Prepared for:

Arcadis

Block 6 Stormwater Management: SWM Facility Design Memo

Design Brief prepared by:

Aquafor Beech Limited

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1 Introduction

Aquafor Beech was retained by Arcadis on behalf of Rohit Homes to complete the design of subsurface Water Quantity Control Detention Chamber and an Infiltration-based Stormwater Management (SWM) facility in support of the development at Block 6 of the Wateridge Development, located in Ottawa. The facilities are to serve as an integral part of the site's ability to achieve the water balance and quantity control targets in accordance with the City of Ottawa Low Impact Development (LID) Technical Guidance Report (February, 2021) and the Former CFB Rockcliffe Master Servicing Study (MSS) (August 2015).

The site, Block 6, is encompassed by Rue Oshedinaa Street to the East and Rue Kijigong Street to the South, and future development lands to the west. The site is currently vacant and located on the former CFB Rockcliffe air base site. The surrounding roads and underground services for the site have not yet been fully constructed. The proposed site is scheduled for a low-rise mixed use residential development.

The proposed development block consists of two four-storey residential buildings, Building B and Building C, including one level of underground parkade with access from Rue Kijigong Street. The site also features a surface parking lot, servicing both residential buildings, with access from the laneway connected to Rue Oshedinaa Street.

2 Background Information

A review of both existing site conditions and relevant design standards was completed to support the development of the two subsurface SWM facilities. The following subsections outline relevant information from both review exercises.

2.1 Relevant Design Standards

The following design standards were referenced in the design development process for the proposed Infiltration facility:

1. City of Ottawa Sewer Design Guidelines (Second Edition, October 2012)
2. Stormwater Management Planning and Design Manual (Ministry of Environment, Conservation, and Parks, March 2003)
3. City of Ottawa Low Impact Development (LID) Technical Guidance Report: Implementation in Areas with Potential Hydrogeological Constraints (February, 2021)
4. Low Impact Development Stormwater Management Guidance Manual – Draft for Consultation (Ministry of Environment, Conservation, and Parks, January 2022)
5. Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide – Version 1.0 (Toronto Region Conservation Authority, 2016)

2.2 Subsurface Conditions

A geotechnical investigation was completed by Terrapex for Block 6 in January 2024 (updated October 2024) for the Block 6 development area, involving installation of seven (7) boreholes and three (3) subsequent monitoring wells on the Block 6 site. These features were used to classify subsurface soil physical and chemical properties, groundwater depth, and bedrock conditions.

In-situ infiltration testing was also completed by Terrapex at a number of test pits and holes to various depths across the site on November 16th and 20th. Field testing was completed using pre-soaked soil and a falling head test conducted by adding water into a select soil horizon and monitoring the soil acceptance rate.

The relevant findings from both investigations in regards to design of both the Infiltration chamber and Water Quantity Control detention chamber are outlined below:

1. LID Facility Setbacks
    a. Infiltration and any other LID practices must be located on site such that a minimum horizontal setback of 4.0m is provided between the LID footprint and edge of building foundations per City of Ottawa Low Impact Development (LID) Technical Guidance Report (February, 2021).

2. Bedrock and Groundwater
    a. Infiltration Chamber:
        i. Per Figure 2 – Infiltration Investigation (from Geotechnical Investigation Report by Terrapex included as Appendix A), the proposed Infiltration chamber excavation area lies between bedrock elevations of approximately 84.0 and 84.4 m. The groundwater table was measured at an elevation of 82.20 m (3.67 m below ground) at the closest installed monitoring well MW 6-6 on November 24, 2023. The relevant 1.0 m vertical clearance constraint for the design will be based on bedrock elevations as they are shallower than the observed groundwater elevations.
    b. Water Quantity Control Detention Chamber:
        i. Per Figure 2 – Infiltration Investigation (from Geotechnical Investigation Report by Terrapex included as Appendix A), the proposed Water Quantity Control Detention Chamber excavation area lies between bedrock elevations of approximately 83.3 and 83.9 m. The invert elevation of the Water Quantity Control Detention Chamber shall not be lower than the bedrock elevation for ease of construction considerations.
3. Infiltration Rate
    a. Infiltration Chamber:
        i. In-situ infiltration rates were obtained from test pits or cores dug varying depths below ground surface at INF 6-1 through INF 6-3 per the map provided in Appendix A of this memo. Infiltration rates across INF 6-1 through INF 6-3 averaged to 54 mm/hr. The design infiltration rate adopts a safety factor in accordance with the LID Stormwater Management Guidance Manual, producing an average design infiltration rate of 15.42 mm/hr.
    b. Water Quantity Control Detention Chamber:
        i. In-situ infiltration rates are not relevant to the design of the Water Quantity Control Detention Chamber due to the closed-bottom system.

3 Subsurface SWM Facility Sizing

The following subsections outline the design development process used in sizing the Subsurface SWM facilities.

3.1 SWM Design Targets

To aid in the development of the facilities, several design targets were identified from the various guidance documents outlined in Section 2.2 above. Table 1 below summarizes the design targets applied and source of information.

Table 1: Various Design Targets Applicable to the Subsurface SWM Facilities.

Design Target Category	Target Value or Range	Source
Clearance to bedrock or groundwater (Infiltration Chamber)	Minimum 1.0m	City of Ottawa LID Technical Guidance Report: Implementation in Areas with Potential Hydrogeological Constraints
Erosion Control Storage	4mm rainfall depth across entire site area	Wateridge Phase 2B LID Developer's Checklist
Water Balance Storage	4mm rainfall depth across entire site area	Wateridge Phase 2B LID Developer's Checklist
Water Quantity Control	Volume calculated via Modified Rational Method to control 100-year storm	City of Ottawa Design Standards
Release rate (Water Quantity Control Detention Chamber)	Maximum Allowable release rate of 79 L/s	Wateridge Phase 4 Design Brief (March, 2023)
Water Quality Storage	N/A	N/A
Drawdown Time (Infiltration Chamber)	48-92 hours	City of Ottawa LID Technical Guidance Report: Implementation in Areas with Potential Hydrogeological Constraints

It is noted that the Water Quality Control target constraint does not apply to Block 6 as discharge from this Block is conveyed to the existing SWM facility servicing the Wateridge development lands, which has been designed to provide quality control for its contributing drainage area through a permanent pool and extended detention storage component.

Two Stormwater Management Facilities are proposed: One Water Quantity Control Detention Chamber below the at-grade parking lot to the west of building B, and one Infiltration chamber below the available green space to the southwest of building B.

While the Infiltration chamber must hold and infiltrate the equivalent volume of 4mm of rainfall depth across the entire site area, the design will be prepared such that only runoff generated from the rooftop of building B contributes to the facility to eliminate the need to pre-treatment that is otherwise required. Additional flow exceeding the designed volume of the Infiltration chamber will overflow via an outlet catchbasin featuring a riser outlet pipe connecting to the Quantity Control detention chamber and surcharge through the outlet catchbasin grate in major storm events to drain over the surface down-grade towards the Quantity Control detention chamber.

The Water Quantity Control detention chamber must be able to store an appropriate volume of water to meet the City of Ottawa Design standards. The chamber will be fitted with an outlet catch-basin flow control orifice to ensure a maximum release rate in accordance with the Wateridge Village Phase 4 Design Brief (2023).

3.2 Proposed Hydrologic Conditions

Intensity-duration-frequency (IDF) data was referenced from the City of Ottawa Sewer Design Guidelines, adopting rainfall intensities for the 2-year to 100-year design storm event under a 10-minute time of concentration. Given that the Infiltration chamber has been designed to only accept inflows from building B rooftop areas, the applicable catchment area was delineated based upon total rooftop area from the proposed four-storey building, with a standard impervious surface runoff coefficient of 0.9 adopted for the hydrological analysis. The Water Quantity Control Detention Chamber receives inflows from general site runoff exclusive of rooftop flows (rooftop runoff from building B and C are handled by other systems). Table 2 through Table 3 below summarize the peak design storm flows and required runoff storage volumes relevant to the design.

Table 2: Design Storm Peak Flows for the Subsurface SWM Facilities.

Return Period	Rainfall Intensity (mm/hr)	Infiltration Chamber Inflow (m^3/s)	Quantity Control Detention Chamber Inflow (m^3/s)
2-year	77.1	0.040	0.060
5-year	104.4	0.057	0.078
10-year	122.5	0.076	0.092
25-year	145.3	0.09	0.12
50-year	162.2	0.11	0.15
100-year	179	0.12	0.17

All inlet pipes to both facilities shall convey up to the 5-year design storm flows under free-flowing conditions in order to meet the minor system standard per the City of Ottawa Sewer Design Guidelines (Second Edition, October 2012). Table 3 below summarizes the specific, quantitative stormwater management targets relevant to the Block 6 site.

Table 3: Total Runoff Volume Storage Requirements for the Infiltration and Quantity Control Facilities.

SWM Category	Target Value	Required Volume (m^3)	Applicable To
Water Balance Storage	4mm rainfall depth across entire site area	46.7m^3	Infiltration facility
Erosion Control Storage	4mm rainfall depth across entire site area	46.7m^3	Infiltration facility
Water Quantity Control Storage	Volume calculated via Modified Rational Method to control 100-year storm	124 m^3	Quantity Control facility
Maximum Release Rate	Maximum Allowable release rate	79 L/s	Quantity Control facility
Drawdown Time	Maximum allowable time for facility to completely drain	48-92 hours	Infiltration facility

To achieve the Water Quantity Control and Maximum Release Rate storage and flow rate targets, the Water Quantity Control Detention Chamber was designed such that a maximum of 124 m^3 of volume is to be stored in the facility at a maximum allowable release rate of 79 L/s via a flow control orifice outlet.

Additionally, to collect the equivalent volume produced from a 4mm rainfall event across the site of 46.7m^3, the rooftop area of building B must capture and direct the runoff generated from a 24mm rainfall event. This rainfall depth is consistent with the 90th percentile rainfall event for the City of Ottawa, or a 27mm depth per the Draft Low Impact Development Stormwater Management Guidance Manual (MECP, 2022).

3.3 Stormwater Management Facilities Summary

With design targets and site constraints established, designs for the SWM facilities were developed. Both facilities consist of a plastic chamber system complete with inlet debris settling rows, inspection ports and inlet and outlet connections. The Infiltration chamber includes an open bottom stone base for infiltration of stored water below the outlet invert, whereas the Water Quantity Control Detention Chamber has a closed bottom consisting of a geotextile impermeable liner with flows being discharged exclusively through the outlet flow control device and the overflow catch basin. A summary of key design information for both facilities is provided in Table 4 below.

Table 4: Key Design Parameters of Proposed SWM Facilities.

Design Parameter	Quantity Control Facility Value	Infiltration Facility Value
Maximum Storage Volume (m^3)	137.5 m^3	52 m^3
Maximum Infiltration Volume (m^3)	N/A	52 m^3
Excavation Footprint Area (m^2)	157 m^2	102 m^2
Total Facility Depth (m)	1.51 m (Aquabox HP)	1.10 m (Aquabox Cube)
Minimum Cover (m)	0.60m	0.60m
Minimum Clearance to Bedrock from invert of Aquabox system (m)	0.15 m	1.00 m
Drawdown Time (hrs)	3.4 hrs	81 hrs
Maximum Release Rate	79.0 L/s	N/A
Orifice Diameter	100 mm	N/A
Inlet Pipe Diameter(s) (mm)	200 mm	200 mm
Outlet Pipe Diameter (mm)	250 mm	N/A
Structural Loading Capacity	HS-25 Rated	HS-25 Rated

In addition to the design information in the above table, various other design aspects were incorporated to enhance the function of the system and allow for greater ease of operation and maintenance. These additional design aspects are outlined and described below:

1. Overflow bypass system
   i. Infiltration chamber: One standard OPSD 705.010 catchbasin is proposed to be installed in the northwest corner of Infiltration chamber, adjacent to the proposed walking path, and features an internal riser outlet pipe which connects to the quantity control detention

chamber before releasing discharge offsite. The invert of the riser shall be set to the top of the infiltration chamber to ensure the target infiltration volume within the facility is achieved before overflow flows into the riser structure. In major storm events when the facility is full and the riser outlet cannot convey sufficient flows, overflow can exit the system via surcharging through the catchbasin grate and drain westward towards the West property line swale and drain back into the quantity control detention chamber via the inlet 2 catchbasin. Finally, a flap valve shall be installed on the downstream end of the outlet pipe connecting the infiltration chamber to the Quantity Control detention chamber. The flap gate shall be installed at the catchbasin (Inlet CB 2 per the design drawings) side wall to ensure ease of access for future maintenance.

   ii. Quantity Control Detention Chamber: One outlet catchbasin is proposed to be installed in the north-east corner of the Quantity Control facility with a connection to a proposed 250mm STM pipe outlet. This outlet catchbasin will receive a small portion of runoff from the aboveground parking lot as well as outflows from the quantity control chamber via a 250mm diameter opening on the catchbasin flush with the chamber sidewall.

2. Outlet Control Device
   i. Quantity Control Detention Chamber: In order to control outflows at or under the maximum allowable release rate, a 100 mm diameter orifice plate will be installed on the outlet pipe at the outlet catchbasin.
3. Subdrain Pipe
   i. Quantity Control Facility: A subgrade pipe is included below the Aquabox system in the base stone levelling course layer to provide an additional 100 mm of depth to the active storage by allowing water to drain from the system at elevations below the main outlet invert. The subdrain pipe will also direct flows into the outlet catchbasin.
4. Inlet Debris Row (Both facilities)
   i. An inlet debris row is included at the inlet location as part of the Aquabox chamber design such that sediment and other debris has the opportunity to settle in a small forebay area before runoff spills over the internal weir wall and into the main chamber area. The debris row concentrates sediment deposition in the system to a small area for ease of maintenance.
5. Inspection Ports (Both facilities)
   i. A combined total of seven inspection ports are proposed for the SWM facilities; five supporting the Quantity Control detention chamber and two supporting the Infiltration chamber. The inspection ports include 375 mm diameter piper risers. These ports can be used for visual inspection inside the chamber or cleanout of sediments via vac truck. One port is provided at each inlet debris row for each facility, with the remainder spread across the main storage chamber area to maximize maintenance and cleanout accessibility.

4 Operation and Maintenance Considerations

A number of operation and maintenance (O&M) practices should be considered by the site owner to ensure the infiltration chamber can maintain its as-designed function in future years. The considerations outlined in Table 5 are summarized from previous industry experience of Aquafor Beech and the TRCAs' Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide.

Table 5: Operation and Maintenance Considerations for Subsurface SWM Facilities.

