Report
Project: 121793-6.2.1

PATHWAYS - BLOCK 232
1055 CEDAR CREEK DRIVE
SERVICING BRIEF

Prepared for Phoenix Homes
by IBI GROUP

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1 INTRODUCTION

Block 232 is located in the south portion of the Leitrim Development Area (LDA) and is part of the Pathways at the Findlay Creek subdivision. IBI Group Professional Services Inc. (IBI Group) has been retained to provide professional engineering services for Block 232. The subject site is approximately 1.01 ha and consists of 1 accessory building for solid waste sorting and storage, 5 stacked townhouse buildings, 2 apartment buildings, with a total of 92 units. The site consists of surface level and below grade parking facilities.

Block 232 is bounded by Salamander Way and existing residential area to the North, Pingwi Place to the south, Cedar Creek Drive to the east and existing residential lands and pathway block to the west. Its Civic Address is 1055 Cedar Creek Drive. Refer to key plan on **Figure 1.1** for block location.

Figure 1.1 Site Location

The proposed servicing design conforms to current City of Ottawa and MECP design criteria, and no pre-consultation meetings were requested from the Rideau Valley Conservation Authority (RVCA) or the Ontario Ministry of Environment, Conservation and Parks (MECP).

2 WATER DISTRIBUTION

2.1 Existing Conditions

There is an existing 250mm watermain in Salamander Way to the north of the site, an existing 250mm watermain in Cedar Creek Drive to the east of the site and an existing 250mm Watermain in Pingwi Place. The proposed development was considered in the water model for the Pathways Phase 1 development.

2.2 Design Criteria

2.2.1 Water Demands

Block 232 consists of 56 stacked townhouse units and 36 apartment units. Per unit population density and consumption rates are taken from **Tables 4.1** and **4.2** of the Ottawa Design Guidelines – Water Distribution and are summarized as follows:

- Single Family 3.4 person per unit
- Townhouse and Semi-Detached 2.7 person per unit
- Average Apartment 1.8 person per unit

- Average Day Demand 350 l/cap/day
- Peak Daily Demand 875 l/cap/day
- Peak Hour Demand 1,925 l/cap/day

A water demand calculation sheet is included in **Appendix A** and the total water demands are summarized as follows:

- Average Day 0.65 l/s
- Maximum Day 1.67 l/s
- Peak Hour 3.68 l/s

2.2.2 System Pressures

The 2010 City of Ottawa Water Distribution Guidelines states that the preferred practice for design of a new distribution system is to have normal operating pressures range between 345 kPa (50 psi) and 552 kPa (80 psi) under maximum daily flow conditions. Other pressure criteria identified in the guidelines are as follows:

Minimum Pressure	Minimum system pressure under peak hour demand conditions shall not be less than 276 kPa (40 psi).
Fire Flow	During the period of maximum day demand, the system pressure shall not be less than 140 kPa (20 psi) during a fire flow event.
Maximum Pressure	Maximum pressure at any point in the distribution system in unoccupied areas shall not exceed 689 kPa (100 psi). In accordance with the Ontario Building/Plumbing Code the maximum pressure should not exceed 552 kPa (80 psi) in occupied areas. Pressure

reduction controls may be required for buildings where it is not possible/feasible to maintain the system pressure below 552 kPa.

2.2.3 Fire Flow Rate

The site consists of five stacked townhouse blocks and two three storey apartment blocks. A Fire Underwriters Survey (FUS) calculation has been done for building 5 which is the largest stacked townhouse block with the most exposures to adjacent buildings and for Building 4 which is the apartment block with the most exposure to adjacent buildings. The calculations result in a fire flow of 13,000 l/min for both buildings; a copy of the FUS calculation is included in **Appendix A**.

2.2.4 Boundary Conditions

The City of Ottawa has provided hydraulic boundary conditions at the connections to Salamander Way watermain and Cedar Creek Drive. The City has provided existing condition and SUC Zone reconfiguration boundary conditions. The existing condition has the highest maximum HGL value and is used in the analysis to determine maximum pressure while the SUC Zone reconfiguration value has the lower values for peak hour and fire and is used in the analysis. A copy of the Boundary Condition is included in **Appendix A** and summarized as follows:

CRITERIA	HYDRAULIC HEAD	
	CONNECTION 1	CONNECTION 2
Max HGL (Basic Day)	155.6 m	155.6 m
Peak Hour	145.1 m	145.1 m
Max Day + Fire (13,000 l/m)	138.0 m	135.4 m

2.2.5 Hydraulic Model

A computer model for the Block 232 water distribution system has been developed using the InfoWater SA program. The model includes the boundary conditions at Salamander Way watermain and Cedar Creek Drive.

2.3 Proposed Water Plan

2.3.1 Hydraulic Analysis

The hydraulic model was run under basic day conditions with the existing boundary condition to determine the maximum pressure for the site. The minimum pressure for the site is determined in the peak hour analysis using the SUC Zone reconfiguration boundary condition. There are two fire hydrants in the site and they are represented by nodes 50 and 52 in the model; the model was run under the max day plus fire (13,000 l/min) SUC Zone Reconfiguration Boundary condition to determine the design fire flow at the hydrant locations. There are several hydrants on Salamander Way, Cedar Creek Drive and Pingwi Place that are adjacent to the site and provide fire protection for the buildings. In the Pathways Phase 1 hydraulic water model, the mains on the adjacent street were run with a 250 l/s (15,000 l/min) fire demand for the fire flow analysis. Results of the Phase 1 fire flow analysis from the Pathways Phase 1 design brief are included in **Appendix A**. Results of the analysis for the Block 232 site are summarized in Section 2.3.2 and the water model schematic and model results are included in **Appendix A**.

2.3.2 Summary of Results

Results of the hydraulic analysis for Block 232 are summarized as follows:

Pressures (kPa)

- Basic Day (Max HGL)	526.7 – 546.8
- Peak Hour	423.3 – 443.9

Minimum Fire Flow @ 140 kPa Residual Pressure 423.5 l/s.

A comparison of the results and design criteria is summarized as follows:

Maximum Pressure	All nodes have basic day pressure below 552 kPa; therefore, pressure reducing control is not required for this site.
Minimum Pressure	All nodes exceed the minimum requirement of 276 kPa during peak hour conditions.
Fire Flow	The minimum design fire flow with a minimum residual pressure of 140 kPa in the site is 423.5 l/s which exceeds the requirement of 216.7 l/s (13,000 l/min). In the pathways Phase 1 water analysis the design fireflows on Salamander Way, Cedar Creek Drive and Pingwi Place range from 246.8 to 289.2 l/s which exceed the requirement of 216.7 l/s (13,000 l/min).

3 WASTEWATER

3.1 Existing Conditions

The Leitrim Pump Station is the wastewater outlet for all developed lands within the LDA, including the subject property. In 2002, the City constructed the station, associated forcemains and outlet sewers in Bank Street and Conroy Road. Sewage from the LDA outlets to the Conroy Road Trunk Sewer eventually discharging to a sewage treatment plant located near the Ottawa River. The Pathways Phase 1 report prepared by IBI Group dated July 2017 confirmed that the existing 375mm sewer in Kelly Farm Drive has sufficient capacity for the Pathways at Findlay Creek property inclusive of the proposed development.

3.1.1 Verification of Existing Sanitary Sewer Capacity

There is an existing 300mm sanitary sewer in Cedar Creek Drive, which connects to the existing 300mm sanitary sewer in Miikana Road, then to the 375 mm diameter sub-trunk sewer in Kelly Farm Drive. In the previous Pathways Phase 1 report, the design population for Block 232 was 129.6, see **Appendix B**. In the proposed site plan, the total population is 165.6. However, using the new design criteria of 280 liter per capita per day and 0.8 correction factor, the calculated sanitary flow rate is 2.23 l/s, which is less than 2.39 l/s in the Pathway Phase 1 design for Block 232. The block area remains unchanged. Therefore, the existing sanitary sewer has adequate capacity for the subject site, and there will be no negative effect to the downstream sanitary system. Refer to **Appendix B** for the detailed sanitary sewer design sheet.

3.1.2 Sanitary Hydraulic Grade Line

Pathways Phase 1 report indicates that the sanitary hydraulic grade line (HGL) in BLK6117 on Cedar Creek Drive is 94.89, refer to **Appendix B** for the Pathways Phase 1 Sanitary HGL analysis. The sanitary HGL extended through the subject site have been calculated as follows:

LOCATION	MH #	USF ELEV (M)	SANITARY HGL (M)	FREEBOARD (M)
Cedar Creek Drive	BLK6117	-	94.890	-
Block 232	MH 200A	98.420	95.816	2.604
Block 232	MH 215A	98.420	95.957	2.463
Block 232	MH 214A	98.420	96.324	2.108
Block 232	MH 202A	98.420	96.635	1.797
Block 232	MH 201A	98.420	96.964	1.456
Block 232	MH 217A	99.820	97.952	1.487
Block 232	MH 216A	99.170	98.578	0.420
Block 232	MH 204A	98.940	97.012	1.626
Block 232	MH 212A	98.470	97.898	0.560
Block 232	MH 205A	98.470	97.174	0.996
Block 232	MH 210A	98.370	97.495	0.708
Block 232	MH 211A	98.370	97.705	0.515
Block 232	MH 206A	98.920	97.230	1.390
Block 232	MH 209A	98.920	98.173	0.456
Block 232	MH 207A	99.870	98.509	1.062
Block 232	MH 208A	100.620	99.173	1.298

All underside of footing elevations have been designed to provide a minimum of 300mm separation between the greater of governing pipe obvert or governing HGL. A copy of the sanitary HGL analysis for Block 232 is provided in **Appendix B**.

3.2 Proposed Sewers

All on-site sewers have been designed to City of Ottawa and MOE design criteria which include but are not limited to the below listed criteria. A copy of the detailed sanitary tributary area plan 400 and the sanitary sewer design sheets are included in **Appendix B** illustrate the population densities and sewers which provide the necessary outlets.

3.2.1 Design Flow:

Average Residential Flow	-	280 l/cap/day
Peak Residential Factor	-	Harmon Formula
Infiltration Allowance	-	0.33 l/sec/Ha
Minimum Pipe Size	-	200mm diameter

3.2.2 Population Density:

Single Family	-	3.4 person/unit
Townhouse Units	-	2.7 person/unit
Apartment Units	-	1.8 person/unit
External Low Density Land	-	120 units/gross Ha

4 SITE STORMWATER MANAGEMENT

4.1 Objective

The purpose of this evaluation is to prepare the dual drainage design, including the minor and major system, for the Block 232 development. The design includes the assignment of inlet control devices, on-site storage, maximum depth of surface ponding and hydraulic grade line analysis. The evaluation takes into consideration the City of Ottawa Sewer Design Guidelines (OSDG) (October 2012), the February 2014 Technical Bulletin ISDTB-2014-01, the September 2016 Technical Bulletin PIEDTB-2016-01 and the June 2018 Technical Bulletin ISTB-2018-04.

4.2 Design Criteria

The stormwater system was designed following the principles of dual drainage, making accommodations for both major and minor flow.

Some of the key criteria include the following:

- Design Storm — 1:2 year return (Ottawa)
- Rational Method Sewer Sizing
- Initial Time of Concentration — 10 minutes
- Runoff Coefficients
  - Landscaped Areas — C = 0.25
  - Landscaped Area with Pathway — C = 0.50
  - Building and Roof Area — C = 0.90
  - Parking Area and Driveway — C = 0.90
- Pipe Velocities — 0.80 m/s to 3.0 m/s
- Minimum Pipe Size — 250 mm diameter (200 mm CB Leads)

4.3 System Concept

According to the Pathways Phase 1 report prepared by IBI Group dated July 2017, the development of the adjacent downstream properties included the expected stormwater servicing needs of the subject property. The existing storm sewers constructed adjacent to the site were oversized to provide the needed capacity for minor storm runoff from the subject site. Minor storm runoff from the subject site will connect to the existing 600 mmØ sewer stub that connects to the existing 1500mmØ trunk storm sewer in Cedar Creek Drive.

4.3.1 Dual Drainage Design

The dual drainage system proposed for the subject site will accommodate both major and minor stormwater runoff. Minor flow from the subject site will be conveyed through the storm sewer network and discharge into the existing 600 mmØ sewer stub that connects to the existing 1500mm ø trunk storm sewer in Cedar Creek Drive.

The balance of the surface flow not captured by the minor system will be conveyed via the major system. Where possible, storage will be provided in surface sags or low points within the roadway. Storage will also be provided within oversized storm pipes. Once the maximum storage is utilized, the excess flow will cascade to the next downstream street sag. Major flow up to 100-year storm event will be restricted and detained on-site. Emergency overflow will be directed towards Salamander Way and Cedar Creek Drive.

4.3.2 Proposed Minor System

Using the criteria identified in Section 4.2, the proposed on-site storm sewers were sized accordingly. A detailed storm sewer design sheet and the associated storm sewer drainage area plan is included in **Appendix C**. The general plan of services, depicting all on-site storm sewers can be found in **Appendix A**.

The owner of the site will be responsible for regular maintenance of the on-site sewers, catch basins and inlet control devices (ICDs). Maintenance includes but is not limited to the cost of regular cleaning of the structures and ICDs as necessary. The site owner will also be responsible for replacement of damaged or missing catch basin structures, grates or ICDs as needed.

4.4 Stormwater Management

4.4.1 Water Quality Control

The subject site is part of the larger development referred to as the Leitrim Development Area. The stormwater management strategy was outlined in the following reports:

• Addendum to Leitrim Development Area Stormwater Management Environmental Study Report and Pre-Design Volumes 1 and II (IBI Group, July 2005);

• Design Brief and Amendment to MOE Certificate of Approval Findlay Creek Village Stormwater Facility (IBI Group, July 2005);

• Final Serviceability Report Leitrim Development Area City of Ottawa (IBI Group, March 2007).

• 2016 Final Updated Serviceability Report (Class EA OPA76 Areas 8a, 9a and 9b) Leitrim Development Area (IBI Group, September 2016)

The subject site is part of the drainage area which ultimately discharges into the existing Findlay Creek Village Stormwater Facility. The Findlay Creek Village Stormwater Facility was constructed in 2006 and provides water quality control to an Enhanced Level of Protection according to MOE Stormwater Management Planning and Design Guidelines (March 2003).

4.4.2 Water Quantity Control

The subject site will be limited to a maximum minor system release rate of 206 L/s and a maximum major system release rate of 84l/s according to Pathways at Findlay Creek Design Brief dated July, 2017. This will be achieved through a combination of inlet control devices (ICD's) at inlet locations, surface storage where possible and underground storage in oversized storm pipes where required.

Surface flows in excess of the site's allowable release rate will be stored on site in strategic surface storage areas or oversized underground pipes and gradually released into the minor system to respect the site's allowable release rate. The maximum surface retention depth located within the developed areas will be limited to 300mm during a 1:100 year event as show on the ponding plan located in **Appendix C** and grading plans located in **Appendix D.** Overland flow routes will be provided in the grading to permit emergency overland flow.

At the south-east corner and two western corner of the site, the opportunity to capture and store runoff is limited due to grading constraints and building geometry. These areas will discharge to Salamander Way, Cedar Creek Drive and Pingwi Place uncontrolled. These locations are generally located at the perimeter of the site where it is necessary to tie into public boulevards and adjacent properties or in areas where ponding stormwater is undesirable.

4.5 Hydrological Evaluation

The hydrological analysis of the proposed dual drainage system was conducted using DDSWMM. This technique offers a single storm event flow generation and routing. Land use, selected modeling routines, and input parameters are discussed in the following sections. Model files are included on the CD enclosed in Appendix C. The main hydrological parameters for the subject site are summarized below.

Storms and Drainage Area Parameters

The main hydrology parameters are summarized below and in **Table 4.1**.

- **Design storms:** The site was evaluated using the following storms:
  - 2 year, 3 hour Chicago storm events with a 10 minute time step (for dual drainage evaluation, specifically to confirm no ponding after the storm event);
  - 100 year 3 hour Chicago storm event with a 10 minute time step (to confirm on-site storage requirements); and
  - 100 year 3 hour Chicago storm event + 20% increase in intensity with a 10 minute time step (for a stress test on major flow conveyance as per the City of Ottawa Sewer Design Guidelines).
- **Infiltration:** The selected infiltration losses are consistent with the City of Ottawa Sewer Design Guidelines. The Horton values are as follows: f_o = 76.2 mm/h, f_c = 13.2 mm/h, k = 0.00115 s^{-1}.
- **Area:** Catchment areas are based on the rational method drainage areas with some minor modifications for modelling purposes.
- **Imperviousness:** Imperviousness for the subject site is based on the rational method runoff coefficients as indicated within Drawing 500.
- **Width:** The catchment width was based on the conveyance route length of the drainage area and multiplied by two. The multiplier of two was only used if the drainage area had runoff contribution from both sides of the drainage area.
- **Slope:** The ground slope was based upon the average slope for both impervious and pervious area. Generally, the slope is approximately 2% (0.02 m/m). This assumes a slope of approximately 1% for impervious or road surfaces and 3% for pervious surfaces (lot grading).
- **Detention storage depth:** Detention storage depths of 1.57 mm and 4.67 mm were used for impervious and pervious areas, respectively.
- **Manning's roughness:** Manning's roughness coefficients of 0.013 and 0.25 were used for impervious and pervious areas, respectively.
- **Baseflow:** No baseflow components were assumed for any of the areas contributing runoff to the minor system.
- **Minor system capture:** The minor system capture is based on the ICD design. ICDs are incorporated into the design to maintain the allowable release rate into the existing downstream storm sewer system to protect the minor system from surcharge during infrequent storm events and to utilize the available on-site storage.

The main hydrological parameters used in the DDSWWM model are summarized in **Table 4.1**. A CD of the model files is provided in **Appendix C**.

- **Major system storage and routing:** The subject site is comprised of parking areas, drive aisle and underground storage within oversized storm pipes. Flow is attenuated within low points with potential overflow cascading to the next segment downstream. The total volume at each low point, up to the overflow depth, is the maximum static storage.

  For areas with ponding, cascading overflow from a low point to a downstream segment utilizes the static storage available plus an additional amount of storage equivalent to the depth required for the flow to cascade over the downstream high point. The attenuation in street sags was evaluated to account for static storage and, if overflow occurs, dynamic storage. Within this report it is referred to as double routing.

  DDSWMM does not have a direct way of coding double routing since it does not allow the user to code dynamic storage over the high point. For this analysis, the method employed is that recommended in the February 2014 City of Ottawa Technical Bulletin (PIEDTB-2016-01). It accounts for overflow from a street segment (regular static storage at a sag) being conveyed to a downstream dummy segment. In other words, a regular low point segment is provided with a downstream dummy segment for further flow attenuation to account for the dynamic ponding during overflow.

  There are no drainage area attributes associated with the dummy segment since it is a segment solely for routing. In addition, there is no inflow to the minor system from these dummy segments. The overflow hydrograph from the upstream catchment is routed in the dummy segment to the next “real” downstream segment. The dummy segments have the following specific characteristics:

  - Segment Length: Equivalent to the length of the maximum static storage from the street segment contributing to it.

  - Road Type: Equivalent to the right-of-way characteristics from the segment contributing to it, but with a longitudinal slope of 0.01% (0.0001 m/m).

  The dummy segments for major system routing have been applied to the analysis of the subject site. The segments are referenced as D1, D2, D3, etc. within the DDSWMM modelling file. The drainage area plan presented in **Drawing 500** does not show the dummy segments, but the DDSWMM output file shows the dummy segments immediately following the corresponding major segment which cascades into that dummy segment.

  Rear yards were considered independently of street segments and rear yard catch basins were incorporated in the DDSWMM model. Simulations were based on the total interception of runoff by the storm inlets. This was done by specifying a one-to-one relationship between approach flow and capture flow. For this particular case, underground storage volumes in rear yards was accounted for as available on-site storage. As per the Technical Bulletin (PIEDTB-2016-01), the effect of flow attenuation due to surface ponding in rear yards has been accounted for by utilizing a constant slope ditch/swale draining to the street. The ditch/swale has a minimum longitudinal slope of 1.5%, a maximum depth of 600mm, and side slopes of 3 horizontal to 1 vertical.

Table 4.1 DDSWMM Hydrological Parameters

DRAINAGE AREA ID	AREA (HA)	D/S SEGMENT ID	IMP RATIO [Tp (h)]	Segment Length (m)	Subcatchment WIDTH (M)	MINOR SYSTEM RESTRICTION (LPS)	AVAILABLE STATIC PONDING (M^3)
ACB1	0.081	ACB2	1.00	30	60	52	36.03*
ACB2	0.066	ACB3	1.00	35	70		
ACB3	0.037	ACB11	1.00	22	44		
ACB4	0.038	ACB3	1.00	21	42		
ACB5	0.054	ACB4	1.00	21	42	17	1.58
ACB6	0.074	ACB5	1.00	27	54	17	6.39
ACB7	0.100	ACB8	1.00	34	68	58	13.87*
ACB8	0.086	OUT1	1.00	32	64		
UNC_CB9	0.038	OUT3	1.00	22	44	0	0
ACB10	0.029	UN3	0.79	20	40	10	0.78
ACB11	0.119	OUT1	0.43	124	124	27	6.59*
ACB12	0.084	OUT1	0.43	30	60	7	2.30
UN1	0.011	OUT1	0.79	4	8	N/A	0
UN2	0.043	OUT1	0.79	11	22	N/A	0
UN3	0.075	OUT2	0.79	6	12	N/A	0
UN4	0.071	OUT2	0.79	10	20	N/A	0

NOTES:

* Restriction controlled for group of catchments
**Oversized storm pipe storage included as part of the available static storage. For detailed calculations refer to Appendix C

4.6 Results of the Hydrological Evaluation

The allowable release rate for the 1.01 Ha site is 206 L/s of minor flow and 84 L/s of major flow for the 100 year Chicago storm according to the previous Pathways Phase 1 report, See Table 4.5 in **Appendix C** and area HD1 DDSWMM model results. As noted in Section 4.4, a portion of the site will be left to discharge to Salamander Way, Cedar Creek Drive and Pingwi Place uncontrolled. As per the detailed DDSWMM model, these uncontrolled areas contribute 71 L/s of the 84 L/s total major flow released from Block 232 for the 100 year Chicago storm. This is on par with the results from the previous Pathway Phase 1 report. Also, catchment UNC_CB9 is set to full capture due to the parking ramp in this area. The flows for this catchment are accounted for in the total minor flow allowance.

Based on the aforementioned flow allowance, 7 inlet control devices are proposed for all of the surface drainage. For the 100 year Chicago Storm, the sum of all the minor flow rates (**205 l/s**) is less than the maximum allowable flowrate of 206 l/s. Table 4.2 summarizes the ICDs characteristics, refer to **Drawing C-010** for detailed calculations and orifice sizing.

Table 4.2 Summary of ICD

LOCATION	AREA (HA)	RELEASE RATE (L/S)	Head (M)	ICD
ACB1	0.081	52	2.38	Custom IPEX MHF 127 mm Diameter
ACB2	0.066			

ACB3	0.037			
ACB4	0.038			
ACB5	0.054	17	1.42	Custom IPEX MHF 82 mm Diameter
ACB6	0.074	17	1.50	Custom IPEX MHF 81 mm Diameter
ACB7	0.100	58	1.98	Custom IPEX MHF 139 mm Diameter
ACB8	0.086			
UNC_CB9	0.038	17	1.25	Full Capture, No ICD
ACB10	0.029	10	1.45	Custom HYDROVEX 100 VHV-1 restricted at 10 l/s
ACB11	0.119	27	1.51	Standard IPEX MHF 102 mm Diameter
ACB12	0.084	7	1.55	Custom HYDROVEX 75 VHV-1 restricted at 7 l/s
TOTAL	**0.806**	**205**	-	

The below **Table 4.1** and summarizes the minor system capture for each subcatchment on the subject site for the 2 year, 3 hour Chicago storm events. The results demonstrates that there is no ponding on the block where the flow is controlled following the 2 year storm event. The site releases a total of 27 l/s from the uncontrolled areas UN1, UN2, UN3 and UN4.

Table 4.1 DDSWMM Hydrological Model Results for 2 Year 3 Hour Chicago

DRAINAGE AREA ID	MINOR SYSTEM RESTRICTION (l/s)	AVAILABLE STATIC STORAGE (m3)	MINOR SYSTEM CAPTURE	TOTAL STORAGE USED (m3)	OVERFLOW (l/s)
ACB1	52	36.03*	40	0.01	0**
ACB2					
ACB3					
ACB4					
ACB5	17	1.58	10	0.01	0
ACB6	17	6.39	13	0.01	0
ACB7	58	13.87*	33	0.01	0**
ACB8					
UNC_CB9	0	0.00	7	0	0
ACB10	10	0.78	5	0.01	0
ACB11	27	6.59*	10	0	0
ACB12	7	2.30	7	0.01	0
UN1	N/A	0	0	0	2
UN2	N/A	0	0	0	6
UN3	N/A	0	0	0	10
UN4	N/A	0	0	0	10
OUT2	N/A	N/A	N/A	N/A	27

NOTES:

* Restriction controlled for group of catchments

**Oversized storm pipe storage included as part of the available static storage. For detailed calculations refer to Appendix C

The **Table 4.2** and **Table 4.3** below, summarize the cascading overflows for each subcatchment on the subject site for the 100 year 3 hour Chicago storm event and the 100 year Chicago storm increased by 20%, respectively. The cascading overflow is the flow exiting a drainage area when maximum minor system inflow and maximum available ponding has been utilized. The overflow is obtained from the respective DDSWMM output file provided in **Appendix C**, CD model files.

Table 4.2 DDSWMM Hydrological Model Results for 100 Year 3 Hour Chicago

DRAINAGE AREA ID	MINOR SYSTEM RESTRICTION (l/s)	AVAILABLE STATIC STORAGE (m3)	MINOR SYSTEM CAPTURE	TOTAL STORAGE USED (m3)	OVERFLOW (l/s)
ACB1	52	36.03*	52	32.59	0**
ACB2					
ACB3					
ACB4					
ACB5	17	1.58	17	1.58	7
ACB6	17	6.39	17	6.39	2
ACB7	58	13.87*	58	11.42	0**
ACB8					
UNC_CB9	0	0	17.33	0	0
ACB10	10	0.78	10	0.46	0
ACB11	27	6.59*	26.99	2.29	0
ACB12	7	2.30	7	2.30	15
UN1	N/A	0	0	0	4
UN2	N/A	0	0	0	16
UN3	N/A	0	0	0	25
UN4	N/A	0	0	0	26
OUT2	N/A	N/A	N/A	N/A	84

NOTES:

* Restriction controlled for group of catchments
**Oversized storm pipe storage included as part of the available static storage. For detailed calculations refer to Appendix C

The above results indicate that the major system releases a total of 84 l/s of major flow from the site during the 100 year 3 hour Chicago design storm. This corresponds to the previous analysis presented with the Pathways Design Brief Phase 1, which included an overflow of 84 L/s generated from the site.

Table 4.3 DDSWMM Hydrological Model Results for 100 Year 3 Hour Chicago +20%

DRAINAGE AREA ID	MINOR SYSTEM RESTRICTION (l/s)	AVAILABLE STATIC STORAGE (m3)	MINOR SYSTEM CAPTURE	TOTAL STORAGE USED (m3)	OVERFLOW (l/s)
ACB1	52	36.03*	52	36.03	28**
ACB2					
ACB3					
ACB4					
ACB5	17	1.58	17	1.58	24
ACB6	17	6.39	17	6.39	23
ACB7	58	13.87*	58	13.87	0**
ACB8					
UNC_CB9	0	0	21	0	0
ACB10	10	0.78	10	0.78	5
ACB11	27	6.59*	27	6.59	34
ACB12	7	2.30	7	2.30	22
UN1	N/A	0	0	0	5
UN2	N/A	0	0	0	20
UN3	N/A	0	0	0	39
UN4	N/A	0	0	0	32
OUT2	N/A	N/A	N/A	N/A	111

The above results indicate that the major system flow from the site is 111 L/s during the 100 year 3 hour Chicago + 20% sensitivity analysis. This is less than the previous analysis within the Pathways Design Brief, which included an overflow of 140 L/s generated from the site.

The following table summarizes the elevation of dynamic ponding, property line elevation and the garage elevations for the street segments during the 100 year storm event increased by 20%.

Table 4.4 Critical Ponding Locations during the Stress Test and Adjacent Property Elevations

DRAINAGE AREA ID	STATIC PONDING DEPTH (M)	MAX. DEPTH (STATIC + DYNAMIC, WHERE APPLICABLE) (M)	(1) CORRESPONDING ELEVATION (M)	(2) ADJACENT PROPERTY LINE ELEVATION (M)	DIFFERENCE (2) – (1)	(3) ADJACENT CRITICAL ELEVATION		DIFFERENCE (3) – (1)
						LOCATION	(3) ELEVATION (M)	
ACB1	0.15	0.29	99.89	100.95	1.06	Property boundary	100.95	1.06
ACB2	0.25			99.85	-0.04	Building envelope	99.95	0.06
ACB3	0.25			100.10	0.21	N/A	N/A	N/A
ACB4	0.10			100.90	1.01	Building entrance	100.95	1.06
ACB5	0.12	0.19	100.29	100.45	0.16	Building entrance	100.50	0.21
ACB6	0.20	0.27	100.47	100.45	-0.02	Building envelope	100.50	0.03
ACB7	0.15	0.00	99.84	100.90	1.06	Building envelope	101.45	1.61
ACB8	0.19			99.95	0.11	Building envelope	100.20	0.36
UNC_CB9	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ACB10	0.15	0.20	101.00	101.10	0.07	Building envelope	101.05	0.10
ACB11	0.18	0.28	99.48	99.55	0.07	To Salamander Way	99.48	0
ACB12	0.25	0.35	100.20	100.20	0	Building envelope	100.25	0.05

From the comparison in **Table 4.4**, during the 100 year storm event increased by 20%, the major system encroaches the adjacent property line, but remains below the garage opening at all locations.

4.7 Storm Hydraulic Grade Line

Pathways Phase 1 report indicates that the storm hydraulic grade line (HGL) in MH 6102 on Cedar Creek Drive is 94.89m, refer to **Appendix C** for the Pathways Phase 1 Storm HGL analysis. The storm HGL extended through the subject site have been calculated as follows:

LOCATION	MH #	USF ELEV (M)	STORM HGL (M)	FREEBOARD (M)
Cedar Creek Drive	BLK6117	-	94.890	-
Block 232	MH 200	98.420	94.905	3.515
Block 232	MH 201	98.420	96.689	1.731
Block 232	MH 203	98.420	97.064	1.356
Block 232	MH 204	98.940	97.455	1.485

Block 232	MH 205	98.940	98.099	0.841
Block 232	MH 206	98.920	98.333	0.587
Block 232	MH 207	100.62	98.100	2.520
Block 232	MH 208	100.62	98.132	2.488

All underside of footing elevations have been designed to provide a minimum of 300mm separation between the greater of governing pipe obvert or governing HGL. A copy of the storm HGL analysis for Block 232 is provided in **Appendix C**.

5 SOURCE CONTROLS

5.1 General

On site level or source control management of runoff will be provided to provide quality control for the subject lands. Such controls or mitigative measures are proposed for the development not only for final development but also during construction and build out. Some of these measures are:

- flat lot grading;
- split lot drainage;
- Roof-leaders to vegetated areas;
- vegetation planting; and
- groundwater recharge.

5.2 Lot Grading

There is an elevation difference of approximately 2m from southwest to northeast in Block 232. In accordance with local municipal standards, the parking lots will be graded northeast between 1.5% and 5.0%. Most landscaped area drainage will be directed into a swale drainage system, and connects to the storm sewer system. Typically swales will have slopes larger than 1.5% with subdrains. Copies of the grading plans have been included in **Appendix D.**

5.3 Roof Leaders

This development will consist of stacked homes and apartments. It is proposed that roof leaders from these units be constructed such that runoff is directed to grass areas adjacent to the units. This will promote water quality treatment through settling, absorption, filtration and infiltration and a slow release rate to the conveyance network.

5.4 Vegetation

As with most subdivision agreements, the developer will be required to complete a vegetation and planting program. Vegetation throughout the development including planting along roadsides and within public parks provides opportunities to re-create lost natural habitat.

6 CONVEYANCE CONTROLS

6.1 General

Besides source controls, the development also proposes to use several conveyance control measures to improve runoff quality. These will include:

- flat vegetated swales;
- catchbasin and maintenance hole sumps; and
- pervious rear yard drainage.

6.2 Flat Vegetated Swales

The development will make use of relatively flat vegetated swales where possible to encourage infiltration and runoff treatment.

6.3 Catchbasins

All catchbasins within the development, either rear yard or street, will be constructed with minimum 600 mm deep sumps. These sumps trap pollutants, sand, grit and debris which can be mechanically removed prior to being flushed into the minor pipe system. Both rear yard and street catchbasins will be fabricated to OPSD 705.010 or 705.020. All storm sewer maintenance holes servicing local sewers less than 900 mm diameter shall be constructed with a 300 mm sump as per City standards.

6.4 Pervious Landscaped Area Drainage

Some of the landscaped area swales make use of a filter wrapped perforated drainage pipe constructed below the rear yard swale. This perforated system is designed to provide some ground water recharge and generally reduce both volumetric and pollutant loadings that enter the minor pipe system.

7 SEDIMENT AND EROSION CONTROL PLAN

7.1 General

During construction, existing stream and conveyance systems can be exposed to significant sediment loadings. Although construction is only a temporary situation, it is proposed to introduce a number of mitigative construction techniques to reduce unnecessary construction sediment loadings. These will include:

- groundwater in trench will be pumped into a filter mechanism prior to release to the environment;
- bulkhead barriers will be installed at the nearest downstream manhole in each sewer which connects to an existing downstream sewer;
- seepage barriers will be constructed in any temporary drainage ditches; and
- silt sacks will remain on open surface structure such as manholes and catchbasins until these structures are commissioned and put into use.

7.2 Trench Dewatering

During construction of municipal services, any trench dewatering using pumps will be discharged into a filter trap made up of geotextile filters and straw bales similar in design to the OPSD 219.240 Dewatering Trap. These will be constructed in a bowl shape with the fabric forming the bottom and the straw bales forming the sides. Any pumped groundwater will be filtered prior to release to the existing surface runoff. The contractor will inspect and maintain the filters as needed including sediment removal and disposal and material replacement as needed.

7.3 Bulkhead Barriers

At the first manhole constructed immediately upstream of an existing sewer, a ½ diameter bulkhead will be constructed over the lower half of the outletting sewer. This bulkhead will trap any sediment carrying flows, thus preventing any construction –related contamination of existing sewers. The bulkheads will be inspected and maintained including periodic sediment removal as needed.

7.4 Seepage Barriers

These barriers will consist of both the Light Duty Straw Bale Barrier as per OPSD 219.100 or the Light Duty Silt Fence Barrier as per OPSD 219.110 and will be installed in accordance with the sediment and erosion control drawing. The barriers are typically made of layers of straw bales or geotextile fabric staked in place. All seepage barriers will be inspected and maintained as needed.

7.5 Surface Structure Filters

All catchbasins, and to a lesser degree manholes, convey surface water to sewers. However, until the surrounding surface has been completed these structures will be covered to prevent sediment from entering the minor storm sewer system. Until rear yards are sodded or until streets are asphalted and curbed, all catchbasins and manholes will be equipped with geotextile filter socks. These will stay in place and be maintained during construction and build until it is appropriate to remove them.

7.6 Stockpile Management

During construction of any development similar to that being proposed both imported and native soils are stockpiled. Mitigative measures and proper management to prevent these materials entering the sewer systems is needed.

During construction of the deeper municipal services, water, sewers and service connections, imported granular bedding materials are temporarily stockpiled on site. These materials are however quickly used up and generally before any catchbasins are installed. Street catchbasins are installed at the time of roadway construction and rearyard catchbasins are usually installed after base course asphalt is placed.

Contamination of the environment as a result of stockpiling of imported construction materials is generally not a concern since these materials are quickly used and the mitigative measures stated previously, especially the use of filter fabric in catchbasins and manholes help to manage these concerns.

The roadway granular materials are not stockpiled on site. They are immediately placed in the roadway and have little opportunity of contamination. Lot grading sometimes generates stockpiles of native materials. However, this is only a temporary event since the materials are quickly moved off site.

The construction of this development will involve a substantial rock blasting, breaking and crushing operation. Given the existing topography, a substantial cut and fill operation is require in order to construction a development that meets City Standards. As part of this operation, materials will be manipulated onsite, and provided the sediment and erosion control measures are in place, are generally inconsequential to the surrounding environment.

8 ROADS AND NOISE ATTENUATION

Vehicular access to Block 232 is provided by two private entrances from Pingwi Place and one private from Salamander Way.

There are 130 parking spaces in total, including 28 underground and 102 surface parking spots.

There are no bus routes proposed within Block 232.

Environmental noise has been evaluated by IBI Group, and recommendations are provided under a separate cover.

9 SOILS

Golder Associates Ltd. was retained to prepare a geotechnical investigation for the proposed mixed use development for the Pathways Phase 1. The objectives of the investigation were to prepare a report to:

- Determine the subsoil and groundwater conditions at the site by means of test pits and boreholes and;
- To provide geotechnical recommendations pertaining to design of the proposed development including construction considerations.

The geotechnical report 13-1121-0083-1046 was prepared by Golder Associates Ltd. in January 2014. A copy of the report is included in **Appendix D**. The report contains recommendations which include but are not limited to the following:

- The maximum permissible grade raise is 2.5m
- In areas where finished grade exceeds grade raise limits, geotechnical reviews are required
- Fill placed below the foundations to meet OPSS Granular 'A' or Granular 'B' Type II placed in 300 mm lifts compacted to 98% SPMDD.
- Fill for roads to be suitable native material in 300mm lifts compared to 95% SPMDD

Pavement Structure:

LOCAL ROAD	THICKNESS
Asphaltic Concrete	90mm
OPSS Granular A Base	150mm
OPSS Granular B Type II Subbase	375mm

- Pipe bedding and cover; bedding to be minimum 150 mm OPSS Granular 'A' up to spring line of pipe. Cover to be 300 mm OPSS A (PUC and concrete pipes) or sand for concrete pipes. Both bedding and cover to be placed in maximum 225 mm lifts compacted to 95% SPMDD.

In general the grading plan for Block 232 adheres to the grade raise constraints noted above. A copy of the grading plans is included in **Appendix D**. For areas that exceed the grade raise limit a light weight fill program will be in place.

10 RECOMMENDATIONS

Water, wastewater and stormwater systems required to develop Pathways Block 232 will be designed in accordance with MOE and City of Ottawa's current level of service requirements.

The use of lot level controls, conveyance controls and end of pipe controls outlined in the report will result in effective treatment of surface stormwater runoff from the site. Adherence to the proposed sediment and erosion control plan during construction will minimize harmful impacts on surface water.

Final detail design will be subject to governmental approval prior to construction, including but not limited to the following:

- Block 232 Commence Work Order: City of Ottawa
- Block 232 ECA (sewers): MECP (Transfer of Review)
- Block 232 Watermain Approval: City of Ottawa
- Block 232 Commence Work Order (utilities): City of Ottawa

Report prepared by:

D.G. Yannoulopoulos

Demetrius Yannoulopoulos, P.Eng.
Director

Ryan Magladry, C.E.T.
Project Designer

J:\121793_Block225\5.2 Reports\5.2.2 Civil\5.2.2.1 Sewers\Submission #2\CTR-Servicing Brief_2019-07.docx

APPENDIX A

APPROVED UNDER SECTION 51 OF THE PLANNING ACT BY THE CITY OF OTTAWA. THIS ________ DAY OF ____________________ , _______ STEPHEN WILLIS, GENERAL MANAGER PLANNING, INFRASTRUCTURE AND ECONOMIC DEVELOPMENT DEPARTMENT CITY OF OTTAWA	**PLAN 4M-** I CERTIFY THAT THIS PLAN IS REGISTERED IN THE LAND REGISTRY OFFICE FOR THE LAND TITLES DIVISION OF OTTAWA-CARLETON NO. 4 AT _ _ _ _ _ O'CLOCK ON THE _ _ _ _ DAY OF _ _ _ _ _ _ _ _ _, _ _ _ _ AND ENTERED IN THE PARCEL REGISTER FOR PROPERTY IDENTIFIERS _ AND THE REQUIRED CONSENTS ARE REGISTERED AS PLAN DOCUMENT NO._ _ _ _ _ _ _ _ _ _ _ LAND REGISTRAR

This plan comprises part of the land identified by PIN 04328-3631 and all of the land identified by PIN 04328-3632.

PRELIMINARY PLAN OF SUBDIVISION OF

PART OF LOT 21
CONCESSION 4 (RIDEAU FRONT)

Geographic Township of Gloucester

CITY OF OTTAWA

Surveyed by Annis , O'Sullivan , Vollebekk Ltd.

Scale 1 : 1000

40 30 20 10 0 20 40 Metres

Metric

DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

SURVEYOR'S CERTIFICATE

I CERTIFY THAT :

1. This survey and plan are correct and in accordance with the Surveys Act, the Surveyors Act and the Land Titles Act and the regulations made under them.
2. The Survey was completed on the _ _ _ day of _ _ _ _ _ _ _ _ _ _ ,2018.

_ _ _ _ _ _ _ _ _ _ Date

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Andre Roy
Ontario Land Surveyor

OWNER'S CERTIFICATE

THIS IS TO CERTIFY THAT :

1. Lots 1 to 215, both inclusive, Blocks 216 to 245, both inclusive, the Streets, namely, promenade Cedar Creek Drive, promenade Dun Skipper Drive, bois Zaatiik Grove, rue Minikan Street, place Pingwi Place, promenade Kelly Farm Drive, voie Salamander Way, voie Spreadwing Way, rue Rallidale Street and placette Viceroy Mews, the Street Widenings, namely, Blocks 246 and 247 and the Reserves, namely, Blocks 248 to 254, both inclusive, have been laid out in accordance with our instructions.
2. The Streets and Street Widenings are dedicated to City of Ottawa as public highways.

Dated the _ _ _ _ day
of _ _ _ _ _ _ _ _ _ _ _ _,2018

_ _
David Kardish
Leitrim South Holdings Inc.
I have the authority to bind the corporation.

NOTES AND LEGEND

—□—	denotes	Survey Monument Planted.
—■—	"	Survey Monument Found
SIB	"	Standard Iron Bar.
SSIB	"	Short Standard Iron Bar.
CC	"	Cut Cross.
IB	"	Iron Bar.
CLF	"	Chain Link Fence
BF	"	Board Fence
(AOG)	"	Annis, O'Sullivan, Vollebekk Ltd.
(P1)	"	Plan 4R-29621
(P2)	"	Plan
P&W	"	Post & Wire
— OHW —	"	Overhead Wires

All planted survey monuments are IB's unless otherwise noted.

Distances shown on curved limits are Arc distances unless otherwise noted.

Distances shown on this plan are ground distances and can be converted to grid distances by multiplying by the combined scale factor of 0.9999xx.

Bearings are grid, derived from Can-Net 2016 Real Time Network GPS observations on reference points A and B, shown hereon, having a bearing of Nxx°xx'xx"W and are referenced to Specified Control Points 01919760735 and 01919871649, MTM Zone 9 (76°30' West Longitude) NAD-83 (original).

Coordinates are derived from Can-Net 2016 Real Time Network GPS observations referenced to Specified Control Points 01919760735 and 01919871649, MTM Zone 9 (76°30' West Longitude) NAD-83 (original).

Coordinate values are to urban accuracy in accordance with O. Reg. 216/10.

. 01919760735	Northing	5026903.34	Easting	376968.72
. 01919871649	Northing	5007189.87	Easting	372435.05
. Point A	Northing		Easting	
. Point B	Northing		Easting	

Caution: Coordinates cannot, in themselves, be used to re-establish corners or boundaries shown on this plan.

11

REVISION SCHEDULE

NO.	REVISION	DATE	
1	PLAN PREPARED	MAY. 18, 2017	N
2	BLAIS ROAD REALIGNMENT	JULY 5, 2017	N
3	STREET NAMES REVISED	JULY 18, 2017	N
4	STREET NAMES REVISED	JULY 31, 2017	N
5	REVISED LOTS 110 TO 115	OCT. 6, 2017	DG
6	REVISED BLOCK 251 & ADDED STREET PLACETTE VICEROY MEWS	NOV. 1, 2017	DG
7	ADDED RESERVE BLKS 253 & 254	FEB. 27, 2018	N

ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
14 Concourse Gate, Suite 500
Nepean, Ont. K2E 7S6
Phone: (613) 727-0850 / Fax: (613) 727-1079
Email: Nepean@aovltd.com
Ontario Land Surveyors

Job No. 19429-17 Regional Pt Lts 21 22 C4 RF GL SUB PHI D7 N

SITE INFORMATION :

		REQUIRED :	PROVIDED :
SITE AREA :	10,061.14 m² = 1.0 ha (2.47 A)		
ZONING :	R4Z [2370]		
PERMITTED USES:	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING		
LOT WIDTH (MIN.):	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING	18.0 m	64.00 m
LOT AREA (MIN.):	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING	1,400.00 m²	10,061.14 m²
BUILDING HEIGHT (MAX.):	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING	15.0 m	12.66 m (EXIST. AVERAGE GRADE CALC)
FRONT YARD (MIN.) :	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING	3.0 m	4.44 m
REAR YARD (MIN.) :	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING	6.0 m (1.&12.)	6.50 m
INTERIOR SIDE YARD (MIN.) :	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING	3.0 m (12.)	4.00 m
CORNER SIDE YARD (MIN.) :	- PLANNED UNIT DEVELOPMENT - APARTMENT DWELLING - LOW RISE, STACKED DWELLING	3.0 m	3.00 m
ACCESSORY BUILDING SIZE (MAX.)		55.0 m²	109.0 m²
ACCESSORY BUILDING HEIGHT (MAX.)		3.6 m	3.6 m
LANDSCAPED AREA OF LOT (MIN.):		30 %	xx.xx % (xx,xxx.xxm²)

TOTAL AMENITY AREA REQUIRED : - APARTMENT LOW RISE - 6.0 m² x 36 = 216 m²
COMMUNAL AMENITY AREA REQ'D. (MIN.): 50% of 216 m² = 108 m²
AMENITY AREA PROVIDED : - PRIVATE AMENITY AREA - (BALCONIES & PATIOS) = 251 m²
- COMMUNAL AMENITY AREA - 472 m²
TOTAL AMENITY AREA PROVIDED : 723 m²

APARTMENT BUILDING, TERRA FLATS & BACK to BACK TERRACE HOMES:

BUILDING No. :		BUILDING AREA:	GROSS FLOOR AREA:	No. UNITS:
BUILDING 1 =	BACK to BACK TERRACE HOMES	358.0 m²	1,394.0 m²	12 UNITS
BUILDING 2 =	BACK to BACK TERRACE HOMES	358.0 m²	1,394.0 m²	12 UNITS
BUILDING 3 =	APARTMENT BLDG.	505.0 m²	1,504.0 m²	18 UNITS
BUILDING 4 =	APARTMENT BLDG.	505.0 m²	1,504.0 m²	18 UNITS
BUILDING 5 =	BACK to BACK TERRACE HOMES	358.0 m²	1,394.0 m²	12 UNITS
BUILDING 6 =	BACK to BACK TERRACE HOMES	358.0 m²	1,394.0 m²	12 UNITS
BUILDING 7 =	BACK to BACK TERRACE HOMES	230.0 m²	907.5 m²	8 UNITS
ACCESSORY BUILDING		109.0 m²		
TOTAL =		2,781.0 m²	6,703.5 m	92 UNITS

APARTMENT BUILDINGS =	36 UNITS
BACK to BACK TERRACE HOMES =	56 UNITS
TOTAL =	92 UNITS

PARKING :
PARKING REQUIRED : 1.2 Spaces / (92) d.u. + 0.2 / (92) d.u. (Visitor) = 110.4 + 18.4 = 129 Spaces

PARKING PROVIDED : UNDERGROUND - 2 x 14 Spaces = 28 Spaces
SURFACE 84 Spaces +18Visitor Spaces = 102 Spaces
TOTAL: = 130 Spaces

16 (4 u/g) PARKING SPACES (12.3% total) INDICATED WITH AN * HAVE A WIDTH OF 2.4m as per SECTION 106 (3)(a)

BICYCLE PARKING REQUIRED : 0.5 / d.u.(92) = 46 Spaces
BICYCLE PARKING PROVIDED : 32 (Accessory bldg.) + 26 u/g (13 per apt. bldg) + 4 Surface = 62 spaces

SNOW STORAGE : CLEARED SNOW TO BE REMOVED FROM SITE

LEGEND:

D.C. - DEPRESSED CURB
- WALL MOUNT LIGHT FIXTURE
- FIRE HYDRANT
L.S. - LIGHT STANDARD
B.S. - BUILDING SERVICES LOCATION

NOTE:
SITE PLAN TO BE READ IN CONJUNCTION WITH :
- SITE SERVICING AND GRADING PLAN PREPARED BY NOVATECH ENGINEERING CONSULTANTS.
- LANDSCAPING PLAN PREPARED BY JAMES B. LENNOX AND ASSOCIATES INC.
BOUNDARIES DERIVED FROM: PLAN 4M -XXX.
PLAN PREPARED BY ANNIS O'SULLIVAN VOLLEBEKK LTD.
DATED XXX. XX, 20XX.

M. David Blakely
Architect Inc.
2200 Prince of Wales Dr. Suite 101 Ottawa, Ontario
Phone (613) 226-8811 Fax (613) 226-7942 k2E 6Z9

GENERAL NOTES:
1. THE CONTRACTOR IS RESPONSIBLE FOR CHECKING AND VERIFYING ALL DIMENSIONS, ANY DISCREPANCY MUST BE REPORTED TO M. DAVID BLAKELY ARCHITECT INC.
2. ALL WORK AND MATERIALS TO BE IN COMPLAINCE WITH ALL CODES, REGULATIONS, & BY-LAWS
3. ADDITIONAL DRAWINGS MAY BE ISSUED FOR CLARIFICATION TO ASSIST THE PROPER EXECUTION OF WORK. SUCH DRAWINGS WILL HAVE THE SAME MEANING AND INTENT AS IF THEY WERE INCLUDED WITH THE PLANS IN CONTRACT DOCUMENTS
4. DO NOT SCALE DRAWINGS.
5. THIS DRAWING SHALL NOT BE USED OR COPIED WITHOUT THE AUTHORIZATION OF THE ARCHITECT
6. THIS DRAWING SHALL NOT BE USED FOR PERMIT OR CONSTRUCTION UNLESS THE DRAWING BEARS THE ARCHITECT'S SEAL AND SIGNATURE

SEAL

REVISIONS

No.	DATE	DESCRIPTION	INIT.
12.			
11.			
10.			
9.			
8.			
7.			
6.			
5.			
4.			
3.		FOR SITE PLAN SUBMISSION	MB
2.	27/06/19	FOR COORDINATION	MB
1.	04/04/19	FOR REVIEW	MB

REVISIONS

No.	DATE	DESCRIPTION	INIT.
24.			
23.			
22.			
21.			
20.			
19.			
18.			
17.			
16.			
15.			
14.			
13.			

A
B | C

A - DETAIL NUMBER
B - SHEET NUMBER (DETAIL REQUIRED)
C - SHEET NUMBER (DETAIL LOCATION)

PROJECT:
PATHWAYS |BLOCK 232
PLANNED UNIT DEVELOPMENT
OTTAWA, ONTARIO

CLIENT:
PHOENIX HOMES
18A Bentley Ave Ottawa, ON K2E 6T8

DRAWING TITLE:
SITE PLAN

DATE: APRIL 2019
SCALE: 1 : 250
DRAWN BY: mdb
CHECKED: MDB
SHEET No.: SP1

Boundary Conditions for 76 Salamander Way

Information Provided:

Date provided: November 2019

Scenario	Demand	
	L/min	L/s
Average Daily Demand	40.2	0.67
Maximum Daily Demand	100.8	1.68
Peak Hour	221.4	3.69
Fire Flow Demand #1	10000	166.67
Fire Flow Demand #2	13000	216.67

Location:

Results: 2019 Existing Conditions

Connection 1 - Salamander Way

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	155.6	84.8
Peak Hour	145.7	70.7
Max Day plus Fire (10,000 l/min)	147.2	72.9
Max Day plus Fire (13,000 L/min)	143.3	67.3

[1] Ground Elevation = 95.945m

Connection 2 - Cedar Creek

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	155.6	81.0
Peak Hour	145.6	66.8
Max Day plus Fire (10,000 l/min)	144.6	66.7
Max Day plus Fire (13,000 L/min)	140.7	59.7

[1] Ground Elevation = 98.662m

Results: SUC Zone Reconfiguration

Connection 1 - Salamander Way

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	146.9	72.4
Peak Hour	145.1	69.9
Max Day plus Fire (10,000 l/min)	140.6	63.4
Max Day plus Fire (13,000 L/min)	138.0	59.9

[1] Ground Elevation = 95.945m

Connection 2 - Cedar Creek

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	146.9	68.5
Peak Hour	145.1	66.0
Max Day plus Fire (10,000 l/min)	138.9	57.2
Max Day plus Fire (13,000 L/min)	135.4	52.3

[1] Ground Elevation = 98.662m

Notes:

1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:

a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.

Disclaimer

The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.

IBI GROUP
333 PRESTON STREET
OTTAWA, ON
K1S 5N4

WATERMAIN DEMAND CALCULATION SHEET

PROJECT : BLOCK 232 PATHWAYS
LOCATION : CITY OF OTTAWA
DEVELOPER : DCR/PHOENIX GROUP OF COMPANIES

FILE: 121793.5.7
DATE PRINTED: 11-Dec-19
DESIGN: LE
PAGE : 1 OF 1

NODE	RESIDENTIAL UNITS				NON-RESIDENTIAL			AVERAGE DAILY DEMAND (l/s)			MAXIMUM DAILY DEMAND (l/s)			MAXIMUM HOURLY DEMAND (l/s)			FIRE DEMAND
	SF	SD & TH	APT	POP'N	INDTRL (ha.)	COMM. (ha.)	INST. (ha.)	Res.	Non-res.	Total	Res.	Non-res.	Total	Res.	Non-res.	Total	(l/min)
T02			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T04			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T06			2	4				0.01	0.00	0.01	0.04	0.00	0.04	0.08	0.00	0.08	
T08			2	4				0.01	0.00	0.01	0.04	0.00	0.04	0.08	0.00	0.08	
T10			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T12			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T14			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T16			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T18			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T20			18	32				0.13	0.00	0.13	0.33	0.00	0.33	0.72	0.00	0.72	
T24			18	32				0.13	0.00	0.13	0.33	0.00	0.33	0.72	0.00	0.72	
T26			2	4				0.01	0.00	0.01	0.04	0.00	0.04	0.08	0.00	0.08	
T28			6	11				0.04	0.00	0.04	0.11	0.00	0.11	0.24	0.00	0.24	
T30			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T32			2	4				0.01	0.00	0.01	0.04	0.00	0.04	0.08	0.00	0.08	
T34			6	11				0.04	0.00	0.04	0.11	0.00	0.11	0.24	0.00	0.24	
T36			4	7				0.03	0.00	0.03	0.07	0.00	0.07	0.16	0.00	0.16	
T50																	13,000
T52																	13,000
TOTALS			92	166						**0.65**			**1.67**			**3.68**	

ASSUMPTIONS

RESIDENTIAL DENSITIES
- Single Family (SF) 3.4 p / p / u
- Semi Detached (SD) & Townhouse (TH) 2.7 p / p / u
- Apartment (APT) 1.8 p / p / u
-Other 66 u / p / ha

AVG. DAILY DEMAND
- Residential 350 l / cap / day
- ICI 50,000 l / ha / day

MAX. DAILY DEMAND
- Residential 875 l / cap / day
- ICI 75,000 l / ha / day

MAX. HOURLY DEMAND
- Residential 1,925 l / cap / day
- ICI 135,000 l / ha / day

FIRE FLOW
13,000 l / min

J:\121793_PathwayBL232\6.0_Technical\6.2_Civil_Eng_Muni_Transp\6.2.4_Design-Analysis_Water\CCS_WaterDemands_2019-11-29

Fire Flow Requirement from Fire Underwriters Survey

Block 232 - Building 4

Building Floor Area

width	24.0	m
depth	23.0	m
stories	3	
Area	1,656.0	m^2

$F = 220C\sqrt{A}$

C	1.5		C =	1.5	wood frame
A	1,656	m^2		1.0	ordinary
				0.8	non-combustile
F	13,429	l/min		0.6	fire-resistive
use	13,000	l/min			

Occupancy Adjustment

			-25%	non-combustile
			-15%	limited combustile
Use	-15%		0%	combustile
			+15%	free burning
Adjustment	-1950	l/min	+25%	rapid burning
Fire flow	11,050	l/min		

Sprinkler Adjustment

Use -30%

Adjustment -3315 l/min

Exposure Adjustment

Building Face	Separation (m)	Adjacent Exposed Wall			Exposure Charge *
		Length	Stories	L*H Factor	
north	19.0	15.5	3	47	13%
east	14.0	23.0	3	69	14%
south	27.0	18.0	2	36	8%
west	24.0	22.5	3	68	9%
Total					44%

Adjustment	4,862	l/min
Total adjustments	1,547	l/min
Fire flow	12,597	l/min
Use	**13,000**	**l/min**
	216.7	**l/s**

* Exposure charges from Techinical Bulletin ISTB 2018-02 Appendix H (ISO Method)

Fire Flow Requirement from Fire Underwriters Survey

Block 232 - Building 5

Building Floor Area

width	15.5	m
depth	22.5	m
stories	3	
Area	1,046.3	m^2

$F = 220C\sqrt{A}$

C	1.5		C =	1.5 wood frame
A	1,046	m^2		1.0 ordinary
				0.8 non-combustile
F	10,674	l/min		0.6 fire-resistive
use	11,000	l/min		

Occupancy Adjustment

			-25% non-combustile
			-15% limited combustile
Use	-15%		0% combustile
			+15% free burning
Adjustment	-1650	l/min	+25% rapid burning
Fire flow	9,350	l/min	

Sprinkler Adjustment

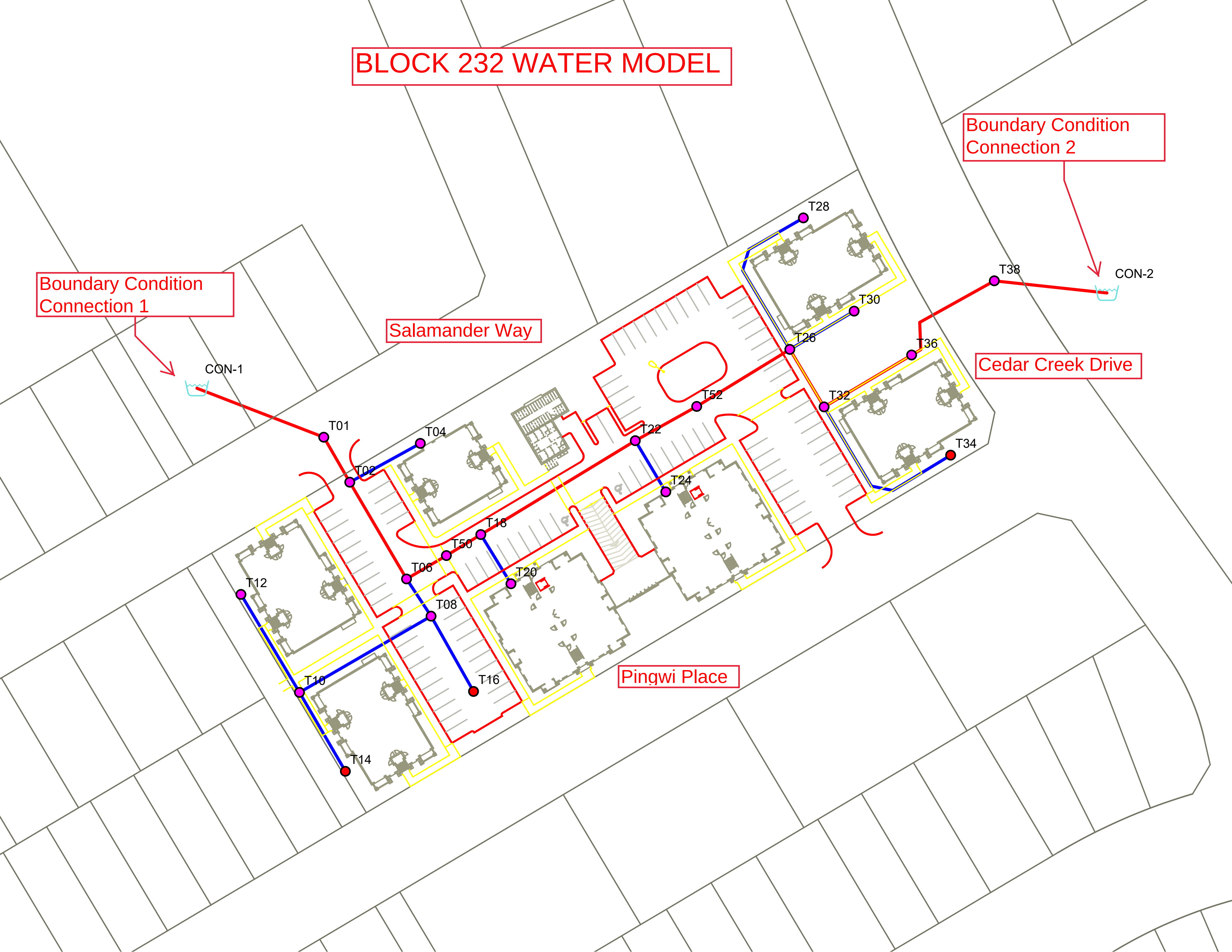
Use	0%	
Adjustment	0	l/min

Exposure Adjustment

Building Face	Separation (m)	Adjacent Exposed Wall Length	Stories	L*H Factor	Exposure Charge *
north	10.5	15.0	3	45	13%
east	24.0	23.0	3	69	9%
south	27.0	18.0	2	36	8%
west	11.0	15.0	2	30	12%
Total					42%

Adjustment	3,927	l/min
Total adjustments	3,927	l/min
Fire flow	13,277	l/min
Use	**13,000**	**l/min**
	216.7	**l/s**

* Exposure charges from Techinical Bulletin ISTB 2018-02 Appendix H (ISO Method)



BLOCK 232 WATER MODEL
Boundary Condition Connection 2
Boundary Condition Connection 1
CON-1
CON-2
Salamander Way
Cedar Creek Drive
Pingwi Place
T01
T02
T04
T06
T08
T10
T12
T14
T16
T18
T20
T22
T24
T26
T28
T30
T32
T34
T36
T38
T50
T52

Basic Day (Max HGL) HGL 155.6m - Junction Report

		ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (kPa)	Water Age (hrs)
1	☐	T01	0.17	100.00	155.60	544.84	1.00
2	☐	T02	0.03	99.80	155.60	546.80	2.00
3	☐	T04	0.03	100.15	155.60	543.37	4.98
4	☐	T06	0.01	100.80	155.60	537.00	3.00
5	☐	T08	0.01	100.90	155.60	536.02	4.00
6	☐	T10	0.03	101.00	155.60	535.04	5.87
7	☐	T12	0.03	100.60	155.60	538.96	10.09
8	☐	T14	0.03	101.85	155.60	526.71	9.25
9	☐	T16	0.03	101.90	155.60	526.22	7.20
10	☐	T18	0.03	100.40	155.60	540.92	5.00
11	☐	T20	0.13	100.80	155.60	537.00	6.00
12	☐	T22	0.00	100.40	155.60	540.92	9.42
13	☐	T24	0.13	100.95	155.60	535.53	10.42
14	☐	T26	0.01	100.60	155.60	538.96	4.00
15	☐	T28	0.04	99.95	155.60	545.33	8.90
16	☐	T30	0.03	100.15	155.60	543.37	6.77
17	☐	T32	0.01	100.90	155.60	536.02	3.00
18	☐	T34	0.04	101.65	155.60	528.67	8.04
19	☐	T36	0.03	100.60	155.60	538.96	2.00
20	☐	T38	0.00	100.15	155.60	543.37	1.00
21	☐	T50	0.00	100.50	155.60	539.94	4.00
22	☐	T52	0.00	100.25	155.60	542.39	5.79

Peak Hour HGL 145.1 m - Junction Report

		ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (kPa)	Water Age (hrs)
1	☐	T01	0.91	100.00	145.10	441.94	0.00
2	☐	T02	0.16	99.80	145.10	443.90	0.00
3	☐	T04	0.16	100.15	145.10	440.47	0.00
4	☐	T06	0.08	100.80	145.10	434.09	0.00
5	☐	T08	0.08	100.90	145.10	433.11	0.00
6	☐	T10	0.16	101.00	145.10	432.13	0.00
7	☐	T12	0.16	100.60	145.10	436.04	0.00
8	☐	T14	0.16	101.85	145.10	423.80	0.00
9	☐	T16	0.16	101.90	145.10	423.31	0.00
10	☐	T18	0.16	100.40	145.10	438.01	0.00
11	☐	T20	0.72	100.80	145.10	434.09	0.00
12	☐	T22	0.00	100.40	145.10	438.01	0.00
13	☐	T24	0.72	100.95	145.10	432.62	0.00
14	☐	T26	0.08	100.60	145.10	436.05	0.00
15	☐	T28	0.24	99.95	145.10	442.42	0.00
16	☐	T30	0.16	100.15	145.10	440.46	0.00
17	☐	T32	0.08	100.90	145.10	433.11	0.00
18	☐	T34	0.24	101.65	145.10	425.76	0.00
19	☐	T36	0.16	100.60	145.10	436.06	0.00
20	☐	T38	0.00	100.15	145.10	440.47	0.00
21	☐	T50	0.00	100.50	145.10	437.03	0.00
22	☐	T52	0.00	100.25	145.10	439.48	0.00

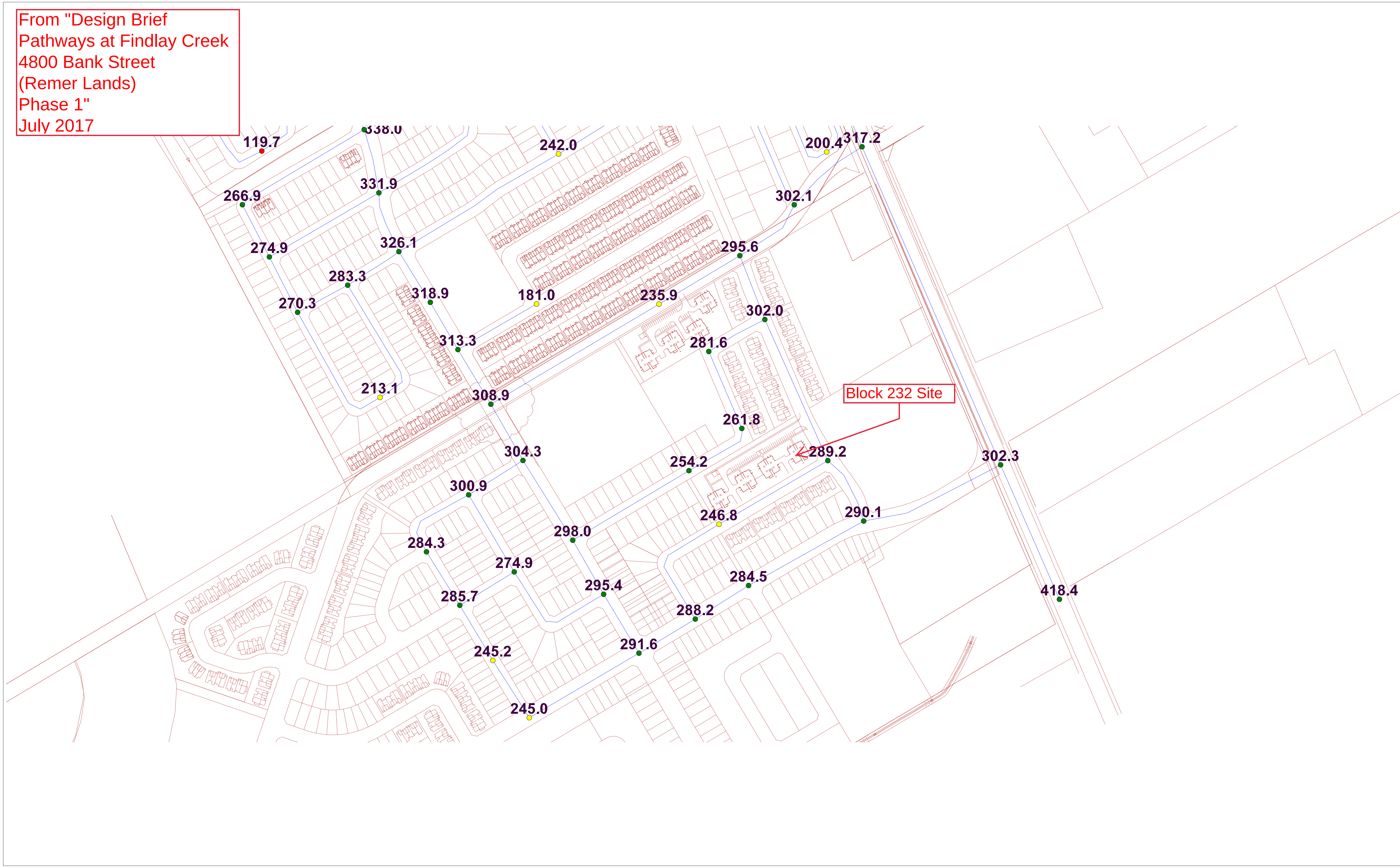
Peak Hour HGL 145.1 m - Pipe Report

		ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status	Flow Reversal Count	Water Age (hrs)
1		P51	T01	T02	10.99	204.00	110.00	2.10	0.06	0.00	0.04	Open	0	0.00
2		P53	T02	T06	23.75	204.00	110.00	1.78	0.05	0.00	0.03	Open	0	0.00
3		P55	T06	T08	9.44	155.00	100.00	0.72	0.04	0.00	0.03	Open	0	0.00
4		P57	T08	T16	18.30	155.00	100.00	0.16	0.01	0.00	0.00	Open	0	0.00
5		P59	T08	T10	32.16	155.00	100.00	0.48	0.03	0.00	0.01	Open	0	0.00
6		P61	T10	T12	24.15	155.00	100.00	0.16	0.01	0.00	0.00	Open	0	0.00
7		P63	T02	T04	17.03	155.00	100.00	0.16	0.01	0.00	0.00	Open	0	0.00
8		P65	T06	T50	9.78	204.00	110.00	0.98	0.03	0.00	0.01	Open	0	0.00
9		P67	T50	T18	8.53	204.00	110.00	0.98	0.03	0.00	0.01	Open	0	0.00
10		P69	T18	T20	12.24	155.00	100.00	0.72	0.04	0.00	0.03	Open	0	0.00
11		P71	T18	T22	38.24	204.00	110.00	0.10	0.00	0.00	0.00	Open	0	0.00
12		P73	T10	T14	19.33	155.00	100.00	0.16	0.01	0.00	0.00	Open	0	0.00
13		P75	T22	T24	12.62	155.00	100.00	0.72	0.04	0.00	0.03	Open	0	0.00
14		P77	T22	T52	14.88	204.00	110.00	-0.62	0.02	0.00	0.01	Open	0	0.00
15		P79	T52	T26	23.10	204.00	110.00	-0.62	0.02	0.00	0.00	Open	0	0.00
16		P81	T26	T30	15.83	155.00	100.00	0.16	0.01	0.00	0.00	Open	0	0.00
17		P83	T26	T28	37.41	155.00	100.00	0.24	0.01	0.00	0.00	Open	0	0.00
18		P85	T26	T32	14.20	204.00	110.00	-1.10	0.03	0.00	0.01	Open	0	0.00
19		P87	T32	T34	38.48	155.00	100.00	0.24	0.01	0.00	0.00	Open	0	0.00
20		P89	T32	T36	21.52	204.00	110.00	-1.42	0.04	0.00	0.02	Open	0	0.00
21		P91	T36	T38	26.09	204.00	110.00	-1.58	0.05	0.00	0.03	Open	0	0.00
22		P93	T38	CON-2	1.00	204.00	110.00	-1.58	0.05	0.00	0.03	Open	0	0.00
23		P95	CON-1	T01	1.00	204.00	110.00	3.01	0.09	0.00	0.08	Open	0	0.00

Max Day + Fire (13,000 l/min) - Fireflow Design Report

		ID	Total Demand (L/s)	Available Flow at Hydrant (L/s)	Critical Node ID	Critical Node Pressure (kPa)	Critical Node Head (m)	Design Flow (L/s)	Design Pressure (kPa)	Design Fire Node Pressure (kPa)
1	☐	T50	216.67	486.27	T50	139.96	114.78	486.28	139.96	139.94
2	☐	T52	216.67	423.46	T52	139.96	114.53	423.46	139.96	139.96

Phase 1 - MXDY + Fire - Design Fireflows (l/s)



Date: Friday, November 18, 2016

Servicing study guidelines for development applications

4. Development Servicing Study Checklist

The following section describes the checklist of the required content of servicing studies. It is expected that the proponent will address each one of the following items for the study to be deemed complete and ready for review by City of Ottawa Infrastructure Approvals staff.

