in days

S=0.3

Input storage coefficient

Ro=18.18

m

Radius of Influence

Alternative equation by Bear (Bear, J., 1979. **Hydraulics of Groundwater**, McGraw-Hill, New York, 569p)  $R_o = 1.5(Tv/S)^{0.5}$  where T is transmissivity in m²/day, t is pumping duration in days.  $R_o$  will be in metres.

\*Note: The above Ro is for comparison. It is not the Ro used to calculate Q below.

Enter additional K values (optional)

K=2.00E-04

1.00E-06

1.00E-05

1.00E-04

1.00E-03

1.00E-02

1.00E-01

1.00E+00

1.00E+01

1.00E+02

cm/s

cm/s

cm/s

cm/s

cm/s

cm/s

cm/s

cm/s

cm/s

cm/s

K=0.1728

0.000864

0.00864

0.0864

0.864

8.64

86.4

864

8640

86400

m/day

m/day

m/day

m/day

m/day

m/day

m/day

m/day

m/day

m/day

Calculated flow rate using Equation 1.0

Results for Ro (radius of influence)

Ro=36.64

m

Ro2=1.13

m

Ro3=3.56

m

Ro4=11.25

m

Ro5=35.58

m

Ro6=112.50

m

Ro7=355.76

m

Ro8=1125.00

m

Ro9=3557.56

m

R10=11250.00

m

Flow Results in m³/day

Q=47.359

m³/day

Q2=-0.05

m³/day

Q3=-0.77

m³/day

Q4=-22.07

m³/day

Q5=249.71

m³/day

Q6=797.38

m³/day

Q7=4744.41

m³/day

Q8=33768.02

m³/day

Q9=262121.68

m³/day

Q10=2141941.10

m³/day

Flow Results in L/min

Q=32.886

L/min

Q2=-0.03

L/min

Q3=-0.53

L/min

Q4=-15.32

L/min

Q5=173.40

L/min

Q6=553.70

L/min

Q7=3294.52

L/min

Q8=23448.51

L/min

Q9=182017.29

L/min

Q10=1487363.90

L/min

Flow Results in gal/min

Q=7.234

gal/min

Q2=-0.01

gal/min

Q3=-0.12

gal/min

Q4=-3.37

gal/min

Q5=38.14

gal/min

Q6=121.80

gal/min

Q7=724.69

gal/min

Q8=5157.95

gal/min

Q9=40038.16

gal/min

Q10=327173.95

gal/min

Additional Information:

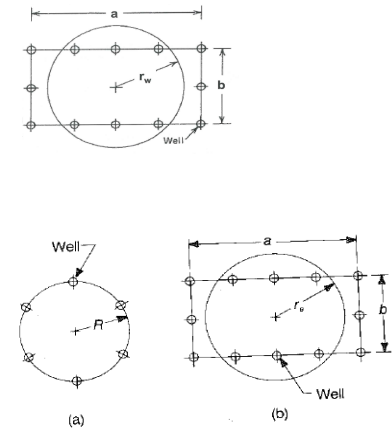
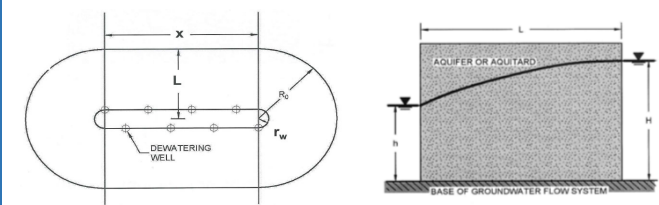


Figure 1.2 (Driscoll, 1986)

Figure 22.2. The circle shown in (a) consists of a series of shallow wells that produce a drawdown similar to the drawdown obtainable by a single, deep well. Dewatering of the rectangular area in (b) can be accomplished by a series of wells placed on a circle or on the perimeter of the rectangle.

Flow to a Trench for a *Unconfined Aquifer*

Information

Steady State flow to a trench for an unconfined aquifer.  
Use this equation when  $a/b > 1.5$ .  
Equation 4.0  
$$Q = \frac{\pi K(H^2 - h^2)}{\ln R_0/r_w} + 2 \left[ \frac{xK(H^2 - h^2)}{2L} \right]$$
  
Equation 4.1  
$$r_w = \frac{a+b}{\pi}$$
  
  
Ro is determined by the Siechardt Equation:  $R_0 = 3000(H-hw)K^{0.5}$  when K is in m/s  
  


Enter Parameters

Shaft or Trench Eq'n Check:

1.0

This number must be greater than 1.5; if not, then use a Shaft equation.