Design Component	O & M Description	Frequency
Contributing Catchment	Inspect Contributing rooftop area for inlet to Infiltration chamber to ensure no significant leaf litter, sediment, leaking contaminated substances, or other garbage debris are present that may enter the system and cause partial or full blockage of the inlet.	Biannual visual inspections.
Inlet Conveyance System	Inlet should remain unobstructed to ensure runoff enters Infiltration chamber unimpeded. Visual inspection of inlet catch basins should be completed. CCTV and flushing of pipe segments should occur when pipe segments are or suspected to be clogged. Standing water within the catch basins or frequent surcharging are indicative of clogging or capacity issues within the infiltration chamber and outlet system, respectively.	Visual Inspection – biannual Flushing & CCTV – when clogging/damage suspected.
Debris Row/ Pretreatment	For effective debris row function, area should be inspected visually via the inspection port for sediment or other debris accumulation limiting storage capacity or conveyance of inlet flows into the main chamber area. Inlet flushing and vac truck cleanout of the debris row shall be adopted to remove debris and sediment when required.	Biannual visual inspections. Flushing & Vac Truck – when sediment accumulation reaches half the height of the debris row geotextile wall.
Sediment Accumulation	Applicable to Quantity Control facility: Visual inspection in dry weather to quantify sediment accumulation. Where sediment accumulation is surpassing the Aquabox base plate, CCTV, flushing and vac truck cleanout shall be adopted to remove sediment when required.	Biannual visual inspections.
Main Filter Bed Area	Applicable to Infiltration chamber: Visual inspection in dry weather to quantify sediment accumulation and inspections following storm events to monitor draw down time. Should facility draw down exceed 92 hours or sediment accumulation limit inlet/outlet function of facility, flushing and vac truck sediment removal shall be adopted.	Annual visual inspections. Flushing & Vac Truck – when drawdown exceeds 92hrs **OR** sediment accumulation impeding inlet/outlet function.
Outlet Conveyance System	Outlet should remain unobstructed to ensure discharged water leaves the site unimpeded. Visual inspection of outlet catchbasins for standing water can help identify any conveyance problems in the outlet system. Where clogging is suspected, CCTV and flushing of pipe sediments should occur.	Visual Inspection – biannual Flushing & CCTV – when clogging/damage suspected.
Emergency Overflow Outlets	Grate opening of catchbasins along inlet pipe should remain unobstructed and free of debris such that surcharge of excess runoff to the surface in major storm events can occur.	Biannual visual inspections.
Inspection Ports	As a vital component to maintenance access, inspection of the inspection ports to ensure proper function and access is maintained via the surface grates.	Biannual access function inspections.

Appendix A: Terrapex Geotechnical Investigation

ADDITIONAL GEOTECHNICAL INVESTIGATION

Wateridge Village - Phase 4, Block 6
Ottawa, Ontario

REPORT

Revision 1

October 1, 2024

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APPENDICES

1. INTRODUCTION

Terrapex Environmental Ltd. (Terrapex) has been retained by Rohit Communities to carry out an additional geotechnical investigation for the proposed development located at 1076 Hemlock Private, Wateridge Community Phase 4 (the Site), in the City of Ottawa, Ontario. Authorization to proceed with this study was given by Mr. John Hebert of Rohit Communities.

We understand that Rohit Communities is seeking approval to develop the land at Wateridge Village referred to as Phase 4 including Block 4 with mid-rise residential apartment dwelling and, Block 5 and Block 6 with low-rise residential apartment dwelling. According to the Site Plan provided to Terrapex by Client on January 19, 2024, the Site is scheduled for a mixed-use residential development which would include the following:

- Block 4 will contain mid-rise residential apartment dwelling (Building D, six storeys with one level of underground parking garage).
- Block 5 will contain low-rise residential apartment dwelling (Building A, four storeys with one level of underground parking garage).
- Block 6 will contain two low-rise residential apartment dwellings (Building B and Building C, four storeys with one level of underground parking garage).

Geotechnical investigations have been conducted at the Site previously and the most recent geotechnical investigation report prepared by Terrapex dated February 5, 2019, with a Title of ***Geotechnical Investigation Report, Proposed Mixed-Use Development, Phase 2A & 2B, Wateridge Village, Ottawa, Ontario*** was reviewed. The relevant soil and groundwater information from this previous investigation are presented in this report.

The purpose of this investigation was to characterize the underlying soil and groundwater conditions and to provide recommendations for the detailed design of the proposed development. This report will provide findings from the geotechnical investigation and engineering recommendations for the design and construction of the proposed development at Block 6. The work carried out for Block 4 and Block 5 are reported under separate covers.

This report presents the results of the investigation performed in accordance with the general terms of reference outlined above and is intended for the guidance of the owner and the design architects or engineers only. It is assumed that the design will be in accordance with the applicable building codes and standards.

2. FIELD WORK AND LABORATORY WORK

2.1 FIELD WORK

The fieldwork for this study was carried out on November 8 to 11 and November 19, 2023. It consisted of seven (7) boreholes advanced by a drilling contractor commissioned by Terrapex utilizing track-mounted drilling equipment. The boreholes are designated as BH/MW6-1, BH6-2, BH/MW6-3, BH6-4 to BH6-5, BH/MW6-6 and BH6-7, advanced to depths ranging from 1.1 to 4.7 m below ground (mbg). Monitoring wells were installed in BH/MW6-1, BH/MW6-3 and BH/MW6-6 for long-term monitoring of the groundwater level. Data loggers were installed in the monitoring wells for real time monitoring of the groundwater level. The location of the boreholes and monitoring wells, together with the boreholes drilled in previous investigation (BH110 and TP205) are presented in Figure 1 of Appendix A.

Standard penetration tests were carried out in the course of advancing the boreholes through the overburden soils to take representative soil samples and to measure penetration index values (N-values) to characterize the condition of the various soil materials. The number of blows of the striking hammer required to drive the split spoon sampler through 300 mm depth increments was recorded and these are presented on the logs in Appendix B as penetration index values.

Bedrock was encountered at depths of 0.7 mbg to 3.0 mbg at all borehole and monitoring well locations, except for BH110. Bedrock was cored from 2.2 mbg to 4.6 mbg in BH/MW6-1, from 1.3 mbg to 4.6 mbg in BH/MW6-3, and from 2.3 mbg to 4.6 mbg in BH/MW6-1 for monitoring well installation.

One Test Pit (TP205) was excavated during the investigation carried out in 2018 to a depth of 1.6 mbg in Block 6. One (1) borehole (BH110) was drilled within Block 6 during the investigation carried out in 2018 to a depth of 1.3 mbg.

Groundwater level observations were made during and upon completion of the borehole drilling, where applicable, as well as in the installed monitoring wells.

The location and ground surface elevation at the locations of the boreholes and monitoring wells were established utilizing a TopCon HiPer V GNSS Receiver referenced to UTM Zone 18T (NAD83) and presented in the attached Borehole Location Plan in Appendix A of this report. The information of the drilled boreholes and installed monitoring wells is summarized in Table 1.

Table 1: Summary of Borehole Information

Borehole No.	Northing (m)	Easting (m)	Ground Elevation (m)	Depth of Borehole (m)	Depth of Monitoring Well (m)
BH/MW6-1	5033727.08	450070.46	82.82	4.7	4.7
BH6-2	5033694.44	450105.97	84.19	1.2	N/A
BH/MW6-3	5033677.45	450119.58	85.70	4.6	4.6
BH6-4	5033626.16	450118.00	87.36	3.0	N/A
BH6-5	5033612.15	450146.62	87.34	3.0	N/A
BH/MW6-6	5033580.10	450125.25	85.87	4.6	4.6
BH6-7	5033564.86	450163.18	86.75	1.8	N/A
BH110	5033554	450130	86.37	1.3	N/A
TP205	5033606	450123	85.81	1.6	N/A

The fieldwork for this project was carried out under the supervision of an experienced technician from this office who laid out the positions of the boreholes in the field; arranged locates of buried services; effected the drilling, sampling and in situ testing; observed groundwater conditions; and prepared field borehole log sheets.

2.2 GEOTECHNICAL LABORATORY TESTS

The soil samples recovered from the split spoon sampler were properly sealed, labelled and brought to Terrapex's Toronto laboratory for detailed examination. Each soil sample was examined in the laboratory for visual and textural characteristics by the Project Engineer. Moisture content determinations were carried out on all recovered soil samples. The results are plotted on the borehole logs attached in Appendix B.

Five (5) grain size analyses and two (2) Atterberg Limits tests were performed on selected soil samples. The geotechnical laboratory results are provided in Appendix C of this report as well as presented on the respective borehole logs provided in Appendix B. One combined subgrade soil sample obtained from the location of Inf 6-1 was subjected to California Bearing Ratio (CBR) test and the results are presented in Appendix F of this Report.

In addition, two (2) soil samples, BH6-5-SS2 and BH/MW6-2-SS3 were submitted to AGAT Laboratories for determination of pH and sulphate content and their potential for sulphate attack on buried concrete. The results of the tests are enclosed in Appendix E and will be discussed in Section 4.2 of this report.

2.3 INFILTRATION TESTING

Soil infiltration rate testing was carried out in unsaturated soils at locations labeled as Inf6-1 through Inf6-4, as shown in Figure 2 of Appendix A. The field tests were carried out on November 16 and November 20 of 2023. Soils were pre-soaked and then a falling head test was conducted by adding a volume of water into a select soil horizon, and monitoring the rate that it was accepted into the soil. Depending upon the target depth, the water was introduced into the select soil horizon via the screened horizon of a drive-point piezometer, or by introducing a volume of water to the soil using a Pask Permeameter instrument. An electronic sounding tape was used to measure the steady-state flow rate of gravimetrically-fed water into the unsaturated soil horizon. The results of the infiltration test are presented in Appendix D of this report and will be discussed in Section 4.1 of this report.

3. SITE AND SUBSURFACE CONDITONS

Full details of the subsurface soil and groundwater conditions at the site are given on the Borehole Log Sheets attached in Appendix B of this report. The following paragraphs present a description of the site and a commentary on the engineering properties of the various soil materials contacted in the boreholes.

It should be noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design, and therefore, should not be construed as exact planes of geological change.

3.1 SITE DESCRIPTION

The subject site is located at the former CFB Rockcliffe property in the City of Ottawa. The former CFB Rockcliffe property is approximately 310 acres; bounded by Aviation Parkway to the west, Sir George Etienne Cartier Parkway to the North, the National Research Council of Canada campus to the east, and existing residential communities and Montfort Hospital to the south. It is bounded by two bedrock escarpments at the south and north boundaries. The Rockcliffe Airport is also located in the vicinity of the site, just north of Sir George Etienne Cartier Parkway.

Our investigation was limited to Phase 4 and the work carried out for Block 6 was bounded by Kijigong Street from the south, future private driveway from the north, future private driveway from the west and future Oshedinaa Street from the east. The ground surface topography of the site is uneven. The ground surface elevations at the locations of the boreholes vary from 82.8 m to 87.3 m.

3.2 SUBSURFACE SOIL CONDITIONS

In general, the subsurface at the site consists of fill material overlying bedrock.

Fill: Fill material consisting of gravelly sand, sandy silt to silty clay was encountered at all borehole locations, extending to depths varying from 0.7 mbg to 3.0 mbg. The fill material is generally presented in a loose to very dense state (soft to hard for silty clay), with the recorded SPT “N” values varying from 2 to over 50 blows per 300 mm penetration. The moisture content of the fill material ranges between 3% and 38%.

Grain size analyses for five (5) selected soil samples and Atterberg Limits test of one (1) soil samples of the fill material was conducted and the results are presented in Appendix C of this report and summarized in Table 2:

Table 2: Grain size Analyses Results (Fill)

Borehole No.	Sample No.	Grain size Analyses Distribution (%)				Atterberg Limits Test (%)		
		Gravel	Sand	Silt	Clay	LL	PL	PI
BH/MW6-1	SS1A	9	21	27	43	N/A		
BH/MW6-1	SS1B	29	38	23	10	N/A		
BH6-4	SS1	6	8	25	61	58	30	28
BH6-5	SS2	7	7	25	61	N/A		
BH6-6	SS3	18	33	36	13	N/A		

3.3 BEDROCK CONDITIONS

Bedrock was encountered at depths of 0.7 mbg to 3.0 mbg at all borehole and monitoring well locations, except for BH110, corresponding to a geodetic elevation of 80.7 m to 85.1 m. At the location of BH/MW6-1, BH/MW6-3 and BH/MW6-6, the bedrock was proven by rock coring to a depth of 4.6 mbg. The bedrock was also proven by excavation/augering at the other borehole/test pit locations. The approximate depth and geodetic elevation of the bedrock surface at each borehole/test pit location is provided in Table 3.

Table 3: Summary of Bedrock Information

Borehole No.	Depth of Bedrock Surface (m)	Elevation of Bedrock Surface (m)	Note
BH/MW6-1	2.1	80.7	Cored
BH6-2	0.7	83.5	Augered
BH/MW6-3	1.3	84.3	Cored
BH6-4	3.0	84.4	Augered
BH6-5	2.8	84.5	Augered
BH/MW6-6	2.3	83.6	Cored
BH6-7	1.7	85.1	Augered
BH110	N/A	N/A	N/A
TP205	1.6	84.2	Excavated

The bedrock surface should not be considered accurate to better than ±0.5 m and some variations in the bedrock surface elevation across the site should be expected.

Review of available geological mapping and previous geotechnical investigations indicates that the bedrock is of the Ottawa Formation, consisting of limestone with some shale bedding and some sandstone in the basal part. In BH/MW6-1, BH/MW6-3 and BH/MW-6-6, the bedrock was cored from 2.1 m to 4.6 m, from 1.3 m to 4.6 m and from 2.3 m to 4.6 m, respectively. Total Core Recovery (TCR) achieved with the HQ double tube size core bit is 100% and the Rock Quality Designation (RQD) varied from 15% to 84%, which indicate very poor to good quality of bedrock. According to the previous investigations at the site, the rock is classified to be strong to very strong.

3.4 GROUNDWATER CONDITIONS

The groundwater table was measured in the installed monitoring wells on November 24, 2023. The groundwater table measured in the monitoring wells were at depths of 3.67 to 4.30 m, corresponding to elevations of 78.5 m to 82.2 m. The measured groundwater levels are provided in Table 4.

Table 4: Groundwater levels observed in Monitoring Wells

Borehole No.	Ground Elevation (m)	Depth of Well (m)	Date of Reading	Depth of Groundwater (mbg)	Groundwater Elevation (m)
BH/MW6-1	82.82	4.6	11/24/2023	4.3	78.52
BH/MW6-3	85.70	4.6	11/24/2023	--	--
BH/MW6-6	85.87	4.6	11/24/2023	3.67	82.2

More information of the groundwater will be provided after downloading the data from the data loggers.

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events.

4. SOIL INFILTRATION, CORROSIVITY AND CBR TEST RESULTS

4.1 SOIL INFILTRATION TEST RESULTS

Field-saturated hydraulic conductivity, (Kfs) was calculated from the measurements using following equation (Elrick et. al., 1989):

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

Where:

Kfs =Field saturated hydraulic conductivity (entrapped air present) (cm/sec)

C_1 = Shape factor

Q_1 = flow rate (cm^3/s)

H_1 = Well height (cm)

a = Well radius (cm)

α* = alpha factor (0.15 cm^{-1})

The field measurement data and analysis of the infiltration rate testing are provided in Appendix D. Based on the resulting Kfs (cm/s), the corresponding infiltration rates (mm/hr) were estimated using the covariable relationship presented in the Low Impact Development Stormwater Management Planning and Design Guide (TRCA and CVCA, 2010). A summary of the infiltration rate testing results is presented below in Table 5.

Table 5: Summary of Infiltration Tests

Location Tested	Measured Kfs (cm/s)	Measured Infiltration Rate (mm/hr)	factor of safety	Design Infiltration Rate(mm/hr)
INF6-1	8.00E-05	3.00E-04	62	2.5
INF6-2	2.00E-04	2.00E-05	36	2.5
INF-6-3	1.00E-05	4.00E-04	65	2.5

4.2 TEST RESULTS OF SOIL CORROSION POTENTIAL

Two (2) bulk soil samples collected during the investigation were submitted for corrosion potential tests. The test results are listed in Table 6 and a detail report is presented in in Appendix E of this report.