The level of required detail in the Servicing Study will increase depending on the type of application. For example, for Official Plan amendments and re-zoning applications, the main issues will be to determine the capacity requirements for the proposed change in land use and confirm this against the existing capacity constraint, and to define the solutions, phasing of works and the financing of works to address the capacity constraint. For subdivisions and site plans, the above will be required with additional detailed information supporting the servicing within the development boundary.

4.1 General Content

- ☐ Executive Summary (for larger reports only).
- ☒ Date and revision number of the report.
- ☒ Location map and plan showing municipal address, boundary, and layout of proposed development.
- ☒ Plan showing the site and location of all existing services.
- ☐ Development statistics, land use, density, adherence to zoning and official plan, and reference to applicable subwatershed and watershed plans that provide context to which individual developments must adhere.
- ☐ Summary of Pre-consultation Meetings with City and other approval agencies.
- ☐ Reference and confirm conformance to higher level studies and reports (Master Servicing Studies, Environmental Assessments, Community Design Plans), or in the case where it is not in conformance, the proponent must provide justification and develop a defendable design criteria.
- ☒ Statement of objectives and servicing criteria.
- ☒ Identification of existing and proposed infrastructure available in the immediate area.
- ☒ Identification of Environmentally Significant Areas, watercourses and Municipal Drains potentially impacted by the proposed development (Reference can be made to the Natural Heritage Studies, if available).
- ☒ Concept level master grading plan to confirm existing and proposed grades in the development. This is required to confirm the feasibility of proposed stormwater management and drainage, soil removal and fill constraints, and potential impacts to neighbouring properties. This is also required to confirm that the proposed grading will not impede existing major system flow paths.
- ☐ Identification of potential impacts of proposed piped services on private services (such as wells and septic fields on adjacent lands) and mitigation required to address potential impacts.
- ☐ Proposed phasing of the development, if applicable.

☒ Reference to geotechnical studies and recommendations concerning servicing.

☒ All preliminary and formal site plan submissions should have the following information:
- Metric scale
- North arrow (including construction North)
- Key plan
- Name and contact information of applicant and property owner
- Property limits including bearings and dimensions
- Existing and proposed structures and parking areas
- Easements, road widening and rights-of-way
- Adjacent street names

4.2 Development Servicing Report: Water

☐ Confirm consistency with Master Servicing Study, if available

☒ Availability of public infrastructure to service proposed development

☒ Identification of system constraints

☒ Identify boundary conditions

☒ Confirmation of adequate domestic supply and pressure

☒ Confirmation of adequate fire flow protection and confirmation that fire flow is calculated as per the Fire Underwriter's Survey. Output should show available fire flow at locations throughout the development.

☒ Provide a check of high pressures. If pressure is found to be high, an assessment is required to confirm the application of pressure reducing valves.

☐ Definition of phasing constraints. Hydraulic modeling is required to confirm servicing for all defined phases of the project including the ultimate design

☒ Address reliability requirements such as appropriate location of shut-off valves

☐ Check on the necessity of a pressure zone boundary modification.

☒ Reference to water supply analysis to show that major infrastructure is capable of delivering sufficient water for the proposed land use. This includes data that shows that the expected demands under average day, peak hour and fire flow conditions provide water within the required pressure range

- ☒ Description of the proposed water distribution network, including locations of proposed connections to the existing system, provisions for necessary looping, and appurtenances (valves, pressure reducing valves, valve chambers, and fire hydrants) including special metering provisions.
- ☐ Description of off-site required feedermains, booster pumping stations, and other water infrastructure that will be ultimately required to service proposed development, including financing, interim facilities, and timing of implementation.
- ☒ Confirmation that water demands are calculated based on the City of Ottawa Design Guidelines.
- ☐ Provision of a model schematic showing the boundary conditions locations, streets, parcels, and building locations for reference.

4.3 Development Servicing Report: Wastewater

- ☒ Summary of proposed design criteria (Note: Wet-weather flow criteria should not deviate from the City of Ottawa Sewer Design Guidelines. Monitored flow data from relatively new infrastructure cannot be used to justify capacity requirements for proposed infrastructure).
- ☐ Confirm consistency with Master Servicing Study and/or justifications for deviations.
- ☐ Consideration of local conditions that may contribute to extraneous flows that are higher than the recommended flows in the guidelines. This includes groundwater and soil conditions, and age and condition of sewers.
- ☒ Description of existing sanitary sewer available for discharge of wastewater from proposed development.
- ☒ Verify available capacity in downstream sanitary sewer and/or identification of upgrades necessary to service the proposed development. (Reference can be made to previously completed Master Servicing Study if applicable)
- ☐ Calculations related to dry-weather and wet-weather flow rates from the development in standard MOE sanitary sewer design table (Appendix 'C') format.
- ☒ Description of proposed sewer network including sewers, pumping stations, and forcemains.
- ☐ Discussion of previously identified environmental constraints and impact on servicing (environmental constraints are related to limitations imposed on the development in order to preserve the physical condition of watercourses, vegetation, soil cover, as well as protecting against water quantity and quality).
- ☐ Pumping stations: impacts of proposed development on existing pumping stations or requirements for new pumping station to service development.
- ☐ Forcemain capacity in terms of operational redundancy, surge pressure and maximum flow velocity.
- ☐ Identification and implementation of the emergency overflow from sanitary pumping stations in relation to the hydraulic grade line to protect against basement flooding.
- ☒ Special considerations such as contamination, corrosive environment etc.

4.4 Development Servicing Report: Stormwater Checklist

- ☒ Description of drainage outlets and downstream constraints including legality of outlets (i.e. municipal drain, right-of-way, watercourse, or private property)
- ☐ Analysis of available capacity in existing public infrastructure.
- ☐ A drawing showing the subject lands, its surroundings, the receiving watercourse, existing drainage patterns, and proposed drainage pattern.
- ☒ Water quantity control objective (e.g. controlling post-development peak flows to pre-development level for storm events ranging from the 2 or 5 year event (dependent on the receiving sewer design) to 100 year return period); if other objectives are being applied, a rationale must be included with reference to hydrologic analyses of the potentially affected subwatersheds, taking into account long-term cumulative effects.
- ☒ Water Quality control objective (basic, normal or enhanced level of protection based on the sensitivities of the receiving watercourse) and storage requirements.
- ☒ Description of the stormwater management concept with facility locations and descriptions with references and supporting information.
- ☐ Set-back from private sewage disposal systems.
- ☐ Watercourse and hazard lands setbacks.
- ☐ Record of pre-consultation with the Ontario Ministry of Environment and the Conservation Authority that has jurisdiction on the affected watershed.
- ☐ Confirm consistency with sub-watershed and Master Servicing Study, if applicable study exists.
- ☒ Storage requirements (complete with calculations) and conveyance capacity for minor events (1:5 year return period) and major events (1:100 year return period).
- ☐ Identification of watercourses within the proposed development and how watercourses will be protected, or, if necessary, altered by the proposed development with applicable approvals.
- ☒ Calculate pre and post development peak flow rates including a description of existing site conditions and proposed impervious areas and drainage catchments in comparison to existing conditions.
- ☐ Any proposed diversion of drainage catchment areas from one outlet to another.
- ☒ Proposed minor and major systems including locations and sizes of stormwater trunk sewers, and stormwater management facilities.
- ☐ If quantity control is not proposed, demonstration that downstream system has adequate capacity for the post-development flows up to and including the 100 year return period storm event.
- ☐ Identification of potential impacts to receiving watercourses
- ☐ Identification of municipal drains and related approval requirements.
- ☒ Descriptions of how the conveyance and storage capacity will be achieved for the development.
- ☒ 100 year flood levels and major flow routing to protect proposed development from flooding for establishing minimum building elevations (MBE) and overall grading.

- ☐ Inclusion of hydraulic analysis including hydraulic grade line elevations.
- ☒ Description of approach to erosion and sediment control during construction for the protection of receiving watercourse or drainage corridors.
- ☐ Identification of floodplains – proponent to obtain relevant floodplain information from the appropriate Conservation Authority. The proponent may be required to delineate floodplain elevations to the satisfaction of the Conservation Authority if such information is not available or if information does not match current conditions.
- ☐ Identification of fill constraints related to floodplain and geotechnical investigation.

4.5 Approval and Permit Requirements: Checklist

The Servicing Study shall provide a list of applicable permits and regulatory approvals necessary for the proposed development as well as the relevant issues affecting each approval. The approval and permitting shall include but not be limited to the following:

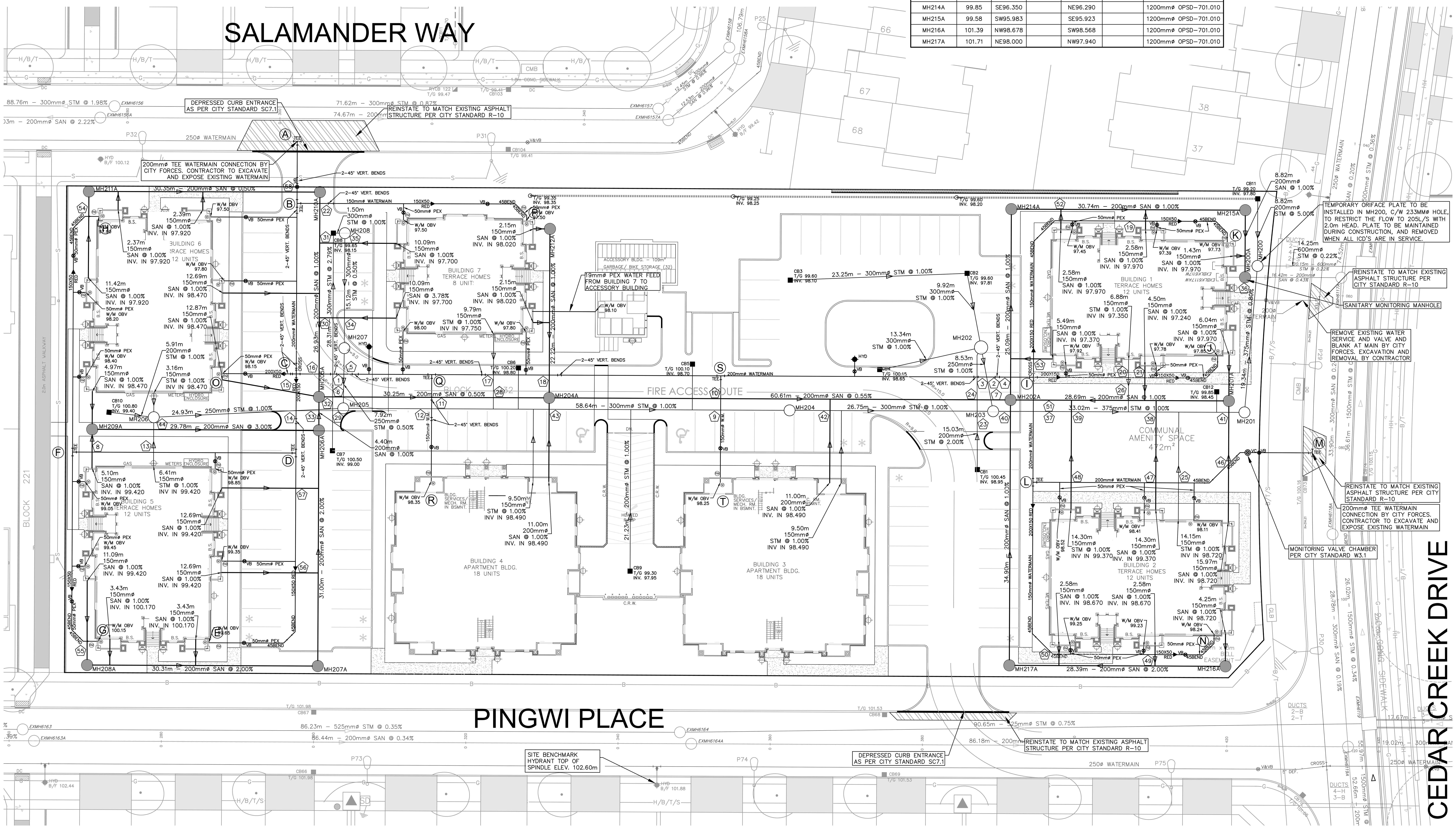
- ☐ Conservation Authority as the designated approval agency for modification of floodplain, potential impact on fish habitat, proposed works in or adjacent to a watercourse, cut/fill permits and Approval under Lakes and Rivers Improvement Act. The Conservation Authority is not the approval authority for the Lakes and Rivers Improvement Act. Where there are Conservation Authority regulations in place, approval under the Lakes and Rivers Improvement Act is not required, except in cases of dams as defined in the Act.
- ☐ Application for Certificate of Approval (CofA) under the Ontario Water Resources Act.
- ☐ Changes to Municipal Drains.
- ☐ Other permits (National Capital Commission, Parks Canada, Public Works and Government Services Canada, Ministry of Transportation etc.)

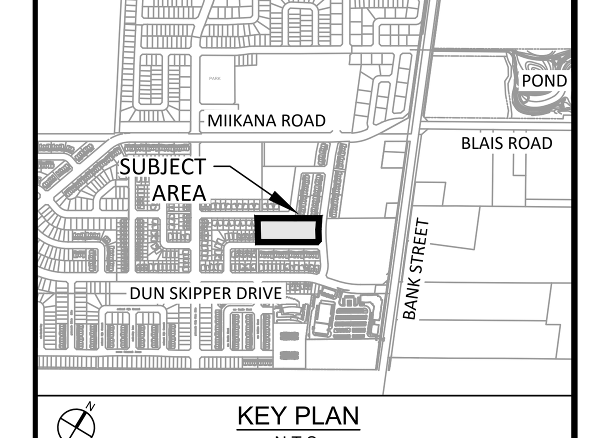
4.6 Conclusion Checklist

- ☒ Clearly stated conclusions and recommendations
- ☒ Comments received from review agencies including the City of Ottawa and information on how the comments were addressed. Final sign-off from the responsible reviewing agency.
- ☒ All draft and final reports shall be signed and stamped by a professional Engineer registered in Ontario

STM STRUCTURE TABLE						
NAME	RIM ELEV.	INVERT IN	INVERT IN AS-BUILT	INVERT OUT	INVERT OUT AS-BUILT	DESCRIPTION
EXMH6117	99.46	SE93.050 SW94.435		NW93.010		2438mm x 2438mm RECTANGULAG METRIC
MH200	99.49	SW94.467 SE96.290 NW97.359		NE94.467		1200mmø OPSD–701.010
MH201	100.26	SW96.505		NW96.445		1200mmø OPSD–701.010
MH202	100.02	NW97.708 SW98.517 S98.649		SE97.688		1200mmø OPSD–701.010
MH203	100.38	SW96.930 NW97.603		NE96.835		1200mmø OPSD–701.010
MH204	100.42	SW97.217		NE97.197		1200mmø OPSD–701.010
MH205	100.67	NW97.939 SW98.030		NE97.804		1200mmø OPSD–701.010
MH206	100.97	SW99.341 NW98.438 SE99.356		NE98.279		1200mmø OPSD–701.010
MH207	100.34	NW97.999		SE97.979		1200mmø OPSD–701.010
MH208	99.68	SW98.135		SE98.075		1200mmø OPSD–701.010

SAN STRUCTURE TABLE						
NAME	RIM ELEV.	INVERT IN	INVERT IN AS-BUILT	INVERT OUT	INVERT OUT AS-BUILT	DESCRIPTION
EXMH6117A	99.58	SE93.580 SW95.720		NW93.520		1200mmø OPSD–701.010
MH200A	99.80	NW95.834 SW95.774		NE95.774		1200mmø OPSD–701.010
MH201A	100.20	NW97.910 SE98.560		SW96.948		1200mmø OPSD–701.010
MH202A	100.36	SW96.647 NE96.661 SE97.591		NW96.601		1200mmø OPSD–701.010
MH204A	100.38	SW97.000 SE98.380 NW97.666		NE96.980		1200mmø OPSD–701.010
MH205A	100.68	SE97.172 NW97.212 W98.341		NE97.152		1200mmø OPSD–701.010
MH206A	100.66	SE97.881 SW97.276		NW97.216		1200mmø OPSD–701.010
MH207A	102.04	SW98.561		NW98.501		1200mmø OPSD–701.010
MH208A	102.46	NW99.309		NE99.167		1200mmø OPSD–701.010
MH209A	101.00	SE99.369 NW98.420		NE98.169		1200mmø OPSD–701.010
MH210A	99.85	SW97.541		SE97.481		1200mmø OPSD–701.010
MH211A	100.19	SE97.806		NE97.693		1200mmø OPSD–701.010
MH212A	100.21	SW97.998		SE97.888		1200mmø OPSD–701.010
MH214A	99.85	SE96.350		NE96.290		1200mmø OPSD–701.010
MH215A	99.58	SW95.983		SE95.923		1200mmø OPSD–701.010
MH216A	101.39	NW98.678		SW98.568		1200mmø OPSD–701.010
MH217A	101.71	NE98.000		NW97.940		1200mmø OPSD–701.010





KEY PLAN
N.T.S.

NOTES:
1. SEE DRAWING C-010, C-011 FOR ADDITIONAL DETAILS AND NOTES.
2. SITE BENCHMARK OBTAINED FROM LEGAL SURVEYOR ANNIS O'SULLIVAN VOLLEBEKK LTD. TOP SPINDLE OF HYDRANT ON PINGWI PLACE, ELEV.=102.60m

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5			
4			
3			
2			
1	ISSUED FOR SPA	DGY	2019:12:18

DCR/PHOENIX GROUP OF COMPANIES

IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title
BLOCK 232 PATHWAYS

LICENSED PROFESSIONAL ENGINEER
D. G. Yannoulopoulos
2019/XX/XX
PROVINCE OF ONTARIO

Drawing Title
SITE SERVICING PLAN

Scale
1:250

Design	Date
RM/WZ	SEPT, 2019
Drawn	Checked
DPS/WZ	DGY
Project No.	Drawing No.
121793	001

D07-XX-XX-XXXX

APPENDIX B

IBI GROUP	SANITARY SEWER DESIGN SHEET
400-333 Preston Street	Pathways Block 232
Ottawa, Ontario K1S 5N4 Canada	City of Ottawa
tel 613 225 1311 fax 613 225 9868	Pheonix Homes
ibigroup.com	

LOCATION				RESIDENTIAL										ICI AREAS								INFILTRATION ALLOWANCE			FIXED FLOW (L/s)		TOTAL FLOW	PROPOSED SEWER DESIGN						
				AREA w/ Units	UNIT TYPES				AREA w/o Units	POPULATION		RES PEAK FACTOR	PEAK FLOW	AREA (Ha)						ICI PEAK FACTOR	PEAK FLOW	AREA (Ha)		FLOW				CAPACITY	LENGTH	DIA	SLOPE	VELOCITY (full)	AVAILABLE CAPACITY	
														INSTITUTIONAL		COMMERCIAL		INDUSTRIAL																
STREET	AREA ID	FROM MH	TO MH	(Ha)	SF	SD	TH	APT	(Ha)	IND	CUM		(L/s)	IND	CUM	IND	CUM	IND	CUM		(L/s)	IND	CUM	(L/s)	IND	CUM	(L/s)	(L/s)	(m)	(mm)	(%)	(m/s)	L/s	(%)
		BLD6-A	MH209A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	4.97	150	1.00	0.871	15.84	99.72%
		BLD5-F	MH209A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	5.10	150	1.00	0.871	15.84	99.72%
	MH209A	MH209A	MH206A	0.052						0.0	7.2	3.74	0.09	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.05	0.05	0.02	0.00	0.00	0.10	59.26	29.78	200	3.00	1.828	59.16	99.82%
		BLD5-E	MH208A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	11.09	150	1.00	0.871	15.84	99.72%
		BLD5-D	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	3.43	150	1.00	0.871	15.84	99.72%
		BLD5-C	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	3.43	150	1.00	0.871	15.84	99.72%
	MH208A	MH208A	MH207A	0.032						0.0	10.8	3.73	0.13	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.03	0.03	0.01	0.00	0.00	0.14	48.39	30.31	200	2.00	1.492	48.25	99.71%
		BLD5-B	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	12.69	150	1.00	0.871	15.84	99.72%
		BLD5-A	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	12.69	150	1.00	0.871	15.84	99.72%
	MH207A	MH207A	MH206A	0.078						0.0	18.0	3.71	0.22	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.08	0.11	0.04	0.00	0.00	0.25	48.39	31.00	200	2.00	1.492	48.14	99.48%
		MH206A	MH205A							0.0	25.2	3.69	0.30	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.16	0.05	0.00	0.00	0.36	34.22	4.40	200	1.00	1.055	33.86	98.96%
		BLD6-B	MH211A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	11.42	150	1.00	0.871	15.84	99.72%
		BLD6-C	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	2.37	150	1.00	0.871	15.84	99.72%
		BLD6-D	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	2.39	150	1.00	0.871	15.84	99.72%
	MH211A	MH211A	MH210A	0.041						0.0	10.8	3.73	0.13	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.04	0.04	0.01	0.00	0.00	0.14	24.19	30.35	200	0.50	0.746	24.05	99.40%
		BLD6-E	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	12.69	150	1.00	0.871	15.84	99.72%
		BLD6-F	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	12.87	150	1.00	0.871	15.84	99.72%
		BLD7-A	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	10.09	150	1.00	0.871	15.84	99.72%
		BLD7-B	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	10.09	150	1.00	0.871	15.84	99.72%
	MH210A	MH210A	MH205A	0.080						0.0	25.2	3.69	0.30	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.08	0.12	0.04	0.00	0.00	0.34	34.22	26.93	200	1.00	1.055	33.88	99.00%
	MH205A	MH205A	MH204A						0.051	3.1	53.5	3.65	0.63	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.05	0.33	0.11	0.00	0.00	0.74	24.19	30.25	200	0.50	0.746	23.45	96.93%
		BLD4	MH204A					18		32.4	32.4	3.68	0.39	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	15.89	11.00	150	1.00	0.871	15.50	97.57%
		BLD7-D	MH212A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	2.15	150	1.00	0.871	15.84	99.72%
		BLD7-C	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	2.15	150	1.00	0.871	15.84	99.72%
	MH212A	MH212A	MH204A	0.045						0.0	7.2	3.74	0.09	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.05	0.05	0.01	0.00	0.00	0.10	34.22	22.22	200	1.00	1.055	34.11	99.70%
		BLD3	MAIN					18		32.4	32.4	3.68	0.39	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	15.89	11.00	150	1.00	0.871	15.50	97.57%
	MH204A	MH204A	MH202A	0.322						0.0	125.5	3.57	1.45	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.32	0.70	0.23	0.00	0.00	1.68	25.38	60.61	200	0.55	0.782	23.69	93.36%
		BLD2-D	MH216A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.70	0.23	0.00	0.00	0.28	15.89	4.25	150	1.00	0.871	15.61	98.27%
		BLD2-E	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.70	0.23	0.00	0.00	0.28	15.89	2.58	150	1.00	0.871	15.61	98.27%
		BLD2-F	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.70	0.23	0.00	0.00	0.28	15.89	2.58	150	1.00	0.871	15.61	98.27%
	MH216A	MH216A	MH217A	0.037						0.0	10.8	3.73	0.13	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.04	0.74	0.24	0.00	0.00	0.37	48.39	28.39	200	2.00	1.492	48.02	99.23%
	MH217A	MH217A	MH202A						0.064	3.8	14.6	3.72	0.18	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.06	0.80	0.26	0.00	0.00	0.44	34.22	34.90	200	1.00	1.055	33.78	98.71%
		BLD1-E	MH201A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	6.04	150	1.00	0.871	15.84	99.72%
		BLD1-F	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	4.50	150	1.00	0.871	15.84	99.72%
		BLD2-C	MH201A					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	15.97	150	1.00	0.871	15.84	99.72%
		BLD2-B	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	14.30	150	1.00	0.871	15.84	99.72%
		BLD2-A	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	14.30	150	1.00	0.871	15.84	99.72%
	MH201A	MH201A	MH202A	0.100						0.0	18.0	3.71	0.22	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.10	0.10	0.03	0.00	0.00	0.25	34.22	28.69	200	1.00	1.055	33.97	99.27%
		BLD1-A	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	5.49	150	1.00	0.871	15.84	99.72%
	MH202A	MH202A	MH214A	0.063						0.0	161.7	3.54	1.86	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.06	0.97	0.32	0.00	0.00	2.18	34.22	25.09	200	1.00	1.055	32.04	93.64%
		BLD1-B	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	2.58	150	1.00	0.871	15.84	99.72%
		BLD1-C	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	2.58	150	1.00	0.871	15.84	99.72%
	MH214A	MH214A	MH215A	0.029						0.0	168.9	3.54	1.94	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.03	0.99	0.33	0.00	0.00	2.27	34.22	30.74	200	1.00	1.055	31.95	93.38%
		BLD1-D	MAIN					2		3.6	3.6	3.76	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	15.89	1.43	150	1.00	0.871	15.84	99.72%
	MH215A	MH215A	MH200A	0.013						0.0	172.5	3.54	1.98	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.01	1.01	0.33	0.00	0.00	2.31	34.22	8.82	200	1.00	1.055	31.91	93.25%
	MH200A	MH200A	*EXMH6117A*							0.0	172.5	3.54	1.98	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.01	0.33	0.00	0.00	2.31	22.44	12.65	200	0.43	0.692	20.13	89.71%
				0.89	0	0	0	92	0.12	172.5	TRUE											1.01	TRUE											

Design Parameters:

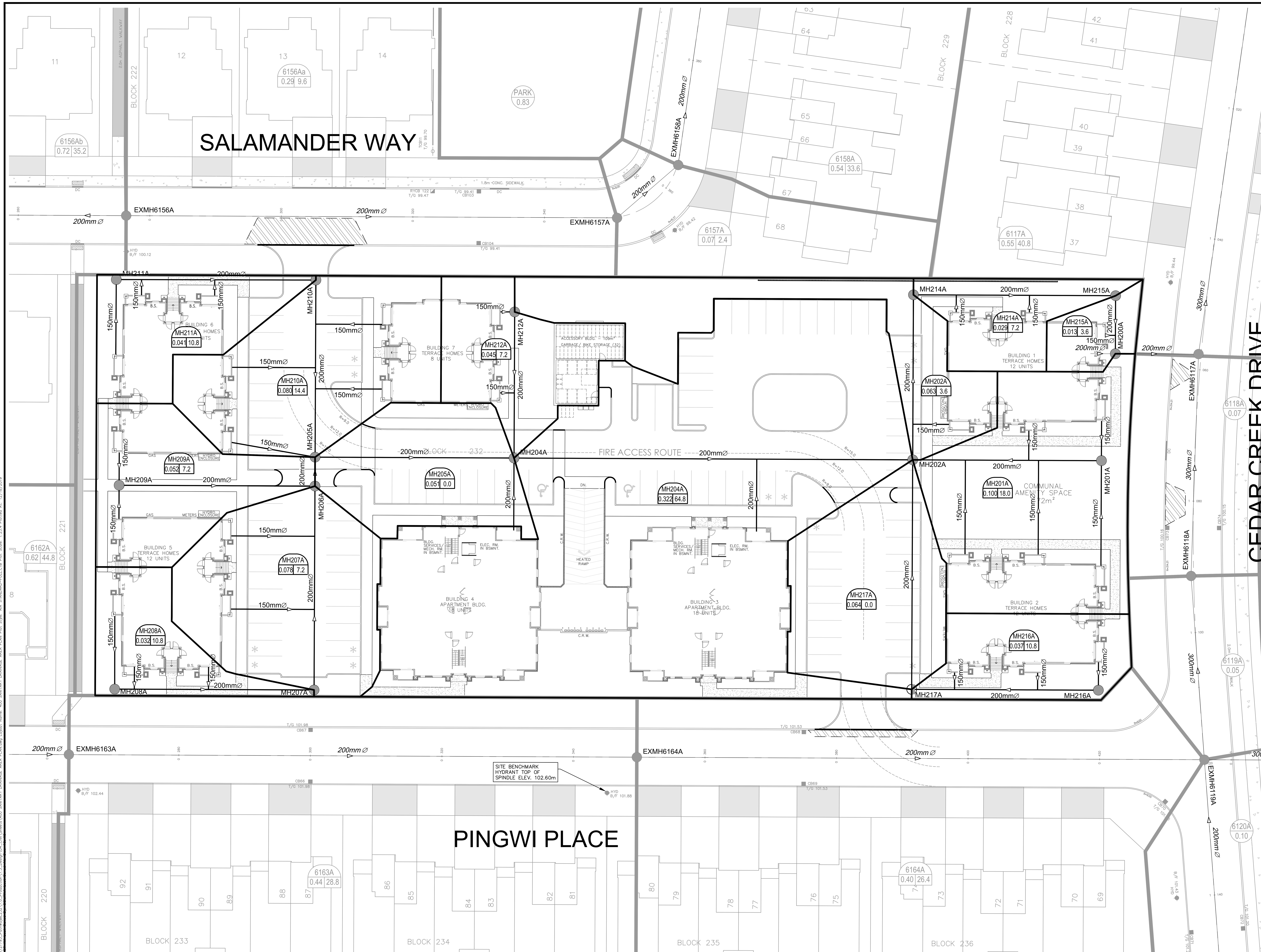
Residential			ICI Areas		
SF	3.4	p/p/u	INST	28,000	L/Ha/day
TH/SD	2.7	p/p/u	COM	28,000	L/Ha/day
APT	1.8	p/p/u	IND	35,000	L/Ha/day
Other	60	p/p/Ha		17000	L/Ha/day MOE Chart

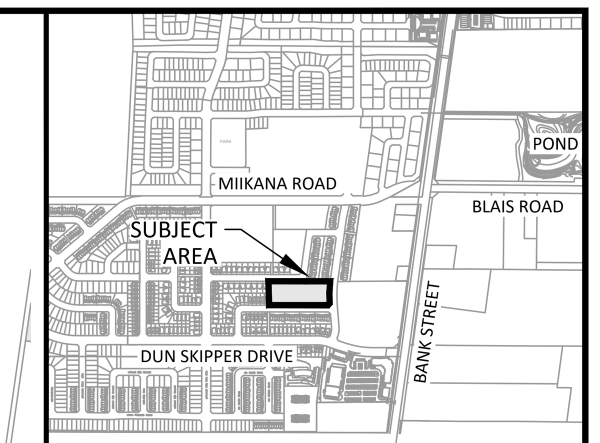
Notes:
1. Mannings coefficient (n) = 0.013
2. Demand (per capita): 280 L/day 200 L/day
3. Infiltration allowance: 0.33 L/s/Ha
4. Residential Peaking Factor:
   Harmon Formula = 1+(14/(4+(P/1000)^0.5))0.8
   where K = 0.8 Correction Factor
5. Commercial and Institutional Peak Factors based on total area,
   1.5 if greater than 20%, otherwise 1.0

Designed:	A.Z.
Checked:	R.M.
Dwg. Reference:	121793-400

No.	Revision	Date
1.	Pathways Block 232 Servicing Brief - Submission No. 1	2019-12-13

File Reference:	Date:	Sheet No:
121793.6.2.4	2019-12-13	1 of 1





KEY PLAN
N.T.S.

NOTES:
1. SEE DRAWING C-010, C-011 FOR ADDITIONAL DETAILS AND NOTES.
2. SITE BENCHMARK OBTAINED FROM LEGAL SURVEYOR ANNIS O'SULLIVAN VOLLEBEKK LTD. TOP SPINDLE OF HYDRANT ON PINGWI PLACE, ELEV.=102.60m

LEGEND :
6115A — AREA NUMBER
0.81 — AREA IN HECTARES
43.2 — POPULATION
FUTURE FLOW DIRECTION
6115A — EXISTING AREA NUMBER
0.81 — EXISTING AREA IN HECTARES
43.2 — EXISTING POPULATION
EXISTING FLOW DIRECTION

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5			
4			
3			
2			
1	ISSUED FOR SPA	DGY	2019:12:18

DCR/PHOENIX GROUP OF COMPANIES

IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title
BLOCK 232 PATHWAYS

LICENSED PROFESSIONAL ENGINEER D. G. Yannoulopoulos 2019/XX/XX PROVINCE OF ONTARIO

Drawing Title
SANITARY DRAINAGE AREA PLAN

Scale 1:250

Design	Date
RM/WZ	SEPT, 2019
Drawn	**Checked**
DPS/WZ	DGY
Project No.	**Drawing No.**
121793	400

D07-XX-XX-XXXX

IBI GROUP
400-333 Preston Street
Ottawa, Ontario K1S 5N4 Canada
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ibigroup.com

LEGEND
Red text High level sanitary sewer

SANITARY SEWER DESIGN SHEET

Remer Lands Phase 1
City of ottawa
Leitrim South Holdings Inc. (Regional Group)

LOCATION				RESIDENTIAL										ICI AREAS							INFILTRATION ALLOWANCE			FIXED FLOW (L/s)		TOTAL FLOW	PROPOSED SEWER DESIGN						
				AREA w/ Units (Ha)	UNIT TYPES				AREA w/o Units (Ha)	POPULATION		PEAK FACTOR	PEAK FLOW (L/s)	AREA (Ha)						PEAK FLOW (L/s)	AREA (Ha)		FLOW (L/s)			(L/s)	CAPACITY (L/s)	LENGTH (m)	DIA (mm)	SLOPE (%)	VELOCITY (full) (m/s)	AVAILABLE CAPACITY	
														INSTITUTIONAL		COMMERCIAL		INDUSTRIAL															
STREET	AREA ID	FROM MH	TO MH		SF	SD	TH	APT		IND	CUM			IND	CUM	IND	CUM	IND	CUM		IND	CUM		IND	CUM							L/s	(%)
Dun Skipper Road	6131C	MH6131C	MH6131A	0.45	7					22.4	22.4	4.00	0.36		0.00		0.00		0.00	0.00	0.45	0.45	0.13		0.00	0.49	39.01	43.00	200	1.30	1.203	38.52	98.75%
Dun Skipper Road	6131A	MH6131A	MH6130A	0.49	8					25.6	48.0	4.00	0.78		0.00		0.00		0.00	0.00	0.49	0.94	0.26		0.00	1.04	61.68	86.07	200	3.25	1.902	60.64	98.31%
Minikan Street	6130A	MH6130A	MH6170A	0.48	11					35.2	83.2	4.00	1.35		0.00		0.00		0.00	0.00	0.48	1.42	0.40		0.00	1.75	48.39	83.57	200	2.00	1.492	46.64	96.39%
Minikan Street	6170A	MH6170A	MH6171A	0.64	14					44.8	128.0	4.00	2.07		0.00		0.00		0.00	0.00	0.64	2.06	0.58		0.00	2.65	50.75	84.42	200	2.20	1.565	48.10	94.78%
					DRAFT 2016 UPDATED SERVICEABILITY REPORT																												
Spreadwing Way	EXT5	BLK3171AW	MH6171A	30.52						1388.8	1388.8	3.70	20.84		0.00		0.00		0.00	0.00	30.52	30.52	8.55		0.00	29.38	45.12	43.00	300	0.20	0.618	15.73	34.88%
Spreadwing Way	6171A	MH6171A	MH6183A	0.15						0.0	1516.8	3.68	22.59		0.00		0.00		0.00	0.00	0.15	32.73	9.16		0.00	31.75	45.12	83.61	300	0.20	0.618	13.36	29.62%
Minikan Street	6176A	MH6176A	MH6172A	0.43	6					19.2	19.2	4.00	0.31		0.00		0.00		0.00	0.00	0.43	0.43	0.12		0.00	0.43	29.63	66.50	200	0.75	0.914	29.20	98.54%
					DRAFT 2016 UPDATED SERVICEABILITY REPORT																												
Viceroy Mews	EXT6	BLK6172AW	MH6172A	0.83	13					41.6	41.6	4.00	0.67		0.00		0.00		0.00	0.00	0.83	0.83	0.23		0.00	0.91	20.24	41.50	200	0.35	0.624	19.34	95.52%
Minikan Street	6172A	MH6172A	MH6173A	0.15	2					6.4	67.2	4.00	1.09		0.00		0.00		0.00	0.00	0.15	1.41	0.39		0.00	1.48	20.24	27.99	200	0.35	0.624	18.76	92.67%
Minikan Street	6173A	MH6173A	MH6174A	0.18	2					6.4	73.6	4.00	1.19		0.00		0.00		0.00	0.00	0.18	1.59	0.45		0.00	1.64	20.24	11.54	200	0.35	0.624	18.61	91.91%
Minikan Street	6174A	MH6174A	MH6175B	0.58	11					35.2	108.8	4.00	1.76		0.00		0.00		0.00	0.00	0.58	2.17	0.61		0.00	2.37	20.24	68.80	200	0.35	0.624	17.87	88.29%
Minikan Street		MH6175B	MH6175A							0.0	108.8	4.00	1.76		0.00		0.00		0.00	0.00	0.00	2.17	0.61		0.00	2.37	45.12	6.00	300	0.20	0.618	42.75	94.75%
Zaatiik Grove	6180A	MH6180A	MH6181A	0.48	8					25.6	25.6	4.00	0.41		0.00		0.00		0.00	0.00	0.48	0.48	0.13		0.00	0.55	34.22	58.50	200	1.00	1.055	33.67	98.39%
Zaatiik Grove	6181A	MH6181A	MH6182A	0.22	2					6.4	32.0	4.00	0.52		0.00		0.00		0.00	0.00	0.22	0.70	0.20		0.00	0.71	34.22	11.58	200	1.00	1.055	33.50	97.91%
Zaatiik Grove	6182A	MH6182A	MH6183A	0.48	7					22.4	54.4	4.00	0.88		0.00		0.00		0.00	0.00	0.48	1.18	0.33		0.00	1.21	54.10	74.74	200	2.50	1.668	52.89	97.76%
Zaatiik Grove		MH6183A	MH6175A							0.0	1571.2	3.66	23.33		0.00		0.00		0.00	0.00	0.00	33.91	9.49		0.00	32.82	45.12	118.54	300	0.20	0.618	12.29	27.25%
Zaatiik Grove	6183A	MH6183B	MH6175D	0.67	12					38.4	38.4	4.00	0.62		0.00		0.00		0.00	0.00	0.67	0.67	0.19		0.00	0.81	37.48	103.00	200	1.20	1.156	36.67	97.84%
Zaatiik Grove		MH6175D	MH6175A							0.0	38.4	4.00	0.62		0.00		0.00		0.00	0.00	0.00	0.67	0.19		0.00	0.81	37.48	6.00	200	1.20	1.156	36.67	97.84%
Minikan Street		MH6175A	MH6106A							0.0	1718.4	3.64	25.31		0.00		0.00		0.00	0.00	0.00	36.75	10.29		0.00	35.60	45.12	85.46	300	0.20	0.618	9.51	21.09%
Minikan Street	6175A	MH6175C	MH6106B	0.58	10					32.0	32.0	4.00	0.52		0.00		0.00		0.00	0.00	0.58	0.58	0.16		0.00	0.68	28.63	69.00	200	0.70	0.883	27.95	97.62%
Minikan Street		MH6106B	MH6106A							0.0	32.0	4.00	0.52		0.00		0.00		0.00	0.00	0.00	0.58	0.16		0.00	0.68	28.63	6.00	200	0.70	0.883	27.95	97.62%
Dun Skipper Road	6132Ac	MH6132A	MH6110A	0.53	9					28.8	28.8	4.00	0.47		0.00		0.00		0.00	0.00	0.53	0.53	0.15		0.00	0.62	43.28	85.00	200	1.60	1.335	42.67	98.58%
					DRAFT 2016 UPDATED SERVICEABILITY REPORT																												
Kelly Farm Drive	EXT1		BLK6110AS	1.34						76.8	76.8	4.00	1.24		0.00		0.00		0.00	0.00	1.34	1.34	0.38										
Kelly Farm Drive	6110Aa	BLK6110AS	MH6110A	0.30	4					12.8	89.6	4.00	1.45		0.00		0.00		0.00	0.00	0.30	1.64	0.46		0.00	1.91	72.58	44.00	200	4.50	2.238	70.67	97.37%
Kelly Farm Drive	6110Ab	MH6110A	MH6109A	0.52	8					25.6	144.0	4.00	2.33		0.00		0.00		0.00	0.00	0.52	2.69	0.75		0.00	3.09	59.26	85.00	200	3.00	1.828	56.18	94.79%
Kelly Farm Drive	6109A	MH6109A	MH6108A	0.56	10					32.0	176.0	4.00	2.85		0.00		0.00		0.00	0.00	0.56	3.25	0.91		0.00	3.76	59.26	81.99	200	3.00	1.828	55.50	93.65%
Salamander Way	6156Ab	MH6156A	MH6155A	0.72	11					35.2	35.2	4.00	0.57		0.00		0.00		0.00	0.00	0.72	0.72	0.20		0.00	0.77	50.75	88.13	200	2.20	1.565	49.98	98.48%
Salamander Way	6155A	MH6155A	MH6108A	0.51	8					25.6	60.8	4.00	0.99		0.00		0.00		0.00	0.00	0.51	1.23	0.34		0.00	1.33	50.75	88.25	200	2.20	1.565	49.42	97.38%
Kelly Farm Drive	6108A	MH6108A	MH6107A	0.33	5					16.0	252.8	4.00	4.10		0.00		0.00		0.00	0.00	0.33	4.81	1.35		0.00	5.44	43.28	60.23	200	1.60	1.335	37.84	87.42%
Kelly Farm Drive	6107A	MH6107A	MH6106A	0.18	1					3.2	256.0	4.00	4.15		0.00		0.00		0.00	0.00	0.18	4.99	1.40		0.00	5.55	43.28	58.91	200	1.60	1.335	37.74	87.19%
Kelly Farm Drive	6106A	MH6106A	*EX. MH647A*	0.19						0.0	2006.4	3.58	29.14		0.00		0.00		0.00	0.00	0.19	42.51	11.90		0.00	41.04	45.12	86.86	300	0.20	0.618	4.08	9.04%
					DRAFT 2016 UPDATED SERVICEABILITY REPORT																												
Miikana Road	EXT7	BLK6105AW	*EX. MH647A*	5.74						379.2	379.2	4.00	6.14		0.00		0.00		0.00	0.00	5.74	5.74	1.61		0.00	7.75	20.24	17.00	200	0.35	0.624	12.49	61.71%

Design Parameters:

Residential			ICI Areas			Peak Factor
SF	3.2	p/p/u	INST	50,000	L/Ha/day	1.5
TH/SD	2.4	p/p/u	COM	50,000	L/Ha/day	1.5
APT	1.9	p/p/u	IND	35,000	L/Ha/day	MOE Chart
Other	43	p/p/Ha		17000	L/Ha/day	

Notes:
1. Mannings coefficient (n) = 0.013
2. Demand (per capita): 350 L/day 300 L/day
3. Infiltration allowance: 0.28 L/s/Ha
4. Residential Peaking Factor:
Harmon Formula = 1+(14/(4+P^0.5))
where P = population in thousands

Designed: WY

Checked: JM

Dwg. Reference: 501, 501A

No.	Revision	Date
1.	City Submission No. 1	11/23/2016
2.	City Submission No. 2	5/12/2017
3.	City Submission No. 3	7/5/2017
4.	Updated Street Name for MOE Submission	8/3/2017

File Reference:	Date:	Sheet No:
33956.5.7.1	5/10/2017	1 of 2

IBI GROUP
400-333 Preston Street
Ottawa, Ontario K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

LEGEND
Red text High level sanitary sewer

SANITARY SEWER DESIGN SHEET

Remer Lands Phase 1
City of ottawa
Leitrim South Holdings Inc. (Regional Group)

LOCATION				RESIDENTIAL										ICI AREAS							INFILTRATION ALLOWANCE			FIXED FLOW (L/s)		TOTAL FLOW	PROPOSED SEWER DESIGN						
STREET	AREA ID	FROM MH	TO MH	AREA w/ Units (Ha)	UNIT TYPES SF	SD	TH	APT	AREA w/o Units (Ha)	POPULATION IND	CUM	PEAK FACTOR	PEAK FLOW (L/s)	INSTITUTIONAL IND	CUM	COMMERCIAL IND	CUM	INDUSTRIAL IND	CUM	PEAK FLOW (L/s)	AREA (Ha) IND	CUM	FLOW (L/s)	IND	CUM	(L/s)	CAPACITY (L/s)	LENGTH (m)	DIA (mm)	SLOPE (%)	VELOCITY (full) (m/s)	AVAILABLE CAPACITY L/s	(%)
Dun Skipper Road	6132Aa	MH6132A	MH6133A	0.64	10					32.0	32.0	4.00	0.52		0.00		0.00		0.00	0.00	0.64	0.64	0.18		0.00	0.70	43.28	82.00	200	1.60	1.335	42.58	98.39%
					DRAFT 2016 UPDATED SERVICEABILITY REPORT																												
Street No. 7	EXT2		BLK6133AS						2.88	123.8	123.8	4.00	2.01		0.00		0.00		0.00	0.00	2.88	2.88	0.81										
Street No. 7	6133Ab	BLK6133AS	MH6133A	0.07						0.0	123.8	4.00	2.01		0.00		0.00		0.00	0.00	0.07	2.95	0.83		0.00	2.83	24.19	44.00	200	0.50	0.746	21.36	88.29%
Dun Skipper Road	6133Aa	MH6133A	MH6134A	0.58	10					32.0	187.8	4.00	3.04		0.00		0.00		0.00	0.00	0.58	4.17	1.17		0.00	4.21	37.48	72.14	200	1.20	1.156	33.27	88.76%
Dun Skipper Road	6134A	MH6134A	MH6135A	0.66	12					38.4	226.2	4.00	3.67		0.00		0.00		0.00	0.00	0.66	4.83	1.35		0.00	5.02	28.63	72.09	200	0.70	0.883	23.61	82.47%
Dun Skipper Road	6135A	MH6135A	MH6136A	0.19	3					9.6	235.8	4.00	3.82		0.00		0.00		0.00	0.00	0.19	5.02	1.41		0.00	5.23	28.63	24.81	200	0.70	0.883	23.40	81.74%
					DRAFT 2016 UPDATED SERVICEABILITY REPORT																												
Easement	EXT3	BLK6145A	MH6146A	2.50						250.8	250.8	4.00	4.06		0.00		0.00		0.00	0.00	2.50	2.50	0.70		0.00	4.76	21.64	22.70	200	0.40	0.667	16.88	77.99%
Easement		MH6146A	MH6136A							0.0	250.8	4.00	4.06		0.00		0.00		0.00	0.00	0.00	2.50	0.70		0.00	4.76	21.64	46.46	200	0.40	0.667	16.88	77.99%
					DRAFT 2016 UPDATED SERVICEABILITY REPORT																												
	EXT4	BLK6138A	MH6138A							0.0	0.0	4.00	0.00		0.00	4.07	4.07		0.00	3.53	4.07	4.07	1.14		0.00	4.67	20.24	20.00	200	0.35	0.624	15.57	76.92%
Dun Skipper Road	6138A	MH6138A	MH6137A	0.08						0.0	0.0	4.00	0.00		0.00		4.07		0.00	3.53	0.08	4.15	1.16		0.00	4.69	20.24	32.25	200	0.35	0.624	15.55	76.81%
Dun Skipper Road	6137A	MH6137A	MH6136A	0.10						0.0	0.0	4.00	0.00		0.00		4.07		0.00	3.53	0.10	4.25	1.19		0.00	4.72	20.24	44.44	200	0.35	0.624	15.52	76.67%
Cedar Creek Drive	6136A	MH6136A	MH6121A	0.04						0.0	486.6	3.98	7.85		0.00		4.07		0.00	3.53	0.04	11.81	3.31		0.00	14.69	20.24	28.03	200	0.35	0.624	5.56	27.45%
Cedar Creek Drive	6121A	MH6121A	MH6120A	0.03						0.0	486.6	3.98	7.85		0.00		4.07		0.00	3.53	0.03	11.84	3.32		0.00	14.69	20.24	12.97	200	0.35	0.624	5.55	27.41%
Cedar Creek Drive	6120A	MH6120A	MH6119A	0.10						0.0	486.6	3.98	7.85		0.00		4.07		0.00	3.53	0.10	11.94	3.34		0.00	14.72	20.24	53.29	200	0.35	0.624	5.52	27.27%
Pingwi Place	6132Ab	MH6132A	MH6161A	0.25	3					9.6	9.6	4.00	0.16		0.00		0.00		0.00	0.00	0.25	0.25	0.07		0.00	0.23	56.22	77.03	200	2.70	1.734	56.00	99.60%
Pingwi Place	6161A	MH6161A	MH6162A	0.22	3					9.6	19.2	4.00	0.31		0.00		0.00		0.00	0.00	0.22	0.47	0.13		0.00	0.44	24.19	11.41	200	0.50	0.746	23.75	98.17%
Pingwi Place	6162A	MH6162A	MH6163A	0.62	14					44.8	64.0	4.00	1.04		0.00		0.00		0.00	0.00	0.62	1.09	0.31		0.00	1.34	20.24	74.88	200	0.35	0.624	18.90	93.37%
Pingwi Place	6163A	MH6163A	MH6164A	0.44			12			28.8	92.8	4.00	1.50		0.00		0.00		0.00	0.00	0.44	1.53	0.43		0.00	1.93	20.24	86.35	200	0.35	0.624	18.31	90.46%
Pingwi Place	6164A	MH6164A	MH6119A	0.40			11			26.4	119.2	4.00	1.93		0.00		0.00		0.00	0.00	0.40	1.93	0.54		0.00	2.47	29.63	86.29	200	0.75	0.914	27.16	91.66%
Block 429	COM	BLK6119AE	MH6119A							0.0	0.0	4.00	0.00		0.00	3.01	3.01		0.00	2.61	3.01	3.01	0.84		0.00	3.46	45.12	20.00	300	0.20	0.618	41.66	92.34%
Cedar Creek Drive	6119A	MH6119A	MH6118A	0.05						0.0	605.8	3.93	9.64		0.00		7.08		0.00	6.15	0.05	16.93	4.74		0.00	20.53	45.12	28.01	300	0.20	0.618	24.58	54.49%
Cedar Creek Drive	6118A	MH6118A	MH6117A	0.07						0.0	605.8	3.93	9.64		0.00		7.08		0.00	6.15	0.07	17.00	4.76		0.00	20.55	45.12	33.76	300	0.20	0.618	24.57	54.45%
Block 443	HD1	BLK6117AW	MH6117A	1.03						129.6	129.6	4.00	2.10		0.00		0.00		0.00	0.00	1.03	1.03	0.29		0.00	2.39	20.24	20.00	200	0.35	0.624	17.85	88.20%
Cedar Creek Drive	6117A	MH6117A	MH6116A	0.55			17			40.8	776.2	3.87	12.16		0.00		7.08		0.00	6.15	0.55	18.58	5.20		0.00	23.51	45.12	75.05	300	0.20	0.618	21.60	47.89%
Cedar Creek Drive	6116A	MH6116A	MH6115A	0.52			17			40.8	817.0	3.85	12.76		0.00		7.08		0.00	6.15	0.52	19.10	5.35		0.00	24.25	59.68	67.16	300	0.35	0.818	35.43	59.36%
Salamander Way	6156Aa	MH6156A	MH6157A	0.29	3					9.6	9.6	4.00	0.16		0.00		0.00		0.00	0.00	0.29	0.29	0.08		0.00	0.24	31.55	74.63	200	0.85	0.973	31.31	99.25%
Salamander Way	6157A	MH6157A	MH6158A	0.07			1			2.4	12.0	4.00	0.19		0.00		0.00		0.00	0.00	0.07	0.36	0.10		0.00	0.30	34.22	12.28	200	1.00	1.055	33.92	99.14%
Salamander Way	6158A	MH6158A	MH6153A	0.54			14			33.6	45.6	4.00	0.74		0.00		0.00		0.00	0.00	0.54	0.90	0.25		0.00	0.99	56.22	106.46	200	2.70	1.734	55.23	98.24%
Block 436	PARK	BLK6153C	MH6153A						0.83	0.0	0.0	4.00	0.00		0.00		0.00		0.00	0.00	0.83	0.83	0.23		0.00	0.23	24.19	13.25	200	0.50	0.746	23.96	99.04%
Salamander Way	6153A	MH6153A	MH6154A	0.03						0.0	45.6	4.00	0.74		0.00		0.00		0.00	0.00	0.03	1.76	0.49		0.00	1.23	28.63	10.53	200	0.70	0.883	27.40	95.70%
Salamander Way	6154A	MH6154A	MH6115A	0.13						0.0	45.6	4.00	0.74		0.00		0.00		0.00	0.00	0.13	1.89	0.53		0.00	1.27	24.19	76.18	200	0.50	0.746	22.93	94.76%
Cedar Creek Drive	6115A	MH6115A	MH6101A	0.61			18			43.2	905.8	3.83	14.04		0.00		7.08		0.00	6.15	0.61	21.60	6.05		0.00	26.24	59.68	87.15	300	0.35	0.818	33.44	56.04%
Miikana Road	6101A	MH6101A	MH6102A	0.45			11			26.4	932.2	3.82	14.42		0.00		7.08		0.00	6.15	0.45	22.05	6.17		0.00	26.74	59.68	91.17	300	0.35	0.818	32.94	55.19%
Block 436	HD2	BLK6102AS	MH6102A	0.94						115.2	115.2	4.00	1.87		0.00		0.00		0.00	0.00	0.94	0.94	0.26		0.00	2.13	20.24	20.00	200	0.35	0.624	18.11	89.48%
Miikana Road	6102A	MH6102A	MH6103A	0.23			6			14.4	1061.8	3.78	16.27		0.00		7.08		0.00	6.15	0.23	23.22	6.50		0.00	28.92	59.68	41.44	300	0.35	0.818	30.76	51.54%
Miikana Road	6103A	MH6103A	MH6104A	0.66			18			43.2	1105.0	3.77	16.88		0.00		7.08		0.00	6.15	0.66	23.88	6.69		0.00	29.72	59.68	120.00	300	0.35	0.818	29.97	50.21%
Block 450	INST	BLK6104AS	MH6104A							0.0	0.0	4.00	0.00	2.55	2.55		0.00		0.00	2.21	2.55	2.55	0.71		0.00	2.93	20.24	20.00	200	0.35	0.624	17.32	85.54%
Miikana Road	6104A	MH6104A	MH6105B	0.60			15			36.0	1141.0	3.76	17.39		2.55		7.08		0.00	8.36	0.60	27.03	7.57		0.00	33.32	59.68	114.40	300	0.35	0.818	26.36	44.17%
Miikana Road		MH6105B	*EX. MH647A*							0.0	1141.0	3.76	17.39		2.55		7.08		0.00	8.36	0.00	27.03	7.57		0.00	33.32	45.12	8.00	300	0.20	0.618	11.80	26.15%
Kelly Farm Drive		*EX. MH647A*	*EX. MH742A*	*0.28*			*5*			*12.0*	3538.6	3.38	48.46		2.55		7.08		0.00	8.36	0.28	75.56	21.16		0.00	77.97	101.84	*80.31*	*375*	*0.31*	0.893	23.87	23.43%

Design Parameters:

Residential			ICI Areas			
SF	3.2	p/p/u				Peak Factor
TH/SD	2.4	p/p/u	INST	50,000	L/Ha/day	1.5
APT	1.9	p/p/u	COM	50,000	L/Ha/day	1.5
Other	43	p/p/Ha	IND	35,000	L/Ha/day	MOE Chart
				17000	L/Ha/day	

Notes:
1. Mannings coefficient (n) = 0.013
2. Demand (per capita): 350 L/day 300 L/day
3. Infiltration allowance: 0.28 L/s/Ha
4. Residential Peaking Factor:
Harmon Formula = 1+(14/(4+P^0.5))
where P = population in thousands

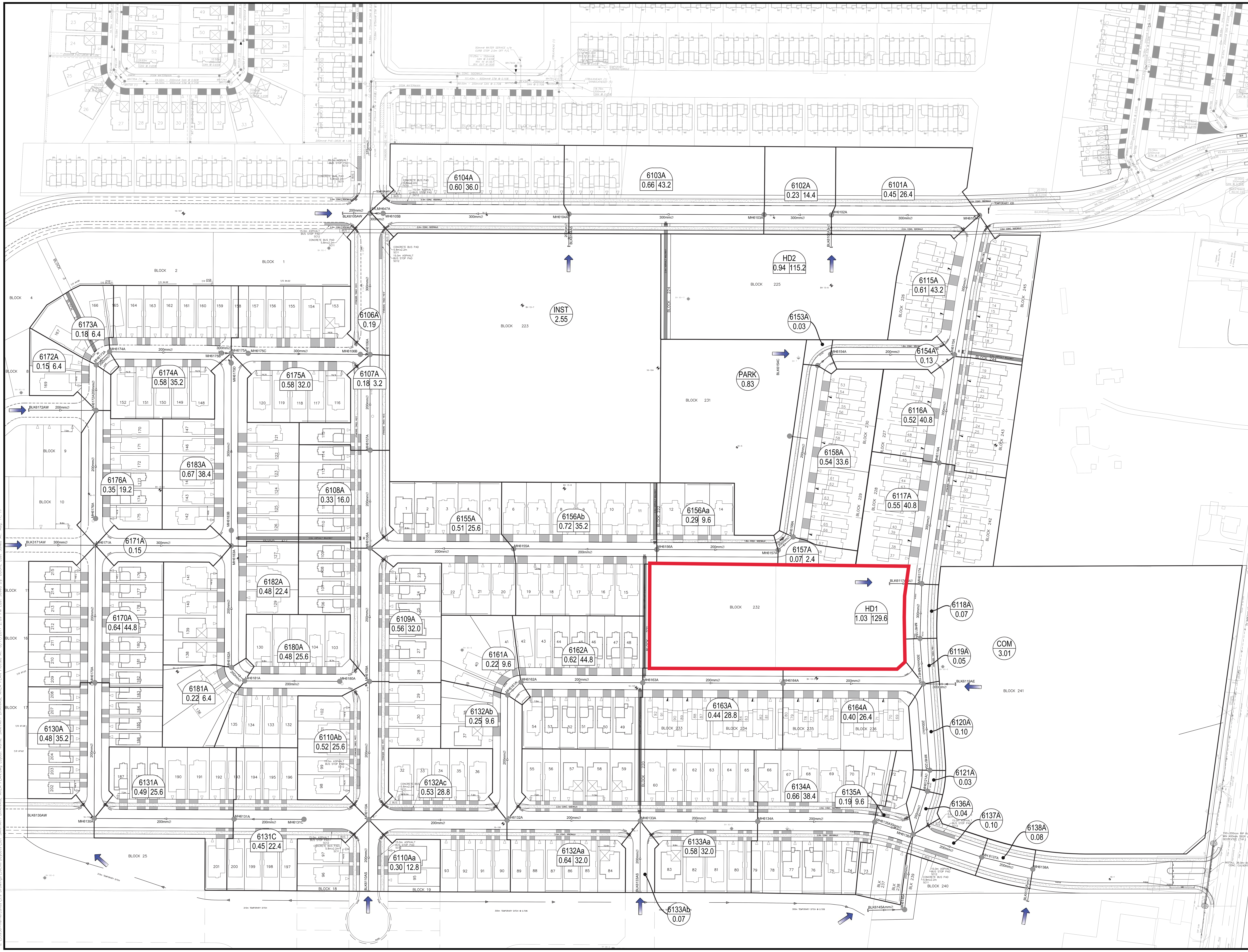
Designed: WY

Checked: JM

Dwg. Reference: 501, 501A

No.	Revision	Date
1.	City Submission No. 1	11/23/2016
2.	City Submission No. 2	5/12/2017
3.	City Submission No. 3	7/5/2017
4.	Updated Street Name for MOE Submission	8/3/2017

File Reference:	Date:	Sheet No:
33956.5.7.1	5/10/2017	2 of 2



REVIEWED BY
DEVELOPMENT REVIEW SERVICES BRANCH

Signed ____________

Date ____________ 2017

Plan Number ____________

LEGEND :

6115A	AREA NUMBER
0.81 43.2	POPULATION
	AREA IN HECTARES
➡	FUTURE FLOW DIRECTION

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5	REVISED BLOCK NUMBERS	J.I.M.	2017:08:11
4	RE-SUBMISSION FOR MOECC APPROVAL & REVISED STREET NAMES	J.I.M.	2017:08:02
3	SUBMISSION FOR MOECC APPROVAL	J.I.M.	2017:07:07
2	SUBMISSION No.2 FOR CITY REVIEW	J.I.M.	2017:05:12
1	SUBMISSION No.1 FOR CITY REVIEW	J.I.M.	2016:11:23

LEITRIM SOUTH HOLDINGS INC.

IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title

pathways at FINDLAY CREEK

LICENSED PROFESSIONAL ENGINEER
J. I. MOFFATT
2017/08/02
PROVINCE OF ONTARIO

Drawing Title

SANITARY DRAINAGE AREA PLAN

Scale 1 : 1000

Design	Date
J.I.M.	NOV 2016
Drawn	Checked
D.D.	----
Project No.	Drawing No.
33956	501

D07-16-13-0023

#17367

and trunk storm sewers included in the XPSWMM model have been compared to the USF and the results are presented in **Appendix E** for all storm events listed in **Section 4.9.1.** It should be noted that the establishment of the sanitary scenarios discussed in **Section 4.9.1**, result in slight or negligible difference in the storm HGL.