K=

2.00E-04

cm/s

Input Hydraulic Conductivity in cm/s

=>

0.1728

m/day

Hydraulic Conductivity converted to m/day

H=

9.7

m

Input height of groundwater pressure

h=

8.5

m

Input dewatering height

x=

17

m

Input length of trench

a=

7

m

Input length of excavation

b=

7

m

Input width of excavation

r\_w=

3.50

m

Input/calculate radius of trench

pi=

3.141592654

pi

\*Note: L and Ro are the same distance\*

\*Note: Height measurements are relative to base of active groundwater

Calculating L and Ro using:

$R_0 = 1.5(T/t/S)^{0.5}$

T=

1.67616

m²/day

Input transmissivity in m²/day

t=

10

days

Input pumping duration in days

S=

0.19

Input storage coefficient

L=Ro=

14.09

m

Line source distance; distance of influence

Alternative equation by Bear (Bear, J., 1979. **Hydraulics of Groundwater**, McGraw-Hill, New York, 569p)  $R_0 = 1.5(T/t/S)^{0.5}$  where T is transmissivity in m²/day, t is pumping duration in days.  $R_0$  will be in metres.

\*Note: The above Ro is for comparison. It is not the Ro used to calculate Q below.

Enter additional K values (optional)

K=

2.00E-04

cm/s

K=

0.1728

m/day

K2=

1.00E-06

cm/s

K2=

0.000864

m/day

K3=

1.00E-05

cm/s

K3=

0.00864

m/day

K4=

1.00E-04

cm/s

K4=

0.0864

m/day

K5=

1.00E-03

cm/s

K5=

0.864

m/day

K6=

1.00E-02

cm/s

K6=

8.64

m/day

K7=

1.00E-01

cm/s

K7=

86.4

m/day

K8=

1.00E+00

cm/s

K8=

864

m/day

K9=

1.00E+01

cm/s

K9=

8640

m/day

K10=

1.00E+02

cm/s

K10=

86400

m/day

Calculated flow rate using Equation 4.0

Results for Ro (radius of influence)

L= Ro=

8.59

m

L2= Ro2=

3.86

m

L3= Ro3=

4.64

m

L4= Ro4=

7.10

m

L5= Ro5=

14.88

m

L6= Ro6=

39.50

m

L7= Ro7=

117.34

m

L8= Ro8=

363.50

m

L9= Ro9=

1141.92

m

L10= R10=

3603.50

m

Flow Results in m³/day

Q=

20.67

m³/day

Q2=

0.69

m³/day

Q3=

2.80

m³/day

Q4=

12.90

m³/day

Q5=

62.51

m³/day

Q6=

325.82

m³/day

Q7=

1,961.18

m³/day

Q8=

13,650.29

m³/day

Q9=

105,235.13

m³/day

Q10=

863,478.57

m³/day

Flow Results in L/min

Q=

14.35

L/min

Q2=

0.48

L/min

Q3=

1.94

L/min

Q4=

8.96

L/min

Q5=

43.40

L/min

Q6=

226.25

L/min

Q7=

1,361.84

L/min

Q8=

9,478.76

L/min

Q9=

73,075.27

L/min

Q10=

599,599.52

L/min

Flow Results in gal/min

Q=

3.16

gal/min

Q2=

0.11

gal/min

Q3=

0.43

gal/min

Q4=

1.97

gal/min

Q5=

9.55

gal/min

Q6=

49.77

gal/min

Q7=

299.56

gal/min

Q8=

2,085.03

gal/min

Q9=

16,074.29

gal/min

Q10=

131,893.31

gal/min

input

input (optional)

output

\*To zoom in or out: Hold down the Ctrl key while scrolling with the mouse.\*

Additional Information:

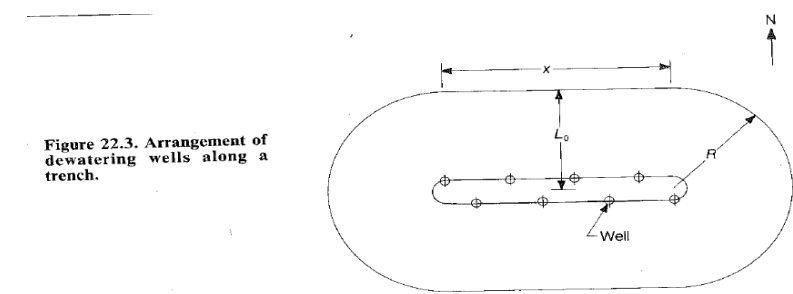


Figure 4.2 (Driscoll, 1986)



## about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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