Table 6: Summary of Soil Corrosivity Tests

SAMPLE ID	PH	SULPHATE (µg/g)
BH6-5 SS2	7.88	38
BH/MW6-6 SS3	8.09	37

The pH of the tested sample indicates a moderate alkalinity. The concentration of water-soluble sulphate content of the tested samples is below the CSA Standard of 0.1% water- soluble sulphate (Table 3 of CSA A23.1/CSA A23.2, Additional Requirement for Concrete Subjected to Sulphate Attack). Special concrete mixes against sulphate attack are therefore not required for the sub-surface concrete. Kg/m^3

4.3 CALIFORNIA BEARING RATIO TEST

One (1) composite sample from the top 1.5 m of the borehole (Inf6-1) was collected at the time of Infiltration test for CBR testing. Proctor test was also performed on the same sample. The results of the test are presented in Appendix C of this report. A summary of the test results is provided in Table 7.

Table 7: Summary of CBR Test

SAMPLE ID	PENETRATION (mm)	CORRECTED STRESS (MPa, after soaking)	BEARING RATIO (%)	MOISTURE AT PENETRATION POINT (%)	MAXIMUM DRY DENSITY (Kg/m3)
INF6-1	2.5	1.10	15.94	10.03	2091
	5.0	2.45	23.79		

5. DISCUSSION AND RECOMMENDATIONS

In this section, the subsurface conditions are interpreted as relevant to the design of the proposed two four-storey building with one level of underground parking garage.

The construction methods described in this report must not be considered as being specifications or recommendations to the prospective contractors, or as being the only suitable methods. Prospective contractors should evaluate all of the factual information, obtain additional subsurface information as they might deem necessary and should select their construction methods, sequencing and equipment based on their own experience in similar ground conditions. The readers of this report are also reminded that the conditions are known only at the borehole locations and in view of the generally wide spacing of the boreholes, conditions may vary significantly between boreholes.

5.1 SITE GRADING

Based on the proposed *"Grading Plan", Sheet Number C-200, prepared by Arcadis, dated September 25, 2024, and the architectural drawings prepared by NORR Architects & Engineers*

Limited, dated September 25, 2024, provided to Terrapex by the Client, it is understood that the underground parking will cover the majority of the site, except for the south of Building C, and southwest corner of Building B. The finished grade in areas which are outside the footprint of the underground parking varies from 85.1 masl to 88.15 masl. According to the elevations surveyed at the borehole locations, the existing topographic elevation within the above area varies from 85.9 masl to 87.4 masl. As such, the proposed grade change is -0.8 m (cut) to 0.7 m (fill).

Prior to carrying out any area grading of the site, the existing fill material should be removed from both cut and fill areas. The exposed subgrade should be inspected by a qualified geotechnical engineer prior to any fill material placement. Fill material should be placed in maximum 300 mm thick lifts and compact to minimum 98% of the SPMDD of the material. If the fill material is used as an engineered fill then must be compacted to 100% of the SPMDD.

5.2 FOUNDATION DESIGN

According to the Site plan provided to Terrapex by Client (Preliminary Site Plan prepared by NORR/Rohit dated May 26, 2023), the proposed buildings on Block 6 will be developed into two low-rise residential apartment dwellings (Building B and Building C, four storeys with one level of underground parking garage). The finished floor elevation at the P1 parking for apartment building was not known to Terrapex at the time of preparing this report but can be assumed at ± 3 m below existing ground for apartment building. The foundation will be about 0.5 to 1.0 m below the finished floor.

The proposed four-storeys building with one level underground parking can be supported by spread and strip footings founded on bedrock minimum 1.0 m below the bedrock surface for a factored bearing resistance at Ultimate Limit States of 1 MPa (ULS).

Foundations designed to the specified bearing capacity stated above are expected to settle less than 25 mm total and 19 mm differential.

Where it is necessary to place footings on bedrock at different levels, the upper footing must be founded below an imaginary 1 horizontal to 1 vertical line (1H:1V in bedrock) drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper footing.

The bedrock may weather rapidly between wetting and drying cycles. In view of this, it is suggested that a lean concrete mat slab be placed immediately after the excavation is complete to keep the bedrock intact, unless the footings are cast immediately after excavating.

It should be noted that the recommended bearing resistances have been calculated by Terrapex from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by Terrapex to validate the information for use during the construction stage.

All footings exposed to seasonal freezing conditions should be provided with at least 1.8 m of earth cover or equivalent thermal insulation against frost.

5.3 CONCRETE SLAB-ON-GRADE

Based on the borehole information, the basement floor slab for apartment building is expected to be in the bedrock. The floor slab can be cast as slab-on-grade provided a 200 mm layer of clear crushed stone (19 mm maximum size) is placed between the underside of the floor slab and the exposed bedrock surface. A perimeter and underfloor drainage system will be required around the exterior basement walls.

5.4 EXCAVATION, BACKFILL AND GROUNDWATER CONTROL

Based on the borehole findings, excavation for foundations, basements, sewer trenches and utilities will be carried out through fill material consisting of sandy silt to clayey silt and bedrock. No significant groundwater issue is anticipated for the excavation and installation of the foundations. It is expected that any seepage, which occurs during wet periods, can be removed by strategically placed sump pumps.

Excavation of the soil strata is not expected to pose any difficulty and can be carried out with heavy hydraulic excavators. Bedrock excavation is anticipated across the site. According to the rock core data from the previous investigations, the bedrock generally consists of strong to very strong limestone with interbedded shale of variable bed thicknesses and depth across the site.

Bedrock excavation is expected to be carried out using line drilling and blasting, hoe ramming or both. Provision should be made in the excavation contract to include the use of these techniques for excavation in bedrock. Any blasting should be carried out in accordance with City of Ottawa Special Provision S.P. No: F-1201 and under the supervision of a blasting specialist engineer. Vibration monitoring of the blasting operation should be carried out to ensure that the blasting meets the limiting vibration criteria at all times.

The contractor should submit a complete and detailed blasting design and monitoring proposal prepared by a blasting/vibrations specialist prior to commencing blasting. This would have to be reviewed and accepted in relation to the requirements of the blasting specifications. Vibration monitoring of the blasting should be carried out to ensure that the blasting meets the limiting vibration criteria at all times. A pre-blast condition survey should be carried out of surrounding structures and utilities located within 100 m of the excavation site. The condition survey should also include the National Research Council's Montreal Road Campus located east of the subject site.

All excavations must be carried out in accordance with Occupational Health and Safety Act (OHSA). With respect to OHSA, the near surface fill material is expected to conform to Type 3 soils. The bedrock is classified as Type 1 soil.

Temporary excavations for slopes in Type 3 soil should not exceed 1.0 horizontal to 1.0 vertical. Excavations in the bedrock may be cut with vertical side-walls. In the event very loose and/or soft soils are encountered at shallow depths or within zones of persistent seepage, it will be necessary to flatten the side slopes as necessary to achieve stable conditions.

For excavations through multiple soil types, the side slope geometry is governed by the soil with the highest number designation. Excavation side-slopes should not be unduly left exposed to inclement weather. Excavation slopes consisting of sandy soils will be prone to gullying in periods of wet weather, unless the slopes are properly sheeted with tarpaulins.

Where workers must enter excavations extending deeper than 1.2 m below grade, the excavation side-walls must be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects.

It should be noted that the on-site fill material may contain boulders, cobbles and remnants of former buildings in the form of buried concrete. Provisions must be made in the excavation and foundation installation contracts for the removal of possible boulders and concrete.

Based on the borehole information, the existing fill is considered unsuitable for re-use as backfill material as it contains organics and other debris. Excavated native soils free from organics can be used as general construction backfill, provided their moisture content is within 2 percent of their optimum moisture contents which will require significant aeration.

Imported granular fill, which can be compacted with hand-held equipment, should be used in confined areas.

Based on observations made during drilling of the boreholes and excavation of the test pits, close examination of the soil samples extracted from the boreholes, and groundwater measurements made in the monitoring wells, significant groundwater problems are not anticipated within the presumed excavation depths throughout the site. It is expected that any seepage from wet sand seams and perched water, which occurs during wet periods, can be removed by pumping from sumps.

5.5 LATERAL EARTH PRESSURE

The lateral earth pressures acting on basement walls may be calculated from the following expression.

$$P = K (\gamma h + q)$$

Where **P** = lateral pressure in kPa acting at a depth h (m) below ground surface

K = lateral earth pressure coefficient, K = 0.40 for vertical walls in overburden and horizontal backfill; K= 0.25 for vertical walls in bedrock.

γ = unit weight of backfill (kN/m^3), a value of 19.5 kN/m^3 may be used for fill and 26.0 kN/m^3 for bedrock

q = the complete surcharge loading (kPa)

This equation assumes that free-draining backfill and positive drainage is provided to ensure that there is no hydrostatic pressure acting in conjunction with the earth pressure.

5.6 EARTHQUAKE DESIGN PARAMETERS

The 2012 Ontario Building Code (OBC) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

The parameters for determination of the Site Classification for Seismic Site Response are set out in Table 4.1.8.4.A of the 2012 OBC. The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (vs) measurements have been taken. In the absence of such measurements, the classification is estimated on the basis of empirical analysis of undrained shear strength or penetration resistance. The applicable penetration resistance is that which has been corrected to a rod energy efficiency of 60% of the theoretical maximum or the (N_{60}) value.

Based on the current and previous borehole and test pit information, the subsurface stratigraphy generally comprises surficial topsoil and asphaltic concrete pavement, underlain by fill material, followed by various native soils consisting of silty sand to sand, sandy silt to silt, and clay and silt soils, underlain by limestone bedrock at shallow depths. Based on the above, the site designation for seismic analysis is estimated to be Class B according to Table 4.1.8.4.A from the quoted code.

The site specific 5% damped spectral acceleration coefficients, and the peak ground acceleration factors are provided in the 2012 Ontario Building.

5.7 PAVEMENT DESIGN

5.7.1 On-Grade Construction

Based on the existing topography of the site and the proposed grades, re-grading of the subgrade will be required. It is anticipated that the sub-grade material for the pavement will generally comprise of engineered fill.

The subgrade should be thoroughly proof-rolled and re-compacted to ensure uniformity in subgrade strength and support. Lift thicknesses should not exceed 200 mm in a loose state and the excavated site material should be compacted using heavy vibratory rollers.

The recommended pavement structures provided in Table 6 are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples. The values may need to be adjusted based on the city of Ottawa Engineering Standard. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

Table 8: Recommended Asphaltic Concrete Pavement Structure Design

Pavement Layer	Compaction Requirements	Light Duty Pavement	Heavy Duty Pavement
Surface Course	as per OPSS 310	40 mm Superpave 12.5 Level B Asphalt (PG58-34)	40 mm Superpave 12.5 Level D Asphalt (PG64-34)
Binder Course	as per OPSS 310	50 mm Superpave 19 mm Level B Asphalt (PG58-34)	100 mm Superpave 19 mm Level D Asphalt (PG64-34)
Granular Base	100% SPMDD	150 mm Granular 'A' (OPSS 1010) Pit Run or 19 mm Crusher Run Limestone	150 mm Granular 'A' (OPSS 1010) Pit Run or 19 mm Crusher Run Limestone
Granular Sub-Base	100% SPMDD	450 mm Granular 'B' Type II (OPSS 1010)	600 mm Granular 'B' Type II (OPSS 1010)

The subgrade must be compacted to at least 98% of SPMDD for at least the upper 600 mm and 95% below this level. The granular base and sub-base materials should be compacted to a minimum of 100% SPMDD.

The long-term performance of the proposed pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as practically possible when fill is placed and that the subgrade is not disturbed and weakened after it is exposed.

Control of surface water is a significant factor in achieving good pavement life. Grading adjacent to the pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb. In addition, the need for adequate drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (preferably at a minimum gradient of three percent) to provide effective drainage toward subgrade drains. Continuous sub-drains are recommended to intercept excess subsurface moisture at the curb lines and catch basins. The invert of sub-drains should be maintained at least 0.3 m below subgrade level.

Additional comments on the construction of pavement areas are as follows:

- As part of the subgrade preparation, the proposed pavement areas should be stripped of vegetation, topsoil, unsuitable earth fill and other obvious objectionable material. The subgrade should be properly shaped and sloped as required, and then proof-rolled. Loose/soft or spongy subgrade areas should be sub-excavated and replaced with suitable approved material compacted to at least 98% of SPMDD.
- Where new fill is needed to increase the grade or replace disturbed portions of the subgrade, excavated inorganic soils or similar clean imported fill materials may be used, provided their moisture content is maintained within 2 % of the soil's optimum moisture content. All fill must be placed and compacted to not less than 98% of SPMDD.
- For fine-grained soils, as encountered at the site, the degree of compaction specification

alone cannot ensure distress free subgrade. Proof-rolling must be carried out and witnessed by Terrapex personnel for final recommendations of sub-base thicknesses.

- In the event that pavement construction takes place in the spring thaw, the late fall, or following periods of significant rainfall, it should be anticipated that an increase in thickness of the granular sub-base layer will be required to compensate for reduced subgrade strength.

5.7.2 Above Parking Garage Roof

The pavement above the parking garage roof slab may be comprised of a minimum of 75 mm thick layer of granular 'A' topped with asphaltic concrete having a minimum thickness of 80 mm (40 mm HL8 and 40 mm HL3). The asphaltic concrete materials should be rolled and compacted in accordance with OPSS 310 requirements.

The gradation and physical properties of HL-3 and HL-8 asphaltic concrete, and Granular 'A' shall conform to the OPSS standards.

The critical section of pavement will be at the transition between the pavement on grade and the pavement above the garage roof slab. In order to alleviate the detrimental effects of dynamic loading / settlement / pavement depression in the backfill to the rigid garage roof structure, it is recommended that an approach type slab be constructed at the entrance/exit points, by extending the granular sub-base to greater depths along the exterior garage wall.

The granular courses of the pavement should be placed in lifts not exceeding 150 mm thick and be compacted to a minimum of 100% SPMDD.

6. LIMITATIONS OF REPORT

The conclusion and recommendations in this report are based on information determined at the inspection locations. Soil and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation. The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known to us, in our analysis certain assumptions had to be made as set out in this report. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

This report was prepared for Rohit Communities by Terrapex Environmental Ltd. The material in it reflects Terrapex Environmental Ltd. judgement in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions which the Third Party may make based on it, are the sole responsibility of such Third Parties.

We recommend, therefore, that Terrapex be retained during the final design stage to review the design drawings and to verify that they are consistent with Terrapex's recommendations, or the assumptions made in our analysis. We recommend also that Terrapex be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the test holes. In cases when these recommendations are not followed, the company's responsibility is limited to accurately interpreting the conditions encountered at the test holes, only.

The comments given in this report on potential construction problems and possible methods are intended for the guidance of the design engineer, only. The number of inspection locations may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

Respectfully submitted,

TERRAPEX ENVIRONMENTAL LTD.