Table 4.12 Storm Hydraulic Grade Line - Local Sewers within Pathways at Findlay Creek Phase 1 for the 100 Year 3 Hour Chicago and 100 Year 3 Hour Chicago increased by 20% Storm Events

XPSWMM Node	USF (m)	Sanitary Inflow Scenario							
		100 Year 3 Hour Chicago				100 Year 3 Hour Chicago + 20%			
		Option 1		Option 2		Option 1		Option 2	
		HGL (m)*	USF–HGL (m)	HGL (m)†	USF–HGL (m)	HGL (m)*	USF–HGL (m)	HGL (m)†	USF–HGL (m)
BLK6172W	n/a	92.50	n/a	92.50	n/a	92.72	n/a	92.72	n/a
S6176	94.30	92.98	1.32	92.98	1.32	92.98	1.32	92.98	1.32
S6172	93.40	92.47	0.93	92.47	0.93	92.69	0.71	92.69	0.71
S6173	93.30	92.46	0.84	92.46	0.84	92.68	0.62	92.68	0.62
S6174	93.40	92.44	0.96	92.44	0.96	92.66	0.74	92.66	0.74
S6131B	100.90	99.93	0.97	99.93	0.97	99.93	0.97	99.93	0.97
S6131	100.20	99.20	1.00	99.20	1.00	99.20	1.00	99.20	1.00
S6130	97.10	96.38	0.72	96.38	0.72	96.38	0.72	96.38	0.72
S6170	95.70	94.64	1.06	94.64	1.06	94.64	1.06	94.64	1.06
S6180	97.55	96.30	1.25	96.30	1.25	96.30	1.25	96.30	1.25
S6181	97.00	95.86	1.14	95.86	1.14	95.86	1.14	95.86	1.14
S6182	96.85	95.73	1.12	95.73	1.12	95.73	1.12	95.73	1.12
S6132	102.40	101.16	1.24	101.16	1.24	101.16	1.24	101.16	1.24
BLK6110S	102.10	101.60	0.50	101.60	0.50	101.60	0.50	101.60	0.50
S6110	100.55	99.36	1.19	99.36	1.19	99.36	1.19	99.36	1.19
S6109	97.95	96.29	1.66	96.29	1.66	96.29	1.66	96.29	1.66
S6156	98.30	96.97	1.33	96.97	1.33	97.15	1.15	97.15	1.15
S6155	97.25	95.54	1.71	95.54	1.71	95.60	1.65	95.60	1.65
S6108	95.45	93.63	1.82	93.63	1.82	93.78	1.67	93.78	1.67
S6107	93.60	92.77	0.83	92.77	0.83	92.97	0.63	92.97	0.63
BLK6105W	n/a	91.92	n/a	91.92	n/a	92.07	n/a	92.07	n/a
S6132B	102.40	101.40	1.00	101.40	1.00	101.40	1.00	101.40	1.00
BLK6133S	n/a	100.57	n/a	100.57	n/a	100.57	n/a	100.57	n/a
S6133	101.80	100.14	1.66	100.14	1.66	100.14	1.66	100.14	1.66
S6134	100.75	99.23	1.52	99.23	1.52	99.23	1.52	99.23	1.52
S6135	100.20	98.74	1.46	98.74	1.46	98.74	1.46	98.74	1.46
BLK900	n/a	96.06	n/a	96.06	n/a	96.06	n/a	96.06	n/a
S6140	n/a	96.06	n/a	96.06	n/a	96.06	n/a	96.06	n/a

XPSWMM Node	USF (m)	Sanitary Inflow Scenario							
		100 Year 3 Hour Chicago				100 Year 3 Hour Chicago + 20%			
		Option 1		Option 2		Option 1		Option 2	
		HGL (m)*	USF– HGL (m)	HGL (m)†	USF– HGL (m)	HGL (m)*	USF– HGL (m)	HGL (m)†	USF– HGL (m)
S6139	n/a	95.91	n/a	95.91	n/a	95.92	n/a	95.92	n/a
S6138	n/a	95.86	n/a	95.86	n/a	95.86	n/a	95.86	n/a
S6137	n/a	95.80	n/a	95.80	n/a	95.81	n/a	95.81	n/a
BLK6145	100.25	98.80	1.45	98.80	1.45	98.80	1.45	98.80	1.45
S6146	n/a	98.72	n/a	98.72	n/a	98.72	n/a	98.72	n/a
S6136	n/a	95.68	n/a	95.68	n/a	95.68	n/a	95.68	n/a
S6120	n/a	94.85	n/a	94.85	n/a	94.85	n/a	94.85	n/a
S6132A	n/a	101.34	n/a	101.34	n/a	101.37	n/a	101.37	n/a
S6161	100.45	99.16	1.29	99.16	1.29	99.18	1.27	99.18	1.27
S6162	100.30	99.06	1.24	99.06	1.24	99.08	1.22	99.08	1.22
S6163	100.50	98.95	1.55	98.95	1.55	98.98	1.52	98.98	1.52
S6164	99.88	98.76	1.12	98.76	1.12	98.78	1.10	98.78	1.10
S6119	n/a	94.33	n/a	94.33	n/a	94.34	n/a	94.34	n/a
BLK6117B	n/a	94.89	n/a	94.89	n/a	94.89	n/a	94.89	n/a
S6117	n/a	94.11	n/a	94.11	n/a	94.11	n/a	94.11	n/a
S6116	96.03	92.84	3.19	92.84	3.19	92.85	3.18	92.85	3.18
S6156B	98.00	96.77	1.23	96.77	1.23	96.77	1.23	96.77	1.23
S6157	n/a	96.13	n/a	96.13	n/a	96.14	n/a	96.14	n/a
S6158	96.93	95.97	0.96	95.97	0.96	95.97	0.96	95.97	0.96
S6153	94.83	93.02	1.81	93.02	1.81	93.02	1.81	93.02	1.81
S6154	n/a	92.86	n/a	92.86	n/a	92.86	n/a	92.86	n/a
S6115	94.71	92.35	2.36	92.35	2.36	92.35	2.36	92.35	2.36

Notes: * HGL results for Option 1 were taken from the results of the XPSWMM model entitled 34738-20170630-MOE1-3CHI100.out or 34738-20170630-MOE1-3CHI120.out and presented on the CD in **Appendix E**.
† HGL results for Option 2 were taken from the results of the XPSWMM model entitled 34738-20170630-MOE2-3CHI100.out or 34738-20170630-MOE2-3CHI120.out and presented on the CD in **Appendix E**.

IBI GROUP

SANITARY HYDRAULIC GRADE LINE DESIGN SHEET
PATHWAYS BLOCK 232
CITY OF OTTAWA
PHOENIX HOMES

JOB #: 121793 - 6.2
DATE: 2019-12-13
DESIGN: W.Z. & R.M.
CHECKED: D.G.Y.
REV #: -

BLK6117 in Cedar Creek Drive to MH200A

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**BLK6117**	**200A**	
INVERT ELEVATION (m)	95.720	95.774	
OBVERT ELEVATION (m)	95.920	95.974	
DIAMETER (mm)			200
LENGTH (m)			12.7
FLOW (l/s)			2.23
HGL (m) ***	**94.890**	**94.891**	**0.001**
MANHOLE COEF K= 0.75	LOSS (m)	0.000	
TOTAL HGL (m)		**95.816**	
MAX. SURCHARGE (mm)		**-158**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	0.430	0.05	0.68	21.42

HYDRAULIC SLOPE = 7.320 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.104
DESIGN FLOW DEPTH = 0.042

Head loss in manhole simplified method p. 71 (MWDM)
fig1.7.1, Kratio = 0.75 for 45 bends K_L=0.75
Velocity = Flow / Area = 0.07 m/s
$HL = K_L * V^2 / 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**200A**	**215A**	
INVERT ELEVATION (m)	95.834	95.923	
OBVERT ELEVATION (m)	96.034	96.123	
DIAMETER (mm)			200
LENGTH (m)			8.8
FLOW (l/s)			2.22
HGL (m) ***	**95.816**	**95.816**	**0.000**
MANHOLE COEF K= 0.75	LOSS (m)	0.000	
TOTAL HGL (m)		**95.957**	
MAX. SURCHARGE (mm)		**-166**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.05	32.93

HYDRAULIC SLOPE = 1.599 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.067
DESIGN FLOW DEPTH = 0.034

Head loss in manhole simplified method p. 71 (MWDM)
fig1.7.1, Kratio = 0.75 for 45 bends K_L=0.75
Velocity = Flow / Area = 0.07 m/s
$HL = K_L * V^2 / 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**215A**	**214A**	
INVERT ELEVATION (m)	95.983	96.290	
OBVERT ELEVATION (m)	96.183	96.490	
DIAMETER (mm)			200
LENGTH (m)			30.7
FLOW (l/s)			2.17
HGL (m) ***	**95.957**	**95.958**	**0.001**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**96.324**	
MAX. SURCHARGE (mm)		**-166**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.76

HYDRAULIC SLOPE = 1.194 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.066
DESIGN FLOW DEPTH = 0.034

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.07 m/s
$HL = K_L * V^2 / 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**214A**	**202A**	
INVERT ELEVATION (m)	96.350	96.601	
OBVERT ELEVATION (m)	96.550	96.801	
DIAMETER (mm)			200
LENGTH (m)			25.1
FLOW (l/s)			2.07
HGL (m) ***	**96.324**	**96.325**	**0.001**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**96.635**	
MAX. SURCHARGE (mm)		**-166**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.79

HYDRAULIC SLOPE = 1.240 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.063
DESIGN FLOW DEPTH = 0.034

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.07 m/s
$HL = K_L * V^2 / 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**202A**	**201A**	
INVERT ELEVATION (m)	96.661	96.948	
OBVERT ELEVATION (m)	96.861	97.148	
DIAMETER (mm)			200
LENGTH (m)			28.7
FLOW (l/s)			0.45
HGL (m) ***	**96.635**	**96.635**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**96.964**	
MAX. SURCHARGE (mm)		**-184**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.79

HYDRAULIC SLOPE = 1.147 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.014
DESIGN FLOW DEPTH = 0.016

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
$HL = K_L * V^2 / 2g$

IBI GROUP

SANITARY HYDRAULIC GRADE LINE DESIGN SHEET
PATHWAYS BLOCK 232
CITY OF OTTAWA
PHOENIX HOMES

JOB #: 121793 - 6.2
DATE: 2019-12-13
DESIGN: W.Z. & R.M.
CHECKED: D.G.Y.
REV #: -

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**202A**	**217A**	
INVERT ELEVATION (m)	97.591	97.940	
OBVERT ELEVATION (m)	97.791	98.140	
DIAMETER (mm)			200
LENGTH (m)			34.9
FLOW (l/s)			0.28
HGL (m) ***	**96.635**	**96.635**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**97.952**	
MAX. SURCHARGE (mm)		**-188**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.78

HYDRAULIC SLOPE = 3.774 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.009
DESIGN FLOW DEPTH = 0.012

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**217A**	**216A**	
INVERT ELEVATION (m)	98.000	98.568	
OBVERT ELEVATION (m)	98.200	98.768	
DIAMETER (mm)			200
LENGTH (m)			28.4
FLOW (l/s)			0.27
HGL (m) ***	**97.952**	**97.952**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**98.578**	
MAX. SURCHARGE (mm)		**-190**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	2.000	0.05	1.48	46.37

HYDRAULIC SLOPE = 2.205 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.006
DESIGN FLOW DEPTH = 0.010

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**202A**	**204A**	
INVERT ELEVATION (m)	96.647	96.980	
OBVERT ELEVATION (m)	96.847	97.180	
DIAMETER (mm)			200
LENGTH (m)			53.3
FLOW (l/s)			1.55
HGL (m) ***	**96.635**	**96.636**	**0.001**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**97.012**	
MAX. SURCHARGE (mm)		**-168**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	0.550	0.05	0.82	25.90

HYDRAULIC SLOPE = 0.707 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.060
DESIGN FLOW DEPTH = 0.032

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.05 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**204A**	**212A**	
INVERT ELEVATION (m)	97.666	97.888	
OBVERT ELEVATION (m)	97.866	98.088	
DIAMETER (mm)			200
LENGTH (m)			22.2
FLOW (l/s)			0.18
HGL (m) ***	**97.012**	**97.012**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**97.898**	
MAX. SURCHARGE (mm)		**-190**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.77

HYDRAULIC SLOPE = 3.987 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.005
DESIGN FLOW DEPTH = 0.010

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**204A**	**205A**	
INVERT ELEVATION (m)	97.000	97.152	
OBVERT ELEVATION (m)	97.200	97.352	
DIAMETER (mm)			200
LENGTH (m)			30.3
FLOW (l/s)			0.68
HGL (m) ***	**97.012**	**97.012**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**97.174**	
MAX. SURCHARGE (mm)		**-178**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	0.500	0.05	0.74	23.24

HYDRAULIC SLOPE = 0.536 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.029
DESIGN FLOW DEPTH = 0.022

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.02 m/s
$HL = K_L * V^2/ 2g$

IBI GROUP

SANITARY HYDRAULIC GRADE LINE DESIGN SHEET
PATHWAYS BLOCK 232
CITY OF OTTAWA
PHOENIX HOMES

JOB #: 121793 - 6.2
DATE: 2019-12-13
DESIGN: W.Z. & R.M.
CHECKED: D.G.Y.
REV #: -

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**205A**	**210A**	
INVERT ELEVATION (m)	97.212	97.481	
OBVERT ELEVATION (m)	97.412	97.681	
DIAMETER (mm)			200
LENGTH (m)			26.9
FLOW (l/s)			0.36
HGL (m) ***	**97.174**	**97.174**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**97.495**	
MAX. SURCHARGE (mm)		**-186**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.76

HYDRAULIC SLOPE = 1.192 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.011
DESIGN FLOW DEPTH = 0.014

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
HL = K_L * V^2/ 2g

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**210A**	**211A**	
INVERT ELEVATION (m)	97.541	97.693	
OBVERT ELEVATION (m)	97.741	97.893	
DIAMETER (mm)			200
LENGTH (m)			30.4
FLOW (l/s)			0.18
HGL (m) ***	**97.495**	**97.495**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**97.705**	
MAX. SURCHARGE (mm)		**-188**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	0.500	0.05	0.74	23.20

HYDRAULIC SLOPE = 0.692 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.008
DESIGN FLOW DEPTH = 0.012

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
HL = K_L * V^2/ 2g

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**205A**	**206A**	
INVERT ELEVATION (m)	97.172	97.216	
OBVERT ELEVATION (m)	97.372	97.416	
DIAMETER (mm)			200
LENGTH (m)			4.4
FLOW (l/s)			0.35
HGL (m) ***	**97.174**	**97.174**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**97.230**	
MAX. SURCHARGE (mm)		**-186**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.78

HYDRAULIC SLOPE = 1.273 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.011
DESIGN FLOW DEPTH = 0.014

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
HL = K_L * V^2/ 2g

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**206A**	**209A**	
INVERT ELEVATION (m)	97.276	98.169	
OBVERT ELEVATION (m)	97.476	98.369	
DIAMETER (mm)			200
LENGTH (m)			29.8
FLOW (l/s)			0.09
HGL (m) ***	**97.230**	**97.230**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**98.173**	
MAX. SURCHARGE (mm)		**-196**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	3.000	0.05	1.81	56.77

HYDRAULIC SLOPE = 3.167 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.002
DESIGN FLOW DEPTH = 0.004

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.00 m/s
HL = K_L * V^2/ 2g

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**206A**	**207A**	
INVERT ELEVATION (m)	97.881	98.501	
OBVERT ELEVATION (m)	98.081	98.701	
DIAMETER (mm)			200
LENGTH (m)			31.0
FLOW (l/s)			0.23
HGL (m) ***	**97.230**	**97.230**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**98.509**	
MAX. SURCHARGE (mm)		**-192**	

MANNING FORMULA - FLOWING FULL						
DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	2.000	0.05	1.48	46.36

HYDRAULIC SLOPE = 4.126 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.005
DESIGN FLOW DEPTH = 0.008

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.01 m/s
HL = K_L * V^2/ 2g

SANITARY HYDRAULIC GRADE LINE DESIGN SHEET
PATHWAYS BLOCK 232
CITY OF OTTAWA
PHOENIX HOMES

JOB #: 121793 - 6.2
DATE: 2019-12-13
DESIGN: W.Z. & R.M.
CHECKED: D.G.Y.
REV #: -

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**207A**	**208A**	
INVERT ELEVATION (m)	98.561	99.167	
OBVERT ELEVATION (m)	98.761	99.367	
DIAMETER (mm)			200
LENGTH (m)			30.3
FLOW (l/s)			0.13
HGL (m) ***	**98.509**	**98.509**	**0.000**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**99.173**	
MAX. SURCHARGE (mm)		**-194**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	2.000	0.05	1.48	46.35

HYDRAULIC SLOPE =	2.191 %
DESIGN FLOW TO FULL FLOW RATIO (Q/	0.003
DESIGN FLOW DEPTH =	0.006

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.00 m/s
$HL = K_L * V^2 / 2g$

Cedar Creek Drive Sanitary HGL has no negative impact on the proposed development.

APPENDIX C

IBI GROUP
400-333 Preston Street
Ottawa, Ontario K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

STORM SEWER DESIGN SHEET

Pathways Block 232
City of Ottawa
Phoenix Homes

LOCATION				AREA (Ha)										RATIONAL DESIGN FLOW															SEWER DATA								
STREET	AREA ID	FROM	TO	C= 0.20	C= 0.25	C= 0.40	C= 0.50	C= 0.57	C= 0.65	C= 0.69	C= 0.70	C= 0.75	C= 0.90	IND 2.78AC	CUM 2.78AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (2) (mm/hr)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	2yr PEAK FLOW (L/s)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	100yr PEAK FLOW (L/s)	FIXED FLOW (L/s)	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	W	H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (2yr) (L/s)	(%)
	CB10	CB10	MH206									0.029		0.06	0.06	10.00	0.09	10.09	76.81	104.19	122.14	178.56	4.64	6.30	7.39	10.80		4.64	34.22	5.91	200			1.00	1.055	29.57	86.43%
		MH206	MH205											0.00	0.06	10.09	0.34	10.43	76.45	103.70	121.56	177.71	4.62	6.27	7.35	10.75		4.62	62.04	24.93	250			1.00	1.224	57.42	92.55%
	CB7	CB7	CB8										0.100	0.25	0.25	10.00	0.20	10.20	76.81	104.19	122.14	178.56	19.22	26.07	30.56	44.68		19.22	168.51	28.31	300			2.79	2.309	149.29	88.60%
	CB8	CB8	MH208										0.086	0.22	0.47	10.20	0.02	10.22	76.03	103.13	120.88	176.71	35.38	47.99	56.26	82.24		35.38	100.88	1.50	300			1.00	1.383	65.50	64.93%
		MH208	MH207											0.00	0.47	10.22	0.26	10.48	75.96	103.03	120.77	176.55	35.35	47.95	56.21	82.16		35.35	71.62	15.12	300			0.50	0.982	36.27	50.64%
		MH207	MH205											0.00	0.47	10.48	0.15	10.63	75.01	101.73	119.24	174.29	34.91	47.34	55.49	81.11		34.91	43.87	7.92	250			0.50	0.866	8.96	20.42%
	CB6	CB6	MAIN										0.074	0.19	0.19	10.00	0.06	10.06	76.81	104.19	122.14	178.56	14.22	19.29	22.61	33.06		14.22	48.39	5.12	200			2.00	1.492	34.17	70.61%
	UNC CB9	CB9	MAIN										0.038	0.10	0.10	10.00	0.34	10.34	76.81	104.19	122.14	178.56	7.30	9.91	11.61	16.98		7.30	34.22	21.23	200			1.00	1.055	26.91	78.66%
	CB5	CB5	MAIN										0.054	0.14	0.14	10.00	0.06	10.06	76.81	104.19	122.14	178.56	10.38	14.08	16.50	24.12		10.38	48.39	5.72	200			2.00	1.492	38.01	78.56%
		MH205	MH204											0.00	0.94	10.63	0.71	11.34	74.46	100.97	118.35	172.98	70.08	95.03	111.38	162.81		70.08	100.88	58.64	300			1.00	1.383	30.80	30.53%
																														0.00							
		MH204	MH203											0.00	0.94	11.34	0.32	11.66	72.02	97.62	114.40	167.18	67.78	91.87	107.67	157.35		67.78	100.88	26.75	300			1.00	1.383	33.10	32.81%
	CB3	CB3	CB2										0.037	0.09	0.09	10.00	0.28	10.28	76.81	104.19	122.14	178.56	7.11	9.65	11.31	16.53		7.11	100.88	23.25	300			1.00	1.383	93.77	92.95%
	CB2	CB2	MH 202										0.066	0.17	0.26	10.28	0.12	10.40	75.75	102.74	120.42	176.04	19.52	26.48	31.03	45.37		19.52	100.88	9.92	300			1.00	1.383	81.36	80.65%
	CB1 & CB4	MH 202	MH203										0.119	0.30	0.56	10.40	0.12	10.52	75.30	102.13	119.71	174.98	41.83	56.73	66.49	97.19		41.83	62.04	8.53	250			1.00	1.224	20.21	32.58%
	CB12	MH203	MH201				0.084							0.12	1.61	11.66	0.34	12.00	70.97	96.17	112.69	164.68	114.49	155.16	181.81	265.69		114.49	182.91	33.02	375			1.00	1.604	68.42	37.40%
		MH201	MH200											0.00	1.61	12.00	0.22	12.23	69.88	94.68	110.94	162.10	112.74	152.75	178.98	261.53		112.74	163.60	19.34	375			0.80	1.435	50.86	31.09%
	CB11	CB11	MH200				0.119							0.17	0.17	10.00	0.06	10.06	76.81	104.19	122.14	178.56	12.70	17.23	20.20	29.54		12.70	76.51	8.82	200			5.00	2.359	63.81	83.40%
		MH200	*EXMH6117*											0.00	1.78	12.23	0.23	12.46	69.19	93.73	109.82	160.46	123.07	166.73	195.35	285.43		123.07	301.81	14.25	600			0.22	1.034	178.74	59.22%
												TOTAL	0.806	1.78	TRUE																						

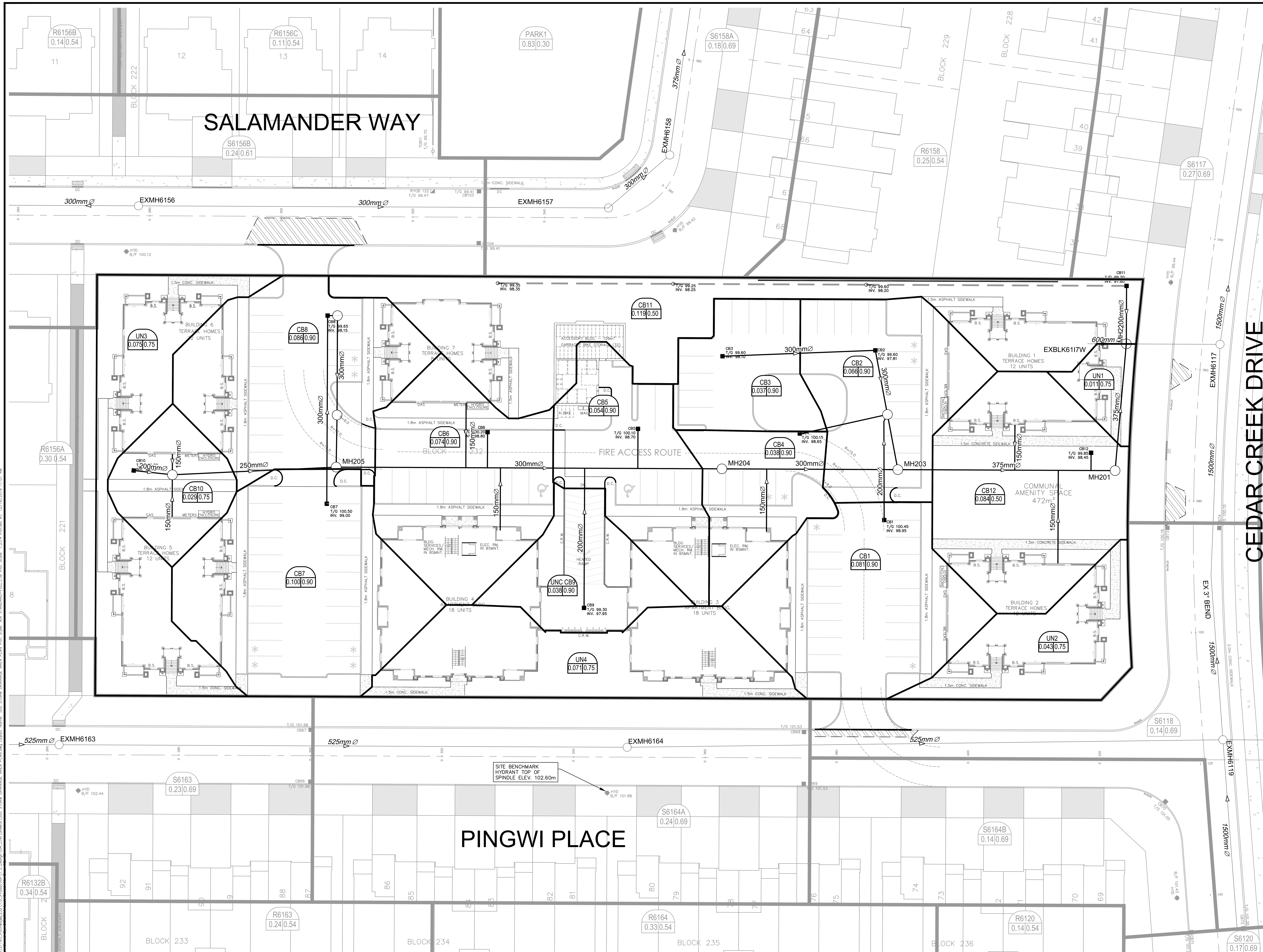
Definitions:
Q = 2.78CiA, where:
Q = Peak Flow in Litres per Second (L/s)
A = Area in Hectares (Ha)
i = Rainfall intensity in millimeters per hour (mm/hr)
[i = 732.951 / (TC+6.199)^0.810] 2 YEAR
[i = 998.071 / (TC+6.053)^0.814] 5 YEAR
[i = 1174.184 / (TC+6.014)^0.816] 10 YEAR
[i = 1735.688 / (TC+6.014)^0.820] 100 YEAR

Notes:
1. Mannings coefficient (n) = 0.013

Designed: W.Z.
Checked: R.M.
Dwg. Reference: 121793-500

No.	Revision	Date
1.	Pathways Block 232 Servicing Brief - Submission No. 1	2019-12-13

File Reference:	Date:	Sheet No:
121793.6.2.4	2019-12-13	1 of 1



KEY PLAN

N.T.S.

NOTES:

1. SEE DRAWING C-010, C-011 FOR ADDITIONAL DETAILS AND NOTES.

2. SITE BENCHMARK OBTAINED FROM LEGAL SURVEYOR ANNIS O'SULLIVAN VOLLEBEKK LTD. TOP SPINDLE OF HYDRANT ON PINGWI PLACE, ELEV.=102.60m

LEGEND :

- 6115A / 0.81 / 0.25 — AREA NUMBER; RUNOFF COEFFICIENT; AREA IN HECTARES
- FUTURE FLOW DIRECTION
- 6115A / 0.81 / 0.35 — EXISTING AREA NUMBER; EXISTING RUNOFF COEFFICIENT; AREA IN HECTARES
- EXISTING FLOW DIRECTION

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5			
4			
3			
2			
1	ISSUED FOR SPA	DGY	2019:12:18

DCR/PHOENIX GROUP OF COMPANIES

IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title

BLOCK 232 PATHWAYS

LICENSED PROFESSIONAL ENGINEER D. G. Yannoulopoulos 2019/XX/XX PROVINCE OF ONTARIO

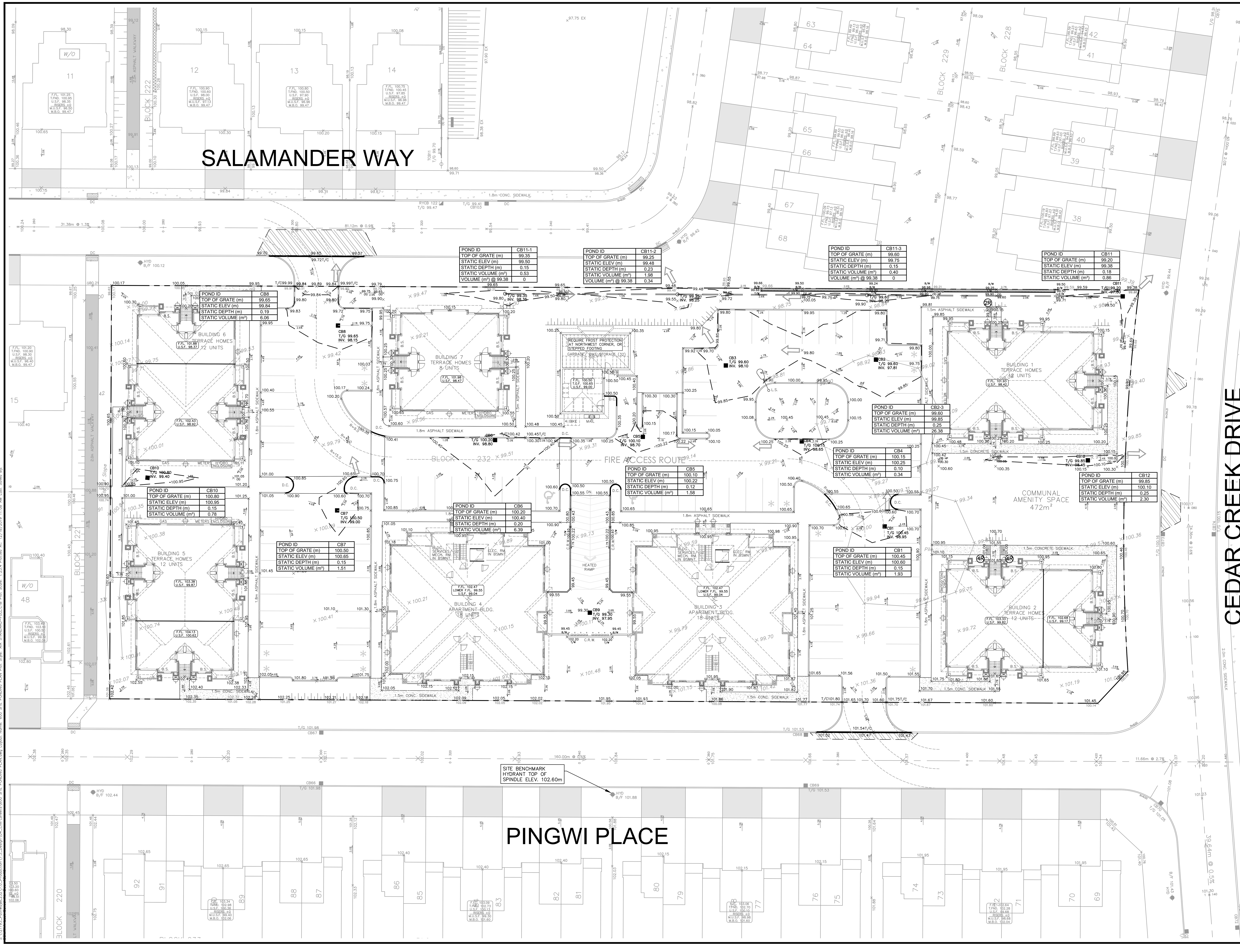
Drawing Title

STORM DRAINAGE AREA PLAN

Scale 1:250

Design	RM/WZ	Date	SEPT, 2019
Drawn	DPS/WZ	Checked	DGY
Project No.	121793	Drawing No.	500

D07-XX-XX-XXXX



POND ID	CB11-1
TOP OF GRATE (m)	99.35
STATIC ELEV (m)	99.50
STATIC DEPTH (m)	0.15
STATIC VOLUME (m³)	0.53
VOLUME (m³) @ 99.38	0

POND ID	CB11-2
TOP OF GRATE (m)	99.25
STATIC ELEV (m)	99.48
STATIC DEPTH (m)	0.23
STATIC VOLUME (m³)	1.98
VOLUME (m³) @ 99.38	0.34

POND ID	CB11-3
TOP OF GRATE (m)	99.60
STATIC ELEV (m)	99.75
STATIC DEPTH (m)	0.15
STATIC VOLUME (m³)	0.40
VOLUME (m³) @ 99.38	0

POND ID	CB11
TOP OF GRATE (m)	99.20
STATIC ELEV (m)	99.38
STATIC DEPTH (m)	0.18
STATIC VOLUME (m³)	0.86

POND ID	CB8
TOP OF GRATE (m)	99.65
STATIC ELEV (m)	99.84
STATIC DEPTH (m)	0.19
STATIC VOLUME (m³)	6.06

POND ID	CB2-3
TOP OF GRATE (m)	99.60
STATIC ELEV (m)	99.85
STATIC DEPTH (m)	0.25
STATIC VOLUME (m³)	26.38

POND ID	CB4
TOP OF GRATE (m)	100.15
STATIC ELEV (m)	100.25
STATIC DEPTH (m)	0.10
STATIC VOLUME (m³)	0.34

POND ID	CB5
TOP OF GRATE (m)	100.10
STATIC ELEV (m)	100.22
STATIC DEPTH (m)	0.12
STATIC VOLUME (m³)	1.58

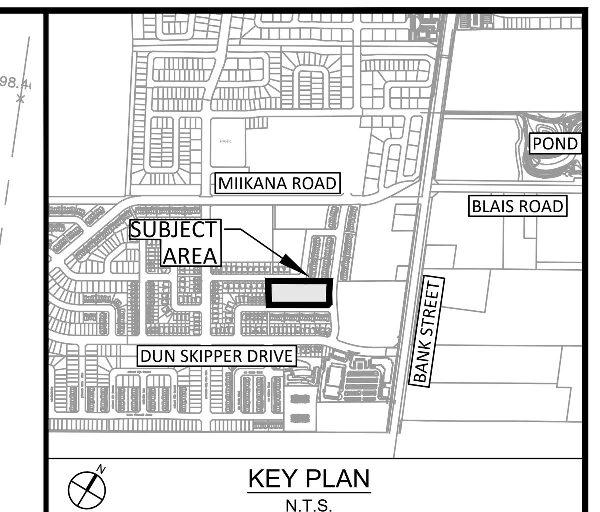
POND ID	CB12
TOP OF GRATE (m)	99.85
STATIC ELEV (m)	100.10
STATIC DEPTH (m)	0.25
STATIC VOLUME (m³)	2.30

POND ID	CB10
TOP OF GRATE (m)	100.80
STATIC ELEV (m)	100.95
STATIC DEPTH (m)	0.15
STATIC VOLUME (m³)	0.78

POND ID	CB6
TOP OF GRATE (m)	100.20
STATIC ELEV (m)	100.40
STATIC DEPTH (m)	0.20
STATIC VOLUME (m³)	6.39

POND ID	CB7
TOP OF GRATE (m)	100.50
STATIC ELEV (m)	100.65
STATIC DEPTH (m)	0.15
STATIC VOLUME (m³)	1.51

POND ID	CB1
TOP OF GRATE (m)	100.45
STATIC ELEV (m)	100.60
STATIC DEPTH (m)	0.15
STATIC VOLUME (m³)	1.93



KEY PLAN
N.T.S.

NOTES:
1. SEE DRAWING C-010, C-011 FOR ADDITIONAL DETAILS AND NOTES.
2. SITE BENCHMARK OBTAINED FROM LEGAL SURVEYOR ANNIS O'SULLIVAN VOLLEBEKK LTD. TOP SPINDLE OF HYDRANT ON PINGWI PLACE, ELEV.=102.60m

No.	REVISIONS	By	Date
14			
13			
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2			
1	ISSUED FOR SPA	DGY	2019:12:18

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Project Title
BLOCK 232
PATHWAYS

LICENSED PROFESSIONAL ENGINEER
D. G. Yannoulopoulos
2019/XX/XX
PROVINCE OF ONTARIO

Drawing Title
SITE PONDING PLAN

Scale
1:250

Design	Date
RM/WZ	SEPT, 2019
Drawn	**Checked**
DPS/WZ	DGY
Project No.	**Drawing No.**
121793	600

D07-XX-XX-XXXX

IBI GROUP
400-333 Preston Street
Ottawa, Ontario K1S 5N4 Canada
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LEGEND
Black text 5 year event curve design
Red text 10 year event curve design (Earl Armstrong Road)

STORM SEWER DESIGN SHEET

Pathways at FINDLAY CREEK
City of Ottawa
Leitrim South Holdings Inc. (Regional Group)

LOCATION				AREA (Ha)										RATIONAL DESIGN FLOW													SEWER DATA								
STREET	AREA ID	FROM	TO	C= 0.15	C= 0.30	C= 0.40	C= 0.54	C= 0.61	C= 0.65	C= 0.69	C= 0.71	C= 0.75	C= 0.80	IND 2.78AC	CUM 2.78AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	100yr PEAK FLOW (L/s)	FIXED FLOW (L/s)	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	W	H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (5yr) (L/s)	(%)
	EXT 1			DRAFT 2016 UPDATED SERVICEABILITY REPORT											0.92			11.23																	
Kelly Farm Drive	S6110B	BLK6110S	MH6110					0.33						0.56	1.48	11.23	0.26	11.49	98.12	114.98	168.05	145.17				145.17	214.00	45.00	300			4.50	2.933	68.83	32.16%
Dun Skipper Road	S6132A, R6132D	MH6132	MH6110				0.11	0.21						0.52	0.52	10.00	0.67	10.67	104.19	122.14	178.56	54.31				54.31	231.37	82.00	375			1.60	2.029	177.06	76.53%
Kelly Farm Drive	S6110A	MH6110	MH6109					0.29						0.49	2.49	11.49	0.47	11.96	96.95	113.61	166.03	241.66				241.66	515.17	88.69	450			3.00	3.138	273.51	53.09%
Kelly Farm Drive	R6109	MH6109	MH6108				0.31							0.47	2.96	11.96	0.45	12.41	94.88	111.18	162.45	280.66				280.66	515.17	85.00	450			3.00	3.138	234.51	45.52%
Salamander Way	S6156A, R6156A-B	MH6156	MH6155				0.44	0.21						1.02	1.02	10.00	0.76	10.76	104.19	122.14	178.56	105.93				105.93	142.67	88.69	300			2.00	1.955	36.74	25.75%
Salamander Way	S6155A-B, R6155	MH6155	MH6108				0.54	0.43						1.54	2.56	10.76	0.74	11.50	100.36	117.63	171.93	256.58				256.58	325.82	88.07	450			1.20	1.985	69.25	21.25%
Kelly Farm Drive	S6108A-B,R6108A-B	MH6108	MH6107				0.46	0.36						1.30	6.82	12.41	0.44	12.85	92.99	108.95	159.18	633.76				633.76	1,109.24	79.65	675			1.60	3.003	475.48	42.87%
Kelly Farm Drive	S6107	MH6107	MH6106					0.25						0.42	7.24	12.85	0.23	13.08	91.21	106.86	156.12	660.34				660.34	1,109.24	41.01	675			1.60	3.003	448.90	40.47%
Dun Skipper Road	R6131B	MH6131B	MH6131				0.54							0.81	0.81	10.00	0.49	10.49	104.19	122.14	178.56	84.46				84.46	115.02	46.00	300			1.30	1.576	30.56	26.57%
Dun Skipper Road	S6131A-B	MH6131	MH6130					0.49						0.83	1.64	10.49	0.50	10.98	101.69	119.20	174.23	166.94				166.94	329.75	86.07	375			3.25	2.892	162.81	49.37%
Minikan Street	S6130, R6130	MH6130	MH6170				0.10	0.25						0.57	2.22	10.98	0.52	11.51	99.28	116.35	170.05	219.96				219.96	420.63	80.58	450			2.00	2.562	200.67	47.71%
Minikan Street	S6170, R6170	MH6170	MH6171				0.25	0.36						0.99	3.20	11.51	0.55	12.06	96.86	113.50	165.87	310.08				310.08	441.17	88.94	450			2.20	2.687	131.08	29.71%
	EXT 6			DRAFT 2016 UPDATED SERVICEABILITY REPORT											62.99			24.12																	
Spreadwing Way		BLK3171W	MH6171											0.00	62.99	24.12	0.34	24.46	62.34	72.92	106.33	3,926.53				3,926.53	7,005.73	40.00	2100			0.15	1.959	3079.20	43.95%
Spreadwing Way	S6171, R6171	MH6171	MH6183				0.32	0.15						0.73	66.92	24.46	0.71	25.17	61.77	72.25	105.35	4,134.00				4,134.00	7,005.73	83.00	2100			0.15	1.959	2871.73	40.99%
Zaatiik Grove		MH6180	MH6181											0.00	0.00	10.00	0.74	10.74	104.19	122.14	178.56	0.00				0.00	100.88	61.25	300			1.00	1.383	100.88	100.00%
Zaatiik Grove	S6181, R6181	MH6181	MH6182				0.47	0.29						1.20	1.20	10.74	0.12	10.86	100.45	117.73	172.08	120.27				120.27	182.91	11.82	375			1.00	1.604	62.64	34.25%
Zaatiik Grove	S6182, R6182	MH6182	MH6183				0.31	0.20						0.80	2.00	10.86	0.52	11.38	99.85	117.03	171.05	199.90				199.90	289.21	79.10	375			2.50	2.537	89.31	30.88%
Zaatiik Grove	S6183A-B, R6183	MH6183	MH6175				0.26	0.38						1.03	69.96	25.17	1.01	26.17	60.63	70.91	103.39	4,241.85				4,241.85	7,005.73	118.56	2100			0.15	1.959	2763.88	39.45%
Minikan Street	S6176, R6176A-B	MH6176	MH6172				0.46	0.05						0.78	0.78	10.00	0.83	10.83	104.19	122.14	178.56	80.79				80.79	158.41	69.50	375			0.75	1.389	77.62	49.00%
	EXT 7			DRAFT 2016 UPDATED SERVICEABILITY REPORT											1.50			12.90																	
Viceroy Mews		BLK6172W	MH6172											0.00	1.50	12.90	0.74	13.64	91.02	106.63	155.78	136.64				136.64	200.65	40.00	525			0.20	0.898	64.01	31.90%
Minikan Street	S6172	MH6172	MH6173					0.11						0.19	2.46	13.64	0.53	14.17	88.22	103.33	150.94	217.28				217.28	402.33	27.82	750			0.12	0.882	185.04	45.99%
Minikan Street	S6173, R6173	MH6173	MH6174				0.40	0.31						1.13	3.59	14.17	0.22	14.39	86.34	101.13	147.71	309.91				309.91	402.33	11.80	750			0.12	0.882	92.41	22.97%
Minikan Street		MH6174	MH6175											0.00	3.59	14.39	1.38	15.77	85.58	100.23	146.38	307.16				307.16	402.33	73.12	750			0.12	0.882	95.16	23.65%
Minikan Street	S6175	MH6175	MH6106					0.18						0.31	73.86	26.17	0.78	26.95	59.08	69.10	100.73	4,363.59				4,363.59	7,005.73	91.44	2100			0.15	1.959	2642.14	37.71%
Kelly Farm Drive	S6106, R6106	MH6106	MH6105				0.27	0.24						0.81	81.91	26.95	0.74	27.69	57.95	67.76	98.78	4,746.28				4,746.28	7,005.73	86.86	2100			0.15	1.959	2259.45	32.25%
	EXT 8			DRAFT 2016 UPDATED SERVICEABILITY REPORT											12.34			18.40																	
Miikana Road		BLK6105W	MH6105											0.00	12.34	18.40	0.25	18.65	73.97	86.58	126.36	913.03				913.03	1,575.26	20.00	1200			0.15	1.349	662.23	42.04%
Miikana Road	S6105A-C	MH6105	MH6104							0.48				0.92	95.17	27.69	1.12	28.81	56.91	66.55	97.00	5,416.41				5,416.41	8,166.82	117.89	2400			0.10	1.749	2750.41	33.68%
Block 450	INST	BLK6102S	MH6104									2.55		5.32	5.32	12.00	0.25	12.25	94.70	110.96	162.13	503.47				503.47	636.13	21.00	750			0.30	1.395	132.66	20.85%
Miikana Road	S6104A-B	MH6104	MH6103							0.32				0.61	0.61	0.00	1.14	1.14	230.48	271.61	398.62	141.48				141.48	8,166.82	119.43	2400			0.10	1.749	8025.35	98.27%
Miikana Road	S6103	MH6103	MH6102							0.16				0.31	95.48	28.81	0.40	29.21	55.42	64.79	94.42	5,290.92				5,290.92	8,166.82	42.00	2400			0.10	1.749	2875.90	35.21%
Block 436	HD2	BLK6102S	MH6102										0.94	2.09	2.09	12.00	0.36	12.36	94.70	110.96	162.13	197.97				197.97	286.47	21.00	600			0.20	0.982	88.50	30.89%
Miikana Road	S6102A-B, R6102	MH6102	MH6101				0.12			0.32				0.79	98.36	29.21	0.92	30.13	54.90	64.19	93.54	5,400.36				5,400.36	8,166.82	96.27	2400			0.10	1.749	2766.46	33.87%

Definitions:
Q = 2.78CiA, where:
Q = Peak Flow in Litres per Second (L/s)
A = Area in Hectares (Ha)
i = Rainfall intensity in millimeters per hour (mm/hr)
[i = 998.071 / (TC+6.053)^0.814] 5 YEAR
[i = 1174.184 / (TC+6.014)^0.816] 10 YEAR
[i = 1735.688 / (TC+6.014)^0.820] 100 YEAR

Notes:
1. Mannings coefficient (n) = 0.013

Designed: W.Y.
Checked: J.M.
Dwg. Reference: 500, 500A

No.	Revision	Date
1.	City Submission No. 1	11/23/2016
2.	City Submission No. 2	5/12/2017
3.	City Submission No. 3	7/6/2017
4.	Updated Street Name for MOE Submission	8/3/2017

File Reference:	Date:	Sheet No:
33956.5.7.1	5/10/2017	1 of 2

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LEGEND
Black text 5 year event curve design
Red text 10 year event curve design (Earl Armstrong Road)

STORM SEWER DESIGN SHEET

Pathways at FINDLAY CREEK
City of Ottawa
Leitrim South Holdings Inc. (Regional Group)

LOCATION				AREA (Ha)										RATIONAL DESIGN FLOW													SEWER DATA									
STREET	AREA ID	FROM	TO	C= 0.15	C= 0.30	C= 0.40	C= 0.54	C= 0.61	C= 0.65	C= 0.69	C= 0.71	C= 0.75	C= 0.80	IND 2.78AC	CUM 2.78AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	100yr PEAK FLOW (L/s)	FIXED FLOW (L/s)	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	W	H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (5yr) (L/s)	(%)
	EXT 2			DRAFT 2016 UPDATED SERVICEABILITY REPORT											4.92			12.88																	
Street No. 7	S6133B	BLK6133S	MH6133					0.20						0.34	5.25	12.88	0.33	13.21	91.10	106.72	155.91	478.64				478.64	1,296.87	47.00	825			0.75	2.350	818.23	63.09%
Dun Skipper Road	S6132B, R6132A, R6132C	MH6132	MH6133				0.70	0.20						1.39	1.39	10.00	1.04	11.04	104.19	122.14	178.56	144.83				144.83	149.72	82.07	375			0.67	1.313	4.89	3.27%
Dun Skipper Road	S6133A, R6133	MH6133	MH6134				0.16	0.30						0.75	7.39	13.21	0.40	13.61	89.81	105.21	153.69	663.99				663.99	1,640.43	71.48	825			1.20	2.973	976.44	59.52%
Dun Skipper Road	R6134	MH6134	MH6135				0.20							0.30	7.69	13.61	0.52	14.13	88.32	103.45	151.12	679.48				679.48	1,580.10	74.61	900			0.70	2.406	900.63	57.00%
Dun Skipper Road	S6135	MH6135	MH6136					0.18						0.31	8.00	14.13	0.20	14.33	86.47	101.28	147.93	691.68				691.68	1,580.10	28.36	900			0.70	2.406	888.43	56.23%
				DRAFT 2016 UPDATED SERVICEABILITY REPORT																															
				DRAFT 2016 UPDATED SERVICEABILITY REPORT																															
	EXT 4	BLK900	MH6140									4.04		8.42	16.42	15.74	0.16	15.90	81.24	95.13	138.90	1,334.13				1,742.71	2,490.17	16.00	1350			0.20	1.685	747.46	30.02%
	EXT 5	BLK900	MH6140									2.06		4.30	4.30	15.74	0.16	15.90	81.24	95.13	138.90		408.58			1,742.71	2,490.17	16.00	1350			0.20	1.685	747.46	30.02%
Dun Skipper Road	S6140A-C	MH6140	MH6139							0.22				0.42	16.84	15.90	0.73	16.63	80.76	94.57	138.07	1,360.38				1,766.55	2,156.55	64.00	1350			0.15	1.460	390.00	18.08%
		MH6140	MH6139											0.00	4.30	15.90	0.73	16.63	80.76	94.57	138.07		406.17			1,766.55	2,156.55	64.00	1350			0.15	1.460	390.00	18.08%
Dun Skipper Road	S6139	MH6139	MH6138							0.08				0.15	17.00	16.63	0.38	17.01	78.64	92.07	134.41	1,336.66				1,732.10	2,156.55	33.27	1350			0.15	1.460	424.45	19.68%
		MH6139	MH6138											0.00	4.30	16.63	0.38	17.01	78.64	92.07	134.41		395.44			1,732.10	2,156.55	33.27	1350			0.15	1.460	424.45	19.68%
Dun Skipper Road	S6138	MH6138	MH6137							0.08				0.15	17.15	17.01	0.38	17.39	77.58	90.83	132.59	1,330.61				1,720.72	2,156.55	33.26	1350			0.15	1.460	435.83	20.21%
		MH6138	MH6137											0.00	4.30	17.01	0.38	17.39	77.58	90.83	132.59		390.11			1,720.72	2,156.55	33.26	1350			0.15	1.460	435.83	20.21%
Dun Skipper Road		MH6137	MH6136											0.00	17.15	17.39	0.46	17.84	76.56	89.62	130.82	1,313.04				1,697.97	2,156.55	39.90	1350			0.15	1.460	458.57	21.26%
		MH6137	MH6136											0.00	4.30	17.39	0.46	17.84	76.56	89.62	130.82		384.93			1,697.97	2,156.55	39.90	1350			0.15	1.460	458.57	21.26%
Temp Ditch		DI 1	BLK6145		6.71									5.60	5.60	49.35	0.01	49.36	38.01	44.39	64.57	212.72				212.72	448.66	1.00	525			1.00	2.008	235.93	52.59%
				DRAFT 2016 UPDATED SERVICEABILITY REPORT																															
Easement	EXT 3	BLK6145	MH6146									2.50		5.21	9.51	12.00	0.26	12.26	94.70	110.96	162.13	900.33				900.33	1,280.55	25.77	975			0.30	1.662	380.22	29.69%
Easement	S6146	MH6146	MH6136					0.21						0.36	9.86	12.26	0.52	12.77	93.61	109.68	160.25	923.30				923.30	1,280.55	51.42	975			0.30	1.662	357.24	27.90%
Cedar Creek Drive		MH6136	BEND6121											0.00	35.01	17.84	0.23	18.08	75.37	88.22	128.77	2,638.86				3,017.79	3,297.98	25.33	1500			0.20	1.808	280.19	8.50%
		BEND6121	MH6120											0.00	35.01	18.08	0.12	18.20	74.77	87.52	127.74	2,618.06				2,993.99	3,297.98	13.56	1500			0.20	1.808	303.99	9.22%
		MH6136	BEND6121											0.00	4.30	17.84	0.23	18.08	75.37	88.22	128.77		378.93			3,017.79	3,297.98	25.33	1500			0.20	1.808	280.19	8.50%
		BEND6121	MH6120											0.00	4.30	18.08	0.12	18.20	74.77	87.52	127.74		375.93			2,993.99	3,297.98	13.56	1500			0.20	1.808	303.99	9.22%
Cedar Creek Drive	S6120, R6120	MH6120	MH6119				0.14			0.17				0.54	35.55	18.08	0.52	18.60	74.77	87.52	127.74	2,658.16				3,034.08	3,297.98	56.40	1500			0.20	1.808	263.90	8.00%
		MH6120	MH6119											0.00	4.30	18.08	0.52	18.60	74.77	87.52	127.74		375.93			3,034.08	3,297.98	56.40	1500			0.20	1.808	263.90	8.00%
Pingwi Place	S6132C, R6132B	MH6132	MH6161				0.34	0.17						0.80	0.80	10.00	0.64	10.64	104.19	122.14	178.56	83.22				83.22	101.94	76.86	250			2.70	2.012	18.72	18.37%
Pingwi Place		MH6161	MH6162											0.00	0.80	10.64	0.12	10.76	100.95	118.32	172.94	80.62				80.62	182.91	11.65	375			1.00	1.604	102.29	55.92%
Pingwi Place	S6162	MH6162	MH6163					0.21						0.36	1.15	10.76	1.39	12.14	100.35	117.62	171.92	115.89				115.89	200.65	74.71	525			0.20	0.898	84.76	42.24%
Pingwi Place	S6163, R6163	MH6163	MH6164				0.24			0.23				0.80	1.96	12.14	1.21	13.36	94.08	110.24	161.07	184.05				184.05	265.43	86.36	525			0.35	1.188	81.37	30.66%
Pingwi Place	S6164A-B, R6164	MH6164	MH6119				0.33			0.38				1.22	3.18	13.36	0.87	14.22	89.27	104.58	152.76	283.94				283.94	388.55	90.57	525			0.75	1.739	104.60	26.92%
Block 429	COM	BLK6119	MH6119									3.01		6.28	6.28	12.00	0.22	12.22	94.70	110.96	162.13	594.30				594.30	844.60	17.00	900			0.20	1.286	250.30	29.64%
Cedar Creek Drive	S6118	MH6119	BEND6118							0.14				0.27	45.27	18.60	0.19	18.79	73.49	86.01	125.53	3,327.09				3,696.53	4,039.18	25.02	1500			0.30	2.214	342.66	8.48%
		BEND6118	MH6117											0.00	45.27	18.79	0.26	19.05	73.03	85.48	124.74	3,306.54				3,673.69	4,039.18	35.20	1500			0.30	2.214	365.50	9.05%
		MH6119	BEND6118											0.00	4.30	18.60	0.19	18.79	73.49	86.01	125.53		369.43			3,696.53	4,039.18	25.02	1500			0.30	2.214	342.66	8.48%
		BEND6118	MH6117											0.00	4.30	18.79	0.26	19.05	73.03	85.48	124.74		367.14			3,673.69	4,039.18	35.20	1500			0.30	2.214	365.50	9.05%
Block 443	HD1	BLK6117W	MH6117										1.02	2.27	2.27	12.00	0.30	12.30	94.70	110.96	162.13	214.82				214.82	320.28	20.00	600			0.25	1.097	105.46	32.93%
Cedar Creek Drive	S6117	MH6117	MH6116							0.27				0.52	48.06	19.05	0.51	19.56	72.41	84.74	123.66	3,479.86				3,843.83	4,362.82	73.12	1500			0.35	2.392	518.99	11.90%
		MH6117	MH6116											0.00	4.30	19.05	0.50	19.56	72.41	84.74	123.66		363.97			3,843.83	4,362.82	72.31	1500			0.35	2.392	518.99	11.90%
Cedar Creek Drive	S6116, R6116A-B	MH6116	MH6115				0.27			0.34				1.06	49.12	19.56	0.41	19.97	71.23	83.36	121.64	3,498.73				3,856.77	5,214.57	69.61	1500			0.50	2.859	1357.80	26.04%
Cedar Creek Drive		MH6116	MH6115											0.00	4.30	19.56	0.40	19.96	71.23	83.36	121.64		358.04			3,856.77	5,214.57	69.28	1500			0.50	2.859	1357.80	26.04%
Salamander Way	S6156B, R6156C	MH6156	MH6157				0.11	0.24						0.57	0.57	10.00	0.93	10.93	104.19	122.14	178.56	59.61				59.61	93.01	71.45	300			0.85	1.275	33.40	35.91%
Salamander Way		MH6157	MH6158											0.00	0.57	10.93	0.15	11.08	99.50	116.62	170.45	56.93				56.93	100.88	12.31	300			1.00	1.383	43.95	43.57%
Salamander Way	S6158A-B, R6158	MH6158	MH6153				0.25			0.35				1.05	1.62	11.08	0.67	11.75	98.80	115.79	169.23	159.94				159.94	300.55	105.99	375			2.70	2.636	140.61	46.78%
Block 438 (Park)	PARK1	BLK6153B	MH6153		0.83									0.69	0.69	11.00	0.16	11.16	99.19	116.25	169.91	68.66				68.66	100.88	13.00	300			1.00	1.383	32.22	31.94%
Salamander Way		MH6153	MH6154											0.00	2.31	11.75	0.13	11.88	95.76	112.22	163.98	221.31				221.31	248.85	11.90	450			0.70	1.516	27.54	11.07%
Salamander Way	S6154, R6154	MH6154	MH6115				0.26			0.16				0.70	3.01	11.88	0.86	12.75	95.20	111.55	163.00	286.37				286.37	452.94	80.33	600			0.50	1.552	166.57	36.78%
Cedar Creek Drive	S6115	MH6115	MH6101							0.33				0.63	52.76	19.97	0.51	20.48	70.32	82.30	120.08	3,710.31				4,063.81	5,214.57	88.17	1500			0.50	2.859	1150.76	22.07%
Cedar Creek Drive		MH6115	MH6101											0.00	4.30	19.96	0.52	20.48	70.33	82.30	120.08		353.50			4,063.81	5,214.57	88.50	1500			0.50	2.859	1150.76	22.07%
Miikana Road	S6101A-B,R6101	MH6101	BLK6101				0.15			0.14				0.49	151.62	30.13	0.23	30.36	53.77	62.86	91.59	8,151.91				8,421.89	12,912.88	38.34	2400			0.25	2.765	4490.99	34.78%
Miikana Road		MH6101	BLK6101											0.00	4.30	30.13	0.23	30.36	53.77	62.86	91.59		269.98			8,421.89	12,912.88	38.34	2400			0.25	2.765	4490.99	34.78%
Dun Skipper culvert				31.15										12.99	12.99	92.20	0.39	92.59	23.84	27.80	40.35	309.73				309.73	452.94	36.00	600			0.50	1.552	143.21	31.62%

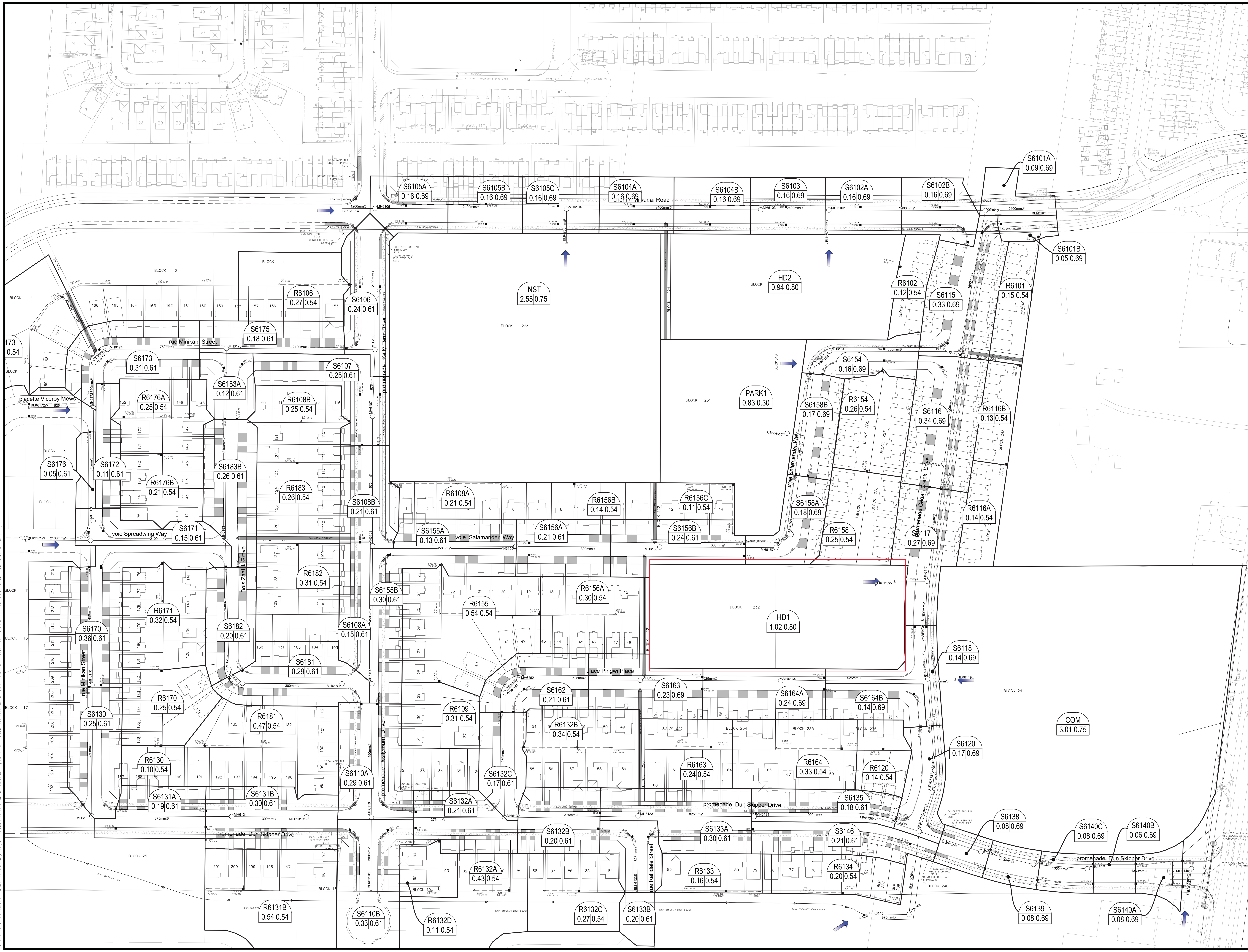
Definitions:
Q = 2.78CiA, where:
Q = Peak Flow in Litres per Second (L/s)
A = Area in Hectares (Ha)
i = Rainfall intensity in millimeters per hour (mm/hr)
[i = 998.071 / (TC+6.053)^0.814] 5 YEAR
[i = 1174.184 / (TC+6.014)^0.816] 10 YEAR
[i = 1735.688 / (TC+6.014)^0.820] 100 YEAR

Notes:
1. Mannings coefficient (n) = 0.013

Designed: W.Y.
Checked: J.M.
Dwg. Reference: 500, 500A

No.	Revision	Date
1.	City submission No. 1	11/23/2016
2.	City Submission No. 2	5/12/2017
3.	City Submission No. 3	7/6/2017
4.	Updated Street Name for MOE Submission	8/3/2017

File Reference:	Date:	Sheet No:
33956.5.7.1	5/10/2017	2 of 2



REVIEWED BY
DEVELOPMENT REVIEW SERVICES BRANCH

Signed ______________________

Date ______________________ 2017

Plan Number ______________________

LEGEND :

S168 — AREA NUMBER
2.01 0.69 — RUNOFF COEFFICIENT / AREA IN HECTARES
FUTURE MINOR FLOW DIRECTION

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5	REVISED BLOCK NUMBERS	J.I.M.	2017:08:11
4	RE-SUBMISSION FOR MOECC APPROVAL & REVISED STREET NAMES	J.I.M.	2017:08:02
3	SUBMISSION FOR MOECC APPROVAL	J.I.M.	2017:07:07
2	SUBMISSION No.2 FOR CITY REVIEW	J.I.M.	2017:05:12
1	SUBMISSION No.1 FOR CITY REVIEW	J.I.M.	2016:11:23

LEITRIM SOUTH HOLDINGS INC.

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ibigroup.com

Project Title

pathways at FINDLAY CREEK

LICENSED PROFESSIONAL ENGINEER J. I. MOFFATT 2017/08/02 PROVINCE OF ONTARIO

Drawing Title

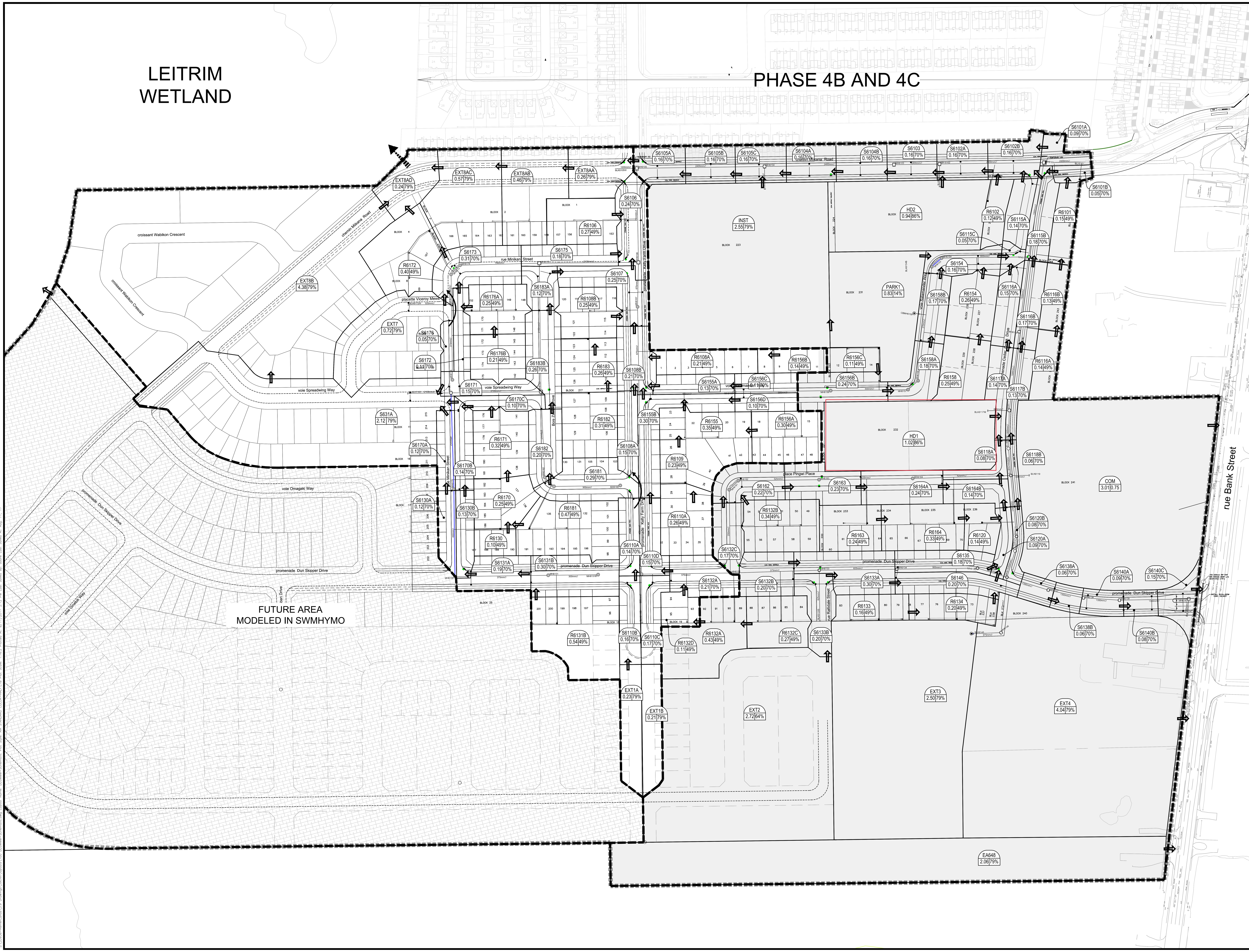
STORM DRAINAGE AREA PLAN

Scale 1 : 1000

Design	Date
J.I.M.	NOV 2016
Drawn	**Checked**
D.D.	----
Project No.	**Drawing No.**
33956	500

D07-16-13-0023

#17367



LEGEND:

- PHASE 1 EAST DRAINAGE AREA MODELED IN DDSWMM
- PHASE 1 WEST DRAINAGE AREA MODELED IN DDSWMM
- FUTURE DRAINAGE AREA MODELED IN DDSWMM
- PHASE 1 DRAINAGE BOUNDARY
- DDSWMM MODELS DRAINAGE BOUNDARIES
- SUBCATCHMENT DRAINAGE BOUNDARY
- AREA ID (S208)
- Imp (%)/Tp.(hr) (0.19 | 71)
- AREA (ha)
- MAJOR FLOW
- MAJOR FLOW TO WETLAND

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5	REVISED BLOCK NUMBERS	D.D.	2017:08:11
4	RE-SUBMISSION FOR MOECC APPROVAL & REVISED STREET NAMES	R.B.	2017:08:02
3	SUBMISSION FOR MOECC APPROVAL	R.B.	2017:07:07
2	SUBMISSION NO.2 FOR CITY REVIEW	R.B.	2017:05:12
1	SUBMISSION NO.1 FOR CITY REVIEW	R.B.	2016:11:23

LEITRIM SOUTH HOLDINGS INC.

IBI GROUP
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Project Title

pathways at FINDLAY CREEK

LICENSED PROFESSIONAL ENGINEER
R.F.D. BROWN
100078940
2017/08/02
PROVINCE OF ONTARIO

Drawing Title

DDSWMM SCHEMATIC

Scale

1:1500

Design	Date
R.B.	NOV 2016
Drawn	Checked
J.F.	R.B.
Project No.	Drawing No.
33956	700

D07-XX-XX-XXXX

#17367

† Pathways at Findlay Creek Phase 1 West modeled flow is from the DDSWMM output file 33956-PH1W-3CHI2.out, 33956-PH1W-3CHI5.out and 33956-PH1W-3CHI100.out which are all presented on the CD in **Appendix E**.

The assigned size of the inlet control devices (ICDs) for the subject site was optimized using DDSWMM. ICDs are incorporated into the stormwater management design to protect the minor system from surcharge during major storm events. The ICDs used for Phase 1 are provided on **Drawing 010**. It should be noted that due to the increased minor system capture at low points flow, there were a few instances where the flow restriction into the minor system was the capacity of the CB inlet. These include one CB on S6115B, one CB on S6183A, one CB on S6107 (indicated in bold in **Table 4.4**). Calculations demonstrating the capacity of the CBs within a road sag is presented in **Appendix E**. In addition, there are two instances where the CB lead is the restriction for the inflow to the minor system. These include S6115B and S6155B. Calculations supporting the lead size for the inflow restriction are provided in **Appendix E**.

For those areas within Phase 1 which will require a separate site stormwater design and analysis, the following table summarizes the assumed inflow rate and minimum on-site storage required for their design.

Table 4.5 Summary of Minimum On-Site Storage and Minor System Inflow Rate for External Development Lands to Phase 1

Drainage Area		Land Use	IMP Ratio (%)	Minimum On-Site Storage Required (m^3)*	Minor System Inflow Rate (l/s)
Segment ID	Area (ha)				
EXT3	2.50	High Density	79	125.00	469
HD1	1.02	High Density	86	100.00	206
PARK1	0.83	Park	14	150.00	38
HD2	0.94	High Density	86	115.00	190
INST	2.55	School	79	290.00	476
EXT4	4.06	Commercial	79	462.00	760
COM	3.01	Commercial	79	345.00	562

** The on-site storage noted was used to evaluate Phase 1. As a minimum this on-site storage should be provided.*

4.9.3 Simulation Results

Minor system hydrographs generated in DDSWMM were downloaded to the XPSWMM model for hydraulic grade line analysis (refer to **Section 4.10**).

The storage available on-site and its maximum depth and the results of the DDSWMM evaluation for the subject site are presented in **Table 4.6**. Also included in **Table 4.6**, is the duration of ponding and depth of ponding for the 2 year, 5 year, 100 year and July 1, 1979 historical storm events. The ponding plan for the subject site is presented on **Drawing 751**. The DDSWMM output files are presented in **Appendix E**.

XPSWMM Node	USF (m)	Finished Grade (m)	Storm Hydraulic Grade Line							
	Existing	Existing	100 Year 24 Hour SCS Type II				100 Year 24 Hour SCS Type II + 20%			
			Sani Inflow Option 1		Sani Inflow Option 2		Sani Inflow Option 1		Sani Inflow Option 2	
	Proposed	*Proposed*	HGL (m)*	USF–HGL (m)	HGL (m)†	USF–HGL (m)	HGL (m)*	USF–HGL (m)	HGL (m)†	USF–HGL (m)
S825	92.80	94.90	90.94	1.86	90.94	1.86	91.00	1.80	91.00	1.80
S840	n/a	n/a	91.17	n/a	91.17	n/a	91.23	n/a	91.24	n/a
P2OUT	n/a	n/a	91.33	n/a	91.33	n/a	91.42	n/a	91.42	n/a
P2	n/a	n/a	91.86	n/a	91.85	n/a	92.10	n/a	92.10	n/a

Notes: * HGL results for Option 1 were taken from the results of the XPSWMM model entitled 34738-20170630-MOE1-24SCS100.out or 34738-20170630-MOE1-24SCS120.out and presented on the CD in **Appendix E**.
† HGL results for Option 2 were taken from the results of the XPSWMM model entitled 34738-20170630-MOE2-24SCS100.out or 34738-20170630-MOE2-24SCS120.out and presented on the CD in **Appendix E**.

The HGL results presented in **Table 4.14** indicate that the minimum 0.3 m clearance between the USF and HGL is maintained along the western trunk storm sewer for both Sanitary Inflow Options 1 and 2 for the 100 year 24 hour SCS Type II and the 100 year 24 hour SCS Type II increased by 20% storm events.

As noted in Section 4.10.1, a tabular summary of the resulting HGL and freeboard for the entire LDA simulated for each storm event, whether presented in the main body of this report or not, is provided on the CD in **Appendix E**.

4.10.4 25% Sediment Accumulation within Submerged Storm Sewers

An evaluation of the hydraulic grade line (HGL) was undertaken assuming that those storm sewer pipes which are permanently submerged have 25% accumulation of sediment. The evaluation was undertaken using the 10 year 3 hour Chicago storm event. The evaluation was undertaken for Sanitary Inflow Option 2. **Tables 4.15 and 4.16** presents the resulting storm HGL for the local storm sewers for the subject site and the south sub-trunk for noted storm event, respectively. The XPSWMM Schematics in **Appendix E** indicates those sewers in the LDA which are permanently submerged. There are no permanently submerged sewers are located within the subject site.

Table 4.15 Storm Hydraulic Grade Line – 25% Submerged Storm Sewers – Phase 1 Pathways at Findlay Creek Local Sewers for the 10 Year 3 Hour Chicago Storm Events – Sanitary Inflow Option 2

XPSWMM Node	USF (m)	Storm Hydraulic Grade Line	
	Existing	100 Year 3 Hour Chicago	
	Proposed	HGL (m)*	USF–HGL (m)
BLK6172W	n/a	92.09	n/a
S6176	94.30	92.98	1.32
S6172	93.40	91.92	1.48
S6173	93.30	91.88	1.42
S6174	93.40	91.83	1.57

XPSWMM Node	USF (m)	Storm Hydraulic Grade Line	
	Existing	100 Year 3 Hour Chicago	
	Proposed	HGL (m)*	USF–HGL (m)
S6131B	100.90	99.93	0.97
S6131	100.20	99.19	1.01
S6130	97.10	96.37	0.73
S6170	95.70	94.62	1.08
S6180	97.55	96.30	1.25
S6181	97.00	95.85	1.15
S6182	96.85	95.70	1.15
S6132	102.40	101.10	1.30
BLK6110S	102.10	101.60	0.50
S6110	100.55	99.33	1.22
S6109	97.95	96.25	1.70
S6156	98.30	96.47	1.83
S6155	97.25	94.90	2.35
S6108	95.45	93.48	1.97
S6107	93.60	92.26	1.34
BLK6105W	n/a	91.28	n/a
S6132B	102.40	101.40	1.00
BLK6133S	n/a	100.57	n/a
S6133	101.80	100.14	1.66
S6134	100.75	99.23	1.52
S6135	100.20	98.73	1.47
BLK900	n/a	96.01	n/a
S6140	n/a	95.99	n/a
S6139	n/a	95.85	n/a
S6138	n/a	95.80	n/a
S6137	n/a	95.75	n/a
BLK6145	100.25	98.80	1.45
S6146	n/a	98.71	n/a
S6136	n/a	95.63	n/a
S6120	n/a	94.81	n/a
S6132A	n/a	101.31	n/a
S6161	100.45	99.13	1.32
S6162	100.30	99.00	1.30
S6163	100.50	98.86	1.64
S6164	99.88	98.64	1.24

XPSWMM Node	USF (m)	Storm Hydraulic Grade Line	
	Existing	100 Year 3 Hour Chicago	
	Proposed	HGL (m)*	USF–HGL (m)
S6119	n/a	94.28	n/a
BLK6117B	n/a	94.89	n/a
S6117	n/a	94.06	n/a
S6116	96.03	92.79	3.24
S6156B	98.00	96.76	1.24
S6157	n/a	96.12	n/a
S6158	96.93	95.96	0.97
S6153	94.83	93.00	1.83
S6154	n/a	92.85	n/a
S6115	94.71	92.27	2.44

Notes: * HGL results for the 10 year 3 hour Chicago storm were taken from the XPSWMM model entitled 34738-20170630-SEDMOE2-3CHI10.out and presented on the CD in **Appendix E**.

Table 4.16 Storm Hydraulic Grade Line – 25% Submerged Storm Sewers – South Sub-Trunk for the 10 Year 3 Hour Chicago Storm Events – Sanitary Inflow Option 2

XPSWMM Node	USF (m)	Finished Grade (m)	Storm Hydraulic Grade Line	
	Existing	Existing	100 Year 3 Hour Chicago	
	Proposed	*Proposed*	HGL (m)*	USF–HGL (m)
S790	91.75	93.80	89.64	2.11
S791C	n/a	94.50	89.49	n/a
S792	92.68	94.53	89.68	3.00
S647	92.68	94.61	90.11	2.57
S649	n/a	95.05	90.60	n/a
S6101	n/a	95.38	90.80	n/a
S6102	93.38	95.25	90.91	2.47
S6103	93.48	95.18	90.96	2.52
S6104	92.98	94.98	91.07	1.91
S6105	92.93	94.95	91.24	1.69
S6106	93.50	95.07	91.49	2.01
S6175	93.65	95.68	91.68	1.97
S6183	94.60	96.75	91.87	2.73
S6171	94.30	96.00	91.98	2.32
BLK3171W	94.50	95.94	92.01	2.49
S631	*93.70*	*95.85*	92.09	1.61
S630	*93.80*	*95.95*	92.25	1.55

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tel 613 225 1311 fax 613 225 9868
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PROJECT:	BLK 232
DATE:	2019-11-19
FILE:	121793 - 6.2.4.
REV #:	-
DESIGNED BY:	RM
CHECKED BY:	RM

UNDERGROUND STORAGE CALCULATIONS - Pathways BLK 232

Pipe Storage MH207

From	To	Length	Diameter	X-sec Area	Volume
CB7	CB8	26.93	300	0.071	1.90
CB8	MH208	1.50	300	0.071	0.11
MH208	Mh207	15.12	300	0.071	1.07
				Total	3.08

Structure Storage MH207

	Base	Top	Height	diameter	X-sec Area	Volume
CB7	99.000	99.83	0.83	600	0.360	0.30
CB8	98.150	99.65	1.50	600	0.360	0.54
MH208	98.075	99.67	1.60	1200	1.131	1.80
MH207	97.979	99.83	1.85	1200	1.131	2.09
					Total	4.74

TOTAL MH207	**7.81**

Pipe Storage MH202

From	To	Length	Diameter	X-sec Area	Volume
CB3	CB2	23.25	300	0.071	1.64
CB2	MH202	9.92	300	0.071	0.70
CB1	MH202	15.03	200	0.031	0.47
CB4	MH202	13.34	300	0.071	0.94
				Total	3.76

Structure Storage MH202

	Base	Top	Height	diameter	X-sec Area	Volume
CB1	98.950	99.90	0.95	600	0.360	0.34
CB2	97.810	99.60	1.79	600	0.360	0.64
CB3	98.100	99.60	1.50	600	0.360	0.54
CB4	98.650	99.90	1.25	600	0.360	0.45
MH202	97.688	99.90	2.21	1500	1.767	3.91
					Total	5.89

TOTAL TO MH 202	**9.65**

Pipe Storage		*CB11*			
From	**To**	**Length**	**Diameter**	**X-sec Area**	**Volume**
ECB 1	TCB 2	26.50	250	0.049	1.30
TCB 2	TCB 3	29.50	250	0.049	1.45
TCB 3	CB11	39.00	250	0.049	1.91
				Total	4.66

Structure Storage			*CB11*			
	Base	**Top**	**Height**	**diameter**	**X-sec Area**	**Volume**
ECB 1	98.350	99.35	1.00	300	0.071	0.07
TCB 2	98.250	99.25	1.00	300	0.071	0.07
TCB 3	98.200	99.38	1.18	300	0.071	0.08
CB11	97.800	99.20	1.40	600	0.360	0.50
					Total	0.73

TOTAL CB11	**5.39**

IBI GROUP

STORM HYDRAULIC GRADE LINE DESIGN SHEET
PATHWAYS BLOCK 232
CITY OF OTTAWA
PHOENIX HOMES

JOB #: 121793 - 6.2
DATE: 2019-12-13
DESIGN: W.Z. & R.M.
CHECKED: D.G.Y.
REV #: -

BLK6117A in Cedar Creek Drive to MH200

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**BLK6117**	**200**	
INVERT ELEVATION (m)	94.435	94.467	
OBVERT ELEVATION (m)	95.035	95.067	
DIAMETER (mm)			600
LENGTH (m)			14.3
FLOW (l/s)			130.92
HGL (m) ***	**94.890**	**94.896**	**0.006**
MANHOLE COEF K= 0.75	LOSS (m)	0.008	
TOTAL HGL (m)		**94.905**	
MAX. SURCHARGE (mm)		**-162**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.6	0.28	1.88	0.220	0.15	1.03	290.82

HYDRAULIC SLOPE = 0.10 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.450
DESIGN FLOW DEPTH = 0.282

Head loss in manhole simplified method p. 71 (MWDM)
fig1.7.1, Kratio = 0.75 for 45 bends — K_L=0.75
Velocity = Flow / Area = 0.46 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**200**	**201**	
INVERT ELEVATION (m)	96.290	96.445	
OBVERT ELEVATION (m)	96.665	96.820	
DIAMETER (mm)			375
LENGTH (m)			19.3
FLOW (l/s)			120.63
HGL (m) ***	**94.905**	**94.996**	**0.092**
MANHOLE COEF K= 0.75	LOSS (m)	0.046	
TOTAL HGL (m)		**96.689**	
MAX. SURCHARGE (mm)		**-131**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.375	0.11	1.18	0.800	0.09	1.42	156.88

HYDRAULIC SLOPE = 9.22 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.769
DESIGN FLOW DEPTH = 0.244

Head loss in manhole simplified method p. 71 (MWDM)
fig1.7.1, Kratio = 0.75 for 45 bends — K_L=0.75
Velocity = Flow / Area = 1.09 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**201**	**203**	
INVERT ELEVATION (m)	96.505	96.835	
OBVERT ELEVATION (m)	96.880	97.210	
DIAMETER (mm)			375
LENGTH (m)			33.0
FLOW (l/s)			122.71
HGL (m) ***	**96.689**	**96.851**	**0.162**
MANHOLE COEF K= 0.05	LOSS (m)	0.003	
TOTAL HGL (m)		**97.064**	
MAX. SURCHARGE (mm)		**-146**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.375	0.11	1.18	1.000	0.09	1.59	175.16

HYDRAULIC SLOPE = 1.14 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 0.701
DESIGN FLOW DEPTH = 0.229

Head loss in manhole simplified method p. 71 (MWDM)
straight through — K_L=0.05
Velocity = Flow / Area = 1.11 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**203**	**204**	
INVERT ELEVATION (m)	96.930	97.197	
OBVERT ELEVATION (m)	97.230	97.497	
DIAMETER (mm)			300
LENGTH (m)			26.8
FLOW (l/s)			100.88
HGL (m) ***	**97.064**	**97.355**	**0.291**
MANHOLE COEF K= 0.05	LOSS (m)	0.005	
TOTAL HGL (m)		**97.455**	
MAX. SURCHARGE (mm)		**-42**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.3	0.07	0.94	1.000	0.08	1.37	96.56

HYDRAULIC SLOPE = 1.46 %
DESIGN FLOW TO FULL FLOW RATIO (Q/ 1.045
DESIGN FLOW DEPTH = 0.258

Head loss in manhole simplified method p. 71 (MWDM)
straight through — K_L=0.05
Velocity = Flow / Area = 1.43 m/s
$HL = K_L * V^2/ 2g$

IBI GROUP

STORM HYDRAULIC GRADE LINE DESIGN SHEET
PATHWAYS BLOCK 232
CITY OF OTTAWA
PHOENIX HOMES

JOB #: 121793 - 6.2
DATE: 2019-12-13
DESIGN: W.Z. & R.M.
CHECKED: D.G.Y.
REV #: -

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**204**	**205**	
INVERT ELEVATION (m)	97.217	97.804	
OBVERT ELEVATION (m)	97.517	98.104	
DIAMETER (mm)			300
LENGTH (m)			58.6
FLOW (l/s)			100.88
HGL (m) ***	**97.455**	**98.094**	**0.639**
MANHOLE COEF K= 0.05	LOSS (m)	0.005	
TOTAL HGL (m)		**98.099**	
MAX. SURCHARGE (mm)		**-5**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.3	0.07	0.94	1.000	0.08	1.37	96.70

HYDRAULIC SLOPE = 1.10 %
DESIGN FLOW TO FULL FLOW RATIO (Q 1.000
DESIGN FLOW DEPTH = 0.243

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 1.43 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**205**	**206**	
INVERT ELEVATION (m)	98.030	98.279	
OBVERT ELEVATION (m)	98.230	98.479	
DIAMETER (mm)			200
LENGTH (m)			24.9
FLOW (l/s)			5.57
HGL (m) ***	**98.099**	**98.106**	**0.007**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**98.333**	
MAX. SURCHARGE (mm)		**-146**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.2	0.03	0.63	1.000	0.05	1.04	32.76

HYDRAULIC SLOPE = 0.94 %
DESIGN FLOW TO FULL FLOW RATIO (Q 0.170
DESIGN FLOW DEPTH = 0.054

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.18 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**205**	**207**	
INVERT ELEVATION (m)	97.939	97.979	
OBVERT ELEVATION (m)	98.189	98.229	
DIAMETER (mm)			250
LENGTH (m)			7.9
FLOW (l/s)			5.57
HGL (m) ***	**98.099**	**98.100**	**0.001**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**98.100**	
MAX. SURCHARGE (mm)		**-129**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.25	0.05	0.79	0.500	0.06	0.86	42.24

HYDRAULIC SLOPE = 0.01 %
DESIGN FLOW TO FULL FLOW RATIO (Q 0.132
DESIGN FLOW DEPTH = 0.060

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.11 m/s
$HL = K_L * V^2/ 2g$

FRICTION LOSS	FROM MH	TO MH	PIPE ID
Block 232	**207**	**208**	
INVERT ELEVATION (m)	97.999	98.075	
OBVERT ELEVATION (m)	98.299	98.375	
DIAMETER (mm)			300
LENGTH (m)			15.1
FLOW (l/s)			5.57
HGL (m) ***	**98.100**	**98.100**	**0.001**
MANHOLE COEF K= 0.05	LOSS (m)	0.000	
TOTAL HGL (m)		**98.132**	
MAX. SURCHARGE (mm)		**-243**	

MANNING FORMULA - FLOWING FULL

DIA (m)	Area (m2)	Perim. (m)	Slope (%)	Hyd.R. (m)	Vel. (m/s)	Q (l/s)
0.3	0.07	0.94	0.500	0.08	0.97	68.52

HYDRAULIC SLOPE = 0.21 %
DESIGN FLOW TO FULL FLOW RATIO (Q 0.081
DESIGN FLOW DEPTH = 0.057

Head loss in manhole simplified method p. 71 (MWDM)
straight through K_L=0.05
Velocity = Flow / Area = 0.08 m/s
$HL = K_L * V^2/ 2g$

Cedar Creek Drive Storm HGL has no negative impact on the proposed development.

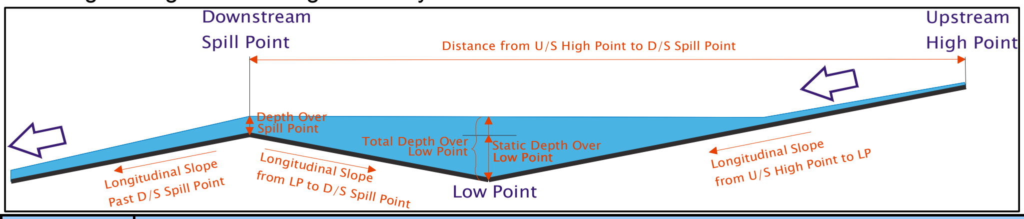
Calculation Sheet: Overflow From Typical Road Ponding Area

User Input Characteristics

Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	3.5	%
Curb Height	0.15	m
Manning's Roughness for Road	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Note: Overflow calculations performed based on Manning's Equation, where $Q = R_h^{2/3} S^{1/2} A / n$, and:

- Q = overflow (m^3/s)
- R_h = hydraulic radius
- A = area (m^2)
- n = Manning's roughness coefficient
- S = friction slope (m/m), as simulated in XPSWMM for a range of longitudinal road slopes downstream of the spill point of the road ponding area:
  - 0.50 - 0.74% longitudinal slope = 0.15% friction slope
  - 0.75 - 1.24% longitudinal slope = 0.16% friction slope
  - 1.25 - 3.74% longitudinal slope = 0.17% friction slope
  - 3.75 - 5.00% longitudinal slope = 0.18% friction slope



Depth Over Spill Point	Overflow (m^3/s)											
	0.50% - 0.74% D/S Slope			0.75% - 1.24% D/S Slope			1.25% - 3.74% D/S Slope			3.75% - 5.00% D/S Slope		
(m)	5.5 m Road	8.5 m Road	11.0 m Road	5.5 m Road	8.5 m Road	11.0 m Road	5.5 m Road	8.5 m Road	11.0 m Road	5.5 m Road	8.5 m Road	11.0 m Road
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.015	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
0.020	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
0.025	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004
0.030	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
0.035	0.008	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009
0.040	0.011	0.011	0.011	0.012	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013
0.045	0.016	0.016	0.016	0.016	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.017
0.050	0.021	0.021	0.021	0.021	0.021	0.021	0.022	0.022	0.022	0.023	0.023	0.023
0.055	0.027	0.027	0.027	0.028	0.028	0.028	0.029	0.029	0.029	0.029	0.029	0.029
0.060	0.034	0.034	0.034	0.035	0.035	0.035	0.036	0.036	0.036	0.037	0.037	0.037
0.065	0.042	0.042	0.042	0.043	0.043	0.043	0.045	0.045	0.045	0.046	0.046	0.046
0.070	0.051	0.051	0.051	0.053	0.053	0.053	0.054	0.054	0.054	0.056	0.056	0.056
0.075	0.061	0.061	0.061	0.063	0.063	0.063	0.065	0.065	0.065	0.067	0.067	0.067
0.080	0.073	0.073	0.073	0.075	0.075	0.075	0.078	0.078	0.078	0.080	0.080	0.080
0.085	0.087	0.086	0.086	0.090	0.088	0.088	0.093	0.091	0.091	0.096	0.094	0.094
0.090	0.104	0.100	0.100	0.108	0.103	0.103	0.111	0.106	0.106	0.114	0.109	0.109
0.095	0.123	0.115	0.115	0.127	0.119	0.119	0.131	0.123	0.123	0.134	0.126	0.126
0.100	0.142	0.132	0.132	0.147	0.136	0.136	0.151	0.141	0.141	0.156	0.145	0.145
0.105	0.163	0.150	0.150	0.168	0.155	0.155	0.173	0.160	0.160	0.178	0.165	0.165
0.110	0.184	0.170	0.170	0.190	0.176	0.176	0.196	0.181	0.181	0.202	0.187	0.187
0.115	0.207	0.192	0.192	0.214	0.198	0.198	0.220	0.204	0.204	0.226	0.210	0.210
0.120	0.230	0.215	0.215	0.238	0.222	0.222	0.245	0.229	0.229	0.252	0.235	0.235
0.125	0.255	0.240	0.240	0.263	0.247	0.247	0.271	0.255	0.255	0.279	0.262	0.262
0.130	0.280	0.269	0.266	0.290	0.278	0.275	0.299	0.287	0.283	0.307	0.295	0.291
0.135	0.307	0.304	0.294	0.317	0.314	0.304	0.327	0.323	0.313	0.336	0.333	0.322
0.140	0.334	0.340	0.324	0.345	0.351	0.335	0.356	0.362	0.345	0.366	0.372	0.355
0.145	0.363	0.377	0.356	0.375	0.390	0.368	0.386	0.402	0.379	0.397	0.413	0.390
0.150	0.392	0.417	0.390	0.405	0.430	0.402	0.417	0.443	0.415	0.429	0.456	0.427
0.155	0.422	0.458	0.425	0.436	0.473	0.439	0.450	0.487	0.453	0.463	0.501	0.466
0.160	0.454	0.500	0.463	0.469	0.517	0.479	0.483	0.532	0.493	0.497	0.548	0.508
0.165	0.486	0.544	0.503	0.502	0.562	0.520	0.518	0.580	0.536	0.533	0.596	0.552
0.170	0.520	0.590	0.556	0.537	0.610	0.574	0.553	0.629	0.592	0.569	0.647	0.609
0.175	0.555	0.638	0.610	0.573	0.659	0.630	0.590	0.679	0.650	0.607	0.699	0.669
0.180	0.590	0.687	0.667	0.610	0.710	0.689	0.629	0.732	0.710	0.647	0.753	0.731
0.185	0.627	0.738	0.726	0.648	0.763	0.750	0.668	0.786	0.773	0.687	0.809	0.795
0.190	0.665	0.791	0.787	0.687	0.817	0.813	0.708	0.842	0.838	0.729	0.867	0.862
0.195	0.705	0.846	0.851	0.728	0.873	0.879	0.750	0.900	0.906	0.772	0.926	0.932
0.200	0.745	0.902	0.917	0.770	0.931	0.947	0.793	0.960	0.976	0.817	0.988	1.004
0.205	0.787	0.960	0.985	0.813	0.991	1.017	0.838	1.022	1.048	0.862	1.052	1.078
0.210	0.830	1.020	1.055	0.857	1.053	1.089	0.884	1.085	1.123	0.909	1.117	1.155
0.215	0.874	1.081	1.127	0.903	1.117	1.164	0.931	1.151	1.200	0.958	1.184	1.235
0.220	0.920	1.144	1.202	0.950	1.182	1.241	0.979	1.218	1.280	1.008	1.254	1.317
0.225	0.967	1.210	1.279	0.999	1.249	1.321	1.029	1.288	1.362	1.059	1.325	1.401
0.230	1.015	1.277	1.358	1.048	1.318	1.403	1.081	1.359	1.446	1.112	1.398	1.488
0.235	1.065	1.345	1.440	1.100	1.389	1.487	1.133	1.432	1.533	1.166	1.474	1.577
0.240	1.116	1.416	1.523	1.152	1.462	1.573	1.188	1.507	1.622	1.222	1.551	1.669
0.245	1.168	1.488	1.610	1.206	1.537	1.662	1.243	1.584	1.713	1.279	1.630	1.763
0.250	1.222	1.563	1.698	1.262	1.614	1.754	1.300	1.664	1.808	1.338	1.712	1.860
0.255	1.277	1.639	1.789	1.318	1.693	1.847	1.359	1.745	1.904	1.398	1.795	1.959
0.260	1.333	1.717	1.881	1.377	1.773	1.943	1.419	1.828	2.003	1.460	1.881	2.061
0.265	1.391	1.797	1.977	1.437	1.856	2.042	1.481	1.913	2.104	1.524	1.968	2.165
0.270	1.450	1.879	2.074	1.498	1.940	2.142	1.544	2.000	2.208	1.589	2.058	2.272
0.275	1.511	1.962	2.174	1.561	2.027	2.245	1.609	2.089	2.314	1.656	2.150	2.382
0.280	1.574	2.048	2.276	1.625	2.115	2.351	1.675	2.180	2.423	1.724	2.244	2.494
0.285	1.638	2.136	2.381	1.691	2.206	2.459	1.743	2.274	2.535	1.794	2.340	2.608
0.290	1.703	2.225	2.488	1.759	2.298	2.569	1.813	2.369	2.648	1.865	2.438	2.725
0.295	1.770	2.317	2.597	1.828	2.393	2.682	1.884	2.467	2.765	1.939	2.538	2.845
0.300	1.838	2.410	2.708	1.899	2.490	2.797	1.957	2.566	2.883	2.014	2.641	2.967
0.305	1.908	2.506	2.822	1.971	2.588	2.915	2.032	2.668	3.005	2.090	2.745	3.092
0.310	1.980	2.603	2.939	2.045	2.689	3.035	2.108	2.772	3.128	2.169	2.852	3.219
0.315	2.053	2.703	3.057	2.120	2.792	3.157	2.186	2.878	3.255	2.249	2.961	3.349
0.320	2.128	2.805	3.178	2.198	2.897	3.282	2.265	2.986	3.383	2.331	3.072	3.482
0.325	2.204	2.908	3.302	2.277	3.004	3.410	2.347	3.096	3.515	2.415	3.186	3.617
0.330	2.282	3.014	3.427	2.357	3.113	3.540	2.430	3.208	3.649	2.500	3.301	3.755
0.335	2.362	3.121	3.556	2.440	3.224	3.672	2.515	3.323	3.785	2.588	3.419	3.895
0.340	2.443	3.231	3.686	2.524	3.337	3.807	2.601	3.440	3.924	2.677	3.540	4.038
0.345	2.527	3.343	3.819	2.609	3.453	3.945	2.690	3.559	4.066	2.768	3.662	4.184
0.350	2.611	3.457	3.955	2.697	3.570	4.085	2.780	3.680	4.210	2.861	3.787	4.332
0.355	2.698	3.573	4.093	2.786	3.690	4.227	2.872	3.804	4.357	2.955	3.914	4.484
0.360	2.786	3.691	4.233	2.877	3.812	4.372	2.966	3.929	4.507	3.052	4.043	4.637
0.365	2.876	3.811	4.376	2.970	3.936	4.520	3.062	4.057	4.659	3.150	4.175	4.794
0.370	2.968	3.934	4.522	3.065	4.063	4.670	3.159	4.188	4.814	3.251	4.309	4.953
0.375	3.061	4.058	4.669	3.161	4.191	4.823	3.259	4.320	4.971	3.353	4.446	5.115
0.380	3.156	4.185	4.820	3.260	4.322	4.978	3.360	4.455	5.131	3.457	4.584	5.280
0.385	3.253	4.314	4.973	3.360	4.455	5.136	3.463	4.592	5.294	3.564	4.725	5.447
0.390	3.352	4.445	5.128	3.462	4.591	5.296	3.569	4.732	5.459	3.672	4.869	5.617
0.395	3.453	4.578	5.286	3.566	4.728	5.459	3.676	4.874	5.627	3.782	5.015	5.790

Calculation Sheet: Overflow From Typical Road Ponding Area

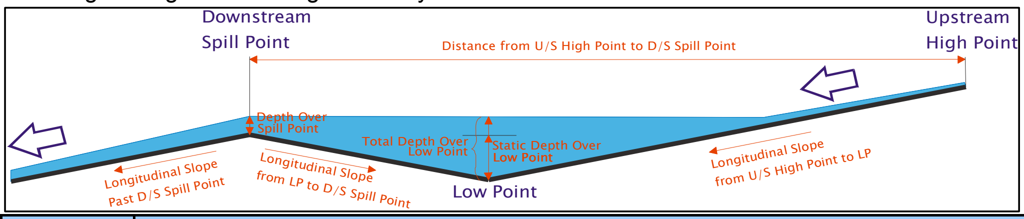
User Input Characteristics

Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	3.5	%
Curb Height	0.15	m
Manning's Roughness for Road	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Note: Overflow calculations performed based on Manning's Equation, where $Q = R_h^{2/3} S^{1/2} A / n$, and:

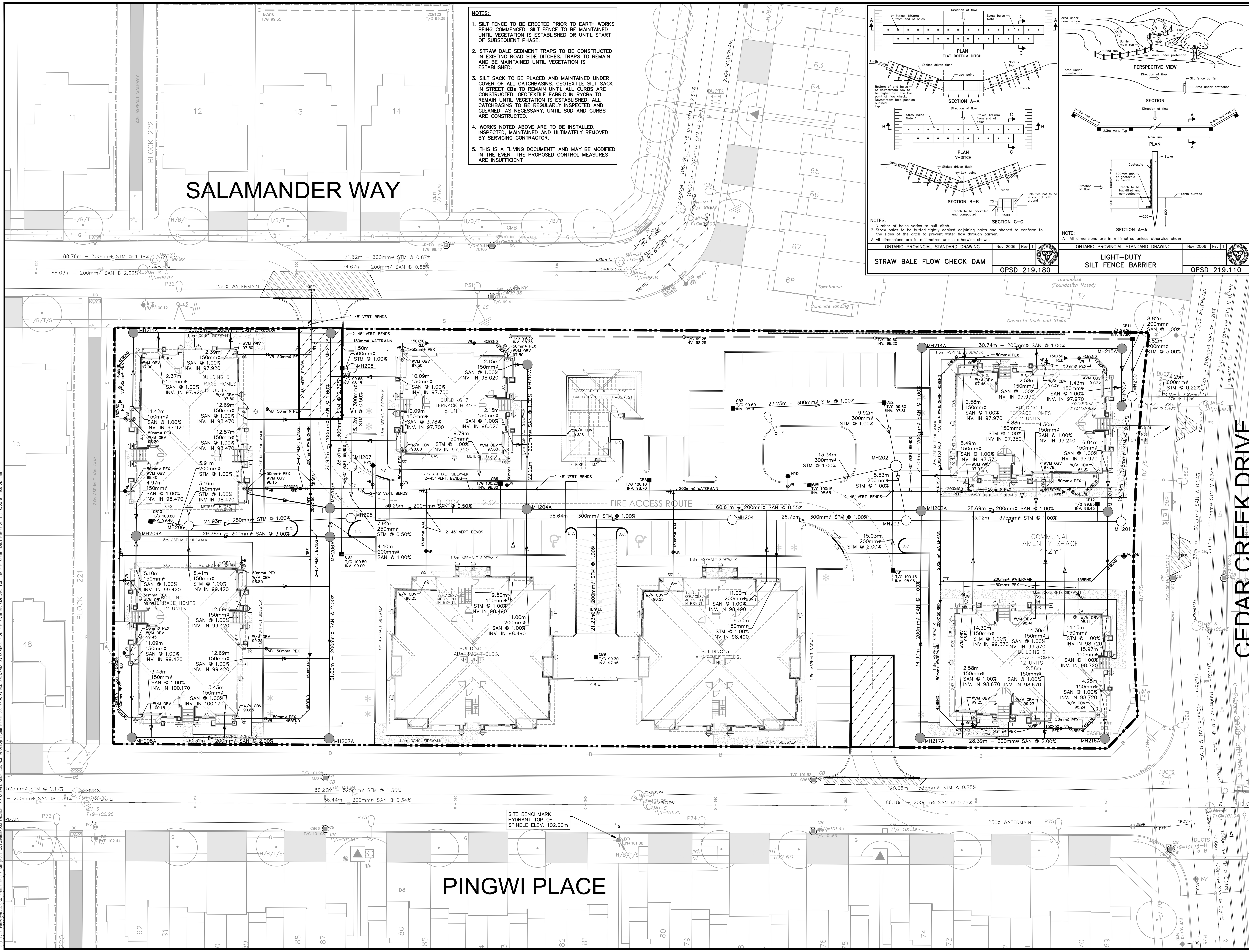
Q = overflow (m^3/s)
R_h = hydraulic radius
A = area (m^2)
n = Manning's roughness coefficient
S = friction slope (m/m), as simulated in XPSWMM for a range of longitudinal road slopes downstream of the spill point of the road ponding area:

0.50 - 0.74% longitudinal slope = 0.15% friction slope
0.75 - 1.24% longitudinal slope = 0.16% friction slope
1.25 - 3.74% longitudinal slope = 0.17% friction slope
3.75 - 5.00% longitudinal slope = 0.18% friction slope



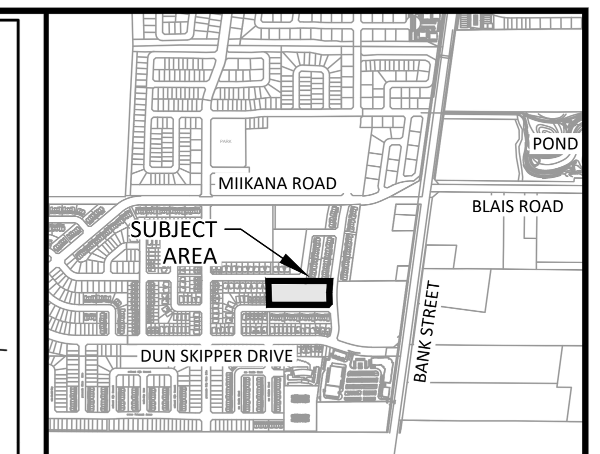
Depth Over Spill Point (m)	Overflow (m^3/s)											
	0.50% - 0.74% D/S Slope			0.75% - 1.24% D/S Slope			1.25% - 3.74% D/S Slope			3.75% - 5.00% D/S Slope		
	5.5 m Road	8.5 m Road	11.0 m Road	5.5 m Road	8.5 m Road	11.0 m Road	5.5 m Road	8.5 m Road	11.0 m Road	5.5 m Road	8.5 m Road	11.0 m Road
0.400	3.555	4.713	5.446	3.672	4.868	5.625	3.785	5.018	5.798	3.895	5.163	5.966
0.405	3.659	4.851	5.609	3.780	5.010	5.793	3.896	5.164	5.972	4.009	5.314	6.145
0.410	3.766	4.991	5.775	3.889	5.155	5.964	4.009	5.313	6.148	4.125	5.467	6.326
0.415	3.874	5.133	5.943	4.001	5.301	6.138	4.124	5.465	6.327	4.243	5.623	6.510
0.420	3.984	5.278	6.113	4.114	5.451	6.314	4.241	5.618	6.508	4.364	5.781	6.697
0.425	4.096	5.424	6.287	4.230	5.602	6.493	4.360	5.774	6.693	4.486	5.942	6.887
0.430	4.209	5.573	6.462	4.347	5.756	6.674	4.481	5.933	6.880	4.611	6.105	7.079
0.435	4.325	5.724	6.641	4.467	5.912	6.859	4.604	6.094	7.070	4.738	6.271	7.275
0.440	4.443	5.878	6.822	4.588	6.071	7.046	4.729	6.257	7.262	4.867	6.439	7.473
0.445	4.562	6.034	7.005	4.712	6.231	7.235	4.857	6.423	7.458	4.998	6.609	7.674
0.450	4.684	6.192	7.192	4.837	6.395	7.427	4.986	6.592	7.656	5.131	6.783	7.878
0.455	4.807	6.352	7.380	4.965	6.561	7.623	5.118	6.762	7.857	5.266	6.958	8.085
0.460	4.933	6.515	7.572	5.095	6.729	7.820	5.251	6.936	8.061	5.404	7.137	8.295
0.465	5.060	6.680	7.766	5.226	6.899	8.021	5.387	7.112	8.268	5.543	7.318	8.507
0.470	5.190	6.848	7.963	5.360	7.072	8.224	5.525	7.290	8.477	5.685	7.501	8.723
0.475	5.321	7.018	8.163	5.496	7.248	8.430	5.665	7.471	8.690	5.829	7.687	8.942
0.480	5.455	7.190	8.365	5.634	7.426	8.639	5.807	7.654	8.905	5.976	7.876	9.163
0.485	5.591	7.365	8.570	5.774	7.606	8.851	5.952	7.840	9.123	6.124	8.067	9.388
0.490	5.728	7.542	8.777	5.916	7.789	9.065	6.098	8.029	9.344	6.275	8.261	9.615
0.495	5.868	7.721	8.987	6.061	7.974	9.282	6.247	8.220	9.568	6.428	8.458	9.845
0.500	6.010	7.903	9.201	6.207	8.162	9.502	6.398	8.414	9.795	6.584	8.657	10.079

APPENDIX D



NOTES:

1. SILT FENCE TO BE ERECTED PRIOR TO EARTH WORKS BEING COMMENCED. SILT FENCE TO BE MAINTAINED UNTIL VEGETATION IS ESTABLISHED OR UNTIL START OF SUBSEQUENT PHASE.
2. STRAW BALE SEDIMENT TRAPS TO BE CONSTRUCTED IN EXISTING ROAD SIDE DITCHES. TRAPS TO REMAIN AND BE MAINTAINED UNTIL VEGETATION IS ESTABLISHED.
3. SILT SACK TO BE PLACED AND MAINTAINED UNDER COVER OF ALL CATCHBASINS. GEOTEXTILE SILT SACK IN STREET CBs TO REMAIN UNTIL ALL CURBS ARE CONSTRUCTED. GEOTEXTILE FABRIC IN RYCBs TO REMAIN UNTIL VEGETATION IS ESTABLISHED. ALL CATCHBASINS TO BE REGULARLY INSPECTED AND CLEANED, AS NECESSARY, UNTIL SOD AND CURBS ARE CONSTRUCTED.
4. WORKS NOTED ABOVE ARE TO BE INSTALLED, INSPECTED, MAINTAINED AND ULTIMATELY REMOVED BY SERVICING CONTRACTOR.
5. THIS IS A "LIVING DOCUMENT" AND MAY BE MODIFIED IN THE EVENT THE PROPOSED CONTROL MEASURES ARE INSUFFICIENT



KEY PLAN
N.T.S.

NOTES:

1. SEE DRAWING C-010, C-011 FOR ADDITIONAL DETAILS AND NOTES.
2. SITE BENCHMARK OBTAINED FROM LEGAL SURVEYOR ANNIS O'SULLIVAN VOLLEBEKK LTD. TOP SPINDLE OF HYDRANT ON PINGWI PLACE, ELEV.=102.60m

LEGEND :

- LIGHT DUTY SILT FENCE AS PER OPSD-219.110
- SNOW FENCE
- STRAW BALE CHECK DAM AS PER OPSD-219.180
- ROCK CHECK DAM AS PER OPSD-219.210
- SILT SACK PLACED UNDER EXISTING CB COVER
- TEMPORARY MUD MAT 0.15m THICK 50mm CLEAR STONE ON NON WOVEN FILTER CLOTH (15.0 × 7.0)

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1	ISSUED FOR SPA	DGY	2019:12:18

DCR/PHOENIX GROUP OF COMPANIES

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Project Title
BLOCK 232 PATHWAYS

LICENSED PROFESSIONAL ENGINEER
D. G. Yannoulopoulos
2019/XX/XX
PROVINCE OF ONTARIO

Drawing Title
EROSION AND SEDIMENTATION CONTROL PLAN

Scale
1:250

Design	Date
RM/WZ	SEPT, 2019
Drawn	Checked
DPS/WZ	DGY
Project No.	Drawing No.
121793	900

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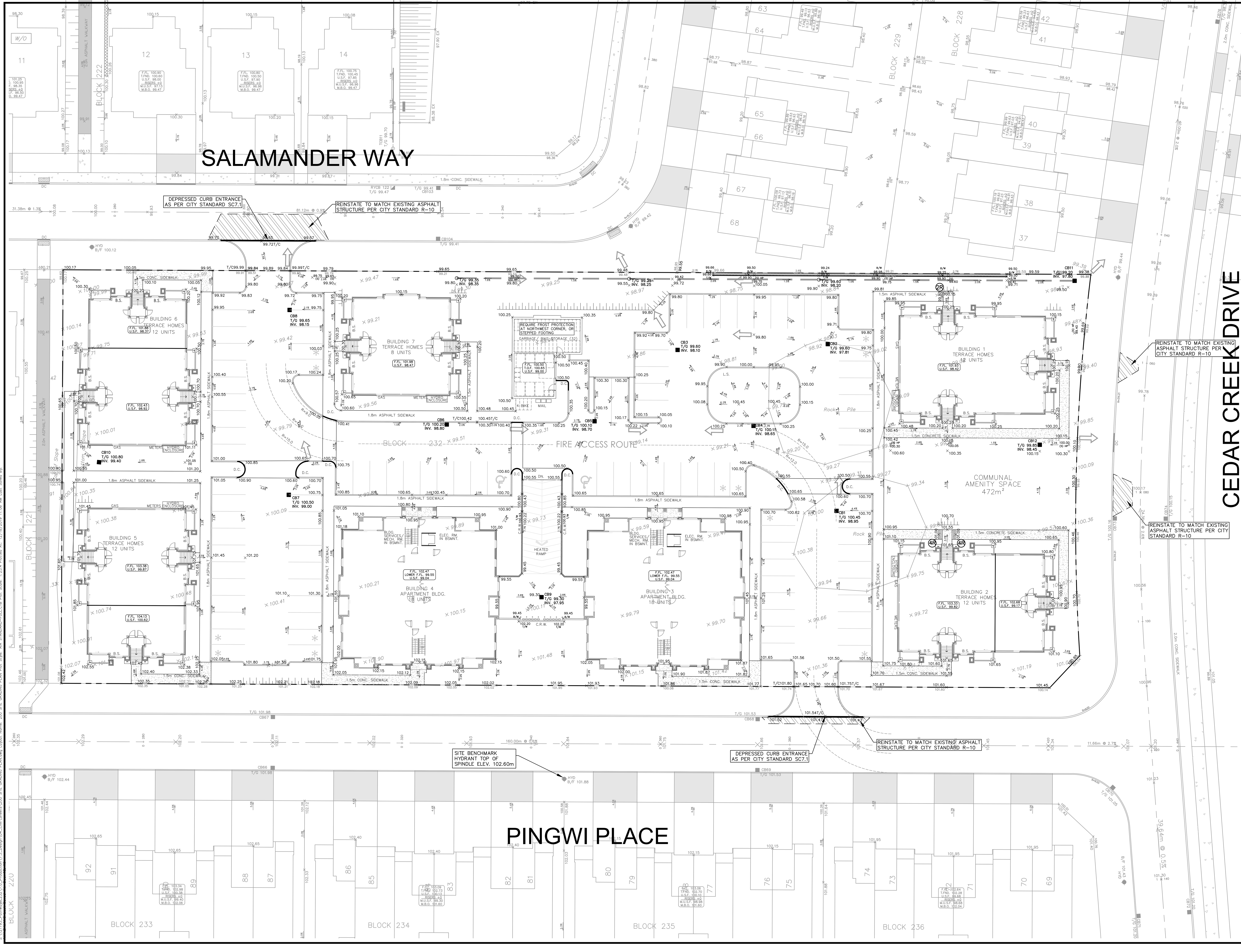

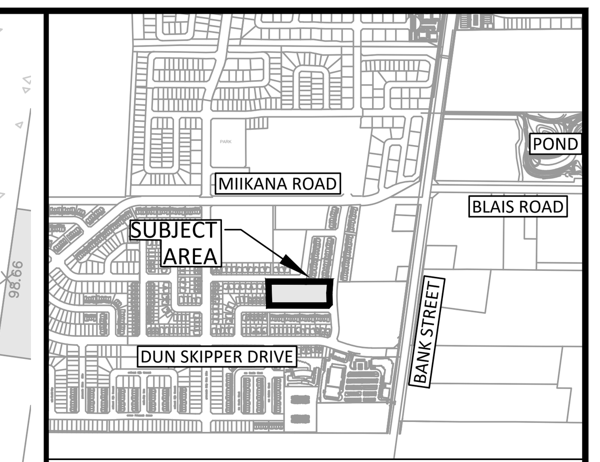

KEY PLAN
N.T.S.

NOTES:

1. SEE DRAWING C-010, C-011 FOR ADDITIONAL DETAILS AND NOTES.
2. SITE BENCHMARK OBTAINED FROM LEGAL SURVEYOR ANNIS O'SULLIVAN VOLLEBEKK LTD. TOP SPINDLE OF HYDRANT ON PINGWI PLACE, ELEV.=102.60m

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LICENSED PROFESSIONAL ENGINEER
D. G. Yannoulopoulos
2019/XX/XX
PROVINCE OF ONTARIO

Drawing Title
SITE GRADING PLAN

Scale
1:250

Design	Date
RM/WZ	SEPT. 2019
Drawn	Checked
DPS/WZ	DGY
Project No.	Drawing No.
121793	200

D07-XX-XX-XXXX

January 2017

REPORT

REPORT ON

Geotechnical Investigation Proposed Residential Development Remer and Idone Lands Ottawa, Ontario

Submitted to:
Leitrim South Holdings Inc. and 4840 Bank St. Ltd.
c/o The Regional Group
1737 Woodward Drive, 2nd Floor
Ottawa, Ontario
K2C 0P9

Report Number: 13-1121-0083 (1046)

Distribution:

1 copy - Leitrim South Holdings Inc.
1 copy - 4840 Bank St. Ltd.
1 copy - IBI Group
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1 copy - Golder Associates Ltd.

Golder Associates

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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for a proposed residential development to be located on the "Remer and Idone Lands" (referred herein as the site) in Ottawa, Ontario. This report supersedes the previous geotechnical report titled "Geotechnical Investigation, Proposed Residential Development, Remer and Idone Lands, Ottawa, Ontario" (report number 13-1121-0083 (1042/2042), dated January 2016) which was issued for this project.

The purpose of this subsurface investigation was to determine the general soil, bedrock, and groundwater conditions across the site by means of 46 boreholes, 17 test pits and 1 hand augerhole. Based on an interpretation of the factual information obtained, along with the existing subsurface information available for the site from previous investigations, engineering recommendations are provided on the geotechnical design aspects of the proposed development, including construction considerations that could affect design decisions.

The reader is referred to the "Important Information and Limitations of This Report", which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared to develop a residential subdivision on the Remer and Idone Lands in Ottawa, Ontario (see Key Plan, Figure 1).

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

- The site is located just west of Bank Street and south of Blais Road.
- The site measures approximately 600 metres by 1,500 metres in plan area.
- The site is proposed to be developed with mixed (singles, semi-detached, and town) residential houses, apartment buildings, one school, park blocks, a commercial area, and sewer installation.
- The apartment buildings will be 3-storeys in height and will have one level of underground parking. The buildings will be supported on shallow spread footings, with footing sizes of up to 1.7 metres by 1.7 metres. The underside of the footings will be on average about 1.8 metres below the finished grade, but will be as deep as about 3 metres below the finished grade.
- The sewer installation will require sewer trenches with varying depths from about 3 to 7 metres.
- This current geotechnical investigation is for the proposed residential development, servicing, and park lands only.
- Additional geotechnical investigations will be required once the details for the commercial development and school are available.

Several previous geotechnical and hydrogeological investigations have been carried out on and adjacent to the site by Golder Associates Ltd., Jacques Whitford, and Paterson Group at various times in the past 30 years. The results of those investigations are provided in the following reports:

- Report to Regional Group by Golder Associates titled "Preliminary Geotechnical Investigation, Proposed Residential Development, Ioni (note: should have read Idone) Property, 4840 Bank Street, Ottawa, Ontario", dated May 2008 (report number 08-1121-0044).
- Report to Minto Development Inc. by Paterson Group titled "Preliminary Geotechnical Investigation, Proposed Development, Highway 31 at Blais Road, Ottawa, Ontario", dated November 20, 2007 (report number PG0627-1).
- Report to Proctor and Redfern Limited by Jacques Whitford Environmental Limited titled "Hydrogeological Investigation, Remer Property, Leitrim, Ontario", dated July 13, 1992 (report number 30227).
- Report to Remer Holdings by Golder Associates titled "Preliminary Geotechnical Investigation, Proposed Residential Development, Remer Holdings, Albion Road, Gloucester, Ontario", dated November 1988 (report number 881-2175).
- Report to Tartan Homes Limited by Golder Associates titled "Preliminary Geotechnical Appraisal, Kellum Property, Leitrim Area, Gloucester, Ontario", dated June 1988 (report number 881-2235).

The approximate locations of the relevant boreholes and test pits from the above previous investigations are shown on the Site Plan, Figure 2.

Based on the results of those previous investigations, as well as a review of the published geological mapping, the subsurface conditions across this site are expected to predominantly consist of variable deposits of sands and silts, overlying bouldery glacial till, above bedrock. The bedrock surface undulates and is expected to vary at depths of about 1 to 7 metres below the existing ground surface. Geological mapping indicates that the bedrock in the area consists of dolomite of the Oxford Formation.

A provincially significant wetland (Leitrim Wetland) is present to the west and northwest of the development site. The wetland area is known to be underlain by peat with thicknesses of up to and greater than 2.5 metres. Previous assessments in the area indicate that groundwater recharge to the Leitrim Wetland largely originates from the northwest-southeast trending sand and gravel ridge located south of the site.

In order to protect the natural function of the Leitrim Wetland and Casino Wetland, a hydrogeological assessment has been carried out in conjunction with this geotechnical investigation to evaluate the existing hydrogeological conditions at the site, and to predict the potential hydrogeological impacts to the groundwater and surface water flow systems that may be induced by the proposed development (both during construction and post-construction). The results of the hydrogeological assessment are provided under separate cover.

3.0 PROCEDURE

The fieldwork for this investigation was carried out between September 23 and October 25, 2013 (Phase I), and between September 29 and October 13, 2016 (Phase II). During those periods, the following test holes were put down at the approximate locations shown on the Site Plan, Figure 2.

- Thirty three (33) boreholes (numbered 13-1 to 13-33, inclusive) were advanced across the site (during Phase I)
- Thirteen (13) additional boreholes (numbered 16-101 to 16-113, inclusive) were advanced along the proposed sewer trenches (during Phase II)
- Seventeen (17) test pits (numbered 16-1 to 16-16, and 16-20) were advanced along the proposed sewer trenches and within the proposed park land (during Phase II)
- One (1) hand augerhole (numbered 16-18) was advanced at the western end of the site where the 3-storey apartment buildings are being proposed (during Phase II)

In 2013, the boreholes were advanced using either a track-mounted hollow stem auger drill rig or portable drilling equipment supplied and operated by Marathon Drilling Company Ltd. (Marathon) of Ottawa, Ontario. These boreholes were advanced through the overburden to depths of about 1.1 (practical refusal to augering) to 7.7 metres below the existing ground surface.

In 2016, the additional boreholes were advanced using a track mounted hollow stem auger drill rig equipment supplied and operated by CCC Geotechnical and Environmental Drilling Ltd. (CCC) of Ottawa, Ontario. These boreholes were advanced through the overburden to depths of about 3.5 to 6.3 metres below the existing ground surface.

Standard penetration tests (SPTs) were carried out in the overburden at regular intervals of depth in the boreholes and samples of the soils encountered were recovered using split spoon sampling equipment.

Upon encountering auger refusal on the bedrock surface, 15 of the boreholes (numbered 13-1, 13-3, 13-6, 13-10, 13-13, 13-17, 13-18, 13-24, 16-101 to 16-104, 16-107, 16-111 and 16-113) were advanced about 0.5 to 3.9 metres into the bedrock, using diamond drilling techniques while retrieving NQ or HQ sized bedrock core. Diamond drilling techniques were also required to advance past the cobbles and boulders within the glacial till in boreholes 13-5, 13-9, 13-10, 13-29, 13-32, 16-101, 16-102, 16-108, 16-109, and 16-111.

Monitoring wells or standpipe piezometers were installed in 18 of the boreholes, to allow for subsequent measurement of the groundwater level and/or for carrying out in situ hydraulic conductivity testing. The groundwater level measurements and in situ hydraulic conductivity testing were carried out on October 28 through November 12, 2013 and November 11, 2016.

The test pits were excavated using a track-mounted hydraulic excavator supplied and operated by R. Pomerleau Ltd. (Pomerleau) through R.W. Tomlinson Limited (Tomlinson) of Ottawa, Ontario. The test pits were extended to depths of about 2.0 to 7.0 metres below the existing ground surface prior to the test pits being terminated or encountering practical refusal to excavating.

The hand augerhole was advanced manually using a hand auger by Golder Associates personnel to a depth of about 2.2 metres below ground surface prior to the side walls sloughing.

Within the test pits and hand augehole, the depths of strata were assessed visually from the sidewalls and samples of soils were obtained from each strata.

The fieldwork was supervised by a member from our engineering staff who located the test holes, directed the drilling, excavating operations, and in situ testing, logged the test holes and samples, and took custody of the soil and bedrock samples retrieved.

Upon completion of the drilling and excavating operations, samples of the soils and bedrock encountered in the test holes were returned to our laboratory for further examination by the project engineer and for laboratory testing. The laboratory testing included natural water content determination, grain size distribution, and Atterberg Limits.

Six samples of soil (one each from boreholes 13-4, 13-6, 13-13, 13-16, 13-23, and 13-31) were submitted to EXOVA laboratories for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried steel elements.

The borehole locations were selected by Golder Associates and were located in the field by a survey crew provided by Tomlinson. The ground surface elevation at each borehole location and the elevation of the top of each monitoring well completed in 2013 was determined by Golder Associates personnel and are referenced to Geodetic datum. The ground surface elevation for the 2016 boreholes was determined by Annis O'Sullivan Vollebekk Ltd. (AOV) and also referenced to Geodetic datum.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions encountered in the test holes put down for the current investigation are shown on the Record of Test Pit, Hand Augerhole, Borehole, and Drillhole Sheets in Appendix A. The results of the laboratory water content and Atterberg limits testing carried out on selected soil samples are also provided on the Record of Borehole Sheets. The results of grain size distribution and Atterberg limits testing carried out on selected samples of soils from the current investigation are provided on Figures 3 to 7.

The subsurface conditions encountered in the relevant boreholes and test pits from previous investigations on this site are shown on the Borehole and Test Pit Records in Appendix B.

The results of the basic chemical analysis carried out on six soil samples are provided in Appendix D.

In general, the subsurface conditions on this site consist of topsoil or peat (at the western portion of the site) overlying, sands, silts, and then overlying bouldery glacial till, above bedrock. The depth to the bedrock surface varies from about 2 to greater than 7 metres below the ground surface, generally increasing in depth from east to west.

The following sections present a more detailed overview of the subsurface conditions encountered in the test holes from the current investigation and the relevant test holes from the previous investigations.

4.2 Topsoil, Peat, and Fill

Topsoil exists at the ground surface at most of the test hole locations. Where encountered, the topsoil ranges from about 38 to 610 millimetres in thickness, but is typically less than about 350 millimetres in thickness.

Peat is present at the ground surface on the western portion of the site. The peat ranges from about 200 to 900 millimetres in thickness, but is more typically between 400 and 600 millimetres.

A layer of organic silt, about 110 millimetres thick, was encountered below the peat at test pit 16-20.

Fill was encountered at TP 08-1. At this location (at the time of the previous investigation) the fill was about 0.8 metres thick (the fill thickness may have changed since the previous investigation). The fill consists of topsoil overlain by sandy silt, some clay and a trace of gravel.

4.3 Clayey Silt and Silty Clay

Localized deposits of clayey silt and silty clay were encountered below the topsoil or peat at test pits 16-3, 16-15, TP 1, TP 4, augerhole AH 220, and boreholes 13-27, 13-30, BH 4 and PH 1 at depths of about 0.2 to 1.9 metres below the ground surface, with thicknesses varying from about 0.1 to 1.8 metres.

Three SPT "N" values measured in the clayey silt deposit ranged from 5 to 6 blows per 0.3 metres of penetration, indicating stiff consistency.

The results of Atterberg limit testing carried out on one sample of the silty clay measured a plasticity index value of about 12 percent and a liquid limit value of about 30 percent, indicating a soil of low to intermediate plasticity. The results of the Atterberg limits testing is presented on Figure 3. The measured water content on samples of the clayey silt and silty clay range from about 22 to 28 percent.

4.4 Sands and Silts

The topsoil, peat, and clayey soils are generally underlain by variable deposits of sands and silts. These deposits predominantly consist of sand, silty sand to sandy silt and silt, with varying amounts of gravel, cobbles and boulders. These deposits extend to depths ranging from about 0.6 to 6.7 metres below the ground surface, generally increasing in thickness from east to west.

SPT "N" values in the sandy and silty deposits ranged widely from 2 to 100 blows per 0.3 metres of penetration, indicating a very loose to very dense state of packing.

The measured water contents of samples from the sandy and silty soils vary from 8 to 64 percent.

The results of grain size distribution testing carried out on selected samples from these deposits are provided on Figures 4 to 6.

4.5 Glacial Till

A deposit of glacial till generally exists below the topsoil, peat, silty clay to clayey silt, and sand and silt deposits. The glacial till consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand to sandy silt.

Where fully penetrated (i.e., the bedrock was cored or the bedrock was observed in the test pits), the glacial till varies from about 0.6 to 6.9 metres in thickness and extends to depths ranging from about 2.6 to 7.0 metres below the existing ground surface. In the remaining test holes, the deposit was proven to depths of about 1.1 to 9.4 metres below the existing ground surface prior to the test holes encountering refusal to augering or being terminated.

SPT "N" values obtained in this deposit ranged widely from 6 to greater than 50 blows per 0.3 metres of penetration, indicating a loose to very dense state of packing. However, the higher "N" values likely reflect the presence of cobbles and boulders within the deposit or the bedrock surface, rather than the actual state of packing of the soil matrix. In several of the boreholes, rotary diamond drilling techniques were required to penetrate past the boulders in this deposit.

The measured water contents of samples of the glacial till ranged from 4 to 17 percent.

The results of grain size distribution testing carried out on selected samples from the glacial till deposit are provided on Figure 7.

4.6 Refusal or Bedrock

Practical refusal to augering or excavating was encountered at depths varying between about 1.1 to 9.4 metres below the existing ground surface. Refusal may indicate the bedrock surface; however, it could also represent boulders within the glacial till.

The bedrock surface was confirmed/proven to exist at depths ranging from about 2.6 to 7.0 metres below the existing ground surface. Fifteen (15) of the boreholes (numbered 13-1, 13-3, 13-6, 13-10, 13-13, 13-17, 13-18, 13-24, 16-101 to 16-104, 16-107, 16-111, and 16-113) were extended into the bedrock for depths of about 0.5 to 3.9 metres using rotary diamond drilling techniques while retrieving NQ or HQ sized core.

The following table provides a summary of the ground surface elevation, depth to the bedrock surface, and the elevation of the bedrock surface; elevations are provided in metres above sea level (masl).

Borehole/ Test Pit Number	Ground Surface Elevation (masl)	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (masl)
13-1	95.95	2.59	93.36
13-3	103.12	6.30	96.82
13-6	95.28	4.52	90.76
13-10	105.83	7.01	98.82
13-13	97.97	3.91	94.06
13-17	99.15	4.44	94.71
13-18	94.74	3.35	91.39
13-24	94.43	6.27	88.16
16-3	95.21	3.20	92.01
16-4	94.17	4.10	90.07
16-5	96.75	2.00	94.75
16-6	98.93	4.20	94.73
16-7	103.09	6.10	96.99
16-8	94.33	3.00	91.33
16-9	99.62	3.40	96.22
16-10	94.62	2.50	92.12
16-11	95.03	3.50	91.53
16-12	96.68	4.20	92.48
16-13	94.43	5.10	89.33
16-14	96.91	2.90	94.01
16-16	95.92	4.60	91.32
16-101	96.98	3.48	93.50
16-102	94.76	6.29	88.47
16-103	98.05	5.10	92.95
16-104	95.82	4.49	91.33
16-107	94.24	4.78	89.46
16-111	94.47	5.09	89.38
16-113	94.75	4.57	90.18

The bedrock encountered in the boreholes consists of sandstone, dolostone, and limestone, with black shale partings. The bedrock is generally slightly weathered to fresh, thinly to thickly bedded, and light grey to light brown in colour.

The Rock Quality Designation (RQD) values measured on the recovered bedrock core samples were quite variable and ranged between 0 and 96 percent, indicating a very poor to excellent rock quality.

4.7 Groundwater and Hydraulic Conductivity

Monitoring devices or standpipe piezometers were installed in 18 of the boreholes. The groundwater level measurement and in situ hydraulic conductivity testing were carried out on October 28 through November 12, 2013 and on November 11, 2016.

The following table summarizes the measured groundwater levels and the calculated hydraulic conductivity.