LICENSED PROFESSIONAL ENGINEER
T. YAN
100208861
Oct. 21/24
PROVINCE OF ONTARIO

Thomas Yan., P.Eng. Senior Geotechnical Engineer	Meysam Najari, PhD Vice President, Geotechnical Services

APPENDIX A

Borehole Location Plan

C:\Users\JSerroul\OneDrive - Terrapex Environmental Ltd\PROJECTS\Ottawa\CO900\CO947.00 Wateridge Village\MXD\GEOTECHNICAL\CO947.00 FIG 2 GENERAL SITE LAYOUT.mxd

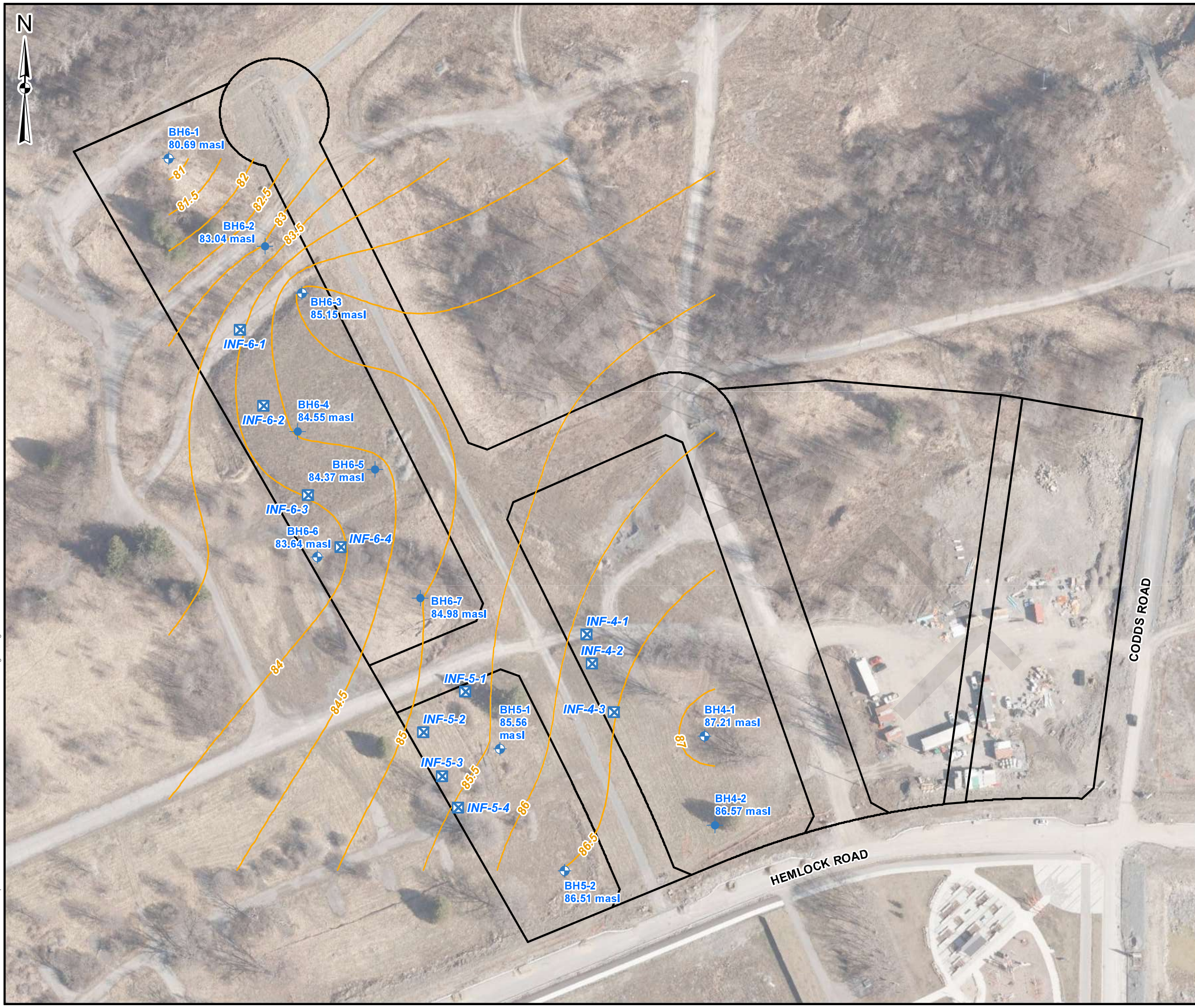
LEGEND

- PROPOSED PLAN OF SUBDIVISION
- BOREHOLE (TERRAPEX, 2023)
- MONITORING WELL (TERRAPEX, 2023)
- BOREHOLE (TERRAPEX, 2018)
- TEST PIT (TERRAPEX, 2018)

0 25 50 75
Metres

DATA SOURCE: CITY OF OTTAWA
MAP PROJECTION: NAD 1983 UTM ZONE 18N

CLIENT: CLC		
SITE LOCATION: WATERIDGE VILLAGE OTTAWA, ONTARIO		
TERRAPEX		
TITLE: **GENERAL SITE LAYOUT**		
DRAWN BY: JS	PROJECT NO.: CO947.00	CHECKED BY: TY
REVISION: 00	DATE: DECEMBER 2023	FIGURE: 1



LEGEND

- PROPOSED PLAN OF SUBDIVISION
- INFILTRATION TESTING LOCATION
- BOREHOLE (TERRAPEX, 2023)
- MONITORING WELL (TERRAPEX, 2023)
- BEDROCK SURFACE CONTOURS

0 25 50 75
Metres

DATA SOURCE: CITY OF OTTAWA
MAP PROJECTION: NAD 1983 UTM ZONE 18N

CLIENT: CLC

SITE LOCATION: WATERIDGE VILLAGE
OTTAWA, ONTARIO

TERRAPEX

TITLE: **INFILTRATION INVESTIGATION**

DRAWN BY:	PROJECT NO.:	CHECKED BY:
JS	CO947.00	CB
REVISION:	DATE:	FIGURE:
00	NOVEMBER 2023	**2**

APPENDIX B

Borehole Log Sheets

CLIENT: Rohit Communities		PROJECT NO.: CO947.00	**RECORD OF: BH/MW6-1**
ADDRESS: Wateridge Village / Hemlock Road Area			
CITY/PROVINCE: Ottawa, ON	NORTHING (m): 5033727.08	EASTING (m): 450070.46	ELEV. (m) 82.82
CONTRACTOR: George Downing Estate Drilling Ltd	METHOD:		
BOREHOLE DIAMETER (cm): 20	WELL DIAMETER (cm): 5	SCREEN SLOT #: 10 SAND TYPE: 2	SEALANT TYPE: Bentonite

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	N-VALUE (Blows/300mm)	WATER CONTENT (%) W.C.	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
FILL stiff, grey, moist sandy silty clay, trace gravel & organics ---- Gr=8.7%,Sa=21.5%,Si=26.6%,Cl=43.2%.	0 – 1	82.82	12	20.7	1A	Split spoon	50			Bentonite	Bentonite 50 mm monitoring well was installed and the water level measured on November 24, 2023: 4.30 mbgs
				16.8	1B	Split spoon					
very dense, light brown, moist SILTY GRAVELLY SAND trace to some clay, rock pieces ---- Gr=29.2%, Sa=37.5%, Si=23.5%, Cl=9.8%.	1 – 2.1		53	10.7	2	Split spoon	40				
			50/125	11.5	3	Split spoon	100				
Bedrock Cored to depth of 4.67 m. TCR(1) = 100% RQD(1) = 15%	2.1 – 4.67				R1	Coring				Sand	Sand Screen + Sand
TCR(2) = 100% RQD(2) = 45%					R2	Coring				Screen + Sand	
END OF BOREHOLE											END OF BOREHOLE: 4.67 mbgs ELEV.(m) = 78.1

TERRAPEX	LOGGED BY: UB	DRILLING DATE: 10-11-2023
	INPUT BY: RR	MONITORING DATE:
	REVIEWED BY: TY	PAGE 1 OF 1

CLIENT: Rohit Communities	PROJECT NO.: CO947.00	RECORD OF: **BH6-2**
ADDRESS: Wateridge Village / Hemlock Road Area		

CITY/PROVINCE: Ottawa, ON	NORTHING (m): 5033694.44	EASTING (m): 450105.97	ELEV. (m) 84.19

CONTRACTOR: George Downing Estate Drilling Ltd	METHOD:

BOREHOLE DIAMETER (cm):	WELL DIAMETER (cm):	SCREEN SLOT #:	SAND TYPE:	SEALANT TYPE:

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) ● 40 80 120 160 / N-VALUE (Blows/300mm) ▲ 20 40 60 80	WATER CONTENT (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	(new title) SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		FILL compact to dense, grey, moist sandy silty clay trace gravel, trace oxidation	0 0.5	84	▲ 30	■ 8.0 ■ 2.7	1A 1B		50				
		Bedrock Cored to depth of 1.15 m.	1	83.5			2						
		END OF BOREHOLE											END OF BOREHOLE: 1.15 mbgs ELEV.(m) = 83.0

TERRAPEX

LOGGED BY: UB	DRILLING DATE: 10-11-2023
INPUT BY: RR	MONITORING DATE:
REVIEWED BY: TY	PAGE 1 OF 1

CLIENT: Rohit Communities		PROJECT NO.: CO947.00	**RECORD OF: BH6-3**
ADDRESS: Wateridge Village / Hemlock Road Area			
CITY/PROVINCE: Ottawa, ON	NORTHING (m): 5033677.45	EASTING (m): 450119.58	ELEV. (m) 85.70
CONTRACTOR: George Downing Estate Drilling Ltd		METHOD:	
BOREHOLE DIAMETER (cm):	WELL DIAMETER (cm):	SCREEN SLOT #:	SAND TYPE: / SEALANT TYPE:

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) ● / N-VALUE (Blows/300mm) ▲	WATER CONTENT (%) PL W.C. LL	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	(new title) SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		FILL very stiff, brown, moist silty clay some gravel, some sand	0 – 1.3	85.5	22 ▲	24.8 ■	1	SPLIT SPOON	50				
		Bedrock Cored to depth of 3.50 m. TCR(1) = 100% RQD(1) = 16%	1.3 – 2.5				R1	CORING					
		TCR(2) = 100% RQD(2) = 30%					R2	CORING					
		END OF BOREHOLE	4.64										END OF BOREHOLE: 4.64 mbgs ELEV.(m) = 81.0

Depth scale (m): 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5
Elevation scale (m): 85.5, 85, 84.5, 84, 83.5, 83, 82.5, 82, 81.5
Shear strength scale: 40, 80, 120, 160; N-value scale: 20, 40, 60, 80
Water content scale: 20, 40, 60, 80

TERRAPEX

LOGGED BY: UB	DRILLING DATE: 09-11-2023
INPUT BY: RR	MONITORING DATE:
REVIEWED BY: TY	PAGE 1 OF 1

CLIENT: Rohit Communities	PROJECT NO.: CO947.00	RECORD OF:
ADDRESS: Wateridge Village / Hemlock Road Area		**BH6-4**

CITY/PROVINCE: Ottawa, ON	NORTHING (m): 5033626.16	EASTING (m): 450118.00	ELEV. (m) 87.36
CONTRACTOR: George Downing Estate Drilling Ltd	METHOD:		
BOREHOLE DIAMETER (cm):	WELL DIAMETER (cm):	SCREEN SLOT #:	SAND TYPE: / SEALANT TYPE:

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) ● 40 80 120 160 / N-VALUE (Blows/300mm) ▲ 20 40 60 80	WATER CONTENT (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	(new title) SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		FILL soft to firm, grey, moist silty clay trace gravel, trace sand, trace organics ---- Gr=6.0%, Sa=7.8%, Si=25.4%, Cl=60.8%. LL=58.3%, PI=28.	0	87	7	29.4	1		42				
			1	86.5	6	32.1	2		33				
			1.5	86	4	34.9	3		50				
		---- stiff	2.5	85	11	38.1	4		50				
		END OF BOREHOLE											END OF BOREHOLE: 2.77 mbgs ELEV.(m) = 84.6

TERRAPEX

LOGGED BY: UB	DRILLING DATE: 10-11-2023
INPUT BY: RR	MONITORING DATE:
REVIEWED BY: TY	PAGE 1 OF 1

CLIENT: Rohit Communities	PROJECT NO.: CO947.00	RECORD OF: **BH6-5**
ADDRESS: Wateridge Village / Hemlock Road Area		

CITY/PROVINCE: Ottawa, ON	NORTHING (m): 5033612.15	EASTING (m): 450146.62	ELEV. (m) 87.34

CONTRACTOR: George Downing Estate Drilling Ltd	METHOD:

BOREHOLE DIAMETER (cm):	WELL DIAMETER (cm):	SCREEN SLOT #:	SAND TYPE:	SEALANT TYPE:

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) / N-VALUE (Blows/300mm)	WATER CONTENT (%) PL W.C. LL	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	SV/TOV (ppm or %LEL) (new title)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		FILL soft, grey, moist silty clay trace gravel, trace sand, trace organics ---- Gr=7.3%, Sa=7.5%, Si=24.6%, Cl=60.6%.	0	87	3	32.8	1		58				
			1	86.5 / 86	2	34.6	2		42				
			1.5 / 2	85.5	2	32.9	3		50				
		---- stiff	2.5	85	13	30.5	4		100				
		Bedrock Core to depth of 2.97 m.		84.5									
		END OF BOREHOLE											END OF BOREHOLE: 2.97 mbgs ELEV.(m) = 84.5

TERRAPEX

LOGGED BY: UB	DRILLING DATE: 10-11-2023
INPUT BY: RR	MONITORING DATE:
REVIEWED BY: TY	PAGE 1 OF 1

CLIENT: Rohit Communities	PROJECT NO.: CO947.00	RECORD OF: BH/MW6-6
ADDRESS: Wateridge Village / Hemlock Road Area		

CITY/PROVINCE: Ottawa, ON	NORTHING (m): 5033580.10	EASTING (m): 450125.25	ELEV. (m) 85.87
CONTRACTOR: George Downing Estate Drilling Ltd	METHOD:		
BOREHOLE DIAMETER (cm): 20	WELL DIAMETER (cm): 5	SCREEN SLOT #: 10 SAND TYPE: 2	SEALANT TYPE: Bentonite

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

Depth (m)	Elevation (m)	Soil Description	N-Value (Blows/300mm)	Water Content (%)	Sample No.	Recovery (%)	Remarks
0	85.87	FILL loose, grey, moist sandy silt some gravel, some clay, trace organics					Bentonite 50 mm monitoring well was installed and the water level measured on November 24, 2023: 3.67 mbgs
~0.3			8	20.4	1	58	
~1.05			5	18.1	2	42	
~1.4		---- Gr=17.8%, Sa=33.2%, Si=36.3%, Cl=12.7%.					
~1.8			8	12.8	3	50	
~2.0		---- rock pieces					
~2.3		Bedrock Cored to depth of 4.64 m.					
~2.8							Sand
~3.0		TCR(1) = 100% RQD(1) = 84%			R1		
~3.2							Screen + Sand
~4.0		TCR(2) = 100% RQD(2) = 74%			R2		
4.64	81.2	END OF BOREHOLE					END OF BOREHOLE: 4.64 mbgs ELEV.(m) = 81.2

Column headers also include: GWL (m), SOIL SYMBOL, SHEAR STRENGTH (kPa), PL W.C. LL, SAMPLE TYPE, (new title) SV/TOV (ppm or %LEL), LABORATORY TESTING, WELL INSTALLATION.