Borehole Number	Geological Unit	Date of Measurement	Ground Surface Elevation (masl)	Water Level Depth (m)	Water Level Elevation (masl)	Estimated Hydraulic Conductivity (m/s)
13-1A	Bedrock	Nov 12, 2013	95.95	3.20	92.75	1×10^{-3}
13-1B	Glacial Till	Nov 12, 2013	95.95	2.05	93.90	-
13-3A	Bedrock	Nov 12, 2013	103.12	3.48	99.64	8×10^{-5}
13-3B	Glacial Till	Nov 12, 2013	103.12	3.49	99.63	7×10^{-8}
13-9	Glacial Till	Nov 12, 2013	106.35	-0.11[1]	106.46	5×10^{-6}
13-13A	Bedrock	Nov 12, 2013	97.97	2.91	95.06	4×10^{-4}
13-13B	Glacial Till	Nov 12, 2013	97.97	2.89	95.08	9×10^{-8}
13-17A	Bedrock	Nov 8, 2013	99.15	1.79	97.36	3×10^{-5}
13-17B	Glacial Till	Nov 8, 2013	99.15	1.31	97.84	3×10^{-6}
13-18A	Bedrock	Oct 28, 2013	94.74	-0.05[1]	94.79	3×10^{-5}
13-18B	Glacial Till/ Sands and Silts	Oct 28, 2013	94.74	0.08	94.66	5×10^{-7}
13-20	Glacial Till	Nov 4, 2013	97.05	0.55	96.50	1×10^{-5}
13-24A	Bedrock	Oct 28, 2013	94.43	0.11	94.32	1×10^{-5}
13-24B	Sands and Silts	Oct 28, 2013	94.43	0.05	94.38	3×10^{-6}
13-25	Sands and Silts	Nov 7, 2013	94.91	-0.21[1]	95.12	2×10^{-6}
13-26A	Sands and Silts	Nov 7, 2013	95.44	-0.02[1]	95.42	7×10^{-6}
13-26B	Sands and Silts	Nov 7, 2013	95.44	0.00	95.46	1×10^{-6}
13-29A	Glacial Till	Nov 4, 2013	97.10	0.08	97.02	9×10^{-6}
13-29B	Sands and Silts	Nov 4, 2013	97.10	0.06	97.04	3×10^{-6}
13-32A	Glacial Till	Nov 7, 2013	96.12	0.10	96.02	6×10^{-6}
13-32B	Sands and Silts	Nov 7, 2013	96.12	0.12	96.00	6×10^{-6}
13-33A	Glacial Till	Nov 8, 2013	100.93	0.71	100.22	9×10^{-5}
13-33B	Sands and Silts	Nov 8, 2013	100.93	0.72	100.21	2×10^{-6}
16-101	Bedrock	Nov 11, 2016	96.98	2.71	94.27	-
16-104	Glacial Till/Bedrock	Nov 11, 2016	95.82	4.27	91.55	-
16-106	Glacial Till	Nov 11, 2016	103.84	4.43	99.41	-
16-107	Glacial Till	Nov 11, 2016	94.24	1.69	92.55	-
16-111	Bedrock	Nov 11, 2016	94.47	0.51	93.96	-

Note: [1] Negative value indicates the measured water level above ground surface.

Groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

5.0 DISCUSSION

5.1 General

This section of the report provides engineering recommendations on the geotechnical design aspects of this project based on our interpretation of the test hole information as well as the project requirements, and is subject to the limitations in the "Important Information and Limitations of This Report" attachment which follows the text of this report, but forms an integral part of this document.

5.2 Site Grading

In general, the subsurface conditions at this site consist of topsoil or peat, overlying variable thicknesses of clays, silts, and sands, followed by glacial till, which is in turn underlain by bedrock. The surface of the bedrock undulates and was encountered at depths ranging from about 2.0 to 7.0 metres below the existing ground surface.

From a foundation design perspective, no practical restrictions apply to the thickness of grade raise fill that may be placed within the proposed residential development area. However, grade raises in excess of 2.5 metres should be reviewed and approved.

With regards to the site grading, it should be noted that excavations for basement construction and installation of the site services within some parts of the site will extend below the groundwater level in the sands and silts. These deposits are somewhat permeable and therefore, in these areas, there would be some advantage to limiting the required depth of excavation (particularly for basements), since the groundwater management requirements (and costs) would increase with excavation depth below the groundwater level. It would be preferred, from a geotechnical perspective, to limit the depth of excavation for basement construction to no more than about 1 metre below the *existing* ground surface.

For predictable performance of the structures, roadways, and site services, preparation for filling of the site should include stripping the existing topsoil (which is up to about 0.6 metres thick) and peat (which is up to about 0.9 metres thick). The topsoil or peat is not suitable as general fill and should be stockpiled separately for re-use in landscaping applications only. In areas with no structures, roadways or services, the existing topsoil or peat may be left in place provided some long term settlement of the ground surface following filling above them can be tolerated.

5.3 Foundations

With the exception of the topsoil and peat, the native undisturbed soils and bedrock at this site are considered suitable for the support of conventional wood frame houses and townhouse blocks on spread footing foundations.

For design purposes, the allowable bearing pressures for spread footings (for the houses and apartment buildings) may be taken as 75 kilopascals for the silty clay to clayey silt as well as sands and silts, provided the soils have not been disturbed by groundwater inflow. For footings founded on the glacial till, an allowable pressure of 100 kilopascals may be used. For footings founded on the bedrock, an allowable bearing pressure of 250 kilopascals may be used.

The post-construction total and differential settlements of footings sized using the above maximum allowable bearing pressures should be less than about 25 and 15 millimetres, respectively, provided that the overburden soils at or below the founding level are not disturbed during construction. Suitable control of the groundwater inflow is required if such disturbance is to be avoided. Footings on bedrock should experience negligible settlements.

The glacial till at this site contains cobbles and boulders. Any boulders in footing areas that have been loosened by the excavation process should be removed and the cavity filled with lean concrete.

At some locations on the property, and depending on the amount of proposed grade raise (i.e., filling), the inorganic or native subgrade elevation may be lower than the underside of footing elevation. At these locations, the subgrade may be raised to the footing elevation using engineered fill consisting of Ontario Provincial Standard Specification (OPSS) Granular B Type II, placed in maximum 300 millimetre thick lifts, and compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment. The engineered fill material must be placed within the full zone of influence of the house foundations. The zone of influence is considered to extend out and down from the edge of the perimeter footings at a slope of 1 horizontal to 1 vertical (1H:1V).

Where the subgrade at footing level changes from bedrock to overburden, differential settlement could result at this transition due to the different settlement properties of these materials. To limit the magnitude of the differential settlement, transition details (such as placing additional reinforcing steel in the foundation walls) may be required. The structural engineering consultant should be contacted for input on this issue.

There may be portions of the site where the shallow sand and silt deposits will be exposed at footing/subgrade level. Prior to construction of footings or the placement of engineered fill within these areas, the surface of the native sandy and silty materials should be proof rolled to provide surficial densification of any loose or disturbed material.

Since these sandy deposits, where present, are sometimes "loose", they could be potentially liquefiable in an earthquake (i.e., potentially subject to temporary strength loss and post-earthquake settlements). That potential issue is not however considered relevant to the house design because:

- The potential post-earthquake differential settlements would be relatively small in relation to the expected collapse potential of a house (and the objective of earthquake-resistant design is only to avoid collapse and to provide for safe exit).
- The proof rolling of the sandy subgrade soils, as specified above, would densify any such soils in the immediate area of the footings and therefore the directly supporting soils would be non-liquefiable.

5.4 Seismic Design

The seismic design provisions of the 2012 Ontario Building Code (OBC) depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or bedrock below founding level. Based on the 2012 OBC methodology, this site can be assigned a Site Class of D, acknowledging that this requirement does not apply to ground oriented residential structures designed per Part 9 of the OBC.

More favourable Site Class values could potentially be assigned for portions of the site if shear wave velocity testing were carried out. The founding levels versus the bedrock levels would also need to be known. However, it is considered that a Site Class of D permits conventional foundation design for this site.

5.5 Frost Protection

The soils at this site are frost susceptible. For frost protection purposes, all exterior footings or interior footings in unheated areas should be provided with a minimum of 1.5 metres of earth cover. Isolated, exterior footings adjacent to surfaces that are cleared of snow cover during winter months should be provided with a minimum of 1.8 metres of earth cover.

Particular attention to frost protection details will be required around the below grade entrances for the apartment buildings. Insulation could be provided as an alternative to earth cover for frost protection.

5.6 Basement Excavations

Excavations for basements will be through the topsoil or peat, and into the underlying silty clay to clayey silt, and sandy and silty deposits. Excavations into the glacial till will be required where the surface of the till is shallower, which will be the case at the eastern portion of the site. Bedrock excavation may also be required depending on the proposed site grading.

No unusual problems are anticipated in excavating the overburden materials using conventional hydraulic excavating equipment, recognizing that large boulders (which may be nested) will likely be encountered in the glacial till. Boulders larger than 0.3 metres in size should be removed from the excavation side slopes, for worker safety.

Based on the measured groundwater levels, excavations deeper than about 1 to 2 metres, depending on the area of the site, will likely extend below the groundwater level. Where this is the case, the excavation will be subject to disturbance to the soils caused by upward flow of groundwater, resulting in possible disturbance of the excavation subgrade and potential instability of the excavation side slopes.

The groundwater levels at this site range from about the existing ground surface to about 4.5 metres below the ground surface. Provided that the basement excavations are no more than about 1 metre deep (relative to the current ground surface level), it is considered that it should generally be possible to handle the groundwater inflow by pumping from well filtered sumps in the floor of the excavations. Where the subgrade is found to be wet and sensitive to disturbance, consideration should be given to placing a mud slab of lean concrete over the subgrade (following inspection and approval by geotechnical personnel), or a 150 millimetre thick layer of OPSS Granular A underlain by a non-woven geotextile, to protect the subgrade from construction traffic.

Some pre-drainage of the site using ditching, or pumping from one or more sumps to locally lower the groundwater level to at least 0.5 metres below the floor of the excavation would assist in avoiding subgrade disturbance, where the subgrade consists of sandy soils. These measures would be particularly necessary wherever the excavation will extend more than about 1 metre below the existing ground surface.

Consideration should be given at the time of tender for the basement excavating work to carrying out a few test excavations across the site in presence of bidders so that the actual excavation conditions and rate of groundwater inflow can be assessed.

Where the groundwater level is lowered below the floor of the excavation in advance of construction, excavation side slopes should be stable in the short term at 1H:1V. In accordance with the Occupational Health and Safety Act of Ontario (OHSA), excavation side slopes below the groundwater will need to be cut back at 3H:1V vertical (i.e., Type 4 soils). If required, near vertical trench walls in the bedrock should stand unsupported for the construction period.

5.7 Basement and Garage Floor Slabs

In preparation for the construction of the basement floor slabs, all loose, wet, and disturbed material should be removed from beneath the floor slabs. Provision should be made for at least 200 millimetres of 19 millimetre crushed clear stone to form the base of the basement floor slabs. The underslab fill should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

To prevent hydrostatic pressure build up beneath the basement floor slabs, it is suggested that the granular base for the floor slabs be positively drained. This could be achieved by providing a hydraulic link between the underfloor fill material and the exterior drainage system.

The groundwater levels at this site range from near the existing ground surface to about 4.5 metres below the ground surface. The sandy and silty soils at this site are relatively permeable and therefore, if/where the groundwater level is encountered above the basement subgrade level, a geotextile could be required between the clear stone underslab fill and the subgrade soil, to avoid loss of fine soil particles from the subgrade soil into the voids in the clear stone and ultimately into the drainage system. Where a geotextile is required, it should consist of a Class II non-woven geotextile with a Filtration Opening Size (FOS) not exceeding 100 microns, in accordance with OPSS 1860.

The backfill material inside the garage should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment. The granular base for the garage floor slab should consist of at least 150 millimetres of OPSS Granular A compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

5.8 Basement Walls and Foundation Wall Backfill

The soils at this site are frost susceptible and should not be used as backfill directly against exterior, unheated, or well insulated foundation elements. To avoid problems with frost adhesion and heaving, these foundation elements should either be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for OPSS Granular B Type I or, alternatively, a bond break such as the Platon system sheeting could be placed against the foundation walls.

Drainage of the wall backfill should be provided by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to an adjacent storm sewer or sump pit. Conventional damp proofing of the basement walls is appropriate with the above design approach.

Should the foundations be designed in accordance with Part 4 of the OBC, further guidelines on the foundation wall design will be required.

5.9 Site Servicing

Excavations for the installation of site services will be made through the topsoil or peat, clayey soils, silty and sandy deposits, glacial till, and into the underlying bedrock. Based on the observed groundwater levels at this site, the excavations are expected to extend below the groundwater level.

No unusual problems are anticipated in excavating in the overburden using conventional hydraulic excavating equipment, recognizing that large boulders may be encountered in the glacial till. Boulders larger than 0.3 metres in size should be removed from the excavation side slopes, for worker safety.

Excavation side slopes above the water table should be stable in short term at 1H:1V (i.e., for Type 3 soils per OSHA of Ontario). Excavation side slopes below groundwater level will need to be cut back at 3H:1V (i.e., Type 4 soils).

The stand up time for exposed side slopes will be extremely short and the subgrade will be disturbed if left exposed for any length of time. Construction of site services should be planned to be carried out in short sections, which can be fully completed in a minimal amount of time. The rate of groundwater inflow from the overburden could be significant. Based on past experience on the adjacent sites and particularly where the excavations are deeper and/or where the overburden is coarser, some pre-drainage of the overburden will be required. For example, several sumps could be constructed and pre-pumping of the overburden carried out.

Alternatively, excavations within the overburden soils could also be carried out within a fully braced steel trench box, which would minimize the width of the excavation. The use of a trench box will not, however, eliminate the potential for disturbance outside the trench box limits.

Excavation through the bedrock will likely require drill and blast procedures. Mechanical break-up of the bedrock using a hoe ram may be slow. Equipment wear (such as for drill bits) could be significant.

Near vertical trench walls in the bedrock should stand unsupported for the construction period.

Some groundwater inflow through the overburden into the excavations should be expected. However, it should be possible to handle the groundwater inflow by pumping from well filtered sumps in the excavations provided that multiple suitably sized pumps are used.

However, significant groundwater inflow should be expected where the excavation extends into/through the upper zone of bedrock. The hydraulic conductivity value for the bedrock at this site is estimated to be in the order of $1x10^{-3}$ to $1x10^{-5}$ metres per second (m/s). The contractor should therefore be made aware that the pumping requirements will be significant. Pre-pumping from sumps in the bedrock for a period of up to a few weeks might be a feasible method to lower the groundwater level.

Additional guidelines pertaining to groundwater control are provided in Section 5.10.

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. The bedding material should, in all cases, extend to the spring line of the pipe and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project, since fine particles from the sandy backfill materials or sandy soils on the trench walls could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the overburden soils and bedrock as trench backfill, provided the bedrock is well broken and broadly graded (maximum size of 300 millimetres). The rock fill, however, should only be placed from at least 300 millimetres above the pipes to avoid damage due to impact or point load. Material from below the water table may be re-used provided that it can be adequately placed and compacted.

Some of the overburden materials below the water table may be too wet to compact. Where that is the case, these materials should be wasted (and drier materials imported) or these materials should be placed only in the lower portions of the trench, recognizing that some future ground settlement over the trenches will likely occur. In that case, it would also be prudent to delay final paving for as long as practical and significant padding of the roadways may be required in these areas prior to final paving.

Boulders larger than 300 millimetres in diameter will also interfere with the backfill compaction and should be removed from the excavated material prior to re-use as backfill.

Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility. Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

Low permeability dykes or cut-offs should be constructed at 100 metre intervals in the service trenches, in particular along main service lines within the development that have continuity with off-site services, to reduce groundwater lowering at the site due to the 'french drain' effect of the granular bedding and surround for the service pipes. It is important that these barriers extend from trench wall to trench wall and that they fully penetrate the granular materials to the trench bottom. The dykes should be at least 1.5 metres wide and could be constructed using relatively dry (i.e., compactable) grey brown weathered silty clay.

5.10 Groundwater Control

5.10.1 Inflow Estimate and Radius of Influence

Significant groundwater control has typically been required during the installation of site services into the upper bedrock zone in the adjacent Findlay Creek Village development, due to the highly permeable and fractured nature of the upper bedrock. Groundwater control requirements in service trenches completed in the silty and sandy deposits and/or glacial till overburden have been typically much smaller.

For example, pumping rates used during the excavation to install the deep trunk storm sewer at Findlay Creek Village in 2005/2006 to a depth of about 5 to 6 metres into the bedrock were typically on the order of 1,000,000 litres per day (L/day) with peaks for several days up to 10,000,000 L/day and 18,000,000 L/day in July 2006. These rates were found to be sufficient to effectively facilitate temporary groundwater control in the sewer excavations. Based on the groundwater elevations recorded in the existing monitoring wells during this period, the radius of influence of this temporary pumping was estimated to be approximately 1,500 metres from the excavation.

In October and November 2013, groundwater pumping from excavations extending into the upper bedrock at Cedar Creek Drive, just south of the existing commercial development at Findlay Creek Village, resulted in a measureable decline of about 0.2 metres in groundwater levels at the groundwater monitors located more than 850 metres from the pumping location. Pumping volumes during this period ranged up to 1,200,000 L/day.

The range of hydraulic conductivity values calculated at the overburden and bedrock groundwater monitors installed on the Remer and Idone Lands is similar to the range calculated at the monitors installed at Findlay Creek Village, therefore the groundwater inflow to service trenches on the Remer and Idone Lands can reasonably be expected to be similar to analogous excavations on Findlay Creek Village lands.

The highest pumping rates are expected when pumping from trenches that extend into the bedrock (i.e., generally along the northern boundary area of the Remer Lands). Based on the measured groundwater levels, approximately 4.5 to 5.0 metres of groundwater level lowering is anticipated to be required in these service trenches.

A hydrogeological analysis was carried out to estimate the groundwater inflow. The analysis assumes that the sewer invert elevations/depths for the final sewer system layout and design will be similar to those provided by IBI Group in correspondence dated June 23, 2014.

The groundwater flow analysis assumes that up to 120 metres of the trench excavation would be open at one time, with a trench width of 5 metres. It was assumed that the groundwater elevation would need to be lowered to 5 metres below the existing groundwater elevation. The Dupuit-Forchheimer flow equation for an unconfined aquifer (Powers, 2007, eq. 6.3) was used to estimate the potential inflow to the trench excavation. Since groundwater inflow at this location will enter the trench from both the overburden and bedrock, the hydraulic conductivity used for this analysis was a depth-averaged value, using the highest (conservative) estimated hydraulic conductivities for the bedrock and the overburden in this part of the site (1×10^{-3} m/s and 1×10^{-5} m/s, respectively). The resulting depth-averaged hydraulic conductivity value was 2.6×10^{-4} m/s.

The results of the analytical modelling for groundwater inflows using the assumed trench excavation configuration are provided in Appendix C and summarized in the following table:

Assumed Hydraulic Conductivity	Initial Pumping Rate	Estimated Steady-State Pumping Rate	Estimated Steady-State Radius of Influence
2.6×10^{-4} m/s	9,100,000 L/day	2,600,000 L/day	240 metres

Based on the results of the analytical model, a pumping rate of approximately 9,100,000 L/day could be required to initially dewater the trench excavation; however, the steady state dewatering rate (i.e., water taking rate once the excavation is fully dewatered) to maintain the trench in a dewatered condition is estimated to be approximately 2,600,000 L/day. These values are similar to the groundwater pumping rates used in 2005/2006 and in 2013 at Findlay Creek Village under similar hydrogeologic conditions and trench configurations.

The radius of influence of temporary dewatering is estimated to range from approximately 240 metres (derived from the analytical model) to 1,500 metres (estimated for the 2005/2006 trunk sewer installation) from the excavation (see Appendix C).

5.10.2 Potential Effects of Dewatering on the Leitrim Wetland

For groundwater taking from trench excavations that extend into the bedrock, the estimated radius of influence ranges from 240 to 1,500 metres from the excavation. Trenches that are anticipated to extend into the bedrock are generally located along the northern boundary of the Remer Lands, as close as 120 metres from the boundary of the Leitrim Core Wetland. Drawdown of bedrock groundwater levels in the wetland is therefore anticipated during construction dewatering.

The maximum drawdown observed in the overburden and bedrock monitors at Findlay Creek Village in July 2006 and October 2013 was plotted against the distance to each monitor from the approximate geographical centre of pumping locations, to create the distance-drawdown graph as shown in Figure 8. When the x-axis (approximate distance from the centroid of the pumping locations) is logarithmic, as shown in Figure 8, the distance-drawdown relationship can be fairly accurately represented by a straight line.

Assuming that the groundwater elevation along the northern boundary area of the Remer Lands would need to be temporarily lowered to a maximum of 5.0 metres below the existing groundwater elevation, and assuming that the radius of influence would be approximately 1,500 metres from the excavation, a drawdown curve has also been plotted on Figure 8 to estimate the extent of groundwater lowering near the excavation. Figure 8 shows that the expected drawdown at 120 metres from the centroid of the pumping locations (i.e., the closest that the service trenches that extend into bedrock come to the wetland) is approximately 1.8 metres, and that at 500 metres, the expected drawdown in the bedrock is approximately 0.8 metres.

At Findlay Creek Village, groundwater pumping from bedrock excavations has been observed to induce a response in overburden groundwater levels. However, the magnitude of the response in the overburden groundwater levels has typically been smaller than the change in bedrock groundwater levels at the same location. Once pumping stopped following the previous historical groundwater control events, the overburden and bedrock groundwater levels were observed to quickly recover to pre-pumping levels (i.e., within hours to a few days).

If variations in the overburden groundwater levels are short-term in nature, impacts to vegetative communities are not expected to occur. The groundwater pumping requirements for servicing of the Remer and Idone Lands are expected to be similar to historical pumping requirements at Findlay Creek Village (i.e., continuous pumping at a rate on the order of 1,000,000 L/day for four to five months with peaks for several days at pumping rates of approximately 10,000,000 L/day to 18,000,000 L/day).

Observations made by biologists conducting photomonitoring and other surveys since 2006 as part of the ongoing vegetation monitoring program in the Leitrim Core Wetland areas to the north have not indicated adverse effects due to temporary groundwater control activities. Since the proposed groundwater taking regime at the Remer and Idone Lands is expected to be similar to the historical groundwater pumping durations and rates at the nearby Findlay Creek Village, it is anticipated that the proposed temporary pumping will not impact the function of the Leitrim Core Wetland. If water taking is required within the overburden, it is also not expected to impact the function of the Leitrim Core Wetland. In addition, no adverse long-term changes in water quantity or quality are expected due to the proposed temporary groundwater control activities required to install services in the Remer and Idone Lands.

Under the new regulations, which came into force on March 29, 2016, if the pumping volumes exceed 400,000 L/day, a Category 3 Permit-To-Take-Water (PTTW) will be required from the Ministry of the Environment and Climate Change (MOECC). A Category 3 PTTW will be required for this site due to the expected high volumes of water that will need to be pumped from the trench excavations. The time required to obtain a PTTW can be several months. Consideration should therefore be given to applying for the permit well in advance of construction.

5.11 Pavement Design

In preparation for pavement construction, all topsoil and peat should be removed from all pavement areas.

Sections requiring grade raising to the proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow or OPSS Select Subgrade Material (SSM). These materials should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the materials' standard Proctor maximum dry density using suitable compaction equipment.

The surface of the subgrade or fill should be crowned to promote drainage of the pavement granular structure. Perforated pipe subdrains should be provided at subgrade level extending from the catch basins for a distance of at least 3 metres in four orthogonal directions or longitudinally where parallel to a curb.

The pavement structure for local roads, which will not experience bus or truck traffic (other than school bus and garbage collection), should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	375

The pavement structure for collector roadways which will experience bus and/or truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	450

The granular base and subbase materials should be uniformly compacted to at least 100 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment. The asphaltic concrete should be compacted in accordance with Table 10 of OPSS 310. The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 millimetres Surface Course – 40 millimetres
- Superpave 19 millimetres Base Course – 50 millimetres

The asphaltic cement should consist of PG 58-34 and the design of the mixes should be based on a Traffic Category B for local roads and Category D for collector roads.

The above pavement design is based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where the trench backfill and grade raise fill have been adequately compacted to the required density and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a woven geotextile beneath the granular materials.

5.12 Park Lands

Three parks are currently being proposed on this site and are to be located within Blocks 414, 446 and 464.

The subsurface conditions in the proposed park land areas generally consist of peat (only at Block 414) and/or topsoil, overlying variable deposits of sands and silts, and glacial till. Peat was not encountered within Blocks 446 and 464. However, approximately 610 to 760 millimetres of peat was encountered in three of the test holes (BH13-25, BH13-26, and AH219) put down within Block 414.

Overall, the subsurface conditions in the proposed park areas are considered to be similar to the subsurface conditions on the adjacent roadways and building lots (i.e., the thickness of peat or topsoil within the park areas is not greater than that of the topsoil within the adjacent roadways and building lots).

As is typical, prior to any filling of the park areas, any topsoil or peat should be removed from within the footprints of any grade dependent structures, concrete slabs, playing fields, and pavements for predictable performance of structures and "grades" (the same guidelines apply to the adjacent roadways and building lot areas). In areas with no proposed structures, services, or roadways, the topsoil or peat may be left in-place provided some settlement of the ground surface following filling above them can be tolerated. The native inorganic overburden soils within the park land areas are considered suitable for the support of grade dependent structures.

Provided that the topsoil and/or peat are removed (which is also a requirement for the adjacent roadways and building lots), it is considered that no unusual design or construction criteria will be required for future buildings or play structures within the park area from a geotechnical point of view.

5.13 Pools, Decks and Additions

5.13.1 Above Ground and In Ground Pools

No special geotechnical considerations are necessary for the installation of in-ground or above ground pools.

5.13.2 Decks

There are no special geotechnical considerations for decks on this site.

5.13.3 Additions

Any proposed addition to a house (regardless of size) will require a geotechnical assessment. Written approval from a geotechnical engineer should be required by the City of Ottawa prior to the building permit being issued.

5.14 Tree Planting Restrictions

Silty clay soils in the Ottawa area are highly sensitive to water depletion by trees of high water demand during periods of dry weather. When trees draw water from the silty clay, the silty clay undergoes shrinkage which can result in settlement of adjacent structures.

Based on the results of this subsurface investigation, silty clay soils exist within the extreme southwest corner of the site (in TP 1). However, this area is designated as a "No Touch Zone" (i.e., no structures will constructed in this area). This being the case, there are no tree planting restrictions for this site.

A localized layer of silty clay was also encountered near the ground surface at test pit 16-15 along the west part of the north site boundary. The silty clay is only about 350 millimetres thick and has a low to intermediate plasticity. However, the silty clay is very localized (i.e., not encountered in other test holes), has a limited thickness, and is located at the site boundary. Based on the above, it is considered that tree planting restrictions do not apply to this site, as concluded above.

5.15 Corrosion and Cement Type

Six samples of soils, one each from boreholes 13-4, 13-6, 13-13, 13-16, 13-23 and 13-31, were submitted to EXOVA laboratories for chemical analysis related to potential corrosion of exposed buried ferrous elements and potential sulphate attack on buried concrete elements. The results of the analysis are provided in Appendix D.

The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a moderate to elevated potential for corrosion of exposed ferrous metal, which should be considered in the design of the substructures.

6.0 ADDITIONAL CONSIDERATIONS

The soils on this site are sensitive to disturbance from ponded water, construction traffic, and frost.

All footing and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that soils having adequate bearing capacity have been reached and that the bearing surfaces have been properly prepared. The placing and compaction of any engineered fill as well as sewer bedding and backfill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction view point.

The test pits excavated and backfilled during the current and previous investigations constitute zones of disturbance to the native soils. The presence of the backfill materials could affect the performance of surface structures or other settlement-sensitive facilities should they be constructed above the zone of influence of those locations. In such cases, the excavated soil should be removed and replaced with engineered fill.

The groundwater level monitoring devices installed at the site will require decommissioning in accordance with Ontario Regulation 128/03. However, it is expected that most of the wells will either be destroyed during construction or can be more economically abandoned as part of the construction contract. If that is not the case or is not considered feasible, abandonment of the monitoring wells can be carried out separately.

Golder Associates should be retained to review the final drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

7.0 CLOSURE

We trust that this report meets your current requirements. If you have any questions, or if we may be of further assistance, please contact the undersigned.

GOLDER ASSOCIATES LTD.

LICENSED PROFESSIONAL ENGINEER
P. F. C. KO
100103970
26/1/17
PROVINCE OF ONTARIO

Christine Ko, P.Eng.
Geotechnical Engineer

Troy Skinner, P.Eng.
Associate, Senior Geotechnical Engineer

KM/CK/TMS/PAS/sg/ob
\\golder.gds\gal\ottawa\active\2013\1121 - geotechnical\13-1121-0083 remer and idone lands\phase 1046 remer detailed design\05-report\13-1121-0083-1046_rpt-001_geotech_24jan2017.docx

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

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

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, Leitrim South Holdings Inc. and 4840 Bank St. Ltd. c/o The Regional Group. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

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

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

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

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

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

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

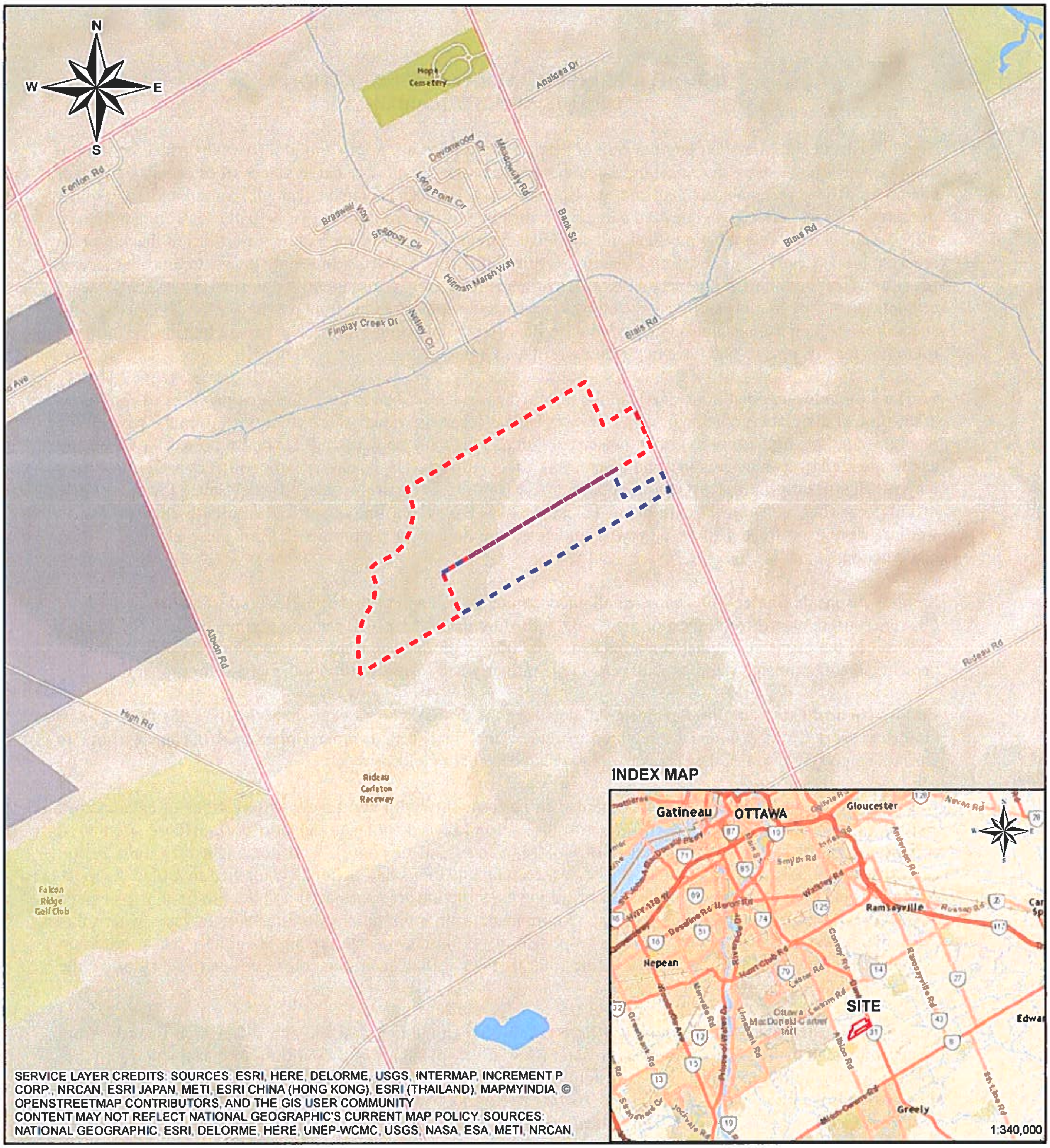
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater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

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

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

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

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



LEGEND

- REMER LANDS STUDY AREA BOUNDARY
- IDONE LANDS STUDY AREA BOUNDARY

500 250 0 500

SCALE 1:25,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 13-1121-0083 (1046).

REFERENCE

DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9

PROJECT

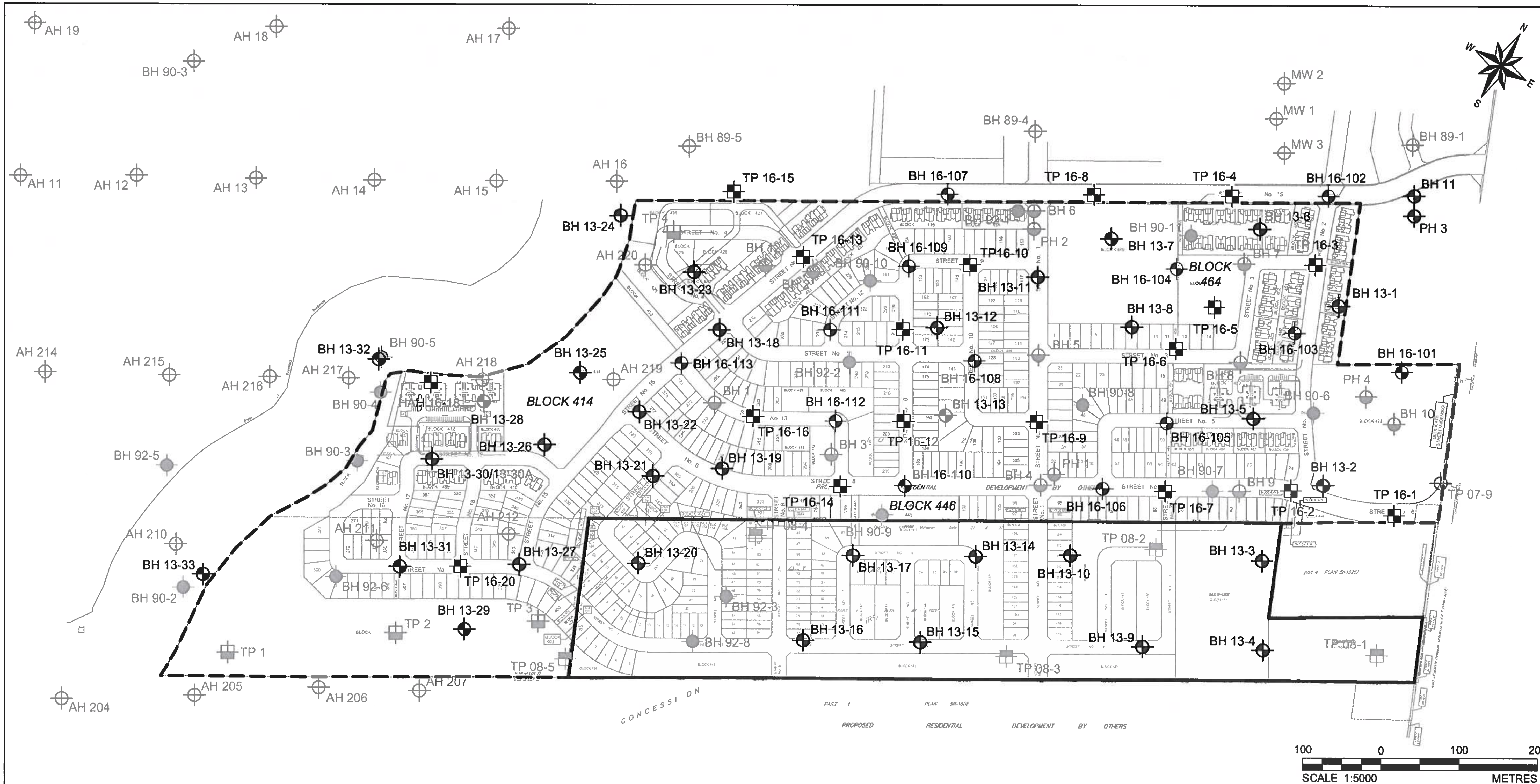
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT, REMER AND IDONE LANDS
OTTAWA, ONTARIO

TITLE

KEY PLAN

Golder Associates

PROJECT No. 13-1121-0083			SCALE AS SHOWN	REV. 0.0
DESIGN	CK	2016-12-22	FIGURE 1	
GIS	BR	2016-12-22		
CHECK	CK	2016-12-22		
REVIEW	TMS	2016-12-22		



LEGEND

- APPROXIMATE BOREHOLE LOCATION IN PLAN, CURRENT INVESTIGATION
- APPROXIMATE TEST PIT/HAND AUGERHOLE, CURRENT INVESTIGATION
- APPROXIMATE TEST PIT LOCATIONS IN PLAN, PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD. REPORT No. 08-1121-0044
- APPROXIMATE BOREHOLE LOCATIONS IN PLAN, PREVIOUS INVESTIGATION BY JACQUES WHITFORD, REPORT No 30227-1
- APPROXIMATE BOREHOLE LOCATIONS IN PLAN, PREVIOUS INVESTIGATION BY JDP, REPORT No PG0627
- APPROXIMATE TEST PIT LOCATIONS IN PLAN, PREVIOUS INVESTIGATION BY JDP, REPORT No PG0627
- APPROXIMATE BOREHOLE, TEST PIT AND HAND AUGERHOLE LOCATIONS IN PLAN, PREVIOUS INVESTIGATIONS BY GOLDER ASSOCIATES LTD.
- IDONE LANDS STUDY AREA BOUNDARY
- REMER LANDS STUDY AREA BOUNDARY

REFERENCE

BASE DATA PLAN PROVIDED IN ELECTRONIC FORMAT BY STANTEC, 2017-01-05.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9

NOTE

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD.REPORT NO.13-1121-0083 (1046)
2. BOREHOLES "GREYED OUT" FOR CLARITY
3. LOCATIONS FOR BH 13-21, BH 13-30, HAH 16-18 AND TP 16-20 ARE APPROXIMATE ONLY

Golder Associates
Ottawa, Ontario

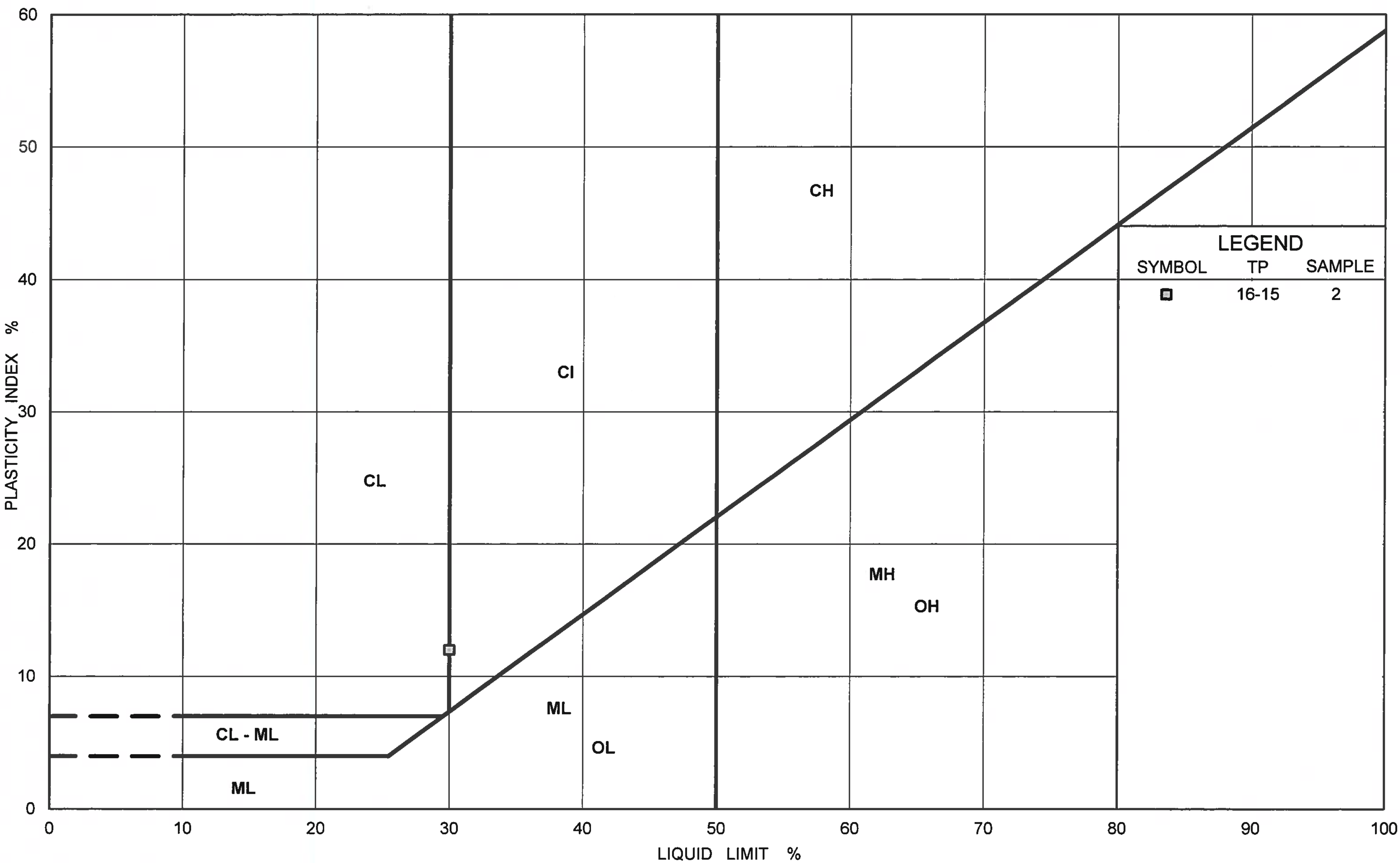
SCALE	AS SHOWN	TITLE	SITE PLAN
DATE	2016-08-17		
DESIGN			
CADD	JM/BR		
CHECK	CK		
REVIEW	TMS		

FILE No. 1311210083-1046-02.dwg
PROJECT No. 13-1121-0083 REV.

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
REMER AND IDONE LANDS, OTTAWA, ONTARIO

FIGURE 2

FILENAME: N:\Active\2013\1121 - Geotechnical\13-1121-0083 Remer and Idone Lands\Spatial_IM\GIS\Autocad\Phase 1046\1311210083-1046-02.dwg



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PLASTICITY CHART

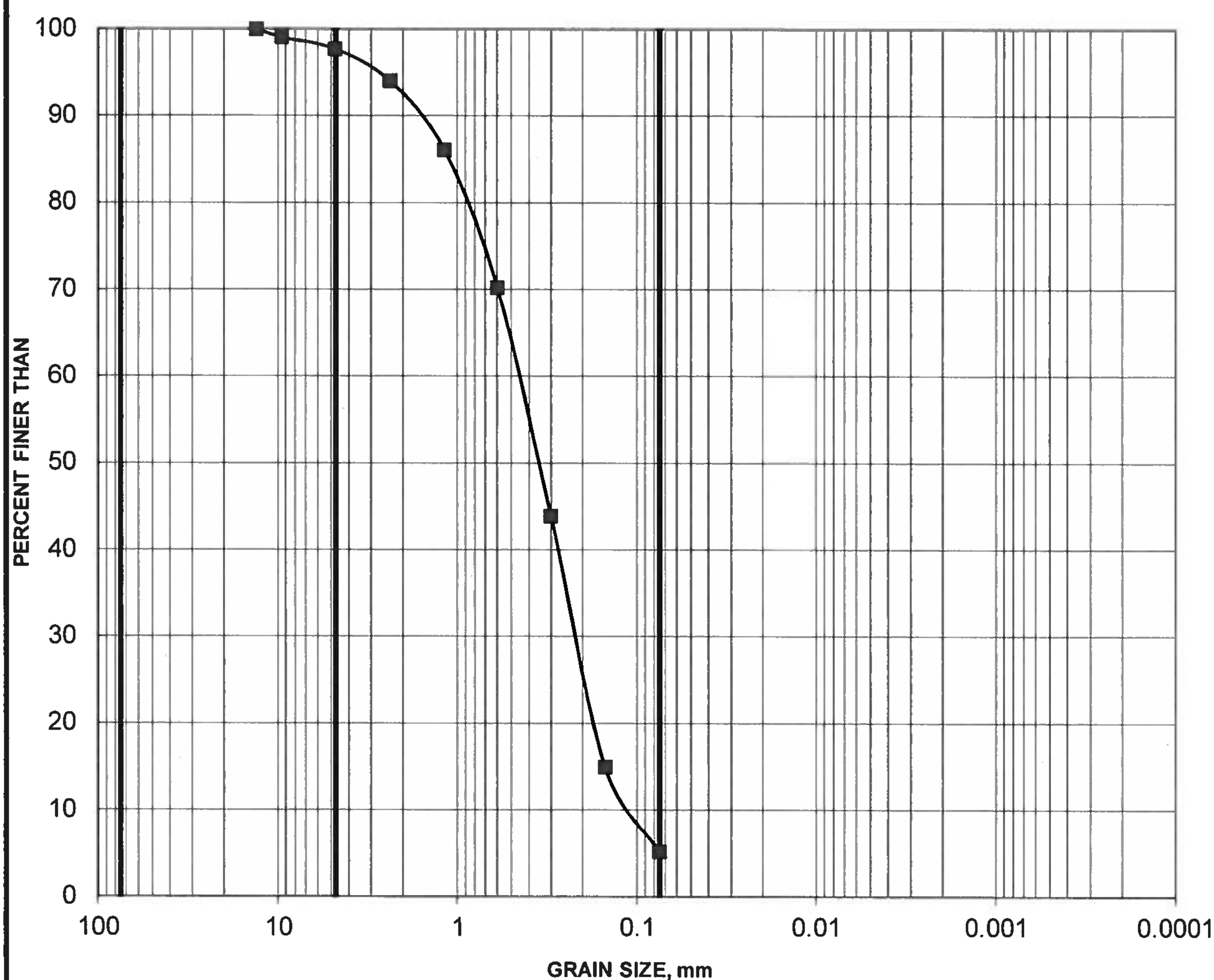
Figure : 3

Project No.: 13-1121-0083-1046

Compiled By : MI Checked By : CNM

GRAIN SIZE DISTRIBUTION	FIGURE 4

SAND



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

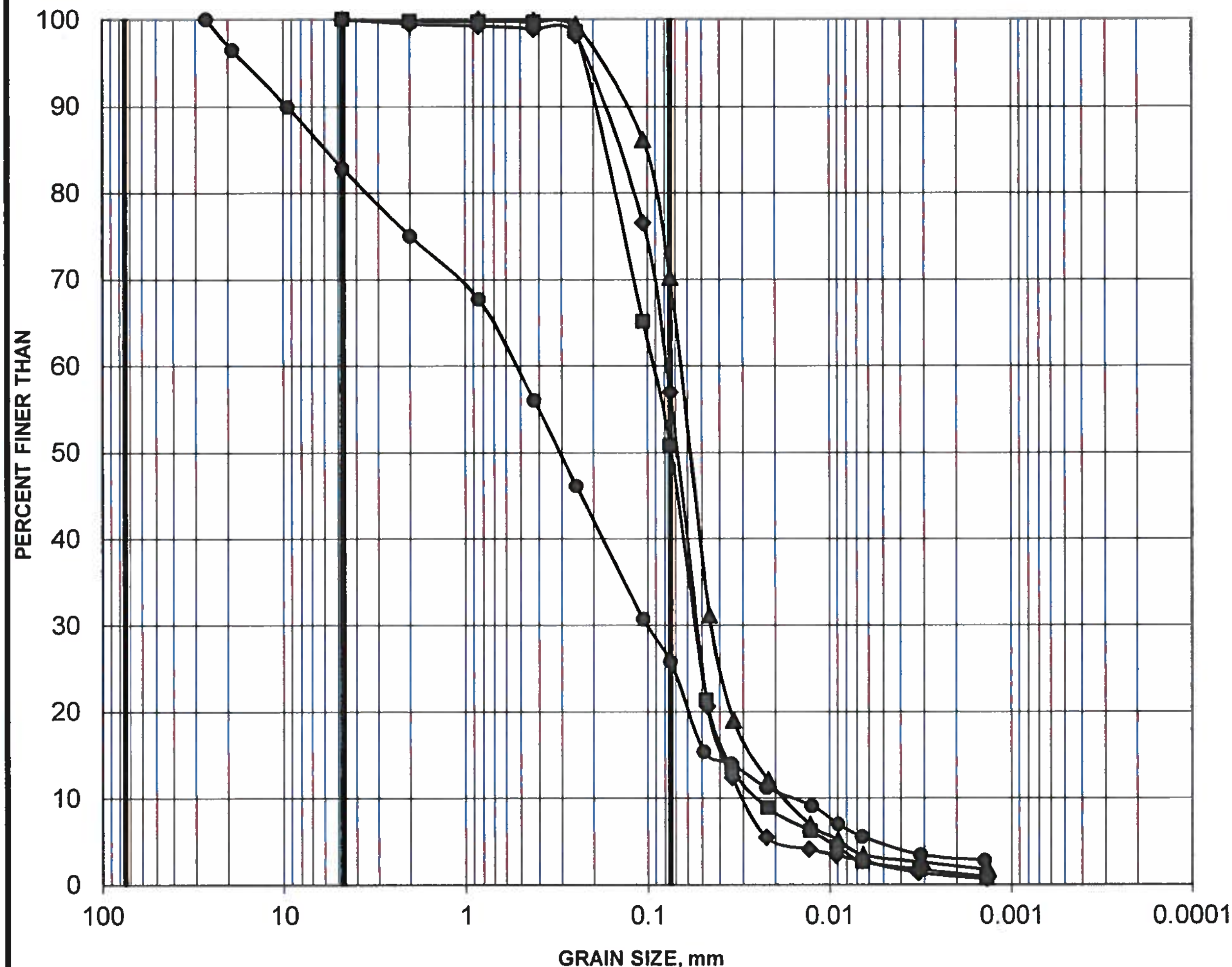
Borehole	Sample	Depth (m)
13-21	7A	4.57-5.03

Project: 13-1121-0083-1046 **Golder Associates**

Created by: MI
Checked by: CNM

GRAIN SIZE DISTRIBUTION	FIGURE 5

SILTY SAND TO SANDY SILT



Cobble Size	coarse	fine	coarse	medium	fine	SILT AND CLAY
	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
13-19	4B	2.64-2.90
13-22	5	3.05-3.66
13-27	6	4.57-5.18
16-113	4	2.29-2.82

Project: 13-1121-0083-1046

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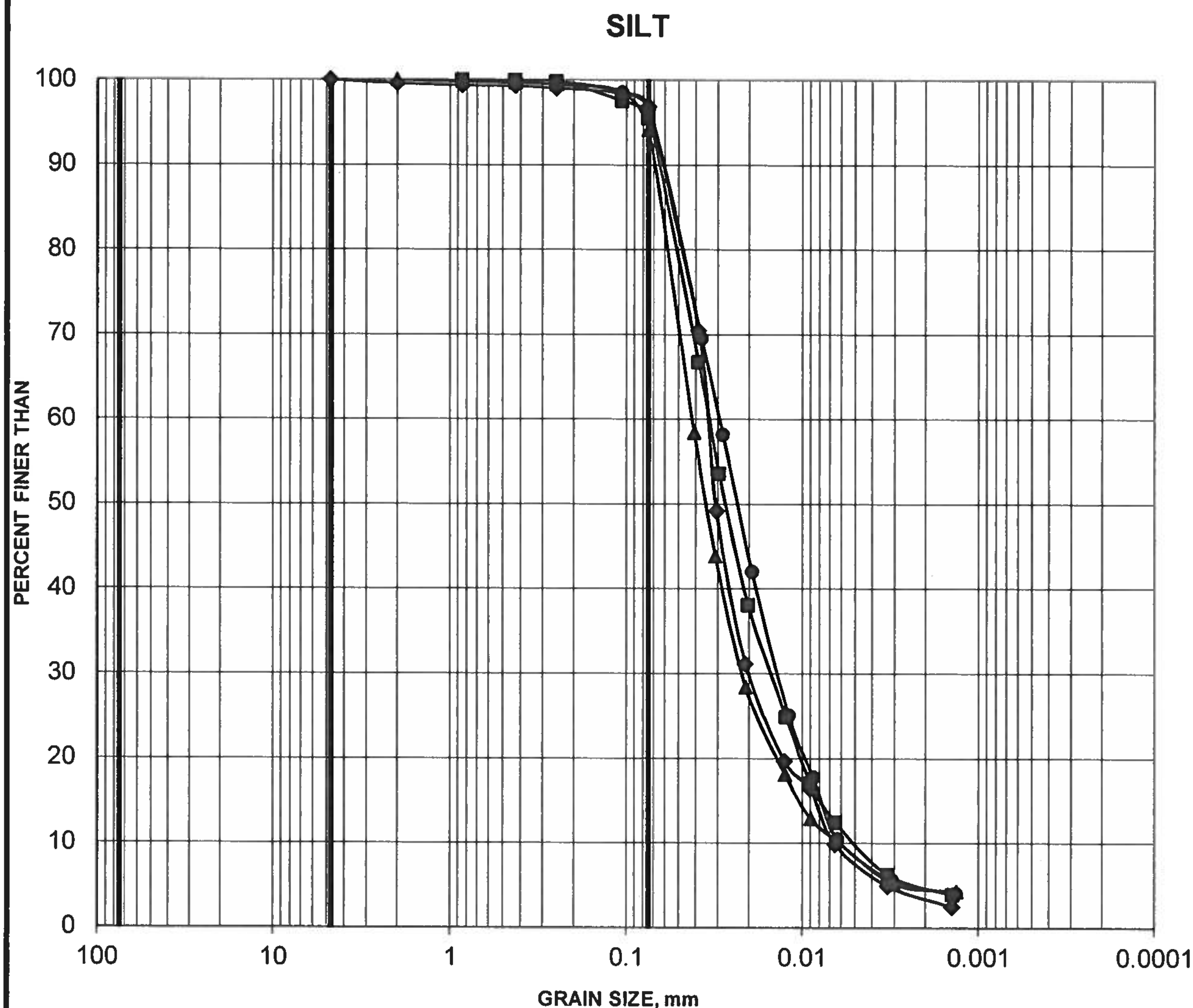
Checked by: CNM

GRAIN SIZE DISTRIBUTION	FIGURE 6



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
13-21	2	0.76-1.37
13-22	2	0.76-1.37
13-23	3	1.22-1.83
13-31	5	2.44-3.05

Project: 13-1121-0083-1046

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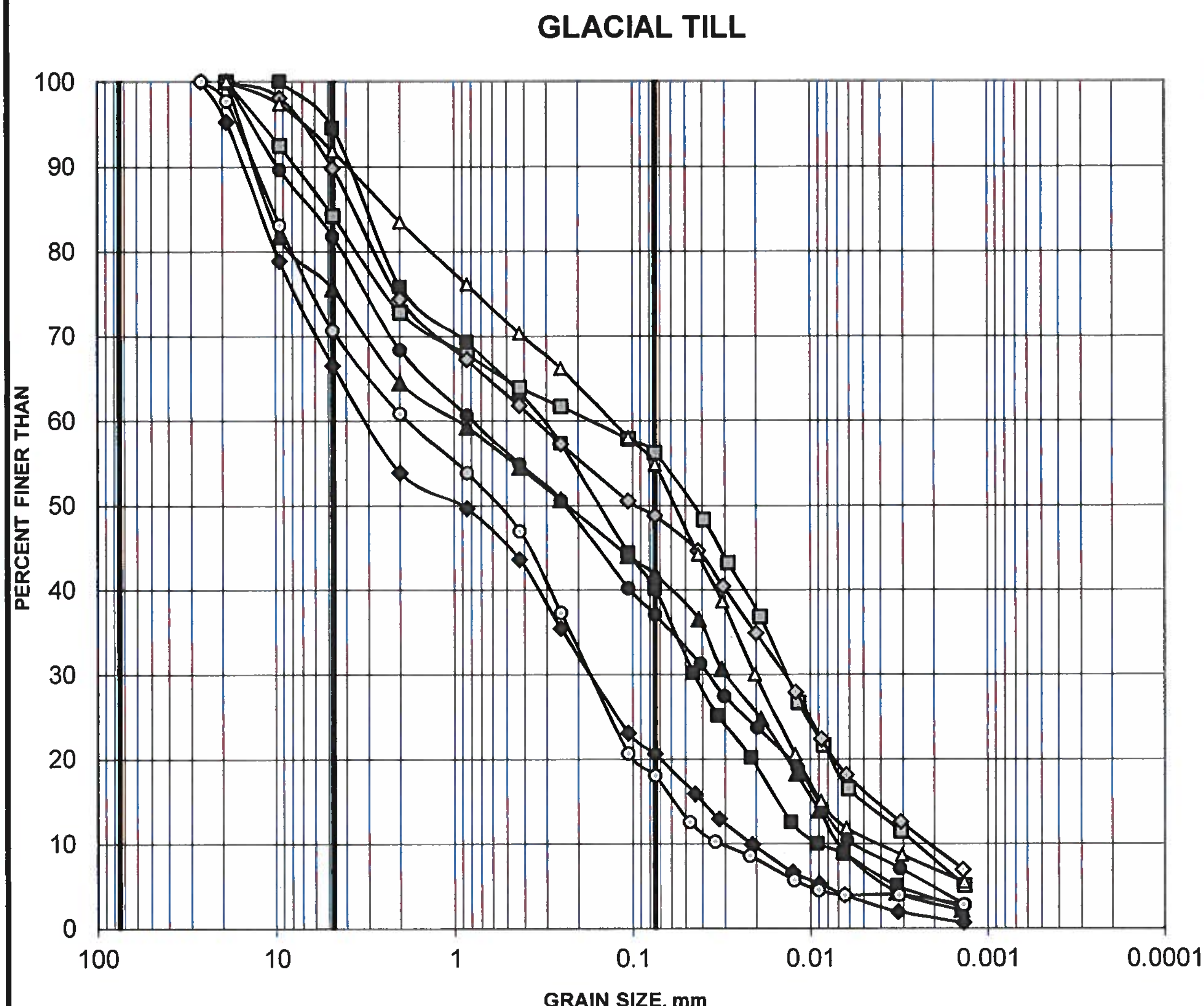
GRAIN SIZE DISTRIBUTION	FIGURE 7



Cobble Size	coarse	fine	coarse	medium	fine	SILT AND CLAY
	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
13-1	3	1.52-2.13
13-6	2	0.76-1.37
13-8	3	1.52-1.93
13-9	4	3.15-3.38
13-13	4	2.29-2.90
13-15	3	1.52-1.75
16-103	5	3.05-3.47
16-109	4	2.29-2.90

Project: 13-1121-0083-1046

Golder Associates

Created by: MI
Checked by: CNM

APPENDIX A

Method of Soil Classification
List of Abbreviations and Symbols
Lithological and Geotechnical Rock Description Terminology
Record of Test Pits and Hand Augerhole Sheets
Record of Borehole and Drillhole Sheets
Current Investigation

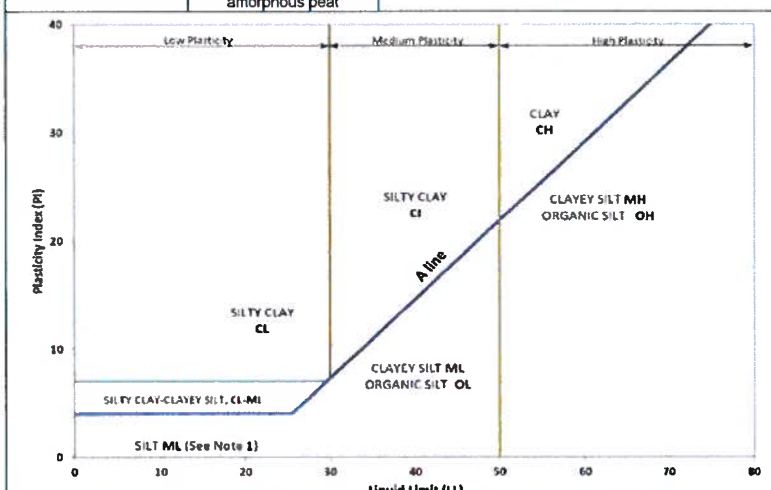
Golder Associates

METHOD OF SOIL CLASSIFICATION

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

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

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



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to ~~or~~ indicates a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

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

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

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

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

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

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

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

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

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

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

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

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

COHESIVE SOILS

Consistency

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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

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

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1 $\tau = c' + \sigma' \tan\phi'$

2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index
A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

TABLE 1

RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-1	0.00 – 0.13	TOPSOIL – (ML) sandy SILT; dark brown; moist
(99.68 m)	0.13 – 0.90	(SM/ML) SILTY SAND to sandy SILT, trace gravel; brown to grey brown with oxidation staining; non-cohesive, moist
	0.90 – 2.60	(SM) SILTY SAND some gravel to gravelly; grey brown, contains cobbles and boulders up to 1.2 metres in diameter (GLACIAL TILL); non-cohesive, moist
	2.60 – 3.50	(SM) gravelly SILTY SAND; grey, contains cobbles and boulders up to 1.2 metres in diameter (GLACIAL TILL); non-cohesive, moist
	3.50	End of Test Pit – Refusal to excavating on cobbles and boulders

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.13 – 0.90
2	0.90 – 2.60
3	2.60 – 3.50

TABLE 1 (Continued)
RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-2 (100.95 m)	0.00 – 0.28	TOPSOIL – (ML) sandy SILT; dark brown; moist
	0.28 – 0.57	(ML) SILT, some sand to sandy; grey brown; non-cohesive, moist
	0.57 – 2.10	(SM) SILTY SAND some gravel; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist
	2.10 – 7.00	(SM) gravelly SILTY SAND; grey, contains cobbles and boulders up to 1.3 metres in diameter (GLACIAL TILL); non-cohesive, moist
	7.00	End of Test Pit – Refusal to excavating on cobbles and boulders

Note: Water seepage at 6.1 metres depth upon completion.

Sample No.	Depth (m)
1	0.28 – 0.57
2	0.57 – 2.10
3	2.10 – 7.00

TABLE 1 (Continued)

RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-3	0.00 – 0.29	TOPSOIL – (ML) sandy SILT; dark brown; moist
(95.21 m)	0.29 – 1.20	(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist
	1.20 – 1.90	(SP) SAND, some low plasticity fines and gravel; grey brown, contains cobbles and boulders; non-cohesive, moist
	1.90 – 2.40	(ML) CLAYEY SILT, some sand; grey brown with oxidation staining, contains cobbles and boulders; cohesive, w>PL
	2.40 – 3.20	(SM) SILTY SAND, some gravel to gravelly; grey brown, contains cobbles and boulders up to 1.3 metres in diameter (GLACIAL TILL); non-cohesive, moist to wet
	3.20	End of Test Pit – Refusal to excavating on probable bedrock

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.29 – 1.20
2	1.20 – 1.90
3	1.90 – 2.40
4	2.40 – 3.20

TABLE 1 (Continued)
RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-4	0.00 – 0.20	TOPSOIL – (ML) sandy SILT; dark brown; moist
(94.17 m)	0.20 – 0.70	(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist
	0.70 – 1.40	(SP) SAND, some gravel; grey brown, contains cobbles; non-cohesive, moist
	1.40 – 4.10	(SM) gravelly SILTY SAND; grey brown, contains cobbles and boulders up to 1.1 metres in diameter (GLACIAL TILL); non-cohesive, moist
	4.10	End of Test Pit – Refusal to excavating on probable bedrock

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.20 – 0.70
2	0.70 – 1.40
3	1.40 – 3.40
4	3.40 – 4.10

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-5	0.00 – 0.17	TOPSOIL – (ML) sandy SILT; dark brown; moist
(96.75 m)	0.17 – 2.00	(SM/ML) SILTY SAND to sandy SILT, some gravel to gravelly; brown, contains cobbles and boulders up to 0.7 metres in diameter; non-cohesive, moist
	2.00	End of Test Pit – Refusal to excavating on probable bedrock

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.17 – 2.00

TABLE 1 (Continued)

RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
16-6	0.00 – 0.19	TOPSOIL – (ML) sandy SILT; dark brown; moist
(98.93 m)	0.19 – 2.30	(SM) SILTY SAND, some gravel; brown; non-cohesive, moist
	2.30 – 4.20	(SP) SAND, some non-plastic fines and gravel; brown, contains cobbles and boulders up to 1.0 metres in diameter; non-cohesive, moist
	4.20	End of Test Pit – Refusal to excavating on probable bedrock

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.19 – 1.10
2	1.10 – 2.30
3	2.30 – 4.20

Test Pit Number (Elevation m)	Depth (m)	Description
16-7	0.00 – 0.21	TOPSOIL – (ML) sandy SILT; dark brown; moist
(103.09 m)	0.21 – 2.90	(SM) SILTY SAND some gravel; grey brown, contains cobbles and boulders up to 0.5 metres in diameter (GLACIAL TILL); non-cohesive, moist
	2.90 – 6.10	(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders up to 0.5 metres in diameter (GLACIAL TILL); non-cohesive, moist to wet
	6.10	End of Test Pit – Refusal to excavating on probable bedrock

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.21 – 0.80
2	0.80 – 2.90
3	2.90 – 5.70
4	5.70 – 6.10

TABLE 1 (Continued)

RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-8	0.00 – 0.19	TOPSOIL – (ML) sandy SILT; dark brown; moist
(94.33 m)	0.19 – 0.60	(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist
	0.60 – 1.60	(SM) SILTY SAND, some gravel; brown, contains cobbles; non-cohesive, moist
	1.60 – 2.60	(SM) gravelly SILTY SAND; dark grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist
	2.60 – 3.00	(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders up to 0.9 metres in diameter (GLACIAL TILL); non-cohesive, moist to wet
	3.00	End of Test Pit – Refusal to excavating on probable bedrock

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.19 – 0.60
2	0.60 – 1.60
3	2.60 – 3.00

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-9	0.00 – 0.19	TOPSOIL – (ML) sandy SILT; dark brown; moist
(99.62 m)	0.19 – 1.10	(SM/ML) SILTY SAND to sandy SILT, trace gravel; brown; non-cohesive, moist
	1.10 – 3.40	(SM) SILTY SAND, some gravel; grey brown, contains cobbles and boulders up to 0.5 metres in diameter (GLACIAL TILL); non-cohesive, moist
	3.40	End of Test Pit – Refusal to excavating on probable bedrock

Note: Test pit dry upon completion.

Sample No.	Depth (m)
1	0.19 – 1.10
2	1.10 – 3.40

TABLE 1 (Continued)

RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-10	0.00 – 0.19	TOPSOIL – (ML) sandy SILT; dark brown; moist
(94.62 m)	0.19 – 0.57	(SP/SM) SAND, some non-plastic fines to silty; brown; non-cohesive, moist
	0.57 – 1.20	(SM) SILTY SAND; grey brown; non-cohesive, moist
	1.20 – 2.00	(SM) SILTY SAND; grey; non-cohesive, moist to wet
	2.00 – 2.20	(SP) SAND, some non-plastic fines, trace gravel; grey; non-cohesive, wet
	2.20 – 2.50	(SP) SAND; brown, contains cobbles and boulders up to 0.8 metres in diameter; non-cohesive, wet
	2.50	End of Test Pit – Refusal to excavating on probable bedrock

Note: Water seepage at 2.4 metres depth upon completion.

Sample No.	Depth (m)
1	0.19 – 0.57
2	0.57 – 1.20
3	1.20 – 2.00
4	2.00 – 2.20
5	2.20 – 2.50

TABLE 1 (Continued)
RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-11	0.00 – 0.16	TOPSOIL – (ML) sandy SILT; dark brown; moist
(95.03 m)	0.16 – 1.10	(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist
	1.10 – 2.50	(SP) SAND, some non-plastic fines and gravel; grey brown, contains cobbles and boulders; non-cohesive, moist
	2.50 – 3.50	(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist to wet
	3.50	End of Test Pit – Refusal to excavating on probable bedrock

Note: Water seepage at 2.6 metres depth upon completion.

Sample No.	Depth (m)
1	0.16 – 1.10
2	1.10 – 2.50
3	2.50 – 3.50

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-12	0.00 – 0.18	TOPSOIL – (ML) sandy SILT; dark brown; moist
(96.68 m)	0.18 – 1.30	(SM) SILTY SAND, trace gravel; brown to grey brown, contains cobbles; non-cohesive, moist
	1.30 – 3.60	(SP) SAND, some gravel; brown, contains cobbles and boulders; non-cohesive, moist
	3.60 – 4.20	(SM) gravelly SILTY SAND; dark grey, contains cobbles and boulders up to 0.9 metres in diameter (GLACIAL TILL); non-cohesive, wet
	4.20	End of Test Pit – Refusal to excavating on probable bedrock

Note: Water seepage at 4.1 metres depth upon completion.

Sample No.	Depth (m)
1	0.18 – 1.30
2	1.30 – 3.60
3	3.60 – 4.20

TABLE 1 (Continued)

RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-13	0.00 – 0.20	TOPSOIL – (ML) sandy SILT; dark brown; moist
(94.43 m)	0.20 – 1.20	(SP) SAND, some non-plastic fines, trace gravel; brown; non-cohesive, moist
	1.20 – 2.25	(SP/SM) SAND, some non-plastic fines to silty, some gravel; brown, contains cobbles; non-cohesive, moist
	2.25 – 3.00	(SM) gravelly SILTY SAND; brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist
	3.00 – 5.10	(SM) SILTY SAND; some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet
	5.10	End of Test Pit – Refusal to excavating on probable bedrock

Note: Water seepage at 3.1 metres depth upon completion.

Sample No.	Depth (m)
1	0.20 – 1.20
2	1.20 – 2.25
3	2.25 – 3.00
4	3.00 – 3.40
5	3.40 – 5.10

TABLE 1 (Continued)
RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-14	0.00 – 0.23	TOPSOIL – (ML) sandy SILT; dark brown; moist
(96.91 m)	0.23 – 1.50	(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist to wet
	1.50 – 2.40	(SP) SAND, some gravel to gravelly; brown, contains cobbles and boulders; non-cohesive, moist
	2.40 – 2.90	(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders up to 1.1 metres in diameter (GLACIAL TILL); non-cohesive, moist
	2.90	End of Test Pit – Refusal to excavating on probable bedrock

Note: Water seepage at 2.9 metres depth upon completion.

Sample No.	Depth (m)
1	0.23 – 0.85
2	0.85 – 1.50
3	1.50 – 2.40
4	2.40 – 2.90

TABLE 1 (Continued)
RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-15	0.00 – 0.40	(PT) PEAT; dark brown to black; moist
(94.01 m)	0.40 – 0.75	(CL/CI) SILTY CLAY; grey brown; cohesive, w>PL
	0.75 – 1.20	(SM) SILTY SAND; grey; non-cohesive, moist to wet
	1.20 – 2.50	(SP) SAND, some gravel; grey brown, contains cobbles; non-cohesive, wet
	2.50 – 4.50	(SM) gravelly SILTY SAND; grey, contains cobbles and boulders up to 0.5 metres in diameter (GLACIAL TILL); non-cohesive, wet
	4.50	End of Test Pit – Side walls sloughing

Note: Water seepage at 2.0 metres depth upon completion.

Sample No.	Depth (m)
1	0.00 – 0.40
2	0.40 – 0.75, Figure 3 (W_L= 30%, W_P = 18%, PI=12%)
3	0.75 – 1.20
4	1.20 – 2.50
5	2.50 – 4.50

TABLE 1 (Continued)
RECORD OF TEST PITS AND HAND AUGERHOLES

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-16	0.00 – 0.26	TOPSOIL – (ML) sandy SILT; dark brown; moist
(95.92 m)	0.26 – 1.60	(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist
	1.60 – 2.60	(SM/SP) SILTY SAND to SAND, some gravel; grey brown, contains silt layers, cobbles and boulders; non-cohesive, moist to wet
	2.60 – 4.60	(SP) SAND, some non-plastic fines to silty, some gravel to gravelly; grey, contains cobbles and boulders up to 0.9 metres in diameter; non-cohesive, wet
	4.60	End of Test Pit – Refusal to excavating on probable bedrock

Note: Water seepage at 3.8 metres depth upon completion.

Sample No.	Depth (m)
1	0.26 – 1.60
2	1.60 – 2.60
3	2.60 – 3.50
4	3.50 – 4.60

TABLE 1 (Continued)
RECORD OF TEST PITS AND HAND AUGERHOLES

Hand Augerhole Number (Elevation m)	Depth (m)	Description
HAH 16-18	0.00 – 0.60	(PT) PEAT; dark brown, fibrous; moist to wet
	0.60 – 1.55	(SM) SILTY SAND, fine; grey; non-cohesive, wet
	1.55 – 2.20	(ML/SM) SILT and SAND; grey; non-cohesive, wet
	2.20	End of Hand Augerhole – Side walls sloughing

Note: Water level at 0.2 metres depth upon completion.

Sample No.	Depth (m)
No samples taken	

Test Pit Number (Elevation m)	Depth (m)	Description
TP 16-20	0.0 – 0.32	(PT) PEAT; dark brown to black, fibrous; moist
	0.32 – 0.43	(OL) ORGANIC SILT; white (MARL); moist to wet
	0.43 – 0.75	(SM) SILTY SAND, trace gravel; grey brown; non-cohesive, wet
	0.75 – 5.50	(SM/ML) SILTY SAND to sandy SILT; grey, contains cobbles and boulders from 4.5 to 5.5 metres depth (GLACIAL TILL); non-cohesive, wet
	5.50	End of Test Pit – Side walls sloughing

Note: Water seepage at 0.7 metres depth upon completion.

Sample No.	Depth (m)
1	0.00 – 0.32
2	0.32 – 0.43
3	0.43 – 0.75
4	0.75 – 5.50

RECORD OF BOREHOLE: 13-1

PROJECT: 13-1121-0083
LOCATION: See Site Plan
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: September 23, 2013

DATUM: Geodetic
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	HYDRAULIC CONDUCTIVITY / WATER CONTENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE	95.95						
	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00						Native Backfill
		Very dense brown SILTY SAND to SANDY SILT, some gravel, trace clay (GLACIAL TILL)	95.73 / 0.22	1	50 DO	3			Bentonite Seal
1				2	50 DO	>50			Silica Sand
2				3	50 DO	55	○	MH	38 mm Diam. PVC #10 Slot Screen 'B'
				4	50 DO	>50			
	Rotary Drill NQ Core	Fresh, thinly to medium bedded, light grey to light brown, fine grained, crystalline, non-porous, strong DOLOMITIC SANDSTONE, with occasional thin interlaminations of black shale and thin interbeds of slightly calcareous sandstone	93.36 / 2.59						Silica Sand
3				C1	NQ RC	DD			Bentonite Seal; Silica Sand
4									38 mm Diam. PVC #10 Slot Screen 'A'
		End of Borehole	91.66 / 4.29						

WL in Screen 'A' at Elev. 92.75 m on Nov. 12, 2013

WL in Screen 'B' at Elev. 93.90 m on Nov. 12, 2013

Chart axes: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp ⊢ ○W ⊣ Wl) (20, 40, 60, 80)

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: ALB
CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF DRILLHOLE: 13-1

LOCATION: See Site Plan

DRILLING DATE: September 23, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME-55

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PIEZOMETER OR STANDPIPE INSTALLATION
		BEDROCK SURFACE		93.36 / 2.59		
3–4	Rotary Drill, NQ Core	Fresh, thinly to medium bedded, light grey to light brown, fine grained, crystalline, non-porous, strong DOLOMITIC SANDSTONE, with occasional thin interlaminations of black shale and thin interbeds of slightly calcareous sandstone			1	Bentonite Seal; Silica Sand; 38 mm Diam. PVC #10 Slot Screen 'A'
		End of Drillhole		91.66 / 4.29		

Column headings also include: COLOUR % RETURN / FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jcon, Jr, Ja); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); Diametral Point Load Index (MPa); RMC -Q' AVG.

WL in Screen 'A' at Elev. 92.75 m on Nov. 12, 2013

WL in Screen 'B' at Elev. 93.90 m on Nov. 12, 2013

Depth scale: 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-2

PROJECT: 13-1121-0083

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 26, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp ⊢ W ⊣ Wl) (20, 40, 60, 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		101.30							
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Brown SILTY SAND		101.05 / 0.25	1	SS	4				
1		Very dense brown SILTY SAND, trace gravel and clay, with cobbles and boulders (GLACIAL TILL)		100.54 / 0.76	2	SS	>50				
					3	SS	>50		○		
2					4	SS	>50				
		End of Borehole Auger Refusal		98.84 / 2.46							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: ALB
CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-3

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: September 30, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, BLOWS/0.30m) | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○) (20, 40, 60, 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl) (20, 40, 60, 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method: Power Auger, 200 mm Diam. (Hollow Stem) (0 to 6.30 m); Rotary Drill, NQ Core (6.30 to 10 m)

Description	Elev. / Depth (m)
GROUND SURFACE	103.12
TOPSOIL	0.00
Brown SANDY SILT, trace clay	102.87 / 0.25
Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	102.15 / 0.97
Very dense to compact grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	100.68 / 2.44
Fresh to slightly weathered, thinly to medium bedded, light grey to white, fine to medium grained, slightly porous, slightly calcareous SANDSTONE, with thin interlaminates of shale, occasional thin (<2 mm thick) calcite veins throughout	96.82 / 6.30

Number	Type	Blows/0.30m
1	50 DO	63
2	50 DO	>50
3	50 DO	>50
4	50 DO	49
5	50 DO	53
6	50 DO	57
7	50 DO	20
8	50 DO	>50
C1	NQ RC	DD
C2	NQ RC	DD
C3	NQ RC	DD

Piezometer or standpipe installation: Bentonite Seal; Native Backfill; Bentonite Seal; Silica Sand; 38 mm Diam. PVC #10 Slot Screen 'B'; Silica Sand; Bentonite Seal; Silica Sand; 38 mm Diam. PVC #10 Slot Screen 'A'; Silica Sand; Bentonite Seal

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-3

LOCATION: See Site Plan

BORING DATE: September 30, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ⊖W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---									
10				92.91	C3	NQ RC	DD				Bentonite Seal
		End of Borehole		10.21							WL in Screen 'A' at Elev. 99.63 m on Nov. 12, 2013 WL in Screen 'B' at Elev. 99.64 m on Nov. 12, 2013
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/20/16 JM/JEM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: PAS

RECORD OF DRILLHOLE: 13-3

PROJECT: 13-1121-0083
LOCATION: See Site Plan
INCLINATION: -90° AZIMUTH: —

DRILLING DATE: September 30, 2013
DRILL RIG: CME-55
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols

Depth (m)	Drilling Record	Description	Elev. / Depth (m)	Run No.	Flush % Return	Piezometer / Notes
		BEDROCK SURFACE	96.82 / 6.30			
7–10	Rotary Drill, NQ Core	Fresh to slightly weathered, thinly to medium bedded, light grey to white, fine to medium grained, slightly porous, slightly calcareous SANDSTONE, with thin interlaminates of shale, occasional thin (<2 mm thick) calcite veins throughout		1	100	Bentonite Seal; Silica Sand
				1	100	38 mm Diam. PVC #10 Slot Screen 'A'
				2	100	Silica Sand
				3	100	Bentonite Seal
		End of Drillhole	92.91 / 10.21			WL in Screen 'A' at Elev. 99.63 m on Nov. 12, 2013; WL in Screen 'B' at Elev. 99.64 m on Nov. 12, 2013

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: PAS

MIS-RCK 004 1311210083.GPJ GAL-MISS.GDT 01/20/16 JM/JEM

RECORD OF BOREHOLE: 13-4

PROJECT: 13-1121-0083

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 1, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp —○W— Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		104.14							
0	Power Auger; 200 mm Diam. (Hollow Stem)	Loose brown SILTY fine SAND, trace gravel, with organic matter		0.00	1	50 DO	8				
				103.38							
1		Very dense brown SILTY SAND, trace gravel and clay, with cobbles and boulders (GLACIAL TILL)		0.76	2	50 DO	53				
					3	50 DO	>50				
2				101.52							
		End of Borehole Auger Refusal		2.62							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-5

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 26 & 27, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		99.74							
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Brown SILTY SAND		99.46 0.28	1	50 DO	8				
		Dense to very dense brown SILTY SAND, trace gravel and clay, with cobbles and boulders (GLACIAL TILL)		98.98 0.76							
1					2	50 DO	49		○		
					3	50 DO	>50				
2	Wash Boring, HQ Core	BOULDER		97.89 1.85	4	NQ RC	DD				
		Very dense brown SILTY SAND, trace gravel and clay, with cobbles and boulders (GLACIAL TILL)		97.55 2.19	5	50 DO	>50				
3					6	50 DO	>50				
4		Very dense SANDY SILT, trace gravel and clay, with cobbles and boulders (GLACIAL TILL)		95.93 3.81	7	50 DO	>50				
		BOULDER		95.17 4.57	8	NQ RC	DD				
5		Very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		94.63 5.11	9	50 DO	>100				
6		End of Borehole Auger Refusal		93.64 6.10							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-6

PROJECT: 13-1121-0083

LOCATION: See Site Plan

BORING DATE: September 23, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	HYDRAULIC CONDUCTIVITY / WATER CONTENT	ADDITIONAL LAB. TESTING
	GROUND SURFACE	95.28					
Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00					
	Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	95.07 / 0.21	1	50 DO	5		
			2	50 DO	67	○	MH
			3	50 DO	>50		
Wash Boring, HQ Core	Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	92.99 / 2.29	4	50 DO	65		
			5	50 DO	>50		
	Dense SILTY SAND and GRAVEL, with cobbles and boulders (GLACIAL TILL)	91.47 / 3.81	6	50 DO	32		
Rotary Drill, NQ Core	Fresh, thinly to medium bedded, grey to dark grey, fine grained, non-porous, strong SHALEY DOLOSTONE, with occasional thin interlaminates of black shale	90.76 / 4.52					
	VOID	90.25 / 5.03	C1	NQ RC	DD		
	Fresh, thinly to medium bedded, grey to dark grey, fine grained, non-porous, strong SHALEY DOLOSTONE, with occasional thin interlaminates of black shale	89.64 / 5.64	C2	NQ RC	DD		
	End of Borehole	88.45 / 6.83					

Column headings also include: DEPTH SCALE METRES (0–10); STRATA PLOT; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp ⊢ ○W ⊣ Wl; 20, 40, 60, 80); PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF DRILLHOLE: 13-6

PROJECT: 13-1121-0083
LOCATION: See Site Plan
INCLINATION: -90° AZIMUTH: ---
DRILLING DATE: September 23, 2013
DRILL RIG: CME-55
DRILLING CONTRACTOR: Marathon Drilling
DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.
		BEDROCK SURFACE	90.76	
	Rotary Drill, NQ Core	Fresh, thinly to medium bedded, grey to dark grey, fine grained, non-porous, strong SHALEY DOLOSTONE, with occasional thin interlaminates of black shale	4.52	
5		VOID	90.25 / 5.03	1
6		Fresh, thinly to medium bedded, grey to dark grey, fine grained, non-porous, strong SHALEY DOLOSTONE, with occasional thin interlaminates of black shale	89.64 / 5.64	2
7		End of Drillhole	88.45 / 6.83	
8				
9				
10				
11				
12				
13				
14				

Additional columns: SYMBOLIC LOG; FLUSH; COLOUR % RETURN; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jcon, Jr, Ja); HYDRAULIC CONDUCTIVITY K, cm/sec; Diametral Point Load Index (MPa); RMC -Q' AVG.

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB
CHECKED: PAS

MIS-RCK 004 1311210083.GPJ GAL-MISS.GDT 01/20/16 JM/JEM

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-7

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 24, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		94.89							
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Loose to compact brown SILTY SAND		0.15	1	50 DO	5				
1					2	50 DO	10				
		Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		93.37 1.52	3	50 DO	>50				
2					4	50 DO	>50		○		
		End of Borehole Auger Refusal		92.07 2.82							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-8

LOCATION: See Site Plan

BORING DATE: September 24, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ├──○W──┤ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		98.04							
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		97.81 0.23	1	50 DO	4				
1					2	50 DO	52				
					3	50 DO	>50		○	MH	
2					4	50 DO	>50				
		End of Borehole Auger Refusal		95.37 2.67							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-9

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 2, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	106.35							
0	Power Auger, 200 mm Diam. (Hollow Stem)	Loose brown SILTY fine SAND, with organic matter	0.00	1	50 DO	4				Native Backfill
1		Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	105.59 0.76	2	50 DO	>50				Bentonite Seal
				3	50 DO	>50				
2	Wash Boring, HQ Core	COBBLES and BOULDERS	104.22 2.13	C1	NQ RC	DD				Silica Sand
3		Very dense grey SILTY SAND to SANDY SILT, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	103.20 3.15	4	50 DO	>50		○	MH	38 mm Diam. PVC #10 Slot Screen
4		End of Borehole	101.78 4.57							
5										WL in Screen at Elev. 106.46 m on Nov. 12, 2013
6										
7										
8										
9										
10										

Dynamic penetration scale: 20 40 60 80. Shear strength: nat V. + Q - ●; rem V. ⊕ U - ○; scale 20 40 60 80.

Hydraulic conductivity scale: 10^{-8} 10^{-6} 10^{-4} 10^{-2}. Water content: Wp ⊢—○W—⊣ Wl; scale 20 40 60 80.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-10

LOCATION: See Site Plan

BORING DATE: October 1 & 2, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		105.83							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		0.15							
1					1	50 DO	>50				
	Wash Bore NW Casing				2	NQ RC	DD				
2					3	NQ RC	DD				
3					4	50 DO	51				
4					5	NQ RC	DD				
		Very dense to dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		101.41 4.42	6	50 DO	>50				
5					7	NQ RC	DD				
					8	50 DO	42				
6					9	50 DO	>50				
7	RD NW	Fresh, medium bedded, light grey, fine to medium grained, non-porous, strong DOLOMITIC SANDSTONE, interbedded with dark grey shaley dolomite		98.82 7.01							
	Rotary Drill NQ Core				C1	NQ RC	DD				
8		End of Borehole		97.75 8.08							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF DRILLHOLE: 13-10

LOCATION: See Site Plan

DRILLING DATE: October 1 & 2, 2013

DATUM: Geodetic

DRILL RIG: CME-55

INCLINATION: -90° AZIMUTH: —

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG
		BEDROCK SURFACE		98.82 / 7.01															
8	Rotary Drill (RD) / NQ Core (NW)	Fresh, medium bedded, light grey, fine to medium grained, non-porous, strong DOLOMITIC SANDSTONE, interbedded with dark grey shaley dolomite		97.75 / 8.08	1														
		End of Drillhole																	
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-11

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 24, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	94.60							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00							
		Brown SILTY SAND	94.42 0.18	1	50 DO	4		○ (approx. 44)		
		Very dense brown SILTY SAND	93.84 0.76	2	50 DO	>50				
1		End of Borehole Auger Refusal	93.48 1.12							
2										
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-12

PROJECT: 13-1121-0083 | SHEET 1 OF 1

LOCATION: See Site Plan | BORING DATE: September 25, 2013 | DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm | PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	WATER CONTENT PERCENT (W)
0	GROUND SURFACE	96.42				
	TOPSOIL	0.00				
	Dense brown SILTY SAND, trace gravel	0.08	1	50 DO	5	
1			2	50 DO	48	
	Compact brown fine to medium SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	94.90 / 1.52	3	50 DO	27	○ (approx. 18)
2	Very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	94.13 / 2.29	4	50 DO	>50	
3	End of Borehole Auger Refusal	93.04 / 3.38				

Chart headings: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION

Depth scale 4–10 m: no data.

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/20/16 JM/JEM

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-13

LOCATION: See Site Plan

BORING DATE: September 27, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	HYDRAULIC CONDUCTIVITY / WATER CONTENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		97.97						
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00						
		Loose brown SILTY SAND		97.67 0.30	1	50 DO	3			Bentonite Seal
1					2	50 DO	5			Native Backfill; Bentonite Seal
		Compact brown SILTY SAND to SANDY SILT, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		96.45 1.52	3	50 DO	20			Silica Sand
2–3					4	50 DO	28		MH	38 mm Diam. PVC #10 Slot Screen 'B'
					5	50 DO	29			Silica Sand
4	Rotary Drill, NQ Core	Fresh to slightly weathered, medium bedded, dark grey, fine grained, non-porous, strong SHALEY DOLOSTONE - Vertical joint from 5.74 m to 6.10 m, with surface stain		94.06 3.91	C1	NQ RC	DD			Bentonite Seal; Silica Sand
5					C2	NQ RC	DD			
					C3	NQ RC	DD			38 mm Diam. PVC #10 Slot Screen 'A'
6				91.75 6.22	C4	NQ RC	DD			
		End of Borehole								WL in Screen 'A' at Elev. 95.08 m on Nov. 12, 2013 WL in Screen 'B' at Elev. 95.06 m on Nov. 12, 2013

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ ; 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl ; 20 40 60 80

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF DRILLHOLE: 13-13

LOCATION: See Site Plan

DRILLING DATE: September 27, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	Piezometer / Notes
	BEDROCK SURFACE	94.06		
4	Fresh to slightly weathered, medium bedded, dark grey, fine grained, non-porous, strong SHALEY DOLOSTONE - Vertical joint from 5.74 m to 6.10 m, with surface stain	3.91	1	Bentonite Seal
5			2	Silica Sand
			3	38 mm Diam. PVC #10 Slot Screen 'A'
6		91.75 6.22	4	
	End of Drillhole			WL in Screen 'A' at Elev. 95.08 m on Nov. 12, 2013 WL in Screen 'B' at Elev. 95.06 m on Nov. 12, 2013
7				
8				
9				
10				
11				
12				
13				

Column headings: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; FLUSH COLOUR % RETURN; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle; DIP w.r.t. CORE AXIS; TYPE AND SURFACE DESCRIPTION; Jcon; Jr; Ja); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-14

PROJECT: 13-1121-0083 — SHEET 1 OF 1

LOCATION: See Site Plan — BORING DATE: October 2, 2013 — DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm — PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		103.31							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Dense to very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		103.13 / 0.18							
1					1	50 DO	40				
2					2	50 DO	84				
					3	50 DO	>50				
		End of Borehole Auger Refusal		100.54 / 2.77							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-15

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 1, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		104.79							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Very dense brown SILTY SAND to SANDY SILT, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		104.59 0.20	1	50 DO	5				
1					2	50 DO	81				
				103.04	3	50 DO	>50		○	MH	
		End of Borehole Auger Refusal		1.75							
2											
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-16

PROJECT: 13-1121-0083

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 3, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ⊖W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		101.13							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00 100.95							
		Brown SANDY SILT, trace clay		0.18							
1		Dense to very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		100.22 0.91	1	50 DO	31				
2					2	50 DO	52				
					3	50 DO	>50				
3		End of Borehole Auger Refusal		98.18 2.95							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: PAS

RECORD OF BOREHOLE: 13-17

PROJECT: 13-1121-0083
LOCATION: See Site Plan
BORING DATE: October 4, 2013
SAMPLER HAMMER, 64kg; DROP, 760mm
PENETRATION TEST HAMMER, 64kg; DROP, 760mm
DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE	99.15				
	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00				Bentonite Seal
		Brown SILTY fine SAND	0.15	1	50 DO	4	
		Compact to very dense brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	98.46 / 0.69				Native Backfill
1				2	50 DO	93	Bentonite Seal
							Silica Sand
2				3	50 DO	53	
				4	50 DO	22	38 mm Diam. PVC #10 Slot Screen 'B'
3	Wash Bore, NW Casing			5	50 DO	>50	
							Silica Sand
4				6	50 DO	54	Bentonite Seal
	RD, NW	Fresh, medium to thickly bedded, dark grey, fine grained, non-porous, medium strong to strong SHALEY DOLOSTONE - Thin (~1-3 mm thick) calcite vein throughout interval. Some veins are open. - Occasional sulphides disseminated throughout	94.71 / 4.44				Native Backfill and Bentonite
5	Rotary Drill, NQ Core			C1	NQ RC	DD	Silica Sand
							38 mm Diam. PVC #10 Slot Screen 'A'
6				C2	NQ RC	DD	
		End of Borehole	92.88 / 6.27				WL in Screen 'A' at Elev. 97.36 m on Nov. 8, 2013 WL in Screen 'B' at Elev. 97.84 m on Nov. 8, 2013
7							
8							
9							
10							

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

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG
CHECKED: PAS

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/20/16 JM/JEM

RECORD OF DRILLHOLE: 13-17

PROJECT: 13-1121-0083
LOCATION: See Site Plan
INCLINATION: -90° AZIMUTH: —

DRILLING DATE: October 4, 2013
DRILL RIG: CME-55
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	NOTES
		BEDROCK SURFACE	94.71 4.44		
5	RD: Rotary Drill; NW: NQ Core	Fresh, medium to thickly bedded, dark grey, fine grained, non-porous, medium strong to strong SHALEY DOLOSTONE - Thin (~1-3 mm thick) calcite vein throughout interval. Some veins are open. - Occasional sulphides disseminated throughout		1	Native Backfill and Bentonite Silica Sand 38 mm Diam. PVC #10 Slot Screen 'A'
6			92.88 6.27	2	
		End of Drillhole			WL in Screen 'A' at Elev. 97.36 m on Nov. 8, 2013 WL in Screen 'B' at Elev. 97.84 m on Nov. 8, 2013
7					
8					
9					
10					
11					
12					
13					
14					

Column headings: SYMBOLIC LOG; COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jcon, Jr, Ja); HYDRAULIC CONDUCTIVITY K, cm/sec; Diametral Point Load Index (MPa); RMC -Q' AVG

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-18

LOCATION: See Site Plan

BORING DATE: September 25, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	94.74				
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00				
		Compact brown SILTY SAND, trace gravel	0.10	1	50 DO	6	Bentonite Seal
1				2	50 DO	26	Silica Sand
		Compact grey SILTY SAND, some gravel, trace clay (GLACIAL TILL)	93.22 1.52	3	50 DO	26	38 mm Diam. PVC #10 Slot Screen 'B'
2		Compact to very dense grey SILTY SAND, some gravel, trace clay (GLACIAL TILL)	92.45 2.29	4	50 DO	11	Silica Sand
3				5	50 DO	>50	Bentonite Seal
	Rotary Drill, NQ Core	Fresh to slightly weathered, thinly to medium bedded, grey, fine grained, non-porous, strong SHALEY DOLOSTONE	91.39 3.35	C1	NQ RC	DD	Silica Sand
5				C2	NQ RC	DD	38 mm Diam. PVC #10 Slot Screen 'A'
		End of Borehole	88.95 5.79				
6							WL in Screen 'A' at Elev. 94.79 m on Oct. 28, 2013 WL in Screen 'B' at Elev. 94.66 m on Oct. 28, 2013

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

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

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp —○W— Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/20/16 JM/JEM

RECORD OF DRILLHOLE: 13-18

PROJECT: 13-1121-0083

LOCATION: See Site Plan

INCLINATION: -90° AZIMUTH: —

DRILLING DATE: September 25, 2013

DRILL RIG: CME-75

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	NOTES
		BEDROCK SURFACE	91.39 3.35		
4	Rotary Drill NQ Core	Fresh to slightly weathered, thinly to medium bedded, grey, fine grained, non-porous, strong SHALEY DOLOSTONE		1	Bentonite Seal; Silica Sand
5			88.95 5.79	2	38 mm Diam. PVC #10 Slot Screen 'A'
6		End of Drillhole			WL in Screen 'A' at Elev. 94.79 m on Oct. 28, 2013; WL in Screen 'B' at Elev. 94.66 m on Oct. 28, 2013
7					
8					
9					
10					
11					
12					
13					

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

MIS-RCK 004 1311210083.GPJ GAL-MISS.GDT 01/20/16 JM/JEM

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-19

LOCATION: See Site Plan

BORING DATE: September 30, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	97.42							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00							
		Brown SILTY SAND, trace organics and gravel	97.12 / 0.30	1	50 DO	3				
		Dense to very dense brown to grey brown SILTY SAND, trace gravel, with cobbles and boulders	96.81 / 0.61	2	50 DO	>50				
1										
2				3	50 DO	39		○		
				4	50 DO	36				
		Dense brown SILTY SAND to SANDY SILT	94.78 / 2.64						MH	
3		Dense brown fine to medium SAND, trace silt	94.52 / 2.90	5	50 DO	41		○		
4		Very dense grey brown SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	93.51 / 3.91	6	50 DO	61				
				7	50 DO	>50				
		End of Borehole Spoon Refusal	92.80 / 4.62							
5										
6										
7										
8										
9										
10										

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/20/16 JM/JEM

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-20

PROJECT: 13-1121-0083 | SHEET 1 OF 1
LOCATION: See Site Plan | BORING DATE: October 3, 2013 | DATUM: Geodetic
SAMPLER HAMMER, 64kg; DROP, 760mm | PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE	97.05				
	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00 / 96.87				
		Loose brown SILTY fine SAND	0.18	1	50 DO	4	Bentonite Seal
1				2	50 DO	7	
		Loose to compact grey fine SAND, trace silt	95.53 / 1.52	3	50 DO	10	Native Backfill
2		Loose grey SILTY fine SAND	94.76 / 2.29	4	50 DO	6	
3		Compact to dense grey SILTY SAND, with rock fragments, cobbles and boulders (GLACIAL TILL)	94.18 / 2.87	5	50 DO	16	Bentonite Seal; Silica Sand
4				6	50 DO	48	
	Wash Bore, HW Casing	Very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	92.48 / 4.57	7	50 DO	54	38 mm Diam. PVC #10 Slot Screen
5				8	50 DO	>50	Silica Sand
		End of Borehole	91.28 / 5.77				
6							WL in Screen at Elev 96.50 m on Nov. 4, 2013
7							
8							
9							
10							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ — 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ├──○W──┤ Wl — 20 40 60 80
ADDITIONAL LAB. TESTING

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG
CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-21

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 30, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	WATER CONTENT PERCENT (W)	ADDITIONAL LAB. TESTING
0	GROUND SURFACE						
	TOPSOIL	0.00					
	Brown fine to medium SAND, trace silt	0.15					
	Grey brown SANDY SILT, trace organics	0.23	1	50 DO	2		
	Compact to very dense grey brown SILT, trace to some clay, with cobbles	0.61					
1			2	50 DO	11	○ (approx. 22)	MH
			3	50 DO	>50		
2	Loose to compact grey SILTY SAND to SANDY SILT, trace gravel	2.29					
			4	50 DO	10		
3			5	50 DO	8		
4			6	50 DO	9	○ (approx. 15)	
	Dense grey fine to coarse SAND, trace gravel and silt	4.57	7	50 DO	35		M
5	Very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	4.95	8	50 DO	>50		
	End of Borehole	5.46					

Note:
Ground surface elevation unable to be determined due to heavy tree cover.

Chart columns: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT Wp —○W— Wl (20, 40, 60, 80); PIEZOMETER OR STANDPIPE INSTALLATION

Depth scale: 0–10 m

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-22

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 1, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	WATER CONTENT PERCENT (W)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	95.29						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00						
		Compact grey brown SILT, trace clay	95.04 / 0.25	1	50 DO	3			
1				2	50 DO	11	○	MH	
2				3	50 DO	16			
		Loose grey SILTY SAND to SANDY SILT, trace clay	93.00 / 2.29	4	50 DO	7			
3				5	50 DO	7	○	MH	
4				6	50 DO	9			
5		Very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	90.57 / 4.72	7	50 DO	64			
				8	50 DO	>50	○		
6		End of Borehole Auger Refusal	89.50 / 5.79						
7									
8									
9									
10									

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ ; 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl ; 20 40 60 80

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-23

PROJECT: 13-1121-0083
LOCATION: See Site Plan
SAMPLER HAMMER, 32kg; DROP, 760mm

BORING DATE: October 4, 2013

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 32kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
0		GROUND SURFACE	94.50				
	Power Auger 200 mm Diam. (Hollow Stem)	Black fibrous PEAT	0.00	1	50 DO	1	
		Loose to compact grey brown SILT, trace clay	94.06 0.44	2	50 DO	9	
1				3	50 DO	10	MH
2				4	50 DO	9	
		Loose grey SILTY SAND	92.06 2.44	5	50 DO	6	
3		Loose to very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	91.45 3.05	6	50 DO	6	
				7	50 DO	>50	
4		End of Borehole Spoon Refusal Note: Blow counts were corrected for half-weight hammer.	90.54 3.96				

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80
PIEZOMETER OR STANDPIPE INSTALLATION

Depth scale: 5, 6, 7, 8, 9, 10

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DEPTH SCALE
1 : 50

Golder Associates

LOGGED: ALB
CHECKED: PAS

RECORD OF BOREHOLE: 13-24

PROJECT: 13-1121-0083
LOCATION: See Site Plan
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: October 24 & 25, 2013

DATUM: Geodetic
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE	94.43				
	Portable Drill / NW Casing	Black fibrous PEAT	0.00				
1		Probable grey SILTY fine SAND, trace gravel	93.82 0.61				Native Backfill and Bentonite Mix
2							Bentonite Seal
3							Silica Sand
4							32 mm Diam. PVC #10 Slot Screen 'B'
5		Probable grey SILTY fine SAND, some gravel	89.86 4.57				Native Backfill and Bentonite Mix
6		Inferred grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	88.79 5.64				
	Portable Drill / NQ Core	Fresh, medium bedded, dark grey, fine grained, slightly porous, strong SHALEY DOLOMITE, with thinly to medium bedded light grey dolomite	88.16 6.27	C1	NQ RC	DD	Peltonite Seal
7				C2	NQ RC	DD	Silica Sand 32 mm Diam. PVC #10 Slot Screen 'A'
8		End of Borehole Note: Soil stratigraphy from 0 m to 6.27 m inferred from casing advancement cuttings and resistance.	86.35 8.08				WL in Screen 'A' at Elev. 94.32 m on Oct. 2013 WL in Screen 'B' at Elev. 94.38 m on Oct. 2013
9							
10							

Chart columns: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT Wp —○W— Wl (20, 40, 60, 80); ADDITIONAL LAB. TESTING

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: HEC
CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF DRILLHOLE: 13-24

LOCATION: See Site Plan

DRILLING DATE: October 24 & 25, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES / WATER LEVELS / INSTRUMENTATION
		BEDROCK SURFACE		88.16											
	Portable Drill, NQ Core	Fresh, medium bedded, dark grey, fine grained, slightly porous, strong SHALEY DOLOMITE, with thinly to medium bedded light grey dolomite		6.27	1										Peltonite Seal
7					2										Silica Sand; 32 mm Diam. PVC #10 Slot Screen 'A'
8				86.35 / 8.08											
		End of Drillhole													WL in Screen 'A' at Elev. 94.32 m on Oct. 2013; WL in Screen 'B' at Elev. 94.38 m on Oct. 2013
9															
10															
11															
12															
13															
14															
15															
16															

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: HEC

CHECKED: PAS

RECORD OF BOREHOLE: 13-25

PROJECT: 13-1121-0083
LOCATION: See Site Plan
BORING DATE: October 15, 2013
SHEET 1 OF 1
DATUM: Geodetic
SAMPLER HAMMER, 32kg; DROP, 760mm
PENETRATION TEST HAMMER, 32kg; DROP, 760mm

Boring method: Portable Drill, NW Casing

DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	94.91				
Black fibrous PEAT	0.00	1	50 DO	WH	Bentonite Seal
Loose brown grey SILTY SAND to SANDY SILT	94.30 / 0.61	2	50 DO	5	
Loose grey SILTY fine SAND	93.69 / 1.22	3	50 DO	5	Silica Sand
		4	50 DO	9	
		5	50 DO	8	32 mm Diam. PVC #10 Slot Screen
Grey SILTY SAND, some gravel	91.86 / 3.05	6	50 DO	>50	
Very dense to compact grey SILTY SAND, trace gravel	3.20	7	50 DO	>50	
		8	50 DO	12	Silica Sand
Compact grey SILTY SAND and GRAVEL (GLACIAL TILL)	90.02 / 4.89	9	50 DO	25	
End of Borehole	89.42 / 5.49				WL in Screen at Elev. 95.12 m on Nov. 7, 2013

Note:
Blow counts were corrected for half-weight hammer.

Column headings also printed: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○) (20 40 60 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT (Wp W Wl) (20 40 60 80); ADDITIONAL LAB. TESTING.

DEPTH SCALE 1 : 50

LOGGED: DWM
CHECKED: PAS

Golder Associates

RECORD OF BOREHOLE: 13-26

PROJECT: 13-1121-0083
LOCATION: See Site Plan
BORING DATE: October 17, 2013
DATUM: Geodetic
SAMPLER HAMMER, 32kg; DROP, 760mm
PENETRATION TEST HAMMER, 32kg; DROP, 760mm

Boring method: Portable Drill, NW Casing

DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	95.44				
TOPSOIL	0.00	1	50 DO	1	Bentonite Seal
Loose to compact grey SILTY SAND to SANDY SILT	94.83 / 0.61	2	50 DO	6	Silica Sand
		3	50 DO	9	
		4	50 DO	8	38 mm Diam. PVC #10 Slot Screen 'B'
		5	50 DO	13	
		6	50 DO	8	Bentonite Seal
					Silica Sand
		7	50 DO	10	
		8	50 DO	11	32 mm Diam. PVC #10 Slot Screen 'A'
		9	50 DO	25	
End of Borehole	89.95 / 5.49				Silica Sand

End of Borehole

Note:
Blow counts were corrected for half-weight hammer.

WL in Screen 'A' at Elev. 95.42 m on November 7, 2013

WL in Screen 'B' at Elev. 95.46 m on November 7, 2013

Column headings: DEPTH SCALE METRES; BORING METHOD; SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)); SAMPLES (NUMBER, TYPE, BLOWS/0.30m); DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp ⊢ ○W ⊣ Wl) (20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DWM
CHECKED: PAS

RECORD OF BOREHOLE: 13-27

PROJECT: 13-1121-0083
LOCATION: See Site Plan
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: October 2, 2013

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE	96.49						
	TOPSOIL	0.00						
	Stiff grey brown CLAYEY SILT, trace sand	96.01 / 0.48						
1			1	50 DO	6	○		
2			2	50 DO	6	○		
	Very loose to loose grey SANDY SILT, trace to some clay	94.20 / 2.29	3	50 DO	4	○		
3	Compact grey SANDY SILT	93.44 / 3.05	4	50 DO	17	○		
4			5	50 DO	10	○		
5			6	50 DO	12	○	MH	
	Loose grey fine SAND, trace silt	91.16 / 5.33	7	50 DO	5	○		
6	End of Borehole	90.55 / 5.94						
7								
8								
9								
10								

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ ; 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl ; 20 40 60 80

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: PAS

RECORD OF BOREHOLE: 13-28

PROJECT: 13-1121-0083

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 4, 2013

DATUM: Geodetic

SAMPLER HAMMER, 32kg; DROP, 760mm

PENETRATION TEST HAMMER, 32kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	95.62							
0	Portable Drill, NW Casing	TOPSOIL	0.00 / 95.01	1	50 DO	2				
		Loose brown SILTY SAND	0.61 / 94.40	2	50 DO	6				
1		Loose to compact grey SILTY SAND	1.22 / 93.79	3	50 DO	10				
2		Very dense dark brown SANDY SILT	1.83 / 93.44	4	50 DO	>50				
		End of Borehole Spoon Refusal	2.18							

Note:
Blow counts were corrected for half-weight hammer.

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DEPTH SCALE
1 : 50

Golder Associates

LOGGED: ALB

CHECKED: PAS

RECORD OF BOREHOLE: 13-29

PROJECT: 13-1121-0083
LOCATION: See Site Plan
SAMPLER HAMMER, 32kg; DROP, 760mm

BORING DATE: October 22, 2013

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 32kg; DROP, 760mm

Boring Method: Portable Drill, NW Casing

DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m
GROUND SURFACE	97.10			
TOPSOIL	0.00			
Compact grey SILTY fine SAND, trace gravel	96.79 / 0.31	1	50 DO	1
		2	50 DO	14
		3	50 DO	14
Compact grey SILTY fine SAND, some gravel	95.27 / 1.83	4	50 DO	22
Compact to very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	94.66 / 2.44	5	NQ RC	DD
		6	50 DO	37
		7	NQ RC	DD
		8	50 DO	14
		9	50 DO	>34
		10	50 DO	>50
End of Borehole	91.67 / 5.43			

Note:
Blow counts were corrected for half-weight hammer.

Column headings: DEPTH SCALE METRES; BORING METHOD; SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)); SAMPLES (NUMBER, TYPE, BLOWS/0.30m); DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp ⊢ W ⊣ Wl) (20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION

Piezometer / Standpipe Installation (top to bottom):
- Bentonite Seal
- Silica Sand
- 38 mm Diam. PVC #10 Slot Screen 'B'
- Bentonite Seal
- Silica Sand
- 32 mm Diam. PVC #10 Slot Screen 'A'
- Silica Sand

WL in Screen 'A' at Elev. 97.02 m on Nov. 4, 2013

WL in Screen 'B' at Elev. 97.04 m on Nov. 4, 2013

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: HEC
CHECKED: PAS

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/20/16 JM/JEM

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-30

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 9, 2013

DATUM: Geodetic

SAMPLER HAMMER, 32kg; DROP, 760mm

PENETRATION TEST HAMMER, 32kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp —○W— Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Portable Drill / NW Casing	TOPSOIL		0.00							
		Stiff brown CLAYEY SILT, some sand, trace gravel, with rootlets		0.15	1	50 DO	5				
		Brown SILTY SAND, some gravel		0.61	2	50 DO	>50				
1		End of Borehole Spoon Refusal		0.91							

Notes:

1. Ground surface elevation unable to be determined due to heavy tree cover.
2. Borehole was terminated and relocated to BH 13-30A due to shallow refusal.
3. Blow counts were corrected for half-weight hammer.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DWM

CHECKED: PAS

RECORD OF BOREHOLE: 13-30A

PROJECT: 13-1121-0083

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 9, 2013

DATUM: Geodetic

SAMPLER HAMMER, 32kg; DROP, 760mm

PENETRATION TEST HAMMER, 32kg; DROP, 760mm

Boring method: Portable Drill, NW Casing

DEPTH SCALE METRES	SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m
0	GROUND SURFACE				
	TOPSOIL	0.00			
	Very loose brown SANDY SILT, some clay	0.15	1	50 DO	2
	Compact brown SILTY SAND, trace clay	0.61	2	50 DO	15
1	Loose to compact grey brown SILTY SAND, trace gravel	1.22	3	50 DO	10
2	Compact to very dense grey fine to medium SAND, some silt, trace gravel, with cobbles and boulders (GLACIAL TILL)	1.83	4	50 DO	22
			5	50 DO	42
3			6	50 DO	>50
	End of Borehole Spoon Refusal	3.20			

Notes:
1. Borehole 13-30A was relocated approximately 1.5 m from borehole 13-30 due to shallow refusal.

2. Blow counts were corrected for half-weight hammer.

Other columns (no data recorded): DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp — W — Wl; 20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION.

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DWM

CHECKED: PAS

PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-31

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 9, 2013

DATUM: Geodetic

SAMPLER HAMMER, 32kg; DROP, 760mm

PENETRATION TEST HAMMER, 32kg; DROP, 760mm

Boring method: Portable Drill, NW Casing (0.00 – 5.49 m)

DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
GROUND SURFACE	96.84				
TOPSOIL	0.00	1	50 DO	1	
Loose brown grey SANDY SILT, occasional silty sand seams	96.23 / 0.61	2	50 DO	8	
Loose to compact grey SILTY fine SAND	95.62 / 1.22	3	50 DO	9	
		4	50 DO	11	
Loose to compact grey SILT	94.40 / 2.44	5	50 DO	10	MH
Loose to compact grey SILTY fine SAND	93.79 / 3.05	6	50 DO	5	
		7	50 DO	9	
		8	50 DO	4	
		9	50 DO	14	
End of Borehole	91.35 / 5.49				

Note:
Blow counts were corrected for half-weight hammer.

Column headings: DEPTH SCALE METRES; BORING METHOD; SOIL PROFILE; STRATA PLOT; SAMPLES; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - O (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT Wp ⊢—O W—⊣ Wl (20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DWM

CHECKED: PAS

RECORD OF BOREHOLE: 13-32

PROJECT: 13-1121-0083

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 10 & 11, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, BLOWS/0.30m) | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20, 40, 60, 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp —○W— Wl; 20, 40, 60, 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method: Wash Boring, NW Casing

Description	Elev. / Depth (m)
GROUND SURFACE	96.12
TOPSOIL	0.00
Inferred brown SILTY fine SAND	95.51 / 0.61
Inferred grey SILTY fine SAND	94.60 / 1.52
Inferred grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	92.69 / 3.43
End of Borehole	88.42 / 7.70

Note:
Soil stratigraphy from 0 m to 6.12 m inferred from casing advancement cuttings and resistance.

Sample Number	Type	Blows/0.30m
C1	NQ RC	DD
C2	NQ RC	DD

Piezometer or standpipe installation (top to bottom):
- Bentonite Seal
- Silica Sand
- 38 mm Diam. PVC #10 Slot Screen 'B'
- Silica Sand
- Bentonite Seal
- Peltonite
- Silica Sand
- 32 mm Diam. PVC #10 Slot Screen 'A'
- Silica Sand

WL in Screen 'A' at Elev. 96.02 m on Nov. 7, 2013

WL in Screen 'B' at Elev. 96.00 m on Nov. 7, 2013

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DWM

CHECKED: PAS

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PROJECT: 13-1121-0083

RECORD OF BOREHOLE: 13-33

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 18 & 21, 2013

DATUM: Geodetic

SAMPLER HAMMER, 32kg; DROP, 760mm

PENETRATION TEST HAMMER, 32kg; DROP, 760mm

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, BLOWS/0.30m) | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20, 40, 60, 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl) (20, 40, 60, 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method (0 to 7.01 m): Portable Drill, NW Casing

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	100.93
TOPSOIL	0.00
Inferred grey brown SILTY fine SAND	0.15
Inferred grey SILTY fine SAND, trace fine gravel	99.41 / 1.52
Inferred grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)	96.71 / 4.22
End of Borehole	93.92 / 7.01

Note:
Soil stratigraphy from 0 m to 7.01 m inferred from casing advancement cuttings and resistance.

Piezometer or standpipe installation:
- Native Backfill and Bentonite Mix
- Bentonite Seal
- Silica Sand
- 38 mm Diam. PVC #10 Slot Screen 'B'
- Native Backfill and Bentonite Mix
- Silica Sand
- 32 mm Diam. PVC #10 Slot Screen 'A'
- Silica Sand

WL in Screen 'A' at Elev. 100.22 m on Nov. 8, 2013

WL in Screen 'B' at Elev. 100.21 m on Nov. 8, 2013

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/20/16 JM/JEM

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DWM/HEC

CHECKED: PAS

PROJECT: 13-1121-0083-1046

RECORD OF BOREHOLE: 16-101

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: October 6, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, BLOWS/0.30m) | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl) (20 40 60 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method: Power Auger, 200 mm Diam. (Hollow Stem) (0 to approx. 2.5 m); Wash Boring, HW Casing (approx. 2.5 to 3.5 m); Rotary Drill, NQ Core (3.5 to 7.21 m)

Description	Elev. / Depth (m)
GROUND SURFACE	96.98
TOPSOIL - (ML) sandy SILT; dark brown; moist	0.00
(SM) SILTY SAND, trace gravel; brown; non-cohesive, dry, loose	96.77 / 0.21
(SP) SAND; brown; non-cohesive, dry	96.22 / 0.76
(SM) SILTY SAND, some gravel; brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, dry to moist, very dense	0.89
Slightly weathered to fresh, thinly to medium bedded, grey, fine grained SANDY DOLOSTONE BEDROCK, with shale interbeds	93.50 / 3.48
Fresh, thinly bedded, grey, fine grained SANDSTONE BEDROCK	90.24 / 6.74
End of Borehole	89.77 / 7.21

Number	Type	Blows/0.30m
1	SS	7
2	SS	>50
3	SS	70
4	SS	>50
5	RC	DD
C1	RC	DD
C2	RC	DD
C3	RC	DD

Piezometer or standpipe installation: Native Backfill; Bentonite Seal; Silica Sand; Standpipe

WL in Standpipe at Elev. 94.27 m on Nov. 11, 2016

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/18/17 JM/JEM

RECORD OF DRILLHOLE: 16-101

PROJECT: 13-1121-0083-1046

LOCATION: See Site Plan

DRILLING DATE: October 6, 2016

DATUM: Geodetic

DRILL RIG: CME-850

INCLINATION: -90° AZIMUTH: —

DRILLING CONTRACTOR: CCC

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	Piezometer / Standpipe Installation
		BEDROCK SURFACE	93.50			
4	Rotary Drill, NQ Core	Slightly weathered to fresh, thinly to medium bedded, grey, fine grained SANDY DOLOSTONE BEDROCK, with shale interbeds	3.48	1	30	
5				2	10	Bentonite Seal
6				3	5	Silica Sand
			90.24			Standpipe
7		Fresh, thinly bedded, grey, fine grained SANDSTONE BEDROCK	6.74			
			89.77			
		End of Drillhole	7.21			WL in Standpipe at Elev. 94.27 m on Nov. 11, 2016
8						
9						
10						
11						
12						
13						

Column headings also include: SYMBOLIC LOG; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jcon, Jr, Ja); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); Diametral Point Load Index (MPa); RMC -Q' AVG.

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

PROJECT: 13-1121-0083-1046

RECORD OF BOREHOLE: 16-102

LOCATION: See Site Plan

BORING DATE: September 29, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		94.76							
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; moist		0.00							
		(SM/ML) SILTY SAND to sandy SILT; brown; non-cohesive, dry, compact to very dense		0.16	1	SS	10				
1					2	SS	26				
					3	SS	80				
2	Wash Boring, HW Casing	(SM) SILTY SAND, some gravel; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, very dense		92.70 2.06							
3					4	SS	86				
4					5	RC	DD				
5					6	RC	DD				
6					7	RC	DD				
	Rotary Drill, NQ Core	Slightly weathered to fresh, thinly bedded, grey, fine grained DOLOSTONE BEDROCK - Vertical fracture from 6.29 m to 6.45 m - Vertical fracture from 6.75 m to 6.98 m		88.47 6.29							
7					C1	RC	DD				
		End of Borehole		87.27 7.49							
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF DRILLHOLE: 16-102

PROJECT: 13-1121-0083-1046

LOCATION: See Site Plan

INCLINATION: -90° AZIMUTH: —

DRILLING DATE: September 29, 2016

DRILL RIG: CME-850

DRILLING CONTRACTOR: CCC

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN
		BEDROCK SURFACE	88.47		
7	Rotary Drill, NQ Core	Slightly weathered to fresh, thinly bedded, grey, fine grained DOLOSTONE BEDROCK - Vertical fracture from 6.29 m to 6.45 m - Vertical fracture from 6.75 m to 6.98 m	6.29 87.27 7.49	1	10
		End of Drillhole			

Depth scale: 8, 9, 10, 11, 12, 13, 14, 15, 16

MIS-RCK 004 1311210083.GPJ GAL-MISS.GDT 01/18/17 JM/JEM

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF BOREHOLE: 16-103

PROJECT: 13-1121-0083-1046

LOCATION: See Site Plan

BORING DATE: October 5, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
		GROUND SURFACE	98.05				
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; moist	0.00				
		(SM/ML) SILTY SAND to sandy SILT, some gravel; brown; non-cohesive, dry, loose to very dense	0.17	1	SS	4	
1				2	SS	>50	
2				3	SS	100	
		(SM) SILTY SAND, some gravel; brown to grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, dry to moist, very dense	95.76 / 2.29	4	SS	>50	
3				5	SS	>50	MH
4				6	SS	59	
				7	SS	>50	
5	Rotary Drill, NQ Core	Fresh, thinly to medium bedded, grey, fine grained DOLOSTONE BEDROCK, with shale interbeds	92.95 / 5.10	C1	RC	DD	
6				C2	RC	DD	
7		End of Borehole	91.04 / 7.01				
8							
9							
10							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ├──○W──┤ Wl; 20 40 60 80

PIEZOMETER OR STANDPIPE INSTALLATION

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/18/17 JM/JEM

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: CK

RECORD OF DRILLHOLE: 16-103

PROJECT: 13-1121-0083-1046
LOCATION: See Site Plan
INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: October 5, 2016
DRILL RIG: CME-850
DRILLING CONTRACTOR: CCC

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		BEDROCK SURFACE		92.95															
6	Rotary Drill, NQ Core	Fresh, thinly to medium bedded, grey, fine grained DOLOSTONE BEDROCK, with shale interbeds		5.10	1	30													
					2	40													
7		End of Drillhole		91.04 / 7.01															
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			

MIS-RCK 004 1311210083.GPJ GAL-MISS.GDT 01/18/17 JM/JEM

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: CK

RECORD OF BOREHOLE: 16-104

PROJECT: 13-1121-0083-1046
LOCATION: See Site Plan
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: September 30, 2016

SHEET 1 OF 2
DATUM: Geodetic
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	95.82				
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; moist	0.00				
		(SM) SILTY SAND; brown; non-cohesive, dry, loose	95.67 (?) / 0.15	1	SS	6	Silica Sand
1		(SM) SILTY SAND, some gravel; brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, dry to moist, very dense	95.06 / 0.76	2	SS	>50	
2				3	SS	68	Bentonite Seal
3	Wash Boring, HQ Core	(SM) gravelly SILTY SAND; brown, contains dolostone fragments, cobbles and boulders (GLACIAL TILL); non-cohesive, moist, compact to very dense	93.31 / 2.51	4	SS	13	
				5	SS	>50	Silica Sand
4				6	SS	>50	Standpipe
	Rotary Drill, NQ Core	Probable Limestone Bedrock	91.33 / 4.49	C1	RC	DD	
5		End of Borehole	90.82 / 5.00				WL in Standpipe at Elev. 91.55 m on Nov. 11, 2016
6							
7							
8							
9							
10							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80
ADDITIONAL LAB. TESTING
STRATA PLOT

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: CK

RECORD OF DRILLHOLE: 16-104

PROJECT: 13-1121-0083-1046

LOCATION: See Site Plan

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 30, 2016

DRILL RIG: CME-850

DRILLING CONTRACTOR: CCC

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES / WATER LEVELS
		BEDROCK SURFACE		91.33											
	Rotary Drill, NQ Core	Probable Limestone Bedrock		4.49	1	5									Standpipe
5				90.82 5.00											
		End of Drillhole													WL in Standpipe at Elev. 91.55 m on Nov. 11, 2016

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF BOREHOLE: 16-105

PROJECT: 13-1121-0083-1046
LOCATION: See Site Plan
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: October 5, 2016

DATUM: Geodetic
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem) (0 to 5.03 m)

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	101.46				
0	TOPSOIL - (ML) sandy SILT; dark brown; moist	101.46 / 0.00				
	(SM/ML) SAND and SILT, trace gravel; grey brown; non-cohesive, moist, loose	101.28 / 0.18	1	SS	6	
1	(SM) SILTY SAND, some gravel; brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, dry to moist, very dense	100.70 / 0.76	2	SS	76	
			3	SS	>50	
2			4	SS	>50	
3			5	SS	>50	
4			6	SS	>50	
			7	SS	>50	
5	End of Borehole	96.43 / 5.03				
						Open borehole dry upon completion of drilling

Column headers also include: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl; 20, 40, 60, 80); ADDITIONAL LAB. TESTING; STRATA PLOT; BORING METHOD.

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: CK

PROJECT: 13-1121-0083-1046

RECORD OF BOREHOLE: 16-106

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 5, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Column headings: DEPTH SCALE METRES; BORING METHOD; SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)); SAMPLES (NUMBER, TYPE, BLOWS/0.30m); DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl; 20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION

Boring method: Power Auger, 200 mm Diam. (Hollow Stem)

Description	Elev. / Depth (m)	Sample Number	Type	Blows/0.30m	Piezometer or Standpipe Installation
GROUND SURFACE	103.84				
TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive, moist	0.00				
(SM/ML) SILTY SAND to sandy SILT, trace gravel; brown, contains cobbles and boulders; non-cohesive, dry compact	0.14	1	SS	10	Native Backfill
(SM) SILTY SAND, some gravel; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, dry to moist, very dense	103.08 / 0.76	2	SS	>50	
		3	SS	77	
		4	SS	>50	Bentonite Seal
		5	SS	68	Silica Sand
(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, very dense	100.03 / 3.81	6	SS	63	Standpipe
		7	SS	88	
End of Borehole	98.71 / 5.13				WL in Standpipe at Elev. 99.41 m on Nov. 11, 2016

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: CK

PROJECT: 13-1121-0083-1046

RECORD OF BOREHOLE: 16-107

LOCATION: See Site Plan

BORING DATE: October 7, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		94.24				
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; moist		0.00				
		(SM/ML) SILTY SAND to sandy SILT, trace gravel; grey brown; non-cohesive, dry, compact		0.11	1	SS	11	Native Backfill
1		(SM) SILTY SAND, some gravel; grey brown to grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, dense		93.48 0.76	2	SS	50	Bentonite Seal
					3	SS	42	Silica Sand
2		(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); wet, compact to very dense		92.11 2.13	4	SS	17	Standpipe
3		- Sand layers between about 2.29 m and 2.90 m			5	SS	65	
4					6	SS	>50	Silica Sand
					7	SS	>50	
5	Rotary Drill, NQ Core	Slightly weathered to fresh, thinly to medium bedded, grey, fine grained LIMESTONE BEDROCK, with shale interbeds		89.46 4.78	C1	RC	DD	Native Backfill
					C2	RC	DD	
6		End of Borehole		88.36 5.88				WL in Standpipe at Elev. 92.55 m on Nov. 11, 2016
7								
8								
9								
10								

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

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

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

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

ADDITIONAL LAB. TESTING

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/18/17 JM/JEM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF DRILLHOLE: 16-107

PROJECT: 13-1121-0083-1046

LOCATION: See Site Plan

DRILLING DATE: October 7, 2016

DATUM: Geodetic

DRILL RIG: CME-850

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: CCC

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG	NOTES
		BEDROCK SURFACE		89.46											
5	Rotary Drill, NQ Core	Slightly weathered to fresh, thinly to medium bedded, grey, fine grained LIMESTONE BEDROCK, with shale interbeds		4.78	1	10									Native Backfill
					2	5									
				88.36											
6		End of Drillhole		5.88											WL in Standpipe at Elev. 92.55 m on Nov. 11, 2016
7															
8															
9															
10															
11															
12															
13															
14															

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF BOREHOLE: 16-108

PROJECT: 13-1121-0083-1046

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 30, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		96.65							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; moist		0.00							
		(SM/ML) SILTY SAND to sandy SILT, trace to some gravel; dark brown to grey brown; non-cohesive, moist, very loose to dense		0.14	1	SS	2				
1					2	SS	16				
					3	SS	43				
2	Wash Boring HW Casing	(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, very dense		94.52 2.13	4	RC	DD				
3					5	SS	>50				
					6	RC	DD				
4					7	SS	>50				
					8	RC	DD				
5		End of Borehole		91.67 4.98							
6											
7											
8											
9											
10											

Dynamic penetration scale: 20 40 60 80; Shear strength: nat V. + Q - ● rem V. ⊕ U - ○; 20 40 60 80

Hydraulic conductivity scale: 10^{-8} 10^{-6} 10^{-4} 10^{-2}; Water content: Wp ⊢—○W—⊣ Wl; 20 40 60 80

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF BOREHOLE: 16-109

PROJECT: 13-1121-0083-1046

LOCATION: See Site Plan

BORING DATE: October 3, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	WATER CONTENT PERCENT (approx.)	ADDITIONAL LAB. TESTING
0		GROUND SURFACE	94.37					
	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; moist	0.00					
		(SM) SILTY SAND; grey brown; non-cohesive, moist, loose	0.16	1	SS	6	○	
1		(SM) SILTY SAND, some gravel; grey brown, with oxidation staining; non-cohesive, moist, compact	93.61 / 0.76	2	SS	29	○	
2		(SP/SW) SAND to gravelly SAND, some non-plastic fines; grey; non-cohesive, moist to wet, compact	92.85 / 1.52	3	SS	19	○	
		(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense	92.08 / 2.29	4	SS	24	○	MH
3	Wash Boring, HW Casing			5	SS	>50	○	
4				6	RC	DD		
				7	SS	>50		
				8	RC	DD		
				9	RC	DD		
5		End of Borehole	89.37 / 5.00					

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

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

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢ ⊖W ⊣ Wl ; 20 40 60 80

PIEZOMETER OR STANDPIPE INSTALLATION

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

PROJECT: 13-1121-0083-1046

RECORD OF BOREHOLE: 16-110

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 5, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		98.65							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; moist		0.00							
		(SM/ML) SILTY SAND to sandy SILT; brown; non-cohesive, dry, loose to dense		0.14	1	SS	7				
1					2	SS	38				
		(SM) SILTY SAND, some gravel; brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, dry to moist, very dense		97.13 1.52	3	SS	49				
2					4	SS	75				
3					5	SS	87				
					6	SS	>50				
4					7	SS	>50				
5		End of Borehole		93.62 5.03							Open borehole dry upon completion of drilling
6											
7											
8											
9											
10											

MIS-BHS 001 1311210083.GPJ GAL-MIS.GDT 01/18/17 JM/JEM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF BOREHOLE: 16-111

PROJECT: 13-1121-0083-1046

LOCATION: See Site Plan

BORING DATE: October 3, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	94.47				
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; moist	0.00				
		(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist, very loose to loose	0.17	1	SS	3	
1				2	SS	9	Silica Sand
		(SM) SILTY SAND; grey brown to grey, contains rock fragments; non-cohesive, wet, compact	92.95 1.52	3	SS	16	
2				4	SS	25	
3		(SP) SAND, some non-plastic fines, trace gravel; grey, contains cobbles and boulders; non-cohesive, wet, dense	91.42 3.05	5	SS	34	Bentonite Seal
4				6	SS	>50	
				7	SS	>50	
5	Wash Boring, HW Casing			8	RC	DD	
	Rotary Drill, NQ Core	Slightly weathered to fresh, thinly to medium bedded, fine grained LIMESTONE BEDROCK, with thin to medium shale interbeds	89.38 5.09	C1	RC	DD	Silica Sand
6		- Vertical fracture from 6.64 m to 7.16 m		C2	RC	DD	Standpipe
7		End of Borehole	87.31 7.16				WL in Standpipe at Elev. 93.96 m on Nov. 11, 2016
8							
9							
10							

Column headings also include: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl) (20, 40, 60, 80); STRATA PLOT; ADDITIONAL LAB. TESTING.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

PROJECT: 13-1121-0083-1046

RECORD OF DRILLHOLE: 16-111

LOCATION: See Site Plan

DRILLING DATE: October 3, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME-850

DRILLING CONTRACTOR: CCC

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate; BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage; PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular; PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN		
		BEDROCK SURFACE		89.38				
	Rotary Drill NQ Core	Slightly weathered to fresh, thinly to medium bedded, fine grained LIMESTONE BEDROCK, with thin to medium shale interbeds		5.09	1	10		Bentonite Seal; Silica Sand
6								Standpipe
		- Vertical fracture from 6.64 m to 7.16 m			2	10		
7				87.31 7.16				
		End of Drillhole						WL in Standpipe at Elev. 93.96 m on Nov. 11, 2016

Columns: RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jcon, Jr, Ja); HYDRAULIC CONDUCTIVITY K, cm/sec; Diametral Point Load Index (MPa); RMC -Q' AVG.

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF BOREHOLE: 16-112

PROJECT: 13-1121-0083-1046

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 4, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	95.75				
0	TOPSOIL - (ML) sandy SILT; dark brown; moist	0.00				
	(ML/SM) sandy SILT to SILTY SAND, trace gravel; grey brown; non-cohesive, moist, compact	0.14	1	SS	12	
1			2	SS	24	
2			3	SS	20	
	(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense	93.46 / 2.29	4	SS	16	▽
3			5	SS	17	
4			6	SS	>50	
			7	SS	>50	
5	End of Borehole	90.74 / 5.01				WL in open borehole at 2.29 m depth below ground surface upon completion of drilling

Column headings also include: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT Wp —○W— Wl (20, 40, 60, 80); ADDITIONAL LAB. TESTING; STRATA PLOT.