TERRAPEX

LOGGED BY: UB	DRILLING DATE: 10-11-2023
INPUT BY: RR	MONITORING DATE: 24-11-2023
REVIEWED BY: TY	PAGE 1 OF 1

CLIENT: Rohit Communities	PROJECT NO.: CO947.00	RECORD OF: **BH6-7**	
ADDRESS: Wateridge Village / Hemlock Road Area			
CITY/PROVINCE: Ottawa, ON	NORTHING (m): 5033564.86	EASTING (m): 450163.18	ELEV. (m) 86.75
CONTRACTOR: George Downing Estate Drilling Ltd	METHOD:		
BOREHOLE DIAMETER (cm):	WELL DIAMETER (cm):	SCREEN SLOT #:	SAND TYPE: / SEALANT TYPE:

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) ● 40 80 120 160 / N-VALUE (Blows/300mm) ▲ 20 40 60 80	WATER CONTENT (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	(new title) SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		FILL very dense, brown, moist sand and gravel some silt, trace clay	0 – 1.80	86.75 – 84.9	50	19.4	1	Split spoon	100				
					50/125	8.9	2	Split spoon	42				
		Bedrock Cored to depth of 1.80 m. END OF BOREHOLE											END OF BOREHOLE: 1.80 mbgs ELEV.(m) = 84.9

TERRAPEX

LOGGED BY: UB	DRILLING DATE: 08-11-2023
INPUT BY: RR	MONITORING DATE:
REVIEWED BY: TY	PAGE 1 OF 1

CLIENT: Canada Lands Company CLC Limited	METHOD: Hollow Stem Auger & Split Spoon		**BH No.: 110**
PROJECT: Wateridge Village	PROJECT ENGINEER: VN	ELEV. (m) 86.374	
LOCATION: Rockcliffe, Ottawa	NORTHING: 5033554	EASTING: 450130	PROJECT NO.: CO682.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 / N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		FROZEN GROUND	0	86.25							Borehole caved-in at 0.91 m bgs and dry on completion.
		very dense, damp, grey gravel, some sand (FILL)	0.25 – 0.5	86	80 ▲		1A		80		
		compact, damp to wet, brown sandy silt, some gravel, trace organics trace oxidization (FILL)	0.75 – 1	85.75 – 85.5			1B 2A				
		compact to very dense, moist to wet, dark brown, silty gravel, trace sand, trace organics and rock fragments (FILL)	1.25	85.25	31 ▲		2B		31		Auger refusal at 1.40 m bgs.

END OF BOREHOLE

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LOGGED BY: RH	DRILLING DATE: November 19, 2018
REVIEWED BY: VN	Page 1 of 1

CLIENT: Canada Lands Company CLC Limited	METHOD: Excavator		**TP No.: 205**
PROJECT: Wateridge Village	PROJECT ENGINEER: VN	ELEV. (m) 85.810	
LOCATION: Rockcliffe, Ottawa	NORTHING: 5033606	EASTING: 450123	PROJECT NO.: CO682.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / Static Cone Tip Resistance (kg/cm 2) 50 100 150 200	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0 – 0.5		On completion the test pit was dry and open.				moist, grey gravel some to trace sand (FILL)				85.75, 85.5
0.5 – 1						damp, dark brown topsoil, trace rootlets (FILL)				85.25, 85
1 – 1.64		Refusal @ 1.64 m bgs on Limestone Bedrock				damp, brown SANDY SILT trace clay, trace gravel				84.75, 84.5, 84.25
						END OF TEST PIT				

Depth scale: 0, 0.25, 0.5, 0.75, 1, 1.25, 1.5

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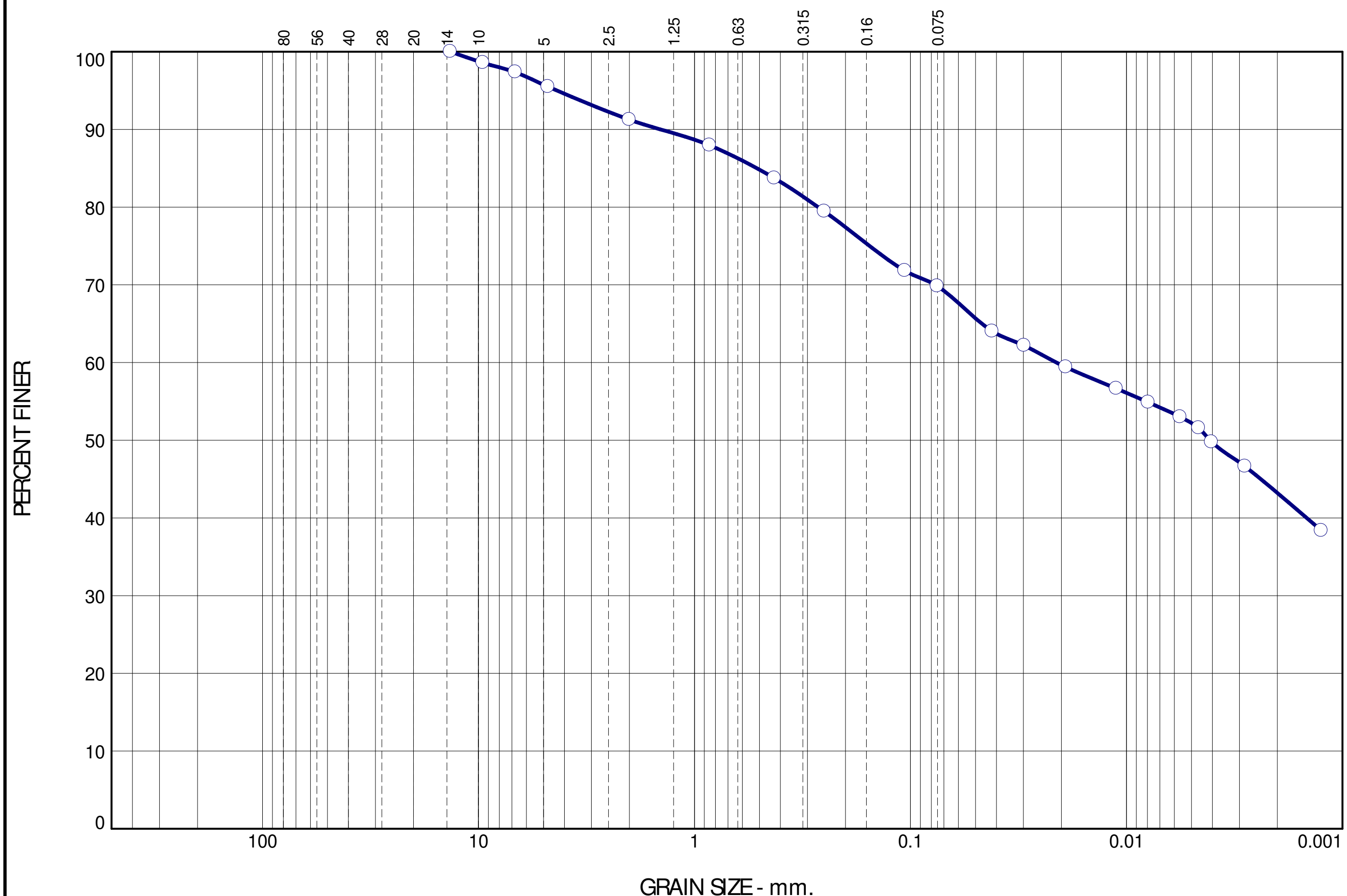
LOGGED BY: RH	DRILLING DATE: December 14,
REVIEWED BY: VN	Page 1 of 1

APPENDIX C

Geotechnical Laboratory Test Results

Particle Size Distribution Report

ASTM D422



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	8.7	7.6	13.9	26.6	43.2

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.5138	0.0211	0.0041					

Material Description	Test Date	USCS	NM
○ SANDY SILTY CLAY trace gravel	Dec 6/23		

Project No. CO947.00 Client: Rohit Communities

Project: Wateridge Village

○ Sample Number: BH6-1 SS1A

Remarks:

○ Hydrometer Details: Spc. Grav. = 2.75(assumed); Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/l

Terrapex

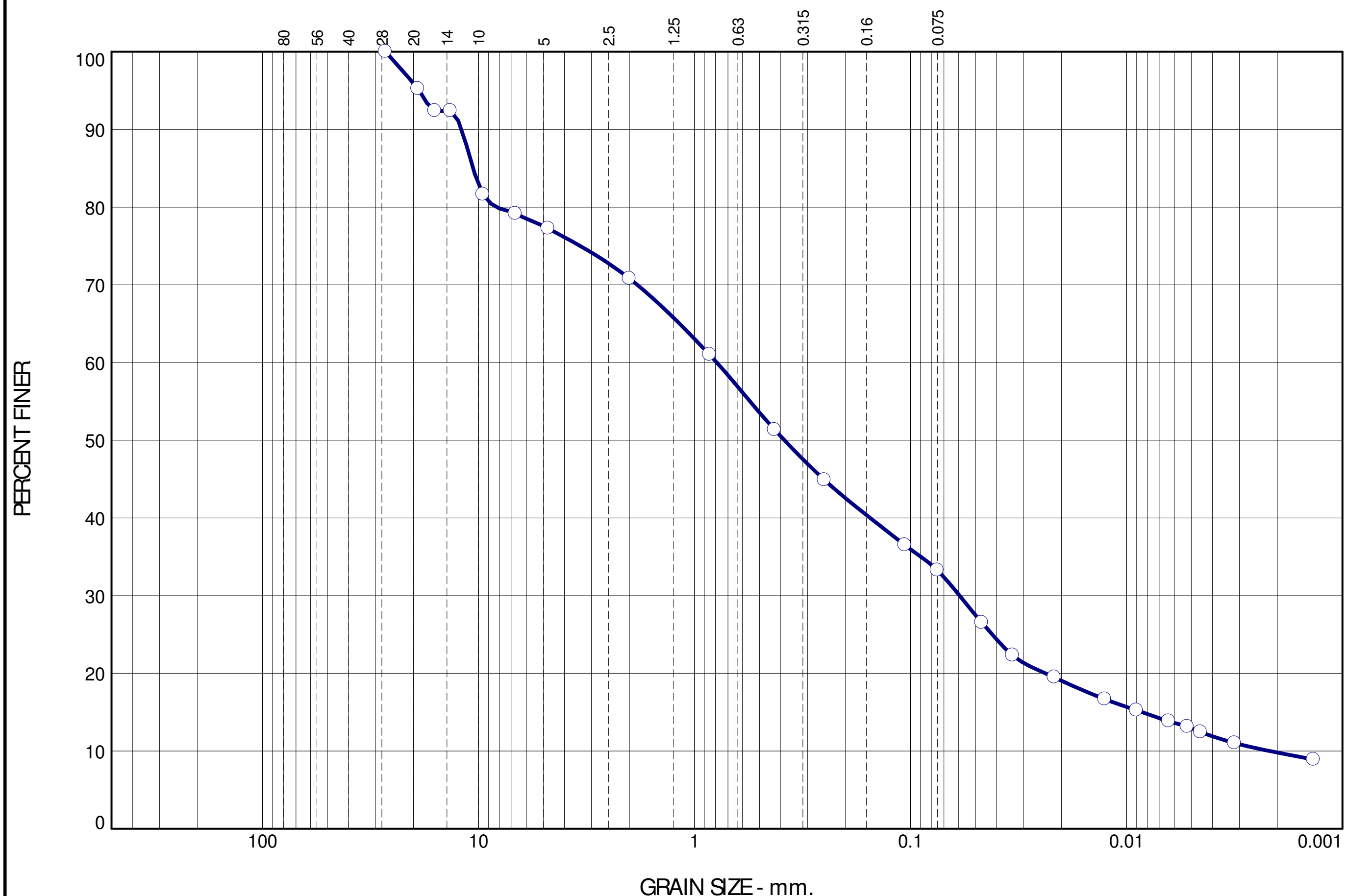
Toronto, Ontario

Figure 3

Tested By: SC

Particle Size Distribution Report

ASTM D422



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	29.2	19.5	18.0	23.5	9.8

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			10.5867	0.7875	0.3832	0.0592	0.0085	0.0022	2.05	362.42

Material Description	Test Date	USCS	NM
○ SILTY GRAVELLY SAND trace to some clay	Dec 6/23		

Project No. CO947.00 Client: Rohit Communities

Project: Wateridge Village

○ Sample Number: BH6-1 SS1B

Terrapex

Toronto, Ontario

Remarks:

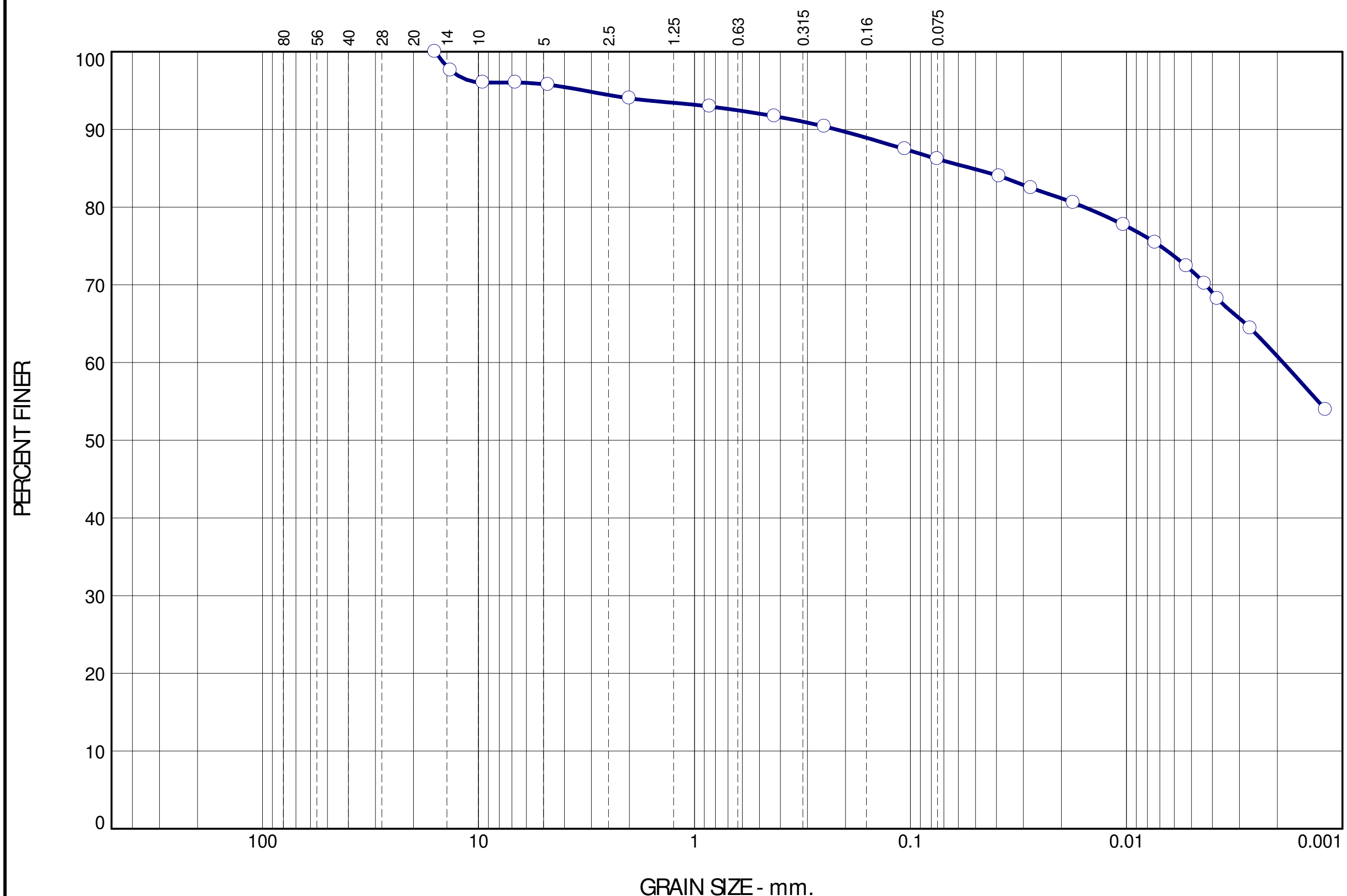
○ Hydrometer Details: Spc. Grav. = 2.75(assumed); Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/l