Depth scale: 0 – 10 m

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF BOREHOLE: 16-113

PROJECT: 13-1121-0083-1046

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: October 4, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (20, 40, 60, 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20, 40, 60, 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		94.75							
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML/OL) sandy SILT to ORGANIC SILT; dark brown; moist		0.00							
		(SM/ML) SILTY SAND to sandy SILT; grey brown; non-cohesive, moist to wet, loose to compact		94.46 / 0.29	1	SS	9		○		
1					2	SS	10		○		
		(ML) sandy SILT; grey; non-cohesive, wet, very loose to loose		93.07 / 1.68	3	SS	4		○		
2		(SM) SILTY SAND, some gravel to gravelly; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense		92.46 / 2.29	4	SS	23		○	MH	
3					5	SS	36		○		
4					6	SS	52		○		
	Rotary Drill, NQ Core	Fresh, thinly to medium bedded, grey, fine grained LIMESTONE BEDROCK, with shale interbeds		90.18 / 4.57	C1	RC	DD				
5		End of Borehole		89.59 / 5.16							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

RECORD OF DRILLHOLE: 16-113

PROJECT: 13-1121-0083-1046

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 4, 2016

DATUM: Geodetic

DRILL RIG: CME-850

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: CCC

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG
		BEDROCK SURFACE		90.18															
5	Rotary Drill, NQ Core	Fresh, thinly to medium bedded, grey, fine grained LIMESTONE BEDROCK, with shale interbeds		4.57	1	10													
		End of Drillhole		89.59 5.16															

Depth scale marks: 6, 7, 8, 9, 10, 11, 12, 13, 14

MIS-RCK 004 1311210083.GPJ GAL-MISS.GDT 01/18/17 JM/JEM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: CK

APPENDIX B

Borehole and Test Pit Records
Previous Investigations

TABLE 1

RECORD OF TEST PITS

Test Pit Number	Depth (metres)	Description
TP 08-1 (Elev. 102.51m)	0.00 – 0.50 0.50 – 0.80 0.80 – 2.50 2.50 – 3.66 3.66	TOPSOIL Grey brown sandy silt, some clay, trace gravel (FILL) Brown SILTY SAND, some gravel, trace clay, with cobbles and boulders Grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL) Excavator Refusal on Bedrock Note 1: Water seepage at depths of 0.5, 0.8 and 1.2 metres below existing ground surface. Note 2: Water level in test pit at 0.2 metres below ground surface upon completion of the excavation. Sample — Depth (m) 1 — 0.50 – 0.80 2 — 1.00 – 1.70 3 — 2.70 – 3.10
TP 08-2 (Elev. 104.69m)	0.00 – 0.25 0.25 – 1.55 1.55	TOPSOIL Grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL) Excavator Refusal on Bedrock Note: Water seepage at a depth of 0.8 metres below existing ground surface. Sample — Depth (m) 1 — 0.30 – 0.60

RECORD OF TEST PITS – continued

Test Pit Number	Depth (metres)	Description
TP 08-3 (Elev. 108.49m)	0.00 – 0.20 0.20 – 1.40 1.40 – 1.70 1.10	TOPSOIL Dark brown coarse SAND and GRAVEL, trace silt, with cobbles and boulders Grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL) Excavator Refusal on Bedrock Note: Water seepage at a depth of 0.7 metres below existing ground surface. Sample — Depth (m) 1 — 0.30 – 0.70 2 — 1.40 – 1.60
TP 08-4 (Elev. 98.59m)	0.00 – 0.25 0.25 – 0.70 0.70 – 2.20 2.20	TOPSOIL Brown SAND, trace silt, with gravel, cobbles and boulders Light brown SAND, some gravel, trace silt, with cobbles and boulders Excavator Refusal on Bedrock Note: Water level in test pit at 0.3 metres below ground surface upon completion of the excavation. Sample — Depth (m) 1 — 0.30 – 0.60 2 — 0.80 – 1.20

RECORD OF TEST PITS – continued

Test Pit Number	Depth (metres)	Description
TP 08-5 (Elev. 105.66m)	0.00 – 0.50 0.50 – 0.95 0.95 – 1.30 1.30 – 2.20 2.20 – 2.60 2.60	TOPSOIL Light brown SANDY SILT Grey SILT Grey SILT, some sand, trace clay, with cobbles and boulders Grey fine SAND, with cobbles and boulders Excavator Refusal on Bedrock Note: Water level in test pit at 1.8 metres below ground surface upon completion of the excavation. Sample — Depth (m) 1 — 0.60 – 0.90 2 — 1.00 – 1.20 3 — 1.40 – 1.80 4 — 2.20 – 2.50

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 21 JUL 05

FILE NO. **PG0627**

HOLE NO. **BH 1**

SOIL DESCRIPTION	Depth of strata boundary (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	96.30
TOPSOIL	0.13						
Compact, brown SILTY SAND	0.94	AU	1				
		SS	2	82	50+	1	95.30
GLACIAL TILL: Very dense, brown silty sand with gravel, cobbles and boulders	3.50	SS	3	67	35	2	94.30
		SS	4	100	50+	3	93.30
		SS	5	100	75+		
End of Borehole							

Practical refusal to augering @ 3.50m depth

(GWL @ 1.42m-Sep. 6/05)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Shear Strength (kPa)

20 40 60 80 100

▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 21 JUL 05

FILE NO. PG0627

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	95.15
TOPSOIL 0.25							
Compact, brown SILTY fine to medium SAND, trace gravel		SS	1	92	12	1	94.15
1.50							
Compact, brown fine to coarse SAND, occasional gravel		SS	2	67	22	2	93.15
		SS	3	83	27	3	92.15
		SS	4	100	25		
- dense and grey by 3.6m depth		SS	5	100	40	4	91.15
4.57							
End of Borehole							
(GWL @ 1.43m-Sep. 6/05)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup
Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM: Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY: CME 55 Power Auger

DATE: 21 JUL 05

FILE NO. PG0627

HOLE NO. BH 3

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	97.19
TOPSOIL	0.20						
Compact, brown SILTY fine SAND		AU	1				
		SS	2	50	10	1	96.19
		SS	3	62	20	2	95.19
- occasional, gravel and cobbles by 2.5m depth	2.80	SS	4	58	19		
GLACIAL TILL: Dense to very dense, grey sandy silt to silty fine sand with gravel, cobbles and boulders		SS	5	75	45	3	94.19
	4.57	SS	6	71	70	4	93.19

End of Borehole

(GWL @ 2.41m-Sep. 6/05)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger DATE 19 JUL 05

FILE NO. PG0627

HOLE NO. BH 4

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	101.39
TOPSOIL	0.18						
Stiff, dark brown CLAYEY SILT, trace sand and gravel	0.60	AU	1				
GLACIAL TILL: Dense to very dense, brown silty fine sand with gravel, cobbles and boulders		SS	2	58	40	1	100.39
		SS	3	92	49	2	99.39
		SS	4	83	85	3	98.39
	3.38	SS	5	85	85+		

End of Borehole

Practical refusal to augering @ 3.38m depth

(BH dry-Sep. 6/05)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger DATE 21 JUL 05

FILE NO. PG0627

HOLE NO. BH 5

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	96.66
TOPSOIL	0.10						
Compact, brown SILTY fine SAND, occasional gravel	1.04					1	95.66
GLACIAL TILL: Very dense, brown silty fine sand with gravel, cobbles and boulders		SS	1	46	16		
		SS	2	83	62	2	94.66
		SS	3	67	27	3	93.66
- grey by 3.1m depth	3.35	SS	4		50+		
End of Borehole							

Practical refusal to augering @ 3.35m depth

(GWL @ 2.02m-Sep. 6/05)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 21 JUL 05

FILE NO. PG0627

HOLE NO. BH 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	93.72		
TOPSOIL 0.20									
Compact, brown SANDY SILT, some clay 1.00		AU	1						
GLACIAL TILL: Compact to dense, brown silty fine to medium sand with gravel, cobbles and boulders		SS	2	50	23	1	92.72		
1.90		SS	3	53	74+				
End of Borehole Practical refusal to augering @ 1.90m depth									

Water Content % axis: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 20 JUL 05

FILE NO. PG0627

HOLE NO. BH 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.77
TOPSOIL (to 0.23)							
Compact to dense, brown **SILTY SAND**, some gravel (to 1.20)		SS	1	73	50+	1	93.77
GLACIAL TILL: Very dense, brown silty fine sand with gravel, cobbles and boulders (to 3.40)		SS	2	82	96+	2	92.77
		SS	3	100	50+	3	91.77
		SS	4	100	50+		
End of Borehole							

Practical refusal to augering @ 3.40m depth

(BH dry-Sep. 6/05)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger DATE 20 JUL 05

FILE NO. PG0627

HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.03
TOPSOIL 0.15							
Compact, brown SILTY fine SAND 0.76		AU	1				
GLACIAL TILL: Very dense, brown silty fine sand with gravel, cobbles and boulders		SS	2	47	79+	1	98.03
		SS	3	67	50+	2	97.03
		SS	4	78	50+	3	96.03
3.56		SS	5	33	77+		
End of Borehole							
Practical refusal to augering @ 3.56m depth							
(GWL @ 3.18m-Sep. 6/05)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM: Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY: CME 55 Power Auger

DATE: 20 JUL 05

FILE NO. PG0627

HOLE NO. BH 9

SOIL DESCRIPTION	Sample TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	101.61
TOPSOIL (to 0.20)						
Compact, brown SILTY fine SAND (to 0.60)						
GLACIAL TILL: Very dense, brown sandy silt with gravel, cobbles and boulders (to 2.72)	SS	1	80	90+	1	100.61
	SS	2	100	50+		
					2	99.61
	SS	3	89	50+		
	AU	4				

End of Borehole

Practical refusal to augering @ 2.72m depth

(GWL @ 2.32m-Sep. 6/05)

Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger **DATE** 21 JUL 05

FILE NO. PG0627

HOLE NO. BH10

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	97.80
TOPSOIL (to 0.28)							
GLACIAL TILL: Very dense, brown sandy silt with gravel, cobbles and boulders		SS	1	73	73+	1	96.80
		SS	2	100	50+		
End of Borehole (at 1.80)							

End of Borehole

Practical refusal to augering @ 1.80m depth

(GWL @ 1.62m-Sep. 6/05)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger DATE 19 JUL 05

FILE NO. **PG0627**

HOLE NO. **BH11**

SOIL DESCRIPTION	Layer depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.01
38mm TOPSOIL							
Compact to dense, brown **SILTY SAND** with gravel		AU	1				
	0.97					1	93.01
GLACIAL TILL: Very dense, brown silty fine sand with gravel, cobbles and boulders		SS	2	33	45		
		SS	3	75	72	2	92.01
		SS	4	30	50+		
End of Borehole	2.54						

Practical refusal to augering @ 2.54m depth

(Piezometer blocked - Sep. 6/05)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM: Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

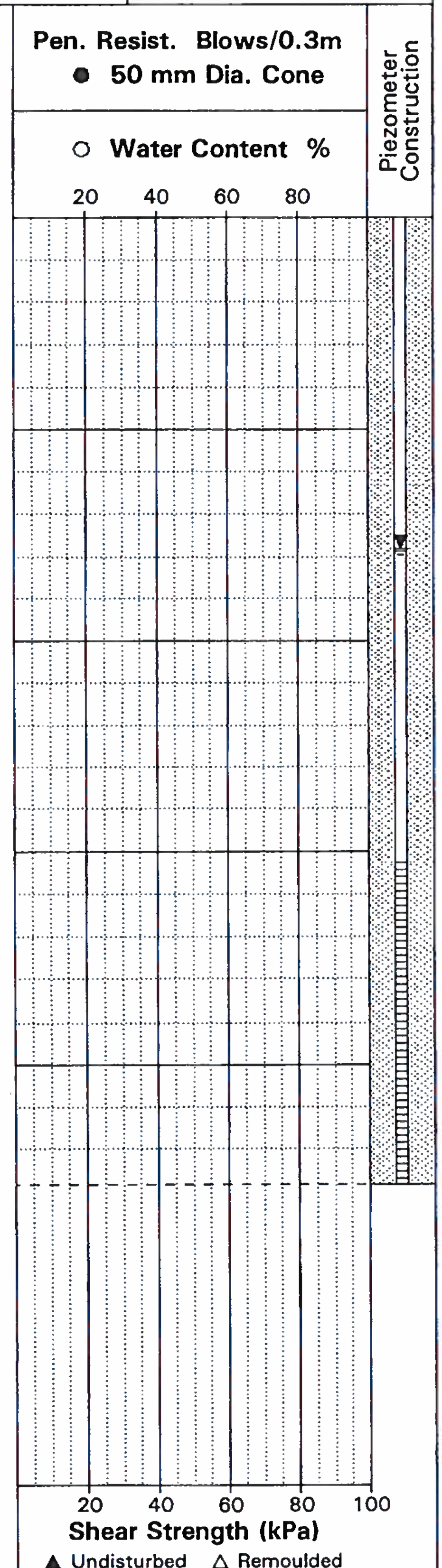
BORINGS BY: CME 55 Power Auger

DATE: 22 JUL 05

FILE NO. PG0627

HOLE NO. BH12

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.50
TOPSOIL	0.28						
Compact, brown SILTY fine SAND - some gravel by 0.8m depth	1.22	SS	1	42	15	1	93.50
GLACIAL TILL: Compact to very dense, grey silty fine sand with gravel, cobbles and boulders	4.57	SS	2	50	28	2	92.50
		SS	3	58	26	3	91.50
		SS	4	33	63	4	90.50
		SS	5	56	50+		
End of Borehole (GWL @ 1.56m-Sep. 6/05)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 19 JUL 05

FILE NO. PG0627

HOLE NO. PH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	101.40		
TOPSOIL — 0.15									
Stiff, dark brown CLAYEY SILT, trace sand and gravel — 0.60									
		AU	1			1	100.40		
GLACIAL TILL: Compact to dense, brown silty fine sand with gravel, cobbles and boulders		AU	2			2	99.40		
						3	98.40		
— 3.40		AU	3						
End of Borehole Practical refusal to augering @ 3.40m depth									

Water Content % axis: 20, 40, 60, 80

Shear Strength (kPa): 20, 40, 60, 80, 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger **DATE** 21 JUL 05

FILE NO. PG0627

HOLE NO. PH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	93.97		
TOPSOIL 0.20									
OVERBURDEN						1	92.97		
1.70									
End of Probehole Practical refusal to augering @ 1.70m depth (GWL @ 1.40m-Sep. 6/05)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 19 JUL 05

FILE NO. PG0627

HOLE NO. PH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	94.00		
TOPSOIL 0.10									
Very dense, brown **SILTY SAND** with gravel		AU	1			1	93.00		
1.22									
End of Borehole Practical refusal to augering @ 1.22m depth									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY CME 55 Power Auger | DATE 21 JUL 05

FILE NO. PG0627

HOLE NO. PH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.64
TOPSOIL (to 0.28)							
GLACIAL TILL: Very dense, brown silty fine sand with gravel, cobbles and boulders (to 2.37)						1	97.64
						2	96.64
		SS	1		50+		
End of Borehole Practical refusal to augering @ 2.37m depth (BH dry-Sep. 6/05)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY 330 Excavator **DATE** 10 AUG 05

FILE NO. PG0627

HOLE NO. TP 1

SOIL DESCRIPTION	Depth to base of layer (m)
GROUND SURFACE	
TOPSOIL	0.30
Dark brown to brown **CLAYEY SILT**, some fine sand	0.40
Grey SILT, trace clay	1.30
Grey **SILTY CLAY** with silt layers	2.70
Grey **SILTY** fine **SAND**	4.00
End of Test Pit (Water infiltration @ 3.0m depth)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
G	1		
G	2		
G	3		
G	4		
G	5		

DEPTH (m)	ELEV. (m)
0	100.09
1	99.09
2	98.09
3	97.09
4	96.09

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY 330 Excavator

DATE 10 AUG 05

FILE NO. PG0627

HOLE NO. TP 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	97.52		
PEAT		G	1						
0.50									
Compact, brown SANDY SILT with gravel and cobbles									
1.00						1	96.52		
Grey SILT mixed with clayey silt		G	2						
		G	3						
						2	95.52		
						3	94.52		
3.20									
End of Test Pit									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM: Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY: 330 Excavator

DATE: 10 AUG 05

FILE NO.: PG0627

HOLE NO.: TP 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	96.96
PEAT 0.20		G	1				
Compact, brown SILT		G	2				
- grey by 1.0m depth		G	3			1	95.96
						2	94.96
- large boulders by 2.2m depth							
		G	4				
						3	93.96
4.00 End of Test Pit						4	92.96

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

Piezometer Construction

Shear Strength (kPa)
20 40 60 80 100
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Proposed Development, Bank Street at Blais Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis O'Sullivan Vollebekk Surveying.

REMARKS

BORINGS BY 330 Excavator — DATE 9 AUG 05

FILE NO. **PG0627**

HOLE NO. **TP 4**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.00
PEAT 0.28		G	1				
Stiff to very stiff, brown **CLAYEY SILT** 0.55		G	2				
Compact, brown SILT		G	3			1	93.00
- grey by 1.8m depth						2	92.00
		G	4				
- large boulders by 3.0m depth 3.05						3	91.00
End of Test Pit							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

JACQUES WHITFORD
ENVIRONMENT LIMITED

BOREHOLE RECORD

BH 92-1

CLIENT: Remer Group

LOCATION: Leitrim Road, Gloucester, Ontario

DATES: BORING 92-05-27 WATER LEVEL 92-06-04

PROJECT No. 30227

DATUM Estimated

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	N-VALUE OR RQD
0	93.70			
	93.4	Dark brown wet silty TOPSOIL		
	93.0	Light brown SILT, some fine sand.		
1		Brown silty SAND some gravel	SS	25
			SS	66
2	91.4			
		Grey silty sand some gravel:TILL	SS	24
3	90.5		SS	50
		End of Borehole (Auger Refusal)		

Column headings: DEPTH (m) · ELEVATION (m) · STRATA DESCRIPTION · STRATA PLOT · WATER LEVEL · DEPTH (ft) · GRAIN SIZE (%) (0 20 40 60 80 100) · SAMPLES (TYPE, N-VALUE OR RQD) · PIEZOMETER CONSTRUCTION DETAILS

DEPTH (m) scale: 0 1 2 3 4 5 6 7 8 9 10

DEPTH (ft) scale: 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

JACQUES WHITFORD
ENVIRONMENT LIMITED

BOREHOLE RECORD

BH 92-2

CLIENT Remer Group

PROJECT No. 30227

LOCATION Leitrim Road, Gloucester, Ontario

DATUM Estimated

DATES: BORING 92-05-27

WATER LEVEL 92-06-05

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	N-VALUE OR RQD
0	94.70			
	94.4	Dark brown silty TOPSOIL		
		Brown silty SAND	SS	7
	93.2	Grey SILT some fine sand	SS	9
	92.6	Grey silty SAND, some to trace gravel	SS	4
			SS	5
	91.1	Grey silty sand and gravel:TILL		
	90.2	End of Borehole (Auger Refusal)		

GRAIN SIZE (%): 0 20 40 60 80 100

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

DEPTH (m): 0 1 2 3 4 5 6 7 8 9 10

PIEZOMETER CONSTRUCTION DETAILS

D S

JACQUES WHITFORD
ENVIRONMENT LIMITED

BOREHOLE RECORD

BH 92-3

CLIENT: Remer Group

LOCATION: Leitrim Road, Gloucester, Ontario

DATES: BORING: 92-05-27

WATER LEVEL: 92-06-04

PROJECT No.: 30227

DATUM: Estimated

TPC ELEV.:

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION
0	100.80	
	100.6	Dark brown silty TOPSOIL
		Brown silty SAND with fine layers that have some gravel
	98.1	Grey sand silt and gravel:TILL, with increasing amounts of clay with depth
	91.4	End of Borehole (Auger Refusal)

STRATA PLOT | WATER LEVEL | DEPTH (ft) | GRAIN SIZE (%): 0 20 40 60 80 100

SAMPLES: TYPE	N-VALUE OR RQD
SS	19
SS	45
SS	50
SS	98
SS	25
SS	44

PIEZOMETER CONSTRUCTION DETAILS: D, S

JACQUES WHITFORD
ENVIRONMENT LIMITED

BOREHOLE RECORD

BH 92-5

CLIENT: Remer Group
LOCATION: Leitrim Road, Gloucester, Ontario
DATES: BORING 92-05-29 WATER LEVEL 92-06-04

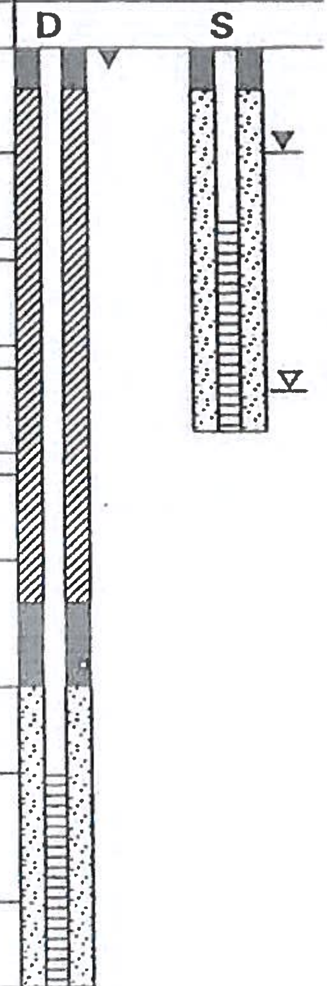
PROJECT No. 30227
DATUM Estimated
TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	N-VALUE OR RQD
0	99.70	Dark brown to black peaty TOPSOIL		
	99.3	Brown silty sand		
	99.0	Grey silty SAND and GRAVEL	SS	50
			SS	29
			SS	47
			SS	22
	95.1	Grey silty sand and gravel:TILL	SS	49
			SS	50
	93.0	End of Borehole (Auger Refusal)		

DEPTH (ft): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32

GRAIN SIZE (%): 0 20 40 60 80 100

PIEZOMETER CONSTRUCTION DETAILS



JACQUES WHITFORD
ENVIRONMENT LIMITED

BOREHOLE RECORD

BH 92-6

CLIENT: Remer Group
PROJECT No.: 30227
LOCATION: Leitrim Road, Gloucester, Ontario
DATUM: Estimated
DATES: BORING: 92-05-29
WATER LEVEL: 92-06-04
TPC ELEV.:

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION
0	99.10	Dark brown silty PEAT
	98.7	Grey sandy SILT, some gravel
	95.3	Grey silty sand and gravel:TILL
	94.7	End of Borehole (Auger Refusal)

SAMPLES TYPE	N-VALUE OR RQD
SS	10
SS	8
SS	6
SS	7

GRAIN SIZE (%): 0 20 40 60 80 100

WELL CONSTRUCTION: D S

DEPTH (m): 0 1 2 3 4 5 6 7 8 9 10

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

JACQUES WHITFORD ENVIRONMENT LIMITED

BOREHOLE RECORD

BH 92-8

CLIENT: Remer Group
LOCATION: Leitrim Road, Gloucester, Ontario
DATES: BORING 92-06-05 WATER LEVEL 92-06-05

PROJECT No. 30227
DATUM: Estimated
TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	GRAIN SIZE (%) 0 20 40 60 80 100	SAMPLES TYPE	SAMPLES N-VALUE OR RQD	PIEZOMETER CONSTRUCTION DETAILS
0	100.00								▽
	99.9	Dark brown silty TOPSOIL							
		Dark brown silty SAND			2				
1					4				
	98.5	End of Borehole (Auger Refusal)							
2					6				
					8				
3					10				
					12				
4					14				
5					16				
					18				
6					20				
					22				
7					24				
8					26				
					28				
9					30				
					32				
10									

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

90-2

CLIENT: Ship & Krakow Architects
LOCATION: Leitrim, Ontario
DATES: BORING 90-06-25
WATER LEVEL:

PROJECT No. 30067
BOREHOLE No. 90-2
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	101.10	Ground Surface						
0 – 6.3		Dense, brown and grey, medium to coarse, SAND, trace to some silt, some gravel (increasing with depth)			SS	1	360	33
					SS	2	500	37
					SS	3	500	59
	94.8				SS	4	200	*
		End of Borehole						
		* Split spoon refusal						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 9

△ Pocket Penetrometer Test

□ Field Vane Test

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

90-3

CLIENT: Ship & Krakow Architects
LOCATION: Leitrim, Ontario
DATES: BORING 90-06-26
WATER LEVEL:
PROJECT No. 30067
BOREHOLE No. 90-3
DATUM: Geodetic

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P, W, W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★
STANDARD PENETRATION TEST, BLOWS/0.3m: ●
Scale: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	96.60	Ground Surface				
0 – 0.6	96.0	Black PEAT				
0.6 – 5.6	91.0	Loose to compact, grey, medium, SAND, trace to some silt, trace gravel	SS	1	320	10
			SS	2	230	7
			SS	3	450	32
5.6 – 6.3	90.3	Compact, greyish brown, SILT and SAND, some gravel and pebbles	SS	4	-	*
6.3		End of Borehole				

* Split spoon refusal

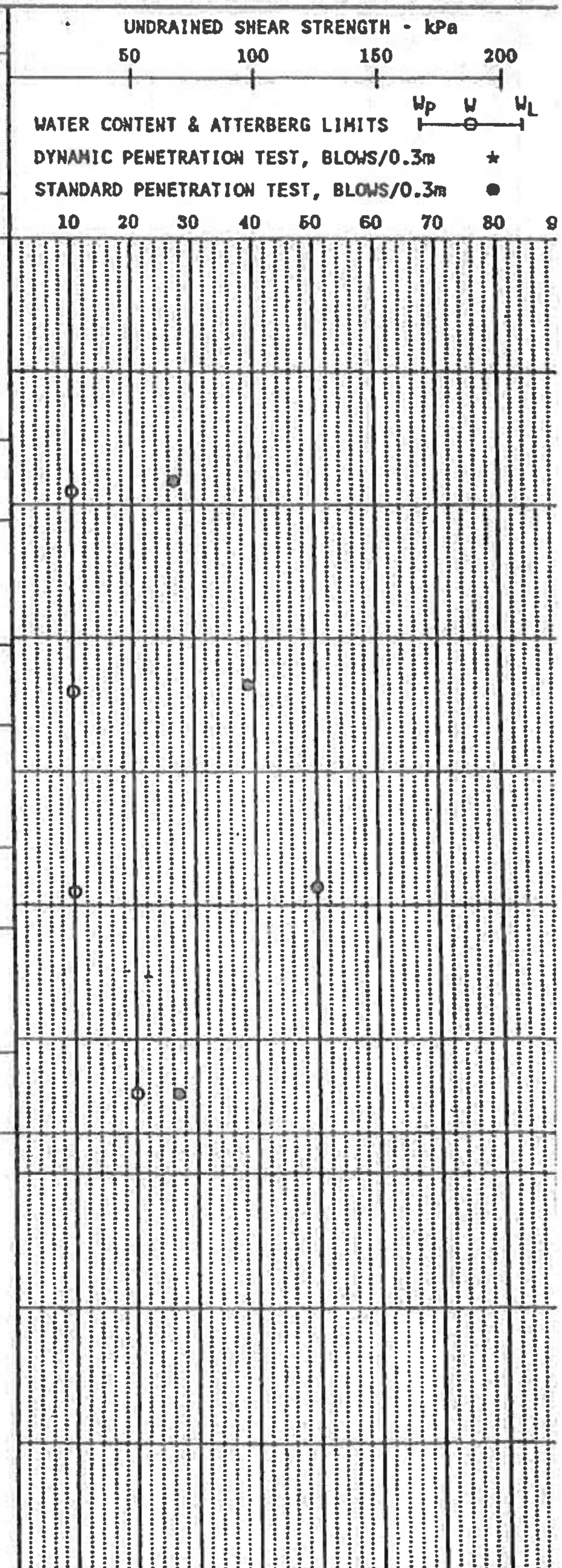
△ Pocket Penetrometer Test
□ Field Vane Test

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD 90-4

CLIENT: Ship & Krakow Architects
LOCATION: Leitrim, Ontario
DATES: BORING 90-06-27
WATER LEVEL:
PROJECT No. 30067
BOREHOLE No. 90-4
DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	96.20	Ground Surface						
0		Black PEAT						
	95.6							
		Compact to dense, grey, (fine becoming coarse at depth), SAND, trace silt, some gravel						
~1.8					SS	1	230	27
~3.3					SS	2	350	39
~4.8					SS	3	380	50
~6.4					SS	4	100	27
	89.5	End of Borehole						



△ Pocket Penetrometer Test
□ Field Vane Test

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD 90-5

CLIENT: Ship & Krakow Architects
LOCATION: Leitrim, Ontario
DATES: BORING 90-06-27 WATER LEVEL
PROJECT No. 30067
BOREHOLE No. 90-5
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	96.10	Ground Surface				
		Black PEAT				
	95.5	Loose, grey, fine to medium, SAND and SILT, trace gravel and small pebbles at depth				
~1.8			SS	1	240	5
~3.3			SS	2	400	3
~4.8			SS	3	300	5
~6.4	89.4		SS	4	420	9
~6.7		End of Borehole				

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
10 20 30 40 50 60 70 80 90

△ Pocket Penetrometer Test
□ Field Vane Test

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD 90-6

CLIENT: Ship & Krakow Architects — PROJECT No. 30067

LOCATION: Leitrim, Ontario — BOREHOLE No. 90-6

DATES: BORING 90-06-27 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	99.70	Ground Surface						
0	99.4	Dark brown, TOPSOIL and ROOTMAT						
		Brown and grey, fine to medium, SAND, trace silt						
1.6	98.1	Very dense, brown, silty sand, some gravel and rock fragments at top of bedrock, TILL			SS	1	250	*
2.3	97.4	End of Borehole (Bedrock)						

* Split spoon refusal

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

Scale: 10, 20, 30, 40, 50, 60, 70, 80, 90

Depth scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

△ Pocket Penetrometer Test

□ Field Vane Test

JACQUES, WHITFORD
LIMITED

BOREHOLE RECORD

90-7

CLIENT: Ship & Krakow Architects

LOCATION: Leitrim, Ontario

DATES: BORING 90-06-27

WATER LEVEL:

PROJECT No. 30067

BOREHOLE No. 90-7

DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES: TYPE	SAMPLES: NUMBER	SAMPLES: RECOVERY (mm)	SAMPLES: N-VALUE OR RQD
	102.10	Ground Surface						
0		Dense, brown, silty sand: TILL						
1	100.9	End of Borehole (Bedrock)						

Depth scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_p W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

△ Pocket Penetrometer Test

□ Field Vane Test

JACQUES, WHITFORD
LIMITED

BOREHOLE RECORD

90-8

CLIENT: Ship & Krakow Architects
LOCATION: Leitrim, Ontario
DATES: BORING 90-06-27
WATER LEVEL:

PROJECT No. 30067
BOREHOLE No. 90-8
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES: TYPE	SAMPLES: NUMBER	SAMPLES: RECOVERY (mm)	SAMPLES: N-VALUE OR RQD
0	99.90	Ground Surface						
	99.6	TOPSOIL						
1		Brown, SANDY SILT, trace organics						
	98.2				SS	1	130	*
2		End of Borehole (Bedrock)						
		* Split spoon refusal						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS (W_P, W, W_L)
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

△ Pocket Penetrometer Test
□ Field Vane Test

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD 90-9

CLIENT: Ship & Krakow Architects

LOCATION: Leitrim, Ontario

DATES: BORING 90-06-28

WATER LEVEL

PROJECT No. 30067

BOREHOLE No. 90-9

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	98.20	Ground Surface						
0	97.9	TOPSOIL						
		Dense, brown, SILTY SAND						
	96.7	Dense, brown, fine to medium, SAND, trace to some silt, trace gravel, trace iron oxidation, occasional organics			SS	1	490	50
	95.6	Light brown, GRAVEL, some sand and rock fragments at bedrock surface			SS	2	270	24
	94.8	End of Borehole (Bedrock)						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Depth scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

△ Pocket Penetrometer Test

□ Field Vane Test

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

90-10

CLIENT: Ship & Krakow Architects
PROJECT No. 30067

LOCATION: Leitrim, Ontario
BOREHOLE No. 90-10

DATES: BORING 90-06-28
WATER LEVEL
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR RQD
0	94.10	Ground Surface						
	93.8	TOPSOIL						
	92.6	Brown, fine to medium, SAND, trace silt, trace gravel						
	91.5	Compact, brown, fine to medium, SAND, trace gravel			SS	1	500	21
	90.6	Compact, brown, medium, SAND and GRAVEL, some rock fragments at bedrock surface			SS	2	410	30
		End of Borehole (Bedrock)						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P, W, W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

DEPTH (m): 0 1 2 3 4 5 6 7 8 9 10

△ Pocket Penetrometer Test

□ Field Vane Test

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

90-11

CLIENT: Ship & Krakow Architects

LOCATION: Leitrim, Ontario

DATES: BORING 90-06-28

WATER LEVEL

PROJECT No. 30067

BOREHOLE No. 90-11

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	95.00	Ground Surface						
0	94.7	TOPSOIL						
	94.4	Brown, SANDY SILT						
	94.1	COBBLES and PEBBLES						
1	93.3	Compact, brown, SAND, trace silt, trace gravel, trace organics (blocky texture)						
2	92.6	Compact, brown, silty sand: TILL			SS	1	460	29
		End of Borehole (Bedrock)						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

△ Pocket Penetrometer Test

□ Field Vane Test

Augerhole Number	Depth (metres)	Soil Description
AH 205	0.0 - 0.15	Brown Silty **TOPSOIL**
	0.15 - 1.52	Light Brown **SILTY** Fine **SAND**, some Clay, trace Gravel
	1.52	End of Augerhole Water at 0.30 metres depth
AH 206	0.0 - 0.76	Black **PEAT**
	0.76 - 1.22	Grey **CLAYEY SILT**, some Sand
	1.22 - 1.52	Grey **SILTY** Fine **SAND**, some Clay
	1.52	End of Augerhole Water at Ground Surface
AH 207	0.0 - 0.61	Black **PEAT**
	0.61 - 1.22	Grey **CLAYEY SILT**, some Sand
	1.22 - 1.52	Grey **SILTY** Fine **SAND**, some Clay
	1.52	End of Augerhole Water at 0.1 metres depth
AH 208	0.0 - 1.52	Black **PEAT**
	1.52 - 1.82	Grey **SILTY** Fine **SAND**, trace Gravel
	1.82	End of Augerhole Water at 0.1 metres depth
AH 209	0.0 - 2.74	Black **PEAT**
	2.74	End of Augerhole Water at Ground Surface
AH 210	0.0 - 0.20	Brown Silty **TOPSOIL**, trace Gravel
	0.20 - 1.52	Light Brown **SANDY SILT**, some Clay, trace Gravel
	1.52	End of Augerhole Augerhole Dry

Augerhole Number	Depth (metres)	Soil Description
AH 211	0.0 - 0.15	Brown Silty **TOPSOIL**
	0.15 - 0.30	Light Brown **SANDY SILT**, some Clay
	0.30 - 0.76	Light Brown **SILTY** Fine **SAND**, some Clay
	0.76 - 1.52	Grey **SILTY** Fine **SAND**
	1.52	End of Augerhole Water at 0.20 metres depth
AH 212	0.0 - 0.10	Brown Sandy **TOPSOIL**
	0.10 - 1.12	Brown **SILTY** Fine **SAND**, trace Gravel
	1.12	End of Augerhole Augerhole Dry
AH 213	0.0 - 1.82	Black **PEAT**
	1.82 - 2.13	Grey **SILTY** Fine **SAND**, trace Gravel
	2.13	End of Augerhole Water at 0.10 metres depth
AH 214	0.0 - 2.74	Black **PEAT**
	2.74	End of Augerhole Water at Ground Surface
AH 215	0.0 - 2.74	Black **PEAT**
	2.74	End of Augerhole Water at Ground Surface
AH 216	0.0 - 1.22	Black **PEAT**
	1.22 - 2.13	Grey **SILTY** Fine **SAND**
	2.13	End of Augerhole Water at Ground Surface

Augerhole Number	Depth (metres)	Soil Description
AH 217	0.0 - 0.61	Black **PEAT**
	0.61 - 1.52	Grey **SILTY** Fine **SAND**
	1.52	End of Augerhole Water at Ground Surface
AH 218	0.0 - 0.91	Black **PEAT**
	0.91 - 1.52	Grey **SILTY** Fine **SAND**
	1.52	End of Augerhole Water at Ground Surface
AH 219	0.0 - 0.76	Black **PEAT**
	0.76 - 1.52	Grey **SILTY** Fine **SAND**
	1.52	End of Augerhole Water at Ground Surface
AH 220	0.0 - 0.30	Black **PEAT**
	0.30 - 0.76	Grey Brown **CLAYEY SILT**, some sand
	0.76 - 1.52	Grey **SILTY** Fine **SAND**, some clay
	1.52	End of Augerhole Water at 0.15 metres depth

Augerhole Number	Depth (metres)	Soil Description
AH 15	0.0 - 0.60	**PEAT**
	0.60 - 1.20	Grey Brown **CLAYEY SILT**
	1.20 - 2.0	Grey layered **SANDY SILT** to **SILTY** Fine **SAND**, occasional Silty Clay Layer
	2.0 - 2.60	Grey **SILTY** Fine **SAND**
	2.60	End of Augerhole Water at Ground Surface
AH 16	0.0 - 0.25	**PEAT**
	0.25 - 0.60	Grey brown layered **SILTY CLAY** and **CLAYEY SILT**
	0.60 - 0.75	**SILTY SAND** and **GRAVEL**
	0.75 - 1.30	Grey Brown layered **SANDY SILT**, **CLAYEY SILT** and Silty Fine **SAND**, trace Gravel
	1.30 - 2.30	Brown to Grey **SILTY** Fine **SAND**
	2.30	End of Augerhole Water at 0.15 metres depth
AH 17	0.0 - 1.10	**PEAT**
	1.10 - 2.10	Grey **SANDY SILT**, some Clayey Silt and Silty Clay Layers
	2.10 - 2.60	Grey **SILTY** Fine **SAND**
	2.60	End of Augerhole Water at 0.1 metre depth
AH 18	0.0 - 1.50	**PEAT**
	1.50 - 2.50	Grey **SILTY** Fine **SAND**, trace to some Gravel
	2.50	End of Augerhole Water at 0.30 metres depth

APPENDIX C

Results of Hydrogeological Assessment

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-1A

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-1A	
DATE OF TEST	12/11/2013	
CASING STICK-UP	0.88	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	4.080	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	2.98	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.038	METRES
TOP OF OPEN INTERVAL	4.25	METRES (btoc)
BOTTOM OF OPEN INTERVAL	5.17	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	1.09	METRES
WATER TABLE TO BOTTOM OF SCREEN	1.09	METRES
EQUIVALENT RADIUS	0.026	METRES
OPEN INTERVAL LENGTH	0.92	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.27	METRES
MAX. HEAD IN SCREEN?	Yes	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	NA	METRES
RADIUS OF SLUG	NA	METRES
VOLUME OF SLUG ($\pi r^2 l$)	#VALUE!	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	#VALUE!	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			4.354	0	0.27	1.000
			4.153	1	0.07	0.267
			4.100	2	0.02	0.072
			4.086	3	0.01	0.023
			4.085	4	0.01	0.020
			4.085	5	0.00	0.018
			4.085	6	0.01	0.019
			4.084	7	0.00	0.016
			4.084	8	0.00	0.016
			4.084	9	0.00	0.016
			4.084	10	0.00	0.014
			4.084	11	0.00	0.015
			4.084	12	0.00	0.014
			4.083	13	0.00	0.012
			4.083	14	0.00	0.012
			4.083	15	0.00	0.012
			4.077	16	0.00	-0.012
			4.088	17	0.01	0.028
			4.083	18	0.00	0.010
			4.083	19	0.00	0.009
			4.083	20	0.00	0.009
			4.082	21	0.00	0.007
			4.082	22	0.00	0.007
			4.082	23	0.00	0.007
			4.082	24	0.00	0.008
			4.082	25	0.00	0.006
			4.082	26	0.00	0.007
			4.081	27	0.00	0.004
			4.081	28	0.00	0.005
			4.082	29	0.00	0.005
			4.082	30	0.00	0.005
			4.081	31	0.00	0.005
			4.08	32	0.00	0.004
			4.08	33	0.00	0.003
			4.08	34	0.00	0.004
			4.08	35	0.00	0.003

* Initial water level inferred from approximate volume purged during 10 seconds of waterra pu

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-1A

INTERVAL (metres below ground surface)

Top of Interval = 3.37
Bottom of Interval = 4.29

$$K = \frac{r_c^{\,2} \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_o}{y_t}$$

where K=m/sec

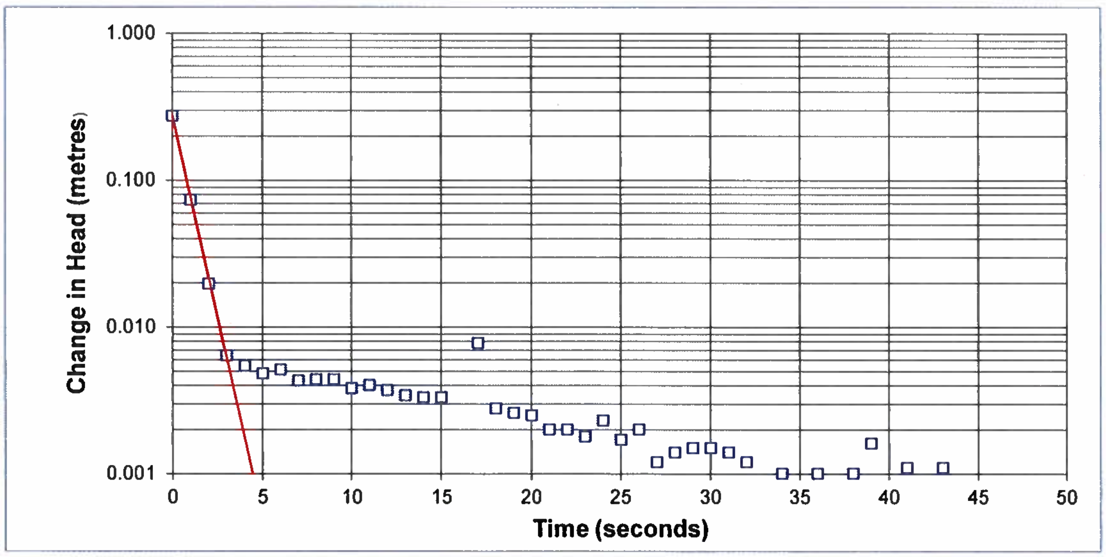
where:

r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS	
r_c =	0.02
r_w =	0.03
L_e =	0.92
$ln(R_e/r_w)$	5.85
y_0 =	0.27
y_t =	0.01
t =	3.0

RESULTS

K=	1E-03	m/sec
K=	1E-01	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 12/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

Golder Associates Ltd.

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-3A

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-3A	
DATE OF TEST	12/11/2013	
CASING STICK-UP	1.01	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	4.490	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	2.98	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.038	METRES
TOP OF OPEN INTERVAL	7.56	METRES (btoc)
BOTTOM OF OPEN INTERVAL	9.09	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	3.91	METRES
WATER TABLE TO BOTTOM OF SCREEN	1.78	METRES
EQUIVALENT RADIUS	0.026	METRES
OPEN INTERVAL LENGTH	1.53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1.49	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624 UBIC	METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			5.983	0	1.49	1.000
			4.999	1	0.51	0.341
			4.869	2	0.38	0.254
			4.771	3	0.28	0.188
			4.701	4	0.21	0.142
			4.645	5	0.16	0.104
			4.608	6	0.12	0.079
			4.573	7	0.08	0.056
			4.556	8	0.07	0.044
			4.545	9	0.06	0.037
			4.537	10	0.05	0.032
			4.532	11	0.04	0.028
			4.528	12	0.04	0.025
			4.524	13	0.03	0.023
			4.521	14	0.03	0.021
			4.520	15	0.03	0.020
			4.518	16	0.03	0.019
			4.516	17	0.03	0.017
			4.515	18	0.03	0.017
			4.514	19	0.02	0.016
			4.509	20	0.02	0.013
			4.513	21	0.02	0.016
			4.512	22	0.02	0.015
			4.512	23	0.02	0.015
			4.510	24	0.02	0.013
			4.510	25	0.02	0.014
			4.509	26	0.02	0.013
			4.509	27	0.02	0.013
			4.509	28	0.02	0.013
			4.507	29	0.02	0.012
			4.508	30	0.02	0.012
			4.507	31	0.02	0.011
			4.507	32	0.02	0.011
			4.507	33	0.02	0.011
			4.506	34	0.02	0.011
			4.506	35	0.02	0.011

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-3A

INTERVAL (metres below ground surface)

Top of Interval = 6.55
Bottom of Interval = 8.08

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln\frac{y_o}{y_t}$$

where K=m/sec

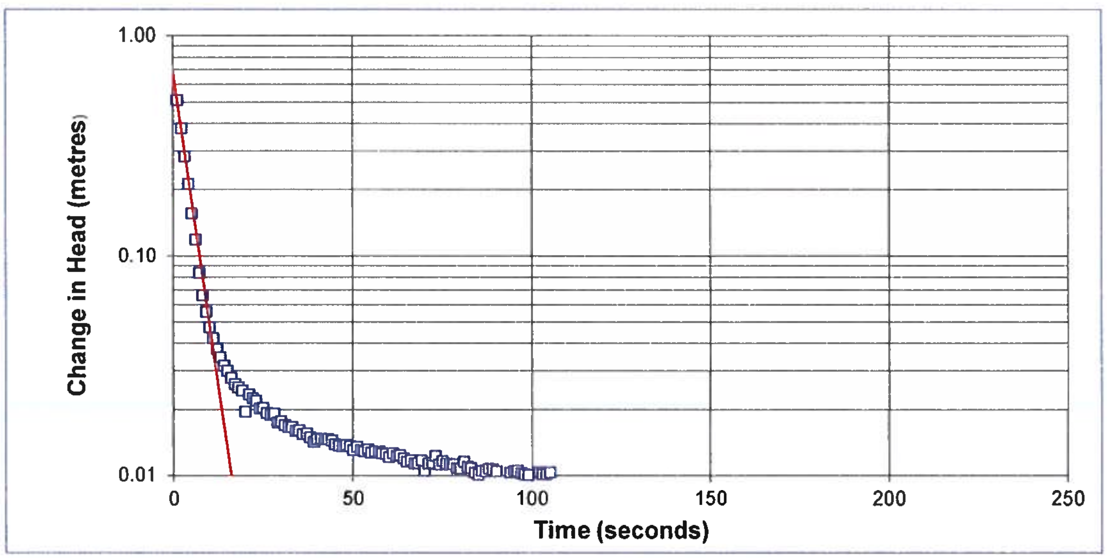
where:

r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS	
r_c =	0.02
r_w =	0.04
L_e =	1.53
$ln(R_e/r_w)$	2.54
y_0 =	0.65
y_t =	0.01
t =	16.0

RESULTS

K=	8E-05	m/sec
K=	8E-03	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 12/11/2013
Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

RED = Calculated Value
BLUE = User defined value

FALLING HEAD TEST BH13-3B

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-3B	
DATE OF TEST	12/11/2013	
CASING STICK-UP	0.97	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	4.460	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	8	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.102	METRES
TOP OF OPEN INTERVAL	5.08	METRES (btoc)
BOTTOM OF OPEN INTERVAL	6.61	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	2.81	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.15	METRES
EQUIVALENT RADIUS	0.058	METRES
OPEN INTERVAL LENGTH	1.53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.93	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			3.531	0	0.93	1.000
			3.550	1	0.91	0.980
			3.522	2	0.94	1.010
			3.805	3	0.66	0.705
			3.702	4	0.76	0.816
			3.724	5	0.74	0.792
			3.722	6	0.74	0.795
			3.722	7	0.74	0.795
			3.723	8	0.74	0.794
			3.723	9	0.74	0.794
			3.724	10	0.74	0.793
			3.724	11	0.74	0.793
			3.725	12	0.74	0.792
			3.706	13	0.75	0.812
			3.732	14	0.73	0.784
			3.725	15	0.74	0.792
			3.726	16	0.73	0.790
			3.725	17	0.73	0.791
			3.727	18	0.73	0.789
			3.728	19	0.73	0.788
			3.728	20	0.73	0.788
			3.729	21	0.73	0.786
			3.729	22	0.73	0.787
			3.729	23	0.73	0.787
			3.730	24	0.73	0.786
			3.731	25	0.73	0.785
			3.728	26	0.73	0.788
			3.731	27	0.73	0.785
			3.731	28	0.73	0.785
			3.731	29	0.73	0.784
			3.730	30	0.73	0.786
			3.732	31	0.73	0.783
			3.732	32	0.73	0.784
			3.733	33	0.73	0.783
			3.733	34	0.73	0.782
			3.733	35	0.73	0.782

BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST BH13-3B

INTERVAL (metres below ground surface)

Top of Interval = 4.11
Bottom of Interval = 5.64

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_o}{y_t}$$

where K=m/sec

where:

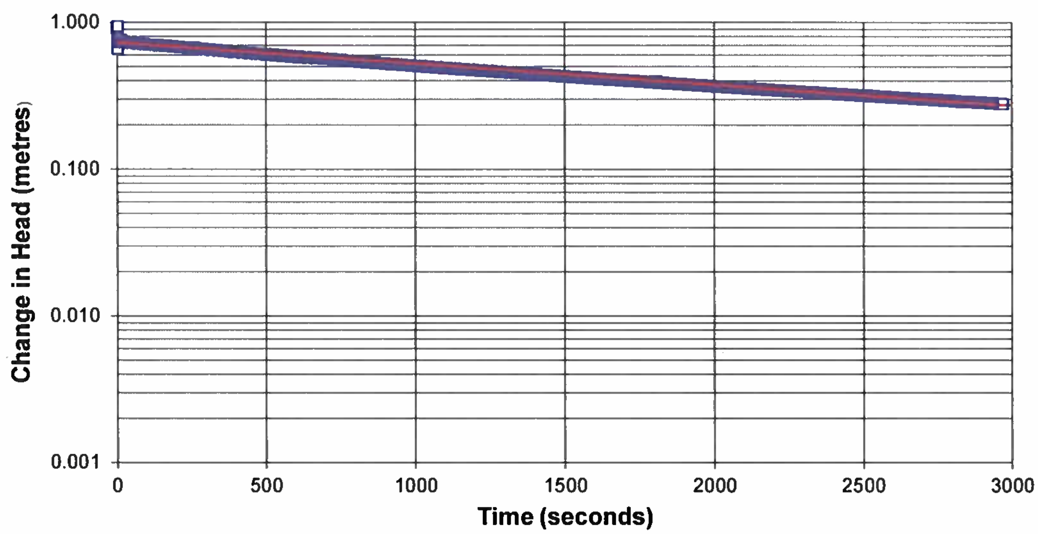
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.10
L_e =	1.52
$ln(R_e/r_w)$	1.90
y_0 =	0.73
y_t =	0.27
t =	3000.0

RESULTS

K=	7E-08	m/sec
K=	7E-06	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 12/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

Golder Associates Ltd.

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-9

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-9	
DATE OF TEST	12/11/2013	
CASING STICK-UP	0.90	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.800	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	3.782	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.048	METRES
TOP OF OPEN INTERVAL	3.95	METRES (btoc)
BOTTOM OF OPEN INTERVAL	5.47	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	4.67	METRES
WATER TABLE TO BOTTOM OF SCREEN	4.67	METRES
EQUIVALENT RADIUS	0.031	METRES
OPEN INTERVAL LENGTH	1.52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1.63	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			2.433	0	1.63	1.000
			2.008	1	1.21	0.740
			1.936	2	1.14	0.696
			1.921	3	1.12	0.687
			1.788	4	0.99	0.605
			1.729	5	0.93	0.569
			1.729	6	0.93	0.569
			1.720	7	0.92	0.563
			1.713	8	0.91	0.559
			1.706	9	0.91	0.555
			1.701	10	0.90	0.552
			1.695	11	0.89	0.548
			1.689	12	0.89	0.545
			1.683	13	0.88	0.541
			1.678	14	0.88	0.538
			1.671	15	0.87	0.533
			1.641	16	0.84	0.515
			1.660	17	0.86	0.527
			1.654	18	0.85	0.523
			1.649	19	0.85	0.520
			1.644	20	0.84	0.517
			1.637	21	0.84	0.512
			1.633	22	0.83	0.510
			1.628	23	0.83	0.507
			1.625	24	0.82	0.505
			1.617	25	0.82	0.501
			1.612	26	0.81	0.497
			1.607	27	0.81	0.494
			1.603	28	0.80	0.492
			1.600	29	0.80	0.490
			1.595	30	0.80	0.487
			1.591	31	0.79	0.484
			1.585	32	0.79	0.481
			1.580	33	0.78	0.478
			1.572	34	0.77	0.473
			1.568	35	0.77	0.470

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-9

INTERVAL (metres below ground surface)

Top of Interval =	**3.05**
Bottom of Interval =	**4.57**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

where:

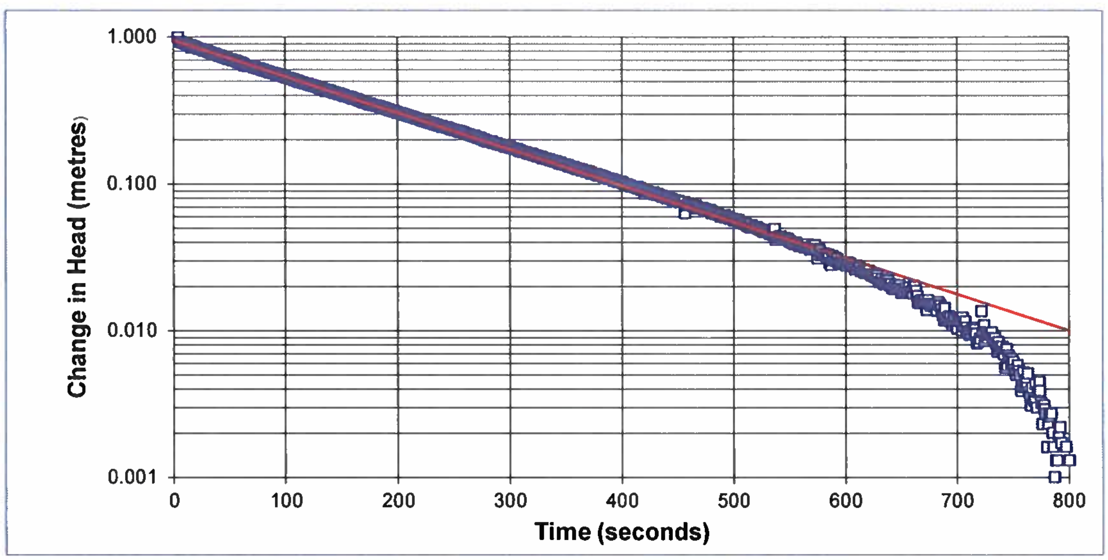
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.05
L_e =	1.52
$ln(R_e/r_w)$	6.93
y_0 =	0.95
y_t =	0.01
t =	800.0

RESULTS

K=	5E-06	m/sec
K=	5E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 12/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

Golder Associates Ltd.

RED = Calculated Value
BLUE = User defined value

FALLING HEAD TEST BH13-13A

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-13A	
DATE OF TEST	12/11/2013	
CASING STICK-UP	0.87	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	3.780	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	2.98	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.038	METRES
TOP OF OPEN INTERVAL	5.57	METRES (btoc)
BOTTOM OF OPEN INTERVAL	7.09	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	2.31	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.31	METRES
EQUIVALENT RADIUS	0.026	METRES
OPEN INTERVAL LENGTH	1.52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	2.38	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.404	0	2.38	1.000
			3.070	1	0.71	0.299
			3.280	2	0.50	0.211
			3.468	3	0.31	0.131
			3.724	4	0.06	0.024
			3.782	5	0.00	-0.001
			3.771	6	0.01	0.004
			3.768	7	0.01	0.005
			3.769	8	0.01	0.005
			3.772	9	0.01	0.003
			3.774	10	0.01	0.003
			3.775	11	0.01	0.002
			3.777	12	0.00	0.001
			3.778	13	0.00	0.001
			3.779	14	0.00	0.000
			3.779	15	0.00	0.000
			3.780	16	0.00	0.000
			3.780	17	0.00	0.000
			3.780	18	0.00	0.000
			3.780	19	0.00	0.000
			3.781	20	0.00	0.000
			3.780	21	0.00	0.000
			3.781	22	0.00	0.000
			3.781	23	0.00	-0.001
			3.781	24	0.00	0.000
			3.781	25	0.00	0.000
			3.781	26	0.00	0.000
			3.781	27	0.00	-0.001
			3.781	28	0.00	0.000
			3.781	29	0.00	0.000
			3.782	30	0.00	-0.001
			3.781	31	0.00	-0.001
			3.781	32	0.00	0.000
			3.782	33	0.00	-0.001
			3.781	34	0.00	0.000
			3.781	35	0.00	0.000

BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST BH13-13A

INTERVAL (metres below ground surface)

Top of Interval =	**4.70**
Bottom of Interval =	**6.22**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln\frac{y_0}{y_t}$$

where K=m/sec

where:

r_c = casing radius (metres);

R_e = effective radius (metres);

L_e = length of screened interval (metres);

r_w = radial distance to undisturbed aquifer (metres)

y_0 = initial drawdown (metres)

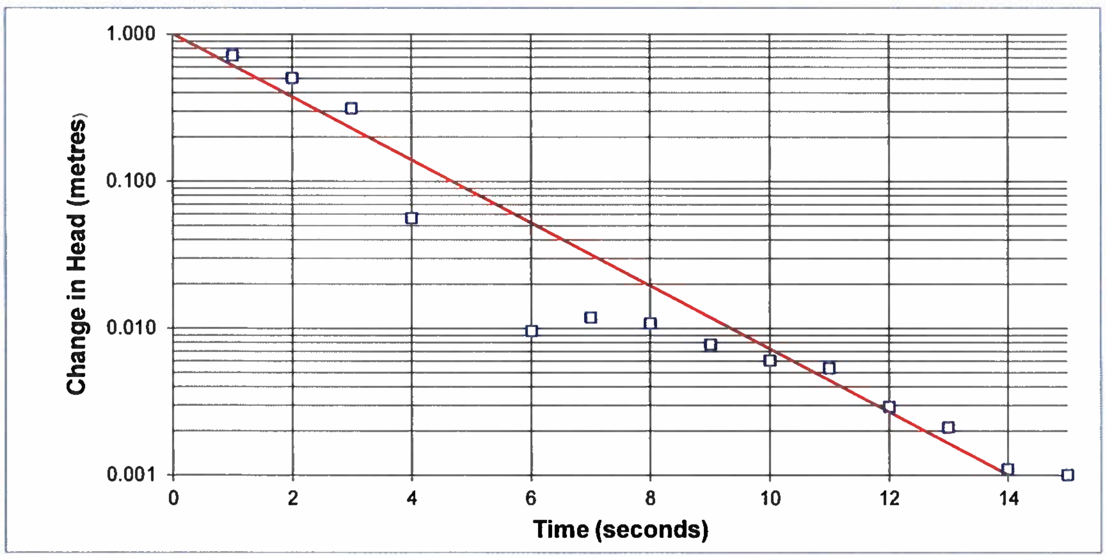
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.52
$\ln(R_e/r_w)$	6.53
y_0 =	1.00
y_t =	0.00
t =	14.0

RESULTS

K=	4E-04	m/sec
K=	4E-02	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 12/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

Golder Associates Ltd.

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RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-13B

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-13B	
DATE OF TEST	12/11/2013	
CASING STICK-UP	0.91	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	3.800	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	8	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.102	METRES
TOP OF OPEN INTERVAL	2.74	METRES (btoc)
BOTTOM OF OPEN INTERVAL	4.26	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	1.02	METRES
WATER TABLE TO BOTTOM OF SCREEN	0.46	METRES
EQUIVALENT RADIUS	0.058	METRES
OPEN INTERVAL LENGTH	0.46	METRES
STATIC IN SCREEN?	Yes	
MAX. HEAD CHANGE	0.11	METRES
MAX. HEAD IN SCREEN?	Yes	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	0	METRES
RADIUS OF SLUG	0	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	0.00	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			3.913	0	0.11	1.000
			3.903	1	0.10	0.910
			3.889	2	0.09	0.781
			3.886	3	0.09	0.756
			3.884	4	0.08	0.742
			3.882	5	0.08	0.719
			3.881	6	0.08	0.713
			3.881	7	0.08	0.710
			3.879	8	0.08	0.698
			3.879	9	0.08	0.693
			3.879	10	0.08	0.697
			3.878	11	0.08	0.687
			3.878	12	0.08	0.690
			3.859	13	0.06	0.517
			3.881	14	0.08	0.711
			3.878	15	0.08	0.688
			3.878	16	0.08	0.686
			3.878	17	0.08	0.690
			3.878	18	0.08	0.685
			3.877	19	0.08	0.679
			3.876	20	0.08	0.673
			3.878	21	0.08	0.688
			3.876	22	0.08	0.670
			3.876	23	0.08	0.671
			3.876	24	0.08	0.672
			3.875	25	0.08	0.665
			3.875	26	0.08	0.663
			3.875	27	0.07	0.660
			3.875	28	0.07	0.660
			3.874	29	0.07	0.654
			3.874	30	0.07	0.653
			3.874	31	0.07	0.651
			3.874	32	0.07	0.652
			3.874	33	0.07	0.653
			3.873	34	0.07	0.646
			3.874	35	0.07	0.650

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-13B

INTERVAL (metres below ground surface)

Top of Interval = 1.83
Bottom of Interval = 3.35

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln\frac{y_o}{y_t}$$

where K=m/sec

where:

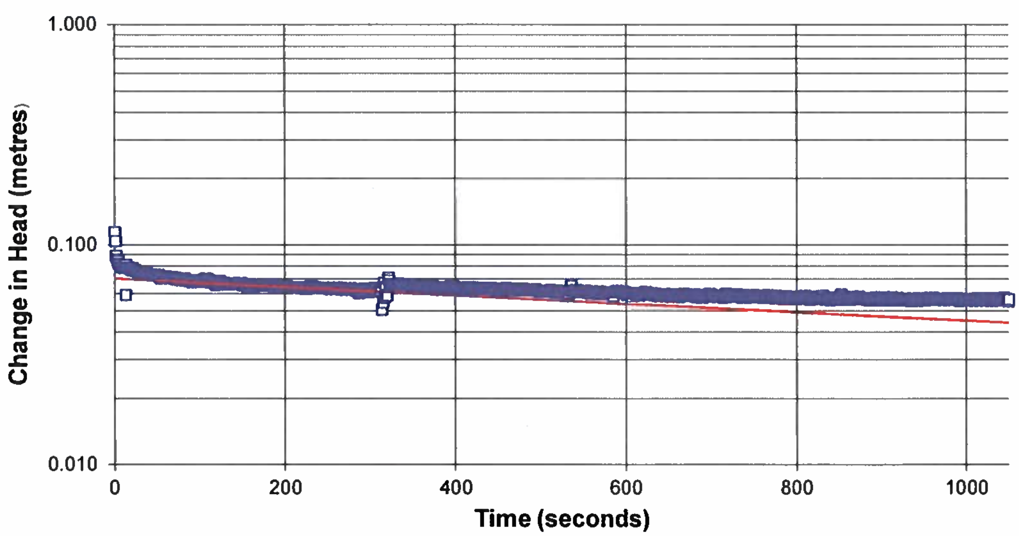
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.06
L_e =	1.52
$ln(R_e/r_w)$	1.63
y_0 =	0.07
y_t =	0.05
t =	1000.0

RESULTS

K=	9E-08	m/sec
K=	9E-06	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 12/11/2013
Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

Golder Associates Ltd.