Figure 4

Tested By: SC

Particle Size Distribution Report

ASTM D422



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	6.0	2.3	5.5	25.4	60.8

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	58.3	30.2	0.0519	0.0019						

Material Description	Test Date	USCS	NM
○ SILTY CLAY trace sand trace gravel	Dec 6/23	CH	

Project No. CO947.00 Client: Rohit Communities

Project: Wateridge Village

○ Sample Number: BH6-4 SS1

Remarks:

○ Hydrometer Details: Spc. Grav. = 2.75(assumed); Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/l

Terrapex

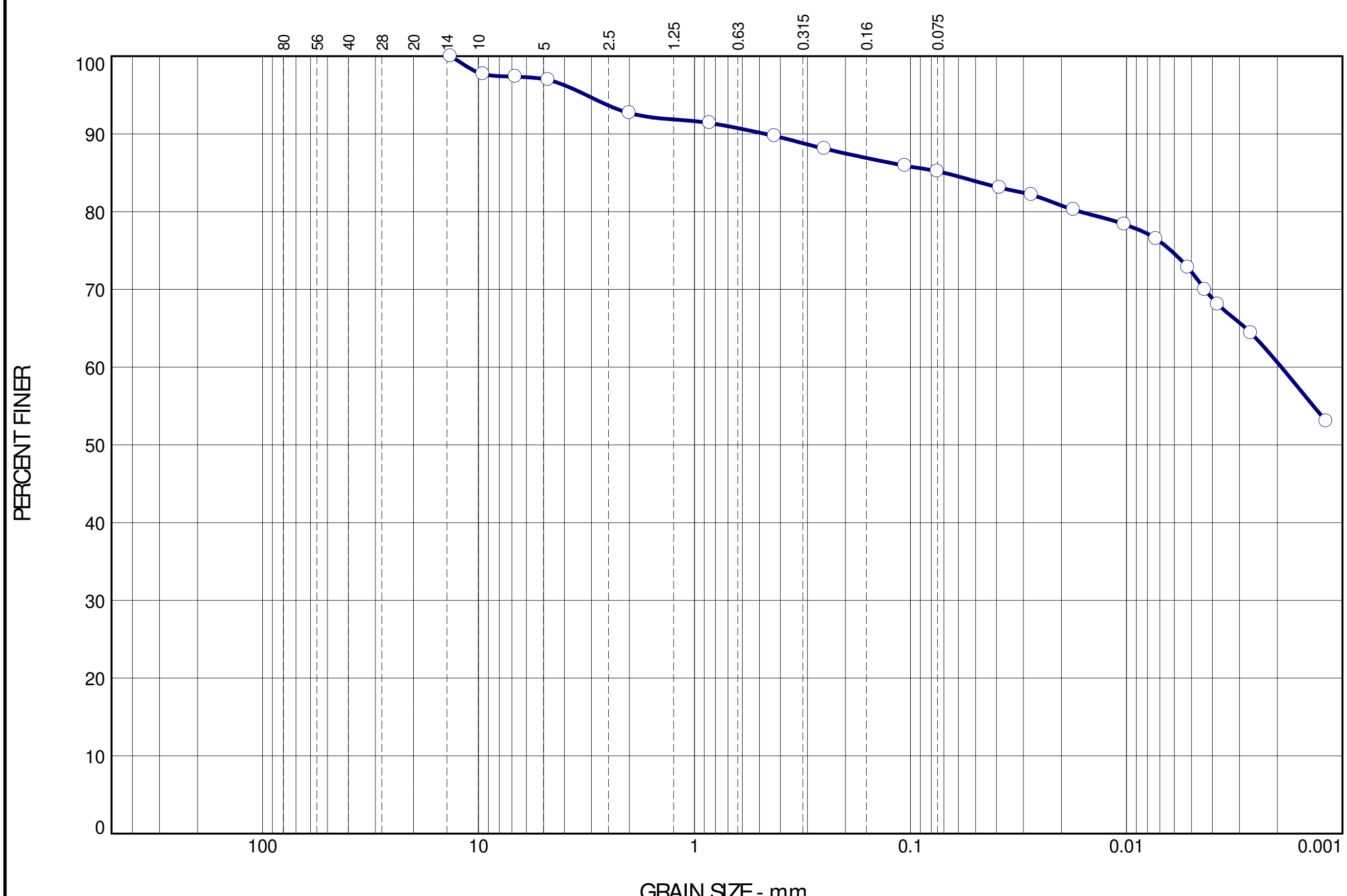
Toronto, Ontario

Figure 5

Tested By: SC

Particle Size Distribution Report

ASTM D422



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	7.3	3.0	4.5	24.6	60.6

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0700	0.0019						

Material Description	Test Date	USCS	NM
○ SILTY CLAY trace sand trace gravel	Dec 6/23		

Project No. CO947.00 Client: Rohit Communities

Project: Wateridge Village

○ Sample Number: BH6-5 SS2

Terrapex

Toronto, Ontario

Remarks:

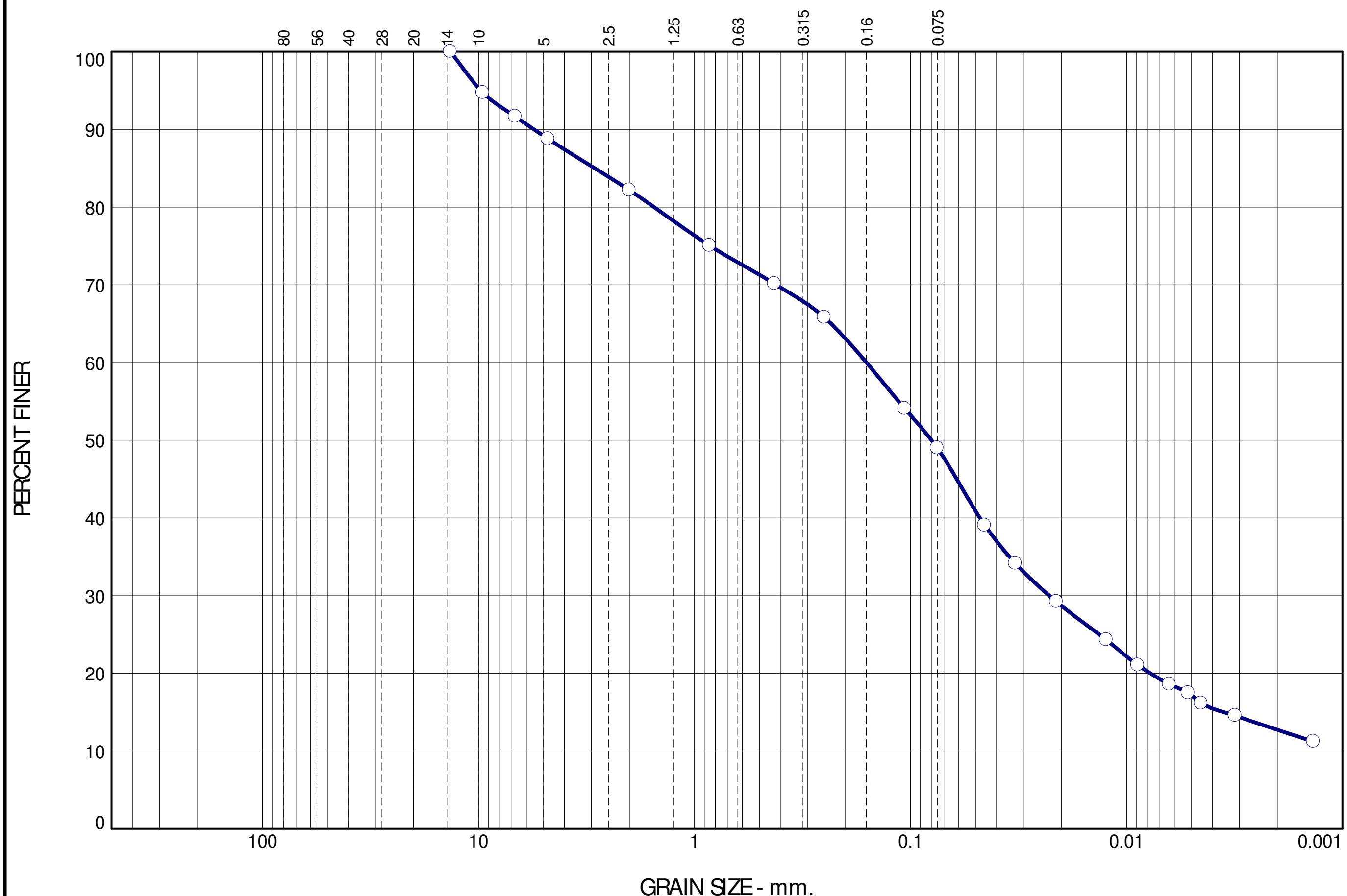
○ Hydrometer Details: Spc. Grav. = 2.75(assumed); Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/l

Figure 6

Tested By: SC

Particle Size Distribution Report

ASTM D422



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	17.8	12.1	21.1	36.3	12.7

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.8934	0.1598	0.0798	0.0228	0.0035			

Material Description	Test Date	USCS	NM
○ SANDY SILT some gravel some clay	Dec 6/23		

Project No. CO947.00 Client: Rohit Communities

Project: Wateridge Village

○ Sample Number: BH6-6 SS3

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Toronto, Ontario

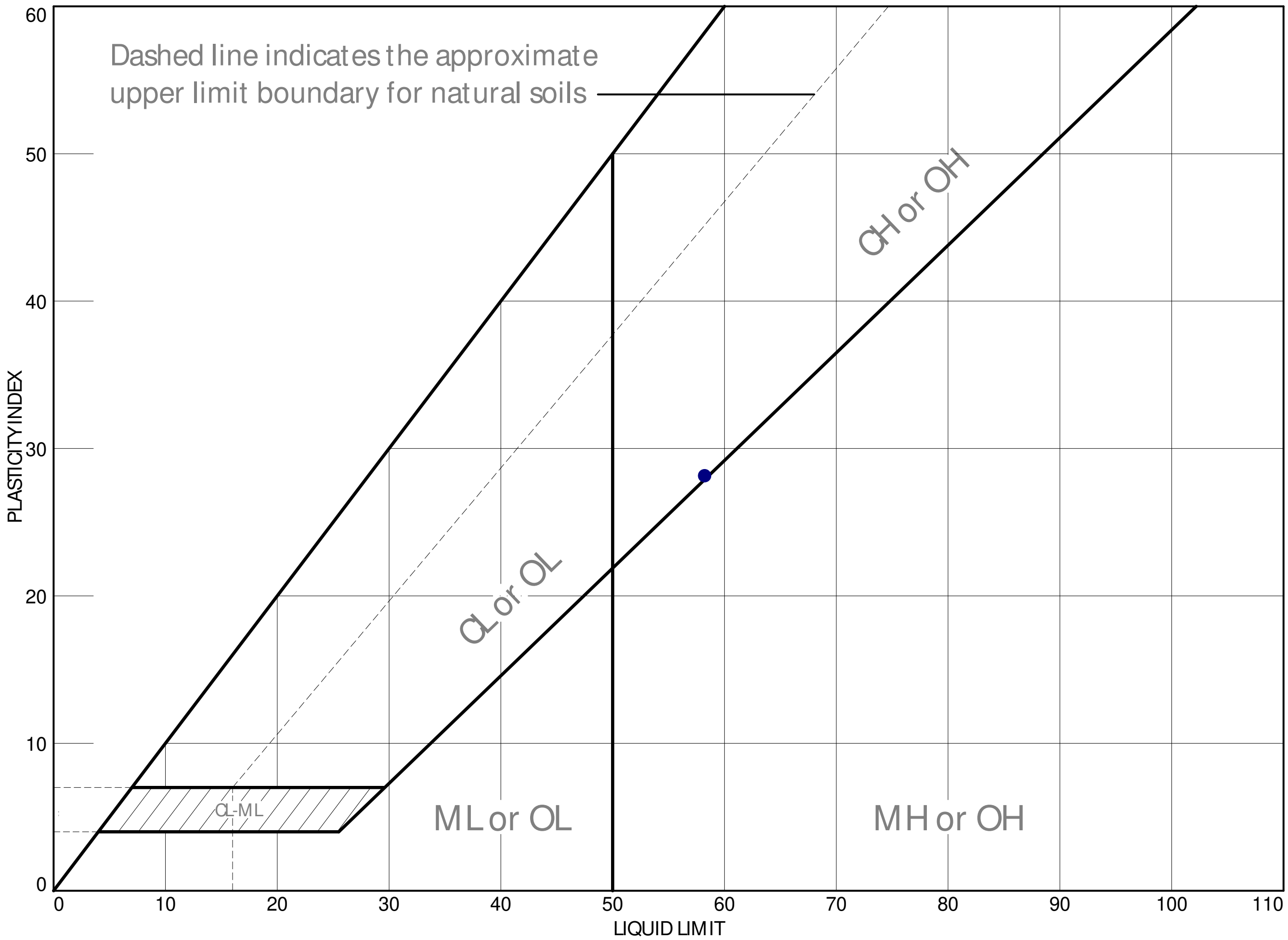
Remarks:

○ Hydrometer Details: Spc. Grav. = 2.75(assumed); Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/l

Figure 7

Tested By: SC

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	SILTY CLAY trace sand trace gravel	58.3	30.2	28.1	91.7	86.2	CH

Project No. CO947.00 Client: Rohit Communities

Project: Wateridge Village

● Sample Number: BH6-4 SS1

Remarks:

● Test Date: December 11, 2023

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Toronto, Ontario

Figure 9

Tested By: AM

APPENDIX D

Certificate of Chemical Analysis

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: TERRAPEX ENVIRONMENTAL LIMITED
90 SCARSDALE RD
TORONTO, ON M3B2R7
(905) 474-5265

ATTENTION TO: Reza Rafiee

PROJECT: CO947.00

AGAT WORK ORDER: 23T101726

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganic Team Lead

DATE REPORTED: Dec 12, 2023

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*
- *For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.*

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 23T101726
PROJECT: CO947.00

CLIENT NAME: TERRAPEX ENVIRONMENTAL LIMITED
SAMPLING SITE:WATERIDGE VILLAGE
ATTENTION TO: Reza Rafiee
SAMPLED BY:UB/JM

(Soil) pH and Sulphate in Soil

DATE RECEIVED: 2023-12-07
DATE REPORTED: 2023-12-12

Parameter	Unit	G / S	RDL	BH4-2-SS1&2	BH5-1-SS2&3	BH6-5-SS2	BH6-6-SS3
SAMPLE TYPE:				Soil	Soil	Soil	Soil
DATE SAMPLED:				2023-11-08 08:50	2023-11-08 12:50	2023-11-10 09:40	2023-11-10 10:25
				5525935	5525936	5525937	5525938
Sulphate (2:1)	µg/g		2	31	36	38	37
pH (2:1)	pH Units		NA	7.97	8.64	7.88	8.09

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
5525935-5525938 pH and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).
Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

CHARTERED NIVINE BASILY CHEMIST — ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Results relate only to the items tested. Results apply to samples as received.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: TERRAPEX ENVIRONMENTAL LIMITED
AGAT WORK ORDER: 23T101726
PROJECT: CO947.00
ATTENTION TO: Reza Rafiee
SAMPLING SITE:WATERIDGE VILLAGE
SAMPLED BY:UB/JM

Soil Analysis

RPT Date: Dec 12, 2023			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
(Soil) pH and Sulphate in Soil															
Sulphate (2:1)	5517672		1100	1110	0.9%	< 2	94%	70%	130%	95%	80%	120%	NA	70%	130%
pH (2:1)	5525010		7.68	7.61	0.9%	NA	96%	80%	120%						

Comments: NA signifies Not Applicable.
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:

Time Markers

AGAT WORK ORDER: 23T101726
PROJECT: CO947.00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
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http://www.agatlabs.com

CLIENT NAME: TERRAPEX ENVIRONMENTAL LIMITED

ATTENTION TO: Reza Rafiee

Sample ID	Sample Description	Sample Type	Date Sampled	Date Received
5525935	BH4-2-SS1&2	Soil	08-NOV-2023	07-DEC-2023

(Soil) pH and Sulphate in Soil

Parameter	Date Prepared	Date Analyzed	Initials
Sulphate (2:1)	08-DEC-2023	08-DEC-2023	LC
pH (2:1)	08-DEC-2023	08-DEC-2023	XL

Sample ID	Sample Description	Sample Type	Date Sampled	Date Received
5525936	BH5-1-SS2&3	Soil	08-NOV-2023	07-DEC-2023

(Soil) pH and Sulphate in Soil

Parameter	Date Prepared	Date Analyzed	Initials
Sulphate (2:1)	08-DEC-2023	08-DEC-2023	LC
pH (2:1)	08-DEC-2023	08-DEC-2023	XL

Sample ID	Sample Description	Sample Type	Date Sampled	Date Received
5525937	BH6-5-SS2	Soil	10-NOV-2023	07-DEC-2023

(Soil) pH and Sulphate in Soil

Parameter	Date Prepared	Date Analyzed	Initials
Sulphate (2:1)	08-DEC-2023	08-DEC-2023	LC
pH (2:1)	08-DEC-2023	08-DEC-2023	XL

Sample ID	Sample Description	Sample Type	Date Sampled	Date Received
5525938	BH6-6-SS3	Soil	10-NOV-2023	07-DEC-2023

(Soil) pH and Sulphate in Soil

Parameter	Date Prepared	Date Analyzed	Initials
Sulphate (2:1)	08-DEC-2023	08-DEC-2023	LC
pH (2:1)	08-DEC-2023	08-DEC-2023	XL

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: TERRAPEX ENVIRONMENTAL LIMITED
AGAT WORK ORDER: 23T101726
PROJECT: CO947.00
ATTENTION TO: Reza Rafiee
SAMPLING SITE:WATERIDGE VILLAGE
SAMPLED BY:UB/JM

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 23T101726

Cooler Quantity: 1 large

Arrival Temperatures: 1.8 | 2.0 | 2.2

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes: Loose Ice

Report Information:

Company: TERRAPEX

Contact: REZA RAFIEE

Address: 90 Scarsdale Road, Toronto, ON.

Phone: 416-991-6242 Fax:

Reports to be sent to:

1. Email: r.rafiee@terrapex.com
2. Email:

Regulatory Requirements: NA

(Please check all applicable boxes)

- ☐ Regulation 153/04 — Table ___ (Indicate One): ☐ Ind/Com ☐ Res/Park ☐ Agriculture
- Soil Texture (Check One): ☐ Coarse ☐ Fine
- ☐ Excess Soils R406 — Table ___ (Indicate One)
- ☐ Regulation 558
- ☐ CCME
- ☐ Sewer Use: ☐ Sanitary ☐ Storm — Region ___
- ☐ Prov. Water Quality Objectives (PWQO)
- ☐ Other ___ (Indicate One)

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT

*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: CO947.00

Site Location: Waterbridge Village

Sampled By: UB/JM

AGAT Quote #: PO:

Please note: If quotation number is not provided, client will be billed full price for analysis.

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis ☐ Yes ☑ No

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company:

Contact:

Address:

Email: accountspayable@terrapex.com

Sample Matrix Legend

Code	Matrix
B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Analysis columns printed: Field Filtered - Metals, Hg, CrVI, DOC (Y/N); O. Reg 153: Metals & Inorganics; Metals - ☐ CrVI, ☐ Hg, ☐ HWSB; BTEX, F1-F4 PHCs; PAHs; PCBs; VOC; Aroclors; O. Reg 558: Landfill Disposal Characterization TCLP: TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs; O. Reg 406: Excess Soils SPLP Rainwater Leach SPLP: ☐ Metals ☐ VOCs ☐ SVOCs; Excess Soils Characterization Package pH, ICPMS Metals, BTEX, F1-F4; ☐ Corrosivity: Include Moisture ☐ Sulphide; pH; Water Soluble Sulphate; Potentially Hazardous or High Concentration (Y/N)

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	pH	Water Soluble Sulphate	Potentially Hazardous or High Concentration (Y/N)
BH4-2-SS1 & 2	8/11/23	8:50 AM	1	S		—	—	NA
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
BH5-1-SS2 & 3	8/11/23	12:50 PM	1	S		—	—	NA
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
BH6-5-SS2	10/11/23	9:40 AM	1	S		—	—	NA
BH6-6-SS3	10/11/23	10:25 AM	1	S		—	—	NA

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
John [signature]	5/12/23	6:00pm	Aniqa Tahir [signature]	07/12/23	1:20pm

Page 1 of 1

Nº: T - 137621

Pink Copy - Client | Yellow Copy - AGAT | White Copy - AGAT

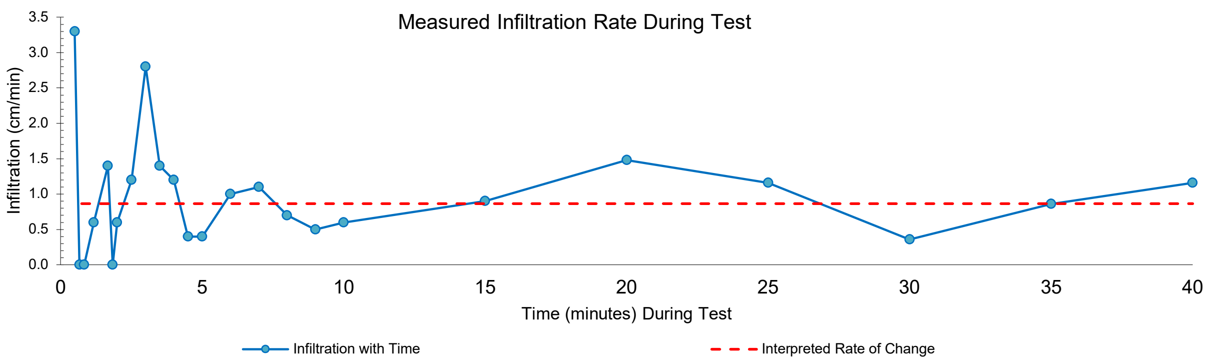
APPENDIX E

Field Infiltration Test Results

Constant Head Well Permeameter Test Report

TERRAPEX

Project:	Rohit Wateridge Village
Project Number:	CO947
Location Name	Inf 6-1
Approximate Location:	450090.093 easting (metres)
	5033652.523 northing (metres)
Approximate Depth Tested:	0.4 mbg
	85.0 masl



Field Measurements:

Elapsed Time (min)	Water Level (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.17	39.6	-	-
0.50	38.5	1.10	3.30
0.67	38.5	0.00	0.00
0.83	38.5	0.00	0.00
1.17	38.3	0.20	0.60
1.67	37.6	0.70	1.40
1.83	37.6	0.00	0.00
2.00	37.5	0.10	0.60
2.50	36.9	0.60	1.20
3.00	35.5	1.40	2.80
3.50	36.2	0.70	1.40
4.00	35.6	0.60	1.20
4.50	35.4	0.20	0.40
5.00	35.2	0.20	0.40
6.00	34.2	1.00	1.00
7.00	33.1	1.10	1.10
8.00	32.4	0.70	0.70
9.00	31.9	0.50	0.50
10.00	31.3	0.60	0.60
15	26.8	4.50	0.90
20	19.4	7.40	1.48
25.00	13.6	5.80	1.16
30.00	11.8	1.80	0.36
35.00	7.5	4.30	0.86
40.00	1.7	5.80	1.16

Soil Description

moist sandy silty clay

Test Conditions:

Instrument: 1" stainless steel Solinst Drivepoint Instrument

hole radius (a) =	6 cm
Water column height in hole (H_1) =	5 cm
Ambient Air Temperature at Testing =	4 °C

Interpretations:

Soil Capillary Type =	Strong
Soil Type Coefficient (α*) =	0.04 cm^{-1}
Average Water Level Change (R_1) =	0.01 cm/s
Steady Intake Water Rate (Q_1) =	0.50 cm^3/s
Shape factor for H_1/a = (C_1) =	0.54 -

Field Saturated Hydraulic Conductivity (K_{fs}):

K_{fs} =	3E-04 cm/s
K_{fs} corrected to 4°C ('freshet') [1]=	3E-04 cm/s
K_{fs} corrected to 24°C ('summer') [1]=	5E-04 cm/s

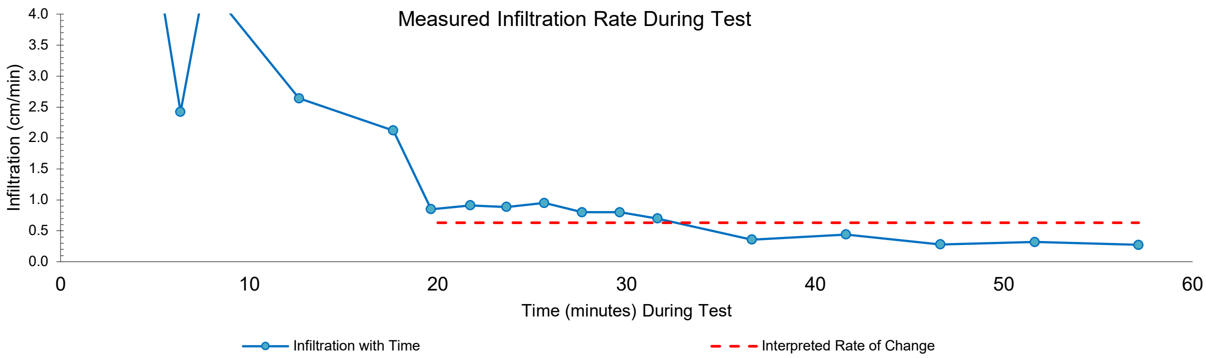
Date of Field Measurements:	20-Nov-23
Field Representative:	EB
Reviewed:	ZK
Reviewed:	ZK

[1] (Streeter and Wylie, 1975)
[1] (Reynolds, 2008 and 2015)

Constant Head Well Permeameter Test Report

TERRAPEX

Project:	Rohit Wateridge Village
Project Number:	CO947
Location Name	Inf 6-2
Approximate Location:	450101.874 easting (metres)
	5033632.943 northing (metres)
Approximate Depth Tested:	2.2 mbg
	85.2 masl



Field Measurements:

Elapsed Time (min)	Water Level (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.20	100	-	-
0.55	160	60.00	171.43
1.20	195	35.00	53.85
1.95	200	5.00	6.67
2.70	210	10.00	13.33
4.28	220	10.00	6.32
6.35	225	5.00	2.42
7.63	230.8	5.80	4.52
12.63	244	13.20	2.64
17.63	254.6	10.60	2.12
19.63	256.3	1.70	0.85
21.72	258.2	1.90	0.91
23.63	259.9	1.70	0.89
25.63	261.8	1.90	0.95
27.63	263.4	1.60	0.80
29.63	265	1.60	0.80
31.63	266.4	1.40	0.70
36.63	268.2	1.80	0.36
41.63	270.4	2.20	0.44
46.633333	271.8	1.40	0.28
51.633333	273.4	1.60	0.32
57.13	274.9	1.50	0.27

Soil Description

moist sandy silty clay

Test Conditions:

Instrument: 1" stainless steel Solinst Drivepoint Instrument

hole radius (a) = 2.54 cm

Water column height in hole (H_1) = 15.24 cm

Ambient Air Temperature at Testing = 4 ^{o}C

Interpretations:

Soil Capillary Type = Strong

Soil Type Coefficient (α*) = 0.04 cm^{-1}

Average Water Level Change (R_1) = 0.01 cm/s

Steady Intake Water Rate (Q_1) = 0.05 cm^3/s

Shape factor for H_1/a = (C_1) = 1.80 -

Field Saturated Hydraulic Conductivity (K_{fs}):

K_{fs} = 2E-05 cm/s

K_{fs} corrected to 4°C ('freshet') [1]= 2E-05 cm/s

K_{fs} corrected to 24°C ('summer') [1]= 4E-05 cm/s

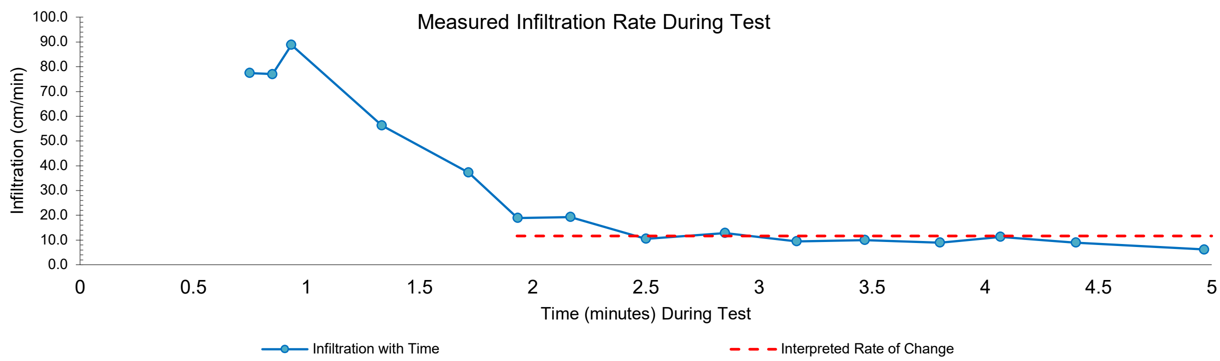
Date of Field Measurements: 16-Nov-23
Field Representative: EB
Reviewed: ZK
Reviewed: ZK

[1] (Streeter and Wylie, 1975)
[1] (Reynolds, 2008 and 2015)

Constant Head Well Permeameter Test Report

TERRAPEX

Project:	Rohit Wateridge Village
Project Number:	CO947
Location Name	Inf 6-3
Approximate Location:	450119.334 easting (metres)
	5033599.579 northing (metres)
Approximate Depth Tested:	1.5 mbg
	85.3 masl



Field Measurements:

Elapsed Time (min)	Water Level (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.58	85.1	-	-
0.75	98	12.90	77.40
0.85	105.7	7.70	77.00
0.93	113.1	7.40	88.80
1.33	135.6	22.50	56.25
1.72	149.9	14.30	37.30
1.93	154	4.10	18.92
2.17	158.5	4.50	19.29
2.50	162	3.50	10.50
2.85	166.5	4.50	12.86
3.17	169.5	3.00	9.47
3.47	172.5	3.00	10.00
3.80	175.5	3.00	9.00
4.07	178.5	3.00	11.25
4.40	181.5	3.00	9.00
4.97	185	3.50	6.18