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-17A

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-17A	
DATE OF TEST	08/11/2013	
CASING STICK-UP	0.83	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	2.610	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	2.98	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.038	METRES
TOP OF OPEN INTERVAL	5.88	METRES (btoc)
BOTTOM OF OPEN INTERVAL	7.10	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	1.83	METRES
WATER TABLE TO BOTTOM OF SCREEN	1.83	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.22	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.89	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			3.500	0	0.89	1.000
			2.970	25	0.36	0.404
			2.900	30	0.29	0.326
			2.820	40	0.21	0.236
			2.770	50	0.16	0.180
			2.740	60	0.13	0.146
			2.720	70	0.11	0.124
			2.700	80	0.09	0.101
			2.690	90	0.08	0.090
			2.680	100	0.07	0.079
			2.680	110	0.07	0.079
			2.675	120	0.06	0.073
			2.660	150	0.05	0.056
			2.655	180	0.04	0.051
			2.650	210	0.04	0.045
			2.645	240	0.04	0.039
			2.640	300	0.03	0.034
			2.640	360	0.03	0.034
			2.635	420	0.02	0.028
			2.635	480	0.02	0.028
			2.635	540	0.02	0.028
			2.630	600	0.02	0.022
			2.630	660	0.02	0.022
			2.630	720	0.02	0.022
			2.630	840	0.02	0.022

* - Water level inferred from slug volume and well response data trend

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-17A

INTERVAL (metres below ground surface)

Top of Interval =	**5.05**
Bottom of Interval =	**6.27**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

where:

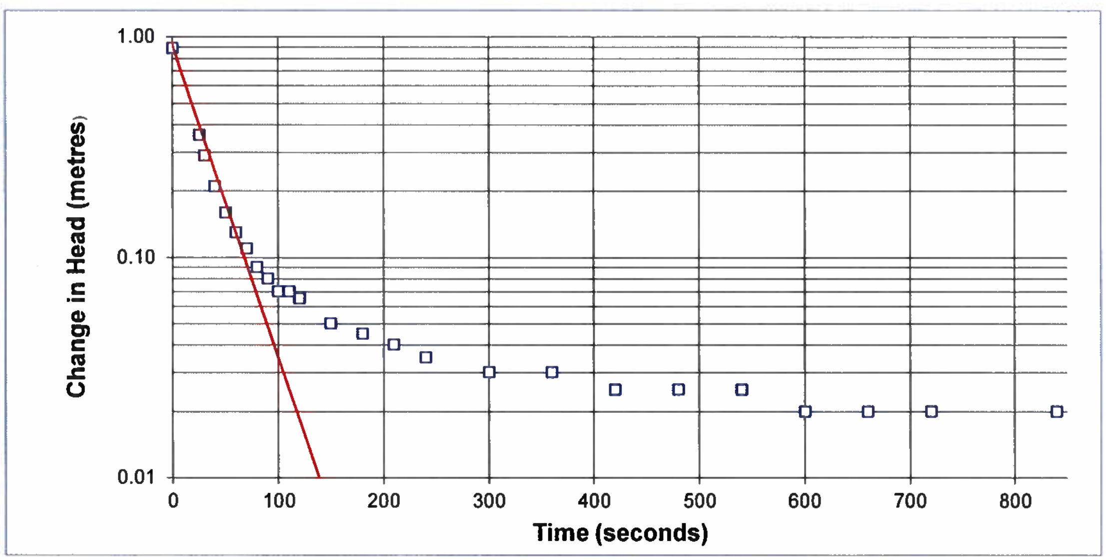
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.22
$ln(R_e/r_w)$	6.00
y_0 =	0.90
y_t =	0.04
t =	100.0

RESULTS

K=	3E-05	m/sec
K=	3E-03	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 08/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

RED = Calculated Value
BLUE = User defined value

FALLING HEAD TEST BH13-17B

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-17B	
DATE OF TEST	08/11/2013	
CASING STICK-UP	0.87	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	2.170	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	8	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.102	METRES
TOP OF OPEN INTERVAL	2.70	METRES (btoc)
BOTTOM OF OPEN INTERVAL	4.22	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	3.14	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.05	METRES
EQUIVALENT RADIUS	0.06	METRES
OPEN INTERVAL LENGTH	1.52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1.09	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 06/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.077	0	1.09	1.000
			1.198	1	0.97	0.889
			1.360	2	0.81	0.741
			1.358	3	0.81	0.743
			1.360	4	0.81	0.741
			1.371	5	0.80	0.732
			1.383	6	0.79	0.720
			1.380	7	0.79	0.722
			1.409	8	0.76	0.696
			1.412	9	0.76	0.694
			1.425	10	0.75	0.682
			1.433	11	0.74	0.674
			1.442	12	0.73	0.666
			1.452	13	0.72	0.657
			1.461	14	0.71	0.649
			1.469	15	0.70	0.641
			1.476	16	0.69	0.635
			1.486	17	0.68	0.626
			1.490	18	0.68	0.622
			1.503	19	0.67	0.611
			1.512	20	0.66	0.603
			1.519	21	0.65	0.596
			1.527	22	0.64	0.589
			1.534	23	0.64	0.582
			1.543	24	0.63	0.574
			1.549	25	0.62	0.568
			1.555	26	0.61	0.563
			1.564	27	0.61	0.555
			1.569	28	0.60	0.550
			1.578	29	0.59	0.542
			1.584	30	0.59	0.536
			1.590	31	0.58	0.531
			1.597	32	0.57	0.524
			1.602	33	0.57	0.520
			1.610	34	0.56	0.512
			1.616	35	0.55	0.507

BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST BH13-17B

INTERVAL (metres below ground surface)

Top of Interval = 1.83
Bottom of Interval = 3.35

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln\frac{y_0}{y_t}$$

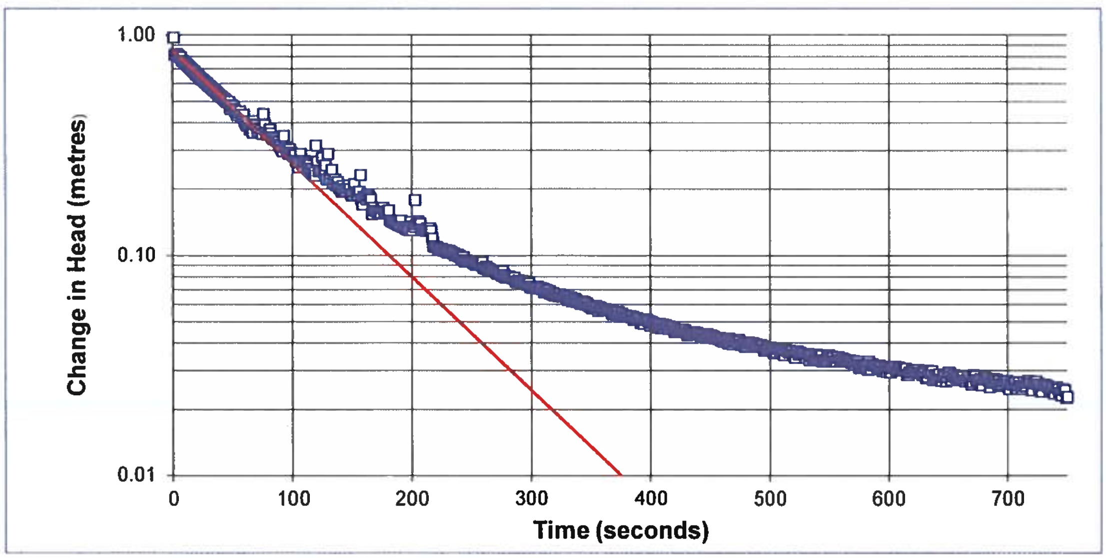
where K=m/sec

where:

r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS	
r_c =	0.02
r_w =	0.10
L_e =	1.53
$ln(R_e/r_w)$	1.85
y_0 =	0.85
y_t =	0.01
t =	375.0

RESULTS		
K=	3E-06	m/sec
K=	3E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 08/11/2013
Analysis By: CHM
Checked By: CAMC
Analysis Date: 06/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-18A Test#2

WELL NO. IH13-18A Test#

Regional Group/Remer + Idone Lands
13-1121-0083

DATE OF TEST	28/10/2013	
CASING STICK-UP	0.87	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.810	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	2.98	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.038	METRES
TOP OF OPEN INTERVAL	5.14	METRES (btoc)
BOTTOM OF OPEN INTERVAL	6.66	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	2.44	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.44	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1.28	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.2827137	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			2.1	0	1.28	1.000
			0.980	16	0.17	0.133
			0.910	20	0.10	0.078
			0.860	30	0.05	0.039
			0.845	50	0.03	0.027
			0.845	70	0.03	0.027
			0.844	80	0.03	0.027
			0.842	90	0.03	0.025
			0.841	120	0.03	0.024
			0.839	150	0.03	0.023
			0.839	180	0.03	0.023
			0.837	210	0.03	0.021
			0.835	240	0.02	0.020
			0.834	270	0.02	0.019
			0.833	300	0.02	0.018
			0.830	360	0.02	0.016
			0.830	480	0.02	0.016
			0.830	600	0.02	0.016

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-18A Test#2

INTERVAL (metres below ground surface)

Top of Interval = 4.27
Bottom of Interval = 5.79

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

where:

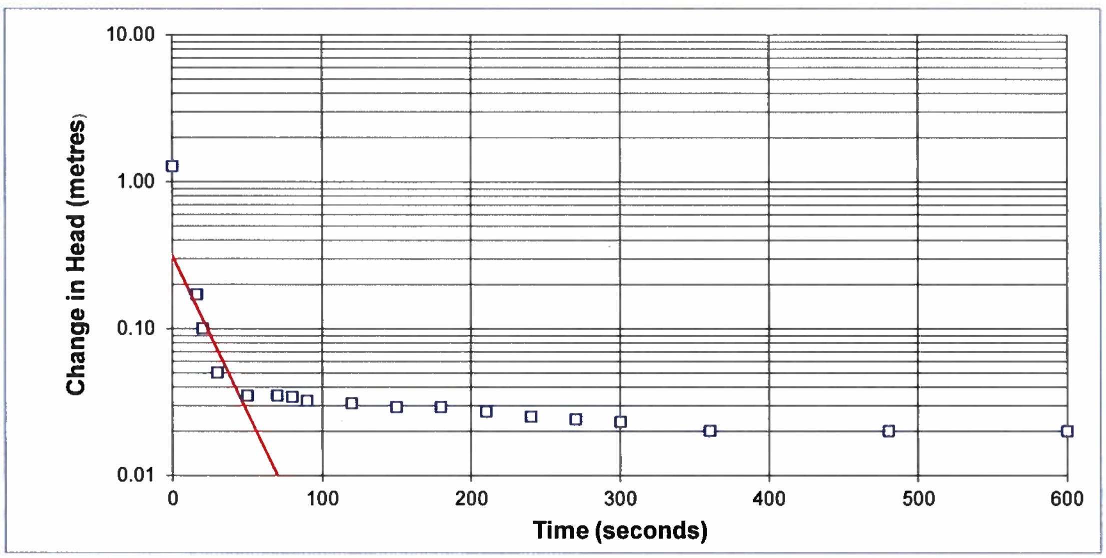
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.52
$\ln(R_e/r_w)$	6.00
y_0 =	0.31
y_t =	0.01
t =	70.0

RESULTS

K=	3E-05	m/sec
K=	3E-03	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 28/10/13
Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-18B

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-18B	
DATE OF TEST	28/10/2013	
CASING STICK-UP	0.89	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.980	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	8	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.102	METRES
TOP OF OPEN INTERVAL	1.66	METRES (btoc)
BOTTOM OF OPEN INTERVAL	3.19	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	3.27	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.21	METRES
EQUIVALENT RADIUS	0.06	METRES
OPEN INTERVAL LENGTH	1.53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1.19	METRES
MAX. HEAD IN SCREEN?	Yes	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	CUBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.2827137	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			2.2	0	1.19	1.000
			1.780	10	0.80	0.672
			1.600	20	0.62	0.521
			1.540	30	0.56	0.471
			1.530	40	0.55	0.462
			1.525	50	0.55	0.458
			1.520	60	0.54	0.454
			1.515	70	0.54	0.450
			1.515	80	0.54	0.450
			1.510	90	0.53	0.445
			1.505	100	0.53	0.441
			1.500	110	0.52	0.437
			1.495	120	0.52	0.433
			1.450	150	0.47	0.395
			1.420	180	0.44	0.370
			1.385	210	0.41	0.340
			1.360	240	0.38	0.319
			1.340	270	0.36	0.303
			1.310	300	0.33	0.277
			1.260	360	0.28	0.235
			1.235	420	0.26	0.214
			1.205	480	0.23	0.189
			1.180	540	0.20	0.168
			1.160	600	0.18	0.151
			1.140	660	0.16	0.134
			1.120	720	0.14	0.118
			1.110	780	0.13	0.109
			1.100	840	0.12	0.101
			1.080	900	0.10	0.084
			1.070	960	0.09	0.076
			1.055	1140	0.08	0.063
			1.040	1320	0.06	0.050

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-18B

INTERVAL (metres below ground surface)

Top of Interval = 0.77
Bottom of Interval = 2.30

$$K = \frac{r_c^{\,2} \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

where:

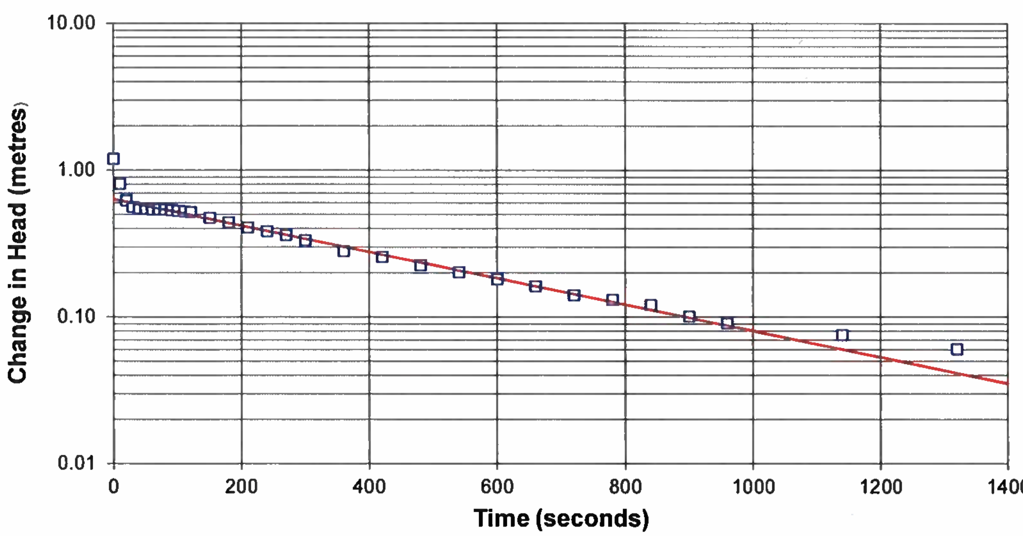
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.10
L_e =	1.53
$ln(R_e/r_w)$	1.88
y_0 =	0.63
y_t =	0.04
t =	1400.0

RESULTS

K=	5E-07	m/sec
K=	5E-05	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 28/10/13
Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-20

WELL NO. BH13-20

Regional Group/Remer + Idone Lands
13-1121-0083

DATE OF TEST	08/11/2013	
CASING STICK-UP	0.84	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	1.390	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	4.5	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.057	METRES
TOP OF OPEN INTERVAL	4.80	METRES (btoc)
BOTTOM OF OPEN INTERVAL	6.33	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	5.22	METRES
WATER TABLE TO BOTTOM OF SCREEN	4.94	METRES
EQUIVALENT RADIUS	0.04	METRES
OPEN INTERVAL LENGTH	1.53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.57	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.525	METRES
RADIUS OF SLUG	0.011	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0005797	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	0.51	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 06/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.964	0	0.57	1.000
			1.923	1	0.53	0.930
			1.891	2	0.50	0.874
			1.864	3	0.47	0.826
			1.840	4	0.45	0.784
			1.818	5	0.43	0.747
			1.799	6	0.41	0.713
			1.782	7	0.39	0.683
			1.767	8	0.38	0.657
			1.751	9	0.36	0.628
			1.736	10	0.35	0.603
			1.723	11	0.33	0.580
			1.697	12	0.31	0.535
			1.697	13	0.31	0.535
			1.683	14	0.29	0.511
			1.674	15	0.28	0.495
			1.665	16	0.27	0.479
			1.655	17	0.26	0.461
			1.644	18	0.25	0.443
			1.636	19	0.25	0.428
			1.628	20	0.24	0.415
			1.620	21	0.23	0.400
			1.609	22	0.22	0.381
			1.603	23	0.21	0.372
			1.596	24	0.21	0.359
			1.588	25	0.20	0.346
			1.581	26	0.19	0.334
			1.575	27	0.18	0.322
			1.569	28	0.18	0.311
			1.562	29	0.17	0.300
			1.557	30	0.17	0.291
			1.551	31	0.16	0.281
			1.546	32	0.16	0.271
			1.541	33	0.15	0.263
			1.536	34	0.15	0.254
			1.532	35	0.14	0.247

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-20

INTERVAL (metres below ground surface)

Top of Interval = 3.96
Bottom of Interval = 5.49

$$K = \frac{r_c^{\,2} \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_o}{y_t}$$

where K=m/sec

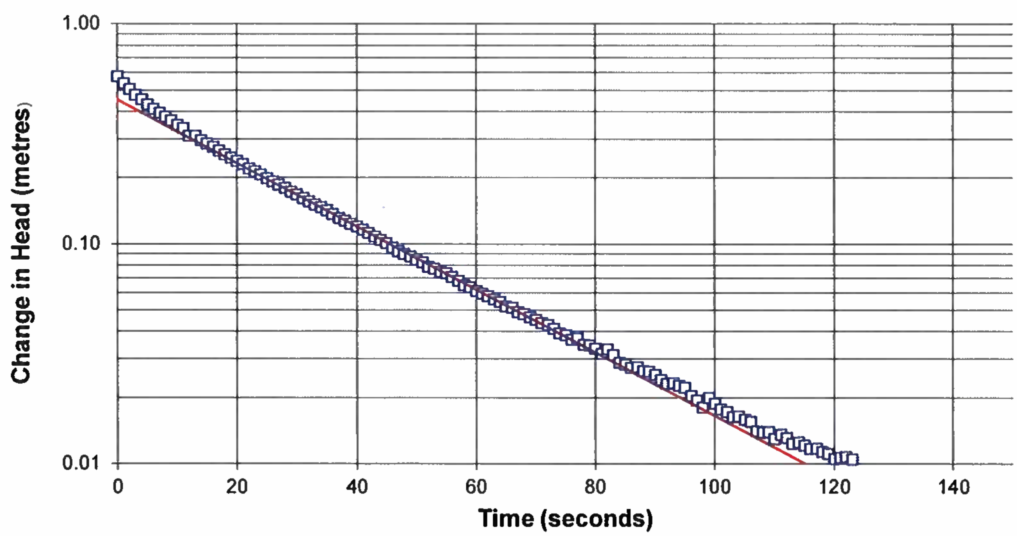
where:

r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS	
r_c =	0.02
r_w =	0.06
L_e =	1.53
$ln(R_e/r_w)$	2.84
y_o =	0.45
y_t =	0.01
t =	115.0

RESULTS

K=	1E-05	m/sec
K=	1E-03	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 08/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 06/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-24A Test#1

WELL NO. BH13-24A Test#1

Regional Group/Remer + Idone Lands
13-1121-0083

DATE OF TEST	28/10/2013	
CASING STICK-UP	0.91	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	1.050	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	2.98	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.038	METRES
TOP OF OPEN INTERVAL	7.77	METRES (btoc)
BOTTOM OF OPEN INTERVAL	8.99	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	8.00	METRES
WATER TABLE TO BOTTOM OF SCREEN	7.94	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.22	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1.75	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	N/A	METRES
RADIUS OF SLUG	N/A	METRES
VOLUME OF SLUG ($\pi r^2 l$)	#VALUE!	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	#VALUE!	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

Approx volume purged (Litres)= 2
Initial Displacement (m) = 1.75

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			2.8	0	1.75	1.000
			2.580	20	1.53	0.874
			2.010	40	0.96	0.549
			1.380	60	0.33	0.189
			1.310	70	0.26	0.149
			1.280	90	0.23	0.131
			1.270	110	0.22	0.126
			1.260	120	0.21	0.120
			1.250	150	0.20	0.114
			1.245	180	0.20	0.111
			1.240	210	0.19	0.109
			1.235	240	0.19	0.106
			1.230	270	0.18	0.103
			1.227	300	0.18	0.101
			1.220	360	0.17	0.097
			1.205	480	0.16	0.089
			1.200	600	0.15	0.086
			1.185	780	0.14	0.077
			1.180	900	0.13	0.074
			1.170	1020	0.12	0.069
			1.165	1080	0.12	0.066
			1.160	1200	0.11	0.063
			1.150	1560	0.10	0.057
			1.130	1800	0.08	0.046

* Initial water level inferred from approximate volume purged during 10 seconds of waterra pur

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-24A Test#1

INTERVAL (metres below ground surface)

Top of Interval = 6.86
Bottom of Interval = 8.08

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

where:

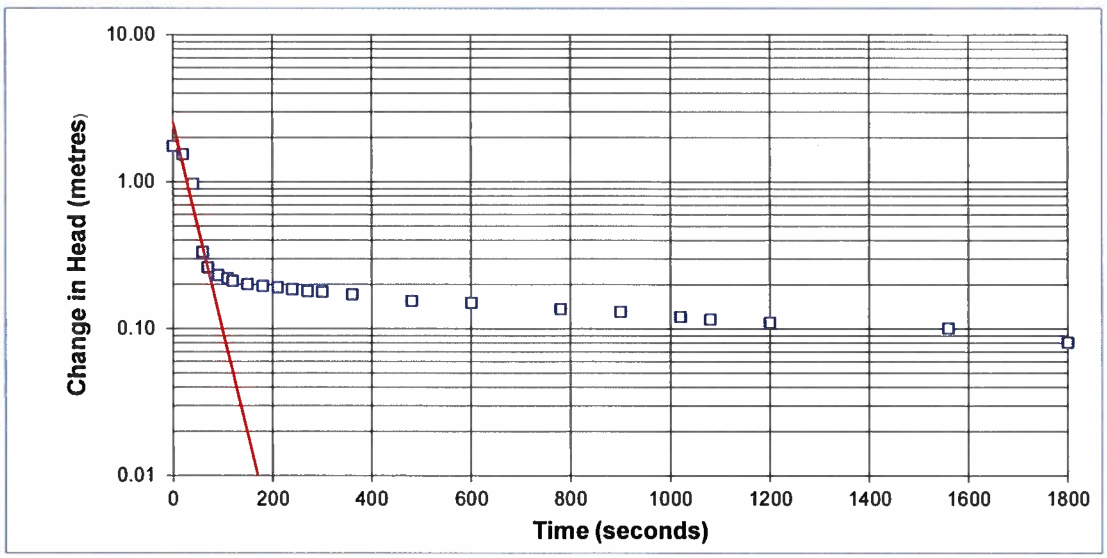
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.22
$\ln(R_e/r_w)$	2.74
y_0 =	2.50
y_t =	0.07
t =	110.0

RESULTS

K=	1E-05	m/sec
K=	1E-03	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 28/10/13

Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-24B Test#2

WELL NO. **BH13-24B Test#2**

Regional Group/Remer + Idone Lands
13-1121-0083

DATE OF TEST	28/10/2013	
CASING STICK-UP	0.93	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.980	METRES (btoc)
CASING DIAMETER	1.25	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0 016	METRES
BOREHOLE RADIUS	0 044	METRES
TOP OF OPEN INTERVAL	3.98	METRES (btoc)
BOTTOM OF OPEN INTERVAL	5.50	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	5.59	METRES
WATER TABLE TO BOTTOM OF SCREEN	4 52	METRES
EQUIVALENT RADIUS	0 03	METRES
OPEN INTERVAL LENGTH	1 52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	2 53	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	N/A	METRES
RADIUS OF SLUG	N/A	METRES
VOLUME OF SLUG ($\pi r^2 l$)	#VALUE!	UBIC METRES
RADIUS OF WELL	0 015875	METRES
INITIAL DISPLACEMENT	#VALUE!	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

Approx volume purged (Litres)= 2
Initial Displacement (m) = 2.53

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			3.5	0	2.53	1.000
			2.890	20	1.91	0.755
			2.490	30	1.51	0.597
			2.130	50	1.15	0.455
			2.010	60	1.03	0.407
			1.870	70	0.89	0.352
			1.740	80	0.76	0.300
			1.640	90	0.66	0.261
			1.480	110	0.50	0.198
			1.430	120	0.45	0.178
			1.280	150	0.30	0.119
			1.190	180	0.21	0.083
			1.120	210	0.14	0.055
			1.080	240	0.10	0.040
			1.040	270	0.06	0.024
			1.020	300	0.04	0.016
			1.000	360	0.02	0.008
			0.985	420	0.01	0.002
			0.980	450	0.00	0.000

* Initial water level inferred from approximate volume purged during 10 seconds of waterra pump

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-24B Test#2

INTERVAL (metres below ground surface)

Top of Interval = **3.05**
Bottom of Interval = **4.57**

$$K = \frac{r_c^{\,2} \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln\frac{y_o}{y_t}$$

where K=m/sec

where:

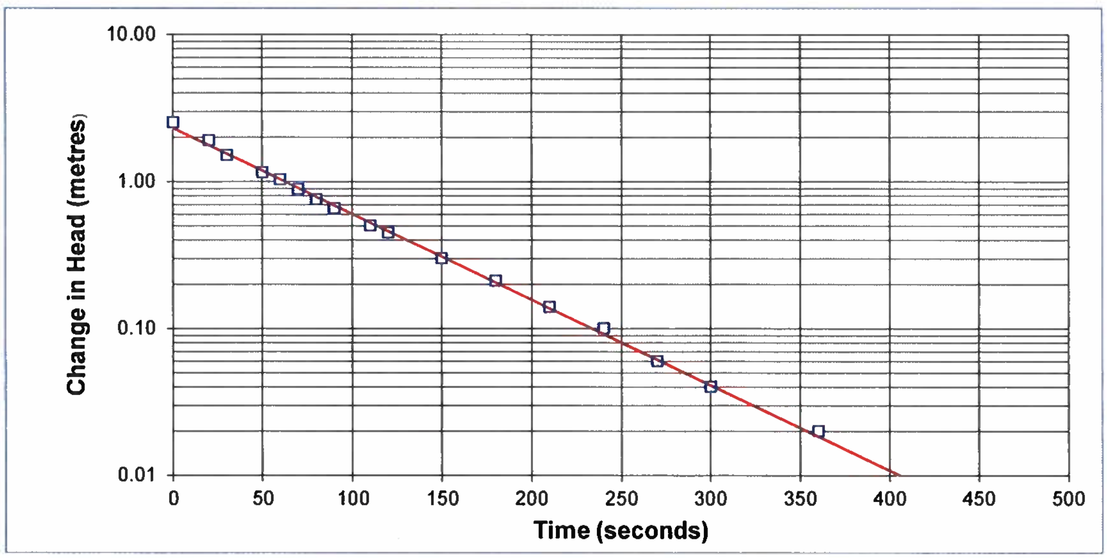
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.52
$ln(R_e/r_w)$	2.90
y_o =	2.30
y_t =	0.01
t =	405.0

RESULTS

K=	3E-06	m/sec
K=	3E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 28/10/13

Analysis By: CHM
Checked By: CAMC
Analysis Date: 02/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-25

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-25	
DATE OF TEST	07/11/2013	
CASING STICK-UP	0.99	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.790	METRES (btoc)
CASING DIAMETER	1.25	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0.016	METRES
BOREHOLE RADIUS	0.044	METRES
TOP OF OPEN INTERVAL	3.12	METRES (btoc)
BOTTOM OF OPEN INTERVAL	4.65	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	5.69	METRES
WATER TABLE TO BOTTOM OF SCREEN	3.86	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1.33	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	CUBIC METRES
RADIUS OF WELL	0.015875	METRES
INITIAL DISPLACEMENT	1.85	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			2.118	0	1.33	1.000
			1.635	1	0.85	0.636
			1.640	2	0.85	0.640
			1.665	3	0.87	0.659
			1.634	4	0.84	0.635
			1.631	5	0.84	0.633
			1.593	6	0.80	0.605
			1.584	7	0.79	0.598
			1.573	8	0.78	0.590
			1.565	9	0.77	0.583
			1.556	10	0.77	0.577
			1.548	11	0.76	0.571
			1.540	12	0.75	0.564
			1.532	13	0.74	0.559
			1.525	14	0.73	0.553
			1.516	15	0.73	0.547
			1.509	16	0.72	0.542
			1.505	17	0.71	0.538
			1.498	18	0.71	0.533
			1.491	19	0.70	0.528
			1.484	20	0.69	0.523
			1.477	21	0.69	0.517
			1.471	22	0.68	0.513
			1.464	23	0.67	0.508
			1.457	24	0.67	0.502
			1.452	25	0.66	0.498
			1.446	26	0.66	0.494
			1.440	27	0.65	0.489
			1.434	28	0.64	0.485
			1.429	29	0.64	0.481
			1.423	30	0.63	0.476
			1.417	31	0.63	0.472
			1.411	32	0.62	0.467
			1.405	33	0.62	0.463
			1.398	34	0.61	0.458
			1.395	35	0.61	0.456

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-25

INTERVAL (metres below ground surface)

Top of Interval =	**2.13**
Bottom of Interval =	**3.66**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e}\frac{1}{t}\ln\frac{y_0}{y_t}$$

where K=m/sec

where:

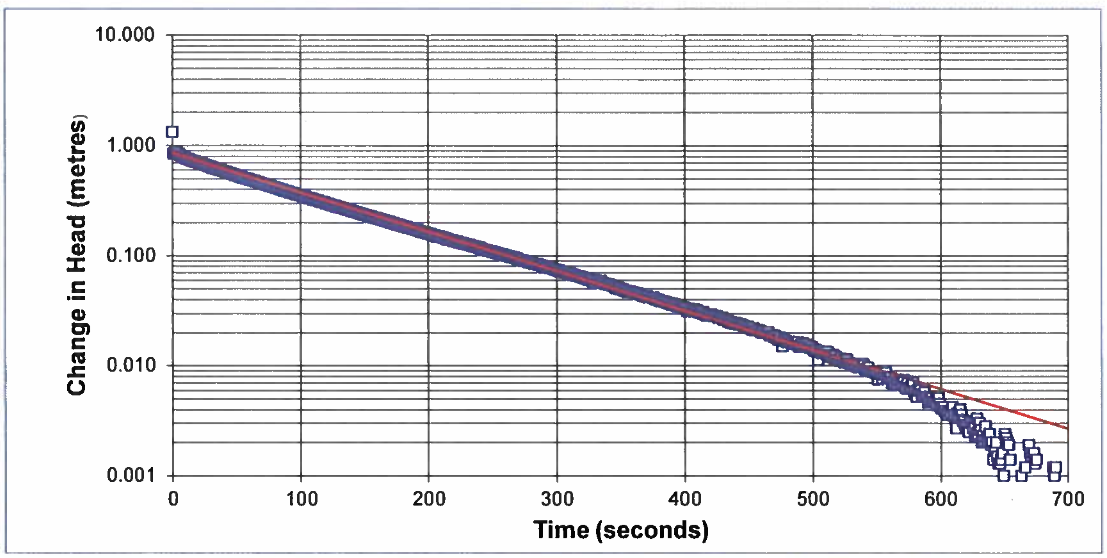
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.53
$\ln(R_e/r_w)$	2.79
y_0 =	0.85
y_t =	0.01
t =	540.0

RESULTS

K=	2E-06	m/sec
K=	2E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 07/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-26A

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-26A	
DATE OF TEST	07/11/2013	
CASING STICK-UP	0.95	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.940	METRES (btoc)
CASING DIAMETER	1.25	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0 016	METRES
BOREHOLE RADIUS	0 044	METRES
TOP OF OPEN INTERVAL	4.84	METRES (btoc)
BOTTOM OF OPEN INTERVAL	6.36	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	5.42	METRES
WATER TABLE TO BOTTOM OF SCREEN	5 42	METRES
EQUIVALENT RADIUS	0 03	METRES
OPEN INTERVAL LENGTH	1 52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0 58	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.011	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0 0005778	UBIC METRES
RADIUS OF WELL	0 015875	METRES
INITIAL DISPLACEMENT	0 73	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.517	0	0.58	1.000
			1.518	1	0.58	1.000
			1.456	2	0.52	0.894
			1.443	3	0.50	0.871
			1.431	4	0.49	0.851
			1.422	5	0.48	0.834
			1.412	6	0.47	0.818
			1.404	7	0.46	0.804
			1.396	8	0.46	0.790
			1.388	9	0.45	0.776
			1.380	10	0.44	0.762
			1.374	11	0.43	0.751
			1.327	12	0.39	0.669
			1.355	13	0.42	0.719
			1.360	14	0.42	0.728
			1.349	15	0.41	0.709
			1.344	16	0.40	0.700
			1.337	17	0.40	0.687
			1.331	18	0.39	0.677
			1.323	19	0.38	0.663
			1.320	20	0.38	0.658
			1.315	21	0.38	0.650
			1.309	22	0.37	0.640
			1.304	23	0.36	0.631
			1.296	24	0.36	0.616
			1.290	25	0.35	0.606
			1.286	26	0.35	0.599
			1.285	27	0.35	0.598
			1.279	28	0.34	0.587
			1.275	29	0.34	0.580
			1.271	30	0.33	0.573
			1.266	31	0.33	0.565
			1.260	32	0.32	0.554
			1.257	33	0.32	0.548
			1.253	34	0.31	0.541
			1.248	35	0.31	0.534

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-26A

INTERVAL (metres below ground surface)

Top of Interval = 3.89
Bottom of Interval = 5.41

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

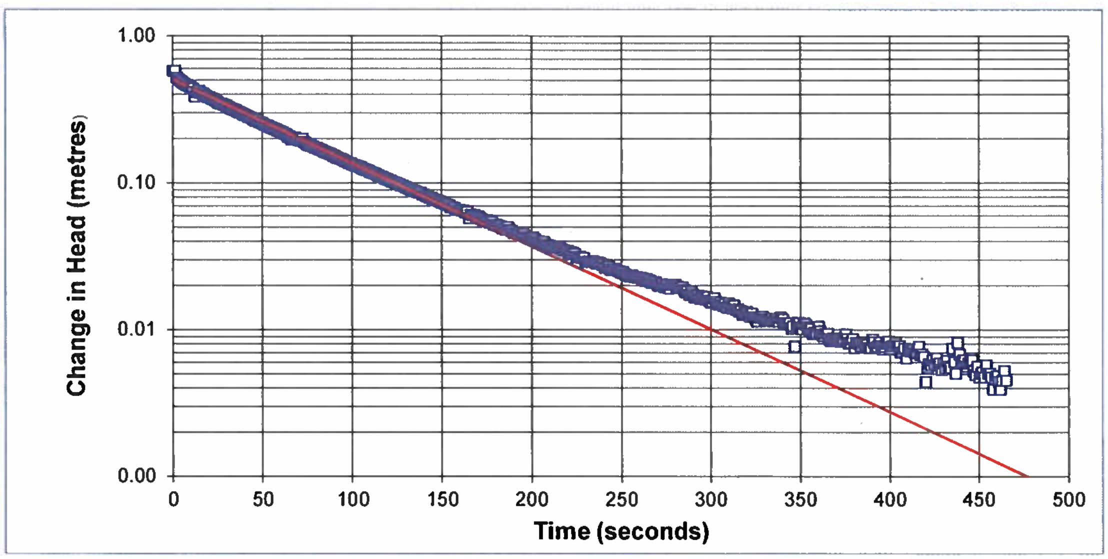
where:

r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS	
r_c =	0.02
r_w =	0.04
L_e =	1.52
$\ln(R_e/r_w)$	6.00
y_0 =	0.50
y_t =	0.01
t =	300.0

RESULTS

K=	7E-06	m/sec
K=	7E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 07/11/2013
Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-26B

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-26B	
DATE OF TEST	07/11/2013	
CASING STICK-UP	0.90	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.900	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.044	METRES
TOP OF OPEN INTERVAL	2.12	METRES (btoc)
BOTTOM OF OPEN INTERVAL	3.64	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	3.00	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.74	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.98	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	CUBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.876	0	0.98	1.000
			1.860	1	0.96	0.985
			1.845	2	0.94	0.968
			1.838	3	0.94	0.962
			1.832	4	0.93	0.955
			1.826	5	0.93	0.950
			1.821	6	0.92	0.944
			1.815	7	0.91	0.938
			1.810	8	0.91	0.932
			1.805	9	0.90	0.927
			1.800	10	0.90	0.923
			1.795	11	0.90	0.918
			1.791	12	0.89	0.913
			1.786	13	0.89	0.909
			1.782	14	0.88	0.904
			1.776	15	0.88	0.898
			1.774	16	0.87	0.896
			1.771	17	0.87	0.893
			1.763	18	0.86	0.884
			1.764	19	0.86	0.886
			1.759	20	0.86	0.880
			1.756	21	0.86	0.878
			1.752	22	0.85	0.873
			1.747	23	0.85	0.869
			1.743	24	0.84	0.865
			1.740	25	0.84	0.861
			1.737	26	0.84	0.858
			1.725	27	0.82	0.845
			1.720	28	0.82	0.840
			1.723	29	0.82	0.844
			1.722	30	0.82	0.843
			1.718	31	0.82	0.839
			1.711	32	0.81	0.831
			1.709	33	0.81	0.830
			1.706	34	0.81	0.826
			1.704	35	0.80	0.824

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-26B

INTERVAL (metres below ground surface)

Top of Interval = 1.22
Bottom of Interval = 2.74

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

where:

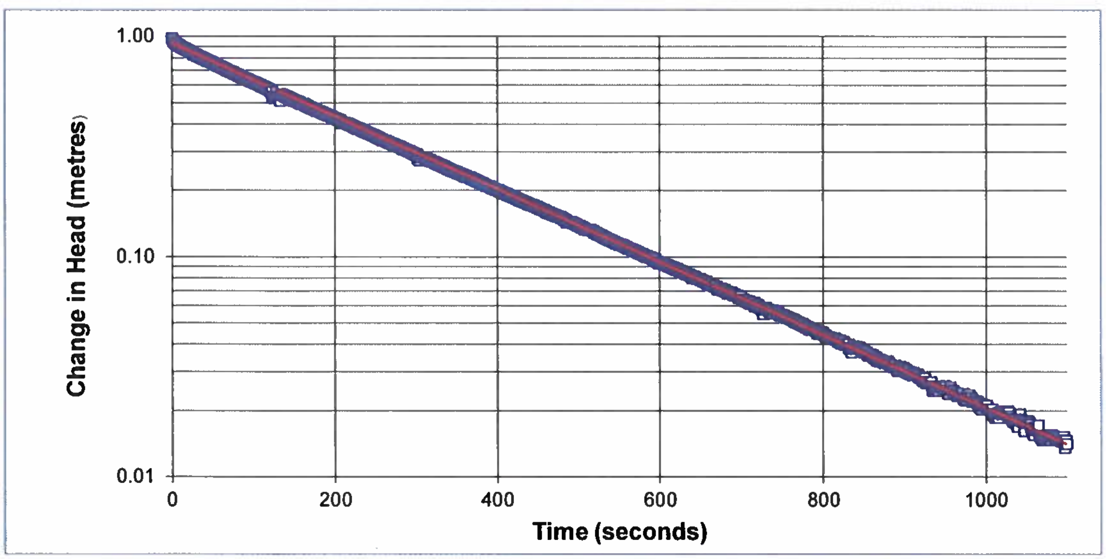
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.52
$ln(R_e/r_w)$	2.78
y_0 =	0.93
y_t =	0.10
t =	585.0

RESULTS

K=	1E-06	m/sec
K=	1E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 07/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 16/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-29A

WELL NO. **BH13-29A**

Regional Group/Remer + Idone Lands
13-1121-0083

DATE OF TEST	08/11/2013	
CASING STICK-UP	0.95	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	1.020	METRES (btoc)
CASING DIAMETER	1.25	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0.016	METRES
BOREHOLE RADIUS	0.044	METRES
TOP OF OPEN INTERVAL	4.61	METRES (btoc)
BOTTOM OF OPEN INTERVAL	6.13	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	5.36	METRES
WATER TABLE TO BOTTOM OF SCREEN	5.11	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.58	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.525	METRES
RADIUS OF SLUG	0.011	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0005797	UBIC METRES
RADIUS OF WELL	0.015875	METRES
INITIAL DISPLACEMENT	0.73	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 06/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.596	0	0.58	1.000
			1.556	1	0.54	0.930
			1.524	2	0.50	0.875
			1.497	3	0.48	0.827
			1.472	4	0.45	0.785
			1.451	5	0.43	0.748
			1.432	6	0.41	0.715
			1.414	7	0.39	0.684
			1.399	8	0.38	0.658
			1.383	9	0.36	0.630
			1.368	10	0.35	0.604
			1.355	11	0.34	0.582
			1.330	12	0.31	0.537
			1.330	13	0.31	0.537
			1.316	14	0.30	0.513
			1.307	15	0.29	0.498
			1.297	16	0.28	0.481
			1.287	17	0.27	0.464
			1.277	18	0.26	0.445
			1.268	19	0.25	0.431
			1.260	20	0.24	0.417
			1.252	21	0.23	0.403
			1.241	22	0.22	0.384
			1.236	23	0.22	0.375
			1.229	24	0.21	0.362
			1.221	25	0.20	0.349
			1.214	26	0.19	0.337
			1.207	27	0.19	0.325
			1.201	28	0.18	0.314
			1.195	29	0.17	0.303
			1.190	30	0.17	0.295
			1.184	31	0.16	0.284
			1.178	32	0.16	0.275
			1.173	33	0.15	0.266
			1.169	34	0.15	0.258
			1.164	35	0.14	0.250

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-29A

INTERVAL (metres below ground surface)

Top of Interval = 3.66
Bottom of Interval = 5.18

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln\frac{y_o}{y_t}$$

where K=m/sec

where:

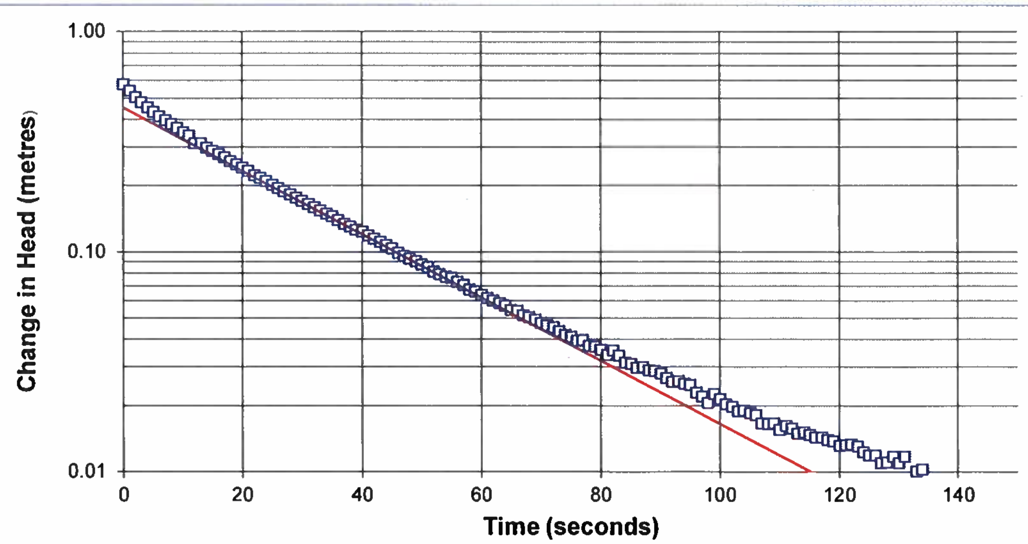
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.52
$\ln(R_e/r_w)$	3.09
y_0 =	0.45
y_t =	0.01
t =	115.0

RESULTS

K=	9E-06	m/sec
K=	9E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 08/11/2013
Analysis By: CHM
Checked By: CAMC
Analysis Date: 06/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-29B

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-29B	
DATE OF TEST	08/11/2013	
CASING STICK-UP	0.86	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	0.895	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.044	METRES
TOP OF OPEN INTERVAL	1.77	METRES (btoc)
BOTTOM OF OPEN INTERVAL	3.30	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	2.50	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.41	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.94	METRES
MAX. HEAD IN SCREEN?	Yes	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.011	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0005778	CUBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	0.51	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 05/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.831	0	0.94	1.000
			1.782	1	0.89	0.947
			1.706	2	0.81	0.866
			1.676	3	0.78	0.834
			1.658	4	0.76	0.815
			1.636	5	0.74	0.792
			1.639	6	0.74	0.795
			1.633	7	0.74	0.788
			1.628	8	0.73	0.783
			1.626	9	0.73	0.781
			1.622	10	0.73	0.776
			1.619	11	0.72	0.774
			1.617	12	0.72	0.771
			1.615	13	0.72	0.769
			1.600	14	0.71	0.753
			1.610	15	0.71	0.763
			1.605	16	0.71	0.758
			1.602	17	0.71	0.755
			1.599	18	0.70	0.752
			1.596	19	0.70	0.749
			1.594	20	0.70	0.746
			1.591	21	0.70	0.743
			1.588	22	0.69	0.740
			1.584	23	0.69	0.735
			1.578	24	0.68	0.729
			1.571	25	0.68	0.722
			1.564	26	0.67	0.714
			1.559	27	0.66	0.709
			1.551	28	0.66	0.701
			1.545	29	0.65	0.694
			1.539	30	0.64	0.687
			1.532	31	0.64	0.680
			1.525	32	0.63	0.673
			1.520	33	0.62	0.667
			1.511	34	0.62	0.658
			1.507	35	0.61	0.654

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-29B

INTERVAL (metres below ground surface)

Top of Interval =	**0.91**
Bottom of Interval =	**2.44**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where K=m/sec

where:

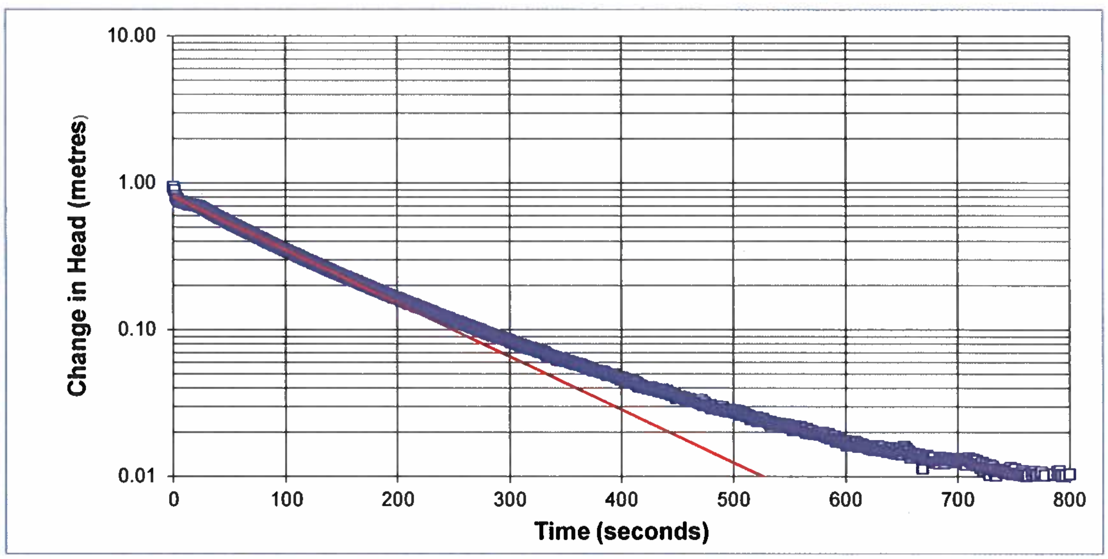
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.53
$\ln(R_e/r_w)$	2.80
y_0 =	0.80
y_t =	0.01
t =	525.0

RESULTS

K=	3E-06	m/sec
K=	3E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 08/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 05/12/2013

RED = Calculated Value
BLUE = User defined value

FALLING HEAD TEST BH13-32A

Regional Group/Remer + Idone Lands
13-1121-0083

WELL NO.	BH13-32A	
DATE OF TEST	07/11/2013	
CASING STICK-UP	0.92	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	1.120	METRES (btoc)
CASING DIAMETER	1.25	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0.016	METRES
BOREHOLE RADIUS	0.044	METRES
TOP OF OPEN INTERVAL	6.92	METRES (btoc)
BOTTOM OF OPEN INTERVAL	8.43	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	7.50	METRES
WATER TABLE TO BOTTOM OF SCREEN	7.31	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.51	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.81	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.011	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0005778	CUBIC METRES
RADIUS OF WELL	0.015875	METRES
INITIAL DISPLACEMENT	0.73	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			0.314	0	0.81	1.000
			0.483	1	0.64	0.790
			0.639	2	0.48	0.597
			0.713	3	0.41	0.505
			0.684	4	0.44	0.540
			0.727	5	0.39	0.487
			0.738	6	0.38	0.473
			0.751	7	0.37	0.458
			0.761	8	0.36	0.445
			0.773	9	0.35	0.430
			0.785	10	0.33	0.415
			0.796	11	0.32	0.402
			0.805	12	0.32	0.391
			0.799	13	0.32	0.398
			0.816	14	0.30	0.377
			0.834	15	0.29	0.354
			0.841	16	0.28	0.346
			0.847	17	0.27	0.338
			0.853	18	0.27	0.331
			0.863	19	0.26	0.318
			0.870	20	0.25	0.309
			0.876	21	0.24	0.303
			0.876	22	0.24	0.303
			0.886	23	0.23	0.291
			0.893	24	0.23	0.282
			0.900	25	0.22	0.273
			0.907	26	0.21	0.264
			0.910	27	0.21	0.260
			0.916	28	0.20	0.253
			0.922	29	0.20	0.245
			0.927	30	0.19	0.240
			0.931	31	0.19	0.234
			0.935	32	0.18	0.229
			0.941	33	0.18	0.222
			0.945	34	0.18	0.217
			0.949	35	0.17	0.213

BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST BH13-32A

INTERVAL (metres below ground surface)

Top of Interval = 6.00
Bottom of Interval = 7.51

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_o}{y_t}$$

where K=m/sec

where:

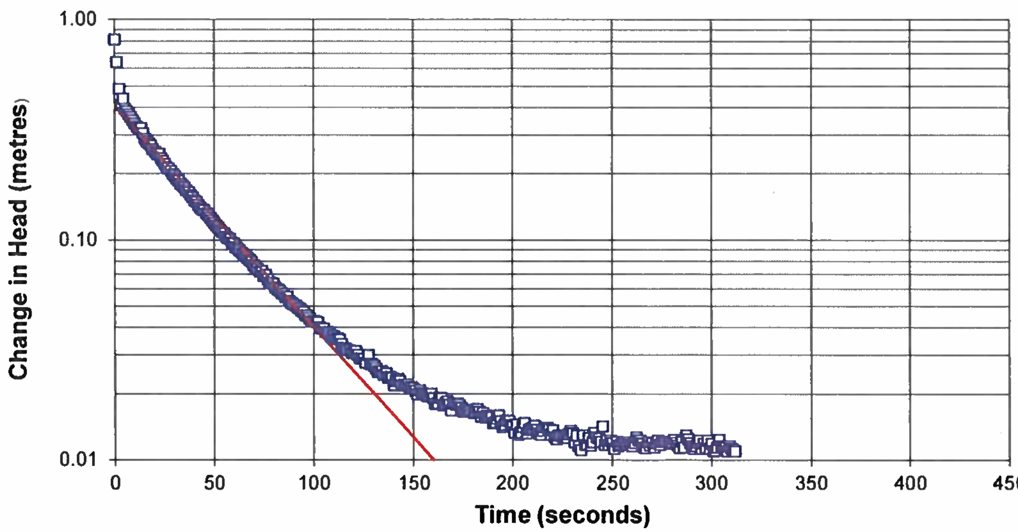
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.51
$ln(R_e/r_w)$	3.28
y_0 =	0.40
y_t =	0.01
t =	160.0

RESULTS

K=	6E-06	m/sec
K=	6E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 07/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

RED = Calculated Value
BLUE = User defined value

Regional Group/Remer + Idone Lands
13-1121-0083

RISING HEAD TEST BH13-32B

WELL NO.	BH13-32B	
DATE OF TEST	07/11/2013	
CASING STICK-UP	0.93	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	1.070	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0.019	METRES
BOREHOLE RADIUS	0.044	METRES
TOP OF OPEN INTERVAL	2.37	METRES (btoc)
BOTTOM OF OPEN INTERVAL	3.90	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	3.29	METRES
WATER TABLE TO BOTTOM OF SCREEN	2.83	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.88	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0014624	UBIC METRES
RADIUS OF WELL	0.01905	METRES
INITIAL DISPLACEMENT	1.28	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			1.946	0	0.88	1.000
			1.849	1	0.78	0.889
			1.829	2	0.76	0.866
			1.801	3	0.73	0.834
			1.780	4	0.71	0.811
			1.763	5	0.69	0.791
			1.749	6	0.68	0.775
			1.736	7	0.67	0.760
			1.721	8	0.65	0.743
			1.707	9	0.64	0.727
			1.690	10	0.62	0.708
			1.679	11	0.61	0.696
			1.670	12	0.60	0.685
			1.642	13	0.57	0.652
			1.640	14	0.57	0.650
			1.628	15	0.56	0.637
			1.623	16	0.55	0.631
			1.621	17	0.55	0.629
			1.616	18	0.55	0.623
			1.612	19	0.54	0.619
			1.606	20	0.54	0.612
			1.589	21	0.52	0.592
			1.578	22	0.51	0.580
			1.569	23	0.50	0.570
			1.557	24	0.49	0.556
			1.552	25	0.48	0.550
			1.543	26	0.47	0.540
			1.535	27	0.47	0.531
			1.527	28	0.46	0.522
			1.521	29	0.45	0.515
			1.516	30	0.45	0.509
			1.508	31	0.44	0.499
			1.500	32	0.43	0.491
			1.489	33	0.42	0.479
			1.480	34	0.41	0.468
			1.472	35	0.40	0.459

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-32B

INTERVAL (metres below ground surface)

Top of Interval =	**1.44**
Bottom of Interval =	**2.97**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e}\frac{1}{t}\ln\frac{y_0}{y_t}$$

where K=m/sec

where:

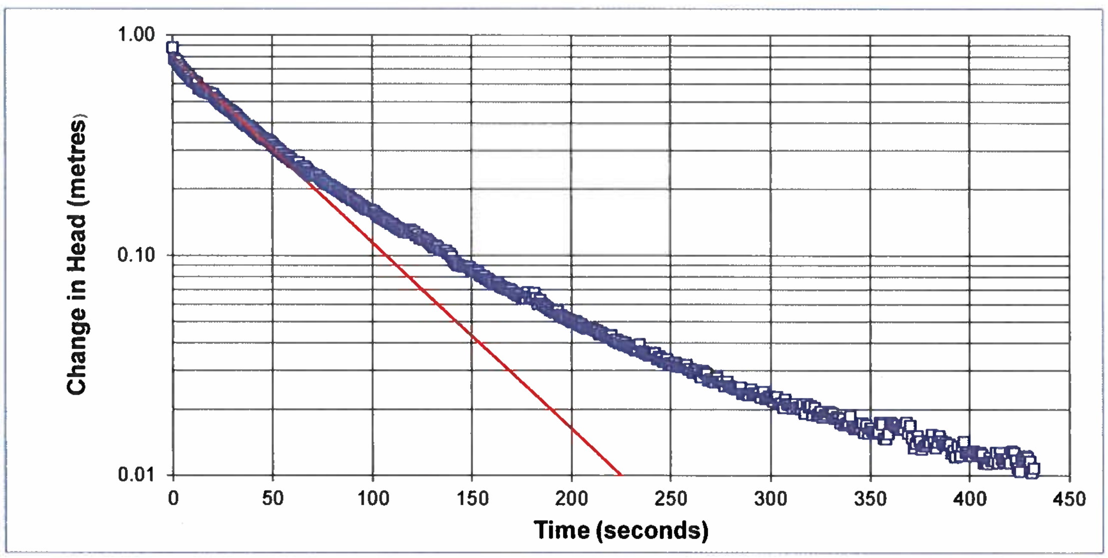
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.53
$ln(R_e/r_w)$	2.76
y_0 =	0.80
y_t =	0.01
t =	225.0

RESULTS

K=	6E-06	m/sec
K=	6E-04	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 07/11/2013
Analysis By: CHM
Checked By: CAMC
Analysis Date: 09/12/2013

RED = Calculated Value
BLUE = User defined value

FALLING HEAD TEST BH13-33A Falling Head Test #1

WELL NO. BH13-33A Falling Head Test #1

Regional Group/Remer + Idone Lands
13-1121-0083

DATE OF TEST	08/11/2013	
CASING STICK-UP	0.99	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	1.620	METRES (btoc)
CASING DIAMETER	1.25	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0.016	METRES
BOREHOLE RADIUS	0.044	METRES
TOP OF OPEN INTERVAL	6.25	METRES (btoc)
BOTTOM OF OPEN INTERVAL	7.77	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	6.38	METRES
WATER TABLE TO BOTTOM OF SCREEN	6.15	METRES
EQUIVALENT RADIUS	0.03	METRES
OPEN INTERVAL LENGTH	1.52	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	0.66	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.011	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0.0005778	UBIC METRES
RADIUS OF WELL	0.015875	METRES
INITIAL DISPLACEMENT	0.73	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 05/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			0.962	0	0.66	1.000
			1.169	1	0.45	0.685
			1.417	2	0.20	0.308
			1.450	3	0.17	0.258
			1.496	4	0.12	0.188
			1.528	5	0.09	0.140
			1.552	6	0.07	0.104
			1.568	7	0.05	0.079
			1.580	8	0.04	0.061
			1.589	9	0.03	0.048
			1.590	10	0.03	0.045
			1.602	11	0.02	0.027
			1.606	12	0.01	0.021
			1.608	13	0.01	0.018
			1.596	14	0.02	0.037
			1.595	15	0.02	0.037
			1.595	16	0.03	0.038
			1.604	17	0.02	0.025
			1.632	18	-0.01	-0.017
			1.627	19	-0.01	-0.011
			1.623	20	0.00	-0.005

BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST BH13-33A Falling Head Test #1

INTERVAL (metres below ground surface)

Top of Interval =	**5.26**
Bottom of Interval =	**6.78**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln\frac{y_o}{y_t}$$

where K=m/sec

where:

r_c = casing radius (metres);

R_e = effective radius (metres);

L_e = length of screened interval (metres);

r_w = radial distance to undisturbed aquifer (metres)

y_0 = initial drawdown (metres)

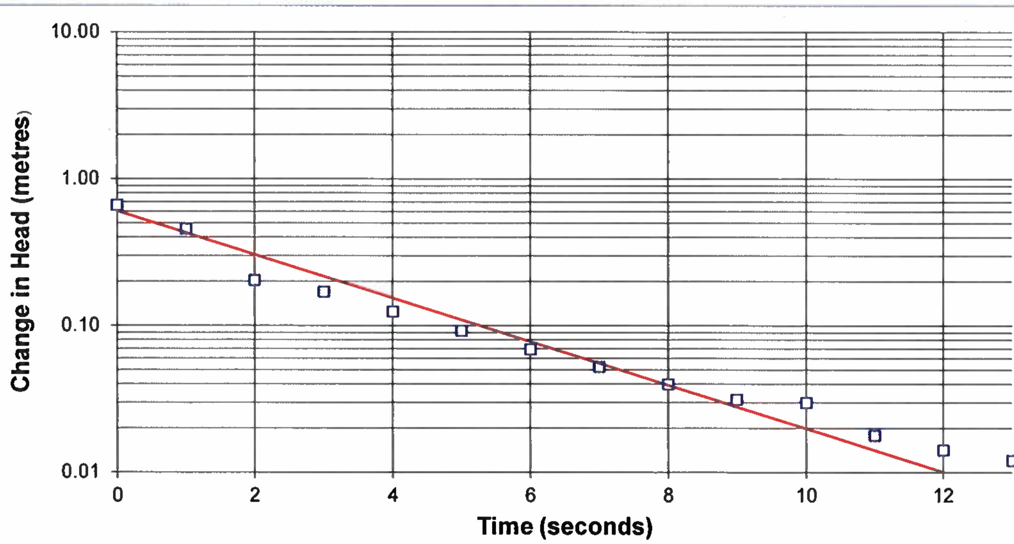
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.52
$ln(R_e/r_w)$	3.18
y_0 =	0.60
y_t =	0.01
t =	12.0

RESULTS

K=	9E-05	m/sec
K=	9E-03	cm/sec



Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 08/11/2013

Analysis By: CHM
Checked By: CAMC
Analysis Date: 05/12/2013

RED = Calculated Value
BLUE = User defined value

RISING HEAD TEST BH13-33B

WELL NO. **BH13-33B**

Regional Group/Remer + Idone Lands
13-1121-0083

DATE OF TEST	08/11/2013	
CASING STICK-UP	0.86	METRES (ags)
INITIAL DEPTH TO WATER (STATIC)	1.590	METRES (btoc)
CASING DIAMETER	1.5	inches
BOREHOLE DIAMETER	3.5	inches
CASING RADIUS	0 019	METRES
BOREHOLE RADIUS	0 044	METRES
TOP OF OPEN INTERVAL	3.12	METRES (btoc)
BOTTOM OF OPEN INTERVAL	4.65	METRES (btoc)
SATURATED THICKNESS OF AQUIFER	3.49	METRES
WATER TABLE TO BOTTOM OF SCREEN	3 06	METRES
EQUIVALENT RADIUS	0 03	METRES
OPEN INTERVAL LENGTH	1 53	METRES
STATIC IN SCREEN?	No	
MAX. HEAD CHANGE	1 06	METRES
MAX. HEAD IN SCREEN?	No	

Slug Testing - Initial Displacement		
LENGTH OF SLUG	1.52	METRES
RADIUS OF SLUG	0.0175	METRES
VOLUME OF SLUG ($\pi r^2 l$)	0 0014624	UBIC METRES
RADIUS OF WELL	0 01905	METRES
INITIAL DISPLACEMENT	1 2827137	METRES

Analysis By: CHM
Checked By: CAMC
Analysis Date: 05/12/2013

DATE	HR-MIN	SEC	DEPTH TO WATER (METRES)	ELAPSED TIME (SEC)	Displacement (METRES)	HEAD RATIO
			2.652	0	1.06	1.000
			2.531	1	0.94	0.887
			2 510	2	0.92	0.866
			2.489	3	0.90	0.847
			2 479	4	0.89	0.837
			2.469	5	0.88	0.828
			2.460	6	0.87	0.820
			2.451	7	0.86	0.811
			2 413	8	0.82	0.775
			2 422	9	0.83	0.784
			2 428	10	0.84	0.789
			2.418	11	0.83	0.780
			2.412	12	0.82	0.774
			2 404	13	0.81	0.767
			2 397	14	0.81	0.760
			2.390	15	0.80	0.753
			2.383	16	0.79	0.747
			2.377	17	0.79	0.741
			2 369	18	0.78	0.734
			2 363	19	0.77	0.729
			2 354	20	0.76	0.720
			2 351	21	0.76	0.716
			2 344	22	0.75	0.711
			2 337	23	0.75	0.704
			2 332	24	0.74	0.698
			2.316	25	0.73	0.684
			2 320	26	0.73	0.687
			2.313	27	0.72	0.681
			2 307	28	0.72	0.676
			2 301	29	0.71	0.670
			2 297	30	0.71	0.666
			2 291	31	0.70	0.661
			2 286	32	0.70	0.656
			2 280	33	0.69	0.650
			2 274	34	0.68	0.645
			2 268	35	0.68	0.639

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-33B

INTERVAL (metres below ground surface)

Top of Interval = 2.26
Bottom of Interval = 3.79

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e}\frac{1}{t}\ln\frac{y_o}{y_t}$$

where K=m/sec

where:

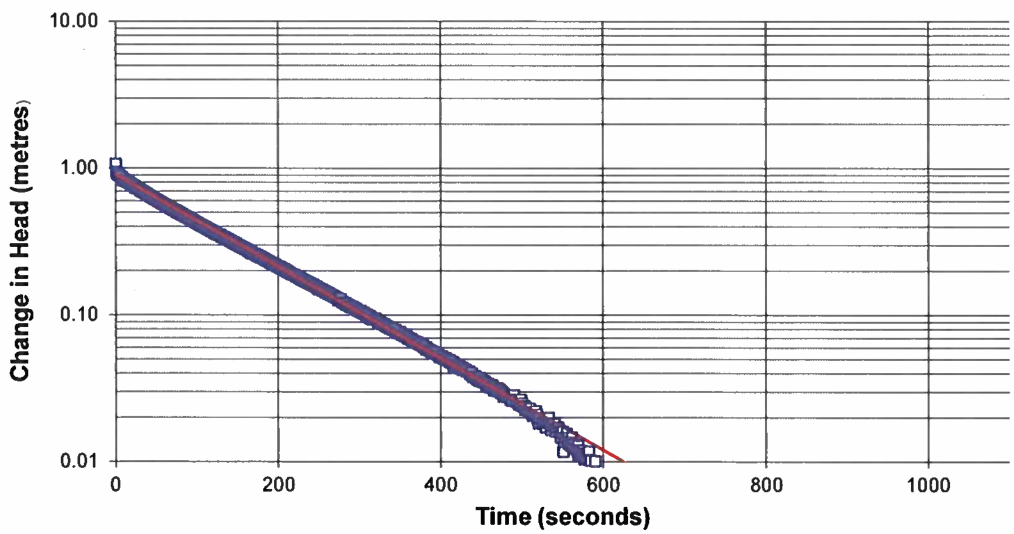
r_c = casing radius (metres);
R_e = effective radius (metres);
L_e = length of screened interval (metres);
r_w = radial distance to undisturbed aquifer (metres)
y_0 = initial drawdown (metres)
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.02
r_w =	0.04
L_e =	1.53
$ln(R_e/r_w)$	2.80
y_o =	0.90
y_t =	0.01
t =	625.0

RESULTS

K=	2E-06	m/sec
K=	2E-04	cm/sec



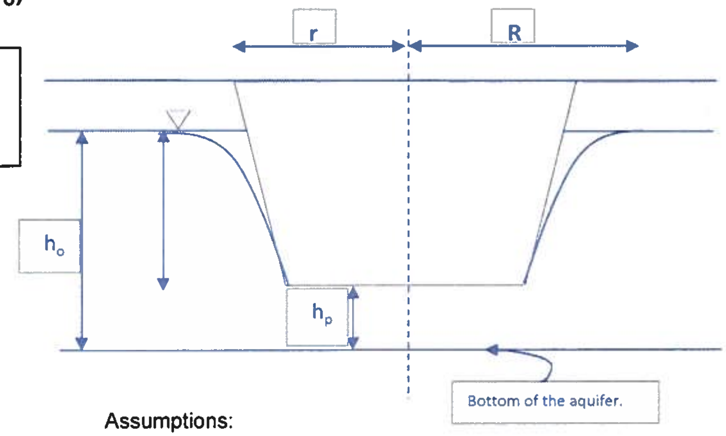
Project Name: Regional Group/Remer + Idone Lands
Project No.: 13-1121-0083
Test Date: 08/11/2013
Analysis By: CHM
Checked By: CAMC
Analysis Date: 05/12/2013

Inflow to Trench Equation: $Q=(K(h_o^2-h_p^2))/(0.733\log(R/r))+(2Kx(h_o^2-h_p^2))/(2L_o)$

K (m/sec) 4.1E-04
h_o (m) 6.5
h_p (m) 1.0
r (m) 2.50

r - half width of trench
L_o = R - radius of influence

TRENCH DIMENSIONS		
Width (2r) =	5	m
Length (x) =	120	m



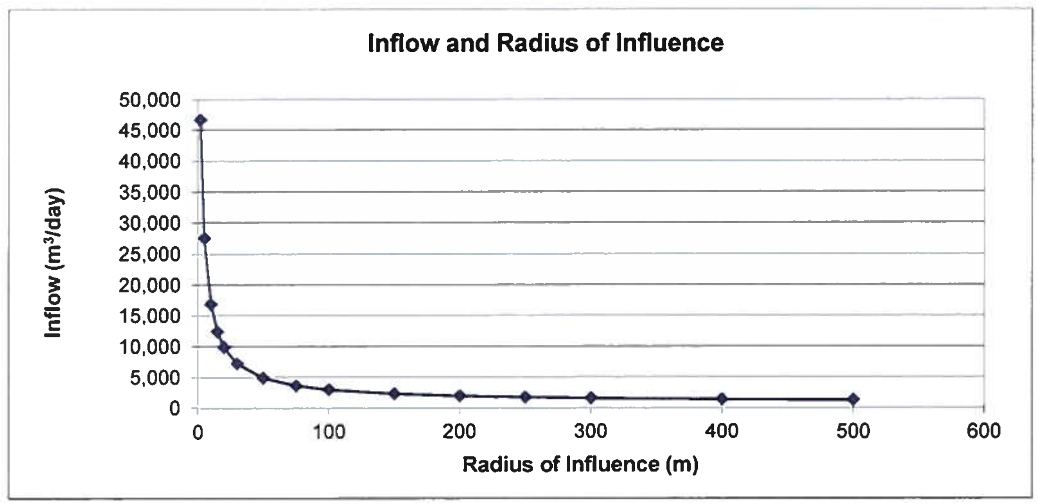
Q (m3/s)	R	Rad of Inf. from edge	m^3/day	L/day
5.4E-01	4.5	2	46,776	46,775,726
3.2E-01	7.5	5	27,558	27,558,036
2.0E-01	12.5	10	16,880	16,879,967
1.4E-01	17.5	15	12,379	12,378,837
1.1E-01	22.5	20	9,882	9,882,378
8.3E-02	32.5	30	7,185	7,184,942
5.6E-02	52.5	50	4,848	4,847,674
4.2E-02	77.5	75	3,599	3,599,267
3.4E-02	102.5	100	2,947	2,946,785
2.6E-02	152.5	150	2,266	2,266,432
2.2E-02	202.5	200	1,910	1,910,469
2.0E-02	252.5	250	1,689	1,689,055
1.8E-02	302.5	300	1,537	1,536,800
1.5E-02	402.5	400	1,339	1,338,986
1.4E-02	502.5	500	1,214	1,214,492

Assumptions:

Depth of trench dewatering (m) = 5.5

Sichart and Kyrieleis Equation: $R=3000\Delta h(K^{1/2})$

Radius of Influence (m) 334



APPENDIX D

Results of Basic Chemical Analysis
EXOVA Laboratories Ltd. Report No. 1323883

EXOVA OTTAWA

Certificate of Analysis

Client: Golder Associates Ltd. (Ottawa)
32 Steacie Drive
Kanata, ON
K2K 2A9
Attention: Ms. Christine Ko
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1323883
Date Submitted: 2013-10-28
Date Reported: 2014-01-30
Project: 13-1121-0083
COC #: 779818

Group	Analyte	MRL	Units	Guideline	1068678	1068679	1068680	1068681
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Type				
				Sampling Date	2013-10-01	2013-09-29	2013-09-27	2013-10-03
				Sample I.D.	13-4 SA#2	13-6 SA#6	13-13 SA#5	13-16 SA#2
Agri. - Soil	Electrical Conductivity	0.05	mS/cm		0.29	0.12	0.11	0.11
	pH	2.0			7.3	8.0	7.9	8.0
General Chemistry	Cl	0.002	%		0.019	<0.002	<0.002	0.004
	Resistivity	1	ohm-cm		3450	8330	9090	9090
	SO4	0.01	%		<0.01	<0.01	<0.01	<0.01

Group	Analyte	MRL	Units	Guideline	1068682	1068683
				Sample Matrix	Soil	Soil
				Sample Type		
				Sampling Date	2013-10-04	2013-10-09
				Sample I.D.	13-23 SA#7	13-31 SA#7
Agri. - Soil	Electrical Conductivity	0.05	mS/cm		0.18	0.13
	pH	2.0			8.1	8.2
General Chemistry	Cl	0.002	%		0.003	0.003
	Resistivity	1	ohm-cm		5560	7690
	SO4	0.01	%		0.03	0.02

Guideline = *** = Guideline Exceedence**
** = Analysis completed at Mississauga, Ontario.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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