Soil Description

moist sandy silty clay

Test Conditions:

Instrument: 1" stainless steel Solinst Drivepoint Instrument

hole radius (a) = 2.54 cm

Water column height in hole (H_1) = 15.24 cm

Ambient Air Temperature at Testing = 4 °C

Interpretations:

Soil Capillary Type = Strong

Soil Type Coefficient (α*) = 0.04 cm^{-1}

Average Water Level Change (R_1) = 0.19 cm/s

Steady Intake Water Rate (Q_1) = 0.97 cm^3/s

Shape factor for H_1/a = (C_1) = 1.80 -

Field Saturated Hydraulic Conductivity (K_{fs}):

K_{fs} = 4E-04 cm/s

K_{fs} corrected to 4°C ('freshet') [1]= 4E-04 cm/s

K_{fs} corrected to 24°C ('summer') [1]= 8E-04 cm/s

Date of Field Measurements:	16-Nov-23
Field Representative:	EB
Reviewed:	ZK
Reviewed:	ZK

[1] (Streeter and Wylie, 1975)

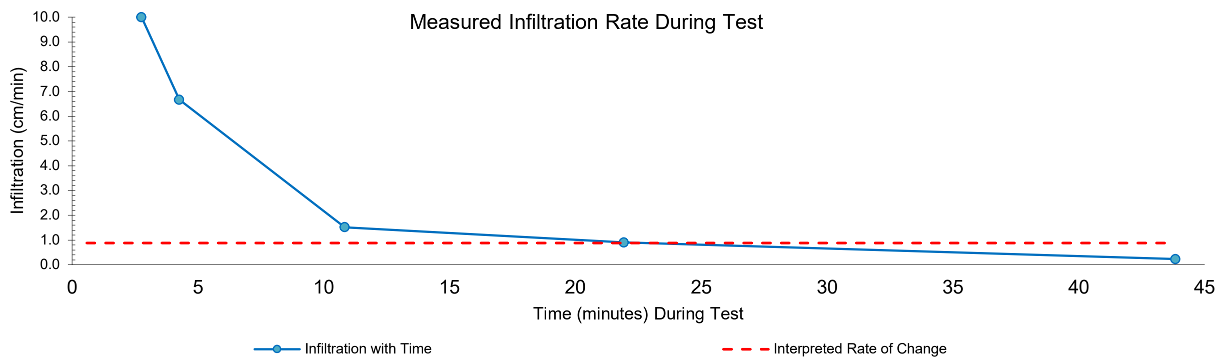
[1] (Reynolds, 2008 and 2015)

Constant Head Well Permeameter Test Report

TERRAPEX

Project:	Rohit Wateridge Village
Project Number:	CO947
Location Name	Inf 6-4
Approximate Location:	450132.294 easting (metres)
	5033578.57 northing (metres)
Approximate Depth Tested:	1.0 mbg
	84.5 masl

Measured Infiltration Rate During Test



Field Measurements:

Elapsed Time (min)	Water Level (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.00	33	-	-
0.17	43	10.00	60.00
0.33	63	20.00	120.00
0.42	83	20.00	240.00
0.58	93	10.00	60.00
0.75	103	10.00	60.00
0.83	113	10.00	120.00
1.00	123	10.00	60.00
1.25	133	10.00	40.00
1.75	143	10.00	20.00
2.75	153	10.00	10.00
4.25	163	10.00	6.67
10.83	173	10.00	1.52
21.92	183	10.00	0.90
43.83	188	5.00	0.23

Soil Description

moist sandy silty clay

Test Conditions:

Instrument: 1" stainless steel Solinst Drivepoint Instrument

hole radius (a) = 2.54 cm

Water column height in hole (H_1) = 15.24 cm

Ambient Air Temperature at Testing = 10 ^{o}C

Interpretations:

Soil Capillary Type = Strong

Soil Type Coefficient (α^*) = 0.04 cm^{-1}

Average Water Level Change (R_1) = 0.01 cm/s

Steady Intake Water Rate (Q_1) = 0.07 cm^3/s

Shape factor for H_1/a = (C_1) = 1.80 -

Field Saturated Hydraulic Conductivity (K_{fs}):

K_{fs} = 3E-05 cm/s

K_{fs} corrected to 4°C ('freshet') [1]= 3E-05 cm/s

K_{fs} corrected to 24°C ('summer') [1]= 5E-05 cm/s

Date of Field Measurements: 16-Nov-23

Field Representative: EB

Reviewed: ZK

Reviewed: ZK

[1] (Streeter and Wylie, 1975)

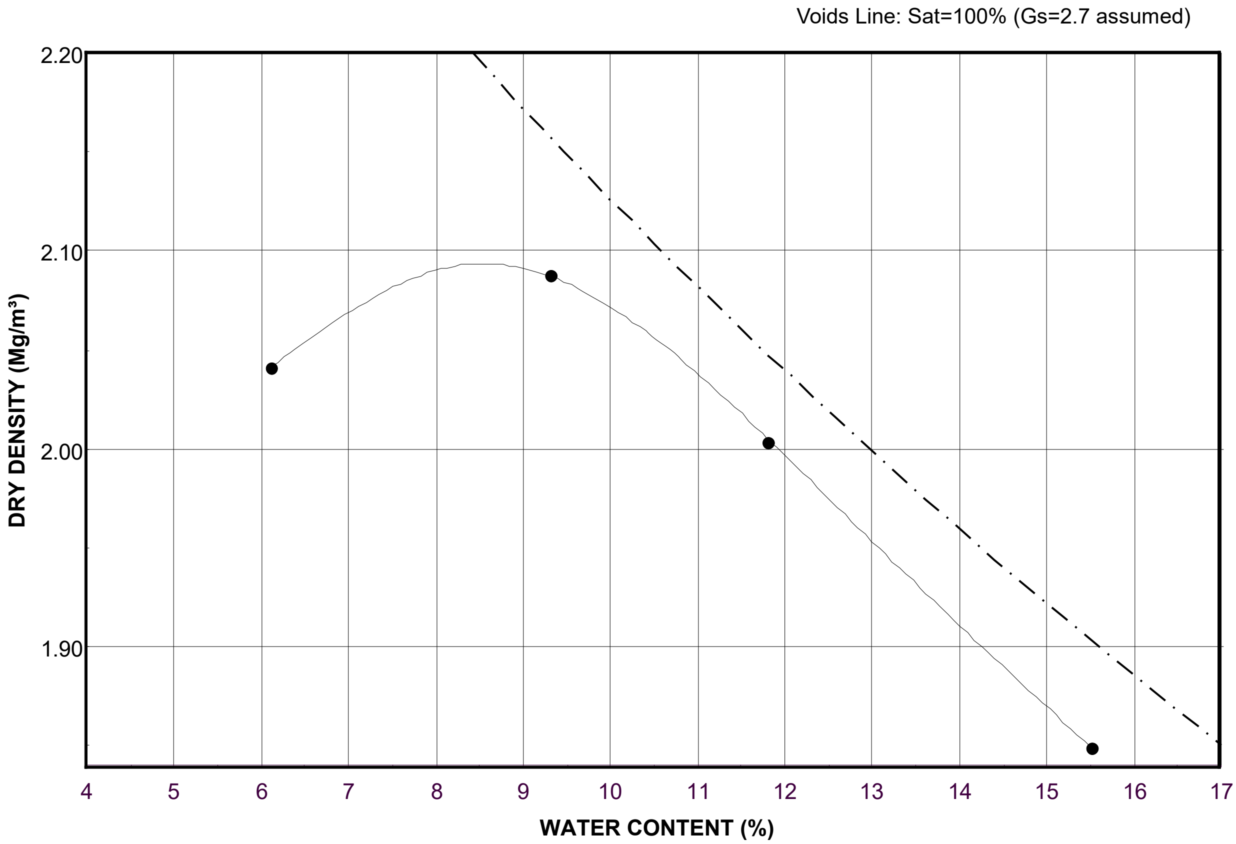
[1] (Reynolds, 2008 and 2015)

APPENDIX F

California Bearing Ratio Test Results

LABORATORY COMPACTION TEST
ASTM D698 Method C

FIGURE



Standard
Proctor Test Results

Sample:
INF 6-1

Max Dry Density:
2.091 Mg/m³

Optimum Water
Content: 8.5%

Natural Water
Content: N/A

Project Number: CA0011941.3280 (3000)
Checked By: AH

WSP Canada Inc.

LABID: 23-998
Date: 19-Dec-23

CALIFORNIA BEARING RATIO TEST (CBR) ASTM D1883

PROJECT NUMBER	CA0011941.3280(3000)	SAMPLE NUMBER	INF6-1
PROJECT NAME	Terrapex/Lab Testing/Miss.	SAMPLE DEPTH (m)	-
BOREHOLE NUMBER	-	DATE	12/15/2023

TEST INFORMATION

STRAIN RATE, mm/min	1.27	PARTICLE SIZE, mm	<19
RAM AREA, cm^2	19.44	COMPACTION	ASTM D698 Method C
LOAD CELL NUMBER	234341	NUMBER OF LAYERS	3
SURCHARGE, kg	4.54	BLOWS PER LAYER	56
SOAKING TIME, hr	92.2	RELATIVE COMPACTION, %	99

SAMPLE INFORMATION

	UNSOAKED	*SOAKED*		*UNSOAKED*	*SOAKED*
SAMPLE HEIGHT, cm	11.63	11.88	DRY WEIGHT, g	4413.21	4413.21
SAMPLE DIAMETER, cm	15.22	15.22	WATER CONTENT, %	8.59	9.71
SAMPLE AREA, cm^2	181.94	181.94	UNIT WEIGHT, kN/m^3	22.20	21.96
SAMPLE VOLUME, cc	2115.92	2161.59	DRY UNIT WT., kN/m^3	20.45	20.01
WET WEIGHT, g	4792.30	4841.60			

PENETRATION

UNSOAKED			SOAKED		
Penetration (mm)	Load (kgf)	Bearing Stress (MPa)	Penetration (mm)	Load (kgf)	Bearing Stress (MPa)
0.0	-	0.00	0.0	0.00	0.00
0.5	-	0.00	0.5	7.81	0.04
1.0	-	0.00	1.0	30.78	0.16
1.5	-	0.00	1.5	73.51	0.37
2.0	-	0.00	2.0	110.73	0.56
2.5	-	0.00	**2.5**	**151.63**	0.76
3.0	-	0.00	3.0	193.90	0.98
3.5	-	0.00	3.5	240.76	1.21
4.0	-	0.00	4.0	287.63	1.45
4.5	-	0.00	4.5	348.28	1.76
5.0	-	0.00	**5.0**	**398.37**	2.01
5.5	-	0.00	5.5	449.37	2.27
6.0	-	0.00	6.0	501.29	2.53
6.5	-	0.00	6.5	551.83	2.78
7.0	-	0.00	7.0	600.99	3.03
7.5	-	0.00	7.5	653.38	3.30
8.0	-	0.00	8.0	704.84	3.56
8.5	-	0.00	8.5	754.00	3.80
9.0	-	0.00	9.0	809.14	4.08
9.5	-	0.00	9.5	871.63	4.40
10.0	-	0.00	10.0	918.95	4.64
10.5	-	0.00	10.5	965.82	4.87
11.0	-	0.00	11.0	1015.90	5.13
11.5	-	0.00	11.5	1058.63	5.34
12.0	-	0.00	12.0	1107.80	5.59
12.5	-	0.00	12.5	1138.12	5.74
13.0	-	0.00	13.0	1180.40	5.95

TEST RESULTS

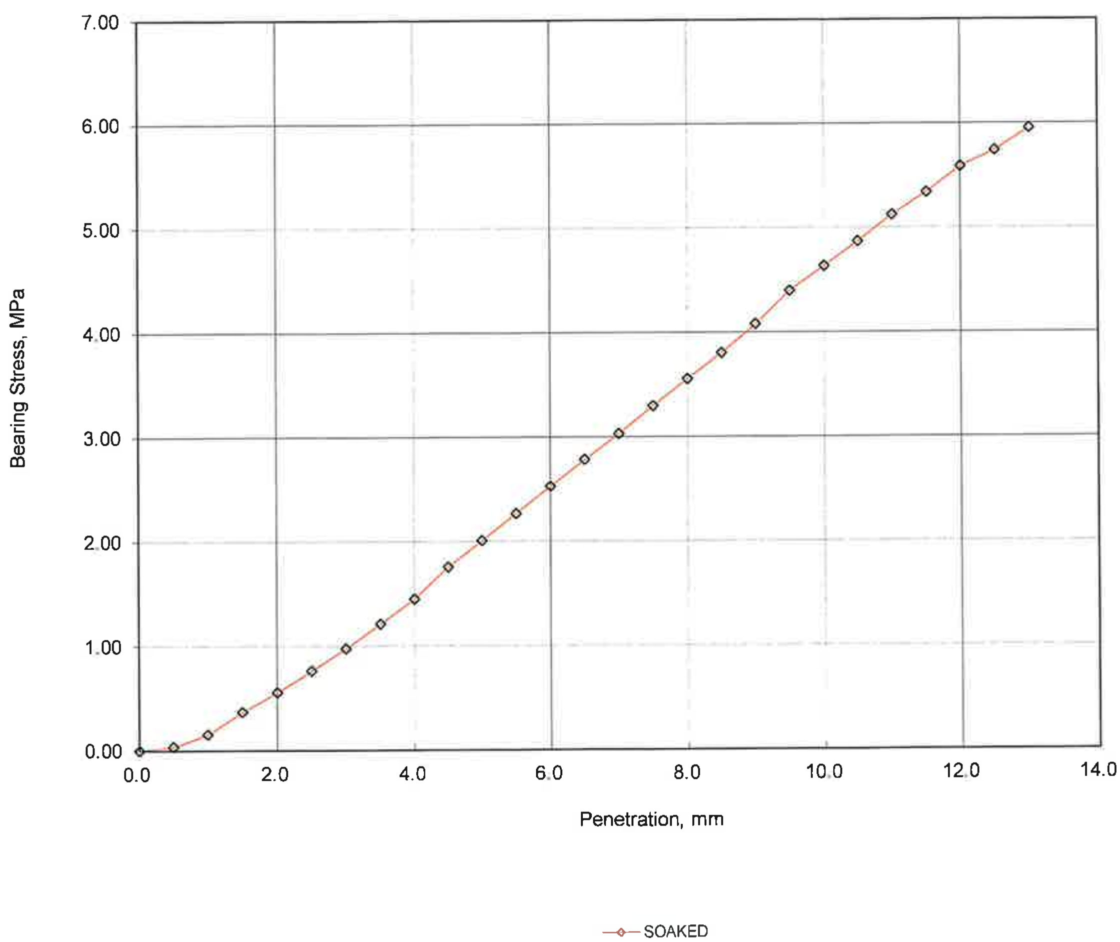
	SOAKED
WATER CONTENT AT PENETRATION POINT, %	10.03
SWELL, %	2.16
CORRECTED STRESS VALUE (at 2.5 mm), MPa	1.10
CORRECTED STRESS VALUE (at 5.0 mm), MPa	2.45
BEARING RATIO (at 2.5 mm), %	***15.94***
BEARING RATIO (at 5.0 mm), %	***23.79***

Checked By: AH

WSP CANADA INC

CALIFORNIA BEARING RATIO TEST (CBR)

Sample INF6-1
California Bearing Ratio Test - ASTM D1883



Project No.CA-0011941.3280(3000)

WSP Canada Inc.

Checked By: AH